

# After Cahokia: Indigenous Repopulation and Depopulation of the Horseshoe Lake Watershed AD 1400–1900

A.J. White , Samuel E. Munoz, Sissel Schroeder, and Lora R. Stevens

---

*The occupation history of the Cahokia archaeological complex (ca. AD 1050–1400) has received significant academic attention for decades, but the subsequent repopulation of the region by indigenous peoples is poorly understood. This study presents demographic trends from a fecal stanol population reconstruction of Horseshoe Lake, Illinois, along with information from archaeological, historical, and environmental sources to provide an interpretation of post-Mississippian population change in the Cahokia region. Fecal stanol data indicate that the Cahokia region reached a population minimum by approximately AD 1400, regional population had rebounded by AD 1500, a population maximum was reached by AD 1650, and population declined again by AD 1700. The indigenous repopulation of the area coincides with environmental changes conducive to maize-based agriculture and bison-hunting subsistence practices of the Illinois Confederation. The subsequent regional depopulation corresponds to a complicated period of warfare, epidemic disease, Christianization, population movement, and environmental change in the eighteenth century. The recognition of a post-Mississippian indigenous population helps shape a narrative of Native American persistence over Native American disappearance.*

**Keywords:** Cahokia, fecal stanols, protohistory, Illinois Confederation, paleodemography, paleoclimate, resilience

*La historia de la ocupación y el abandono del complejo arqueológico de Cahokia (ca. dC 1050–1400) ha sido de interés científico desde el siglo XIX, pero la repoblación de la región después de su abandono no está bien entendido. Este artículo usa información demográfica inferida de estanoles fecales preservados en los sedimentos del lago Horseshoe (Illinois, Estados Unidos), junto con datos arqueológicos, históricos, y ecológicos para entender cambios demográficos del período después del abandono de Cahokia. Nuestros datos muestran que la región tuvo un mínimo de población en el año 1400, la población se recuperó después del año 1500, llegó a su punto máximo en el año 1650, y volvió a disminuir después del año 1700. La repoblación de la región entre los años 1500 y 1700 coincide con cambios ecológicos asociados con la ocupación de la Confederación de los Illinois, un grupo indígena que cultivaba el maíz y cazaba bisontes en esta región. La despoblación de la región después del año 1700 coincide con un período de guerra, enfermedades epidémicas, cristianización, y cambios demográficos y ecológicos. El reconocimiento de una población indígena después del período Mississippian y el abandono Cahokia pone énfasis en la persistencia de los nativos americanos en lugar de su desaparición.*

**Palabras clave:** Cahokia, estanoles fecales, protohistoria, Confederación de Illinois, paleodemografía, paleoclima, resiliencia

---

The demographic history of Greater Cahokia, from its peak in the eleventh century to its minimum at approximately AD 1350–1400 has received significant academic attention (Benson et al. 2009; Bird et al. 2017; Emerson 2018; Gregg 1975; Kelly 2009; Milner

---

**A.J. White** ■ Department of Anthropology, University of California, Berkeley, 232 Kroeber Hall, Berkeley, CA 94720, USA ([ajwhitesemail@gmail.com](mailto:ajwhitesemail@gmail.com), corresponding author) <https://orcid.org/0000-0002-8069-1993>

**Samuel E. Munoz** ■ Department of Marine and Environmental Sciences, Northeastern University, Marine Science Center, 430 Nahant Road, Nahant, MA 01908, USA

**Sissel Schroeder** ■ Department of Anthropology, University of Wisconsin-Madison, 1180 Observatory Drive, Madison, WI 53706, USA

**Lora R. Stevens** ■ Department of Geological Sciences, California State University, Long Beach, 1250 Bellflower Boulevard, Long Beach, CA 90840, USA

*American Antiquity* 85(2), 2020, pp. 263–278  
Copyright © 2020 by the Society for American Archaeology  
doi:10.1017/aaq.2019.103

2006:120–125; Munoz et al. 2015; Pauketat and Lopinot 1997; Reed et al. 1968; White et al. 2018, 2019), but efforts to understand the repopulation of the region by indigenous peoples prior to the establishment of European colonists at the close of the eighteenth century have been limited (Brown and Kelly 2010; Morgan 2010; Walthall and Benchley 1987; Zitomersky 1994). The primary reasons for which the period after AD 1400 is understudied are (1) limited archaeological evidence for occupation of the watershed between AD 1400 and AD 1700 and (2) widespread acceptance of the Vacant Quarter hypothesis for regional abandonment between AD 1450 and 1550 (Cobb and Butler 2002; Edging 2007; Emerson 1997:54; Fortier et al. 2006; Hanenberger 2003; Jackson 1998; Meeks and Anderson 2013; Milner et al. 1984, 2001; Williams 1980, 1983, 1990, 2001).

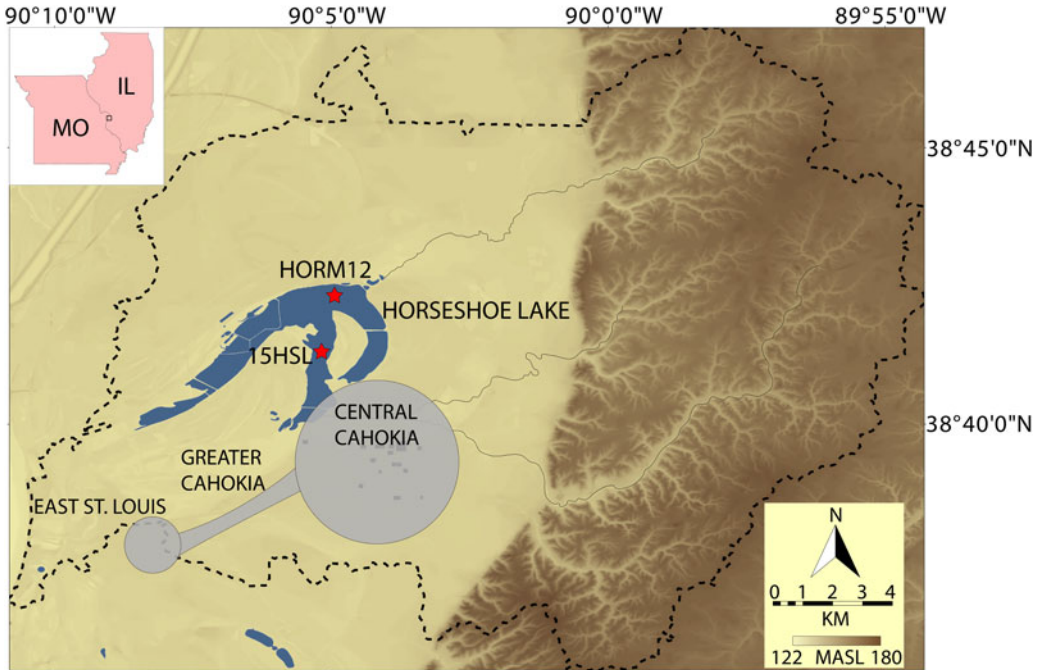
The underappreciation of a post-Cahokia indigenous population in the region has contributed to a romanticization of Cahokia by some popular science writers who have depicted the eroding mounds as an example of total collapse (Diamond 2006:3) or attributed abandonment of the site to environmental mismanagement (Mann 2006:303), leaving the reader with a sense of finality to the native population. Although researchers immersed in the Cahokia area literature are well aware of a post-Cahokia indigenous population (Brown and Kelly 2010; Morgan 2010; Walthall and Benchley 1987; Zitomersky 1994), the popular emphasis on Cahokia's decline and abandonment may perpetuate the myth of the “vanishing Indian” that consciously or unconsciously exists in the minds of many Americans (see Lightfoot and Gonzalez 2018; Silliman 2012; Wilcox 2009, 2010). This may be another reason that the period after AD 1400 is understudied—throughout the history of archaeological research, Native American disappearance has been emphasized more than Native American persistence (Rubertone 2000; Wilcox 2009).

Investigations of the significant population decline at Greater Cahokia indicate a protracted process and implicate a concatenation of many factors, including drought, flooding, climate change, the overexploitation of resources, political and religious instabilities, sociopolitical

factionalism, intergroup conflict, ethnic diversity, and historically contingent circumstances, as well as the loss or departure of prominent individuals, kin groups, leaders, or deities (Benson et al. 2009; Emerson 1997, 2018; Emerson and Hedman 2015; Kelly 2009; Lopinot and Woods 1993; Milner 2006; Munoz 2015; Munoz et al. 2015; Pauketat 1994, 2018; Pauketat and Lopinot 1997; White et al. 2019). In contrast to the considerable attention that has been paid to the dissolution and abandonment of Greater Cahokia, what happened after Cahokia's depopulation is poorly understood. Here, we present post-AD 1400 demographic trends from a fecal stanol population reconstruction of Horseshoe Lake, Illinois (White et al. 2018)—along with information from archaeological, historical, and environmental sources—to understand the resilience of indigenous peoples during the post-Mississippian period.

### Horseshoe Lake Fecal Stanol Population Reconstruction

Horseshoe Lake is a large oxbow lake of the Mississippi River that contains within its watershed the Cahokia archaeological complex (Figure 1). White and colleagues (2018) used variations in the concentrations of fecal stanol molecules retained in lake sediments from two cores, HORM12 and 15HSL, to create a population reconstruction of the lake's watershed (Figure 2). The two cores were correlated on the basis of stratigraphic variation in layers interpreted as flood deposits (Munoz et al. 2015) and loss-on-ignition (LOI) data (White et al. 2019), and they share the age-depth model established by Munoz and others (2014) for HORM12 constrained by nine radiocarbon dates on terrestrial plant macrofossils and the rise of *Ambrosia* (ragweed) pollen, marking the onset of widespread Anglo-American agricultural clearance at approximately AD 1850. Coprostanol is a fecal stanol molecule primarily produced by the bacterial degradation of cholesterol in the guts of humans that can persist in sediments for hundreds to thousands of years (Bull et al. 1999; Simpson et al. 1999; Sistiaga et al. 2014; Vachula et al. 2019). Although other mammals—including donkeys, seals, horses, goats, and cattle—produce



**Figure 1.** The modern Horseshoe Lake watershed, shown as the black dashed line. Coring sites are indicated by stars. Central Cahokia is approximated by deposits that are within the large circle. Greater Cahokia includes Central Cahokia and a region extending to East St. Louis. Base map elevation data are derived from the National Elevation Dataset (Gesch et al. 2002). Adapted from White and colleagues (2018). (Color online)

coprostanol, only sheep and pigs are known to generate sufficient quantities that could mask changes in human stanol concentration (Bull et al. 2002; Leeming et al. 1996; Martins et al. 2005; Prost et al. 2017), and neither domesticated was present in the Cahokia area prior to sustained European settlement (Mann 2012). Once introduced into the environment as a component of feces, coprostanol is typically buried in situ or transported during rain events and deposited in a basin, such as a lake. We analyzed two sediment cores from opposite sides of Horseshoe Lake to address the issue that a single core may not represent the entire watershed (White et al. 2018). We interpret the Horseshoe Lake fecal stanol record as representative of the watershed because HORM12 and 15HSL show parallel trends in fecal stanol data, and activities such as hunting, fishing, and gathering likely expanded the indigenous presence on the landscape throughout much of the watershed.

Due to its prevalence in human feces and recalcitrance in sediments, variations in coprostanol

concentration may be linked to changes in the relative size of a population within a region (D'Anjou et al. 2012). To account for variations in degradation rate and low stanol abundance, the concentrations of coprostanol are reported in comparison to  $5\alpha$ -cholestanol, following Grimalt and colleagues (1990):

$$\text{coprostanol}/\text{coprostanol} + 5\alpha\text{-cholestanol} \quad (1)$$

$5\alpha$ -cholestanol is formed from the degradation of cholesterol by soil microbial communities (Bull et al. 2002). By relating coprostanol to  $5\alpha$ -cholestanol, we make a comparison of stanol input and preservation in a specific environment ( $5\alpha$ -cholestanol) to stanol input from feces (coprostanol). Consequently, high values of ratio (1) indicate a large presence of humans in the region and low values indicate a small human presence. Horseshoe Lake fecal stanol data (White et al. 2018) record the timing of three important demographic events following Greater Cahokia's population maximum and

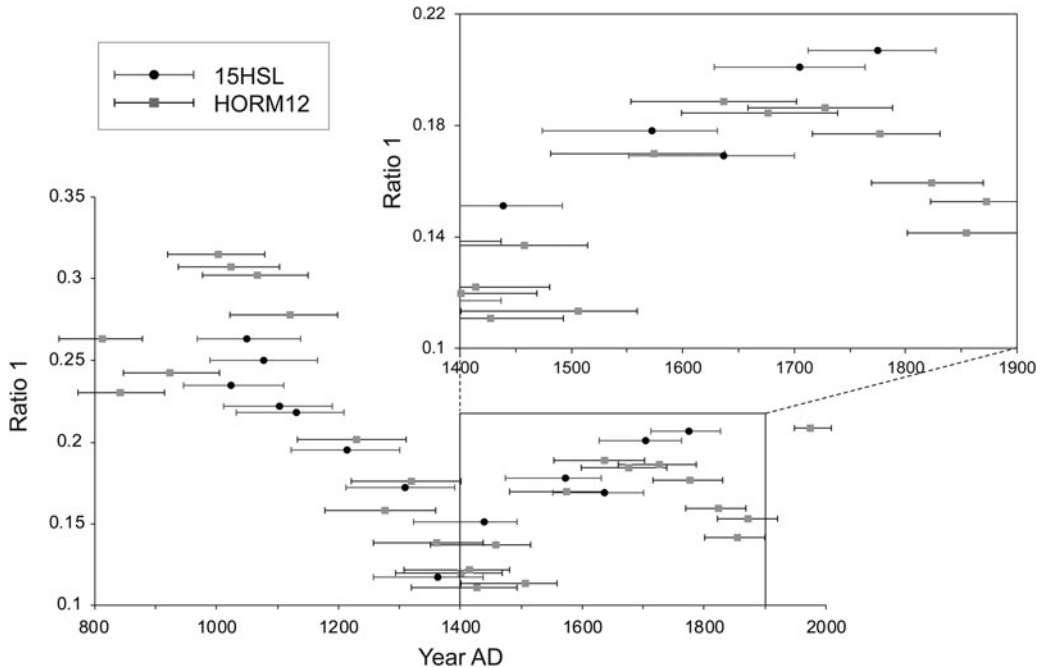


Figure 2. Horseshoe Lake stanol data plotted as coprostanol/ $5\alpha$ -cholestanol ratio. Error bars represent temporal uncertainty reported as  $2\sigma$  (95%) confidence generated by the Clam 2.2 model (Munoz et al. 2014). The lower left plot shows all fecal stanol data from White and colleagues (2018), and the upper right plot shows fecal stanol data from AD 1400 to 1900.

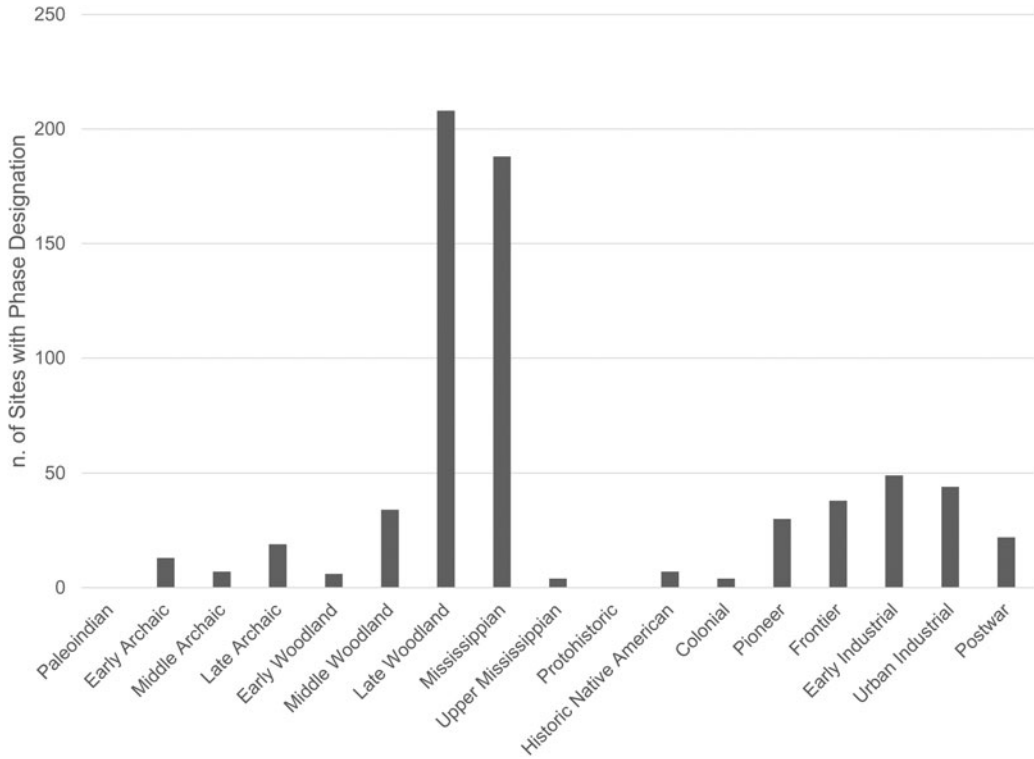
prior to the arrival of European colonists: the Cahokia population minimum at AD 1400, the initiation of indigenous repopulation by AD 1500, and the post-Cahokia population maximum reached by approximately AD 1650 (Figure 2). The Cahokia area experienced a continuous population decline from approximately AD 1100 to 1350–1400 in the much discussed “Cahokia collapse” (Delcourt and Delcourt 2004:115; Emerson 1991, 2002; Emerson and Hedman 2015; Kelly 2009; Milner 1986, 1990, 2006; Pauketat 2004; Pauketat and Lopinot 1997). Following this period, the fecal stanol record indicates that the watershed’s population remained relatively low during the fifteenth century, but it began to increase after AD 1500. This suggests that the region’s demographic nadir was short lived. Despite the dearth of archaeological evidence for a post-AD 1500 occupation, the fecal stanol record indicates that people were again living in the Horseshoe Lake watershed.

The watershed’s population increased into the sixteenth century to a height at approximately

AD 1650. The fecal stanol ratio values then plateau to AD 1700 before declining through the nineteenth century. Outlier data points from core 15HSL are present at approximately AD 1710 and 1775, possibly resulting from laboratory or chronometric uncertainties in the age model and core correlation. Alternatively, these data points may indicate that a historic population was centered on the south end of the lake closer to 15HSL than HORM12.

## Discussion

The fecal stanol record provides a proxy of population change in the Horseshoe Lake watershed, but additional information is needed to understand the cultural and environmental factors that influenced these demographic trends. We include evidence from historical, archaeological, and environmental sources to construct a narrative of population change in the Horseshoe Lake watershed after AD 1400.



**Figure 3. Temporal phases identified at previously recorded archaeological sites within three miles of Horseshoe Lake (approximate extent of the Horseshoe Lake watershed). Source: Illinois State Museum.**

Greater Cahokia's regional population was at its lowest in the fifteenth century, marking the end of a nearly continuous demographic decline that began 300 years earlier (Emerson 2018; Milner 2006; Pauketat and Lopinot 1997; White et al. 2018). Numerous explanations for the decline have been put forward (Benson et al. 2009; Bird et al. 2017; Emerson and Hedman 2015; Kelly 2009; Lopinot and Woods 1993; Munoz et al. 2015; Pauketat 2018; Pauketat et al. 2013; Pompeani et al. 2019; White et al. 2019), but its reversal has not been discussed. In eastern North America, protohistoric sites are identified on the basis of native-made materials in association with European trade goods in locations that do not appear on maps and that are not mentioned in historic records or European travel accounts (Ehrhardt 2010; Mazrim and Esarey 2007). Definitive archaeological evidence for occupation of the Cahokia region during the protohistoric period (approximately AD 1550–1670) is scant, but given that archaeologists

have poor control over the kinds of artifacts that may have been distinctive to late precontact sites (sixteenth- to seventeenth-century European trade goods need to be present to classify a site as protohistoric) and that many native groups were highly mobile at this time, it is not surprising that such sites are underrepresented in state site files (Ehrhardt 2010; Lewis 1990; Mazrim and Esarey 2007; Milner and Chaplin 2010; Milner et al. 2001). For example, a search of the Illinois State Museum site records within three miles of Horseshoe Lake revealed no previously recorded sites with protohistoric components and just two sites with Oneota (Upper Mississippian) components, the Sponemann and Sand Drive sites, both dating to the fourteenth century (Figure 3; Jackson 1998; Jackson et al. 1992; Pauketat et al. 1998:90). In addition, small amounts of Oneota materials have been recovered from Mound 51, Mound 66, Mounds 19–20, Tract 15B, and the Powell Tract at Cahokia. These materials likely date to the fourteenth

century, but some might represent a small fifteenth-century Oneota presence at Cahokia (Bareis and Lathrap 1962; Brown and Kelly 2010; Jackson 1998; O'Brien 1972).

Elsewhere in the American Bottom region, Oneota sites include the 78th Street, Range, and Booker T. Washington (also called Greene) sites near the base of the bluff over 7 km south of Cahokia; Stolle Quarry on the edge of the bluff about 20 km south of Cahokia; McDonough Lake and Ringering, 5–7 km north of Cahokia; and Pere Marquette State Park, just north of the American Bottom near the confluence of the Illinois and Mississippi Rivers (Brown and Kelly 2010; Hall and Vogel 1963; Hanenberger 2003; Jackson 1998; Milner et al. 1984; Munson 1971:Figure 12q, Figure 21d; Perino 1959; Rinaldo 1937; Wells and Holley 1993). The materials recovered from Cahokia and the 78th Street site date to the fourteenth century (Jackson 1998; Wells and Holley 1993), the Oneota component at Range has been dated to approximately AD 1500–1650 (Hanenberger 2003:377, 434; cf. Hollinger 1995:157–158), and it has been suggested that the Oneota components at Booker T. Washington, Stolle Quarry, and Ringering also fall within this range (Jackson 1998). In short, archaeological evidence of an Oneota presence in the American Bottom is sparse, most of the sites lie outside the Horseshoe Lake watershed, and all of the sites are small, most likely representing short-term occupation of isolated farmsteads.

Additionally, historic-era Illinois hunting camps rarely contain diagnostic materials necessary to make a temporal and cultural determination (Nolan 2010). These factors, in addition to the mixing of archaeological material, sedimentation of the Mississippi River Valley, historic and modern urban development, and limited access to private lands, make the identification of protohistoric and early historic archaeological sites difficult (Ehrhardt 2010). Furthermore, the research emphasis on Mississippian archaeology may create a recording bias that impacts the identification of Illinois material culture during archaeological survey. Van Thienen (2017) found a “Germanic bias” that led to an underrepresentation of late Roman archaeological sites in Flanders due to a

traditional narrative that northern Gaul was abandoned by the Romans around AD 275. It is possible that a similar “Mississippian bias” exists in the Cahokia region—why look for post-Cahokia material if you do not expect to find it?

### *Ethnohistoric Information*

A lack of archaeological evidence does not preclude the existence of a protohistoric population in the Horseshoe Lake watershed. The Cahokia subgroup of the Illinois Indians was present in the vicinity of Horseshoe Lake in the early eighteenth century (Brown 1979; Fowler 1997; Morgan 2010:66; Walthall and Benchley 1987; Zitomersky 1994). Various accounts from the early eighteenth century describe widespread movement of Cahokia, Tamaroa, and other subgroups of the Illinois in the broader region in response to the growing presence of Europeans and the threat of raiding from the Iroquois (Brown and Sasso 2010; Morgan 2010; Temple 1958). From direct historical analogy (Brain 1978; Deal 2017; Wedel 1959), it is likely that a population similar to the Cahokia subgroup occupied the Cahokia region at some point between the depopulation of Cahokia and the historic period. Illinois subsistence strategies were more similar to seasonally mobile Oneota settlement-subsistence systems and distinctly different from the sedentary agricultural practices of Mississippians (Schroeder 2004). The Illinois were semisedentary and practiced agriculture at villages near major river drainages or lakes that were occupied primarily in the spring and fall (Brown 1979; White 1996). A majority of the group would leave for a summer bison hunt, and after the fall harvest, the entire village population would reorganize into smaller winter hunting camps (Brown 1979; Hauser 1976; Walthall et al. 1992; White 1996). Additionally, war parties would leave winter camps early in the year to raid other groups (Walthall et al. 1992). Settlement-subsistence systems of earlier Oneota period (AD 1400–1700; Fortier et al. 2006) groups included mixed horticulture, communal bison and elk hunting, and a greater degree of mobility than Mississippian populations (Benn 1989; Gibbon 1972; Hart 1990). Consequently, Illinois habitation or Oneota sites would yield less archaeological material than similarly sized



Mississippian sites because they were seasonally occupied.

### *Paleoenvironmental Information*

The fecal stanol data indicate the watershed's repopulation occurred during an ecological transition in the Cahokia region. The vegetation communities around Horseshoe Lake inferred from fossil pollen data were dynamic throughout the prehistoric and historical periods (Munoz et al. 2014). Fossil pollen assemblages from Horseshoe Lake sediments described by Munoz (2015) and Munoz and colleagues (2014) identified an increase in both upland and floodplain tree pollen between AD 1500 and 1800 that was attributed to a reduction in agricultural production following Cahokia's decline. Grass pollen (Poaceae) and cellular charcoal derived from the burning of grasses increased over this time period, implying that grasslands expanded in the region at this time (Morrissey 2015; Munoz 2015). The expansion of grasslands into this region coincides with the expansion of the bison population in Illinois (Brown and Sasso 2010; McMillan 2006; Morrissey 2015; Munoz 2015; Tankersley 1992) and occurs alongside an increase in Horseshoe Lake fecal stanol values (Figure 4). The concomitant increase in grassland extent, burning, and human population levels implies that indigenous groups visited the region for hunting and possibly game management through periodic burning of grasslands.

Low values in the fecal stanol record coincide with droughts, one in the mid-fifteenth century and one at the turn of the nineteenth century. Tree-ring-inferred Palmer Hydrological Drought Index (PHDI) reconstruction records from Missouri and Iowa (Stambaugh et al. 2011) and Palmer Drought Severity Index (PDSI; Benson et al. 2009; Cook et al. 2007) reconstruction records from Missouri and Illinois display negative values in the mid-fifteenth century and at the onset of the nineteenth century, indicating regional drought conditions (Figure 4). A negative excursion in PDSI values in the sixteenth century, however, is not shown by the PHDI values. The fifteenth and nineteenth century droughts are also captured by  $\delta^{18}\text{O}$  values of endogenic carbonate from Martin Lake in northeastern Indiana (Bird et al. 2017; Figure 4). Bird

and colleagues (2017) interpreted variations in  $\delta^{18}\text{O}$  as responses to changing precipitation source and seasonality, with negative excursions indicating summer season droughts. It is notable that the seventeenth-century post-Mississippian population maximum occurs during a period of little variation in the PHDI, PDSI, and  $\delta^{18}\text{O}$  records, suggesting a time of hydroclimatic stability. Although precipitation would not have affected semisedentary Illinoian groups as directly as Mississippian agriculturalists, a stable environment may have supported regional population growth through more predictable and reliable resources. The watershed's post-Mississippian population was lowest during times of precipitation variation and highest during a time of relative precipitation stability.

### *Historical Information*

Although the Spanish Hernando de Soto expedition of AD 1539–1543 reached the lower Mississippi River Valley (Hudson 1998:284), there is no evidence of a sustained European presence in the Cahokia region prior to the eighteenth century (Blasingham 1956a; Ekberg 1998; Morgan 2010; Temple 1958; Zitomersky 1994). Consequently, the repopulation of the Horseshoe Lake watershed in the sixteenth and seventeenth centuries following a minimum in the fifteenth century is attributable only to indigenous groups. This is significant because researchers have previously suggested that indigenous populations were in decline during this period from Old World diseases that spread across North America in advance of European colonists (Dobyns 1983; Dunnell 1991). The fecal stanol data, however, indicate that population and/or human activity in the region actually increased in the sixteenth and seventeenth centuries, despite multiple epidemics known to have occurred in the Caribbean, Mexico, the eastern United States, and Canada over this time period (Figure 5; Crosby 1976; Dobyns 1983; Kelton 2007; Larsen et al. 1992; Ramenofsky 1987; Snow 1996; Snow and Lanphear 1988; Thornton 1987; Verano and Ubelsker 1992; Ward and Davis 1991). The stanol data imply that the impact of newly introduced diseases in the sixteenth and early seventeenth centuries in the interior of the southeastern United States was not as great as in coastal

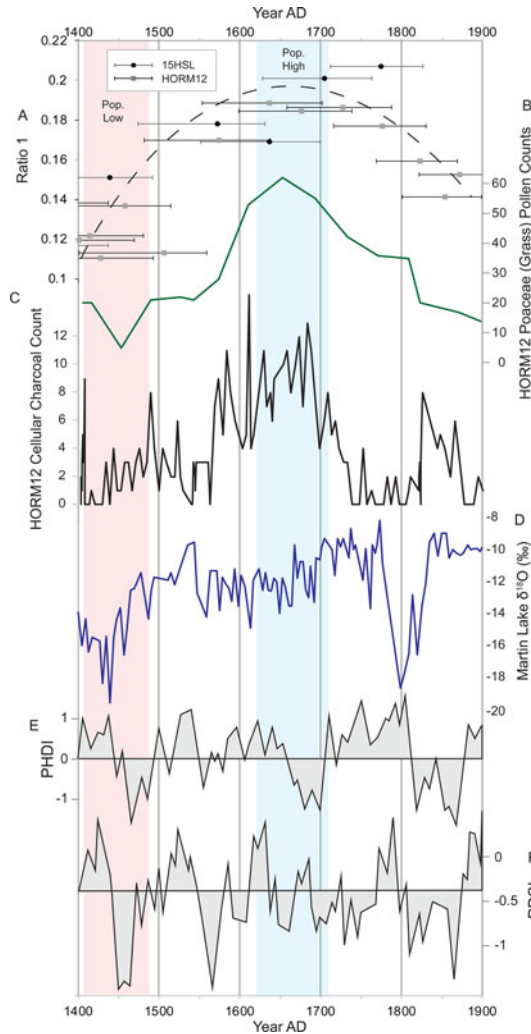
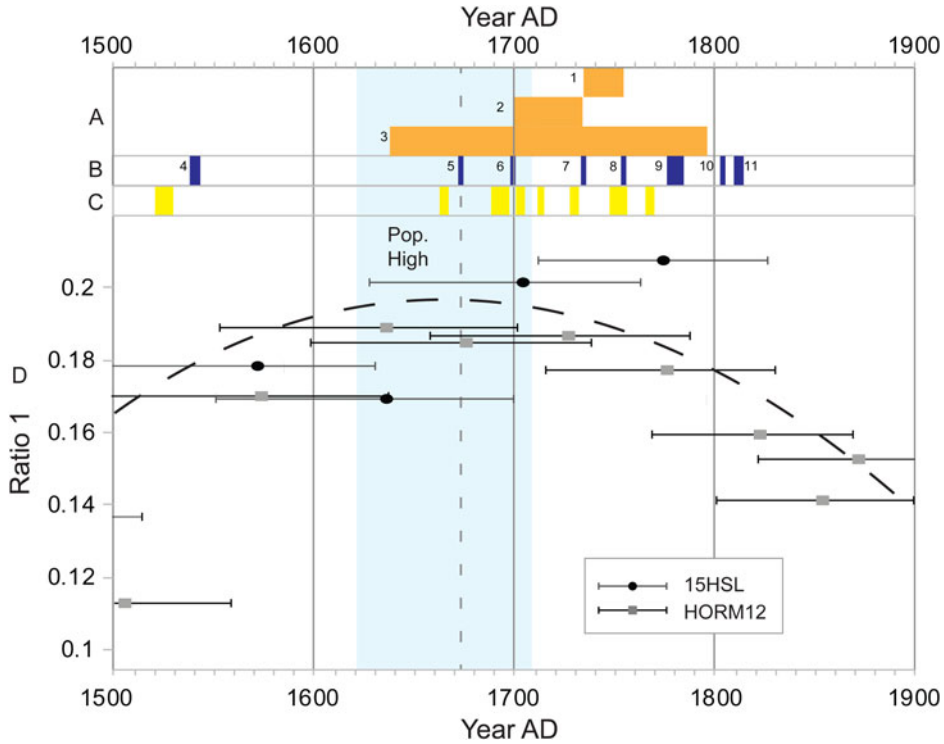


Figure 4. HORM12 and 15HSL fecal stanol ratio values with interpreted trend line (a) plotted against (b) HORM12 grass pollen counts (Munoz, 2015), (c) HORM12 cellular charcoal counts (Munoz, 2015), (d) Martin Lake  $\delta^{18}\text{O}$  values (Bird et al. 2017), (e) regional PHDI reconstruction (Stambaugh et al. 2011), and (f) regional PDSI reconstruction (Benson et al. 2009). Shaded vertical bars indicate the interpreted population low (red, left) and population high (blue, right) over this time range. (Color online)

areas (Kelton 2007), but it is possible that immigration to the Horseshoe Lake watershed masked population loss to disease. Furthermore, the population increase after AD 1500 has implications for the Vacant Quarter hypothesis that suggested widespread abandonment of a region extending from the American Bottom to the southern border of Missouri and Kentucky, up the Ohio River to the eastern end of Indiana, and south along the Tennessee River into northeastern Mississippi and northwestern Alabama

between AD 1450 and 1550 (Williams 1990). If the American Bottom saw a protohistoric reoccupation from AD 1500 to 1700, then the abandonment of the Vacant Quarter was neither as widespread as originally proposed nor wholly synchronous—as some have suggested (Cobb and Butler 2002; Meeks and Anderson 2013)—and R. Barry Lewis may have been correct in his suggestion that archaeologists have poor temporal control over artifacts diagnostic of that time interval (Lewis 1990).





**Figure 5.** HORM12 and 15HSL fecal stanol ratio values with interpreted trend line (d) plotted against (a) historic events of Cahokia and Illinois groups, (b) historic events of European groups, and (c) eastern North American epidemics (Blasingham 1956a, 1956b; Dobyns 1983; Zitomersky 1994). The vertical dashed line indicates the arrival of Europeans to the Horseshoe Lake watershed. Key to historic events: 1 = Cahokia occupy village near Horseshoe Lake (Walthall and Benchley 1987), 2 = Cahokia occupy village near Cahokia/Tamaroa mission (Walthall and Benchley 1987), 3 = intermittent warfare and skirmishes by Illinois tribes (Blasingham 1956b; Morrissey 2015; Rogers 2016), 4 = de Soto expedition (Hudson 1998), 5 = Marquette expedition (Mazrim and Esarey 2007), 6 = establishment of Cahokia/Tamaroa mission (Zitomersky 1994), 7 = establishment of River L'Abbe mission (Walthall and Benchley 1987), 8 = closure of River L'Abbe mission (Walthall and Benchley 1987), 9 = cantine operation near Monk's Mound (Walthall and Benchley 1987), 10 = settlement of French farmers near Monk's Mound (Walthall and Benchley 1987), 11 = occupation of Monk's Mound by Trappist monks (Walthall and Benchley 1987). (Color online)

The fecal stanol values plateau following a population maximum at approximately AD 1650. Although Europeans are not documented in the region until the Jacques Marquette expedition of AD 1673 (Ehrhardt 2010; Mazrim and Esarey 2007), it is possible that diseases began to be transmitted to the region from European-indigenous interactions to the north and east. Hull (2012), for example, attributed a population decline in the Awhnichi of eastern California to epidemics that occurred decades before a sustained European presence was established. Frequent indigenous warfare and mobility known to have occurred in seventeenth-century Illinois, however, are better understood drivers of

population change during this period (Ehrhardt 2010; Mazrim and Esarey 2007; Morrissey 2015; Rogers 2016; Zitomersky 1994). Illinois groups were engaged in warfare with multiple indigenous groups—and later with Europeans to the east and west—throughout the seventeenth century and into the eighteenth century, most notably against the Iroquois after the start of the Beaver Wars in the 1640s (Brown 1979; Morrissey 2015; Temple 1958; White 1991). Indigenous warfare in the Mississippi River Valley during this time was based on replacement: as groups lost members to violence, those members were replaced through a complex system of raids for slaves from foreign groups (Alt 2008; Morrissey 2015; Peregrine

2008). This system of population replacement may have contributed to the population plateau interpreted from Horseshoe Lake fecal stanol data (Figure 5). Additionally, the high mobility of Illinois groups for both subsistence and political reasons may appear in the fecal stanol record as a plateau as the signals of population rise and loss from movement cancel out. In any case, it is clear that the beginning of the post-Mississippian decline of the region's indigenous population was not passive.

European settlement in the region began in AD 1699 with the establishment of the Cahokia/Tamaroa mission by the French Seminary of Foreign Missions approximately 15 km southwest of Horseshoe Lake (Figure 5; Ekberg 1998; Gums 1988; Morgan 2010; Walthall and Benchley 1987). The mission was founded next to a village of the Tamaroa subgroup of the Illinois, but after the Tamaroa joined the Kaskaskia in AD 1701, the mission became associated primarily with members of the Cahokia group (Walthall and Benchley 1987). In AD 1735, members of the Cahokia tribe living at the Cahokia/Tamaroa mission relocated to the Horseshoe Lake region due to tensions with French colonists, and the River L'Abbe mission was established on the first terrace of Monk's Mound within the Cahokia archaeological complex to continue the goals of the French Seminary (Morgan 2010:66; Walthall and Benchley 1987). Although the River L'Abbe mission was not large, its construction is significant because it means there was a large enough native population in the Cahokia vicinity to justify building and maintaining a mission. The new mission operated until AD 1752, when the Cahokia are thought to have left the region (Walthall and Benchley 1987). Following the closure of the River L'Abbe mission, a trading post known as the Cantine operated close to Monk's Mound from AD 1776 to 1784. French farmers settled just east of Monk's Mound in AD 1804, and a group of Trappist monks occupied Monk's Mound from AD 1809 to 1813 (Walthall and Benchley 1987). By the 1830s, land in the Horseshoe Lake watershed had been appointed to Euro-American settlers (McAdams 1882).

Fecal stanols values indicate that the watershed's population was in decline by the middle

of the eighteenth century. The majority of the watershed's population in the first half of the eighteenth century was most likely indigenous; Zitomersky (1994:203) estimates that approximately 1,700 Cahokians were present in the vicinity of the Cahokia/Tamaroa mission in AD 1701 along with 14 French missionaries and colonists. Although Zitomersky (1994:321) estimates that the Cahokian population fell to 350 people by 1752, the French population had only risen to 113. Consequently, the fecal stanol decline in the late eighteenth century likely represents a decline in the indigenous population, despite a slowly increasing number of Europeans arriving to the watershed.

The late eighteenth-century indigenous population decline within the Horseshoe Lake watershed corresponds with multiple biological, social, and environmental events that occurred in the region (Figure 5), including several smallpox and measles epidemics, particularly during the first half of the eighteenth century (Blasingham 1956b; Koch et al. 2019; Morrissey, 2015; Zitomersky 1994). The near coincidence of the fecal stanol maximum and the arrival of Europeans to the region followed by multiple recorded epidemics suggest that disease played a role in the depopulation of the Horseshoe Lake watershed. Other agents of change, however, also exist.

Blasingham (1956b) identified warfare as a major cause of Illinois population loss. Frequent warfare with other indigenous groups continued after the arrival of the French through the eighteenth century (Figure 5). The French frequently allied with the Illinois as part of a much larger system of Native American and European alliances and adversaries on the western colonial frontier (Morrissey 2015). The practice of captive-taking continued in the eighteenth century and likely played a role in Illinois population change. Additionally, the Illinois were frequently mobile, and much of the watershed's decline could have resulted from movements of the Cahokia tribe out of the watershed. The efforts of missionaries to convert Native Americans to Catholicism and enforce monogamy may also have led to a reduction in births (Morgan 2010:67). Researchers have not previously implicated environmental changes in the decline

of the Illinois populations, but the rapid decrease of grass pollen in Horseshoe Lake's sediments at the beginning of the eighteenth century suggests a loss of prairie that created poor conditions for bison hunting, making the watershed an unattractive destination for Illinois groups. In addition, the pronounced negative excursions of PHDI, PDSI, and Martin Lake  $\delta^{18}\text{O}$  values at the close of the eighteenth century indicate that drought conditions ended a period of relative hydroclimatic stability that had coincided with the region's post-Mississippian population maximum (Figure 4; Benson et al. 2009; Bird et al. 2017; Stambaugh et al. 2011).

Fecal stanol values remain low into the nineteenth century, corresponding to emigration of the remaining Cahokia group to join other Illinois populations (Hauser 1976; Walthall and Benchley 1987) and a low immigration rate of European settlers. The settler population of the entire Illinois Territory upon its creation in 1809 was recorded as 9,090, and the 1820 U.S. census listed 13,550 inhabitants in Madison County, which at the time comprised a significant area of Illinois that included the Cahokia site (McAdams 1882). Although early nineteenth-century Anglo-American settlers recognized the agricultural potential of the American Bottom, they often described the ponds and lakes as emitting noxious fumes and large quantities of "miasm" that made it an unhealthy place to reside (Mitchell 1837:18; Peck 1837:6). Indeed, Charles Dickens, traveling from St. Louis to visit the Looking-Glass Prairie in Illinois in 1842, referred to it as "an ill-favoured Black Hollow" (Dickens 1842:66). By the mid-nineteenth century, canals and ditches had been constructed to drain the wetlands and open up more land to cultivation and development (McAdams 1882:475), but the population residing in the bottomlands remained low. Even in 1880, the population of the township that encompasses Horseshoe Lake was only 1,466, just 3% of the population of the entire county (Census Office 1880:387; McAdams 1882:503). Consequently, the low values of fecal stanols in the latter half of the nineteenth century may be related as much to low population as to a possible divergence of fecal input to Horseshoe Lake through the

introduction of plumbing and other formal receptacles for fecal waste.

It is difficult to determine the number of native people who remained in the Cahokia vicinity, but many of those who left and their descendants were forcibly moved to Oklahoma during the first half of the nineteenth century (Robertson 1992; White 1996). The depopulation of Illinois groups has been taken to mean that "today the Illinois tribe is culturally extinct" (Hauser 1976:138); however, the Peoria Tribe of Indians of Oklahoma, who assimilated other Illinois subgroups in the nineteenth century, is a sovereign community with over 2,900 members, including members in Illinois, and is active in the state through consultation efforts with government agencies (Oklahoma Indian Affairs Commission 2011; Logan Pappenfort, personal communication 2018). Regional depopulation and relocation do not equate to cultural extinction. The historic-era indigenous depopulation of the Horseshoe Lake watershed and the greater American Bottom region should not be interpreted as Native American disappearance, but rather as Native American persistence through warfare, disease, removal, environmental change, and political developments.

## Conclusion

The Horseshoe Lake fecal stanol record combined with historical and paleoenvironmental data indicate that the Cahokia region supported an indigenous population following Cahokia's decline. The repopulation of the watershed occurred during the posited widespread abandonment of the region that is referred to as the "Vacant Quarter," and it coincided with environmental changes conducive to Illinois subsistence strategies, which may have contributed to a pre-contact population high at about AD 1650. A complicated series of movements along with warfare, environmental change, disease, and Christianization in the eighteenth century led to an indigenous depopulation of the watershed. It is important to note that the depopulation of Cahokia in the twelfth to fourteenth centuries was not the end of an indigenous presence in the Horseshoe Lake watershed, despite a lack of archaeological evidence and research

emphasis on Mississippian occupations. By acknowledging a repopulation following the Mississippian decline, we move closer to a narrative of native persistence over disappearance.

*Acknowledgments.* This work was supported by funding from the Geological Society of America and California State University, Long Beach (CSULB). We thank Claire Martin, Erich Schroeder, Marge Schroeder of the Illinois State Museum, and Mike Lewis of the Illinois State Archaeological Survey for providing access to site records and GIS information, and we thank John Kelly for pointing out Oneota materials at some sites in the northern American Bottom. We thank Kent Lightfoot, Logan Pappenfort, and Amanda White for their contributions to this manuscript, as well as the three anonymous reviewers whose constructive suggestions helped strengthen the article. We dedicate this article to the memory of the late James B. Stoltman, who was always generous with his time, ideas, discussions, and his extensive library of obscure and not-so-obscure publications.

*Data Availability Statement.* No original data were presented in this article.

### References Cited

- Alt, Susan  
2008 Unwilling Immigrants: Culture, Change, and the "Other" in Mississippian Societies. In *Invisible Citizens: Captives and Their Consequences*, edited by Catherine M. Cameron, pp. 205–222. Foundations of Archaeological Inquiry. University of Utah Press, Salt Lake City.
- Bareis, Charles J., and Donald W. Lathrap  
1962 University of Illinois Projects. In *First Annual Report: American Bottom Archaeology, July 1, 1961–June 30, 1962*, pp. 3–9. Illinois Archaeological Survey, Urbana.
- Benn, David W.  
1989 Hawks, Serpents, and Bird-Men. *Plains Anthropologist* 34:233–260.
- Benson, Larry V., Timothy R. Pauketat, and Edward R. Cook  
2009 Cahokia's Boom and Bust in the Context of Climate Change. *American Antiquity* 74:467–483.
- Bird, Broxton W., Jeremy J. Wilson, William P. Gilhooly III, Byron A. Steinman, and Lucas Stamps  
2017 Midcontinental Native American Population Dynamics and Late Holocene Hydroclimate Extremes. *Scientific Reports* 7:41628. DOI:10.1038/srep41628.
- Blasingham, Emily J.  
1956a The Depopulation of the Illinois Indians. Part 2, Concluded. *Ethnohistory* 3:361–412.  
1956b The Depopulation of the Illinois Indians, Part I. *Ethnohistory* 3:193–224.
- Brain, Jeffrey P.  
1978 The Archaeological Phase: Ethnographic Fact or Fancy? In *Archaeological Essays in Honor of Irving B. Rouse*, edited by Robert C. Dunnell and Edwin S. Hall, pp. 311–318. Mouton, The Hague, Netherlands.
- Brown, Margaret K.  
1979 *Cultural Transformations among the Illinois: An Application of a Systems Model*. Vol. 1. Michigan State University, East Lansing.
- Brown, James A., and John E. Kelly  
2010 Oneota-ization of the Vacant Quarter and Beyond. Paper presented at the Midwest Archaeological Conference, Bloomington, Indiana.
- Brown, James A., and Robert F. Sasso  
2010 Prelude to History on the Eastern Prairies. In *Societies in Eclipse: Archaeology of the Eastern Woodlands Indians, A.D. 1400–1700*, edited by David S. Brose, C. Wesley Cowan, and Robert C. Mainfort, pp. 205–228. University of Alabama Press, Tuscaloosa.
- Bull, Ian D., Matthew J. Lockheart, Mohamed M. Elhmmali, David J. Roberts, and Richard P. Evershed  
2002 The Origin of Faeces by Means of Biomarker Detection. *Environment International* 27:647–654.
- Bull, Ian D., Ian A. Simpson, P. F. van Bergen, and Richard P. Evershed  
1999 Muck 'n' Molecules: Organic Geochemical Methods for Detecting Ancient Manuring. *Antiquity* 73:86–96.
- Cobb, Charles R., and Brian M. Butler  
2002 The Vacant Quarter Revisited: Late Mississippian Abandonment of the Lower Ohio Valley. *American Antiquity* 67:625–641.
- Cook, Edward R., Richard Seager, Mark A. Cane, and David W. Stahle  
2007 North American Drought: Reconstructions, Causes, and Consequences. *Earth-Science Reviews* 81:93–134.
- Crosby, Alfred W.  
1976 Virgin Soil Epidemics as a Factor in the Aboriginal Depopulation in America. *William and Mary Quarterly* 33:289–299.
- D'Anjou, Robert M., Raymond S. Bradley, Nicholas L. Balascio, and David B. Finkelstein  
2012 Climate Impacts on Human Settlement and Agricultural Activities in Northern Norway Revealed through Sediment Biogeochemistry. *Proceedings of the National Academy of Sciences of the United States of America* 109(50):20332–20337.
- Deal, Michael  
2017 The Role of the Direct Historical Approach in North American Ethnoarchaeology: A Northern Perspective. *Ethnoarchaeology* 9:30–52.
- Delcourt, Paul A., and Hazel R. Delcourt  
2004 *Prehistoric Native Americans and Ecological Change: Human Ecosystems in Eastern North America since the Pleistocene*. Cambridge University Press, New York.
- Diamond, Jared M.  
2006 *Collapse: How Societies Choose to Fail or Succeed*. Penguin, New York.
- Dickens, Charles  
1842 *American Notes for General Circulation*. Harper and Brothers, New York.
- Dobyns, Henry F.  
1983 *Their Number Become Thinned: Native American Population Dynamics in Eastern North America*. Native American Historic Demography Series. University of Tennessee Press in cooperation with the Newberry Library Center for the History of the American Indian, Knoxville, Tennessee.
- Dunnell, Robert C.  
1991 Methodological Impacts of Catastrophic Depopulation on American Archaeology and Ethnology. In *The Spanish Borderlands in Pan-American Perspective*, edited by David Hurst Thomas, pp. 561–580. *Columbian Consequences* Vol. 3. Smithsonian Institution, Washington, DC.

- Edging, Richard  
2007 The Vacant Quarter Hypothesis: A Survivor's Story. *Missouri Archaeologist* 68:59–93.
- Ehrhardt, Kathleen L.  
2010 Problems and Progress in Protohistoric Period Archaeology in the Illinois Country since Calumet and Fleur-de-Lys. *Illinois Archaeology* 22:256–287.
- Ekberg, Carl J.  
1998 *French Roots in the Illinois Country: The Mississippi Frontier in Colonial Times*. University of Illinois Press, Urbana.
- Emerson, Thomas E.  
1991 Some Perspectives on Cahokia and the Northern Mississippian Expansion. In *Cahokia and the Hinterlands*, edited by Thomas E. Emerson and R. Barry Lewis, pp. 221–236. University of Illinois Press, Urbana.  
1997 *Cahokia and the Archaeology of Power*. University of Alabama Press, Tuscaloosa.  
2002 An Introduction to Cahokia 2002: Diversity, Complexity, and History. *Midcontinental Journal of Archaeology* 27:127–148.  
2018 Greater Cahokia – Chiefdom, State, or City? Urbanism in the North American Midcontinent, AD 1050–1250. In *Revealing Greater Cahokia, North America's First City: Rediscovery and Large-Scale Excavations of the East St. Louis Precinct*, edited by Thomas E. Emerson, Brad H. Koldehoff, and Tamira K. Brennan, pp. 487–535. Studies in Archaeology No. 12. Illinois State Archaeological Survey, University of Illinois, Urbana-Champaign.
- Emerson, Thomas E., and Kristin M. Hedman  
2015 The Dangers of Diversity: The Consolidation and Dissolution of Cahokia, Native North America's First Urban Polity. In *Beyond Collapse: Archaeological Perspectives on Resilience, Revitalization, and Transformation in Complex Societies*, edited by Ronald K. Fauseit, pp. 168–197. Southern Illinois University Press, Carbondale.
- Fortier, Andrew C., Thomas E. Emerson, and Dale L. McElrath  
2006 Calibrating and Reassessing American Bottom Culture History. *Southeastern Archaeology* 25:170–211.
- Fowler, Melvin L.  
1997 *The Cahokia Atlas: A Historical Atlas of Cahokia Archaeology*. Studies in Archaeology No. 2. Illinois Transportation Archeological Research Program, University of Illinois, Urbana.
- Gesch, Dean B., Michael J. Oimoen, Susan K. Greenlee, Charles A. Nelson, Michael J. Steuck, and Dean J. Tyler  
2002 The National Elevation Dataset. *Photogrammetric Engineering and Remote Sensing* 68:5–11.
- Gibbon, Guy E.  
1972 Cultural Dynamics and the Development of the Oneota Life-Way in Wisconsin. *American Antiquity* 37:166–185.
- Gregg, Michael L.  
1975 A Population Estimate for Cahokia. In *Perspectives in Cahokia Archaeology*, pp. 126–136. Bulletin 10. Illinois Archaeological Survey, Urbana.
- Grimalt, Joan O., Pilar Fernandez, Josep M. Bayona, and Joan Albaiges  
1990 Assessment of Fecal Sterols and Ketones as Indicators of Urban Sewage Inputs to Coastal Waters. *Environmental Science & Technology* 24:357–363.
- Gums, Bonnie L.  
1988 *Archaeology at French Colonial Cahokia*. Studies in Illinois Archaeology No. 3. Illinois Historic Preservation Agency, Springfield.
- Hall, Robert L., and Joseph O. Vogel  
1963 Illinois State Museum Projects. In *Second Annual Report: American Bottoms Archaeology, July 1, 1962–June 30, 1963*, edited by Melvin L. Fowler, pp. 24–30. Illinois Archaeological Survey, Urbana.
- Hanenberger, Ned H.  
2003 *The Range Site 3: Mississippian and Oneota Occupations*. Transportation Archaeology Research Reports No. 17. Illinois Transportation Archaeological Research Program, Urbana.
- Hart, John P.  
1990 Modeling Oneota Agricultural Production: A Cross-Cultural Evaluation. *Current Anthropology* 31:569–577.
- Hauser, Raymond E.  
1976 The Illinois Indian Tribe: From Autonomy and Self-Sufficiency to Dependency and Depopulation. *Journal of the Illinois State Historical Society* 69(2):127–138.
- Hollinger, R. Eric  
1995 Residence Patterns and Oneota Cultural Dynamics. In *Oneota Archaeology: Past, Present, and Future*, edited by William Green, pp. 141–174. Office of the State Archaeologist Report 20. University of Iowa, Iowa City.
- Hudson, Charles  
1998 *Knights of Spain, Warriors of the Sun: Hernando de Soto and the South's Ancient Chiefdoms*. University of Georgia Press, Athens.
- Hull, Kathleen  
2012 Death and Sex: Procreation in the Wake of Fatal Epidemics within Indigenous Communities. In *The Archaeology of Colonialism: Intimate Encounters and Sexual Effects*, edited by Barbara L. Voss and Eleanor Conlin Casella, pp. 122–137. Cambridge University Press, New York.
- Jackson, Douglas K.  
1998 Settlement on the Southern Frontier: Oneota Occupations in the American Bottom. *Wisconsin Archeologist* 79:93–116.
- Jackson, Douglas K., Andrew C. Fortier, and Joyce A. Williams  
1992 *The Sponemann Site 2: The Mississippian and Oneota Occupations*. American Bottom Archaeology FAI-270 Site Reports Vol. 24. University of Illinois Press, Urbana.
- Kelly, John E.  
2009 Contemplating Cahokia's Collapse. In *Global Perspectives on the Collapse of Complex Systems*, edited by Jim A. Riley and Richard Martin Reycraft, pp. 147–168. Anthropological Papers No. 8. Maxwell Museum of Anthropology, Albuquerque, New Mexico.
- Kelton, Paul  
2007 *Epidemics and Enslavement: Biological Catastrophe in the Native Southeast, 1492–1715*. University of Nebraska Press, Lincoln.
- Koch, Alexander, Chris Brierley, Mark M. Maslin, and Simon L. Lewis  
2019 Earth System Impacts of the European Arrival and Great Dying in the Americas after 1492. *Quaternary Science Reviews* 207:13–36.
- Larsen, Clark Spencer, Christopher B. Ruff, Margaret J. Schoeninger, and Dale L. Hutchinson  
1992 Population Decline and Extinction in La Florida. In *Disease and Demography in the Americas*, edited by

- John W. Verano and Douglas H. Ubelaker, pp. 25–39. Smithsonian Institution, Washington, DC.
- Leeming, R., Andrew Ball, Nicholas J. Ashbolt, and Peter D. Nichols  
1996 Using Faecal Sterols from Humans and Animals to Distinguish Faecal Pollution in Receiving Waters. *Water Research* 30:2893–2900.
- Lewis, R. Barry  
1990 The Late Prehistory of the Ohio-Mississippi Rivers Confluence Region, Kentucky and Missouri. In *Towns and Temples along the Mississippi*, edited by David H. Dye and Cheryl Anne Cox, pp. 38–58. University of Alabama Press, Tuscaloosa.
- Lightfoot, Kent G., and Sara L. Gonzalez  
2018 The Study of Sustained Colonialism: An Example from the Kashaya Pomo Homeland in Northern California. *American Antiquity* 83:427–443.
- Lopinot, Neal H., and William I. Woods  
1993 Wood Overexploitation and the Collapse of Cahokia. In *Foraging and Farming in the Eastern Woodlands*, edited by C. Margaret Scarry, pp. 206–231. University of Florida Press, Gainesville.
- Mann, Charles C.  
2006 *1491: New Revelations of the Americas Before Columbus*. 2nd ed. Knopf Doubleday, New York.  
2012 *1493: Uncovering the New World Columbus Created*. Vintage Books, New York.
- Martins, César de Castro, Rosalinda Carmela Montone, Rosa Carvalho Gamba, and Vivian Helena Pellizari  
2005 Sterols and Fecal Indicator Microorganisms in Sediments from Admiralty Bay, Antarctica. *Brazilian Journal of Oceanography* 53(1–2):1–12.
- Mazrim, Robert, and Duane Esarey  
2007 Rethinking the Dawn of History: The Schedule, Signature, and Agency of European Goods in Protohistoric Illinois. *Midcontinental Journal of Archaeology* 32:145–200.
- McAdams, W.  
1882 *History of Madison County, Illinois: Illustrated, with Biographical Sketches of Many Prominent Men and Pioneers*. Madison County Genealogical Resources. W. R. Brink and Company, Edwardsville, Illinois.
- McMillan, R. Bruce  
2006 Perspectives on the Biogeography and Archaeology of Bison in Illinois. In *Records of Early Bison in Illinois*, edited by R. Bruce McMillan, pp. 67–129. Scientific Papers 31. Illinois State Museum, Springfield.
- Meeks, Scott C., and David G. Anderson  
2013 Drought, Subsistence Stress, and Population Dynamics: Assessing Mississippian Abandonment of the Vacant Quarter. In *Soils, Climate, and Society: Archaeological Investigations in Ancient America*, edited by John D. Wingard and Sue Eileen Hayes, pp. 61–83. University Press of Colorado, Boulder.
- Milner, George R.  
1986 Mississippian Population Density in a Segment of the Central Mississippi River Valley. *American Antiquity* 51:227–238.  
1990 The Late Prehistoric Cahokia Cultural System of the Mississippi River Valley: Foundations, Florescence, and Fragmentation. *Journal of World Prehistory* 4:1–43.  
2006 *The Cahokia Chiefdom: The Archaeology of a Mississippian Society*. University Press of Florida, Gainesville.
- Milner, George R., David G. Anderson, and Marvin T. Smith  
2001 The Distribution of Eastern Woodlands Peoples at the Prehistoric and Historic Interface. In *Societies in Eclipse: Archaeology of the Eastern Woodlands Indians, AD 1400–1700*, edited by David S. Brose and Robert C. Mainfort Jr., pp. 9–18. Smithsonian Institution, Washington, DC.
- Milner, George R., and George Chaplin  
2010 Eastern North American Population at ca. AD 1500. *American Antiquity* 75:707–726.
- Milner, George R., Thomas E. Emerson, Mark M. Mehrer, Joyce A. Williams, and Duane Esary  
1984 Mississippian and Oneota Period. In *American Bottom Archaeology: A Summary of the FAI-270 Project Contribution to the Culture History of the Mississippi River Valley*, edited by Charles J. Bareis and James W. Porter, pp. 158–186. University of Illinois Press, Urbana.
- Mitchell, S. Augustus  
1837 *Illinois in 1837*. Grigg and Elliot, Philadelphia.
- Morgan, M. J.  
2010 *Land of Big Rivers: French and Indian Illinois, 1699–1778*. Southern Illinois University Press, Carbondale.
- Morrissey, Robert Michael  
2015 The Power of the Ecotone: Bison, Slavery, and the Rise and Fall of the Grand Village of the Kaskaskia. *Journal of American History* 102:667–692.
- Munoz, Samuel E.  
2015 *Forests, Fields, and Floods: A Historical Ecology of the Cahokia Region, Illinois, USA*. PhD dissertation, Department of Geography, University of Wisconsin, Madison.
- Munoz, Samuel E., Kristine E. Gruley, Ashtin Massie, David A. Fike, Sissel Schroeder, and John W. Williams  
2015 Cahokia's Emergence and Decline Coincided with Shifts of Flood Frequency on the Mississippi River. *Proceedings of the National Academy of Sciences of the United States of America* 112(20):6319–6324.
- Munoz, Samuel E., Sissel Schroeder, David A. Fike, and John W. Williams  
2014 A Record of Sustained Prehistoric and Historic Land Use from the Cahokia Region, Illinois, USA. *Geology* 42:499–502.
- Munson, Patrick J.  
1971 An Archaeological Survey of the Wood River Terrace and Adjacent Bottoms and Bluffs in Madison County, Illinois. In *Archaeological Surveys of the American Bottoms and Adjacent Bluffs*. Reports of Investigations No. 21, pp. 3–21. Illinois State Museum, Springfield.
- Nolan, David J.  
2010 “Dem Bones”: An Aboriginal Winter Hunting Camp from Mercer County, Illinois. *Illinois Archaeology* 22:288–317.
- O'Brien, Patricia J.  
1972 *A Formal Analysis of Cahokia Ceramics from the Powell Tract*. Monograph 3. Illinois Archaeological Survey, Springfield.
- Census Office  
1880 *Statistics of the Population of the United States at the Tenth Census (June 1, 1880)*. Government Printing Office, Washington, DC.
- Oklahoma Indian Affairs Commission,  
2011 *Oklahoma Indian Nations Pocket Pictorial Directory*. Oklahoma Indian Affairs Commission, Oklahoma City.
- Pauketat, Timothy R.  
1994 *The Ascent of Chiefs: Cahokia and Mississippian*



- Politics in Native North America*. University of Alabama Press, Tuscaloosa.
- 2004 *Ancient Cahokia and the Mississippians*. Cambridge University Press, New York.
- 2018 Thinking through the Ashes, Architecture, and Artifacts of Ancient East St. Louis. In *Revealing Greater Cahokia, North America's First City: Rediscovery and Large-Scale Excavations of the East St. Louis Precinct*, edited by Thomas E. Emerson, Brad H. Koldehoff, and Tamira K. Brennan, pp. 463–486. *Studies in Archaeology* No. 12. Illinois State Archaeological Survey, University of Illinois, Urbana-Champaign.
- Pauketat, Timothy R., Andrew C. Fortier, Susan M. Alt, and Thomas E. Emerson
- 2013 A Mississippian Conflagration at the East St. Louis Civic-Ceremonial Precinct in Illinois and Its Political-Historical Implications. *Journal of Field Archaeology* 38:210–226.
- Pauketat, Timothy R., and Neal H. Lopinot
- 1997 Cahokian Population Dynamics. In *Cahokia: Domination and Ideology in the Mississippian World*, edited by Timothy R. Pauketat and Thomas E. Emerson, pp. 103–123. University of Nebraska Press, Lincoln.
- Pauketat, Timothy R., Mark A. Rees, and Stephanie L. Pauketat
- 1998 *An Archaeological Survey of the Horseshoe Lake State Park, Madison County, Illinois*. Reports of Investigations No. 55. Illinois State Museum Society, Springfield.
- Peck, J. M.
- 1837 *A Gazetteer of Illinois*. 2nd ed. Grigg and Elliott, Philadelphia.
- Peregrine, Peter
- 2008 Social Death and Resurrection in the Western Great Lakes. In *Invisible Citizens: Captives and Their Consequences*, edited by Catherine M. Cameron, pp. 223–232. University of Utah Press, Salt Lake City.
- Perino, Gregory H.
- 1959 Recent Information from Cahokia and Its Satellites. *Central States Archaeological Journal* 6(4):130–138.
- Pompeani, David P., Aubrey L. Hillman, Matthew S. Finkenbinder, Daniel J. Bain, Alexander Correa-Metrio, Katherine M. Pompeani, and Mark B. Abbott
- 2019 The Environmental Impact of a Pre-Columbian City Based on Geochemical Insights from Lake Sediment Cores Recovered Near Cahokia. *Quaternary Research* 91:714–728.
- Prost, Katharina, Jago Jonathan Birk, Eva Lehndorff, Renate Gerlach, and Wulf Amelung
- 2017 Steroid Biomarkers Revisited – Improved Source Identification of Faecal Remains in Archaeological Soil Material. *PLOS ONE* 12(1):e0164882. DOI:10.1371/journal.pone.0164882.
- Ramenofsky, Ann F.
- 1987 *Vectors of Death: The Archaeology of European Contact*. University of New Mexico Press, Albuquerque.
- Reed, Nelson A., John W. Bennett, and James Warren Porter
- 1968 Solid Core Drilling of Monks Mound. *American Antiquity* 33:137–148.
- Rinaldo, John B.
- 1937 The Pere Marquette Park Sites. Master's thesis, Department of Anthropology, University of Chicago, Chicago.
- Robertson, Philip A.
- 1992 Factors Affecting Tree Growth on Three Lowland Sites in Southern Illinois. *American Midland Naturalist* 128:218–236.
- Rogers, Gerald
- 2016 Consequences of Peaceful Actions: Political Decisions of the Illinois Indians, 1778–1832. *Confluence* 7 (2):46–55.
- Rubertone, Patricia E.
- 2000 The Historical Archaeology of Native Americans. *Annual Reviews of Anthropology* 29:425–446.
- Schroeder, Sissel
- 2004 Current Research on Late Precontact Societies of the Midcontinental United States. *Journal of Archaeological Research* 12:311–372.
- Silliman, Stephen W.
- 2012 Between the Longue Durée and the Short Purée: Postcolonial Archaeologies of Indigenous History in Colonial North America. In *Decolonizing Indigenous Histories: Exploring Prehistoric/Colonial Transitions in Archaeology*, edited by Maxine Oland, Siobhan M. Hart, and Liam Frink, pp. 113–131. Archaeology of Colonialism in Native North America. University of Arizona Press, Tucson.
- Simpson, Ian A., Pim F. van Bergen, Vincent Perret, Mohamed M. Elhmmali, David J. Roberts, and Richard P. Evershed
- 1999 Lipid Biomarkers of Manuring Practice in Relict Anthropogenic Soils. *Holocene* 9:223–229.
- Sistiaga, A., F. Berna, R. Laursen, and P. Goldberg
- 2014 Steroidal Biomarker Analysis of a 14,000 Years Old Putative Human Coprolite from Paisley Cave, Oregon. *Journal of Archaeological Science* 41:813–817.
- Snow, Dean R.
- 1996 Mohawk Demography and the Effects of Exogenous Epidemics on American Indian Populations. *Journal of Anthropological Archaeology* 15:160–182.
- Snow, Dean R., and Kim M. Lanphear
- 1988 European Contact and Indian Depopulation in the Northeast: The Timing of the First Epidemics. *Ethnohistory* 35:15–33.
- Stambaugh, Michael C., Richard P. Guyette, Erin R. McMurry, Edward R. Cook, David M. Meko, and Anthony R. Lupo
- 2011 Drought Duration and Frequency in the U.S. Corn Belt during the Last Millennium (AD 992–2004). *Agricultural and Forest Meteorology* 151:154–162.
- Tankersley, Kenneth B.
- 1992 Bison and Subsistence Change: The Protohistoric Ohio Valley and Illinois Valley Connection. In *Long-Term Subsistence Change in Prehistoric North America*, edited by Dale R. Croes, Rebecca A. Hawkins, and Barry L. Isaac, pp. 103–130. Research in Economic Anthropology 6. Jai Press, Greenwich, Connecticut.
- Temple, Wayne Calloun
- 1958 *Indian Villages of the Illinois Country: Historic Tribes*. Scientific Papers Vol. 2, Pt. 2. Illinois State Museum, Springfield.
- Thornton, Russell
- 1987 *American Indian Holocaust and Survival: A Population History since 1492*. University of Oklahoma Press, Norman.
- Vachula, Richard S., Yongsong Huang, William M. Longo, Sylvia G. Dee, William C. Daniels, and James M. Russell
- 2019 Evidence of Ice Age Humans in Eastern Beringia Suggests Early Migration to North America. *Quaternary Science Reviews* 205:35–44.
- Van Thienen, Vince
- 2017 The Absence of Late Roman Archaeology:

- Identification Issues in the Flemish Archaeological Record. *SIGNA* 6:119–126.
- Verano, John, and Douglas Ubelaker (editors)  
1992 *Disease and Demography in the Americas*. Smithsonian Institution, Washington, DC.
- Walthall, John A., and Elizabeth D. Benchley  
1987 *The River L'Abbe Mission: A French Colonial Church for the Cahokia Illini on Monks Mound*. Illinois Historic Preservation Agency, Springfield.
- Walthall, John, Terry Norris, and Barbara Stafford  
1992 Woman Chief's Village: A Late Seventeenth Century Illini Winter Hunting Camp. In *Calumet and Fleur-de-Lys: Archaeology of Indian and French Contact in the Midcontinent*, edited by Thomas E. Emerson, pp. 129–154. Smithsonian Institution, Washington, DC.
- Ward, H. Trawick, and R. P. Stephen Davis Jr.  
1991 The Impact of Old World Diseases on the Native Inhabitants of the North Carolina Piedmont. *Archaeology of Eastern North America* 19:171–181.
- Wedel, Mildred Mott  
1959 Oneota Sites on the Upper Iowa River. *Missouri Archaeologist* 21:1–180.
- Wells, Christy L., and George R. Holley  
1993 *Archaeological Investigations at the 78th Street Site (11MS821), East St. Louis, Illinois*. Office of Contract Archaeology, Southern Illinois University, Edwardsville.
- White, Richard  
1991 *The Middle Ground: Indians, Empires, and Republics in the Great Lakes Region, 1650–1815*. Studies in North American Indian History. Cambridge University Press, New York.
- White, J. K.  
1996 Illinois. In *Encyclopedia of North American Indians*, pp. 226. Houghton Mifflin Harcourt, Boston.
- White, A. J., Lora R. Stevens, Varenka Lorenzi, Samuel E. Munoz, Carl P. Lipo, and Sissel Schroeder  
2018 An Evaluation of Fecal Stanols as Indicators of Population Change at Cahokia, Illinois. *Journal of Archaeological Science* 93:129–134.
- White, A. J., Lora R. Stevens, Varenka Lorenzi, Samuel E. Munoz, Sissel Schroeder, Angelica Cao, and Taylor Bogdanovich  
2019 Fecal Stanols Show Simultaneous Flooding and Seasonal Precipitation Change Correlate with Cahokia's Population Decline. *Proceedings of the National Academy of Sciences of the United States of America* 116 (12):5461–5466.
- Wilcox, Michael  
2009 *The Pueblo Revolt and the Mythology of Conquest: An Indigenous Archaeology of Contact*. University of California Press, Berkeley.
- 2010 Marketing Conquest and the Vanishing Indian: An Indigenous Response to Jared Diamond's *Guns, Germs, and Steel and Collapse*. *Journal of Social Archaeology* 10:92–117.
- Williams, Stephen  
1980 The Armored Phase: A Very Late Complex in the Lower Mississippi Valley. *Southeastern Archaeological Conference Bulletin* 22:105–110.
- 1983 Some Ruminations on the Current Strategy of Research in the Southeast. *Southeastern Archaeological Conference Bulletin* 25:72–81.
- 1990 The Vacant Quarter and Other Late Events in the Lower Valley. In *Towns and Temples along the Mississippi*, edited by David H. Dye and Cheryl Anne Cox, pp. 170–180. University of Alabama Press, Tuscaloosa.
- 2001 The Vacant Quarter Hypothesis and the Yazoo Delta. In *Societies in Eclipse: Archaeology of the Eastern Woodlands Indians, AD 1400–1700*, edited by James A. Brown and Robert F. Sasso, pp. 191–203. Smithsonian Institution, Washington, DC.
- Zitomersky, Joseph  
1994 *French Americans–Native Americans in Eighteenth-Century French Colonial Louisiana: The Population Geography of the Illinois Indians, 1670s–1760s: The Form and Function of French-Native Settlement Relations in Eighteenth-Century Louisiana*. Lund University Press, Sweden.

---

Submitted August 22, 2019; Revised December 7, 2019;  
Accepted December 9, 2019