Lakes and Estuaries Reconsidered: A Comment on Lacustrine Resource Intensification in the Southern Santa Clara Valley, California

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The relative value of lacustrine resources to hunter-gatherers, while debated contentiously among Great Basin archaeologists for nearly three decades, has been largely ignored in California until recent efforts by Hartzell (1992), Basgall (1993), Hildebrandt and Mikkelsen (1993), and Hildebrandt (1997 [this volume]). In the Great Basin and arid southeastern California, the debate has focused on the value of lakes relative to desert scrub and other xeric environments.

In his article, *The Relative Importance of Lacustrine and Estuarine Resources to Prehistoric Hunter-Gatherer Populations: A View from Southern Santa Clara Valley, California* (this volume), William Hildebrandt evaluated lakes relative to coastal estuaries, and challenged a statement I made in 1991 that estuaries and lakes harbor equally valuable resource assemblages, both of which would have been attractive to the earliest human colonists of California. While he acknowledged significant variability among lakes and the use of lacustrine resources throughout the southern Santa Clara Valley occupational sequence, Hildebrandt argued that the Elkhorn Slough estuary provided a superior resource base for the early inhabitants of central California, and that lacustrine foods were mostly relied upon as foci of Late Period subsistence intensification. He further suggested that estuaries like Elkhorn Slough were important sources of winter foods, and used data from five archaeological sites to project a sequence of progressive lacustrine intensification over the last 4,200 years (i.e., from the Early Period [4,200 to 2,500 B.P.], through the Middle Period [2,500 to 1,000 B.P.], and into the Late Period [post-1,000 B.P.]. Early peoples are thought to have largely ignored lacustrine resources, but during the Late Period, these foods were exploited heavily after access to Elkhorn Slough was cut off to interior peoples due to population circumscription.

In an area like the Santa Clara Valley, long characterized by undirected, atheoretical data collection, Hildebrandt's research, as presented in his article and the technical report which preceded it (Hildebrandt and Mikkelson 1993) stands out as an unequivocally important contribution, and he deserves considerable praise for bringing a meaningful body of data to bear on an interesting, if not significant, anthropological issue. To further thought and debate on the topics of lacustrine/estuarine resource value and seasonality, however, I would like to offer an alternative perspective on recent archaeological findings from the southern Santa Clara Valley and central Monterey Bay area, and raise issues related to lacustrine intensification and the seasonal resource value of estuaries. My primary points are that paleoenvironmental causes for apparent transitions are not considered in Hildebrandt's model, and that estuaries like Elkhorn Slough were most important not for their winter foods, but for their summer fisheries. To make these points, I reinterpret the relatively shallow cultural chronology employed by Hildebrandt and Mikkelson (1993) in the southern Santa Clara Valley, raise some concerns about sampling strategies appropriate for the characterization of wetland adaptations, and question whether the vertebrate faunal data reported by Hildebrandt truly reflect lacustrine intensification.

AN ALTERNATIVE PERSPECTIVE ON THE GILROY CULTURAL CHRONOLOGY

The five sites discussed by Hildebrandt (1997) were among 14 investigated in anticipation of the realignment of Highways 101 and 152 in the vi-

cinity of Gilroy, in southern Santa Clara County. The highway construction is commonly referred to as the Gilroy Project, and this designation is, for simplicity's sake, retained here. The chronological placement of the components at Gilroy was accomplished through the use of a fairly extensive suite of chronometric data, including 24 radiocarbon dates and 285 obsidian hydration and source pairings. Based on these data, Hildebrandt and Mikkelson (1993) concluded that the Gilroy occupations extended back only 4,200 years ago. This assessment is critical to Hildebrandt's model of lacustrine intensification, in that it establishes the temporal framework for comparison with Elkhorn Slough, the nearest coastal estuary. Taken at face value, this sequence posits an unusually shallow time depth for the region, especially in comparison with the Monterey Bay area, where there are no fewer than five sites which date ca. 6,000 to 5,000 B.C. (CA-MNT-228, -229, -234, -1570, and CA-SCR-177), and dozens which show evidence for occupation ca. 3,000 B.C. (see Breschini et al. 1992). I suggest, however, that an alternative interpretation of the Gilroy obsidian hydration data reveals a longer chronology, with the oldest site component marking a lacustrine habitation.

Local approaches to interpretation of hydration results are presently divergent, if not polarized. Following Dietz et al. (1988) and Bouey and Basgall (1991), among others, Hildebrandt and Mikkelsen (1993) used a local effective hydration temperature (EHT) value to convert hydration bands into calendric dates. Although two different dating schemes were used in the technical report (see Hildebrandt and Mikkelsen 1993: 110, 183), most interpretations were based on locally specific formulae for the commonly occurring obsidians: Napa, Annadel, Coso, Bodie, and Casa Diablo. These conversion formulae are based on research completed by others, and little, if any, attempt was made to re-evaluate the resulting chronology, despite only 43% correspondence between radiocarbon and obsidian hydration chronologies (Hildebrandt and Mikkelsen 1993:108), as well as problems with the conversion formulae as applied in other geographic areas. Bouey and Basgall (1991:56), for example, employed this approach at Piedras Blancas on the coast of San Luis Obispo County, but reported only limited success.

Jones and Jones (1992) and Jones and Waugh (1995:34-39) raised serious questions about the legitimacy of calendric dates based on obsidian hydration readings, contending that the development of hydration rinds is subject to more variables than can possibly be controlled with regional EHT corrections. Microclimate in the immediate vicinity of the obsidian specimen controls band development, and regionally based EHTs do not reflect microclimatic variability. Furthermore, the hydration environment changes through time, as specimens move between surface and subsurface contexts. Broad-scale climatic changes are also not accounted for in linear/logarithmic hydration conversion formulae. The hydration formulae employed by Hildebrandt and Mikkelsen (1993) also ignored important results of induced hydration studies, which illuminate intersource relationships. Based on such experiments, Tremaine and Fredrickson (1988) and Tremaine (1989, 1991) found that Napa, Casa Diablo, and Bodie obsidians all hydrate at the same rate. Similarity in distribution frequencies further suggests that Coso obsidian develops hydration bands at nearly the same rate (Jones et al. 1994:185; Jones and Waugh 1995:131), although this conclusion has not been tested by induced hydration. The formulae employed by Hildebrandt and Mikkelsen (1993) posit vastly different hydration rates for these obsidians (particularly Napa, Casa Diablo, and Coso), while the Jones and Waugh (1995) chronology is more consistent with the induced hydration studies.

Application of the Jones and Waugh (1995) hydration spans to the combined Gilroy obsidian data suggests that the occupation sequence began during the Milling Stone Horizon (6,500 to 3,500

B.C.), which is more consistent with regional patterns. Half of the readings suggesting this time depth came from one site: CA-SCL-119/SBN-24/H on Lake San Felipe. While a total of only 12 readings marks this period, interregional exchange was clearly not well established in California at this time depth, and large obsidian samples cannot be expected in areas that are far from obsidian sources, such as the southern Santa Clara Valley. At the Scotts Valley site in Santa Cruz County, for example, fewer than 12 readings correlate with an unequivocal Early Holocene occupation, but over 200 $m.^3$ of deposit were required to obtain this small sample (Cartier 1993). Reinterpretation of the Gilroy obsidian indicates a longer human chronology, in which a lakeside setting was favored by the earliest local inhabitants. This conforms with the previously identified overrepresentation of lacustrine and estuarine settings among the earliest sites in the region, which suggests that these habitats were preferred by initial human colonists (Jones 1991; Jones and Jones 1992). Terrestrial settings do not show temporal priority over lacustrine sites in the regional settlement chronology.

PALEOENVIRONMENTAL CONSIDERATIONS

The apparent complexity of past hydrographic events along this portion of the central California coast cannot be overestimated, but as Hildebrandt's review of local studies showed, there is no Holocene paleoenvironmental reconstruction for the southern Santa Clara Valley. In the absence of such studies, Hildebrandt downplayed the presence of lakes in the southern Santa Clara Valley, and developed a model in which diachronic environmental variability plays no significant role. He described the setting of CA-SCL-178, for example, as adjacent to the "seasonally marshy bottomlands of La Laguna Seca" (p. 201). Description of this location as a dry lake by early Spanish explorers suggests more than a seasonally marshy bottomland, but there are no paleoenvironmental data that indicate the nature of the actual conditions, either those observed historically or those which may have existed previously.

Sites in the western portion of the Gilroy project area were also described as nonlacustrine, but it is entirely possible that San Felipe Lake extended across the valley along the 150-ft. contour during the past. Between present-day San Felipe Lake (waterline 138 ft.) and the western edge of the southern Santa Clara Valley lies the *Llano del Tequiquista,* or "potash plain." These potash deposits were exploited historically for soap and other products. The California Division of Mines and Geology (1984:7) described two origins for potash: "(1) crystalline deposits of saline rocks of marine origin . . ., and (2) concentrated brines from wells or in relict lakes and lacustrine sediments of continental origin in arid regions." While Hildebrandt attributed these deposits strictly to artesian wells, it is equally possible that the *Llano del Tequiquista* marks a former lake with a shoreline between 140 and 155 ft.

These deposits were readily visible to early Spanish explorers, suggesting that the disappearance of the lake was not too far in the distant past. The extent and chronology of this event have not yet been defined, but CA-SCL-698 and CA-SCL-577 would have been situated on the 150 ft. shoreline. These sites produced notable quantities of freshwater mussel shell (Hildebrandt and Mikkelsen 1993:125) in their Early and Middle period components. Both were also apparently abandoned at the end of the Middle Period, when the lake probably receded to its present 138-ft. shoreline at San Felipe Lake. A recession at the end of the Middle Period is consistent with the onset of the Medieval Warm Period (ca. A.D. 850 to 1400), when serious droughts occurred throughout central California (Graumlich 1993; Stine 1994). CA-MNT-228, -229, -234, and -1570 at Elkhorn Slough all were abandoned

during this interval, suggesting that the Medieval Warm Period had impacts on central Monterey Bay estuaries as well. While this interpretation is conjectural in the absence of a local paleoenvironmental sequence, it is no more so than that of Hildebrandt, who posited strict population-driven subsistence intensification with no reference to environmental change.

The need to consider paleoenvironmental variability is more acute at Elkhorn Slough, where the pollen record shows significant changes in the vitality of the marine ecosystem over time. Of particular import is an intrusion of freshwater taxa in the local pollen rain during the Early Period. This intrusion was first recognized by West (1988) and it was originally dated to about 1,895 B.C. by a single radiocarbon assay. Newly reported dates establish the beginning of this apparent freshwater event ca. 3,040 B.C. (Jones and Waugh 1997).

Most sites excavated in the Elkhorn Slough locality (CA-MNT-228, -229, -234, -414, and -1570) show evidence for an occupational hiatus coeval with this freshwater event, and it is fairly clear that the slough's outlet to the Pacific Ocean was cut off during this period, effecting a significant deterioration in the marine environment. The co-occurrence of estuarine shellfish and freshwater fish remains at Elkhorn Slough sites CA-MNT-228 and -229 dates intervals before and after this hiatus (ca. 6,200 to 4,000 B.C. and 1,000 B.C. to A.D. 1000) during which the Salinas and/or Pajaro rivers joined the slough with the Pacific Ocean, and a rich estuarine habitat was present. Radiocarbon dated *Mytilus* shells from CA-SCL-577/H and -698 in the Gilroy area suggest that the second event may have begun as early as ca. 1,800 B.C. (Hildebrandt and Mikkelsen 1993:75), but it is not certain whether these shells originated at Elkhorn Slough. The importance of the paleoenvironmental record is its indication that Elkhorn Slough was stagnant and nonproductive during much of the Early Period, when Hildebrandt argued that it was a favored resource base for peoples of the southern Santa Clara Valley.

SAMPLING STRATEGIES AND CHARACTERIZATION OF WETLAND ADAPTATIONS

Hildebrandt's model of lacustrine intensification is largely based on faunal remains, and to evaluate its interpretive success, it is necessary to make some comments on sampling strategies, particularly those used to collect the faunal constituents most associated with lacustrine and estuarine habitats, that being shellfish and fish remains. Because these remains are small and relatively fragile, they require fine-grained, controlled recovery techniques; coarse methods can lead to misinterpretation. For example, fish are the most significant dietary constituent at Elkhorn Slough, but this fact only became evident with the use of three mm. (1/8-in. mesh) water screening and laboratory sorting, as reported from CA-MNT-228 (Jones et al. 1996), and CA-MNT-234 (Breschini and Haversat 1995). At CA-MNT-228, a total of 10 $m.^3$ of deposit screened with six mm. mesh yielded only 20 fish bones, and only 39 fish (number of identified specimens [NISP]) were recovered from 20.6 $m.^3$ of deposit dry-screened with three mm. mesh (Jones et al. 1996). On the other hand, a single 1 x 1 $m.^3$ unit from this same site, water-processed through three mm. mesh and laboratory sorted, yielded 3,416 NISP. Shellfish assemblages are likewise misrepresented by large mesh screens. Mussel shells are much more fragile than clams, and are often significantly underrepresented in six mm. residues. Furthermore, bias from screen size is not uniform from site to site. A fish assemblage that includes small species (e.g., anchovies) will be completely misrepresented in six mm. samples, but assemblages lacking diminutive taxa are less distorted (see Gobalet 1989).

Minimal application of fine-grained recovery techniques during the Gilroy project raises ques-

tions about the subsistence inferences drawn from the faunal remains. Emphasis on larger mesh was appropriate for the management context in which the sites were investigated (i.e., site evaluation), but the resulting faunal inventories are nonetheless subject to question. Invertebrate remains, analyzed exclusively from six mm. samples, are undoubtedly misrepresented in dietary calculations. Freshwater shells, in particular, are highly fragile, and are unlikely to survive for long periods of time as large fragments. Their increasing presence through time in the Gilroy samples probably reflects their poor preservation qualities. Fish bones are also probably underrepresented in the Gilroy collections, as only 8.8 $m.^3$ were screened with three mm. mesh, and no water screening was completed.

Because of this disregard for small mesh samples, and consequent underappreciation of fish as a resource, Hildebrandt and Mikkelsen (1993) misrepresented the subsistence values and seasonal implications of central coast wetlands. In particular, they suggested that Elkhorn Slough was important as a winter resource, but a growing body of data indicate that its resource value lies in its summer fisheries. Contemporary studies of Elkhorn Slough (Yoklavich et al. 1991) indicate that Elkhorn Slough harbors its greatest numbers and highest variety of fish in the summer when spawning migrants enter the system. Abundant fish remains and otoliths from CA-MNT-228 (Huddleson 1996) indicate that occupation of slough sites corresponded with the seasonal peak in fish populations. A similar occupation pattern was identified at Morro Bay (Jones et al. 1994). The relatively depauperate stone tool assemblages at both CA-MNT-228 and -229, are deceptive in their lack of obvious fishing paraphernalia (e.g., fishhooks). Fishing at the slough would not have involved hooks and lines, but instead was probably accomplished with traps, nets, and/or baskets, which do not preserve well archaeologically. Shell hooks are associated with fishing on rocky shores (Strudwick 1986).

RECONSIDERING THE GILROY FAUNA

The case for lacustrine intensification at Gilroy is also based on mammal and bird remains which ostensibly show increased presence of lacustrine taxa through time. Early Period components are dominated by terrestrial taxa (i.e., rabbits), but this conclusion is reached only by lumping together data from two discrete components (CA-SCL-698 and CA-SCL-119/SBN-24/H). Individually, these components show different trends: the Early Period at CA-SCL-119/SBN-24/H (San Felipe Lake) is dominated by waterfowl (NISP = 20) and deer (NISP = 12), while the early component at CA-SCL-698 shows rabbit (NISP = 11), carnivores (NISP = 3), and terrestrial birds (NISP = 3) (Hildebrandt and Mikkelsen 1993:125-130, Appendix A). When lumped, the composite trend shows a terrestrial emphasis, but this is only a reflection of the sample size of the individual components; it is not an indication of an overall focus on terrestrial taxa.

With respect to subsistence intensification, the most important consideration in zooarchaeological assemblages is the relative importance of animals that can yield more calories with the application of new technologies or the addition of processing labor. Large animals, such as tule elk (available in lacustrine and estuarine settings), deer, and large carnivores (available in terrestrial settings), are not generally compatible with these criteria. Only their frequency relative to smaller, labor-intensive taxa is significant. In central California wetland habitats, such resources are limited to fish and waterfowl. Shellfish, although posited by Hildebrandt as a focus of intensified lacustrine subsistence, are strictly limited in their dietary potential, due to the restricted nature of their colonies (Jones and Richman 1995).

Among animals that could sustain an intensified economy, fish were probably important at both Elkhorn Slough and the southern Santa

Clara Valley. When the system was open to the sea, Elkhorn Slough probably provided a superior fish habitat, owing to the influx of seasonal migrants, but the value of such fisheries would only be realized under conditions of intensive subsistence. It is possible that technologically simple fishing techniques may have been more fruitful at the slough than at inland lakes. Waterfowl habitat was probably equally good in both settings. Overall, there is no reason to believe that lacustrine resources, as a group, are distinct from or inferior to those of estuaries, and there is little in the lacustrine environment, besides fish, that would sustain an intensified subsistence economy.

SUMMARY AND DISCUSSION

The concept of subsistence intensification has much to offer to interpretations of hunter-gatherer subsistence in prehistoric California. It seems fairly clear that the high population density of native California was sustained by heavy reliance on small, labor-intensive resources, and intensification models have provided effective explanations for diachronic subsistence variability in many regions, including the North Coast Range (Basgall 1987) and the Mojave Desert (Basgall and Hall 1992). Powerful as these models may be, they do not provide a mandate to overlook environmental context, as some types of environmental events would have effected major alterations to the richness and configuration of habitats and their constituent resources. Such variability over time makes it difficult, if not impossible, to establish a strict optimization ranking of habitats. Estuaries, for example, provide rich resource bases when they are open to the sea, but when tidal inlets are shut off, they become stagnant and unattractive for human settlement. Likewise, lacustrine settings change significantly through time in response to altered drainage patterns and variation in rainfall. Hildebrandt's model of population-driven subsistence intensification in the southern Santa Clara Valley will achieve enhanced credibility only when it incorporates such contextual variables.

Evaluation of wetland adaptations, intensive or otherwise, further requires strict attention to recovery techniques, especially for the small constituents (fish and shellfish) that make these environments unique. Due to their fragile nature, the frequency of these remains through time can mimic the pattern anticipated by an increasingly intensive economy. Results of fine-grained recovery strategies indicate that fish were probably the most important focus of subsistence through time in central coast estuaries, and their exploitation would have taken place in the summer, when the fishery was the richest.

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Late Holocene Use of Wetland Habitats in Central California: A Reply to Jones

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In this volume, Terry Jones (1997) provided a thorough critique of my summary (also in this volume [Hildebrandt 1977a]) of prehistoric hunter-gatherer adaptations in the southern Santa Clara Valley, California (also see Hildebrandt and Mikkelsen 1993). His review identified a variety of issues that warrant additional consideration, particularly those pertaining to settlement chronology, paleoenvironmental change, and Late Holocene subsistence intensification. I appreciate his comments, as my attempts to address them will hopefully improve our understanding of wetland adaptations in central California and beyond.

Analysis of archaeological data from five habitation sites in the southern Santa Clara Valley revealed an occupational sequence characterized by a progressive increase in the use of lacustrine resources over the last 4,200 years. The earliest components (4,200 to 2,500 B.P.) contained significant quantities of estuary shellfish obtained from Elkhorn Slough (located 20 to 26 km. to the west), but only limited amounts of resources from nearby San Felipe Lake and its associated wetlands. Based on these findings, it was inferred that Elkhorn Slough was a preferred resource area and represented a major component of the subsistence-settlement system in use at that time (Hildebrandt 1997a). During both the Middle (2,500 to 850 B.P.) and Late (post-850 B.P.) periods, evidence for the use of Elkhorn Slough progressively decreased, and local peoples intensified the exploitation of wetland resources obtained from the San Felipe Lake area (e.g., freshwater mussel, waterfowl, fish, turtles, *Scirpus* seeds). Based on this shift in subsistence focus, it was argued that access to Elkhorn Slough was cut off by increased population densities and social circumscription, resulting in a more intensive use of the local resource base.

Jones's (1997) review of this model raises several questions regarding the actual antiquity of wetland resource use, the influence of paleoenvironmental change on local adaptions, and the reliability of archaeological patterns produced by the original study of Hildebrandt and Mikkelsen (1993). As will be discussed in more detail be-