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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 hun-

ter-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 adaptations, and the reliability of archaeological patterns produced by the original study of Hildebrandt and Mikkelsen (1993). As will be discussed in more detail be-

low, Jones's (1997) views on settlement chronology and paleoenvironment change are quite useful, and help to improve the accuracy and value of the southern Santa Clara Valley model. His concerns about the reliability of the archaeological patterns produced by Hildebrandt and Mikkelsen (1993) are more difficult to understand, as these patterns seem quite solid and are replicated in other parts of the state. Hopefully, my review of these data will convince Jones and other students of California prehistory that a process of lacustrine resource intensification did occur during the last 3,000 or 4,000 years.

### CHRONOLOGICAL ISSUES

Two major chronological issues were identified by Jones, one focused on obsidian hydration and the other on settlement chronology in the southern Santa Clara Valley. Excavations by Hildebrandt and Mikkelsen (1993) recovered small amounts of obsidian debitage originating from the Napa, Casa Diablo, and Coso source areas. Because none of the domestic structures, processing features, burials, or single-component strata produced large numbers of hydration readings, Hildebrandt and Mikkelsen (1993) relied almost entirely on site structure and 24 radiocarbon dates to establish temporal components for the project sites. Obsidian hydration data, although considered a secondary source of chronological information, were interpreted using effective hydration temperature (EHT) corrections and rate formulae developed by Origer (1982) for Napa, Hall and Jackson (1989) for Casa Diablo, and Basgall (1990) for Coso. Their analyses indicate that all three source groups hydrate at different rates and, therefore, their raw hydration values are not directly comparable.

Jones (1997) put forth an entirely different perspective based on the analysis of several obsidian assemblages obtained along the central California coast (see also Jones and Waugh 1995). He argued that all three glasses hydrate at similar rates and, therefore, application of the

Origer (1982), Hall and Jackson (1989), and Basgall (1990) rate formulae is not appropriate because they add undue complexity and confusion to a record that is better off left alone. Jones supported this argument for Napa and Casa Diablo obsidians based on induced hydration studies by Tremaine (1990), but provided little compelling evidence for obsidian from the Coso Volcanic Field. While Jones's approach to the analysis of Napa and Casa Diablo obsidians is a reasonable alternative, particularly given Tremaine's (1990) results, I cannot buy his argument for Coso. Analysis of temporally diagnostic projectile points in areas where Coso and Casa Diablo obsidian co-occurs (e.g., Owens Valley) indicates that Coso hydrates at a rate that is significantly faster than Casa Diablo. Moreover, when the two obsidians are found in the same domestic structures, Casa Diablo artifacts consistently produce thinner rim values than those made from Coso obsidian (Basgall and McGuire 1988). These relationships encountered in Owens Valley are important and should be considered by archaeologists working along the central California coast (see also Hildebrandt 1997b).

The second chronological issue involves the antiquity of occupation in the southern Santa Clara Valley. Jones noted that there is a number of obsidian hydration readings in the Hildebrandt and Mikkelsen (1993) sample that probably represent Early Holocene (8,500 to 5,500 B.P.) use of the area. I agree with this assessment completely. It is important to note, however, that these early hydration readings represent less than 12% ( $n = 33$ ) of the five-site sample, and none could be tied to single-component assemblages (the earliest robust assemblages date to about 4,200 B.P.). Because 10 of the 33 early rim values were found at the San Felipe Lake site, Jones argued that the importance of lacustrine resource use during the Early Holocene may have been underestimated. I consider it an open question until we obtain better samples of material dating to this early period of time (see below).

### PALEOENVIRONMENTAL CONSIDERATIONS

Although Jones agreed that demographically based models of subsistence intensification offer powerful interpretations of prehistoric human adaptations in California (see Hildebrandt and Jones 1992; Jones and Hildebrandt 1995), he also correctly argued that they do not provide a mandate to overlook environmental changes that may have altered the richness and configuration of important habitats and their associated resources. Interpretations of the southern Santa Clara Valley data base have so far relied very little on paleoenvironmental reconstruction, and such analyses would improve the overall model. Jones attempted to solve this problem by suggesting that San Felipe Lake may have been much larger during the Early (4,200 to 2,500 B.P.) and Middle (2,500 to 850 B.P.) periods, creating a hypothetical association between the terrace sites and lacustrine habitats. This association would, by extension, indicate a greater interest in lacustrine resources than Hildebrandt and Mikkelsen (1993) originally thought. Jones also noted that the terrace sites were largely abandoned at the end of the Middle Period. This abandonment co-occurs with the onset of the Medieval Warm Period (ca. 1,100 to 550 B.P.), which could have caused a recession of the lake and explain the shift in settlement to the modern edge of San Felipe Lake. Several sites along the shores of Elkhorn Slough were also abandoned at this time and, according to Jones, could indicate that the slough was cut off from the ocean (due to decreased flows of freshwater), creating a stagnant, nonproductive habitat.

Jones's reconstructions help improve the paleoenvironmental context of the Hildebrandt and Mikkelsen (1993) study but result in minimal modification to their model of subsistence-settlement pattern change. Little or no change is necessary for the Early and Middle period parts of the model because the hypothetical expansion

of San Felipe Lake still had little effect on the overall adaptation—Early and Middle period components at the terrace sites lack good evidence for lacustrine resource use. Given these findings, it remains plausible that mobile peoples moved back and forth between Elkhorn Slough and the terrace sites, making maximum use of estuary foods and local terrestrial resources, but little or no use of the lacustrine resource base. The environmental history of Elkhorn Slough does come into play at the end of the Middle Period, as decreases in the consumption of its resources can now be attributed to the degradation of the slough habitat, rather than population circumscription. It is also possible that the Late Period shift to San Felipe Lake could reflect an overall decrease in the size of the lake. Despite these paleoenvironmental considerations, it is important to stress that the archaeological record still reflects a Late Period intensification in the use of lacustrine resources, probably due to the elimination of alternative resources like those previously available at Elkhorn Slough.

### ISSUES OF SUBSISTENCE INTENSIFICATION

Jones's (1997) comments regarding chronology and paleoenvironmental change are quite insightful and help identify some important gaps in the reconstruction of southern Santa Clara Valley prehistoric adaptations. His questioning of the subsistence trends generated by the Hildebrandt and Mikkelsen (1993) excavations are less compelling. Rather than accepting the multidimensional trends that clearly show a greater emphasis on the use of lacustrine resources over time, Jones argued that these patterns may simply be a function of taphonomy and inadequate sampling strategy. He suggests that because freshwater shellfish physically degrades over time, the collection of shellfish samples from 1/4-in. screens will underestimate their abundance in older deposits (i.e., a higher proportion of shell from early deposits will fall through 1/4-in. screens

than samples obtained from more recent contexts). He also noted that the abundance of vertebrate fish may also be underrepresented due to the use of 1/4-in. and 1/8-in. screens (as opposed to finer mesh), but did not argue that fish bone will differentially degrade over time to the same degree as shellfish.

Although Jones's call for more refined sampling is justified and would improve our ability to estimate the absolute contribution that particular taxa made to the prehistoric diet, he incorrectly infers that our approach to sampling creates false patterns in the relative proportion of resources used by prehistoric people through time. He could be correct about the taphonomic problems of *Anodonta* shell, but he does not consider trends generated by the more resistant wetland indicators from the San Felipe Lake site (e.g., waterfowl, fish, and turtles). When these data are included in the analysis, it is clear that all wetland taxa increase relative to terrestrial taxa over time (Hildebrandt 1997a:Table 5, Fig. 3). It is also important to note that the plant macrofossil data follow similar trends, particularly indicated by the relative increase in the abundance of *Scirpus* seeds over time.

Furthermore, if one accepts Jones's hypothesis that San Felipe Lake was much larger in the past, and both the terrace sites and the San Felipe Lake site were associated with wetland habitats, it is justifiable to combine all project data into a single chronological sequence (see Hildebrandt 1997a:Table 8, Fig. 4). This procedure clearly illustrates the strength of these trends, as the relationship between wetland taxa z-scores and time period produces a correlation coefficient of 0.91 (significant at the 0.001 level). These data show that there was a significant increase in the relative intensity of lacustrine resource use over time. This pattern is real, and cannot be dismissed on the basis of inadequate sampling strategy.

## DISCUSSION

The foregoing debate has not only improved our comprehension of local prehistoric adaptations in the southern Santa Clara Valley, it has also increased our ability to understand the general role of lacustrine and estuarine environments in the evolution of prehistoric adaptations in central California. Jones correctly noted that there was an Early Holocene presence of people adjacent to the shores of San Felipe Lake who probably used lacustrine resources to one degree or another. Whether the early use of San Felipe Lake was as intensive as that of Elkhorn Slough cannot be determined with the data at hand, but the limited amount of information we do have from CA-SCL-178 and Buena Vista Lake (Hartzell 1992; Hildebrandt 1997a) indicates that wetland habitats were probably used as part of a larger seasonal round and did not represent the limno-sedentary adaptation often attributed to the Western Pluvial Lakes Tradition (see Moratto 1984). Jones's review of the dynamic history of Elkhorn Slough is also important because the diminished use of this resource zone by interior peoples may not have resulted from social circumscription, but simply from the closing of the estuary and the degradation of its resource productivity.

Jones's call for improved consideration of environmental context and paleoenvironmental change also helped clarify some important differences in resource potential and prehistoric use of estuaries and lakes. First, estuaries often contain a greater abundance and diversity of resources than lakes. This can be illustrated by comparing archaeofaunas recovered from Elkhorn Slough (CA-MNT-229) to those found at the San Felipe Lake site (Dietz et al. 1988; Hildebrandt and Mikkelsen 1993). Elkhorn Slough produced multiple species of terrestrial mammal, marine mammal, freshwater fish, estuary fish, outer



coast fish, freshwater birds, marine birds, estuary shellfish, and outer coast shellfish, while San Felipe Lake yielded a more limited diversity of freshwater shellfish, fish, waterfowl, turtles, and terrestrial mammals. In addition to a higher degree of diversity, the Elkhorn Slough faunae include a greater number of large meat packages (e.g., harbor seal, sea otter) and large quantities of spawning fish that could be captured with a limited output of labor (Jones 1997).

A second, more important difference between the two habitats is that coastal settings (including estuaries and exposed shorelines) are less affected by paleoclimatic changes than lakes. This is evidenced by the widespread abandonment of most lacustrine areas in the western Great Basin during the Middle Holocene (Grayson 1993) simultaneous to the widespread occupation of coastal settings along the central and southern California coasts (Jones 1991). The question remains, however, whether the more xeric conditions of the Middle Holocene affected wetland areas in cismontane California. According to Hartzell (1992), lacustrine resources are essentially absent in Buena Vista Lake components dating between 7,400 and 4,000 B.P., probably due to the Middle Holocene desiccation of the lake.

It is probably not coincidental that the post-4,000 B.P. increase in archaeological visibility at Buena Vista Lake is replicated at Owens Lake, Stillwater Marsh, and San Felipe Lake, and could signal the beginning of climatic conditions more conducive to the development of wetland habitats. One might conclude, therefore, that Jones is correct in his assessment of the rough equivalence of lakes and estuaries during the Early Holocene. As the former habitats were depleted by expanding human populations and declining climatic conditions during the Middle Holocene, human groups maintained subsistence productivity by relying more on small seeds, small mammals, and a variety of coastal resources (e.g., shellfish), resulting in the wide-

spread emergence of the "Milling Stone Horizon" (see Jones 1991). Lacustrine resources may have been of minor importance until the Late Holocene, when effective moisture increased and hydrologic conditions improved. Use of most wetland areas did not reach maximum intensity right away, however, but gradually increased through time as increased population densities resulted in a greater dependence on the use of localized resources.

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