10-1-2005

Watson Brake, A Middle Archaic Mound Complex in Northeast Louisiana

Joe W. Saunders
University of Louisiana at Monroe, saunders@ulm.edu

Rolfe D. Mandel
University of Kansas, mandel@kgs.ku.edu

C. Garth Sampson
Southern Methodist Uniersity, gsampson@smu.edu

Charles M. Allen
Environmental and Natural Resources Management Division, charles.allen@polk.army.mil

E. Thurman Allen
Natural Resources Conservation Service, thurman.allen@la.usda.gov

See next page for additional authors

Authors
Joe W. Saunders, Rolfe D. Mandel, C. Garth Sampson, Charles M. Allen, E. Thurman Allen, Daniel A. Bush, James K. Feathers, Kristen J. Gremillion, C.T. Hallmark, H. Edwin Jackson, Jay K. Johnson, Reca Jones, Roger T. Saucier, Gary L. Stringer, and Malcolm F. Vidrine

WATSON BRAKE, A MIDDLE ARCHAIC MOUND COMPLEX IN NORTHEAST LOUISIANA

Joe W. Saunders, Rolfe D. Mandel, C. Garth Sampson, Charles M. Allen, E. Thurman Allen, Daniel A. Bush, James K. Feathers, Kristen J. Gremillion, C. T. Hallmark, H. Edwin Jackson, Jay K. Johnson, Reca Jones, Roger T. Saucier, Gary L. Stringer, and Malcolm F. Vidrine

Middle Archaic earthen mound complexes in the lower Mississippi valley are remote antecedents of the famous but much younger Poverty Point earthworks. Watson Brake is the largest and most complex of these early mound sites. Very extensive coring and stratigraphic studies, aided by 25 radiocarbon dates and six luminescence dates, show that minor earthworks were begun here at ca. 3500 B.C. in association with an oval arrangement of burned rock middens at the edge of a stream terrace. The full extent of the first earthworks is not yet known. Substantial moundraising began ca. 3350 B.C. and continued in stages until some time after 3000 B.C. when the site was abandoned. All 11 mounds and their connecting ridges were occupied between building bursts. Soils formed on some of these temporary surfaces, while lithics, fire-cracked rock, and fired clay/loam objects became scattered throughout the mound fills. Faunal and floral remains from a basal midden indicate all-season occupation, supported by broad-spectrum foraging centered on nuts, fish, and deer. All the overlying fills are so acidic that organics have not survived. The area enclosed by the mounds was kept clean of debris, suggesting its use as ritual space. The reasons why such elaborate activities first occurred here remain elusive. However, some building bursts covary with very well-documented increases in El Niño/Southern Oscillation events. During such rapid increases in ENSO frequencies, rainfall becomes extremely erratic and unpredictable. It may be that early moundraising was a communal response to new stresses of droughts and flooding that created a suddenly more unpredictable food base.

Los complejos de montículos de tierra del Arcaico Medio del valle del río Mississippi son los antecedentes remotos de los famosos montículos de Poverty Point, que se fechan mucho más temprano. Watson Brake es el más grande y el más complejo

Joe W. Saunders and **Reca Jones** ■ Regional Archaeology Program, Museum of Natural History, Department of Geosciences, University of Louisiana at Monroe, Monroe, LA 71209-6520 (saunders@ulm.edu)
Gary L. Stringer ■ Museum of Natural History, Department of Geosciences, University of Louisiana at Monroe, Monroe, LA 71209-6520 (saunders@ulm.edu)
Charles M. Allen ■ Environmental and Natural Resources Management Division, 1647 23rd St.l Bld. 2529, Fort Polk, LA 71459 (charles.allen@polk.army.mil)
E. Thurman Allen ■ Natural Resources Conservation Service, 2410 Old Sterlington Road, Suite B, Monroe, LA 71203 (thurman.allen@la.usda.gov)
Daniel A. Bush ■ P.O. Box 396, Deerfield, NH 03037 (guans@u.washington.edu)
James K. Feathers ■ Department of Anthropology, University of Washington, Seattle, WA 98195-3100 (jimf@u.washington.edu)
Kristen J. Gremillion ■ Department of Anthropology, Ohio State University, 244 Lord Hall, 214 West 17 Avenue, Columbus, OH 43210-1364 (gremillion.1@osu.edu)
C. T. Hallmark ■ Soil and Crop Sciences Department, Texas A&M University, College Station, TX 77843-2474 (hallmark@tamu.edu)
Edwin H. Jackson ■ Department of Sociology and Anthropology, University of Southern Mississippi, Box 5074, Hattiesburg, MS 39406-5074 (ed.jackson@usm.edu)
Jay K. Johnson ■ Department of Sociology and Anthropology, University of Mississippi, University, MS 38677 (sajay@olemiss.edu)
Rolfe D. Mandel ■ Kansas Geological Survey, University of Kansas, Lawrence, KS 66045-2121 (mandel@kgs.ku.edu)
C. Garth Sampson ■ Department of Anthropology, Southern Methodist University, Dallas, TX 75275-0336 (gsampson@smu.edu)
Roger T. Saucier ■ Deceased
Malcolm F. Vidrine ■ Division of Sciences, Louisiana State University at Eunice, P.O. Box 1129, Eunice, LA 70535 (mvidrine@lsue.edu)

American Antiquity, 70(4), 2005, pp. 631–668

de estos sitios tempranos de montículos. Los estudios extensivos estratigráficos y de bloques de sedimentos taladrados, o sean corazones, junto con la obtención de 25 fechas de radicarbono y seis fechas de luminiscencia, muestran que la construcción de montículos pequeños comenzó aquí hacia 3500 a.C. en asociación con un arreglo oval de piedras quemadas ubicado al borde de la terraza del río. La extensión espacial de estos primeros montículos de tierra no ha sido establecida todavía. La construcción sustancial de montículos comenzó hacia 3350 a.C. y continuó a través de varias fases hasta después de 3000 a.C. cuando el sitio fue abandonado. Los once montículos con sus crestas interconectadas fueron ocupados entre estadios rápidos de construcción. Las capas de sedimentos se acumularon en algunas de las superficies temporales de estos componentes de tierra, mientras que el material lítico, las piedras fracturadas por fuego y los objetos de arcilla o tierra arcillosa cocida se dispersaron por todos partes del montículo. El registro faunístico y arqueobotánico de los depósitos basales demuestran que el sitio fue ocupado durante todas las estaciones del año, idea apoyada por una subsistencia concentrada en la explotación de nueces, peces y venado. Las capas estratigráficas más superficiales son de una matriz muy ácida, la cual ha impedido la conservación de restos orgánicos. El área circundada por los montículos fue mantenida limpia y libre de despojos, los que sugiere que tenía una función ceremonial. Las razones por las cuales tales actividades se llevaron a cabo aquí no son claras. Sin embargo, algunas de las fases de construcción se correlacionan con algunos de los períodos mejor documentados de aumentos de los eventos de El Niño. Durante aumentos rápidos en la frecuencia de ENSO, las lluvias ocurren en forma irregular e imprevisible. Es posible que la construcción de montículos de tierra fuera una respuesta comunal a presiones causadas por una imprevisible escasez de recursos, la cual estuvo ligada a sequías e inundaciones.

The discovery of massive Late Archaic earthworks at Poverty Point (16WC5) in the lower Mississippi valley (Figure 1) has posed two enduring questions in North American prehistory—when and where did such moundbuilding begin, and what triggered those activities? (Ford 1969; Ford and Webb 1956; Gibson 2001; Russo 1994a; Webb 1982). Today, only the first question can be satisfactorily answered. Earthworks were constructed in the vicinity of Poverty Point at least two millennia before building began (ca. 1750 cal B.C.) at that formidable complex. Six older radiometrically dated mound complexes are now known within a 150 km radius of Poverty Point (Figure 1), of which Lower Jackson (16WC10) is the nearest (Gibson 1989; Saunders et al. 2001), followed by Nolan (16MA201) (T. Kidder, personal communication 2005), Frenchman's Bend Mounds (16OU259) (Saunders et al. 1994), Watson Brake (16OU175) (Saunders et al. 1997), Hedgepeth (16L17) (Saunders and Allen 1994), and Caney Mounds (16CT5) (Gibson 1991; Saunders et al. 2000). Limited testing shows that their builders were Middle Archaic hunter-foragers who exploited riverine habitats and used locally available lithic materials like those used at nearby campsites without mounds such as Plum Creek (16OU89) (Saunders 1998; Sheffield 2003) and Metz Midden (16RI105) (Saunders 2000). Farther afield, six other dated Middle Archaic mound sites are known in southern Louisiana (Brown and Lambert-Brown 1978; Hays 1995; Russo and Fogleman 1996; Saunders and Allen 1998; R. Saunders 1994, personal communication 2005), and there is another in Mississippi (Connaway et al. 1977). One mound site (Monte Sano, destroyed in 1968) may date to >5000 cal B.C. (Hays 1995; Saunders 1994), while all the others have been dated to between 4050 and 3050 cal B.C.

Thus far, Watson Brake has the most extensively tested and dated Middle Archaic earthworks in North America. However, previous publications include only a condensed summary of results (Saunders et al. 1997) and specialist reports on OSL dates (Bush and Feathers 2003; Feathers 1997), lithics (Johnson 2000), fired earthen objects (Saunders et al. 1998), and fauna (Jackson and Scott 2001). The goal of the present report is to integrate all these lines of investigation and to make available other unpublished essentials including sampling design, methods, and the results from more recent analyses. We also assess the relevance to Watson Brake of two current models of the origins of Middle Archaic moundbuilding.

Background

The Site and Its Setting

Watson Brake[1] is an oval arrangement of 11 earthen mounds with connecting ridges. These form two curved rows of earthworks called the north and south mounds (Figure 2). The level enclosure between them measures about 300 m long by 200 m across, and the tallest mound (Gentry Mound, A in Figure 2) is 7.5 m high.

The earthworks were built on the east rim of an alluvial terrace, some of which was probably

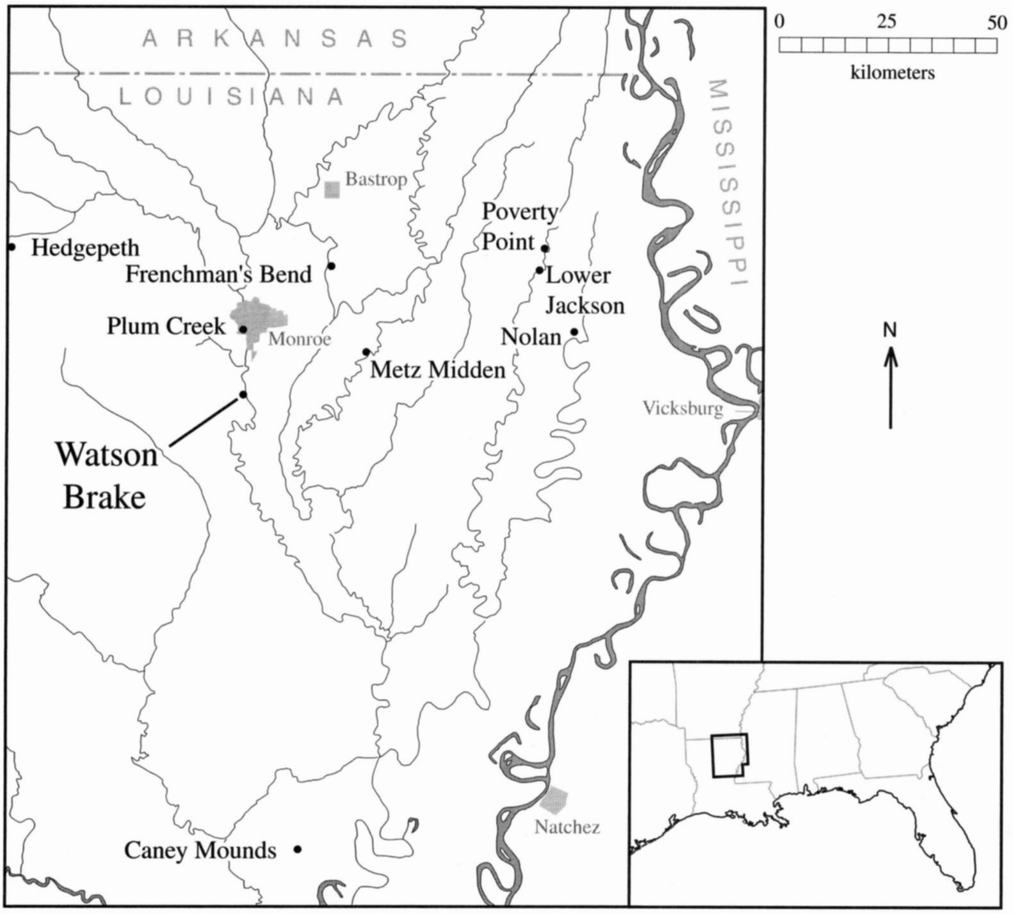

Figure 1. Location of Watson Brake in N. E. Louisiana in relation to other sites mentioned in the text.

formed by the Ouachita River during the late Pleistocene. Today, the river channel flows about 500 m farther east of the site, and a minor tributary known as Watson Brake forms a swampy floodplain immediately below and to the west of the terrace rim. At the time of site occupation, this was probably a clear-running side channel that flowed about a meter lower than today, and it was less swampy. Complex shifts in major local drainages between 3000 and 2000 B.C. (Saucier 1994; Washington 2001) placed natural levees across the mouth of Watson Brake, thereby converting it to a swampy backwater. These events may be implicated in the abandonment of the site at this time, but the relationship has not yet been fully investigated.

The site is on an ecotone between riverine and upland mosaics, both extremely rich in edible plants. The upland sector of the site's catchment supports deer and a full range of small mammals and birds, while the riverine sector carries a diverse aquatic fauna. As will be shown, the site's inhabitants exploited the full range of animal resources, but limited preservation of macrobotanical remains restricts our knowledge of the plants consumed. Another asset of this site's location is the immediately available toolstone in chert gravels eroding from the terrace scarp.

Research History

The first recorded visit to the site was in 1981, when seven mounds and a few ridges were identified and sketched by Reca Jones and visited by Stephen Williams. Surface finds suggested a Poverty Point age (ca. 2000-1000 B.C.) for the site (Jones 2000). Four more mounds and other ridges were located the following year. John Belmont and Reca Jones compiled a map of the site in 1984, and Watson Brake was first mentioned in print the following year (Jones 1985). The age estimate went unchallenged, although Kidder (1991) suggested

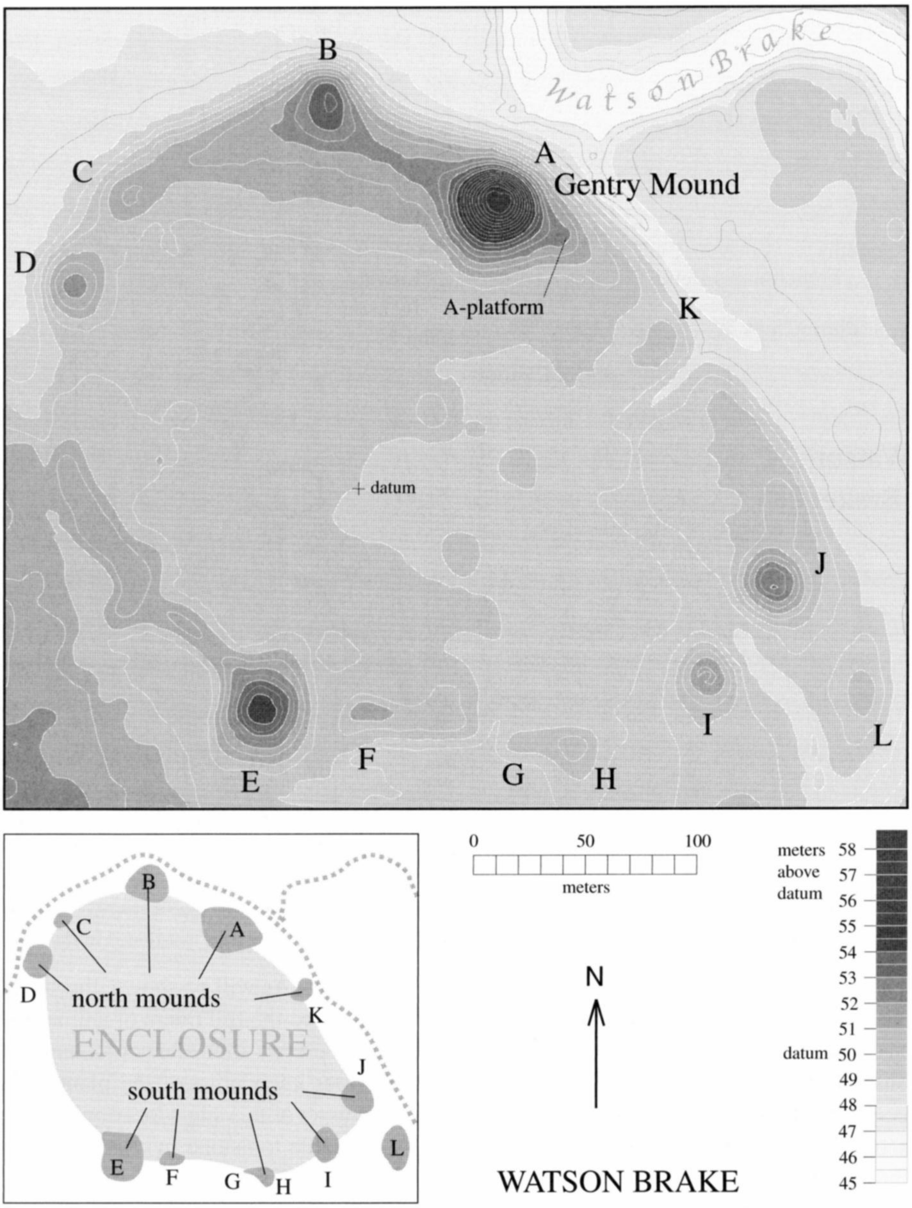

Figure 2. Surface elevations of the Watson Brake mounds and ridges at half-meter intervals. Inset: group names used in the text.

that it might be placed earlier in the Late Archaic, at ca. 2000 B.C. In 1992, pedological analysis of Mound A fill suggested a Middle Archaic age for the mound (Saunders et al. 1994) and prompted the design of field investigations, which ran between 1993 and 1999, followed by multidisciplinary analyses. Until 1998, fieldwork was limited to the north mounds because the landowner of the south mounds denied access. After the south group was purchased by the Archaeological Conservancy, and subsequently sold to the State of Louisiana, the south mounds could be tested for the first time.

Goals

Research programs were designed to establish the age of the site, to confirm that the mounds and ridges were of human origin, to measure the effects of longer and shorter building hiatuses on soil for-

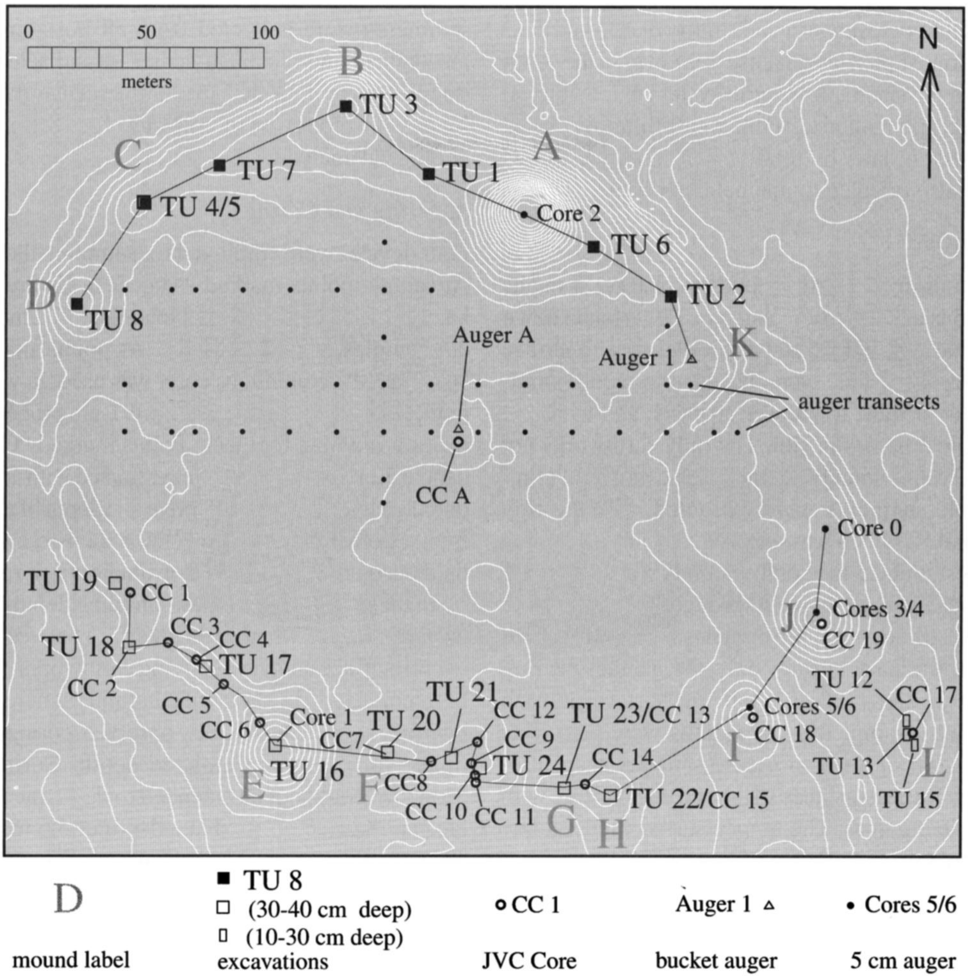

Figure 3. Locations of all excavated test units and cores at Watson Brake.

mation within the mound fills, and to document whether earthworks were raised individually or as groups. Datable materials from buried soils in mound and ridge fills were recovered with minimal destruction to the earthworks themselves by using augers, cores, and limited test excavations. When middens with fauna were discovered at the base of Mound B, it also became possible to examine the subsistence base of the site's earliest occupants.

Samples and Methods

Sampling Layout

A site datum was established in the middle of the enclosure and assigned an arbitrary elevation of 50 m. Over 14,000 total station topographic readings were collected for a site map (Figure 2). All stratigraphic descriptions and correlations use the same vertical scale.

The layout of auger points and test pits is shown in Figure 3, together with the field labels. Test units on the north mounds and ridges were aligned within a 20 m grid, oriented to magnetic north, with each location predetermined by auger/core/probe results that revealed buried soils and/or other organics. Two of the auger/core locations were outside the grid and their locations recorded with a total station. Within the north half of the central enclosure, auger probe layout follows the grid system, with a few placed at 10 m intervals. This was designed to explore patterns of artifact density inside the enclosure. Auger/core probes into a low rise in the center of the enclosure were arbitrarily placed and their locations shot in later. Dense tree cover in the south half of the site made the grid system unfeasible, so all auger points and test units were arbitrarily placed and shot in later by total station. These test units were also oriented to magnetic north.

Excavations

Test units in the north mounds were 1-x-1.5-m pits (TU 5 is a 1-x-1-m extension of TU 4) taken down to what was judged to be the Pleistocene terrace surface. Test units were designed to record stratigraphic details, to recover artifacts, and to obtain datable organics in situ. The only earthworks not tested were Mound A, from which continuous core-sample segments were extracted, and the tiny Mound K, which was augered.

Test units in the south mounds were 1.5 m x 1 m for E, 1 m x 1 m for F through H, and 1 m x .5 m for L. Since no buried organics were encountered by preliminary coring, only the artifact-bearing upper portions (30-40 cm below surface) in each unit were sampled. No test units were placed on Mounds I or J because core samples again provided good sequences of buried A-horizons with datable organics. The terrace surface under a few earthworks may not have been reached.

Not shown in Figure 3 are four 1-x-1-m units to the west of the complex. These offsite excavations were conducted to investigate possible peripheral occupations, and went to depths of only 10-30 cm.

Test units were excavated by cultural/natural layers where these occurred. Most visible layers are buried A-horizons of ancient soils, but concentrations of lithics and/or fire-cracked rock were also intersected. Deep homogenous fills were more common, and these were excavated in arbitrary levels. In each unit, excavation was halted within what was thought to be submound or subridge alluvial deposits. Culturally sterile deposits were not reached at the bottom of any unit. All deposits were dry-screened through 3.2 mm mesh and all retained materials, including gravel and concretions, were collected and processed. Scarce midden deposits were dry-screened into plastic garbage bags and taken to the lab for flotation.

All four walls of each test unit were drawn, and the north and south walls photographed. Features such as small pits, depressions, hearths, and postholes were drawn in section and plan form. Bulk sediments were collected from all horizons for mechanical and chemical analyses, and selective samples were collected for luminescence dating. Intact soil blocks were collected for micromorphological analysis.

Augering and Coring

Four devices were employed for sampling the site. At sample points marked "Auger" in Figure 3, a hand bucket auger was used to collect 17-cm-x-8-cm samples of loose deposit. At points marked "CC," a JMC continuous corer was used, in which a slide hammer pounds a 2-cm-x-91-cm probe then extracts it with a foot jack. Points marked "Core" denote 5-cm continuous cores extracted with a foot-operated hydraulic rig, effective to a depth of about 5 m. At other points of interest, a 25.4-mm Oakfield push probe was used to evaluate stratigraphy.

In the mounds and ridges, sampling depths varied according to whether the interface between the terrace surface and the overlying earthworks could be recognized. In the south mounds where this interface could not be readily observed, coring continued to below its predicted depth. Coring in Mound A could not be extended to the terrace surface and was abandoned at a depth of 5.6 m. The 42 auger holes inside the enclosure reached a depth of about 45 cm. Those in the low rise (Auger A, CC-A in Figure 3) went to 138 cm below surface.

Deposits from augers and cores in the earthworks were described in the field and sampled by soil horizon. These were passed through a 3.2-mm mesh or stored for later analysis. The samples taken from within the enclosure were processed through a .5-mm screen to recover microdebitage and small pieces of fire-cracked rock.

Radiocarbon Dating

Altogether, 28 radiocarbon samples were collected from seven mounds and one ridge. Of these, 19 were recovered in situ from test unit excavations and the rest were taken from core or auger samples. Charcoal was assayed in 16 cases where the buried A-horizon incorporated traces of cultural debris. In all but one case (ridge K/A, TU 2), the charcoal occurred as small, scattered particles rather than large intact pieces. One charcoal sample in Mound D proved to be a historical intrusion, presumably a burnt tree root, and this date has been omitted.

One date was run on charred bone from Mound B, but results were discouraging and no further bone samples were submitted. The balance of the dates were run on humates extracted from six buried soils, four organically enriched sediments of buried A-horizons, and a feature fill, all subjected to rigorous pretreatments. Seven of the samples were dated by AMS ^{14}C, and the remainder by conventional (unextended) gas counting. $\partial^{13}C$ values were obtained with all but one date and used to correct for isotopic fractionation. All calibrations use the same INTCAL curve (Stuiver et al. 1998).

Luminescence Dating

This program concentrated on exploring the feasibility of dating mound fill by optically stimulated luminescence (OSL). Preliminary work analyzed buried soil samples from Mound B (TU 3) and ridge K/A (TU 2) (Feathers 1997). Subsequently, more refined methods were applied to buried soil samples from Mounds B, C, and K and ridges K/A and J/K (Bush and Feathers 2003). In more recent work, sample columns were collected across buried soils and analyzed in 5 cm segments, using both multigrain and single-grain aliquots of 90-125 μm quartz. Segments corresponding to the buried A-horizon proved in most cases to be the best bleached. Only well-bleached grains as determined from single-grain analyses were used for dating, using a leading edge algorithm. In addition, 35 cm-deep topsoil columns were collected from Mounds B and C to study sediment turnover rates in active soils, which is reflected in the frequency of well-bleached grains.

Soil Analysis

Soils were described in the field using standard U.S.D.A. terminology (Soil Survey Staff 1996). Soil samples were collected from eight excavation units (TU 1-8) for physical and chemical analysis, including particle size distribution, pH, cation exchange capacity, exchangeable Al, organic carbon, and Fe_2O_3 content. Total exchangeable bases (Ca, Mg, Na, K) and exchange acidity were used to calculate percent base saturation. Micromorphological analyses were conducted on soil thin sections from several mounds and ridges.

Sediment samples from cores were not subjected to laboratory analysis. Color and pH were measured in the field and texture classes were estimated from hand specimens. The only core sample textures derived from particle size analysis are from the top meter of Core 2 in Mound A (Saunders et al. 1994:Table 1).

Artifact Analysis

Gravel and concretions were separated from artifacts, weighed, size-graded, and stored. Fire-cracked rock was then separated from the artifacts, weighed, size-graded, and stored. The fired earthen objects were weighed, measured in three dimensions, and classified by shape using a typology detailed in Saunders et al. (1998). Lithics were weighed, measured, and classified by reduction and typological criteria. A reduction sequence analysis developed to deal with biface industries made from Mississippi gravels (Johnson 1989; Johnson and Raspet 1980) was employed. Finished bifaces were typed following local definitions (Ford and Webb 1956; Webb 1981).

Faunal Analysis

Faunal remains were encountered in four of the north mound earthworks and from two cores in Mound J. Most of this material was too fragmented to be identified to taxon, excepting in Mound B, where preservation was good. The latter samples were divided into large (>6.4 mm) and small (6.4 mm–3.2 mm) fragments. Human remains, bone artifacts, antler fragments, gar scales, fish otoliths, and shell were first removed from the large fraction. The residue was then identified to taxon and element where possible, and MNI counts were computed from these. Subsamples of the small fraction were drawn from six levels and subjected to the same procedure.

Age-at-death was determined for the limited deer sample using dentition, epiphyseal fusion onset data (Purdue 1983), and modern reference collections. Season-of-death data were determined for fish otolith annuli (Stringer 1998), and weight estimates for drum were derived from otolith lengths and weights compared to modern reference collections. Mussel shell fragments were identified to species using modern reference collections and tallied, as was the single species of aquatic snail.

Macroplant Analysis

All dry-screened midden deposits encountered in

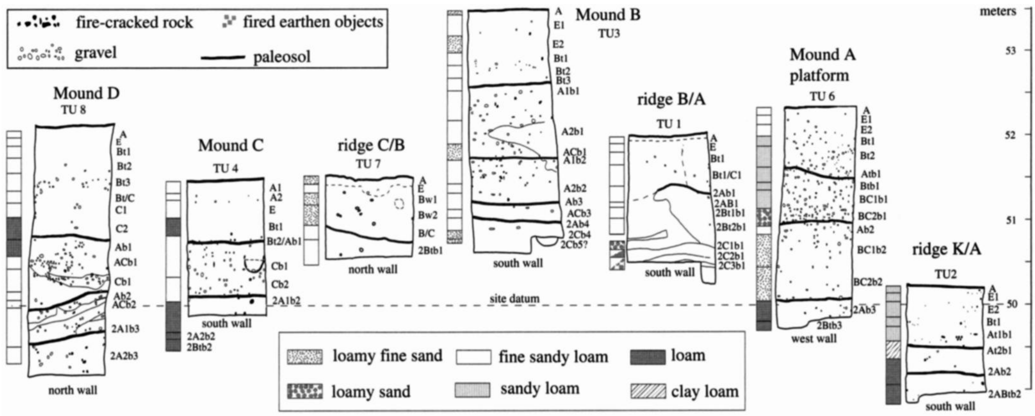

Figure 4. Watson Brake north mounds: profiles of the seven test units showing soil horizons, inclusions, and sediment sample columns with texture classes. Ap in TU6 refers to Mound A platform.

the north Mounds B, C, and D were floated in a 190-liter flotation device using city water. The heavy fraction was collected on a 1.6-mm nylon mesh screen, and runoff from the tank was passed through a fine mesh bag to collect the light fraction. Once dried, the light fraction was macroscopically scanned. Samples of heavy fractions were also scanned, but were found to contain relatively little charcoal. Portions of the 3.2-mm dry screenings were also checked for materials. Specimens were bagged by provenience and identified using modern reference collections. Seed coat-thickness was measured using a scanning electron microscope.

Human Remains

No burials were encountered. Isolated human fragments were identified to element, and age-at-death was determined where possible.

Mound Construction History

The mounds and ridges identified by Jones (1985) all contain abundant artifacts and buried or truncated soils that verify the earthworks' cultural origins. They are composed of one or more units of fill, and a soil has developed at the top of most fills (Figure 4). Fill units are numbered sequentially in

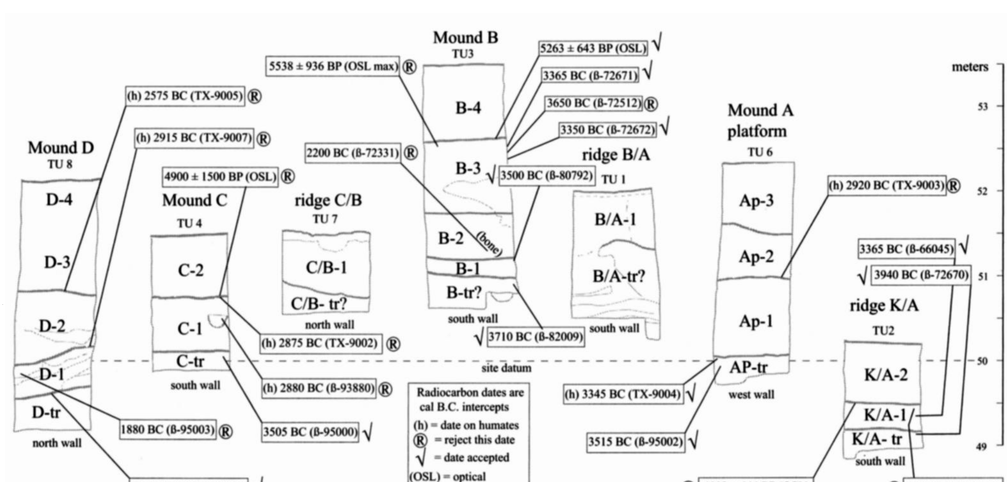

Figure 5. Watson Brake north mounds: profiles of test units with numbered earthwork fills over terrace (-tr) deposits. Textures of the terrace deposits under C/B, B, and B/A (-tr?) resemble fills. Pointers show locations of dated samples.

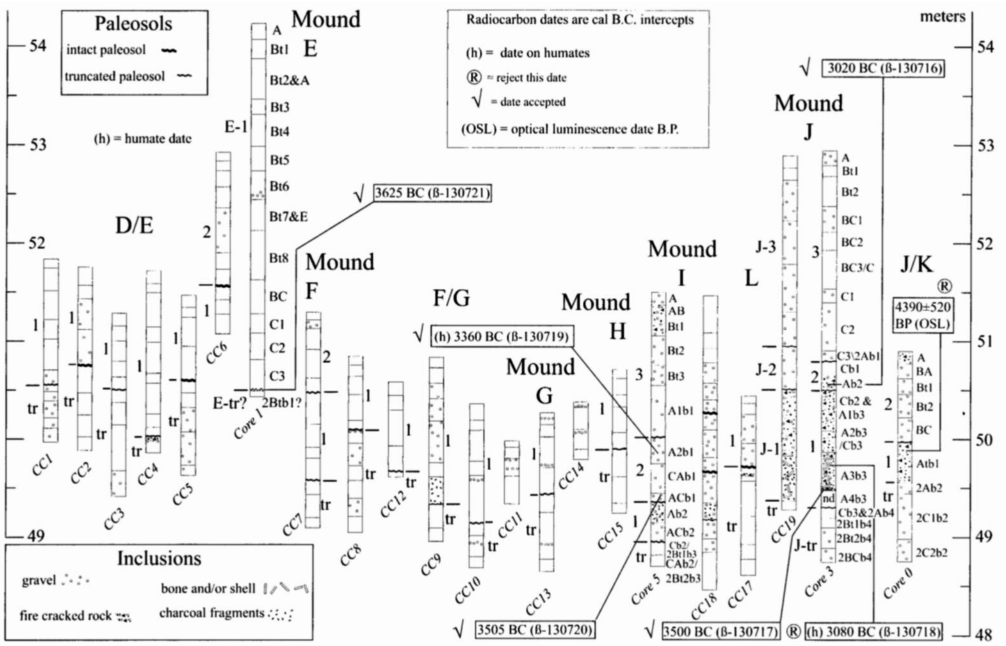

Figure 6. Watson Brake south mounds: core profiles showing numbered fill units, soil horizons, inclusions, and locations of dated samples.

each earthwork (Figure 5) with the first fill (e.g., D-1) overlying the surface soil developed on the terrace (D-tr). These acronyms are used hereafter to denote individual bodies of fill. They reflect construction episodes, punctuated by hiatuses during which soils developed. The soils at the top of most fills have very abrupt upper margins and diffuse lower boundaries that can be traced around all four walls of test units. One fill unit is not capped by a soil: the top of D-3 is defined by a thin clayey lens with very abundant flaked lithics (Figure 5).

Most sequences rest on a soil that formed on the original terrace surface. Uncertainty remains if the terrace soil (-tr?) has been reached below C/B, B, and B/A earthworks, where the seemingly elevated terrace has the same texture as the fill (Figure 5). In places, the terrace soil was truncated to provide fill for initial building episodes (Figure 6). Five mounds (E, G, H, K, and L) contain only one unit of fill, two mounds (C and F) contain two superimposed fills, two mounds (I and J) contain three fills, and two mounds (B and D) contain a sequence of four fills. Mound A contains at least six fills (Figure 7), although its attached platform contains only three fills. Ridges are built of only one or two fills.

Composition and Sources of Mound Fills

All fill units in the north mounds contain large amounts of gravel, as shown in the profiles (Figure 4). About 90 percent of the gravels recovered from all test units (1,133 kg) came from the north mounds (TU 1-8). The obvious source of this material is the exposed terrace edge immediately next to each mound and/or ridge. Evidently the scarp face was systematically quarried for material. In the south mound fills, gravel is common in earthworks adjacent to the terrace edge in ridge J/K and Mounds I, J, and L (Figure 6), which again points to the scarp face as the source. All other south mounds are made of bulk sediment in which gravel inclusions are scarce. These must have been scraped from the terrace surface outside the oval where irregular topography suggests remnants of borrow pits. Surface irregularities inside the enclosure (Figure 2) hint at another source, as do the truncated terrace soils under some of the earthworks themselves (Figure 6).

The terrace-edge sediments in the fills of Mound D through ridge B/A are notably uniform: a loam, fine sandy loam, and loamy fine sand. This changes abruptly to sandier (and more gravelly) deposits in Mound A and ridge K/A where terrace scarp expo-

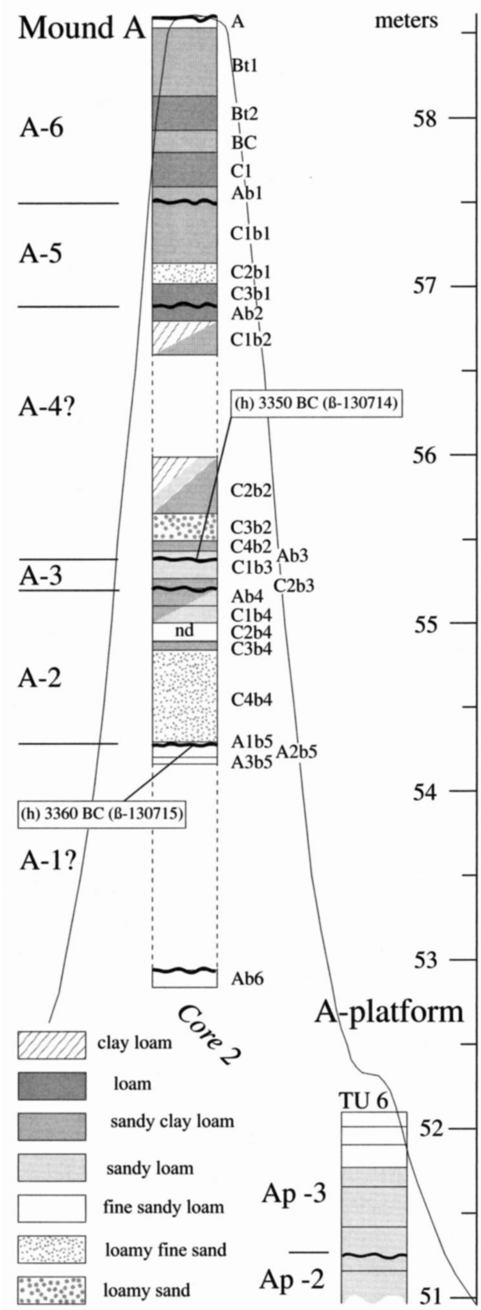

Figure 7. Watson Brake Mound A: core profile showing soil horizons, numbered fills, sediment classes, and locations of dated samples.

sures evidently yield deposits reflecting higher-velocity flow regimes (Figure 4 and Figure 7). Traces of basket loading can be seen only in lower Mound D (Figure 4).

Terrace deposits immediately below most south mounds are sandy clay loams, and mound fills consist of this material mixed with small amounts of topsoil. The undisturbed terrace sediment has a grayish hue, whereas many fill units are yellowish brown. Sediments in earthworks near the terrace edge (ridge J/K, Mounds I, J) have more in common with fills of the north mounds.

Radiocarbon Dates

The excavations and coring produced 27 viable radiocarbon dates; 15 are from charcoal, one from bone, six from soil humates, and five from organically enriched sediments. Details are listed in Table 1 and sample locations are shown in Figures 5–7.

Fourteen of the 15 charcoal samples are greater than 3000 cal B.C., which not only establishes a minimum age for the Watson Brake earthworks, but also places the Middle Archaic age (3000 cal B.C.) of the site beyond any reasonable doubt. The single younger date (1880 ± 120 cal B.C., ß-95003) is on charcoal that is clearly not in situ and should be rejected. From the top of the D-1 fill (Figure 5), it is out of stratigraphic order with all other dates in Mound D and is younger than any date from the site (Figure 8). Possible causes of this stratigraphic inversion are uncertain. While some of the charcoal may be intrusive, a complicating factor is that the tiny in situ sample had to be augmented with particles taken from the screens.

Another inversion is the age determined on the charcoal scatter (3650 ± 100 cal B.C., ß-72512) from the A2b1 horizon in B–3 of Mound B (Figure 5). It is 300 years older than charcoal (3350 ± 110 cal B.C., ß-72672), just ca. 5 cm lower in the same horizon (Figure 5), and 150 years older than charcoal (3500 ± 110 cal B.C., ß-80792) in the lower Ab3 horizon (B-1). The older age (3650 ± 100 cal B.C., ß-72512) is rejected as one determined on secondary refuse, probably incorporated when terrace midden material was recycled into the mound fill.

A third inverted date is 3640 ± 170 cal B.C. (ß-72669) (Figure 5). It is a thin charcoal scatter from near the top of the K/A-1 fill (At1b1 in Figure 4), and older than the underlying date of 3360 ± 90 cal B.C. (ß-66045), which comes from a single large piece of charcoal, and is thus of greater integrity. The older sample (B-72669) has a larger sigma value (±170 yr.) and is thus more likely to be the

Table 1. Radiocarbon Dates from Watson Brake.

Structure, (Test Unit/Core) Fill, and Soil horizon	Uncalibrated ^{13}C corrected $\delta^{14}C \pm 1\sigma$ Yrs B.P.	Lab. Number	Material	Cal B.C. Intercept	Cal B.C. Yrs ± 2 sigma, 95% Probability	*p*
Ridge K/A (TU 2)	5070 ± 110	ß-72670	charcoal scatter		4220–4200	.011
K/A-tr, 2Ab2					4160–4150	.005
					4140–4125	.008
				3937, 3876, 3871, 3862, 3807	4050–3640	.967
Ridge K/A (TU 2)	4840 ± 170	ß-72669	charcoal scatter	3643	3980–3305	.947
K/A-1, At1b1					3300–3280	.005
					3270–3265	.002
					3240–3170	.025
					3165–3100	.022
Ridge K/A (TU 2)	4610 ± 90	ß-66045	charcoal piece		3635–3555	.080
K/A-1, At2b1				3366	3540–3090	.909
					3060–3040	.011
A-platform (TU 6)	4700 ± 90	ß-95002	charcoal scatter	3513, 3412, 3383	3660–3325	.953
Ap-tr, 2Ab3					3225–3175	.024
					3160–3120	.022
A-platform (TU 6)	4540 ± 60	TX-9004	humates		3500–3460	.041
Ap-tr, 2Ab3				3345	3375–3080	.918
					3070–3025	.041
A-platform (TU 6)	4360 ± 70	TX-9003	humates		3335–3215	.124
Ap-1, Ab2					3190–3155	.026
				2921	3125–2875	.85
Mound A (Core 2)	4550 ± 60	ß-130714	organic sedim.		3500–3450	.064
A-3, Ab3					3440–3435	.005
				3348	3380–3085	.902
					3065–3030	.029
Mound A (Core 2)	4580 ± 60	ß-130715	organic sedim.		3515–3400	.232
A-1?, A1b5				3358	3385–3095	.768
Mound B (TU 3)	4960 ± 120	ß-82009	charcoal scatter		4035–4025	.004
B-tr?, 2Ab4				3710	3985–3515	.987
					3405–3385	.008
Mound B (TU 3)	4660 ± 110	ß-80792	charcoal scatter	3497, 3463, 3376	3655–3090	.996
B-1, Ab3					3055–3045	.004
Mound B (TU 3)	3780 ± 60	ß-72331	charred bone		2455–2445	.007
B-2, A2b21					2430–2420	.007
					2405–2360	.007
				2200	2355–2030	.936
					1990–1985	.003
Mound B (TU 3)	4610 ± 90	ß-72671	charcoal scatter		3635–3560	.08
B-3, A1b1				3366	3540–3090	.909
					3060–3040	.011
Mound B (TU 3)	4860 ± 100	ß-72512	charcoal scatter		3935–3875	.049
B-3, A1b1					3870–3860	.004
				3647	3805–3495	.845
					3465–3375	.102
Mound B (TU 3)	4550 ± 110	ß-72672	charcoal scatter		3620–3600	.012
B-3, A1b1				3348	3520–2920	.988
Mound C (TU 4)	4690 ±90	ß-95000	charcoal scatter	3503, 3428, 3381	3655–3325	.935
C-tr, 2A1b2					3320–3315	.003
					3230–3170	.032
					3160–3115	.027
					3110–3105	.003
Mound C (TU 4)	4200 ± 60	TX-9002	humates	2876	2905–2620	.986
C-1, Bt2/Ab1					2610–2600	.013
Mound C (TU 4)	4220 ± 60	ß-93880	organic sedim.	2879	2920–2655	.937
C-1, hearth					2655–2620	.056
					2605–2600	.006

Table 1. Radiocarbon Dates from Watson Brake (continued).

Structure, (Test Unit/Core) Fill, and Soil horizon	Uncalibrated ^{13}C corrected $\delta^{14}C \pm 1\sigma$ Yrs B.P.	Lab. Number	Material	Cal B.C. Intercept	Cal B.C. Yrs ± 2 sigma, 95% Probability	*p*
Mound D (TU 8)	4700 ± 50	TX-9006	humates		3630–3575	.211
D-tr, 2A1b3					3575–3560	.033
				3513, 3412, 3383	3540–3370	.756
Mound D (TU 8)	3520 ± 120	ß-95003	charcoal scatter		2190–2180	.006
D-1, ACb2				1879, 1839, 1829, 1785	2140–1595	.957
					1590-1525	.037
Mound D (TU 8)	4330 ± 60	TX-9007	humates		3305–3300	.003
D-1, Ab2					3265–3240	.015
					3170–3165	.002
				2916	3100–2865	.955
Mound D (TU 8)	4050 ± 50	TX-9005	humates		2860–2810	.097
D-2, Ab1					2750–2725	.025
				2575, 2508, 2504	2700–2465	.878
Mound E (Core 1)	4750 ± 60	ß-130721	charcoal scatter	3625, 3588, 3525	3645–3495	.697
E-tr,? 2Btb1?					3470–3375	.303
Mound I (Core 5)	4580 ± 70	ß-130719	organic sedim.	3358	3520–3085	.981
I-2 top, A2b1					3060–3035	.017
Mound I (Core 5)	4690 ± 40	ß-130720	charcoal scatter		3630–3580	.149
I-2 base, ACb1				3503, 3428, 3381	3535–3370	.851
Mound J (Core 3)	4400 ± 50	ß-130716	charcoal scatter		3325–3225	.143
J-2, Ab2					3175–3160	.019
				3021	3120–2900	.837
Mound J (Core 3)	4670 ± 40	ß-130717	charcoal scatter		3625–3595	.071
J-1, A3b3 base				3499, 3457, 3435, 3377	3525–3360	.929
Mound J (Core 3)	4410 ± 70	ß-130718	organic sedim.		3335–3210	.25
J-1, A3b3 top					3195–3150	.066
				3078, 3071. 3025	3140–2900	.684
Ridge K/A (TU 2)	5070 ± 110	ß-72670	charcoal scatter		4220–4200	.011
K/A-tr, 2Ab2					4160–4150	.005
					4140–4125	.008
				3937, 3876, 3871, 3862, 3807	4050–3640	.967
Ridge K/A (TU 2)	4840 ± 170	ß-72669	charcoal scatter	3643	3980–3305	.947
K/A-1, At1b1					3300–3280	.005
					3270–3265	.002
					3240–3170	.025
					3165–3100	.022
Ridge K/A (TU 2)	4610 ± 90	ß-66045	charcoal piece		3635–3555	.080
K/A-1, At2b1				3366	3540–3090	.909
					3060–3040	.011
A-platform (TU 6)	4700 ± 90	ß-95002	charcoal scatter	3513, 3412, 3383	3660–3325	.953
Ap-tr, 2Ab3					3225–3175	.024
					3160–3120	.022
A-platform (TU 6)	4540 ± 60	TX-9004	humates		3500–3460	.041
Ap-tr, 2Ab3				3345	3375–3080	.918
					3070–3025	.041
A-platform (TU 6)	4360 ± 70	TX-9003	humates		3335–3215	.124
Ap-1, Ab2					3190–3155	.026
				2921	3125–2875	.85
Mound A (Core 2)	4550 ± 60	ß-130714	organic sedim.		3500–3450	.064
A-3, Ab3					3440–3435	.005
				3348	3380–3085	.902
					3065–3030	.029
Mound A (Core 2)	4580 ± 60	ß-130715	organic sedim.		3515–3400	.232
A-1?, A1b5				3358	3385–3095	.768

Table 1. Radiocarbon Dates from Watson Brake (continued).

Structure, (Test Unit/Core) Fill, and Soil horizon	Uncalibrated ^{13}C corrected $\delta^{14}C \pm 1\sigma$ Yrs B.P.	Lab. Number	Material	Cal B.C. Intercept	Cal B.C. Yrs ± 2 sigma, 95% Probability	*p*
Mound B (TU 3)	4960 ± 120	ß-82009	charcoal scatter		4035–4025	.004
B-tr?, 2Ab4				3710	3985–3515	.987
					3405–3385	.008
Mound B (TU 3)	4660 ± 110	ß-80792	charcoal scatter	3497, 3463, 3376	3655–3090	.996
B-1, Ab3					3055–3045	.004
Mound B (TU 3)	3780 ± 60	ß-72331	charred bone		2455–2445	.007
B-2, A2b21					2430–2420	.007
					2405–2360	.007
				2200	2355–2030	.936
					1990-1985	.003
Mound B (TU 3)	4610 ± 90	ß-72671	charcoal scatter		3635–3560	.08
B-3, A1b1				3366	3540–3090	.909
					3060–3040	.011
Mound B (TU 3)	4860 ± 100	ß-72512	charcoal scatter		3935–3875	.049
B-3, A1b1					3870–3860	.004
				3647	3805–3495	.845
					3465–3375	.102
Mound B (TU 3)	4550 ± 110	ß-72672	charcoal scatter		3620–3600	.012
B-3, A1b1				3348	3520–2920	.988
Mound C (TU 4)	4690 ±90	ß-95000	charcoal scatter	3503, 3428, 3381	3655–3325	.935
C-tr, 2A1b2					3320–3315	.003
					3230–3170	.032
					3160–3115	.027
					3110–3105	.003
Mound C (TU 4)	4200 ± 60	TX-9002	humates	2876	2905–2620	.986
C-1, Bt2/Ab1					2610–2600	.013
Mound C (TU 4)	4220 ± 60	ß-93880	organic sedim.	2879	2920–2655	.937
C-1, hearth					2655–2620	.056
					2605–2600	.006
Mound D (TU 8)	4700 ± 50	TX-9006	humates		3630–3575	.211
D-tr, 2A1b3					3575–3560	.033
				3513, 3412, 3383	3540–3370	.756
Mound D (TU 8)	3520 ± 120	ß-95003	charcoal scatter		2190–2180	.006
D-1, ACb2				1879, 1839, 1829, 1785	2140-1595	.957
					1590-1525	.037
Mound D (TU 8)	4330 ± 60	TX-9007	humates		3305–3300	.003
D-1, Ab2					3265–3240	.015
					3170–3165	.002
				2916	3100–2865	.955
Mound D (TU 8)	4050 ± 50	TX-9005	humates		2860–2810	.097
D-2, Ab1					2750–2725	.025
				2575, 2508, 2504	2700–2465	.878
Mound E (Core 1)	4750 ± 60	ß-130721	charcoal scatter	3625, 3588, 3525	3645–3495	.697
E-tr,? 2Btb1?					3470–3375	.303
Mound I (Core 5)	4580 ± 70	ß-130719	organic sedim.	3358	3520–3085	.981
I-2 top, A2b1					3060–3035	.017
Mound I (Core 5)	4690 ± 40	ß-130720	charcoal scatter		3630–3580	.149
I-2 base, ACb1				3503, 3428, 3381	3535–3370	.851
Mound J (Core 3)	4400 ± 50	ß-130716	charcoal scatter		3325–3225	.143
J-2, Ab2					3175–3160	.019
				3021	3120–2900	.837
Mound J (Core 3)	4670 ± 40	ß-130717	charcoal scatter		3625–3595	.071
J-1, A3b3 base				3499, 3457, 3435, 3377	3525–3360	.929
Mound J (Core 3)	4410 ± 70	ß-130718	organic sedim.		3335–3210	.25
J-1, A3b3 top					3195–3150	.066
				3078, 3071, 3025	3140–2900	.684

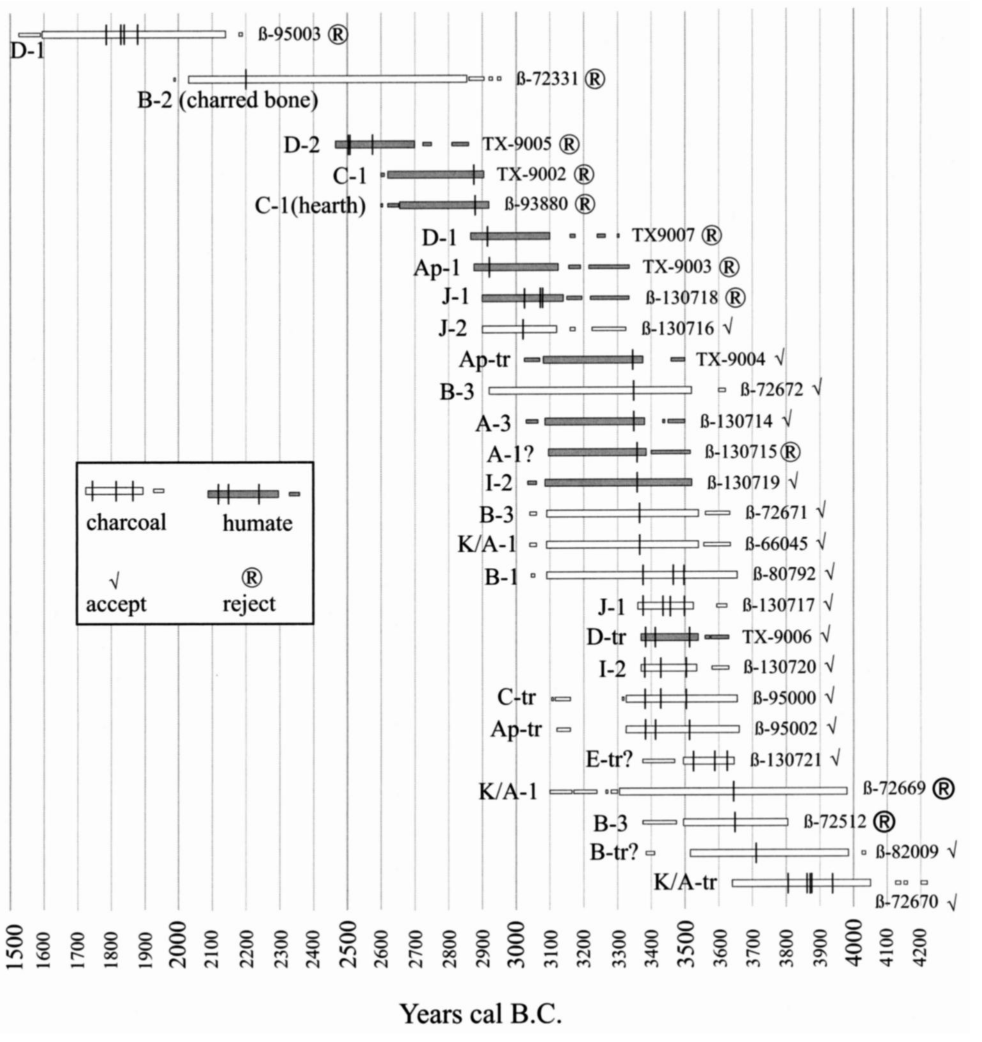

Figure 8. Watson Brake: calibrated radiocarbon age ranges at ± 2σ, with intercepts.

cause of this inversion. It is probably derived from a basal midden deposit that was used as later mound fill.

The charred bone date (2200 ± 60 cal B.C., ß-72331) near the base of the A2b2 horizon of Mound B (Figure 4) in the B-2 fill (Figure 5) is also clearly out of sequence. Although it is younger than all but one charcoal date (Figure 8), the bone cannot be derived from higher in the sequence, where no bone is preserved. In fact it may come from the underlying B-1 midden (see below). Reduced collagen content due to burning is the most likely cause of this anomalous date, which is rejected.

The two cases in which premound charcoal apparently became incorporated in later fills raises this important question: could *all* the charcoal from the fills have come from premound midden refuse? If so, the mound complex could be younger than any of the dates. This argument can be confidently dismissed on the grounds that the four accepted charcoal dates in Mound B are in correct stratigraphic order (older with depth), as are the two in ridge K/A. Such orderly sequences of stratified dates would not occur if premound charcoal was incorporated randomly as the earthworks grew. Under such conditions, inverted dates would be universal. There can be no doubt that the accepted charcoal samples date the fills in which they occur.

This is confirmed by two sets of humate dates on buried soils and/or middens that are also in correct stratigraphic order (older with depth). There are three in Mound D and two in A-platform (Figure 5 and Table 1). Buried soils developed on fills are in situ and cannot be interpreted as recycled humus from the premound terrace surface. However, dates on humates or bulk (organic sediment) samples are notoriously prone to contamination by modern humic acids and other modern carbon sources, as many authors have warned (e.g., Kristiansen et al. 2003; Martin and Johnson 1995). Indeed, the average calibrated age of the accepted charcoal samples from Watson Brake is 4696 ± 175 RCYBP versus 4410 ± 200 RCYBP for all soil humate/organically enriched sediments, a difference of 286 years. Statistically, the variance between the two groups is significant at the $p = .01$ level, confirming that some humate dates must be contaminated. Likely candidates for rejection are five humate dates with intercepts younger than the youngest acceptable charcoal date of 3020 ± 50 cal B.C. (ß-130716) in Figure 8. While none of these is out of correct stratigraphic order, we prefer for now to err on the side of caution and reject them as unsupported by the charcoal dates.

Two of the humate dates older than ca. 3000 B.C. should be rejected. Although ß-130718 (3080 ± 70 cal B.C) in the upper J-1 fill (A3b3) is in correct stratigraphic order, it is the same age as the charcoal date (3020 ± 50 cal B.C., ß-130716) in the overlying J-2 fill (Ab2) some 90 cm higher up the core (Figure 6). It is very probably contaminated. The same problem besets ß-130715 (3360 ± 60 cal B.C.) at the top of A1-? (A1b5 in Figure 7), which is the same age as ß-130714 (3350 ± 60 cal B.C.) in A-3 (Ab3) over a meter higher up the core.

As shown by the check marks in Figure 8, four humate dates and 12 charcoal dates have sufficient integrity to survive the purge. Together, they lend strong support to three propositions. The first is that Watson Brake was occupied very shortly after 4000 B.C. (ß-72670 in K/A-tr, At2b1). The second is that earthmoving began before 3500 B.C. (ß-130720 in I-2, ACb1; ß-130717 in J-1, A3b3; ß-80792 capping B-1, Ab3). The third is that moundraising continued until some time after 3000 B.C. (ß-130716 in J-2, Ab2), long enough for at least one more fill (J-3) to be added to Mound J. At around this time, at least after >2900 B.C. (TX 9002 in Mound C, Bt2/Ab1), one more fill (C-2) was added, and in Mound D two more fills (D-3 and D-4) were added on top of TX-9005.

Luminescence Dates

OSL dates (Table 2) should signal the onset of new earthworking activity when a soil surface was abruptly cut off from sunlight and optical bleaching stopped. Of the six available OSL dates, four fall within the age range of the accepted radiocarbon dates, while the other two are younger. They provide independent proof that all radiocarbon dates in the fills are not recycled from earlier terrace occupations. The OSL dates are evaluated in order of descending age estimate.

The oldest OSL date (5538 ± 936 yr B.P.) comes from 3–7 cm below the Ab1 horizon at the top of the B-3 fill (Figure 5). However, this bulk sample was incompletely bleached and a range of ages was obtained for different aliquots. The quoted value is for the youngest aliquot, and is a maximum age only (Saunders et al. 1997:1798).

A new sample from the (sharply defined) Ab1 horizon at the top of B-3 yielded an OSL date 5263 ± 643 yr B.P. (Figure 5). Based on single-grain analysis, it is preferable to the preceding set of results in terms of sampling position and method. At ca. 3300 B.C., its age estimate is strongly supported by the accepted charcoal dates (3370 ± 90 cal B.C., ß-72671; 3350 ±110 cal B.C., ß-72672) from just below the same Ab1 horizon. It also supports the case for rejecting the older date (3650 ± 100 cal B.C., ß-72512. The match between OSL dates and radiocarbon dates indicates that the Ab1 horizon formed in a relatively short time, probably a few centuries.

Mound K has a reliable date of 5468 ± 443 yr B.P. It comes from the uppermost segment of an intact buried soil with an ill-defined interface with the overlying fill. As no deeper buried soils were encountered in this 103-cm deep core (Auger 1 in Figure 3), this buried soil was assumed to be the original terrace surface. But its age (ca. 3500 B.C.) is younger than a radiocarbon date (3940 ± 110 cal B.C., ß-72670) on charcoal from the terrace soil (2Ab2 horizon) under adjacent ridge K/A (Figure 5). It may be that Auger 1 did not reach the terrace surface under Mound K. If so, the buried soil in question could be a cap on an older mound fill.

A sample cutting across the surface of the Ab1 horizon at the top of the C-1 (Bt2/Ab1) fill in

Table 2. Optical Luminescence (OSL) Dates from Watson Brake.

Provenience Structure (unit/core) Soil horizon, Depth below surface (cm)	OSL date Years B.P.	Lab No.	Sample Type	Quartz Grain Size Range	Source
Mound B (TU 3) A1b1, 98--102 cm	5538 ± 936	-	bulk , ~1000 grain aliquots	90–120 μ	Saunders et al. 1997 Feathers 1997
Mound B (Core) A1b1, nd	5263 ± 643	-	multi-aliquot, then single-gr.	nd	new date
Mound C (Core) Bt2/Ab1, 71 cm	4900 ± 1500	UW-524	multi-aliquot, then single-gr	90–125 μ	Bush and Feathers 2003
Mound K (Auger 1) Ab1, 49 cm	5468 ± 443	-	multi-aliquot, then single-gr.	nd	new date
Ridge K/A (TU 2) A2tb1, 90--93 cm	4003 ± 444	-	bulk , ~1000 grain aliquots	90–120 μ	Saunders et al. 1997
Ridge J/K (Core 0) 2Ab1, 81--111 cm	4391 ± 517	-	multi-aliquot, then single-gr.	n.d.	new date

Mound C (Figure 5) yielded a bimodal curve from the multi-aliquot analysis. The older spike reflects the poorly bleached overburden and the younger spike is the fully bleached surface (Bush and Feathers 2003). When separated, the younger aliquot gives a date of 4900 ± 1500 yr B.P. Although this overlaps with the rejected humate dates (2880 ± 60 cal B.C., ß-93880; 2880 ± 60 cal B.C., TX-9002) from C-1, the error on the OSL date sigma is so large that it cannot be accepted as solid support for the humate dates.

The well-defined At1b1 horizon at the top of K/A-1 produced an average age from multigrain single aliquots of 4003 ± 444 yr B.P. (Figure 5). Although the sample appeared well bleached before burial (Saunders et al. 1997), it is more than a millennium younger than the accepted charcoal date (3370 ± 90 cal B.C., ß-66045) just below the same buried soil. Until the more refined single-grain method is applied here, this date is not easily judged and should be rejected for now.

Ridge J/K has an OSL date of 4391 ± 517 yr B.P. Based on single-grain age distributions, it comes from the top of the Atb1 horizon with fire-cracked rock that is certainly fill (Figure 6). At ca. 2400 B.C., it is much younger than a charcoal date from the adjacent and similar buried soil (Ab2) in J-2 (3020 ± 50 cal B.C., ß-130716). In spite of the single-grain method applied, this date should be rejected.

Six values obtained from the crest of Mound C track the presence of recently bleached surface grains down the profile. The deepest segment, at 25–30 cm below the surface, yielded an average single-aliquot age of 3535 ± 230 years. Ages decline steadily upward through the sample column to an average of 68 ± 10 years for the surface sample (0–5 cm). Details are given in Bush and Feathers (2003:Tables 1–3, Figure 2). These results are not true dates but reflect the proportion of fully bleached grains (age 0) mixed in with poorly bleached fill at different depths in the topsoil profile.

The same strictures apply to the deepest age of 2642 ± 305 years from 30–35 cm below the crest of Mound B. Values again decline steadily upwards, to just 17 ± 9 years for the almost fully bleached surface sample.

Age Estimates for Soils

There are no absolute dates that establish when moundbuilding activity ceased, because the active topsoils preclude the use of both OSL dating and radiocarbon dating. Surface soils on both the mounds and ridges are all well-drained Alfisols with strongly expressed A-E-Bt horizonation. The Mound A-platform (T U6) profile is a good example (Table 3 and Figure 4). At the top, the A horizon is a 9-cm-thick dark brown fine sandy loam. Like older soils, it is relatively thin because leaf litter is not deeply incorporated in well-drained forest soils due to rapid mineralization (Buol et al. 1989:311–312). By contrast, its underlying E horizon is 25 cm thick. Heavily eluviated, this albic horizon has lost silicate clays, organic compounds, extractable bases, iron, and aluminum, leaving concentrated sand- and silt-sized mineral particles with low pH (Table 4). Although the rate of E horizon

Table 3. Watson Brake Mound A-platform (TU 6) Soil Horizons.

Depth (cm)	Soil Horizon	Soil Color[a]	Texture Class[b]	Structure[c]	Consistency	Lower Boundary[d]	Comments
0-9	A	7.5YR 3/2	FSL	w, m, sbk prt. w, f, gr	very friable	c, s	Common fine to coarse roots; few fine gravel.
9-20	E1	7.5YR 4/3	FSL	w, md, sbk	very friable	c, s	Common fine to coarse roots; few fine gravel.
20-34	E2	7.5YR 4/4	FSL	w, md, sbk	very friable	c, w	Common fine to coarse roots; common fine gravel.
34-46	Bt1	7.5YR 3/4	SL	m, md, sbk	friable	c, s	Few thin distinct patchy clay films on ped faces; few fine to medium roots; many fine gravel.
46-71	Bt2	5YR 4/4	SL	m, md, sbk	friable to firm	a, w	Many thick, prominent, nearly continuous clay films on ped faces and in pores; common micro-laminated clay films, especially in pores; few fine to medium roots; many fine to medium gravel.
71-89	Atb1	7.5YR 3/2	SL	m, md, sbk	friable	c, i	Common thick, prominent, discontinuous clay films on ped faces and in pores; common micro-laminated clay films, especially in pores; few fine to medium roots; many fine gravel.
89-98	Btb1	7.5YR 4/6	SL	w, md, sbk	friable	c, s	Few thin, distinct, patchy clay films on ped faces and in pores; few fine to medium roots; many fine gravel.
98-120	BC1b1	7.5YR 3/4	SL	w, md, sbk	friable	c, w	Common fine to medium roots; common fine pores; many fine to coarse gravel.
120-141	BC2b1	7.5YR 4/6	LS	w, md, sbk	friable	c, s	Few fine roots; common fine pores; many fine to coarse gravel.
141-151	Ab2	7.5YR 3/3	FSL	w, md, sbk	friable	c, w	Few fine roots; common fine to coarse gravel.
151-190	BC1b2	7.5YR 4/6	LFS	w, m, sbk	friable	d, w	Few fine roots; common fine to coarse gravel; few clean sand grains; few silt coats on some ped faces.
190-230	BC2b2	7.5YR 5/6	LFS	w, md, sbk	friable	a, s	Few fine roots; few medium to coarse gravel; common clean sand grains; common silt coats on some ped faces.
230-254	2Ab3	7.5YR 2.5/1	L	w, md, sbk	friable	c, s	Few fine roots; few medium gravel; common fine to medium pores.
254-265+	2Btb	7.5YR 3/4	L	m, md, sbk	friable	- -	Common medium distinct brown (10YR 5/3) and dark brown (10YR 3/3) mottles; few fine roots; few thin, distinct, discontinuous clay films on ped faces and in pores; common fine and medium pores; few medium gravel.

[a]Dry color (Munsell color chart)

[b]Textural classes: L = Loam; SL = Sandy loam; FSL = Fine sandy loam; LS = Loamy sand

[c]Structure: w = weak; m = moderate; md = medium; f = fine; gr = granular; sbk = subangular blocky; prt. = parting to

[d]Boundaries: a = abrupt; c = clear; d = diffuse; s = smooth; w = wavy

development remains unknown for northeastern Louisiana, this one is so thick and heavily leached that it certainly formed over a long period.

The underlying argillic Bt horizon is thick, strongly expressed, and clay rich. Illuviation has caused ubiquitous laminated clay coatings (argillans) on chert artifacts and charcoal fragments. Argillans even form clay bridges between sand grains. Clay illuviation has clearly continued long after mound construction ceased, so much so that the Bt horizon of the surface soil is welded onto the underlying Atb1 buried soil horizon; this accounts for the latter's subangular-blocky structure and clay films as well as its Atb1-Btb1 horizonation. Exchangeable bases and minerals leached from the E horizon have accumulated in the Bt horizon. Base saturation increases abruptly down profile, as does free (extractible) iron (Fe) and cation exchange capacity (Table 4). Changes of this magnitude indicate a period of soil development measurable in thousands of years.

Perhaps the weathered (preconditioned) nature of the material used as earthwork fill in the final stages of mound construction contributed to the intensity of pedogenesis, but this could not have helped accelerate the process. Formation of thick E and Bt horizons is time dependent because weathering and clay formation and translocation are all slow processes (Birkeland 1999). In sum, the physical and chemical properties of the surface soils, plus their macro- and micromorphology, do not refute the maximum "ages" derived from the luminescence studies at the crests of Mounds B and C (see above).

By contrast, most buried soils have weakly expressed A-C, A-AC, or A-BC profiles. The absence of B horizons can only mean that individual construction phases were not separated by long periods. In Mound A-platform, the Ab2-BC1b2 profile probably reflects less than 200 years of pedogenesis before emplacement of the overlying fill. Overall, the soil-stratigraphic record strongly suggests that most earthworks were quickly constructed, with only short hiatuses between them, as suggested by the three cases discussed above where OSL dates of new construction starts overlap the humate dates of the buried soils that they covered. The one exception (a 1,000-yr hiatus in ridge K/A) has not been sampled at small enough intervals to detect the down-profile changes so typical of the surface soils.

A Partial Correlation

We now turn to the question of whether the earthworks grew in a set of haphazard building increments, or in coordinated bouts of moundraising in which several earthworks were heightened and extended together. Clearly, a convincing correlation of all fill units will not be possible until many slit trench profiles have been exposed so that buried soils can be traced from one earthwork to the next. For now, there are only 18 acceptable chronometric dates by which to test either scenario. Haphazard growth will result in a random spatial and temporal distribution of dates, while building bursts will result in clusters of contemporary dates in adjacent earthworks.

Figure 9 summarizes the (very) partial correlation attained with all currently available data, a synthesis that presents more questions than answers. Whether the terrace rim (or deeper fill) has been encountered under C/B, B, and B/A remains unresolved. Matters are further complicated by the paucity of accepted dates (10) distributed among only seven fill units. Other accepted dates all come from the terrace surface.

The initial occupation of the terrace surface was sporadic, first at ca. 4000 B.C. (K/A-tr), again at ca. 3700 B.C. (B-tr? shell midden), then at ca. 3600 B.C. (E-tr?). At ca. 3500 B.C., terrace occupation became widespread (J-tr, Ap-tr, C-tr, and D-tr). The last dated terrace occupation is at ca. 3350 B.C. (Ap-tr, top).

No fill units can be firmly tied to the ca. 4000–3600 B.C. terrace occupation(s), but the ca. 3500 B.C. occupation correlates firmly with two fill units (B-1, I-1), and with a probable fill in K-1. Substantial earthworks can also be linked to the ca. 3350 B.C. occupation (I-2, K/A-1, A-3, and B-3).

The last dated event was the modest raising of J-2 at ca. 3000 B.C., but this was followed by a more substantial addition (J-3) that demonstrates further building activity beyond that date. Although humate dates from C-1 and D-1 suggest that final construction began on Mounds C and D before 2900 B.C., firm correlation with J-3 is not possible.

There was evidently a pause in construction at ca. 3500 B.C. at three mounds (B, I, K) and again

Table 4. Watson Brake Mound A-platform Granulometric and Chemical Properties of Soils.

Depth (cm)	Soil Horizon	Sand VC	Sand C	Sand M	Sand F	Sand VF	Sand Total %	Silt F	Silt Total	Clay F	Clay Total	Coarse Frags.	pH (1:1)	OC %	Total Extr. Bases (meq./100 g)	Al (meq./100 g)	CEC (meq./100 g)	Base Sat. %	Free Fe %
0-9	A	2.0	6.6	13.2	30.5	12.8	65.1	13.1	31.5	1.0	3.4	2.0	4.3	2.06	2.8	.6	7.2	39	.4
9-20	E1	1.5	2.5	18.6	28.4	12.5	63.5	18.4	31.1	1.6	5.4	2.0	4.1	.44	.7	1.2	4.8	15	.4
20-34	E2	1.5	5.6	14.5	29.1	12.4	63.1	17.3	31.5	1.7	5.4	9.0	4.2	.15	.9	1.1	3.9	23	.4
34-46	Bt1	3.3	15.1	27.8	18.3	5.5	70.0	11.0	15.4	8.6	14.6	13.0	4.5	.2	3.1	1.8	6.1	51	.8
46-71	Bt2	2.9	14.2	31.5	16.4	5.8	70.8	8.5	12.2	11.0	17.0	16.0	4.3	.17	2.3	3.4	6.5	35	.8
71-89	Atb1	2.0	19.4	35.0	19.3	3.9	79.6	6.7	7.9	7.3	12.5	7.0	4.5	.25	2.9	1.7	7.0	41	.6
89-98	Btb1	2.3	14.4	37.2	23.3	2.3	79.5	3.7	6.6	8.5	13.9	11.0	4.6	.14	2.8	2.5	6.2	45	.4
98-120	BC1b1	1.6	11.9	34.4	25.5	5.6	79.0	3.9	9.2	6.6	11.8	9.0	4.6	.17	2.7	1.7	5.5	49	.4
120-141	BC2b1	3.0	15.7	32.1	26.9	6.2	83.9	4.2	8.4	4.6	7.7	11.0	4.5	.07	1.8	1.4	4.2	43	.3
141-151	Ab2	1.2	6.1	19.1	42.8	5.6	74.8	9.8	15.3	5.7	9.9	4.0	4.5	.16	2.1	1.6	5.7	37	.5
151-190	BC1b2	1.1	4.7	18.4	55.6	4.6	84.4	5.0	8.4	3.8	7.2	4.0	4.4	.07	1.3	.9	4.2	31	.3
190-230	BC2b2	.8	4.4	20.2	55.1	5.1	85.6	4.9	9.5	2.9	4.9	5.0	4.5	.05	1.0	.8	3.4	29	.3
230-254	2Ab3	.9	1.6	6.0	22.9	14.9	46.3	23.7	37.0	7.9	16.7	2.0	4.7	1.28	9.0	.1	20.9	43	1.2
254-265+	2Btb	.1	.7	3.6	29.6	12.2	46.2	18.9	34.5	11.2	19.3	.0	4.7	.2	6.2	.4	11.3	55	.9

OC = Organic carbon; Al = Exchangeable aluminum; CEC = Cation Exchange Capacity; Base Sat. = Base Saturation

Abbreviations for sand-size (2.0-.05 mm) particles: VC = Very Coarse (2.0-1.0 mm); C = Coarse (1.0-.5 mm); M = Medium (.5-.25 mm); F = Fine (.25-.10); VF = Very Fine (.10-.05 mm). Abbreviations for silt-size (.05-.002 mm) particles: F = Fine (.02-.002 mm). Abbreviations for clay-size (< .002 mm) particles: F = Fine (<.0002 mm).

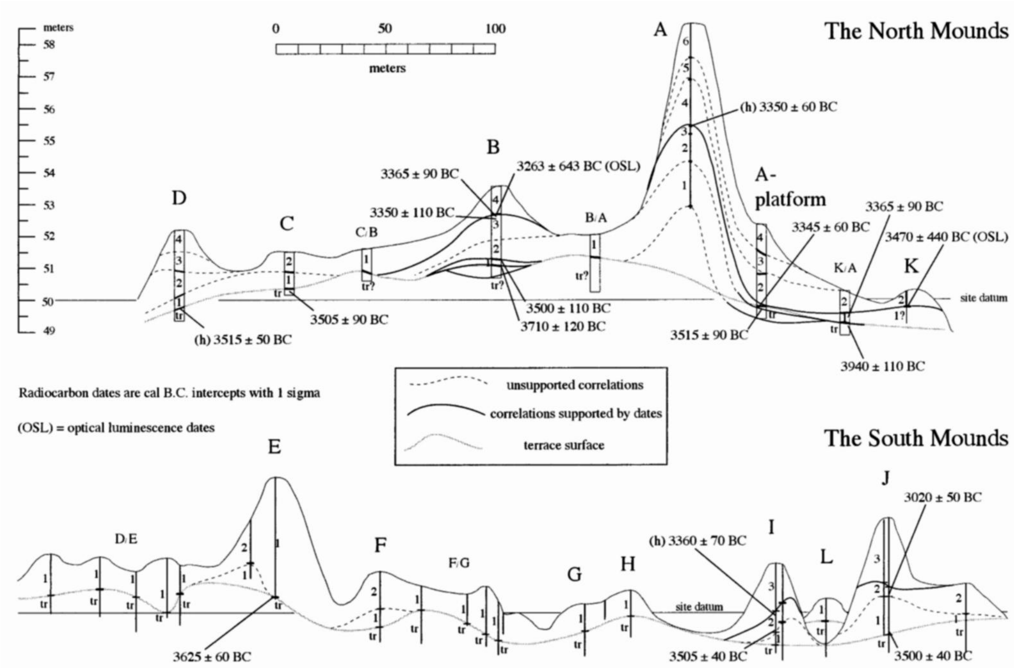

Figure 9. Partial correlations of Watson Brake earthworks based on the accepted chronometric dates.

at ca. 3350 B.C. at four mounds (I, K/A, A, B). Both pauses are a strong hint that building efforts were widespread and coordinated, but little more can be said at this stage. Any other correlations suggested in Figure 9 by dashed lines are pure conjecture, since none is supported by a chronometric date. All the earthworks on the west side of the complex fall outside the partial correlation. Any further attempt to subdivide the record into building stages cannot be supported by the available dates.

Artifacts

The structural fills contain variable amounts of cultural debris dominated by fire-cracked rock, flaked lithics, and fired earthen objects. Although a few artifacts were recovered from the very shallow south mound test units, only the north mound assemblages have been studied in detail.

Fire-cracked Rock

This material is mostly chert gravel with characteristic heat fractures, discoloration, and crazing. These attributes were replicated on local gravels used in roasting, steaming, and boiling experiments (Jones 1997). Fire-cracked rock is the most abundant artifact class (347 kg recovered), with densities far higher in the north mounds near the terrace edge (av. 8.5 kg/m^3 of fill) than in the south mounds (av .9 kg/m^3 of fill) farther away from gravel supplies.

In the north mounds, fire-cracked rock is concentrated in the lowest levels of Mounds D, C, A-platform, and ridge K/A, but is absent from the terrace (?) sediments under C/B, B, and B/A (Figure 10, lower row). Densities decline sharply in the topmost fills of most test units. They disappear altogether from two levels in the Ap-1 fill (Figure 10). Fire-cracked rock was incorporated in most fills by three different processes. It either came from nearby occupational middens recycled as building material, or as fresh gravel hauled on to mound surfaces for use in cooking. Later pedoturbation of briefly occupied surfaces may have diffused fire-cracked rock into the underlying sediment. Relatively intact sheet middens are suggested by the several high-density spikes seen in Figure 10 (lower row).

Flaked Lithics

Flaked lithics were made of smallish tan chert gravels (Wang 1952:71), obtainable from the underlying terrace deposits. A few flakes are of ferruginous

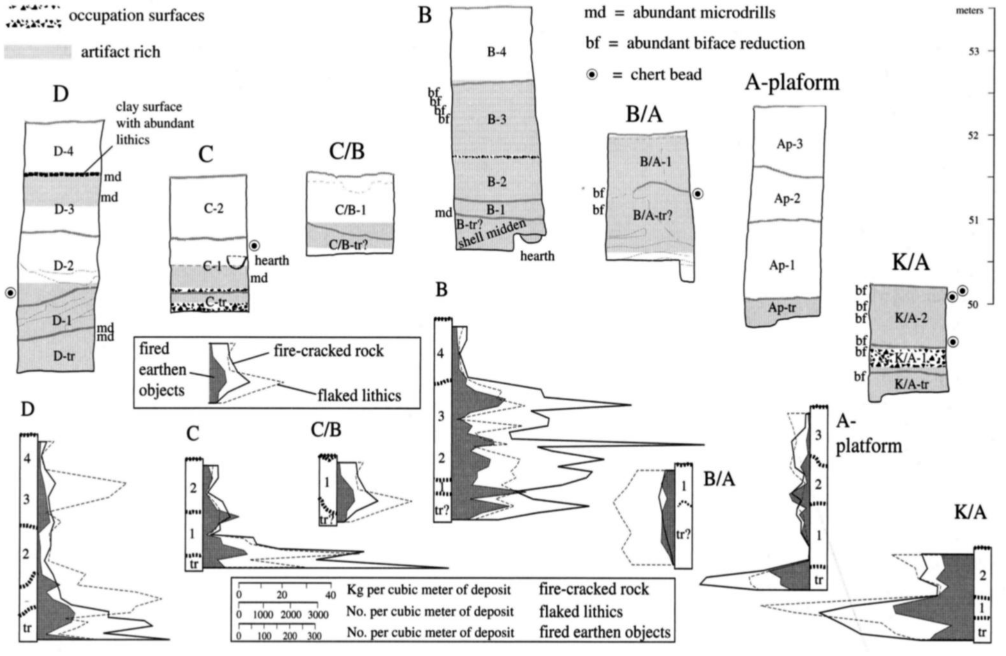

Figure 10. Watson Brake north mounds: top row, profiles of the seven test units showing cultural markers; lower row, changes in density of lithics, fired earthen objects, and fire-cracked rock from the same test units.

sandstone and unworked petrified wood from upland deposits less than six km west of the site (Wang 1952:66).

A total of 16.9 kg of lithics was recovered. They occur in all levels in the north mound fills, and their densities partly mimic that of the fire-cracked rock, with greatly reduced densities in the uppermost fills (Figure 10, lower row). However, there is a notable exception in upper Mound D, where lithic densities briefly peak around a thin clayey surface that suggests a temporary workshop floor. This defines the boundary between the D-3 and D-4 fills. Lithics reach extraordinary densities in the K/A-1 levels of ridge K/A, also in Mound C at the base of the C-1 fill, both reflecting relatively intact occupation surfaces (Figure 10).

Altogether, 32,640 flaked lithics were recovered from the north mounds, of which only 1.2 percent (n = 392) are formal tools and .5 percent (n = 175) are cores (Johnson 2000). The rest are flakes and flake fragments of which 67 percent are quite small (<6 mm). Some larger pieces show casual retouch and/or visible edge damage. Only one was unifacially trimmed. Table 5 gives the distribution of major core and tool types among the richer occupation levels. No trends can be discerned in the data. Of the 24 finished bifaces, only nine match established chronological types. Four are Evans points (e.g., Figure 11a, b); another four are Ellis points (e.g., Figure 11c, d); and one (Figure 11e) is a rather wide Ponchartrain point. Although all three types are found at Poverty Point period sites, Evans points are considered to be Middle Archaic (Jeter et al. 1989; Saunders et al. 2001). The other bifaces cannot be typed due to severe rejuvenation and/or breakage. Unfinished bifaces (n = 51) in various stages of reduction (Table 6) indicate that bifaces were routinely made on site, and this is confirmed by the debitage breakdown shown in Figure 12. A full range of biface reduction flakes is split evenly between early and late stage types. Some of the early stage flakes probably come from bifacially worked flake cores, but the rest show clearly that bifaces were being made on site. This activity was heavily concentrated on ridges B/A and K/A (Figure 10, top row) and briefly on a possible temporary surface in upper B-3 in Mound B.

Although bladelet production is definitely present, it was not well developed (Figure 11f, g). The average blade scar count per bladelet core is only 3.6 ±1.6 scars, and half of all bladelets retain some pebble cortex. Platform edges were not prepared,

Table 5. Major Lithic Types in Occupation Levels of North Mounds at Watson Brake.

Mound-Fill unit, Soil horizon	Flake Core	Blade Core	Blade	Drill Preform	Drill	Unfinished Biface	Finished Biface	Total
D-3 top, Bt3-BtC	3	2	6	51	73	-	-	135
D-2 top, Ab1	3	-	-	1	3	1	-	8
D-1 top, Ab2	5	-	5	3	7	-	1	21
D-tr top, 2A1b3	3	-	3	1	7	1	-	15
C-2 top, A1-A2	7	-	-	-	-	1	1	9
C/B-1 top, A-E	1	-	1	1	1	2	-	6
B-4 top, A-E1	-	1	-	-	-	-	1	2
B-3 upper, A1b1	2	-	-	-	-	2	2	6
B-2 top, A1b2	6	-	-	-	1	-	-	7
B/A-1 top, A-E	1	-	3	3	-	2	-	9
Ap-3 top, A-E1	1	-	-	3	2	1	-	7
Ap-2 top, Atb1-Btb1	2	1	-	-	-	-	-	3
Ap-1 top, Ab2	8	-	-	1	3	2	-	14
K/A-2 top, A-E1	13	1	10	4	3	5	1	37
K/A-tr top, 2Ab2	6	-	4	3	-	1	4	18
All occupation lvls.	61	5	32	68	100	18	10	294
All other fills	98	11	38	22	54	34	13	270
Grand Totals	159	16	70	90	154	52	23	564

Note: Data from Johnson (2000).

unlike the more formalized Poverty Point period bladelet technology (Webb and Gibson 1981). At Watson Brake, none of the bladelets was systematically retouched although 19 larger ones display light edge damage from use. Some (n = 39) were converted into drill preforms (Figure 11h, 1) and drills (Figure 11j, k), a pattern that prefigures the Poverty Point period when bladelets were routinely transformed into Jaketown perforators to be used as drills (Yerkes 1983).

The drills from Watson Brake and their preforms are extremely small (Table 6) and can reasonably be termed "microdrills." At least half the preforms are made on flake blanks rather than bladelets. Of the finished microdrills, 62 percent are steeply retouched to a rectangular cross section, with one end tapered and the other blunt. Some (22 percent) are blunt at both ends, and a few (eight percent) are tapered at both ends. The rest are drill fragments. At 40x magnification, over half the drill tips show rotary wear, mostly on the blunt end, which suggests that the tapered end was hafted in some sort of hardwood or bone shaft for the bow drill. Prominent in the tool inventory in Table 5 is the Mound D assemblage, dominated by drills and drill preforms. This is from the clayey surface with very high lithic density, interpreted as a workshop surface between D-3 and D-4 (Figure 10, top row).

Chert Beads

Although chert beads were found in various stages of production, none came from the drill-rich floor

Table 6. Dimensions (mm) of Biface and Drill Reduction Stages at Watson Brake.

		Thickness			Width			Length		
Biface Stage	Total	N	Mean	S.D.	N	Mean	S.D	N	Mean	S.D
Biface blank	34	33	13.6	4.4	31	31.4	5.6	23	43.7	8.6
Preform 1	5	5	7.8	2.6	1	28.0	-	-	-	-
Preform 2	12	10	10.2	4.3	5	27.0	2.8	1	44.0	-
Finished Biface	24	21	7.9	2.5	12	27.6	5.5	7	52.7	17.1
Drill Stage										
Microblade	70	62	3.1	1.7	62	10.3	3.0	24	23.4	8.6
Drill Preform	93	93	2.7	1.1	92	5.7	2.8	85	13.5	5.7
Finished Drill	154	154	2.1	0.5	154	2.7	0.7	141	9.2	2.8

Note: Data from Johnson (2000).

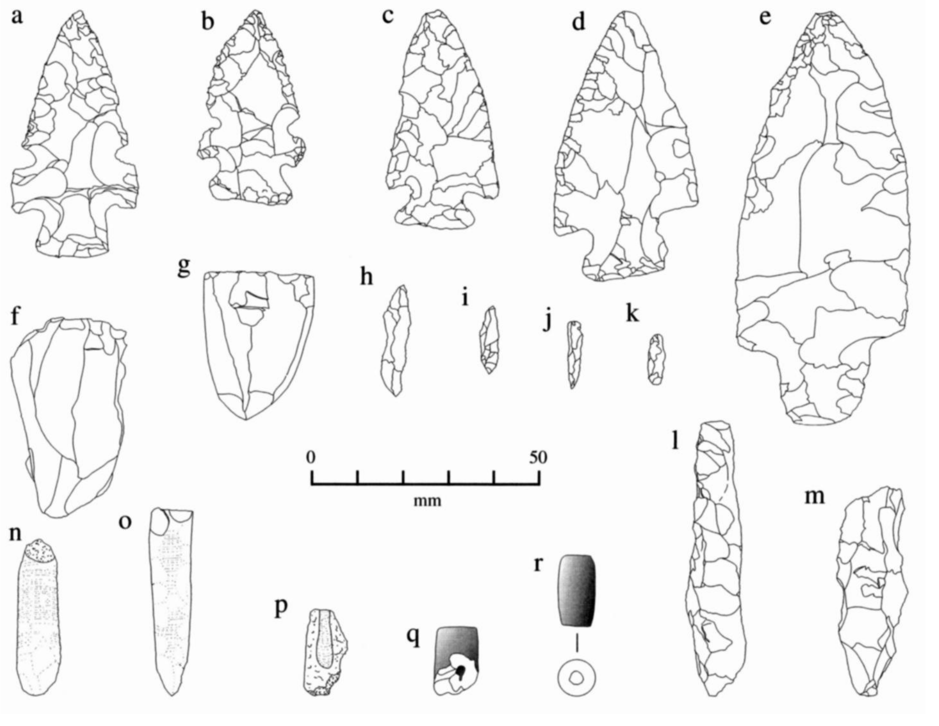

Figure 11. Stone artifacts from Watson Brake: (a, b) Evans points; (c, d) Ellis points; (e) Pontchartrain point; (f, g) bladelet cores; (h, i) drill preforms; (j, k) microdrills; (l, m) flaked bead preforms; (n, o) ground bead preforms; (p-r) chert beads.

described above. Instead, they are scattered through the later fills (Figure 10, top row), nowhere associated with concentrations of microdrills. Another came from Mound A-platform at an unknown depth (a wall drop), and an eighth is unprovenienced.

The beads are made of local chert except for one drilled fossil crinoid stem, also of local origin. Usually an elongated pebble was shaped into a rough cylindrical blank by bifacial or trifacial flaking (Figure 11l, m). Flaked edges were then reduced by rotational grinding (Figure 11n, o), after which the two ends were ground off flat, and these facets were drilled (Figure 11p-r). The sides of the drill holes are parallel, wider than the diameter of surviving drill bits, and several times their length, indicating that drills were hafted. This production sequence is duplicated at other sites such as Keenan Cache (Connaway 1981) and Site 22WR691 near Vicksburg (Figure 1), both of Middle Archaic age (S. McGahey, personal communication 2005), and at Cad Mound in east central Louisiana (Gibson 1968).

Non-flaked Lithics

Non-flaked lithics include 13 hammerstones of sandstone gravel, nine abraders, 16 handheld grindstones, and a large metate. Many of these are broken. They are made of siltstone, sandstone, and ferruginous sandstone, totaling 2.8 kg. Their distribution in the fills appears random.

Bone and Antler Tools

Given the poor state of bone preservation in most parts of the site, bone and antler tools are relatively scarce. There are eight bone awls, one definite and another possible fish hook, a small bone spatula, a finished bone bead, and five bone bead blanks (ring-cut shafts). One long-bone shaft fragment is stained with red pigment. There is only one antler artifact, a flaker for stoneworking. Almost all items come from the B-tr? shell midden at the base of Mound B (Figure 10, top row), the only excavated deposit with suitable conditions for bone preservation.

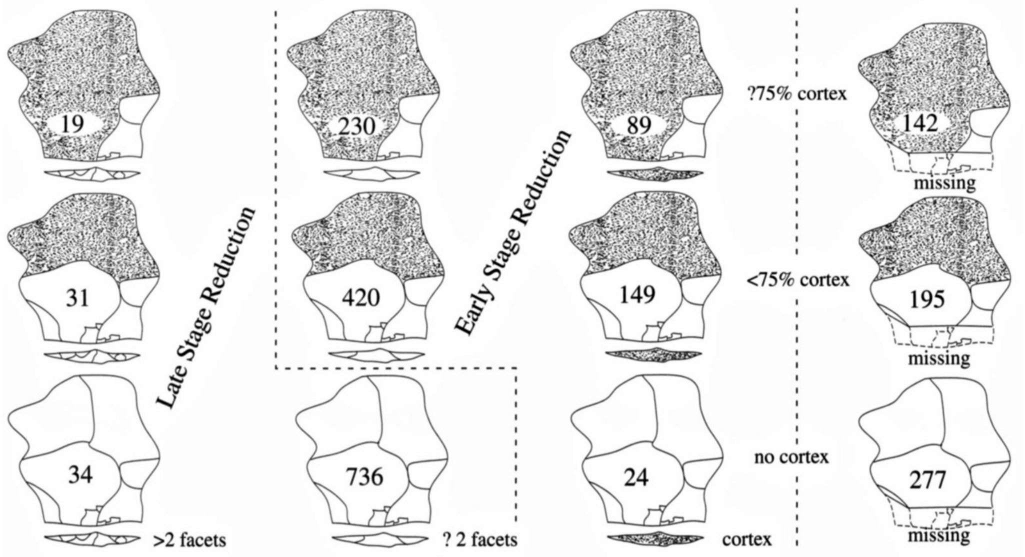

Figure 12. Numbers of biface reduction flakes, in categories sorted by dorsal cortex (columns) and platform facetting (rows).

Manuports

Manuports include a quartz crystal, fossils (mostly crinoid stems), two red jasper pebbles, and lumps of hematite and limonite (a few possibly shaped). They are randomly distributed in the fills. All of these originate in the terrace gravels beneath the earthworks. There are also pieces of slate not found locally, but certainly sourced to the Ouachita River valley (R. De Hon, personal communication 2003), so they probably came from only a few kilometers away. Two pieces were found in ridge K/A and another in Mound G.

Younger Artifact Intrusions

A ground and polished hematite plummet came from the upper fill of Mound E at a depth of 32–42 cm (Johnson 2000:Figure 7). It is typical of Poverty Point period sites and the hematite can be sourced to central Arkansas (Gibson 2001). This is certainly a surface drop worked downward by pedoturbation next to a burnt tree stump. The absence of a buried A horizon excludes the possibility that a final veneer of fill could have been added in Poverty Point times. Another classic Poverty Point item is a biconical fired clay object from a depth of 20–40 cm near the top of ridge C/B, also certainly worked in from the surface.

A very thin scatter of ten sherds is restricted to the top levels of the north mounds. The uppermost spits yielded single sherds on Mound D, ridge B/A (incised, grog-tempered), Mound A-platform, and ridge K/A (a decorated rim). These were also surface drops worked into the topsoil, including a plain grog-tempered body sherd from a depth of 20–40 cm, and another from the 40–50-cm spit. The latter is a Tammany Punctated *var. Tammany* sherd (Phillips 1970) that dates to the Tchefuncte period (500–100 B.C.). A sand-tempered, weathered sherd also came from the 20–40-cm spit in the top of Mound B.

Fired Earthen Objects

A total of 34.2 kg of fired earthen objects and fragments was recovered. These are relatively small and roughly finished in several shapes that invite comparisons with solid geometry. Most specimens are broken, and none has been found to refit. The typology is detailed in Saunders et al. (1998) along with variations in dimensions. Sizes are quite standardized, typically 4 cm x 4 cm x 3.5 cm for a whole cuboidal (n = 7), and 4 cm x 4.5 cm x 3 cm for a whole rectanguloid (n = 2), while fragments of both (n = 178) are of similar dimensions. Other shapes are shown in Figure 13, including cylindrical (n = 3), rounded cube (n = 13), and spherical (n = 27). Other rare shapes include tabuloid (n = 2), barrel (n = 3), amorphous (n = 4), and unknown shape (n = 8). The density by weight of fired earthen objects in the deposits (1.65 kg/m^3) is actually higher

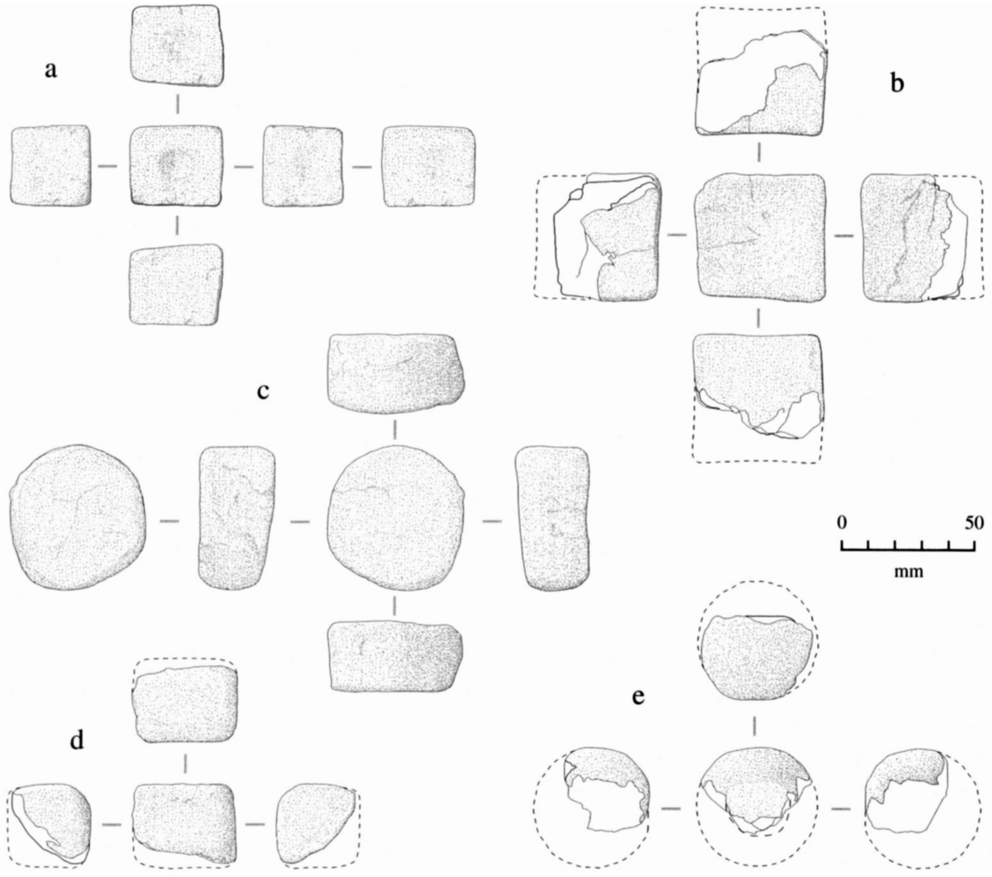

Figure 13. Fired earthen objects from Watson Brake: (a, b) cuboidal; (c) cylindrical; (d) rounded cube; (e) spherical.

than that of the lithics. Although densities change in overall harmony with those of lithics and fire-cracked rock (Figure 10, lower row), their distribution does not mimic the others. The correlation coefficient with fire-cracked rock distribution is only .585. A small concentration of fired earthen objects comes from the surface of C-1 fill in Mound C, where a cube was found set against another block fragment, with several others scattered around them, all within in a darker colored sediment than the surrounding matrix. This recalls the imperfectly described cache of blocks reported from Lower Jackson Mound (Figure 1) described by the finder as so tightly stacked in a pit that no sediment occurred between the pieces (Saunders et al. 2001). Several other Middle Archaic sites in Louisiana and one on the Mississippi coast have produced similar objects (Saunders et al. 1998; Webb 1982).

The function of these objects remains unknown, although their distribution in the north mounds suggests mundane domestic and/or craft activities rather than ritual associations. Both cookery and/or heat treatment may be implicated, but these possibilities need to be investigated.

Features

Given the limited areas of excavation, the high number of features encountered suggests that area excavations may reveal much more about structures and spatial organization.

Firepits

Six small pit outlines were encountered in the north mounds. These may be hearths, cooking pits, or heating pits. The oldest is in B-tr? under Mound B,

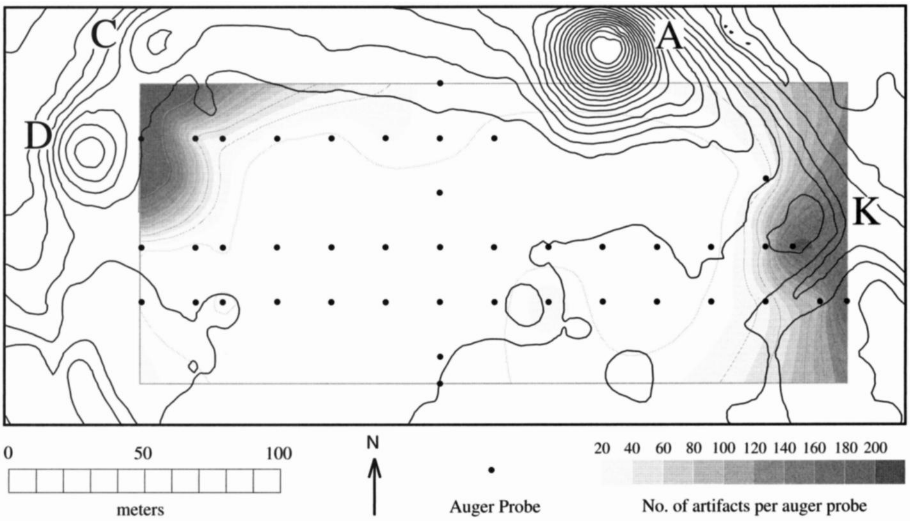

Figure 14. Density of all artifacts (lithics, fired earthen objects and fire-cracked rock) from the auger probes in the enclosure.

an outline of a small firepit base (charcoal and burned shell) in the shell-rich 2B4 horizon (Figure 4). Only 25 cm in diameter and 10 cm deep, its rim is now is obliterated by pedoturbation, but it must originate in the overlying sediments of the 2Ab4 horizon. Thus the original pit must have been 25–30 cm deep.

Next in sequence is a small firepit outline in the C-1 fill of Mound C, shown in profile in Figure 4. Just 25 cm in diameter and 15 cm deep, it contained nothing but organically enriched sediment. Matching radiocarbon dates suggest that its rim must originate in the Bt2/Ab1 horizon (Figure 5), so it was twice as deep as its surviving outline suggests.

The D-2 fill in Mound D produced one firepit originating in the Ab1 horizon and dug 30–35 cm into the underlying fill. With a 40-cm diameter, it had a basin-shaped base with random patches of fired clay. The fill is a light gray sediment without charcoal or artifacts. Above it, two identical pits were dug from the drill-rich "workshop" surface into the D-3 fill.

Another small pit was dug into the Ap-2 fill in the Mound A-platform. Measuring 30 cm in diameter and 30 cm deep, it contained a mix of organically enriched sediment, very little charcoal, some fire-cracked rock, small pieces of burned loam, and one burned bone fragment. Its rim does not originate in the Atb1 horizon (Figure 4) but just above it, in the overlying Ap-3 fill. This same level yielded an Evans point, a bead blank, and a small cluster of broken fired earthen objects. Clearly, a small ephemeral occupation took place here at the very beginning of the uppermost Ap-3 building episode.

Postholes

Postholes were found only in the terrace surface. One is under Mound B, dug into the pedoturbated shell midden deposit (2Ab4) in Figure 4. Its rim originates in a thin lens of mottled fill that may represent a prepared floor.

The other two were found just 10 cm apart under ridge K/A. They were dug 20 cm into terrace deposits from its surface (2Ab2 in Figure 4).

Miscellaneous Depressions

The terrace surface under Mound A-platform revealed three shallow (15–25 cm deep) depressions of uneven outline, quite possibly tree-uprooting shadows. The density of all cultural items within the depressions was the same as in the 2Ab3 horizon (Figure 4).

The Enclosure

None of the rises in the enclosure (Figure 2) appears to be cultural in origin. No features were revealed by augering or coring (Figure 3). Indeed, the enclosure is almost bereft of lithics and fire-cracked rock (Figure 14). By contrast, densities rise steeply on the flanks of Mounds D and K where auger samples were taken. Occupation was restricted to the mounds and ridges, and the enclosure was not inhabited. While it is remotely possible that all trace of enclosure habitation has been scraped away and incorporated in the younger fills, we doubt that the enclosure would have been left this clean.

Subsistence

Extreme acidity of the structural fills (pH 4.0–5.0) precludes survival of bone and shell, but fragments were encountered at or near the bases of some earthworks where pH rises to weakly acidic or neutral levels. A total of 95.5 kg of bone and shell was recovered under the north mounds D, C, B, A, and ridge K/A and below mound J in the south mounds (Figure 5). Plant macroremains were recovered (~5 kg) from under Mound B, A-platform, and ridge K/A.

Fauna

Exceptionally high pH values (6.1–7.8) for the sediments at the base of Mound B led to good preservation of shell midden deposits in B-tr? and B-1, with some 13,000 larger (>6.4 mm) bones plus 175,000 smaller pieces. As the two samples are identical in composition, it is possible that the B-1 fill is composed of derived B-tr? midden. They will be described as a single assemblage.

At least 56 taxa are present (Table 7). As expected in this floodplain setting, riparian and bottomland taxa dominate the assemblage: small mammals (beaver, raccoon, muskrat, and otter); waterfowl (mostly ducks and geese); aquatic turtles (snapping and soft-shell, also emydids); watersnakes; amphibians; and abundant fish. Closed canopy forest on the bottomlands would have harbored the gray squirrel, swamp rabbits, and some of the relatively scarce whitetail deer. The marsh rat and cotton rat reflect the immediate habitat around the site itself. Adjacent upland and open habitats would have provided the turkey, fox squirrel, cottontail, pocket gopher, ruffed grouse, and the rest of the whitetail deer.

Fish contribute over half of the total bone weight, while whitetail deer make up about 30 percent by weight. Others (small mammals, birds, reptiles/amphibians) each make up less than 10 percent. Thus fish and deer contributed the bulk of the meat in the diet, despite the taxonomic richness of the assemblage.

The sample of whitetail deer includes at least three adults of about 1.5, 2.5, and 4.5 years of age; a fawn of about six months; and a newborn. Deer bone was highly fragmented, and much of the unidentified large mammal bone is probably also deer. This suggests extensive processing for bone marrow and grease. Deer element survival does not match expected element distributions for whole deer carcasses. Furthermore, there is no relationship between element survival and their various bulk densities (RHO = .18) as provided by Lyman (1984), so burial attrition appears to have had little impact on the sample. However, there is no relationship between the distribution of elements and their likelihood to survive as measured by bone density (RHO = .018) (Lyman 1984). Neither is there a clear relationship between element distribution and utility as measured by Binford's (1978) Modified General Utility Index (RHO = .11). Nonetheless, when deer are merged with large mammal specimens, there does appear to be an overrepresentation of meat-bearing anatomical parts, masked by intensive processing, which may hint at offsite field butchery.

Ten families of fish are present (Table 7), of which six contributed the bulk: bowfin, gar, sucker, catfish, bass and other sunfish, and drum. Of these, finfish (bass, sunfish, temperate bass, sauger, and drum) dominate, followed closely by catfish and gar. This ranking is similar for both the large- and small-bone fractions.

However, differences between the fractions emerge when the Perciformes are ranked. Here, only atlas vertebrae were used to avoid counting the same individual in both samples. Drum dominate the large-bone fraction, indicating that the main river channel was being heavily fished. This would also have yielded the temperate bass, buffalo, and the larger specimens of channel catfish and blue catfish.

The lengths of drum otoliths indicate that they were much smaller than the modern drum average in Louisiana, namely 54 cm long and 2.3 kg in weight (Douglas 1974). By contrast, the average Watson Brake drum is only 19-cm long and weighs only .2 kg. Only one otolith (20.2 mm long) came from a drum approaching the modern average. Sampling error is unlikely to be the sole cause of this pattern, and overfishing is an even less plausible explanation, especially with the main river channel so close to the site. Inadequate fishing

Table 7. Watson Brake Mound B (TU 3) Vertebrate Fauna in B-tr? and B-1.

		Large-bone (6.4 mm) Fraction					3.2 mm Fraction			
Common Name	Scientific Name	NISP	%NISP	Weight	%Weight	MNI	NISP	%NISP	Weight	%Wt.
Mammal		103	1.12	28.0	.5		138	2.02	9.2	2.87
Large mammal		1397	15.15	1177.3	23.0		102	1.49	33.4	10.41
Medium mammal		7	.08	3.8	.1					
Small mammal		64	.69	18.9	.4		94	1.38	5.6	1.75
Sm./med. mammal		116	1.26	42.0	.8		15	.22	.8	.25
Opposum	*Didelphis virginianus*	8	.09	12.9	.3	2				
Rodent	Rodentia	1	.01	.1						
Mole	*Scalopus aquaticus*	5	.05	1.0		2				
Vole	*Microtus* sp.	1	.01	.1		1				
Mouse	Cricetidae	1	.01	.1		1				
Rat	Cricetidae	1	.01	.1		1				
Rat/mouse	Cricetidae	1	.01	.1						
Marsh rice rat	*Oryzomys palustris*						1	.01	.1	.03
Cotton rat	*Sigmodon hispidus*						2	.03	.1	.03
Plains pocket gopher	*Geomys bursarius*	4	.04	.9		1				
Squirrel sp.	*Sciurus* sp.	5	.05	.7						
Eastern gray squirrel	*Sciurus carolinensis*	15	.16	3.5	.1	2	1	.01	.3	.09
Eastern fox squirrel	*Sciurus niger*	7	.08	1.9		1				
Rabbit sp.	*Sylvilagus* sp.	5	.05	1.0						
Eastern cottontail	*Sylvilagus floridanus*	23	.25	7.2	.1	2				
Swamp rabbit	*Sylvilagus aquaticus*	5	.05	1.2		1	1	.01	.1	.03
Beaver	*Castor canadensis*	1	.01	1.1		1				
Medium carnivore	Carnvivora	1	.01	.5						
Small carnivore		1	.01	.3			1	.01	.1	.03
Raccoon	*Procyon lotor*	12	.13	12.3	.2	1				
Muskrat	*Ondatra zibethicus*	2	.02	1.3		1				
Otter	*Lutra canadensis*	1	.01	.6		1				
Domestic dog	*Canis familiaris*	4	.04	15.1	.3	1				
Canid	Canidae	1	.01	.2						
Whitetail deer	*Odocoileus virginianus*	306	3.32	1618.3	31.6	4				
	Subtotals Mammals	2098	22.75	2950.5	57.7	23	355	5.20	49.7	15.50
Bird		320	3.47	71.4	1.4		249	3.65	13.8	4.30
Large bird		415	4.50	174.4	3.4					
Medium bird		22	.24	5.7	.1					
Small bird		4	.04	.6						
Goose sp.	Anserinae	7	.08	10.0	.2					
Canada/Blue goose	*Branta/Chen*	8	.09	7.6	.1	2				
Canada goose	*Branta canadensis*	2	.02	4.1	.1	1				
Duck	Anatidae	4	.04	3.2	.1					
Medium duck	Anatidae	7	.08	3.3	.1	2				
Small duck	Anatidae	2	.02	.4		1				
Mallard/Black duck	*A. platyrhynchos/ruprides*	29	.31	19.4	.4	3				
Diving duck	Aythinae	1	.01	.6		1				
Raptor	Accipitridae	1	.01	.3		1				
Turkey	*Meleagris gallopavo*	31	.34	51.9	1.0	3				
Ruffed grouse	*Bonasa umbellus*	1	.01	.5		1				
	Subtotal Aves	854	9.26	353.4	6.9	15	249	3.65	13.8	4.30
Reptile		1	.01	.3						
Turtle	Testudines	562	6.09	161.1	3.1		198	2.90	13.7	4.27
Snapping turtle	Chelydridae	22	.24	30.8	.6	1				
Mud/musk turtle	Kinosternidae	26	.28	8.5	.2	1				
Soft shell turtle	Trionychidae	46	.50	41.2	.8	1				
Pond and Box turtles	Emydidae	3	.03	1.7						
Aquatic emydid	Emydidae	56	.61	79.1	1.5					
Map turtle	*Graptemys* sp.	4	.04	1.5		1				
Chicken turtle	*Deirochelys* sp.	1	.01	.9		1				

Table 7. Watson Brake Mound B (TU 3) Vertebrate Fauna in B-tr? and B-1. (continued)

		Large-bone (6.4 mm) Fraction					3.2 mm Fraction			
Common Name	Scientific Name	NISP	%NISP	Weight	%Weight	MNI	NISP	%NISP	Weight	%Wt.
Box turtle	*Terrapene carolina*	33	.36	23.4	0.5	1				
Snake	Serpentes	3	.03	.5			82	1.20	2.9	.90
Viper	Viperidae	4	.04	.8		1				
Non-poisonous snake	Colubridae	17	.18	2.8	0.1					
	Coluber/Masticophus	12	.13	1.9		1				
	Lampropeltis/Elaphe	22	.24	4.0	.1	1				
Water snake	*Nerodia* sp.	14	.15	3.2	.1	1				
Mudsnake	*Farancia* sp	8	.09	1.4		1				
Alligator	*Alligator mississippiensis*	1	.01	.4		1				
	Subtotal Reptilia	835	9.05	363.5	7.1		280	4.10	16.6	5.18
Amphibians	Amphibia						6	.09	.2	.06
Frog/Toad	*Rana/Bufo* sp.	6	.07	.6			1	.01	-	
Frog	*Rana* sp.	3	.03	1.7		1				
Amphiuma	*Amphiuma* sp.	2	.02	.9		1				
	Subtotal Amphibia	11	.12	3.2	.1	1	7	.10	.2	.06
Fish	Pisces	2237	24.25	479.2	9.4		5039	73.83	193.4	60.31
Eel	*Anguilla rostrata*	1	.01	.2		1				
Bowfin	*Amia calva*	384	4.16	92	1.8	13	123	1.80	5.6	1.75
Gar	Lepisosteidae	811	8.79	202.9	4.0	19	253	3.71	12.9	4.02
Alligator gar	*Atractosteus spatula*	2	.02	1.6		3				
Shortnose gar	*Lepisosteus platostomas*	1	.01	6.8	.1	1				
Longnose gar	*Lepisosteus osseus*	1	.01	.2		1				
Shad	Clupeidae						1	.01	.1	.03
Sucker	Catostomidae	188	2.04	56.3	1.1	3	39	.57	2.0	.62
Buffalo	*Ictiobus* sp.	105	1.14	53.0	1.0	4				
Smallmouth buffalo	*Ictiobus bubalus*	21	.23	7.8	.2	7				
Largemouth buffalo	*Ictiobus cyprinellus*	15	.16	4.5	.1	4				
Catfish family	Ictaluridae	265	2.87	72.5	1.4		281	4.12	17.1	5.33
Flathead catfish	*Pylodictus olivaris*	12	.13	8.6	.2	3				
Catfish	*Ictalurus* sp.	251	2.72	63.0	1.2	2				
Blue/Channel catfish	*I.furcatus/punctatus*	94	1.02	46.2	.9	6				
Blue catfish	*Ictalurus furcatus*	23	.25	25.8	.5	11				
Channel catfish	*Ictalurus punctatus*	21	.23	10.7	.2	7				
Bullhead	*Ictalurus* sp.	37	.40	6.6	.1	2				
Black bullhead	*Ictularus melas*	9	.10	2.3		6				
Yellow bullhead	*Ictalurus natalis*	2	.02	.5		1				
Brown bullhead	*Ictalurus nebulosus*	2	.02	.6		2				
Finfish	Perciformes	266	2.88	54.4	1.1		192	2.81	8.9	2.78
Centrarchids	Centrarchidae	91	.99	18.7	.4	3	2	.03	.1	.03
Bass	*Micropterus* sp.	76	.82	19.8	.4	14				
Largemouth bass	*Micropterus salmoides*	3	.03	1.0		3				
Sunfish	*Lepomis* sp.	2	.02	.3		1				
Crappie	*Pomoxis* sp.	17	.18	3.3	.1	6	1	.01	.1	.03
Black crappie	*Pomoxis nigromaculatus*	1	.01	.1		1				
Temperate bass	*Morone* sp.	3	.03	.6		2				
Freshwater drum	*Aplodinotus grunniens*	483	5.24	206.9	4.0	27	3	.04	.2	.06
Sauger	*Stizostedion canadense*	2	.02	.2		2				
	Subtotal Pisces	5426	58.82	1446.6	28.3	155	5934	86.95	240.4	74.96
	TOTAL NISP	9224	100.00	5117.2	100.0	194	6825	100.00	320.7	100.00
	Unidentified Bone	3179		602.7					354.1	
	Antler	6								
	Scales	518					1828			
	TOTAL SAMPLE	12927		5719.9			8653		674.8	

Note: Data from Jackson and Scott (2001).

Table 8. Watson Brake Mound B (TU 3) Mussel Species in B-tr?.

Common Name	Scientific Name	NISP
Mapleleaf	*Quadrula quadrula* (Rafinesque)	246
Bankclimber	*Plectomerus dombeyanus* (Valenciennes)	95
Threehorn Wartyback	*Obliquaria reflexa* (Rafinesque)	46
Pimpleback	*Quadrula pustulosa* (Lea)	34
Louisiana Fatmucket	*Lampsilis hydiana* (Lea)	21
Texas Lilliput	*Toxolasma texasensis* (Lea)	14
Yellow Sandshell	*Lampsilis teres* (Rafinesque)	12
Western Pimpleback	*Quadrula pustulosa mortoni* (Conrad)	10
Washboard	*Megalonaias nervosa* (Rafinesque)	7
Deertoe	*Truncilla truncata* (Rafinesque)	4
Fawnsfoot	*Truncilla donaciformis* (Lea)	4
Wartyback	*Quadrula nodulata* (Rafinesque)	4
Pink Pigtoe	*Pleurobema rubrum* (Rafinesque)	4
Ebonyshell	*Fusconaia ebena* (Lea)	3
Threeridge	*Amblema plicata* (Say)	3
Western Fanshell	*Cyprogenia aberti* (Conrad)	2
Southern Mapleleaf	*Quadrula apiculata* (Say)	2
Butterfly	*Ellipsaria lineolata* (Rafinesque)	1

tackle is more likely to have placed the upper size limit on the fish remains (Witt 1960).

The small-bone fraction of Perciformes is dominated by bass, crappie, and bream, so the floodplain backwaters (brakes) were also being extensively exploited. Such stillwater niches were probably quite close to the site at the time. Whether they increased slightly in B-1 times remains uncertain, but bream first appears in the B-1 when there is also a slight increase in crappie.

Mollusks

The shell midden beneath Mound B produced 512 well-preserved and classifiable mussel shell fragments, from which no less than 18 species were identified (Table 8). Such species richness is typical of living mussel communities collected from large and medium streams with sand and gravel bottoms in the Ouachita River drainages, of which the Watson Brake is one. Only the western fanshell, unique to the Ozarkian fauna, has not yet been collected live in Louisiana. All others listed are extant in the waterways of northeast Louisiana, although some are rare (George and Vidrine 1993; Vidrine 1993, 1995, 1996).

Most of the recovered specimens are small to medium in size compared to recent live collections, hinting at collecting pressure on the prehistoric shellfish population. However, thinner-shelled mussels that frequent lakes and ponds are notably absent. This contrasts sharply with evidence that such waterbodies were being heavily fished (see above).

Extensive shell breakage indicates that mussel flesh was routinely extracted before cooking, which would allow the shell to open as the abductor muscles break free from the shell. Although some of the shell was burned, this could be secondary burning of trash.

Breakage cannot be ascribed to excavation damage because the very abundant (124 liters) aquatic snail shell *Campeloma decisum* from the same shell midden was mostly intact. These must have been steamed or boiled to loosen the columellar muscle to ease the removal of meat from the shell. This snail thrives in sandy bottom, shallow littoral zones along rivers, and frequently shares the same habitats as mussels.

A few heavily leached mussel and snail fragments were present in the overlying B-1 earthwork fill.

Seasonal Indicators

Among the fish remains from the B-tr? shell midden under Mound B were 114 well-preserved otoliths of eight species (Table 9). The dominant species is drum, as it is in the fish bone sample (Table 7), but drum overwhelms the otolith sample by 93 percent. Being much larger than otoliths of others species, they are less prone to damage and burial attrition. Dimensions of this sample are described above.

Table 9. Watson Brake Mound B (TU 3) Fish Otoliths.

Common Name	Scientific Name	NISP	MNI	% by Unit
B-tr? Shell Midden				
Freshwater drum	*Aplodinotus grunniens*	93	77	81.5
White crappie	*Pomoxis annularis*	5	5	4.4
Bluegill	*Lepomis macrochirus*	4	3	3.5
Largemouth bass	*Micropterus salmoides*	3	3	2.6
Sunfish or Brim	*Lepomis* spp.	3	3	2.6
Flier	*Centrarchus macropterus*	1	1	.9
Yellow bass	*Morone mississippiensis*	2	2	1.8
Sunfish family	Centrarchid fragments	2	2	1.8
Freshwater catfish	*Ictalurus* sp.	1	1	.9
Total B-tr? midden		114	97	100.0
B-1 Mound Fill				
Freshwater drum	*Aplodinotus grunniens*	17	16	94.4
Largemouth bass	*Micropterus salmoides*	1	1	5.6
Total B-1 fill		18	17	100.0

Only 39 otoliths had sufficiently well-defined annuli to determine season of death, of which most (37) were drum. All seasons are represented with remarkably even distribution, given the modest size of the samples: 17.9 percent winter ($n = 7$); 25.6 percent spring ($n = 10$); and 28.2 percent each for summer ($n = 11$) and fall ($n = 11$). The depressed winter proportion defies interpretation, since there are no modern controls for seasonal catch rates of drum in local rivers; thus seasonal availability remains unknown.

Multiseason occupations at the shell midden are supported by the few available indicators among other fauna. The whitetail deer newborn fawn (proximal humerus) is from the shell midden and must be a summer marker, while dentition and loose teeth from the same levels indicate fall and and/or winter hunting. Remains of migratory blue goose are either fall or spring kills (Jackson 1986). Elements from fingerlings among the fish remains attest to spring and summer deaths.

The overlying B-1 fill produced another 15 extensively leached otoliths of 2 species, none of which could be used for seasonal determinations. However, there is the fetal/newborn longbone shaft of whitetail deer and the metapodial of an adult, both of which point to summer procurement. Canada goose and blue goose are also present, indicating fall and/or spring kills.

While support for all-season occupation of the terrace is quite strong, it would be premature to suppose that it reflects year-round (permanent) residence here. That would require many different case studies using multiple lines of evidence.

Flora

Macroplant remains were recovered in Mound B, A-platform, and ridge K/A. Charred nutshell fragments of hickory (*Carya* spp.) were most common, with only a few charred seeds of grape (*Vitis* spp.), hackberry/sugarberry (*Celtis occidentalis/laevigata*), goosefoot (*Chenopodium berlandieri*), and possibly sumpweed/marshelder (*Iva annua*) in the lower levels of Mound B.

Hickory (*Carya* spp.) nutshell was present throughout all levels of Mound B except the top 20 cm. Fragments were also recovered in the base of A-platform (Ap-tr). In ridge K/A, they occurred in the basal level (K/A-tr), and again in the buried soil on K/A-1, and in lowermost K/A-2.

Grape (*Vitis* spp.) seeds were recovered from the shell midden under Mound B and from the base of its B-2 fill.

The Mound B shell midden also produced burned or mineralized seeds of either hackberry (*Celtis occidentalis*) or sugarberry (*C. laevigata*).

Goosefoot (*Chenopodium berlandieri)* seeds were recovered from near the base of the Mound B shell midden, from the B-1 fill (with fauna) over the shell midden, and from the base of the B-2 fill above that (Figure 10). Only 24 seeds were recovered. Diameters average about 1.0 mm, which is at the low end of the size range for modern wild populations. Seed coats average about 30 microns thick, also typical of modern wild/weed populations

(Gremillion 1993a, 1993b). The reticulated patterning seen on coats of the subsection Cellulata of *Chenopodium* (Smith 1984) occurs on all specimens. They show no signs of the reduced coat thickness or of increased seed volumes typical of domesticated *C. berlandieri*, e.g., at Russell Cave, Alabama, where mean seed diameter is 1.3 mm (Smith 1985a, 1985b). Goosefoot favors sandy disturbed floodplain settings over uplands (Smith 1987), so the nearby Watson Brake channel is a likely niche, as well as the heavily disturbed surface of the site itself.

One kernel of a composite (family Asteraceae) was recovered from the base of B2 in Mound B. Its morphology is consistent with sumpweed/marshelder (*Iva annua*). At 2.3 mm long, its reconstructed uncarbonized achene length would be 3.3 mm, which falls within the range of wild populations (Asch and Asch 1985).

This short recovery list is a poor reflection of the enormous plant food potential still available around Watson Brake today. There are five species of hickory nuts ranging from bitter pecan (*Carya aquatica*) in the bottomlands to the mockernut hickory (*Carya alba*) on adjacent dry uplands. Although no acorn remains were identified, mast crops abound everywhere in the catchment, with ten oaks ranging from overcup oak (*Quercus lyrata*) in the wetlands to white oak (*Q. alba*) on the well drained uplands. Among the wild grapes (*Vitis* spp.) is muscadine (*V. rotundifolia*). Other available fruits include blueberry (*Vaccinium elliottii*) and huckleberry (*V. arboreum*), persimmon (*Diospyros virginiana*), hawthorns (*Crataegus* spp.) including mayhaw (*C. opaca*), blackberries/dewberries (*Rubus* spp.), wild plum (*Prunus mexicana*), black cherry (*P. serotina*), and pawpaw (*Asima triloba*). Saw briers (*Smilax* spp.) also abound, providing tubers and edible stem tips.

Also not recovered but locally available are several edible herbaceous flora like the tubers of ground nut (*Apios tuberosa*), fruits of mayapple (*Podophyllum peltatum*), and corms of spring beauty (*Claytonia virginica*). Local spice plants include sassafras (*Sassafras albidum*), mountain mint (*Pycnanthemum tenuifolium*), and wild onion (*Allium canadense*), all with medicinal and/or flavoring properties.

Closer to the site, along the Watson Brake channel, there is little barley (*Hordeum pusillum*), sumpweed/marshelder (*Iva annua*), and a knotweed species (*Polygonum hydropiperoides*). Perhaps the original (less swampy) channel configuration favored the growth of goosefoot.

While the recovered plant material may have been introduced naturally during seasonal flooding of the terrace surface, such arguments are strained by the lack of modern actualistic studies. These plant remnants occur with abundant fauna not only in the terrace shell midden, but also in the overlying fills, both contexts that suggest they are more likely to be components of the prehistoric diet. If the goosefoot (and sumpweed/marshelder) were being collected from nearby channel settings in preference to the many other edible taxa from farther afield, such focused gathering is of great interest because both species were eventually domesticated (Smith and Cowan 1987).

Human Remains

No human burials were encountered. However, the B-tr? shell midden under Mound B produced three adult hand phalanges and a radius or ulna shaft fragment, possibly all from a single individual.

An adult cranium fragment was identified in the 2Ab4 horizon at the top of the B-tr? shell midden.

Among the fauna from the overlying B1 fill was the humerus of a child about three years old, and a deciduous molar, possibly from the same individual.

Watson Brake and Middle Archaic Mounds

In spite of the impressive size and complexity of Watson Brake, it is but one example of an earthen moundbuilding tradition that thrived in the Lower Mississippi Valley between ca. 6000 and 5000 B.P. The number of Middle Archaic mound sites has grown to 13 in Louisiana and one in Mississippi. The Mississippi site has two mounds. One- ($n = 2$), two- ($n = 3$), three- ($n = 1$), and eight- mound ($n = 1$) sites makeup the seven southern Louisiana sample; one- ($n = 1$), two- ($n = 1$), four- ($n = 1$) five- ($n = 1$), six- ($n = 1$), and eleven-mound- ($n = 1$) sites compose the northern Louisiana mounds, with three of the sites (Watson Brake, Caney Mounds, and Frenchman's Bend Mounds) possibly sharing a layout design (Clark 2004; Sassaman and Heckenberger 2004). Although our data are limited, they suggest that the early moundbuilders were composed of localized traditions, if not individualized ones. The sites in northeast Louisiana are associated with fired earthen objects, the ones in south Louisiana are not. The mound groups west of the Mississippi River have Evans points, those on the east side of the river do not. Yet western Mississippi (S. McGahey, personal communication 2005) and eastern Louisiana share the same blade core/blade/microdrill/bead technology found at Watson Brake. Submound posthole patterns were uncovered at two sites: Monte Sano Mounds on the east side of the Mississippi River and on the west side at Frenchman's Bend Mounds. Successive floors also have been identified under two other mounds at Frenchman's Bend Mounds (Saunders et al. 1994). Interestingly, neither submound posthole patterns nor floors were identified at Watson Brake.

Thus, the only trait common to all Middle Archaic mound sites is the mounds themselves. This limited sample does nevertheless show that moundbuilding was not a monolithic cultural expression. Sites varied not only in size, number of mounds, and site layout, but also in the presence/absence of artifact types, and perhaps, standing architecture. The distribution of shared and disparate traits suggests that concomitant, independent social currents existed during the Middle Archaic, of which moundbuilding was one—it was not a package deal.

As mysteriously as the Middle Archaic mounds appeared 6,000 years ago, moundbuilding disappeared 1,000 years later, and for 1,300 years mound construction stopped. It did not resume until Poverty Point times (2700–2300 B.P.). At present, there is virtually no evidence of continuity between the Middle Archaic and Poverty Point cultures. During the moundbuilding hiatus, evidence of trade expands (Jackson and Jeter 1991; Jeter and Jackson 1994), suggesting increased social interaction among the regions in the Lower Mississippi Valley. As trade became more widespread, two dominant mound centers emerge: Poverty Point in northeast Louisiana and Jaketown in westcentral Mississippi. In contrast to the local and unique mound groups of the Middle Archaic, Poverty Point and Jaketown people apparently focused their energy on one site (Saunders 2004). Other than Poverty Point and Jaketown, very few Poverty Point mound sites are known to exist.

Watson Brake and Moundbuilding Origins

Although it is now reasonably certain that the great earthworks at Poverty Point were preceded by a much older local moundbuilding tradition, what triggered that tradition at Watson Brake and elsewhere in the lower Mississippi valley (Figure 1) remains far from clear. Their first built stages are too small to have been motivated by personal or group aggrandizement. They were not burial mounds. Once completed, some earthworks may have turned out to be useful for flood protection, or as defensive ramparts, but no current researcher seriously proposes that this was why they were built. All agree that they had some higher purpose, but there is no consensus on what that might be. Two very different models are proposed to explain why moundbuilding started here, and Watson Brake provides the best available test case for each of them.

Geometry and Design

Clark (2004) presents measurements to support his contention that Watson Brake and Caney were laid out according to a shared geometric system. This implies that submound middens were deliberately positioned to "stake out" that system on the ground before building commenced. At Watson Brake ca. 3500 B.C., the first earthworks were being raised over earlier middens at B and I, and probably at A and K (we may not have reached their bases). At about the same time, occupational debris were deposited along the terrace rim locations of mounds D and C, but also under the south mounds J and E. Their positions certainly prefigure the oval shape of the whole complex of future mounds.

Clark's model also implies that the earliest mounds were built "as one" and not by haphazard accretion of fills and ridges. The building of Watson Brake took at least five centuries to complete, and our short list of well-dated fills already weakens this assumption. We note, however, that several of the south mounds, including the tall mound E (a key mound in Clark's geometric scheme), do appear to have been built "as one," which lends partial support to the model. Clark (2004:204) reads this shared geometry between Watson Brake and Caney as proof that the mounds were "laid out to replicate or even capture features of the cosmos."

The geometric scheme of Sassaman and Heckenberger (2004) shares a focus on equilateral triangles. Their scheme partially fits Watson Brake, Caney, Frenchman's Bend Mounds, and another large Poverty Point?/Woodland complex (Insley, 16FR2). However, they reach the exact opposite conclusion to Clark's, namely that the mounds were *not* "standardized for purposes of astronomical and calendrical observations" due to "the varied orientation of mound complexes to cardinal directions (that) precludes this possibility" (Sassaman and Heckenberger 2004:226).

For now, both schemes encourage the view that the purpose of the mounds was mainly (perhaps wholly) ceremonial. A shared geometry also implies that ideas were circulating freely through Watson Brake, even though it did not participate in any exchange network of (durable) material items.

Environmental Change and Instability

Hamilton (1999) was the first to propose a causal link between early moundbuilding and the rise of El Niño-Southern Oscillation (ENSO) climatic events. Today, ENSO's are well-documented drivers of drought, flooding, and hurricane frequencies on the Gulf coast (Caviedez 2001; D'Aleo and Grube 2002; Diaz and Kiladis 1992). Indeed, rainfall near Watson Brake over the past 50 years (National Climatic Data Center 2004) precisely tracks the stronger ENSO events in the Pacific (Kessler 2004). The cooler La Niñas cause multiseason rainfall surpluses, some of them fluctuating in near-perfect harmony. Significantly, the strongest of the warm El Niños in this record (one of only four in the last century) brought catastrophic flooding.

The onset of ENSO events in the mid-Holocene (Sandweiss et al. 1999) would have introduced unpredictable flooding into Lower Mississippi weather patterns. Hamilton's (1999) hypothesis, derived from bet hedging or "wasteful behavior" models (Dunnell 1989), predicts a rise in uncertainty about year-to-year food supplies that in turn induced new stresses for the bottomland communities. Any proposed links between such stress and early moundbuilding cannot be directly tested, but the timing of the two events certainly can.

The chronologically fine-tuned record of strong El Niño frequencies from the Laguna Pallcacocha sediments in the southern Ecuador highlands (Moy et al. 2002) shows that the incidence of strong El Niños rose above five per century for the first time in 4775 B.C., several centuries before Watson Brake was occupied. This first brief pulse of activity peaked at eight ENSO/100yr and declined sharply in 4650 B.C. A second brief pulse occurred between 4325–4200 B.C., peaking at seven ENSO/100yr. The oldest four intercept dates from Watson Brake precede the third pulse between 3600–3500 B.C. when the strong El Niño rate hit 12 ENSO/100yr. Although a fifth date partly overlaps with Pulse 3, it is split by multiple intercepts, which casts doubt on the overlap.

The other (accepted) intercept dates from Watson Brake fall in the calm period one or two centuries after Pulse 3, as do the dates from several other Middle Archaic mounds (Sampson and Saunders 2005). The youngest accepted date at Watson Brake is near the end of this calm interval. Pulse 4 (2975–2675 B.C.) was more severe than the first three, reaching 27 ENSO/100yr. This translates into a catastrophic flood every 3.7 years in the lower Mississippi, with dire ecological disruptions that are probably implicated in the abandonment of all known Middle Archaic mound complexes. There are no dated mounds in the prolonged calm interval following following Pulse 4.

Hamilton's (1999) model calls for moundbuilding activity during the ENSO pulses, and perhaps immediately following pulses. From this brief synopsis we conclude that all dated submound occupations and all building hiatuses (with buried soils) at Watson Brake occurred during calm, stable periods between pulses. In balance, it is more likely that the unstable Pulse 3 caused a halt in building activity and that the devastating Pulse 4 put a stop to it altogether. While it could be argued that (undated) fill was being added during Pulse 3, this strikes us as extreme special pleading based on absence of evidence. We propose that the mounds were built during stable conditions, not unstable ones. First priority for testing this proposition should go to obtaining a highly detailed local environmental record comparable to that from Laguna Pallcacocha.

For now, bet hedging does not explain moundbuilding at Watson Brake, unless folk memory of past calamities or fear of future ones was invoked to get it started. In our view this is an untestable proposition.

Summary

The research at Watson Brake established the initial occupation of the site at ca. 4000 B.C. The first occupants came to Watson Brake to fish, hunt deer, and gather plants in every season of the year. Prolonged visits probably occurred. Within northern Louisiana, this pattern (fish, deer, extended residence times) was already established by the beginning of the Middle Archaic (Girard 2000; Jackson and Scott 2001).

Test units, augering, and coring verified the cultural origin of the 11-mounds-and- ridge oval, first identified by Jones. Six, perhaps seven, of the mounds and at least two ridges were constructed in stages. The degree of soil development in the multistage mound and ridge fills suggests periods of 200+ years between construction phases.

The construction of the first minor earthworks began around 3500 B.C. with Mounds K and B (and possibly A) followed by midden accumulations where Mounds D and C, and to the south I, J, and E were subsequently built; this suggests that the shape of the complex was deliberately laid out by 3500 B.C. Major building projects then commenced ca. 3350 B.C., and existing earthworks may have been heightened and extended along the north mound row. Mound J was erected on the south side at around 3000 B.C.

Site occupation was concentrated along the terrace escarpment before construction began and continued after the earthworks were completed. Mounds set back from the escarpment received marginal use, while activities in the enclosed area were rare. The data suggest that the mound and ridge surfaces were host to daily, secular events. Activities included processing/cooking of food and making bifaces and stone beads. Local gravel was the lithic source for both the bifaces and beads; evidence of trade for nonlocal material does not exist. Fired earthen objects are common, but their function is unknown.

The economy of the Watson Brake centered on riverine resources. Fish were the most abundant food; the diet was supplemented with shellfish, snail, amphibians, reptiles, small game, and deer. Plants included goosefoot, marshelder, grape, hickory, and pecan. Seasonal indicators suggest periodic site use throughout the year, but not year-round occupation—the data are too preliminary to draw such an important conclusion.

Acknowledgments. Thanks to the Gentry family for allowing access to the north mounds, and to Louisiana State Parks for allowing research on the south mounds. Willamette Industries voluntarily left a 50 m tree buffer around the southern mounds prior to selling the property to the Archaeological Conservancy. Research was funded, in part, by two grants from the National Geographic Society, and by funds from the National Park Service and the State of Louisiana, through the Division of Archaeology. Thanks to Nancy Hawkins, Tom Eubanks, Robert Neuman, Kass Byrd, Sunny Meriwether, the Thomas family, Roger Kennedy, Alan Gruber, Kathryn Lemoine, and Gloria Swoveland for their individual contributions to making the work possible. Thanks to Beta Analytic, Inc. The Spanish abstract was written by Amanda Aland and Antonieta Jerardino. The insightful comments of John Clark, Jeff Girard, and Chris Hays helped us greatly to improve the quality of the manuscript. Any oversights or errors in the interpretation of the data are the responsibility of the senior author.

References Cited

Asch, David L., and Nancy E. Asch
1985 Prehistoric Plant Cultivation in West-central Illinois. In *Prehistoric Food Production in North America*, edited by Richard I. Ford, pp. 149–203. Anthropological Papers No. 75. Museum of Anthropology, University of Michigan, Ann Arbor.

Binford, Lewis R.
1978 *Nunamiut Ethnoarchaeology*. Academic Press, New York.

Birkeland, Peter W.
1999 *Soils and Geomorphology*. Oxford University Press, New York.

Brown, Ian W., and Nancy Lambert-Brown
1978 *Lower Mississippi Survey Petite Anse Project*. Research Notes of the Peabody Museum of American Archaeology and Ethnology No. 5. Harvard University, Cambridge.

Buol, Stanley W., F. D. Hole, and R. J. McCracken
1989 *Soil Genesis and Classification*. 3rd ed. Iowa State University Press, Ames.

Bush, Daniel A., and James K. Feathers
2003 Application of Single-aliquot and Single-grain Dating to Quartz from Anthropogenic Soil Profiles in the SE United States. *Quaternary Science Reviews* 22:1153–1159.

Caviedez, César N.
2001 *El Niño in History: Storming Through the Ages*. University Press of Florida, Gainesville.

Clark, John E.
2004 Surrounding the Sacred: Geometry and Design of Early Mound Groups as Meaning and Function. In *Signs of Power, The Rise of Cultural Complexity in the Southeast*, edited by Jon L. Gibson and Philip J. Carr, pp. 162–213. University of Alabama Press, Tuscaloosa.

Connaway, John
1981 The Keenan Bead Cache: Lawrence County, Mississippi. *Louisiana Archaeology* 8:57–71.

Connaway, John M., Samuel O. Brookes, and Samuel O. McGahey
1977 *The Denton Site: a Middle Archaic Occupation in the Northern Yazoo Basin, Mississippi*. Archaeological Report No. 4. Mississippi Department of Archives and History, Jackson.

D'Aleo, Joseph S., and Pamela G. Grube
2002 *The Oryx Resource Guide to El Niño and La Niña.* Oryx Press, Westport, Connecticut.
Diaz, Henry F., and George N. Kiladis
1992 Atmospheric Teleconnections Associated with the Extreme Phases of the Southern Oscillation. In *El Niño: Historical and Paleoclimatic Aspects of the Southern Oscillation*, edited by Henry F. Diaz and Vera Markgraf, pp 7–28. Cambridge University Press, Cambridge.
Douglas, Neil H.
1974 *Freshwater Fishes of Louisiana.* Claitor's Publishing Division, Baton Rouge, Louisiana.
Dunnell, Robert C.
1989 Aspects of the Application of Evolutionary Theory in Archaeology. In *Archaeological Thought in the Americas*, edited by C. C. Lamberg-Karlovsky, pp. 35–49. Cambridge University Press, Cambridge.
Feathers, James K.
1997 Luminescence Dating of Early Mounds in Northeast Louisiana. *Quaternary Science Reviews (Quaternary Geochronology)* 16:333–340.
Ford, James A.
1969 *A Comparison of Formative Cultures in the Americas.* Smithsonian Contributions to Anthropology Vol. 11. Smithsonian Institution Press, Washington, D.C.
Ford, James A., and Clarence H. Webb
1956 *Poverty Point, a Late Archaic Site in Louisiana.* Anthropological Papers Vol. 46, Pt. 1. American Museum of Natural History, New York.
George, Steven G., and Malcolm F. Vidrine
1993 New Louisiana Records for Freshwater Mussels (Unionidae) and a Snail (Pleuroceridae). *The Texas Journal of Science* 45:363–366.
Gibson, Jon L.
1968 Cad Mound: A Stone Bead Locus in East Central Louisiana. *Bulletin of the Texas Archaeological Society* 38:1–17.
1989 *Digging on the Dock of the Bay(Ou): The 1988 Excavations at Poverty Point.* University of Southwestern Louisiana Center for Archaeological Studies Report 8, Lafayette.
1991 Catahoula—an Amphibious Poverty Point Period Manifestation in Eastern Louisiana. In *The Poverty Point Culture: Local Manifestations, Subsistence Practices, and Trade Networks*, edited by K. Byrd, pp. 133–188. Geoscience and Man, Vol. 29. Geoscience Publications, Department of Geography and Anthropology, Louisiana State University, Baton Rouge.
2001 *The Ancient Mounds of Poverty Point: Place of Rings.* University Press of Florida, Gainseville.
Girard, Jeffrey S.
2000 *Regional Archaeology Management Unit 1: Eleventh Annual Report.* Department of Social Sciences, Northwestern State University, Natchitoches. Report on file, Louisiana Division of Archaeology, Department of Culture, Recreation, and Tourism, Baton Rouge.
Gremillion, Kristen J.
1993a Crop and Weed in Prehistoric Eastern North America: the *Chenopodium* Example. *American Antiquity* 58:496–509.
1993b The Evolution of Seed Morphology in Domesticated *Chenopodium*: an Archaeological Case Study. *Journal of Ethnobiology* 13:149–169.
Hamilton, Fran E.
1999 Southeastern Archaic Mounds: Examples of Elaboration in a Temporally Fluctuating Environment? *Journal of Anthropological Archaeology* 18:344–355.
Hays, Christopher T.
1995 *1995 Annual Report for Management Units IV and V.* Regional Archaeology Program, Museum of Natural Science, Louisiana State University, Baton Rouge. Report on file, Louisiana Division of Archaeology, Department of Culture, Recreation, and Tourism, Baton Rouge.
Jackson, H. Edwin
1986 Sedentism and Hunter-gatherer Adaptations in the Lower Mississippi Valley: Subsistence Strategies During the Poverty Point Period. Ph.D. dissertation, University of Michigan, Ann Arbor. University Microfilms, Ann Arbor.
Jackson, H. Edwin, and Marvin Jeter
1991 Late Archaic Settlement and Poverty Point Connections in the Lowlands of Southeast Arkansas: An Initial Assessment. *Mississippi Archaeology* 26(2):33–55.
Jackson, H. Edwin, and Susan L. Scott
2001 Archaic Faunal Utilization in the Louisiana Bottomlands. *Southeastern Archaeology* 20:187–196.
Jeter, Marvin D., Jerome C. Rose, G. Ishmael Williams Jr., and Anna M. Harmon
1989 *Archaeology and Bioarchaeology of the Lower Mississippi Valley and Trans-Mississippi South in Arkansas and Louisiana.* Research Series 37. Arkansas Archaeological Survey, Fayetteville.
Jeter, Marvin D., and H. Edwin Jackson
1994 Poverty Point Extraction and Exchange: The Arkansas Lithic Connections. *Louisiana Archaeology* 17:133–206.
Johnson, Jay K.
1989 The Utility of Production Trajectory Modeling as a Framework for Regional Analysis. In *Alternative Approaches to Lithic Analysis*, edited by Donald O. Henry and George H. Odell, pp. 119–138. Archaeological Papers of the American Anthropological Association 1. American Anthropological Association, Washington, D.C.
2000 Beads, Microdrills, Bifaces, and Blades from Watson Brake. *Southeastern Archaeology* 19:95–104.
Johnson, Jay K., and Carol A. Raspet
1980 Delta Debitage. *Mississippi Archaeology* 15:3–11.
Jones, Reca
1985 Archaeological Investigations in the Ouachita River Valley, Bayou Bartholemew to Riverton, Louisiana. *Louisiana Archaeology* (1983) 10:103–169.
1997 Replicating Fire-Cracked Rock. Paper presented at the 25th Annual Meeting of the Louisiana Archaeological Society, Alexandria.
Kessler, William S.
2004 Southern Oscillation Index, 1950–2003. National Oceanic and Atmospheric Administration, Pacific Marine Environmental Laboratory. Electronic document, http://www.pmel.noaa.gov/~kessler/ENSO/soi-shade–2003.gif, accessed April 5, 2004.
Kidder, Tristram R.
1991 New Directions in Poverty Point Settlement Archaeology: An Example from Northeast Louisiana. In *The Poverty Point Culture: Local Manifestations, Subsistence Practices, and Trade Networks*, edited by Kathleen M. Byrd, pp. 27–54. Geoscience and Man, Vol. 29. Geoscience Publications, Department of Geography and Anthropology, Louisiana State University, Baton Rouge.
Kristiansen, Soren M., Kristian Dalsgaard, Mads K. Holst, Bent Aaby, and Jan Heinimeier
2003 Dating of Prehistoric Burial Mounds by ^{14}C Analysis of Soil Organic Matter Fractions. *Radiocarbon* 45(1):101–112.
Lyman, R. Lee
1984 Bone Density and Differential Survivorship of Fossil Classes. *Journal of Anthropological Archaeology*

3:259–299.
Martin, Charles W., and William C. Johnson
1995 Variation in Radiocarbon Ages of Soil Organic Matter Fractions from Late Quaternary Buried Soils. *Quaternary Research* 43:232–237.
Moy, Christopher M., Geoffrey O. Seitzer, Donald T. Rodbell, and David M. Anderson
2002 Variability of El Niño/Southern Oscillation Activity at Millennial Timescales During the Holocene Epoch. *Nature* 420:162–165.
National Climatic Data Center
2004 Station 166303/13942, Monroe Regional Airport, Louisiana. Electronic document, http://cdo.ncdc.noaa.gov/ancsum/ACS, accessed January 10, 2004.
Phillips, Philip
1970 *Archaeological Survey in the Lower Yazoo Basin, Mississippi, 1949–1955*. Papers of the Peabody Museum of Archaeology and Ethnology 60. Peabody Museum, Harvard University, Cambridge, Massachusetts.
Purdue, James R.
1983 Epiphyseal Closure in Whitetail Deer. *Journal of Wildlife Management* 47:1207–1213.
Russo, Michael
1994 A Brief Introduction to the Study of Archaic Mounds in the Southeast. *Southeastern Archaeology* 13:89–92.
Russo, Michael, and James Fogleman
1996 Stelly Mounds (16SL1): an Archaic Mound Complex. *Louisiana Archaeology* (1994) 21:127–158.
Sampson, Garth, and Joe Saunders
2005 Do the Earliest Earthworks Coincide with the Onset of Mid-Holocene El Niño/ENSO climatic events? A Review of Current Evidence. Paper presented at the 70th Annual Meeting of the Society for American Archaeology, Salt Lake City.
Sandweiss, Daniel H., Kirk A. Maasch, and David G. Anderson
1999 Transitions in the Mid-Holocene. *Science* 283:499–500.
Sassaman, Kenneth E., and Michael J. Heckenberger
2004 Crossing the Symbolic Rubicon in the Southeast. In *Signs of Power, The Rise of Cultural Complexity in the Southeast*, edited by Jon L. Gibson and Philip J. Carr, pp. 214–233. University of Alabama Press, Tuscaloosa.
Saucier, Roger T.
1994 *Geomorphology and Quaternary Geologic History of the Lower Mississippi Valley I.* U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi.
Saunders, Joe W.
1998 *1998 Annual Report for Management Unit 2*. College of Pure and Applied Sciences, Department of Geosciences, University of Louisiana at Monroe. Report on file, Louisiana Division of Archaeology, Department of Culture, Recreation, and Tourism, Baton Rouge.
2000 *2000 Annual Report for Management Unit 2*. Regional Archaeology Program, Department of Geosciences, University of Louisiana at Monroe. Report on file, Louisiana Division of Archaeology, Department of Culture, Recreation, and Tourism, Baton Rouge.
2004 Are We Fixing to Make the Same Mistake Again? In *Signs of Power: The Rise of Cultural Complexity in the Southeast*, edited by J. L. Gibson and P. J. Carr, pp. 214–233. University of Alabam Press, Tuscaloosa and London.
Saunders, Joe W., and Thurman Allen
1994 Hedgepeth Mounds, an Archaic Mound Complex in North-Central Louisiana. *American Antiquity* 59:471–489.
1998 The Archaic Period. *Louisiana Archaeology* 22:1–30.
Saunders, Joe W., Thurman Allen, Reca Jones, and Gloria Swoveland
2000 Caney Mounds (16CT5). Louisiana Archaeological Society Newsletter 27:14–21.
Saunders, Joe, Thurman Allen, Dennis Labatt, Reca Jones, and David Griffing
2001 An Assessment of the Antiquity of the Lower Jackson Mound. *Southeastern Archaeology* 20:67–77.
Saunders, Joe W., Thurman Allen, and Roger T. Saucier
1994 Four Archaic? Mound Complexes in Northeast Louisiana. *Southeastern Archaeology* 13:134–153.
Saunders, Joe W., Reca Jones, Kathryn Moorhead, and Brian Davis
1998 "Watson Brake Objects," an Unusual Archaic Artifact Type from Northeast Louisiana and Southwest Mississippi. *Southeastern Archaeology* 17:72–79.
Saunders, Joe W., Rolfe D. Mandel, Roger T. Saucier, E. Thurman Allen, C. T. Hallmark, Jay K. Johnson, Edwin H. Jackson, Charles M. Allen, Gary L. Stringer, Douglas S. Frink, James K. Feathers, Stephen Williams, Kristen J. Gremillon, Malcolm F. Vidrine, and Reca Jones
1997 A Mound Complex in Louisiana at 5500–5000 Years Before Present. *Science* 277:1796–1799.
Saunders, Rebecca
1994 The Case for Archaic Period Mounds in Southeastern Louisiana. *Southeastern Archaeology* 13:118–134.
Sheffield, Mason West
2003 Archaic Faunal Exploitation In the Lower Mississippi Valley: Analysis of Faunal Remains from Plum Creek Archaic (16OU89*)*. Unpublished Master's thesis, University of Southern Mississippi, Hattiesburg.
Smith, Bruce D.
1984 *Chenopodium* as a Prehistoric Domesticate in Eastern North America: Evidence from Russel Cave, Alabama. *Science* 226:165–167.
1985a *Chenopodium berlandieri* ssp. *jonesanum*: Evidence for a Hopewellian Domesticate from Ash Cave, Ohio. *Southeastern Archaeology* 4:107–133.
1985b The Role of *Chenopodium* as a Domesticate in the Pre-Maize Garden Systems of the Eastern United States. *Southeastern Archaeology* 4:51–72.
1987 The Economic Potential of *Chenopodium berlandieri* in Prehistoric Eastern North America. *Journal of Ethnobiology* 7:29–54.
Smith, Bruce D., and C. Wesley Cowan
1987 Domesticated *Chenopodium* in Prehistoric Eastern North America: New Accelerator Dates from Eastern Kentucky. *American Antiquity* 52:355–357.
Soil Survey Staff
1996 *Soil Survey Manual*. U.S. Department of Agriculture Handbook 18. U.S. Government Printing Office, Washington D.C.
Stringer, Gary
1998 Taxonomy and Seasonality: Teleostean Otoliths from the Eagle's Ridge Site, Chambers County, Texas. In *Eagle's Ridge: A Stratified Archaic and Clear Lake Period Shell Midden, Wallisville Lake Project Area, Chambers County, Texas*, edited by H. Blaine Ensor, pp. C1-C27. Wallisville Lake Project Technical Series Reports of Investigations Number 4, Geo-Marine, Dallas.
Stuiver, Minze, Paula J. Reimer, Edouard Bard, J. Warren Beck, G. S. Burr, Konrad A. Hughen, Bernd Kromer, Gerry McCormac, Johannes van der Plicht, and Marco Spurk
1998 INTCAL 98 Radiocarbon Age Calibration, 24,000-0 cal BP. *Radiocarbon* 40:1041–1083.
Vandaveer, Chelsie

2003 What's in a Name? Electronic document, http://www.killerplants.com/whats-in-a-name/20030117.asp, last accessed January 17, 2003.

Vidrine, Malcolm F.

1993 *The Historical Distributions of Freshwater Mussels in Louisiana.* Gail Q. Vidrine Collectibles, Eunice Louisiana.

1995 *River Survey of Freshwater Mollusks of Bayou Bartholemew in Northeastern Louisiana.* Final Report to Natural Heritage Program, Louisiana Department of Wildlife and Fisheries, Baton Rouge, Louisiana.

1996 *River Survey of Freshwater Mollusks of Tensas River System in Northeastern Louisiana.* Final Report to Natural Heritage Program, Louisiana Department of Wildlife and Fisheries, Baton Rouge, Louisiana.

Wang, Kia Kang

1952 *Geology of Ouachita Parish.* Geological Bulletin No. 28. Department of Conservation, Louisiana Geological Survey, Baton Rouge.

Washington, Paul A.

2001 Geomorphic Evidence for the Origins and Draining History of Paleolake Monroe, Ouachita River Valley, Louisiana and Arkansas. *Gulf Coast Association of Geological Societies Transactions* 51:367–377.

Webb, Clarence H.

1981 Stone Points and Tools of Northwestern Louisiana. *Special Publication No. 1, Louisiana Archaeological Society.*

1982 *The Poverty Point Culture.* 2nd Revised ed. Geoscience and Man, vol. 17. School of Geoscience, Louisiana State University, Baton Rouge.

Webb, Clarence H., and Jon L. Gibson

1981 Studies of the Microflint Industry at the Poverty Point Site. In *Traces of Prehistory: Papers in Honor of William G. Haag*, edited by Frederick H. West and Robert W. Neuman, pp. 85–101. Geoscience and Man, Vol. 22. School of Geoscience, Louisiana State University, Baton Rouge.

Witt, A.

1960 Length and Weight of Ancient Freshwater Drum, *Aplodinotus grunniens*, Calculated from Otoliths Found in Indian Middens. *Copeia* 3:181–185.

Yerkes, Richard W.

1983 Microwear, Microdrills and Mississippian Craft Specialization. *American Antiquity* 48:499–518.

Note

1. According to the 1889 *Century Unabridged Dictionary*, another Middle English name for "bracken" was "brake," derived from the Anglo-Saxon *bracce* meaning fern. The name is thought related to (or confused with) the Middle Low German *brake*, a thicket of willow or bushes found on rough and broken ground. Brake (the fern) was found in brakelands, land left fallow and reverting to brush. (Vandaveer 2005).

Received November 3, 2004; Revised April 19, 2005; Accepted April 19, 2005.