2013

Radiocarbon Trends and the East Texas Caddo Tradition (ca. A.D. 800-1680)

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Through the employment of radiocarbon (^{14}C) dates as data, we use the date combination process to refine site-specific summed probability distributions for 555 dates from Caddo sites (n = 19) in East Texas with 10 or more ^{14}C dates. Summed probability distributions are then contrasted across river basins and natural regions with the remainder of the East Texas Caddo Radiocarbon Database (n = 338 dates from 132 other Caddo sites), highlighting the temporal and spatial character of Caddo archaeological sites throughout East Texas.

The Southern Caddo Area stretches across East Texas, northwest Louisiana, southwest Arkansas, and southeast Oklahoma (Figure 1). While delineating the geographic extent of ancestral Caddo settlements across this broad area has been of considerable research interest since the early 1900s (see Brown et al. 1978; Early 1982, 2004; Girard 2010; Krieger 1946, 2009; Rogers and Sabo 2004; Schambach 1982; Story 1990), this article focuses on the temporal and spatial variability in Caddo native history that occurred in East Texas. Using radiocarbon (^{14}C) dates as data (e.g., Rick 1987), we combine ^{14}C assays from all sites with 10 or more dates in order to construct a temporal and spatial model of ancestral Caddo occupation by natural region and river basin. This effort represents the first phase of a larger research approach to focus on better understanding long-term trends in interaction between Caddo and non-Caddo cultural groups between ca. A.D. 850 and 1680 (Formative to Late Caddo periods).

To this end, it is important to identify those sites with occupational episodes (of a particular district/region/phase) that are archaeologically contemporary. Here we use detailed analyses of radiocarbon dates from East Texas Caddo sites to address the issue.

Problems with chronology and cultural taxonomies persist in East Texas Caddo studies (Perttula 2012), but with the availability of the extensive East Texas Radiocarbon Database (Perttula and Selden 2011) there is hope that these problems will be replaced with new ideas regarding nonchronological issues in the archaeological record: technology, traditions, politics, religion, and rituals of the East Texas Caddo people. It is important to dig deeper into the cultural nuances and traditions of the Caddo people to investigate how human interaction influenced the creation of this socially powerful group of complex mound-building societies at the western edge of the Eastern Woodlands. Representative of the first step in furthering current dialogues, this article explores various avenues through which large data sets—such as the one employed herein—from the Caddo region can be used gainfully to address more pointed and focused research questions.

To us, the logical first step in addressing the temporal and spatial character of the East Texas Caddo tradition is through an analysis of the ^{14}C data. Although "deceptively simple" (Perttula 2012:12), the current chronology of the Caddo tradition (Table 1) embraces "no unstated assumption …that [these] periods represent linear or evolutionary views of regional developments or that archaeological developments within the East Texas Caddo area conform in any way from one region to another within the overall regional framework" (Perttula 1992:58).

Methods

Radiocarbon dates have been gathered from the East Texas Radiocarbon Database (ETRD) (Perttula and Selden 2011), which is an amalgam of ^{14}C dates collected from research and cultural resource management reports and publications spanning the last 50 or more years, synthesized, then recalibrated in version 4.1.7 of OxCal (Bronk Ramsey 2012) using IntCal09 (Reimer et al. 2009). These data were analyzed using a variety of statistical processes within version 2.15.1 of R (www.r-project.org), and summed probability distributions (SPD) were produced using OxCal. For older assays lacking δ^{13}C data, we used estimates for fractionation correction as suggested by Stuiver and

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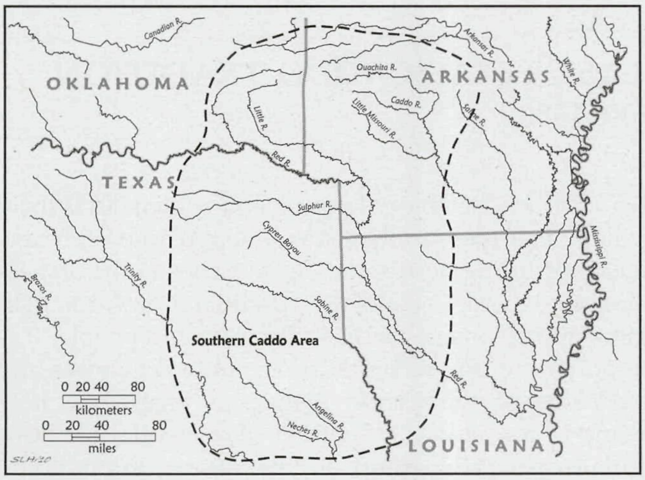

Figure 1. Location of the Southern Caddo area.

Reimer (1993:Table 1): -25‰ for nutshells and charcoal (C_3 plants) and −10‰ for charred maize (C_4 plants) (Perttula 1998a, 1998b; Perttula and Selden 2011; Selden 2012). Once recalibrated, median ages were utilized to select the bulk of the Caddo sample, while others—those straddling the A.D. 800 or A.D. 1680 temporal boundaries—were selected on a case-by-case basis and were segregated based upon probability. Statistical calculations employ negative numbers to represent B.C. and positive numbers to represent A.D. (Sirkin 2006).

The raw sample of Caddo ^{14}C dates (n = 893) exceeds the minimum number of dates needed for statistical significance—750 as suggested by Michczyńska and Pazdur (2004) and 500 by Williams (2012)—but the combined sample (n = 405) does not. However, the distilled sample of 405 dates reduces probability bias introduced by sites with large numbers of ^{14}C dates, and provides a more accurate representation of the temporal character for Caddo sites with 10 or more ^{14}C dates.

The ^{14}C date combination process assumes that if all assays collected at a particular site draw carbon from the same reservoir, then they should have the same underlying F^{14}C value and can be combined prior to calibration (Bronk Ramsey 2008). The measurements have Gaussian uncertainty distributions, and the calibration curve will have an expanded range of probability that broadens the temporal span within which the date of the event may be said to have occurred. Conversely, if the calibrated intercept occurs at a point in the curve with no plateaus or reversals, the resultant date range will be smaller. Thus, no matter how precise the sample, prolonged (plateaus) and multimodal probability distributions (reversals) occur across the sample. However, through an understanding of the nuances in the current ^{14}C calibration curve, samples that fall within temporal periods where plateaus and reversals occur can be more easily identified and given a more critical analysis.

Table 1. Caddo chronological framework (Perttula 2012:Table 1-1).

Period	Dates (A.D.)
Formative Caddo	800–1000
Early Caddo	1000–1200
Middle Caddo	1200–1400
Late Caddo	1400–1680
Historic Caddo	1680–1860+

The Caddo sample was selected from the ETRD on the basis of median age. If the median age fell within the currently accepted temporal construct (ca. A.D. 850–1680) for the Caddo tradition prior to sustained European contact (see Story 1990; Perttula 2012), it was included. Data fields imported from the ETRD include site name, trinomial (site number), assay number, raw age, δ^{13}C, corrected ^{14}C age, 2-sigma age range, and median age.

There are 118 sites in the ETRD that have between one and five ^{14}C samples, 17 sites with 6–10 samples, seven sites with 11–20 samples, four sites with 21–30 samples, two sites with 31–40 samples, one site with 41–50 samples, and two sites with 91–115 samples. The assays from the 19 sites with 10 or more ^{14}C dates were combined via OxCal for two reasons: (1) to reduce the standard deviation and increase the accuracy of each site's temporal assignments and (2) to reduce sampling bias that was created by the number of samples during statistical analyses. Once combined, an SPD was produced for each of the 19 sites with more than 10 dates to illustrate the temporal position for each group of assays. The dates were then plotted in a manner that allowed the SPDs, the combined groups, and the individual assays that comprise them to be viewed together. These efforts permit the uncombined SPD to be contrasted with the combined SPD alongside the combined groups that comprise it. This comparison demonstrates the impact of each site upon the whole of the Caddo sample and allows for a discussion of regional trends within the temporal sample.

Caddo sites with 10 or more ^{14}C dates are geographically illustrated in Figure 2. The ^{14}C assays from these 19 sites are refined through date combination, and the subsequent results (combined dates) replace the original assays within the analysis of all East Texas Caddo dates. Radiocarbon samples from these sites were refined through date combination in an effort to create accurate site and temporally specific summed probability distributions.

As an example of the date combination process, the Caddo period ^{14}C dates from the Lang Pasture site (n = 23) (Perttula et al. 2011) were combined into four groups (Figure 3 and Table 3). Group 1 has three dates

Table 2. Caddo sites in East Texas with radiocarbon dates.

Site Name	Site Trinomial	No. of ^{14}C Dates
Emma Owens	41AN21	1
Fred McKee	41AN32	1
Pierce Freeman	41AN34	1
Lang Pasture	41AN38	22
Pace McDonald	41AN51	2
Ferguson	41AN67	1
Alcoa No. 1	41AN87	4
Hatchel	41BW3	8
Cranfill	41BW171	3
Dogwood Mound	41BW226	1
-	41BW553	4
Weaver Creek	41BW692	1
Solon Stanley	41CE3	1
A. H. Reagor	41CE15	1
George C. Davis	41CE19	115
-	41CE299	3
Kah-hah-ko-wha	41CE354	6
Tuck Carpenter	41CP5	1
Harold Williams	41CP10	1
Shelby Mound	41CP71	8
-	41CP88	5
Kitchen Branch	41CP220	17
Underwood	41CP230	1
Polk Estates	41CP245	2
Pilgrim's Pride	41CP304	29
-	41CP313	2
-	41CP316	2
Honey Suckle	41CP335	1
Hickory Hill	41CP408	27
Coker Mound	41CS1	1
Knight's Bluff	41CS14	2
-	41CS150	1
-	41CS151	4
-	41CS155	1
Tick	41DT6	1
Spider Knoll	41DT11	22
Spike	41DT16	7
L. O. Ray	41DT21	1
-	41DT50	1
Luna	41DT52	2
Johns Creek	41DT62	2
-	41DT63	3
Thomas	41DT80	5
Doctors Creek	41DT124	5
-	41DT141	2
New Hope	41FK107	1
Hardin-A	41GG69	2
Woldert	41HE80	1
-	41HE139	1
Winston	41HE245	2
-	41HE257	1
-	41HE343	2
Hargrove Lake	41HO150	1
Nabedache Azul	41HO214	1
Butler Branch	41HO216	1
Lawson	41HP78	2
Arnold	41HP102	11
Hurricane Hill	41HP106	11
-	41HP116	1
Finley Fan	41HP159	1
Peerless Bottoms	41HP175	11
Tuinier Farm	41HP237	2
Mound Pond	41HS12	2
Pine Tree Mound	41HS15	92
-	41HS231	5
-	41HS573	1
-	41HS574	1
-	41HS588	9
-	41HS843	1
-	41HS846	2
Mackin	41LR39	7
Ray	41LR135	8
Stallings Ranch	41LR297	5
-	41MX5	3
Chayah	41NA44	3
Washington Square	41NA49	7
Tallow Grove	41NA231	15
Foggy Fork	41NA235	5
Naconiche Creek	41NA236	8

Table 2. Continued.

Site Name	Site Trinomial	No. of ^{14}C Dates
Beech Ridge	41NA242	10
Stroddard	41NA243	1
Jas. Miles	41NA247	1
Miles Boundary	41NA248	2
Telesco	41NA280	3
Boyette	41NA285	6
Tom Moore	41PN149	1
Murvaul Creek	41PN175	1
Hudnall-Pirtle	41RK4	4
Nawi haia ina	41RK170	11
Oak Hill Village	41RK214	32
Herman Ballew	41RK222	3
-	41RK342	1
-	41RK468	1
-	41RK557	5
-	41RK558	4
-	41RK562	1
Holdeman	41RR11	4
Fasken	41RR14	2
Sam Kaufman	41RR16	9
Rowland Clark	41RR77	2
Sawmill	41SA89	1
Blount	41SA123	1
P4	41SM53	1
Jamestown	41SM54	1
Bryan Hardy	41SM55	1
Henry Chapman	41SM56	1
Redwine	41SM193	2
Wolf	41SM195	1
Browning	41SM195A	1
Broadway	41SM273	7
Lindsey Park	41SM300	1
Leaning Rock	41SM325	6
-	41SM404	6
Buddy Hancock	41SY45	1
Tyson	41SY92	4
Keith	41TT11	1
-	41TT154	1
-	41TT372	4
-	41TT373	1
-	41TT406	1
-	41TT409	1
Mockingbird	41TT550	9
Ear Spool	41TT653	17
-	41TT670	1
-	41TT672	1
James Owens	41TT769	3
George E. Richey	41TT851	44
William A. Ford	41TT852	38
James E. Richey	41TT853	20
S. Stockade	41TT865	1
Harroun	41UR10	2
Dalton Mound	41UR11	1
Boxed Springs	41UR30	2
Seahorn	41UR105	1
Kelsey Creek Dam	41UR118	3
Verado	41UR129	2
Rookery Ridge	41UR133	10
Griffin Mound	41UR142	1
Camp Joy	41UR144	2
S. Lilly #4	41UR279	2
Henry Spencer	41UR315	2
Carlisle	41WD46	1
McKenzie	41WD55	8
Quitman Lake Burial site	41WD60	3
Osborn	41WD73	1
Spoonbill	41WD109	5
-	41WD244	1
Turbeville	41WD382	1
Hines	41WD450	1
Taddlock	41WD482	4
Steck	41WD529	1

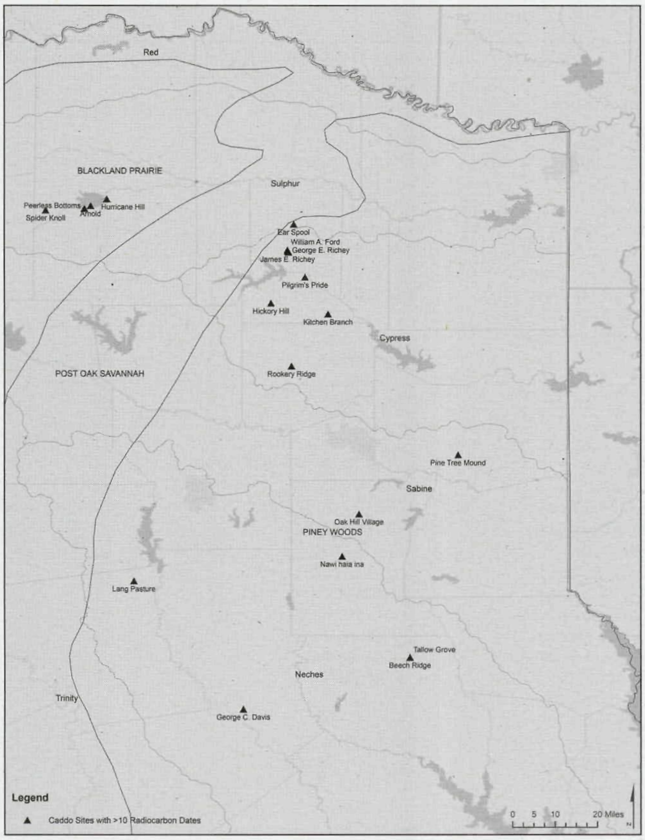

Figure 2. Location of Texas natural regions and Caddo sites with 10 or more ^{14}C dates.

and ranges from A.D. 887 to 987, Group 2 has two dates ranging from A.D. 1264 to 1388, Group 3 has 12 dates ranging from A.D. 1320 to 1413, and Group 4 consists of three dates ranging from A.D. 1430 to 1610. Two dates from the site are unable to be combined (Beta-236788 and Beta-239847). There are six newly combined age ranges at the Lang Pasture site, two of which are represented by one ^{14}C sample each.

This process was followed for all sites with 10 or more dates, after which the assays were organized by river basin since there are known temporal differences in the ancestral Caddo use of the major river basins in East Texas, and the summed probability distribution was plotted for each (Figure 4 and Table 3). Combining the spatial and revised temporal data, Caddo sites of probable contemporaneity can be identified (Figure 5).

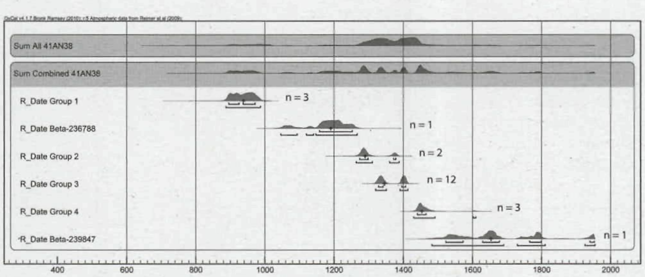

Figure 3. All and combined summed probability distributions for Caddo tradition dates from the Lang Pasture site (41AN38) with 1- and 2-sigma ranges, median ages, and number of samples.

Results

The use of OxCal's R_Combine process on the East Texas Caddo sites with more than 10 ^{14}C dates reduced the number of ^{14}C dates from 893 (with a standard deviation of 58) to 405 (with a standard deviation of 53), decreasing probability bias from sites with large catalogs of ^{14}C dates and providing a more accurate representation for the temporal character of the SPD for the entirety of the East Texas Caddo tradition. Subsequent to date combination, the combined ^{14}C assays replaced those assays used to create them. These data were then joined with the remaining assays from sites with less than 10 ^{14}C dates, and the SPD across time were calculated for all the Caddo dates (Figure 6). This demonstrates the SPD for all Caddo ^{14}C dates before (All Caddo) and after (Combined Caddo) the date combination process. Further, those sites with 10 or more ^{14}C dates (Caddo 10Plus), were subject to the process of date combination, resulting in a decrease of bias in the associated probability distribution. In viewing the SPD for the sample of sites with 10 or more dates in tandem with the dates from sites with fewer than 10 dates, it becomes clear that the 555 dates from sites with 10 or more ^{14}C dates heavily influence the probability distributions. Although the 67 dates from the R_Combine process still influence probability distributions for the larger sample, the probability bias from archaeological sites with a greater number of ^{14}C samples is decreased.

One trend noted early in the study was that the number of ^{14}C dates increased through time; that is to say, there are fewer dates from Formative Caddo contexts than there are from Late Caddo contexts. This trend was also noted in research by Surovell and Brantingham (2007) and Surovell et al. (2009), which addressed concerns of taphonomic bias. In the context of those studies, taphonomic bias was defined as "the tendency for younger things to be overrepresented relative to older things in the archaeological record due to the operation of destructive processes like erosion and weathering" (Surovell et al. 2009:1715). As a curative measure, Surovell and Brantingham (2007) modeled taphonomic bias as an exponential function to account for the proportion of archaeological sites that are lost (per year) to destructive processes. They subsequently refined that model (Surovell et al 2009).

Table 3. Date ranges for sites with combined samples.

Site Name	Site Number	Group/Assay No. of ^{14}C Dates	2σ Date Range (Probability)
Lang Pasture	41AN38	1 (n = 3)	A.D. 887–987 (0.95)
	41AN38	Beta-236788	A.D. 1046–1093 (0.12), A.D. 1120–1141 (0.04), A.D. 1148–1267 (0.79)
	41AN38	2 (n = 2)	A.D. 1264–1310 (0.73), A.D. 1360–1388 (0.22)
	41AN38	3 (n = 12)	A.D. 1320–1351 (0.53), A.D. 1390–1413 (0.42)
	41AN38	4 (n = 3)	A.D. 1430–1491 (0.93), A.D. 1602–1610 (0.02)
		Beta-239847	A.D. 1482–1690 (0.65), A.D. 1729–1810 (0.24), A.D. 1925–1955 (0.07)
George C. Davis	41CE19	1 (n = 47)	A.D. 896–923 (0.31), A.D. 940–995 (0.64), A.D. 1006–1012 (0.01)
	41CE19	2 (n = 66)	A.D. 1185–1258 (0.95)
	41CE19	3 (n = 2)	A.D. 1310–1360 (0.10), A.D. 1386–1525 (0.74), A.D. 1557–1632 (0.12)
Kitchen Branch	41CP220	1 (n = 3)	A.D. 894–988 (0.95)
	41CP220	Beta-322667	A.D. 993–1059 (0.46), A.D. 1068–1155 (0.50)
	41CP220	2 (n = 2)	A.D. 1218–1273 (0.95)
	41CP220	Beta-319977	A.D. 1261–1310 (0.76), A.D. 1360–1388 (0.19)
	41CP220	3 (n = 4)	A.D. 1303–1365 (0.74), A.D. 1383–1404.(0.21)
	41CP220	4 (n = 6)	A.D. 1431–1461 (0.95)
Pilgrim's Pride	41CP304	1 (n = 11)	A.D. 1323–1347 (0.22), A.D. 1392–1430 (0.73)
	41CP304	2 (n = 18)	A.D. 1453–1522 (0.66), A.D. 1578–1581 (0.01), A.D. 1591–1620 (0.29)
Hickory Hill	41CP408	Beta-313943	A.D. 1035–1225 (0.95)
	41CP408	1 (n = 8)	A.D. 1296–1325 (0.38), A.D. 1344–1395 (0.57)
	41CP408	2 (n = 14)	A.D. 1434–1453 (0.95)
	41CP408	3 (n = 4)	A.D. 1458–1528 (0.45), A.D. 1552–1634 (0.50)
Spider Knoll	41DT11	1 (n = 16)	A.D. 995–1045 (0.87), A.D. 1099–1120 (0.07), A.D. 1142–1147 (0.01)
	41DT11	2 (n = 6)	A.D. 1218–1277 (0.95)
Arnold	41HP102	1 (n = 10)	A.D. 1037–1189 (0.93), A.D. 1198–1207 (0.03)
	41HP102	Tx-2049	A.D. 1280–1528 (0.85), A.D. 1552–1634 (0.11)
Hurricane Hill	41HP106	1 (n = 4)	A.D. 989–1057 (0.52), A.D. 1076–1155 (0.44)
	41HP106	2 (n = 4)	A.D. 1220–1279 (0.95)
	41HP106	3 (n = 3)	A.D. 1294–1405 (0.95)
Peerless Bottoms	41HP175	1 (n = 3)	A.D. 1189–1198 (0.02), A.D. 1207–1288 (0.94)
	41HP175	2 (n = 8)	A.D. 1417–1464 (0.95)
Pine Tree Mound	41HS15	1 (n = 2)	A.D. 1053–1080 (0.04), A.D. 1152–1269 (0.91)
	41HS15	Beta-217070	A.D. 1278–1398 (0.95)
	41HS15	2 (n = 18)	A.D. 1397–1429 (0.95)
	41HS15	3 (n = 69)	A.D. 1451–1495 (0.83), A.D. 1601–1612 (0.12)
	41HS15	4 (n = 3)	A.D. 1520–1593 (0.48), A.D. 1619–1665 (0.46), A.D. 1786–1792 (0.01)
Tallow Grove	41NA231	1 (n = 2)	A.D. 1033–1220 (0.95)
	41NA231	2 (n = 7)	A.D. 1280–1310 (0.52), A.D. 1360–1388 (0.43)
	41NA231	3 (n = 6)	A.D. 1419–1460 (0.95)
Beech Ridge	41NA242	1 (n = 9)	A.D. 1333–1337 (0.01), A.D. 1397–1435 (0.94)
	41NA242	Beta-193131	A.D. 1442–1646 (0.95)
Nawi haia ina	41RK170	Beta-166767	A.D. 990–1185 (0.95)
	41RK170	1 (n = 6)	A.D. 1185–1270 (0.95)
	41RK170	2 (n = 3)	A.D. 1297–1410 (0.95)
	41RK170	Beta-164352	A.D. 1432–1527 (0.67), A.D. 1556–1633 (0.29)
Oak Hill Village	41RK214	Beta-107401	A.D. 775–1049 (0.91), A.D. 1085–1124 (0.03),A.D. 1137–1151 (0.01)
	41RK214	1 (n = 12)	A.D. 1219–1268 (0.95)
	41RK214	2 (n = 18)	A.D. 1299–1370 (0.77), A.D. 1380–1399 (0.18)
	41RK214	Beta-107400	A.D. 1415–1527 (0.71), A.D. 1555–1633 (0.25)
Ear Spool	41TT653	1 (n = 3)	A.D. 1297–1407 (0.95)
	41TT653	2 (n = 14)	A.D. 1452–1521 (0.68), A.D. 1591–1620 (0.28)
George E. Richey	41TT851	1 (n = 2)	A.D. 880–990 (0.95)
	41TT851	Beta-305076	A.D. 898–920 (0.07), A.D. 948–1033 (0.88)
	41TT851	2 (n = 4)	A.D. 1189–1197 (0.02), A.D. 1207–1264 (0.93)
	41TT851	3 (n = 16)	A.D. 1276–1296 (0.95)
	41TT851	4 (n = 12)	A.D. 1303–1365 (0.78), A.D. 1382–1399 (0.18)
	41TT851	5 (n = 6)	A.D. 1415–1441 (0.95)
	41TT851	6 (n = 3)	A.D. 1513–1601 (0.73), A.D. 1616–1645 (0.22)
William A. Ford	41TT852	Beta-300101	A.D. 720–742 (0.03), A.D. 769–898 (0.89), A.D. 921–944 (0.04)
	41TT852	Beta-242379	A.D. 1049–1085 (0.08), A.D. 1123–1138 (0.02), A.D. 1151–1271 (0.86)
	41TT852	1 (n = 14)	A.D. 1328–1341 (0.12), A.D. 1395–1421 (0.84)
	41TT852	2 (n = 10)	A.D. 1428–1449 (0.95)
	41TT852	3 (n = 12)	A.D. 1521–1576 (0.73), A.D. 1582–1591 (0.03), A.D. 1623–1644 (0.19)
James E. Richey	41TT853	Beta-305110	A.D. 720–742 (0.03), A.D. 769–898 (0.89), A.D. 921–944 (0.04)
	41TT853	1 (n = 4)	A.D. 1320–1350 (0.37), A.D. 1390–1422 (0.59)
	41TT853	2 (n = 15)	A.D. 1470–1523 (0.53), A.D. 1573–1627 (0.43)
Rookery Ridge	41UR133	1 (n = 4)	A.D. 1297–1407 (0.95)
	41UR133	2 (n = 6)	A.D. 1454–1524 (0.53), A.D. 1558–1632 (0.42)

However, these models are most useful for discussions of deeper time than are covered within Caddo archaeology, and taphonomic correction of this dataset could be problematic (Todd A. Surovell, personal communication 2012).

Temporal Considerations

Efforts to analyze the temporal nature of Caddo occupations across the East Texas landscape utilizing ^{14}C dates assume that (1) ^{14}C dates combined via OxCal

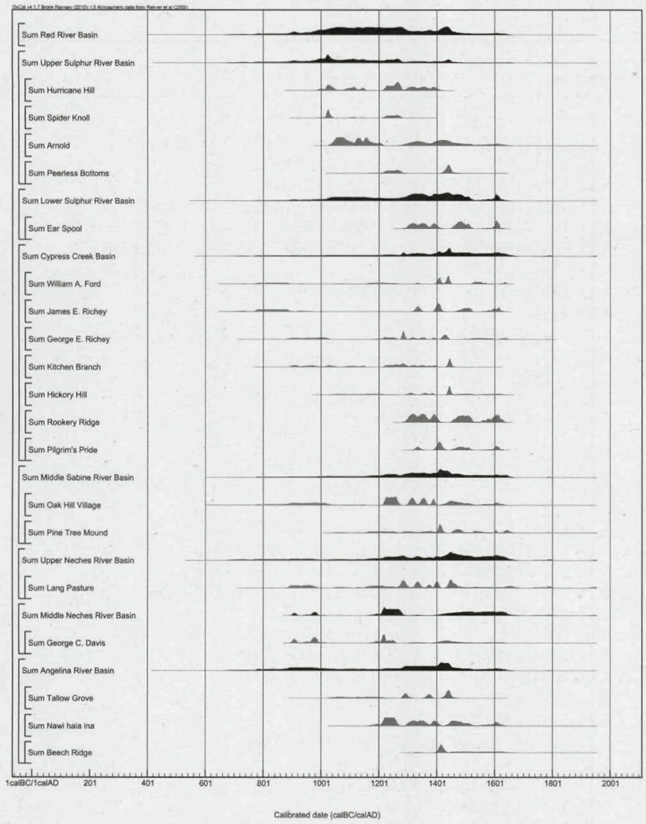

Figure 4. Summed probability distributions from the 19 Caddo sites contrasted against the entirety of the ^{14}C sample from each river basin.

X-test decrease probability bias introduced by larger site-specific samples, (2) the summed probability distribution for archaeological sites with 10 or more ^{14}C assays illustrates the discrete or extended nature of ^{14}C date ranges, and (3) median dates represent the age of highest probability within each ^{14}C date range.

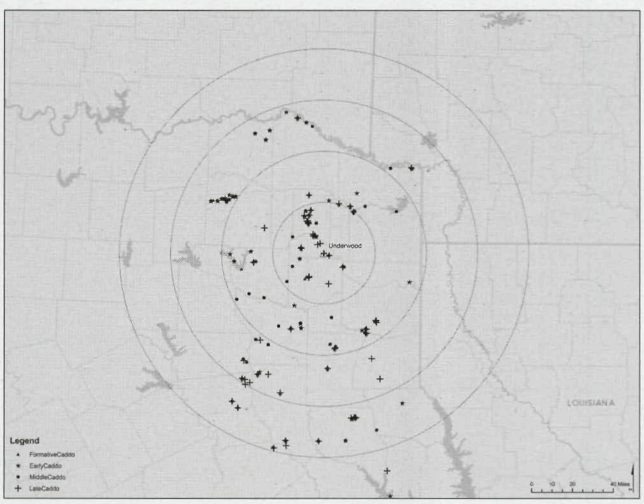

Figure 5. Probable sites of Caddo contemporaneity in East Texas (per ^{14}C determinations) with the Underwood site (41CP230) at 25-mile increments.

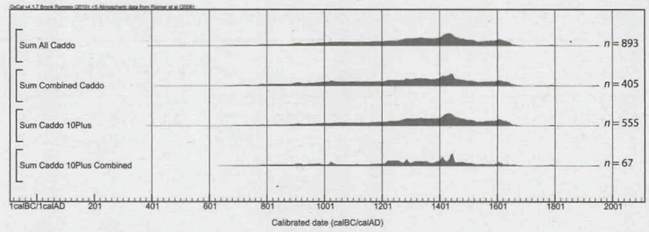

Figure 6. Summed probability distributions illustrating the effect of the date combination process upon the entirety of the Caddo tradition dates and upon those sites with 10 or more ^{14}C samples.

Subsequent to date combination, the Caddo sample consists of 48 dates from the Red River basin, 25 dates from the lower Sulphur River basin, 46 dates from the upper Sulphur River basin, 89 dates from the Cypress Creek basin, 56 dates from the middle Sabine River basin, 42 dates from the upper Sabine River basin, 39 dates from the upper Neches River basin, six dates from the middle Neches River basin, and 59 dates from the Angelina River basin. The shift in sample size illustrates the reduction in the number of ^{14}C dates from each of the river basins for sites with 10 or more assays (Table 4).

Based on the radiocarbon data, Caddo sites dating after the early fifteenth century A.D. are uncommon in the upper Sulphur River basin, the upper Sabine River basin, the middle Neches River basin, and the Angelina River basin. Conversely, post–fifteenth century A.D. Caddo sites are particularly well represented in the lower Sulphur River basin (Jelks 1961), the Cypress Creek basin (Perttula 2004), the middle Sabine River basin (Fields and Gadus 2012), and the upper Neches River basin (Perttula et al. 2011), where distinct regional polities had developed and were flourishing. These polities are marked by higher regional populations than was the case prior to ca. A.D. 1400, as well as dense but localized clusters of settlements, public architecture (i.e., earthen mounds), and associated family and community cemeteries. Most notably, these polities also have evidence for broad social and political hierarchies, led by religious and political leaders known ethnographically as the *Xinesi* and *Caddi* (see Story and Creel 1982).

Spatial Considerations

The spatial divisions of the nine river basins crosscut three natural regions: the Blackland Prairie, Post Oak Savannah, and the Pineywoods (see Figure 2). While no sites with 10 or more ^{14}C samples occur in the Post Oak Savannah, this natural region is well represented by sites with less than 10 ^{14}C samples (see Table 4). Of the spatial divisions by stream basin, five occur only in the

Table 4. Radiocarbon dates by Caddo period and stream basin.

		Dates by Period				
Site Name	Site Trinomial	FC	EC	MC	LC	N
Red River basin						
Hatchel[cd]	41BW3	-	2	3	2	7
Cranfill[ce]	41BW171	-	-	3	-	3
Dogwood Mound[cd]	41BW226	-	-	1	-	1
Mackin[cd]	41LR39	1	5	1	-	7
Ray[ce]	41LR135	2	4	2	-	8
Stallings Ranch[be]	41LR297	3	1	1	-	5
Holdeman[cd]	41RR11	-	1	3	-	4
Fasken[cd]	41RR14	-	2	-	-	2
Sam Kaufman[cd]	41RR16	-	5	2	2	9
Rowland Clark[ce]	41RR77	-	-	2	-	2
Totals		*6*	*20*	*18*	*4*	*48*
Blackland Prairie		*3*	*1*	*1*	-	*5*
Post Oak Savannah		*3*	*19*	*17*	*4*	*43*
Lower Sulphur River basin						
-[ae]	41BW553	-	2	1	1	4
Weaver Creek[ae]	41BW692	-	1	-	-	1
Coker Mound[ad]	41CS1	-	-	1	-	1
Knight's Bluff[ae]	41CS14	-	-	2	-	2
-[ae]	41CS150	-	-	1	-	1
-[ae]	41CS151	1	1	1	1	4
-[ae]	41CS155	-	-	1	-	1
-[ae]	41MX5	-	1	-	2	3
-[ae]	41TT406	-	-	1	-	1
-[ae]	41TT409	-	1	-	-	1
Ear Spool[ad]	41TT653	-	-	4(1)	13(1)	17(2)
-[ce]	41TT670	-	1	-	-	1
James Owens[ce]	41TT769	-	-	1	2	3
Totals		*1*	*7*	*13(10)*	*19(7)*	*40(25)*
Pineywoods		*1*	*6*	*12(9)*	*17(5)*	*36(21)*
Post Oak Savannah		-	*1*	*1*	*2*	*4*
Upper Sulphur River basin						
Tick[be]	41DT6	1	-	-	-	1
Spider Knoll[be]	41DT11	7(-)	11(1)	4(1)	-	22(2)
Spike[be]	41DT16	5	1	1	-	7
L. O. Ray[be]	41DT21	1	-	-	-	1
-[be]	41DT50	-	-	1	-	1
Luna[be]	41DT52	-	1	1	-	2
John's Creek[be]	41DT62	1	1	-	-	2
-[be]	41DT63	1	2	-	-	3
Thomas	[be]	41DT80	-	5	-	-
Doctors Creek[be]	41DT124	1	4	-	-	5
Lawson	[be]	41HP78	-	2	-	-
Arnold[be]	41HP102	1	8(1)	2(1)	-	11(2)
Hurricane Hill[be]	41HP106	2	3(1)	6(2)	-	11(3)
-[be]	41HP116	-	-	1	-	1
Finley Fan[be]	41HP159	-	-	1	-	1
Peerless Bottoms[be]	41HP175	-	1	7(1)	3(1)	11(2)
Tuinier Farm[ce]	41HP237	-	-	-	2	2
Totals		*20(13)*	*39(20)*	*24(10)*	*5(3)*	*88(46)*
Blackland Prairie		*20(13)*	*39(20)*	*24(10)*	*3(1)*	*84(44)*
Post Oak Savannah		-	-	-	*2*	*2*
Cypress Creek basin						
Tuck Carpenter[af]	41CP5	-	-	-	1	1
Harold Williams[ae]	41CP10	-	-	-	1	1
Shelby Mound[ad]	41CP71	-	-	4	4	8
-[ae]	41CP88	-	1	-	4	5
Kitchen Branch[ae]	41CP220	3(1)	1(1)	10(3)	3(1)	17(6)
Underwood[ae]	41CP230	-	-	-	1	1
Polk Estates[ae]	41CP245	-	1	1	-	2
Pilgrim's Pride[ad]	41CP304	-	-	10(1)	19(1)	29(2)
-[ae]	41CP313	-	-	1	1	2
-[ae]	41CP316	-	-	-	2	2
Honey Suckle[ae]	41CP335	-	-	-	1	1
Hickory Hill[ae]	41CP408	-	1(1)	14(2)	12(1)	27(4)
New Hope[ae]	41FK107	-	-	1	-	1
Mound Pond[ad]	41HS12	-	2	-	-	2
Keith[ad]	41TT11	-	-	1	-	1
-[ae]	41TT154	-	1	-	-	1
-[ae]	41TT372	-	1	3	-	4
-[ae]	41TT373	-	-	-	1	1
Mockingbird[aef]	41TT550	1	3	1	4	9
-[ae]	41TT672	-	-	-	1	1
George E. Richey[ae]	41TT851	3(2)	1(-)	36(4)	4(1)	44(7)
William A. Ford[ae]	41TT852	1(1)	-	22(3)	15(1)	38(5)

Table 4. Continued.

		Dates by Period				
Site Name	Site Trinomial	FC	EC	MC	LC	N
James E. Richey[ae]	41TT853	1(1)	-	4(1)	15(1)	20(3)
S. Stockade[ae]	41TT865	-	-	-	1	1
Harroun[ad]	41UR10	-	-	2	-	2
Dalton Mound[ad]	41UR11	-	-	1	-	1
Seahorn[ae]	41UR105	1	-	-	-	1
Kelsey Creek Dam[ae]	41UR118	-	-	-	3	3
Verado[ae]	41UR129	1	-	1	-	2
Rookery Ridge[ad]	41UR133	-	-	4(1)	6(1)	10(2)
Griffin Mound[ae]	41UR142	-	-	1	-	1
Camp Joy[ad]	41UR144	-	-	-	2	2
S. Lilly #4[ae]	41UR279	-	1	1	-	2
Henry Spencer[af]	41UR315	-	-	-	2	2
Totals		*11(8)*	*13(12)*	*118(33)*	*103(36)*	*245(89)*
Pineywoods		*11(8)*	*13(12)*	*118(33)*	*103(36)*	*245(89)*
Middle Sabine River basin						
Hardin-A[ae]	41GG69	-	-	2	-	2
Pine Tree Mound[ad]	41HS15	-	-	27(3)	65(2)	92(5)
-[ae]	41HS231	-	-	5	-	5
-[ae]	41HS573	-	-	-	1	1
-[ae]	41HS574	-	-	1	-	1
-[ae]	41HS588	-	-	5	4	9
-[ae]	41HS843	-	-	-	1	1
-[ae]	41HS846	-	-	2	-	2
Tom Moore[ad]	41PN149	-	-	-	1	1
-[ae]	41PN175	-	-	-	1	1
Hudnall-Pirtle[ad]	41RK4	-	4	-	-	4
Oak Hill Village[ad]	41RK214	1(1)	4(-)	26(2)	1(1)	32(4)
Herman Ballew[ae]	41RK222	2	-	-	1	3
-[ae]	41RK342	-	-	1	-	1
-[ae]	41RK468	-	-	1	-	1
-[ae]	41RK557	1	-	3	1	5
-[ae]	41RK558	-	2	1	1	4
-[ae]	41RK562	-	-	1	-	1
Buddy Hancock[ae]	41SY45	-	1	-	-	1
Totals		*4(4)*	*11(11)*	*75(27)*	*77(14)*	*167(56)*
Pineywoods		*4(4)*	*11(11)*	*75(27)*	*77(14)*	*167(56)*
Upper Sabine River basin						
P4[ae]	41SM53	-	1	-	-	1
Jamestown[cd]	41SM54	-	-	1	-	1
Bryan Hardy[ae]	41SM55	-	-	1	-	1
Henry Chapman[ae]	41SM56	-	-	1	-	1
Redwine[ad]	41SM193	-	-	1	1	2
Wolf[ae]	41SM195	-	-	1	-	1
Browning[ae]	41SM195A	1	-	-	-	1
Leaning Rock[ae]	41SM325	-	1	5	-	6
Boxed Springs[ad]	41UR30	-	2	-	-	2
Carlisle[ae]	41WD46	-	-	1	-	1
McKenzie[ad]	41WD55	-	-	8	-	8
Quitman Lake Burial site[cf]	41WD60	-	-	2	1	3
Osborn[ce]	41WD73	1	-	-	-	1
Spoonbill[ce]	41WD109	-	2	3	-	5
-[cf]	41WD244	-	-	-	1	1
Turbeville[ce]	41WD382	-	-	1	-	1
Hines[ce]	41WD450	-	1	-	-	1
Taddlock[ce]	41WD482	-	3	1	-	4
Steck[ce]	41WD529	-	-	1	-	1
	Totals	2	10	27	3	42
	Pineywoods	1	4	18	1	24
	Post Oak Savannah	1	6	9	3	19
Upper Neches River basin						
Emma Owens[ae]	41AN21	-	-	-	1	1
Fred McKee[af]	41AN32	-	-	-	1	1
Pierce Freeman[af]	41AN34	-	-	-	1	1
Lang Pasture[ae]	41AN38	3(1)	1(1)	16(3)	2(1)	22(6)
Pace McDonald	ad	41AN51	-	-	2	-
Ferguson[ae]	41AN67	-	-	-	1	1
Alcoa No. 1[ae]	41AN87	-	-	2	2	4
Solon Stanley[af]	41CE3	-	1	-	-	1
A. H. Reagor[af]	41CE15	-	-	-	1	1
-[ae]	41CE299	-	1	-	2	3
Kah-hah-ko-wha[ae]	41CE354	-	1	1	4	6
Woldert[ae]	41HE80	-	-	1	-	1
-[ae]	41HE139	-	-	1	-	1
-[ae]	41HE257	1	-	-	-	1

Table 4. Continued.

Site Name	Site Trinomial	Dates by Period				
		FC	EC	MC	LC	N
-[ae]	41HE343	-	-	-	2	2
Lindsey Park[af]	41SM300	-	-	-	1	1
-[ae]	41SM404	1	-	5	-	6
	Totals	*5(3)*	*4(4)*	*28(15)*	*18(17)*	*55(39)*
	Pineywoods	*5(3)*	*4(4)*	*28(15)*	*18(17)*	*55(39)*
Middle Neches River basin						
George C. Davis[ad]	41CE19	29(1)	54(-)	31(2)	1	115(3)
Hargrove Lake[ae]	41HO150	-	-	-	1	1
Nabedache Azul[ae]	41HO214	-	-	-	1	1
Butler Branch[ae]	41HO216	-	-	1	-	1
	Totals	*29(1)*	*54(-)*	*32(2)*	*3*	*118(6)*
	Pineywoods	*29(1)*	*54(-)*	*32(2)*	*3*	*118(6)*
Angelina River basin						
Chayah[ae]	41NA44	1	-	1	1	3
Washington Square[ad]	41NA49	2	2	3	-	7
Tallow Grove[ae]	41NA231	-	2(1)	12(2)	1	15(3)
Foggy Fork[ae]	41NA235	-	-	4	1	5
Naconiche Creek[ae]	41NA236	5	-	2	1	8
Beech Ridge[ae]	41NA242	-	-	8(1)	2(1)	10(2)
Stroddard[ae]	41NA243	-	1	-	-	1
Jas. Miles[ae]	41NA247	-	-	1	-	1
Miles Boundary[ae]	41NA248	-	-	2	-	2
Telesco[ae]	41NA280	-	-	-	3	3
Boyette	ae	41NA285	2	2	2	-
Nawi haia ina[ae]	41RK170	-	4(1)	6(2)	1(1)	11(4)
Sawmill[ae]	41SA89	-	1	-	-	1
Blount[ae]	41SA123	-	-	-	1	1
Broadway[ae]	41SM273	5	-	2	-	7
Tyson[ae]	41SY92	-	-	4	-	4
	Totals	*15*	*12(8)*	*47(26)*	*11(10)*	*85(59)*
	Pineywoods	*15*	*12(8)*	*47(26)*	*11(10)*	*85(59)*

Note: FC = Formative Caddo, ca. A.D. 800–1000; EC = Early Caddo, ca. A.D. 1000–1200; MC = Middle Caddo, ca. A.D. 1200–1450; LC = Late Caddo, ca. A.D. 1450–1680+; numbers in parentheses indicate results from the date combination process

[a] Pineywoods

[b] Blackland Prairie

[c] Post Oak Savannah

[d] Mound Center

[e] Settlement

[f] Cemetery

Pineywoods (Cypress Creek, middle Sabine River, upper Neches River, middle Neches River, and Angelina River basins), two in the Blackland Prairie and Post Oak Savannah (Red River and upper Sulphur River basins), and two in the Pineywoods and Post Oak Savannah (lower Sulphur River basin and upper Sabine River basins) (Figure 7).

In most instances where dated archaeological sites occur in the Pineywoods, ^{14}C dates range from the Formative to the Late Caddo period, indicating a long-lasting continuity in settlements in this natural region. In the upper Sabine River and Angelina River basins, however, dated sites are rare after the early fifteenth century A.D. Perttula and Rogers (2007) have suggested that drought-bearing climatic conditions beginning in the mid-fifteenth century may have led to the abandonment or lessened use of some parts of East Texas where agricultural economies were at risk. Sites in the Blackland Prairie are defined by a bimodal probability distribution in the Red River basin, and a

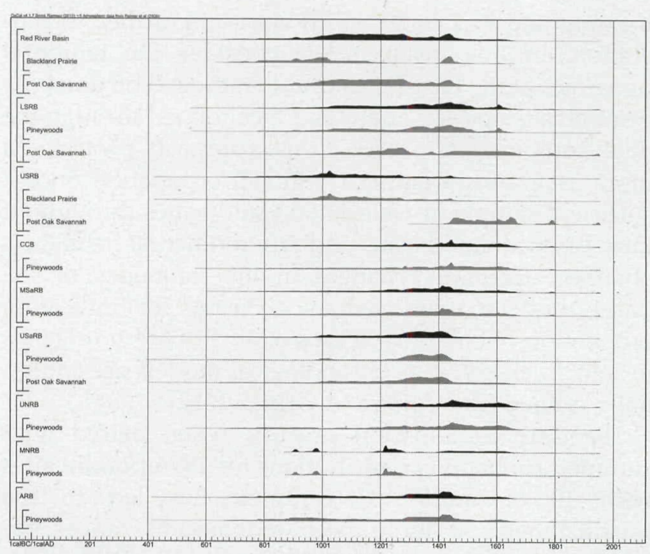

Figure 7. Summed probability distributions by spatial divisions and natural regions.

more continuous probability distribution in the upper Sulphur River basin for Formative, Early and Middle Caddo periods. The natural region with the greatest amount of temporal variability in dated sites is the Post Oak Savannah. To better illustrate the differing settlement trends in this region (per ^{14}C dates), probability distributions are used to demonstrate that Formative Caddo (ca. A.D. 800–1000) settlements appear first in the Red River basin, followed by the Early Caddo (ca. A.D. 1000–1200) settlements in the lower Sulphur River basin, and Late Caddo (ca. A.D. 1450–1680) settlements in the upper Sulphur River basin (although only represented by two ^{14}C dates).

Conclusions

While the specifics of each probability range can be challenging to discern without the raw numbers, it is possible to manipulate a large sample of ^{14}C dates to create a regional model that highlights the temporal character of specific sites, where the cause of the differing temporal spans illustrated in the probability distributions associated with each episode can be correlated with the ^{14}C calibration curve (see also Bamforth and Grund 2012). The temporal analysis presented here effectively reduces bias introduced by sites with large numbers of ^{14}C dates, providing a means by which the number and character of the ^{14}C dates—in lieu of relative occupational episodes (see Rick 1987:56; Kuzmin and Keates 2005:780)—can be conveyed more meaningfully.

This approach to the interpretation of ^{14}C data is fruitful, but whether it is capable of rendering accurate predictions regarding "occupation intensity" (see Rick 1987:67) or the "intensity of human occupation" (see Kuzmin and Keates 2005:773) warrants further consideration. In this instance, we consider the temporal dynamics of the East Texas Caddo radiocarbon database through site-specific analyses. Once refined through the date combination process, this approach provides a more accurate measure of regional occupation once a sufficient sample of well-dated Caddo sites throughout East Texas stream basins and environmental habitats is obtained. Certainly changes in the frequency of ^{14}C dates may be employed as a proxy for indicating population fluctuations (Peros et al. 2010), but it is best to remain skeptical as chronological models are continually refined (Bamforth and Grund 2012).

The date combination process, when paired with summed probability distributions for 19 important sites with 10 or more ^{14}C samples, has led to the establishment of more precise temporal ranges for specific Caddo occupations of East Texas. Within the context of an ongoing synthesis of research concerning all available Caddo radiocarbon dates in the four-state Caddo area, this method can be used to explore the temporal range of sites, and their combination can be a means of highlighting both temporal and spatial trends within the Caddo archaeological tradition (ca. A.D. 800–1680). Taken together and in combination with archaeological assemblage data, the analysis of Caddo radiocarbon dates can identify features and occupational events that are archaeologically contemporary across the larger region. The volume of ^{14}C dates from East Texas is fairly robust, and it is becoming easier to explore the "actual relations between data points ...instead of boxes of our own cryptic creation" (Dunnell 2008:64).

With the decreasing cost of attaining accurate ^{14}C determinations from much smaller samples, archaeologists are becoming more mindful of the research potential that ^{14}C dates can offer (see Kuzmin and Keates 2005; Rick 1987; Steele 2010; Williams 2012). One trend evidenced here and in other studies (see Surovell and Brantingham 2007; Surovell et al. 2009) is that the number of younger components outnumbers that of older components. This observation plays an integral role in the recent push toward highlighting fluctuations in prehistoric demography via radiocarbon (Bamforth and Grund 2012; Buchanan et al. 2008; Faught 2008; Hinz et al. 2012; Peros et al. 2010) and the curative methods advanced to correct for taphonomic bias (Surovell and Brantingham 2007; Surovell et al. 2009).

Advances in combining the analysis of ^{14}C with data from other sources—stratigraphic contexts (Bronk Ramsey 1995, 2007; Michczyńska and Pazdur 2003), phases (Buck et al. 1991; Zeidler et al. 1998), architecture (Bayliss et al. 2007; Whittle et al. 2011), paleoenvironmental records (Gearey et al. 2009), tephrochronology (Buck et al. 2003), climate (Kidder 2006), and ceramics (Buck et al. 1992)—provide an integral toolkit for exploring potential associations between ^{14}C determinations and archaeological datasets, providing testable hypotheses that can be validated or falsified with the addition of more data (Bayliss and Ramsey 2004). Bayesian analyses of radiocarbon data have been employed for over 15 years in Great Britain (Bayliss 2009; Bronk Ramsey 2008, 2009; Buck et al. 1996) with great success. Within the context of Caddo archaeological studies, further analysis of the trends highlighted here will aid in the development of more substantive and empirically supported hypotheses and theories of culture change in East Texas and the larger Caddo area.

While it is certain that more ^{14}C dates are needed to identify the specific temporal and spatial patterns that characterize the Caddo tradition, this synthesis of data from the ETRD represents the initial undertaking in that endeavor. More attention should be given to the appearance and temporal character of specific types of sites in the future (i.e., mound centers, settlements, cemeteries, etc.), as well as for better known sites within regions whose material culture assemblages (particularly ceramic vessels and sherds) are becoming increasingly well known. This will serve to further elucidate the temporal progression or abandonment of East Texas Caddo communities through the detailed consideration of micro-stylistic changes in ceramic assemblages (see Girard 2012) that can be associated with suites of calibrated radiocarbon dates.

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