BACK WHEN HOUSTON RECYCLED: RESOURCE UTILIZATION PATTERNS IN THE UPPER GULF COASTAL PLAIN

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Introduction

Today, Houston has one of the lowest recycling rates among all major US cities. In a 2001 waste management study (NYC Department of Sanitation 2001), Houston's recycling rate for waste (excluding yard waste) ranked 26th out of 30 major U.S. Cities. Cheap landfill rates and the high expense of collection caused by the city's lack of zoning are cited in a 2008 *The New York Times* (Ellick 2008) study as contributing to the low value Houston places on conservation. Major initiatives like the city's new "One Bin for All" program aim to change this pattern, making the area a model for responsible resource use. However, while many will view Houston's new dedication to resource recycling as innovative and progressive, archaeologists, with our appreciation for the *longue durée*, view the approach as more retro. Indeed, for several millennia, residents of the greater Houston region were diligent and successful recyclers that expended considerable effort in extracting every last bit of utility out of material resources.

Perhaps the marked difference observed between present and past levels of material conservation throughout the Texas' Upper Gulf Coastal Plain is principally related to availability. Several critical resources were once less readily accessible and required more planning and energy to obtain. Group mobility may also be a factor as prehistoric peoples followed mobile lifeways, accumulating few material possessions. Today, our sedentary lives allow us to amass more material, and along with it, we generate more waste. This paper considers chipped-stone artifact data from a number of archaeological assemblages across southeast Texas in an attempt to better understand how Houston deviated from its early conservation ethic.

The Dimond Knoll Site (41HR796)

The recently excavated Dimond Knoll site provides one of the largest stone tool assemblages in the Houston area. Moore Archeological Consulting, Inc. (MAC) discovered the site in northwestern Harris in 1996 during TxDOT-sponsored investigations associated with the Grand Parkway project (Figure 1). The

Figure 1. Location of Dimond Knoll (41HR796) and other sites discussed in the text within Texas' Upper Gulf Coastal Zone.

low, sandy knoll is one of many similar knolls that once flanked Cypress Creek for much of its length. Data recovery investigations, sponsored by TxDOT, were conducted at Dimond Knoll from early May through late October 2012 by Coastal Environments, Inc. (CEI) and MAC.

Archeological investigations produced a wealth of important data relating to prehistoric diet, resource use, and technological transitions within the Upper Gulf Coastal Region, and the potential for more finely discerning patterns of group mobility and interaction through time appears high. While material analyses are presently in their incipient stages, preliminary findings based on the presence of chronologically-sensitive artifact types within the assemblage suggests that the site was visited regularly by mobile foraging groups for more than ten millennia.

Dimond Knoll in Context

Overall, 105.1m^3 of sediments were hand excavated. Additionally, approximately 275m^3 of sediments were taken off-site for screening by volunteer groups as part of TxDOT's public outreach program. Artifacts recovered in off-site screening have increased the available study sample, allowing for a more comprehensive trait analysis to be undertaken for various artifact classes including stone tools, prehistoric ceramics, and faunal bone. From the more than 900 bifacially chipped stone tools discovered through hand excavation and off-site screening, a sample of 600 dart points, arrow points, and knives was chosen for a preliminary study focused on resource use and material conservation (Barrett et al. 2014).

Dimond Knoll is situated within the San Jacinto River basin, a resource poor area with respect to tool-quality lithic resources. The San Jacinto River and its tributaries, including Cypress Creek, carry few gravels exploitable for tool construction as there are no major chert-bearing formations within the drainage basin. The most common siliceous stone found within the San Jacinto River Basin with utility for tool manufacture is petrified wood emanating from the Miocene Fleming and Pliocene Willis Formations (Banks 1990). However, the petrified wood is generally of a poor, platy quality, and typically available only in small package sizes. Higher quality stone, including cherts, chalcedonies, and petrified woods with a more cryptocrystalline structure, can be found among channel gravel deposits within the Brazos, Colorado, and Trinity drainages and were well represented among the tools found at Dimond Knoll. Nevertheless, none of these source areas offer exploitable deposits within Dimond Knoll's immediate catchment, however generously defined.

Archaeological Measures of Material Conservation

Given that the availability of tool-quality lithic resources is notably poor in the site's immediate environs, which is true in a more general sense throughout much of the Upper Gulf Coast, high levels of material conservation should be expected. Evidence of material conservation may be expressed through a variety of traits observable within the chipped-stone artifact assemblage. For example, resharpening is the most basic form of material conservation, and is observed fairly ubiquitously among stone-tool using cultures, regardless of resource availability. This maintenance activity generally takes the form of pressure-flake removals along the blade edge, often resulting in removal of previously developed polish along the lateral margin, a more steeply beveled, less acute edge angle, and the distal portion of the blade becoming disproportionately thin in proportion to the midsection when viewed from the side (Figure 2). Resharpening primarily affects the overall length and width of the blade; thickness of the tool is affected to a much lesser degree, if at all.

The metric transformations that occur over the use-life of a projectile point through material attrition have a distinct effect on the effectiveness of the tool (Wilhelmsen 2001). This is particularly true of dart points as the higher velocity achieved in arrow delivery can compensate for many of the negative design effects resulting from curation (Tomka 2013). Two primary changes occur in dart points over their use-life that directly affects their functionality as effective

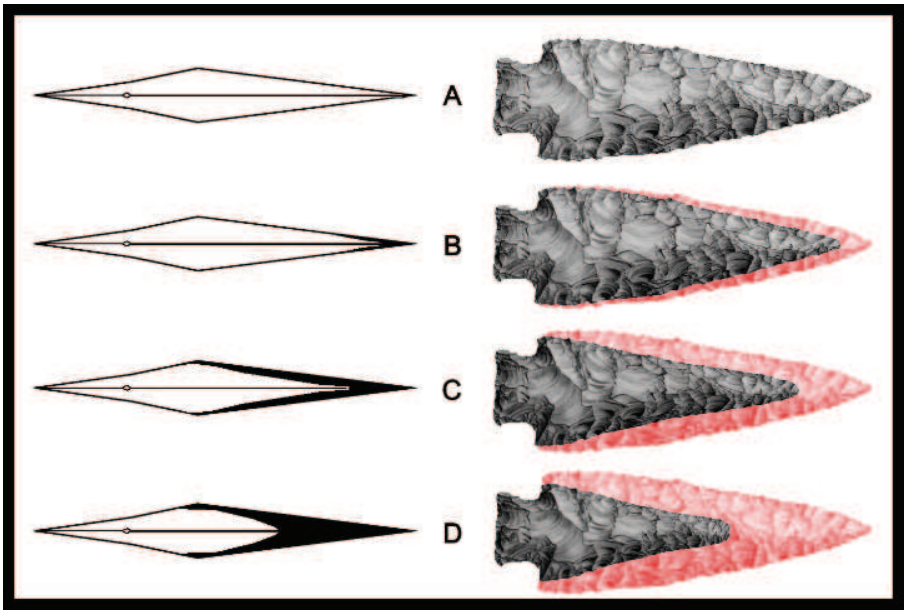

Figure 2. Illustration of typical curation effects on dart points. The relative reduction in thickness is illustrated on the left, and the corresponding reduction in length and width is illustrated on the right.

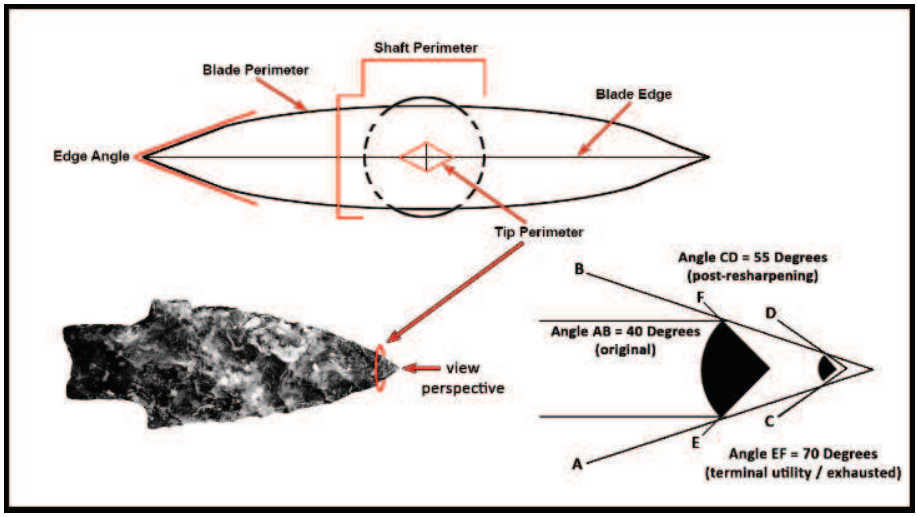

Figure 3. Metric attributes related to measuring point utility.

weapons. First, the decrease in blade width produces a decrease in the weapon's tip perimeter (Figure 3), which directly effects how effectively the haft and shaft are able to penetrate the prey's hide and flesh (Hughes 1998). Secondly, the edge angle of the lateral margins and tip become less acute as tool thickness does not reduce in proportion to length and width. As such, the tip and blade become correspondingly less sharp and less effective at piercing and cutting.

Experimental studies have demonstrated that the edge angle of a dart point's tip is within its optimal range when measuring between 20° and 40° degrees, and is ineffective when the angle exceeds 55° degrees (Dev and Riede 2012). When newly manufactured, the blade-edge angle of a bifacial dart point form generally measures between 45° and 55° degrees. So long as the tip maintains an effective edge (i.e. less than 55° degrees), the lateral margins may become less acute and still retain functionality. However, there does appear to be a limit to this as expended dart forms typically have edge angles measuring at or in excess of 70° degrees. It would seem perhaps that blade edges at that point cannot reach the degree of sharpness necessary to increase the aperture of the wound to effectively outweigh the frictional effects acting against the weapon. In support of this, ballistic studies have shown that the thin, elliptical cross-section typical of a dart point form early in its use history is an ideal design for maximizing target penetration, while the thicker, more conical shape often observed near the end of a dart's life cycle is markedly less effective without an exponential increase in delivery velocity (Hughes 2008).

Thus, a study incorporating a metric analysis of blade edge-angle, tip angle, and tip perimeter relative to the haft perimeter, as well as observations assessing a specimen's ability to be further reduced to achieve functionality, should produce a reasonably objective measure of utility or exhaustion. At this early stage in the analytical process, however, only the latter has been achieved for the Dimond Knoll study sample. Remaining utility was gauged for the study sample through a subjective assessment of observed edge and tip sharpness, along with an assessment of future reducibility, measured as a function of remaining material mass, material hardness, siliceous structure of the raw material, presence of detectable material flaws, and presence of observable manufacturing errors that would inhibit present functionality or future resharpening.

Thermal Alteration

Thermal alteration was another common tactic employed to extend the functional use-life of stone tools, including dart points. Heat treating raw materials, generally as bifacial blanks, has been shown to increase the knapping quality of poor-quality stone. However, excessive heating may cause raw materials to fracture or spall, rendering them useless. Evidence of alteration on stone tools often takes the form of color changes within the material and development of a dull, waxy texture. Of the 600 tools analyzed within the study sample, an astounding 506 (84%) were observed as exhibiting some signs of thermal alteration (Figure 4). Only 12 (2%) specimens were definitively not heat altered, while no assessment could be reached for 75 specimens (13%). The raw material could not be directly observed on the remaining seven due to heavy oxide staining or patination. It is worth considering that this high number of thermally altered specimens could partially reflect the incidental, post-depositional heating of several pieces.

Comparing the degree of thermal alteration observed within prehistoric tool assemblages among various sites in the Upper Gulf Coast region is

Figure 4. Examples of thermally-altered material among the Dimond Knoll stone tool assemblage.

problematic. First, this data is not recorded consistently within all site reports. The more critical issue, however, is that published datasets are not readily comparable because the ability to accurately detect thermal alteration on stone artifacts is a skill not equally developed among all analysts. A sample of sites from which comparative information can be drawn includes 41HR751, a Late Prehistoric site on Greens Bayou in central Harris County, site 41HR530 on Langham Creek, and 41HR1114 on South Mayde Creek. The relatively low percentages of thermally altered material in the lithic assemblages at sites 41HR751 (56%, n=47), 41HR530 (25%, n=11), and 41HR1114 (5%, n=37) may reflect differences in how analysts identify heated material. Each of these sites are predominantly Early Ceramic or Late Ceramic in age, which is an important consideration as the relatively small-sized, flake-based arrow points that dominate the later period weaponry forms may have required less thermal alteration of lithic raw materials to make.

The senior author additionally analyzed the lithic assemblage from 41LB42, a Late Prehistoric site in nearby Liberty County, finding that 75% (n=21) of the assemblage exhibited thermal alteration. Higher percentages of heat modified material may be more indicative of prehistoric patterns throughout the region, although its relative prevalence may have varied between periods. Regardless, the prolific use of thermal alteration at Dimond Knoll as a means to improve material knapping qualities and extend the use-life of tools is undeniable.

Assessment of Remaining Utility

Out of the 100 specimens within the Dimond Knoll sample that represent point types likely to have functioned as arrows (Figure 5), 44 were assessed as having no further utility, 53 were found to have remaining functionality, and three were observed as indeterminate. If we limit the analysis of arrow point only to those that were found complete (unbroken), 12 were assessed as having no further utility, 47 were found to have remaining functionality, and one was observed as indeterminate. Thus, if we eliminate the potential for post-depositional breakage to skew the determination

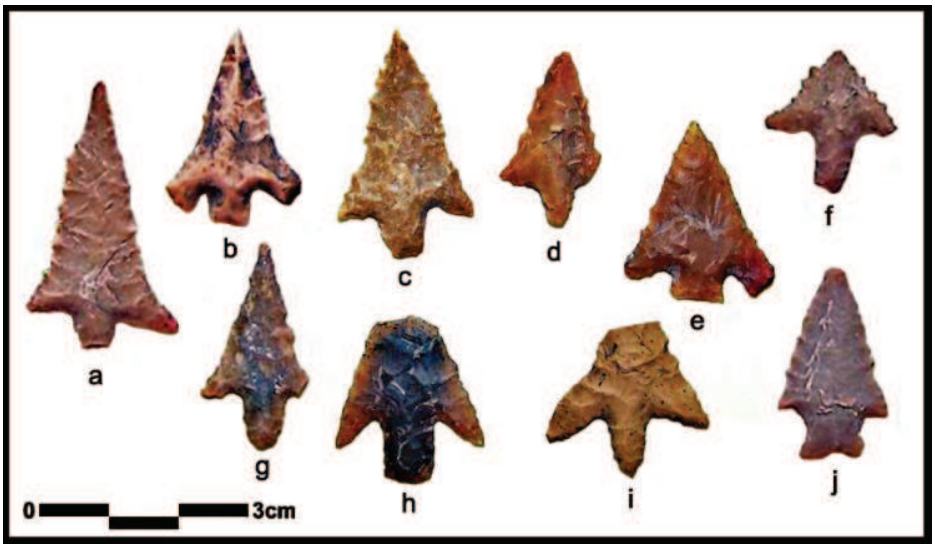

Figure 5. Examples of bifacial arrow points within the Dimond Knoll lithic assemblage.

Figure 6. Examples of bifacial dart points within the Dimond Knoll lithic assemblage.

of utility, 80% of Late Prehistoric arrow point forms are observed as retaining future utility.

Out of the 462 various types of points analyzed that are likely to have functioned as atlatl darts (Figure 6), 245 were assessed as having no further utility, 180 were found to have remaining functionality, and 37 were observed as indeterminate. If we include in our assessment only those specimens for which a determination of utility could be made, approximately 58% were assessed as having no further utility, with about 42% exhibiting remaining functionality.

We attempted to integrate these observations from Dimond Knoll with some other extensively excavated sites in the Southeast Texas region. Unfortunately, a direct comparison of remaining dart or arrow point utility is not possible because no such systematic evaluation of the degree of point exhaustion has been made for any of the regional sites for which comparative data is available. Perhaps the most comparable measure is the enumeration of resharpened Middle Archaic to Early Ceramic period dart points from 41HR1114 located near the Addicks Reservoir. There, seventeen out of 26 (65%) of the bifacial dart points exhibited evidence of resharpening.

The lack of standardized reporting across the region makes direct, ready comparison of site data rele-

vant to this topic problematical. This is actually an issue for much of the reported lithic data across the state of Texas, where idiosyncratic research strategies and the subjective nature of recording methodologies, as well as significantly varying skill levels among analysts, have contributed to unusable or unreliable datasets. An analysis of chipped stone tools assemblages from a number of sites across the Upper Gulf Coastal region following the same analytical protocols being employed at Dimond Knoll would make a substantial contribution to our understanding of the region's prehistory. The state-wide adoption of this or a similar protocol would be a beneficial and reachable goal for the professional community.

Discussion and Conclusions

When one evaluates the available data from the Houston region, the picture of material conservation through time is fairly complex. Interestingly, if we use the rate of remaining utility and the prevalence of thermal alteration on point forms as a proxy measure for conservation, from a temporal perspective, the ascent of Houston's resource wastefulness appears to have begun about 1300 years ago during the Late Prehistoric period. This assessment is based on there being less evidence for tool exhaustion and (possibly) thermal alteration during this period. However, this pattern could simply reflect a reduction in the overall level of lithic raw material consumption caused by a change in weapons systems during this period as the bow and arrow replaced atlatl-propelled darts. Arrow point forms are notably smaller than dart points, and in general are more expediently produced. Arrows also show a tendency to fracture after a limited number of uses, which would affect their ability to exhibit extensive curation. Thermal alteration would have a negative effect on durability, so this may have been avoided whenever possible.

From the early zeal observed in resource conservation among Houston's prehistoric residents, the decline into the present has been markedly steep. We can only hope that Houston's ambitious new recycling program, "One Bin for All," can return the region to its glory years of millennia past, where Houstonians appreciated the finite availability of natural resources and planned accordingly.

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