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# 11. Summary

EILEEN JOHNSON AND VANCE T. HOLLIDAY

Lubbock Lake was discovered in 1936 during dredging operations in Yellowhouse Draw for a city reservoir. Four major archaeological projects have investigated the site, the most recent being the Lubbock Lake Project through The Museum, Texas Tech University (Lubbock). Data from these various excavations demonstrate that Lubbock Lake contains detailed and interdependent histories of the cultural and natural records of the past 11,000+ years.

Five major stratigraphic units and five soils provide the physical framework for the cultural and natural-history records. Stratum 1 represents a graded, meandering stream that terminated abruptly at ca. 11,000 B.P. Stratum 2 represents a series of ponds and an aggrading marsh from 11,000 to 8600 B.P. The impounding of stratum 2 waters may have been due to eolian sediments choking the more constricted reaches of the draw and locally damming the valley. The Firstview Soil represents a period of landscape stability from ca. 8600 to 6400 B.P. The depositional environments of upper stratum 2 and stratum 3 indicate a warming and drying trend. Strata 3 (6400 to 5500 B.P.) and 4 (5000 to 4500 B.P.) eolian sediments point to increased amounts of blowing dust and long-term reduction in the vegetation cover. These deposits represent two periods of relatively intense drought (Altithestral) separated by a brief return (5500 to 5000 B.P.) to moisture and stable land conditions (Yellowhouse Soil). Xeric conditions end ca. 4500 B.P., and the return to mesic conditions is denoted by the Lubbock Lake Soil. Stratum 5 signals another warming and drying trend with a cyclical drought pattern, beginning with deposition from about 1000 B.P. to the present.

The vertebrate and invertebrate faunas and flora reflect communities existing in the local environs at a particular time. These records represent living communities, not simply death assemblages, and reflect an evolving community responding to changing environmental conditions. A number of species are good climatic or environmental indicators, occur outside their modern ranges, or constitute fossil temporal or spatial records. The flora reflects primarily the riparian environ, and bullrush seeds are the most common floral macrofossil through time. Netleaf hackberry persists in the earlier and later parts of the record, with an increase in the variety of deciduous trees in stratum 5. A replacement pattern is evident for this evolving community as climatic trends wax and wane with decrease or increase in available moisture, annual temperature fluctuation, seasonal differentiation, and amount and distribution of grasses and trees or shrubbery.

This physical framework provides for a first approximation of a detailed regional cultural chronology. Five major cultural periods are recognized: Paleoindian (11,500–8500 B.P.); Archaic (8500–2000 B.P.); Ceramic (2000 B.P.–A.D. 1450); Protohistoric (1450–1650s); Historic (1650s–

1930s). The three earlier periods are subdivided.

The cultural record reflects the economic system in a variety of environmental settings through time. Various cultural activities centered around subsistence and the technology employed to carry out those pursuits. Both lithic and fracture-based utilitarian bone tools were used throughout the time span. At bison kill/butchering locales an inverse relationship of lithic to bone expediency tools existed, whereas in processing stations quantities of tools from these two media were about equal. Resharpener and reuse of projectile points as knives were prevalent during Paleoindian times and appear to have been part of a general conservancy of lithic tools. During the Paleoindian period there occurred a trend away from fine-grained cherts toward locally available quartzites and silicified caliche. This trend was reversed in the Archaic. Edwards Formation chert attains dominant use, along with a greater use frequency of obsidian, during the last 1,000 years.

The most common tool kits were those of expediency tools, both lithic and bone. In the kill/butchering locales emphasis was on lithic percussion flake tools and unmodified fracture-based utilitarian tools. Stylized tools formed a minor component. In processing stations and camps a greater emphasis was on stylized tools, although expediency tools remained a component of the processing-station tool kit. A wide variety of lithic material sources recovered in resharpener debris indicated a greater number of tools used in the pursuits than recovered. On a smaller scale the same pattern occurred with bone expediency tools, with the recovery of broken working edges.

The various data sets available permit the reconstruction of the late Quaternary environments, speculation on the nature of the climate and climatic changes, and study of cultural adaptation to the environment and those changes. In turn, these data can be used to establish a model of the late Quaternary history of the region. Wide-ranging cultural and environmental correlations are fraught with risks, but such correlations are probably more realistic for the Southern High Plains than many other areas owing to the flat topography, low modern environmental gradients, and uniform regional geology.

Throughout the past 11,000+ years the resources available to aboriginal occupants of the Lubbock Lake area were considerable. Water was always present, and because of the water plants and animals were always present. The relief along Yellowhouse Draw, considerable during the earlier stages of occupation, also provided the only natural shelter of any sort on the otherwise open High Plains surface. Abundant skeletal resources were available for tool and decorative production. Lithic materials were the only fundamental resource in short supply. A poor-quality silicified caliche was the only lithic resource in the immediate vicin-

ity. Higher-quality materials were a minimum of 20 km away, and abundant supplies were considerably farther.

During the earliest aboriginal occupations at the site, in Clovis times, a competent stream flowed along the floor of the relatively deep valley. Wet-meadow sedge beds grew along the waterway and graded into a parkland. Stands of netleaf hackberry grew along the stream and valley floor. Tortoises, box turtles, and a variety of herd herbivores grazed the open prairie. Mild, frost-free winters and cool summers provided a more equitable climate of less temperature fluctuation and seasonality and more effective precipitation and available moisture.

The Clovis-age feature at Lubbock Lake was unlike Clovis features elsewhere in that it was not primarily a mammoth kill, but instead a wide variety of game animals were represented. Secondary butchering, marrow processing, and bone quarrying were the dominant activities along point bars of the stream. Bone expediency tools were made from ungulate and giant bear elements. Elements were disarticulated and disassociated from carcasses. The appendicular skeleton was underrepresented, and recovered limb elements were represented by ends. Elements of the axial skeleton were more common. Bone quarrying of mammoth limb elements produced blanks of diaphyseal radial segments and production and technological debris such as cone flakes. These blanks appear to have been slated for use in the production of highly modified formal tools dependent on thick cortical bone.

At about 11,000 B.P. a number of changes occurred in the area. Seasonality became more pronounced with a general warming and drying trend, probably representing a trend in a changing climate that began long before the Clovis-age occupation. Various large mammals became extinct, and other animals were extirpated. Water ceased to flow along the floor of the draw, and the valley slowly began to fill, first with diatomaceous sediments from freshwater ponds and then, starting about 10,000 B.P., with freshwater marsh sediments. A decrease in runoff probably contributed to this condition as well as creation of impoundments along the valley, possibly by wind scouring the surface of stream sediments and choking the more constricted reaches of the draw with eolian deposits. Eolian sediments began to aggrade in the draw by 9000 B.P., suggesting some destruction of the grasslands on the High Plains surface. Faunal extirpation continued as the warming and drying trend accelerated, changing the character of the pluvial-related fauna toward a more modern one by 8600 B.P.

During Folsom through Plainview times the valley setting was one of axial ponds within a savanna. Scattered hackberry and cottonwood grew along the marshy banks. Mild winters persisted with occasional periods of below-freezing conditions; summers were warming. By Firstview times the area was a scrub grasslands that was transitional from the mixed prairie of the preceding period and desert-plains grasslands of the following period. The axial wet-meadow-marshland was surrounded by open prairie. Although conditions were still mesic, they reflected a marked acceleration of the warming and drying trend. Yearly precipitation or effective moisture was decreasing. On the basis of inter-

preted grassland association, a probable shift occurred in the rainfall pattern away from spring-summer to summer-winter rains.

Task-group-oriented small-scale bison kills around the marshy edges of ponds (Folsom and Plainview) and marshes (Firstview) were the main subsistence activity. The focus was on meat procurement, and bison were supplemented by puddle ducks and muskrats. Marrow processing was minimal to nonexistent. The dietary protein from the bison meat appeared to be supplemented by fat from puddle ducks and muskrat meat (high-fat meat sources) and not bone marrow to provide a balanced diet and avoid a lean-meat-low-energy situation (cf. Speth, 1983; Speth and Spielman, 1983). Elements were disarticulated from carcasses but were generally kept associated with the carcass by carcass-specific bone piling. Meat stripping was extensive, and bone fracturing was oriented toward expediency tool production. This production was a subsidiary activity conducted to carry out processing of the bison carcasses.

Some controversy surrounds the reconstruction of the Folsom paleoecology of Lubbock Lake and the Southern High Plains. Hafsten (1961) and Oldfield and Schoenwetter (1964) proposed that a pine parkland existed in the area. Wendorf (1970:23, 32) proposed the Lubbock Subpluvial, a period of cool, moist conditions and a time of dense pine and spruce forestation. The Subpluvial dated from about 10,600 to 10,300 B.P. Some of these interpretations were based on pollen from Lubbock Lake (substratum 2A). Oldfield and Schoenwetter (1975) later modified their paleoecological reconstructions, but the interpretation remained that of a pine parkland. These interpretations were questioned on several grounds including reproduceability (Holliday et al., 1985b; Holliday, 1986). Considerably more geochronological data are now available at Lubbock Lake, as well as at other Southern High Plains sites. Pollen diagrams of Oldfield (1975) and Schoenwetter (1975) apparently do not reproduce one another or those from other sites, and more recent work failed to reproduce any of the previous records (Bryant and Schoenwetter, chap. 5). The significance of increases and decreases in pine pollen was questioned owing to the problems of long-distance transport of pine and differential preservation (Holliday et al., 1985b; Bryant and Holloway, 1983). Furthermore, morphological and chemical data from regional soils do not provide any indications that the area ever supported a coniferous forest or pine parkland. While the Folsom and Plainview faunal assemblages (10,800 to 10,000 B.P.; tables 6.1, 6.2, 7.1, 8.1) indicate relatively cool, moist conditions, strictly woodland-dependent forms are lacking. Moreover, the snail fauna, in particular, is indicative of a grasslands.

By Firstview times selection of certain meat cuts instead of total meat stripping was occurring. Semiarticulated units were still grouped in carcass-specific piles close to anatomical position. Long-bone elements were whole, and bone expediency tool production and use were minimal. The marsh was boglike with waterlogged spongy ground. Shallow surface water may have puddled in small areas. Muskrats were rare, small catfish were present, and waterfowl were available. Marsh-plant harvesting was occurring. Although the

purpose of the harvesting is speculative, marsh plants are a ready source of carbohydrates. Because supplemental fat sources were dwindling, plant carbohydrates may have taken the place of fatty meat to provide the high-energy source needed in the diet.

Small-scale task-group-oriented bison hunting continued throughout the Archaic with a greater reliance on plants as a food source during the Middle Archaic. Warming and drying intensified during the Early Archaic occupations, with a decrease in available moisture and humidity level. Eolian sediment accumulation increased with eolian sediments draped across the valley margin and encroaching on the marsh. A gradual decrease in the vegetative cover was occurring. The bison kill/butchering locale was situated away from the boglike marsh (although nearby) toward the drier ground of a sandy eolian drape. The grasslands fauna was a modern one that could withstand xeric conditions. The invertebrates were a depauperate fauna of heat- and drought-tolerant species. A treeless dry prairie surrounded a restricted axial freshwater marsh.

Selectivity of meat cuts continued with carcass grouping and articulated to semiarticulated associated units. Bone fracturing was nonexistent, neither marrow processing nor bone expediency tool production or use being evident. Aquatic resources at best would be minimal and may have been nonexistent. Extensive marsh-plant resources were available, although direct evidence of their use as a food source was lacking. Their use may be inferred from the lack of fatty meat sources and selectivity of bison meat cuts. Without dietary fat carbohydrates would have been necessary to counterbalance the effects of a lean meat diet.

At about 6400 B.P. a geochemical and sedimentological change occurred along the valley floor and the freshwater marsh was replaced by an alkaline marsh. Xeric conditions were prevalent, and eolian sedimentation became more common. Between 6400 and 4500 B.P. several meters of eolian sediment filled the draw, indicating considerable destruction of the regional grasslands by drought. The depauperate microvertebrate and invertebrate faunas were xeric-adapted. Since water was still available in the draw, the area may have acted as a local refugium. During the first drought the brackish marsh was surrounded by a treeless prairie, probably a desert plains grasslands. During the respite interval a small freshwater stream flowed in the valley axis. An increase in precipitation reactivated spring discharge. The landscape was stable. Although conditions were not as harsh as during the drought intervals, the climate still was dry and warm. A scrub grasslands dominated the draw. The second drought interval was marked by a decrease in precipitation and renewed vegetation denuding. A restricted freshwater marsh was surrounded by another treeless prairie, again probably a desert plains grasslands.

During the Middle Archaic occupations climatic conditions were the harshest of any time in the late Quaternary. Despite the length and intensity of the two-drought Altithermal, the area was not abandoned by humans or game herd animals. Disarticulated remains indicated a return to muscle stripping and more thorough utilization of the meat resource than in the Early Archaic. Bone fracturing was

minimal, and bone expediency tools were lacking. Lithic percussion tools were rare in the locale. Range conditions were poor, the bison herd size was probably reduced, and marrow was not being processed. The oven indicated a systematic use of desert plant resources, which implied a greater reliance on dietary carbohydrates than previously. More meat may have been taken per animal because it would have been of poorer quality than previously owing to the harsh conditions. The meat may have been the supplement to counteract a diet that was carbohydrate-rich but lacked complete essential amino acids. Numerous camping events were recorded on the valley margin. Retouched tools were relatively common.

Data from other localities corroborate the interpretation of harsh environmental and climatic conditions during the Middle Archaic, as local manifestations of the Altithermal (Antevs, 1955). Similar cycles of middle Holocene droughts are known from various parts of the central United States, although the timing varies from region to region (Benedict, 1978, 1979; Dean et al., 1984; Gaylord, 1982; Winkler et al., 1986).

Beginning around 4500 B.P. climatic conditions ameliorated. Cooler, more mesic conditions prevailed with a return to a stable vegetative cover. Moisture availability increased significantly. A mixed-grasslands prairie surrounded the freshwater marsh. Modern climatic conditions and probably a modern rainfall pattern were established, and a modern fauna inhabited the area. This situation prevailed until about 1000 B.P. During the Late Archaic into the earlier Ceramic, small-scale bison hunting continued, and camping events were recorded. Little is known of these cultural periods during this time span because of the lack of deposition and possible admixture of materials.

During the past 1,000 years several climatic departures toward drought conditions occurred but apparently were not severe enough to affect adversely the faunal and floral communities. The presence of slopewash and eolian sediments along the valley floor indicates that vegetation along the valley margin and on the High Plains surface was reduced during episodes of drier and warmer climate. Nevertheless, the recurrence of netleaf hackberry and additional hardwoods indicates a greater availability of moisture and less arid conditions overall than during the mid-Holocene droughts. From about 1000 to 300 B.P. a spring-fed stream and wet meadow-marshland complex was surrounded by an open mixed-grasslands habitat. By 500 B.P. and extending into the twentieth century the draw environs was that of a mesquite savanna grading into an extensive freshwater marshlands and open-water complex.

From later Ceramic through aboriginal Historic times the subsistence focus was on secondary by-product retrieval in these processing stations. Small-scale, task-oriented hunting continued, but a broader meat subsistence base developed through the 1,000 years. Elements were disarticulated and disassociated from carcasses. Long bones were fractured and underrepresented, while axial elements were overrepresented. Marrow processing was minimal in the later Ceramic but increased through time, and grease production also intensified. A much more nearly complete to

exhaustive use of bone nutritional resources indicates an orientation toward increasing dietary-fat production. Metates indicate plant processing, and both mesquite and marsh-plant resources were readily available. Both fat and carbohydrates appear to have had a role in balancing the diet.

Camping events are numerous, and prepared hearths may indicate extended stays. Mesquite was the common firewood during the Protohistoric and Historic, probably favored over the other hardwoods owing to its hot- and long-burning qualities. Food refuse indicates that a large variety of meat sources was hunted. Small-animal carcasses were brought back to camp, while only selected parts of large-animal carcasses were transported back. Marrow processing and grease production also occurred in camp. Lithic tool production occurred in camp, and stylized tools were more common. "Keeled scrapers" were frequent in both camps and processing stations, indicating hide preparation. Bone expediency tools were absent from the camps but were common in the processing stations. Most were proposed choppers, and the common lithic tools were choppers and scrapers. A probable anvil underscores the heavy-duty orientation of the processing-station tool kit.

The Lubbock Lake record is one of intensive and repeated use of the area through time by a small group of people involved in task-oriented economic activities. Because only a few bison mandibles could be aged, seasonality determinations are very tenuous, but activities appeared to have occurred in the fall (more common) or spring. Given the emphasis on obtaining fatty meats and plants, a late-winter or early-spring pattern may have been more expectable.

A number of trends or patterns are emerging. In bison butchering, the main objective during the Paleoindian period was meat retrieval with little attention paid to marrow. Completely disarticulated to semiarticulated carcasses were the trend through the period, with distinct bone piling. Fractured elements were utilized for fracture-based utilitarian tools. The trend of semiarticulated units and the lack of marrow processing were carried into at least the Early Archaic. During the Ceramic through Historic the focus of the activity areas was on intense processing of bone for marrow and grease production. Complete disarticulation, disassociation, and bone fracturing and reduction with a wide-

spread bone disposal were the pattern. Whole elements were rare. Bone expediency tools were used, but their manufacturing debris was not recovered probably because it was further processed. This difference in handling the bone resource may account for the difference in element selection for tool use between the Paleoindian and Ceramic through Historic periods. Metapodials dominated the Paleoindian assemblage, whereas a large variety of elements was used in the Ceramic through Historic assemblage. The frequency of broken tool sections increased through time, perhaps reflecting the greater amount of heavy-duty processing in stations than in locales.

The general Paleoindian tool assemblage is predominantly a meat-retrieval assemblage for muscle-bundle stripping, although hide preparation may also have occurred as a subsidiary activity. The Ceramic through Historic tool assemblage is primarily a processing assemblage for disjuncting, bone reduction, and hide preparation. A major technological thrust in these activities is that of production of fracture-base utilitarian tools. These tools were minimally modified implement categories. Both categories were employed in the late Pleistocene, but bone expediency tools emerge as the tradition throughout the Holocene. Bone quarrying, focused on the use of thick cortical bone, ceased at the end of the Pleistocene with proboscidean extinction. The bone expediency tool tradition employed a wider range of resources, using elements of middle to large-sized mammals, and that flexibility permitted its continued use from a wide-based procurement setting through a focused setting to a mixed economy.

The excellent geologic sequence at Lubbock Lake holds evidence of successive cultures and changing lifeways from Clovis times continuing through to the founding of the Lubbock community in the latter part of the nineteenth century. This remarkable sequence is further enhanced by the excellent age control available, which establishes the site as one of the best dated in the New World. Analysis, integration, and interpretation of generated data have progressed to varying degrees, and vast amounts of data are yet to be recovered. Nevertheless, the site has produced one of the most nearly complete late Quaternary records in the New World and serves as a model for the late Quaternary history of the Southern High Plains.