Radiocarbon, Vol 65, Nr 3, 2023, p 789–808 DOI:10.1017/RDC.2023.37

UPDATING THE CLASSIC NEW YORK LAMOKA LAKE AND SCACCIA SITES: REFINED CHRONOLOGIES THROUGH AMS DATING AND BAYESIAN MODELING

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ABSTRACT. The Lamoka Lake and Scaccia sites in present-day New York have played important roles in the development of archaeology in New York, and in the case of Lamoka Lake, in eastern North America. Lamoka Lake is the type site for the "Archaic" period in eastern North American culture history and the "Late Archaic" "Lamoka phase" in New York culture history. The Scaccia site is the largest "Early Woodland" "Meadowood phase" site in New York and has the earliest evidence for pottery and agriculture crop use in the state. Lamoka Lake has been dated to 2500 BC based on a series of solid carbon and gas-proportional counting radiometric dates on bulk wood charcoal obtained in the 1950s and 1960s. Scaccia has been dated to 870 BC based on a single uncalibrated radiometric date obtained on bulk charcoal in the early 1970s. As a result, the ages of these important sites need to be refined. New AMS dates and Bayesian analyses presented here place Lamoka Lake at 2962–2902 BC (68.3% highest posterior density [hpd]) and Scaccia at 1049–838 BC (68.3% hpd).

KEYWORDS: AMS dating, Bayesian modeling, New York.

INTRODUCTION

Two recent articles have brought to the forefront the need for archaeologists working in eastern North America to abandon the archaeological practice of culture history (Feinman and Neitzel 2020; Holland-Lulewicz et al. 2020). The continued use of culture-historical taxa as units of analysis and narrative obscure variation in Indigenous history that should be of explanatory interest. Culture-historical methods arose in the early to mid-twentieth century at a time when the archaeological toolbox was very limited. This is no longer the case—archaeology has a wide range of techniques, methods, and theories on which to draw to address almost any issue without resorting to the imposition of culture-historical taxa on the past. The combination of AMS radiocarbon dating and Bayesian analyses of radiocarbon datasets is one means of addressing chronological issues independent of culture history (Bayliss et al. 2007; Bronk Ramsay 2009a). As demonstrated in present-day New York and Ontario, the application of Bayesian analysis to new suites of AMS radiocarbon dates is changing archaeological understandings of Indigenous history, challenging traditional chronologies based on limited numbers of radiocarbon dates and/or the present/absence and/or seriation of artifact types/categories, including European trade goods within culture-historical frameworks (Manning and Hart 2019; Birch et al. 2021, 2022; Manning et al. 2018, 2021; Manning and Birch 2022).

In any region of eastern North America, interpretations of sites excavated during the early twentieth century continue to influence archaeological narratives of the past. These are often sites that have only legacy radiocarbon dates obtained during the first few decades of the method's applications in archaeology, such as the regionally significant Neville site in

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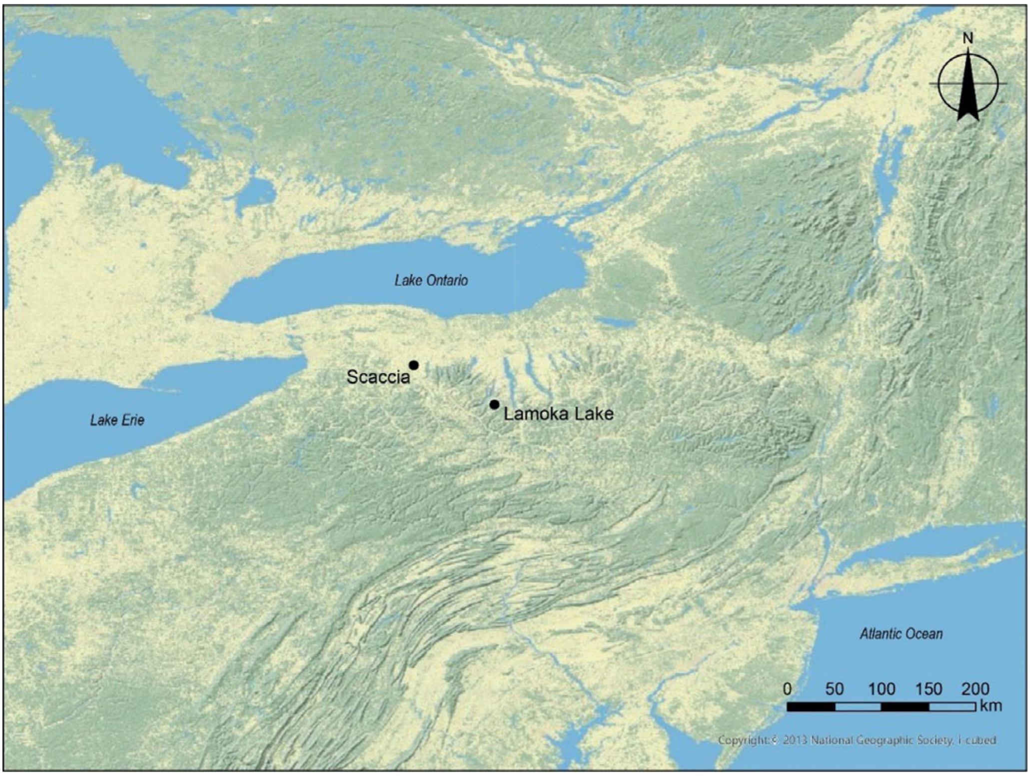

Figure 1 Map of site locations in New York State.

Massachusetts (Dincauze 1971; Martindale et al. 2016). Among others, two such sites in present-day New York are Lamoka Lake and Scaccia (Figure 1; Ritchie 1932a, 1965; Ritchie and Funk 1973). These sites are ascribed to the culture historical "Late Archaic" and "Early Woodland" periods or stages, respectively; both occupy relatively extensive areas and have large numbers of features for their estimated times of occupation in comparison to other such sites.

Occupying ca. 3 acres (1.2 ha), the Lamoka Lake site was primarily excavated by William A. Ritchie in 1925, 1927, and 1928 under the auspices of the Rochester Museum of Arts and Science and in 1958 and 1962 under the auspices of the New York State Museum. These excavations uncovered hundreds of deep pits, hearths, platforms for smoking fish and terrestrial game, and postmold patterns and compact floors that have been interpreted as houses (Ritchie 1932a, 1965; Ritchie and Funk 1973). Based on Ritchie's publications (1932a, 1932b), Lamoka Lake became the type site for the "Archaic period" in eastern North America (Willey and Phillips 1952; Starna 1979) and continues to be a focus of interest into "Archaic" settlement, subsistence, and society (Miroff et al. 2008; Pagoulatos 2010; Bourcy 2018).

The Scaccia site was initially excavated by members of the Morgan Chapter of the New York State Archaeological Association in 1963 (Wray 1965) and then by the New York State Museum in 1965 under the direction of Robert E. Funk (Ritchie and Funk 1973). Well over 100 deep pits and other features were exposed, and a large amount of early pottery referred to as "Vinette 1," as well as "Meadowood"-type cache blades, were recovered. Ritchie and Funk (1973) ascribed the primary occupation to the "Early Woodland" period "Meadowood phase." The site has since played significant roles in regional syntheses (Granger 1978; Taché 2011a) as well as recent specialized analyses that have used collections from the 1960s excavations (Hart et al. 2007; Hart and Brumbach 2009; Taché and Hart 2013; Taché and Craig 2015).

Ritchie obtained 8 radiocarbon dates on wood charcoal and bark from the Lamoka Lake site during the 1950s and early 1960s (Supplementary Table 1), based on which he estimated a date for the site's occupation of 2500 BC (Ritchie 1965; Ritchie and Funk 1973). Ritchie and Funk (1973) reported a single date on wood charcoal for the Scaccia site (Supplementary Table 2), which "would seem to place the Woodland component in the lower range of the radiocarbon series for the Meadowood culture, which runs from c. 1000 to 560 B.C." Ritchie and Funk (1973:116). As was typical for their times of excavation and reporting, the dates obtained were based on large charcoal samples and used to place the sites within culture-historical time periods, taking into account contemporary ideas on relative chronologies based on artifact types. Both sites continue to produce important information on Indigenous occupations of New York through new analyses of Ritchie's and Funk's collections. Both sites are larger and seemingly reflect more intensive occupations than typical of other sites associated with their culture-historical time periods. However, their exact times of occupation remain uncertain. The dates Ritchie and Funk obtained, while pioneering and important at the time, do not meet current standards.

Some 60 years have passed since the last legacy radiocarbon dates were obtained for the sites. The intervening span of time has seen major advances in radiocarbon dating techniques and methods and analyses of the resulting radiocarbon dates. These include corrections for isotopic fractionation, calibration for fluctuations in atmospheric ^{14}C concentrations, refinements in the pretreatments of samples to remove contaminants, accelerator mass spectrometry (AMS) dating requiring only milligram-sized samples, and Bayesian analyses of radiocarbon dates (Taylor and Bar-Yosef 2014). Despite this, Ritchie's date estimate for Lamoka Lake has been used in discussions of the site ever since, generally without question (e.g., Madrigal and Holt 2002; Engelbrecht 2003; Watson and Thomas 2013; Curtin 2015; Pauketat and Sassaman 2020:248). Two AMS dates obtained in recent years for Scaccia (Hart et al. 2007; Taché and Hart 2013) have not been used to model a date range for the site's occupation(s).

The importance of these sites for building understandings of Indigenous histories demands more precise date estimates based on contemporary methods and techniques independent of assumed culture-historical time periods and phases. Here we report a series of 18 new AMS ^{14}C dates on short-lived seeds and other macrobotanical remains, as well as short-lived branches, twigs, and ^{14}C wiggle-matched tree-ring sequences from carbonized wood fragments, all of which were collected by Ritchie in 1958 and 1962 for Lamoka Lake and by Funk in 1965 from Scaccia and curated at the New York State Museum. The dates have been used in two new Bayesian chronological models, providing accurate and precise date ranges for these important sites independent of culture-historical considerations.

LAMOKA LAKE SITE

The Lamoka Lake site in the Finger Lakes region of present-day New York (Figures 1–3), holds a unique place in North American archaeology. Originally excavated in the second

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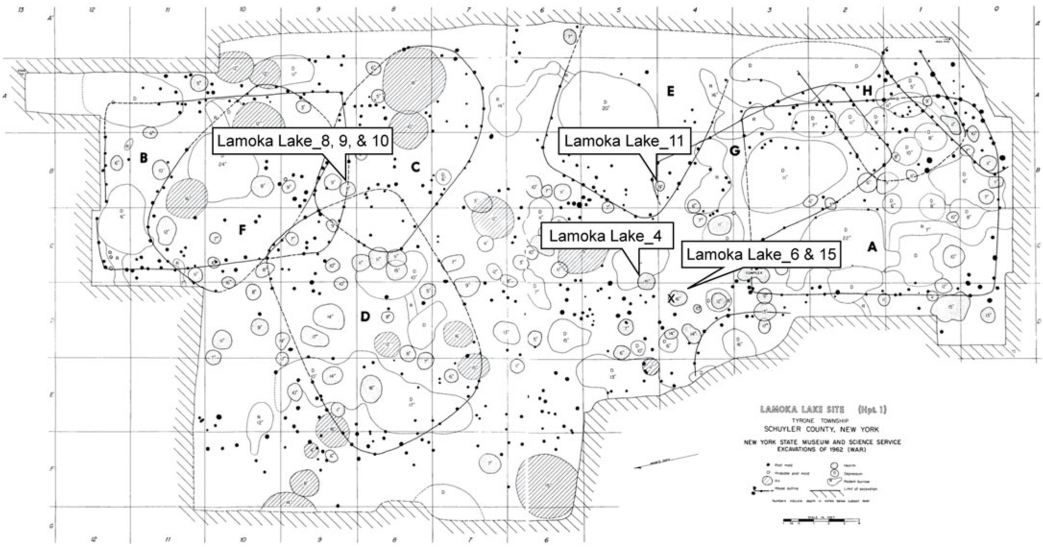

Figure 2 Map of Ritchie's Lamoka Lake site 1962 block excavations with identified sample locations indicated. Modified after Ritchie (1965:72–73).

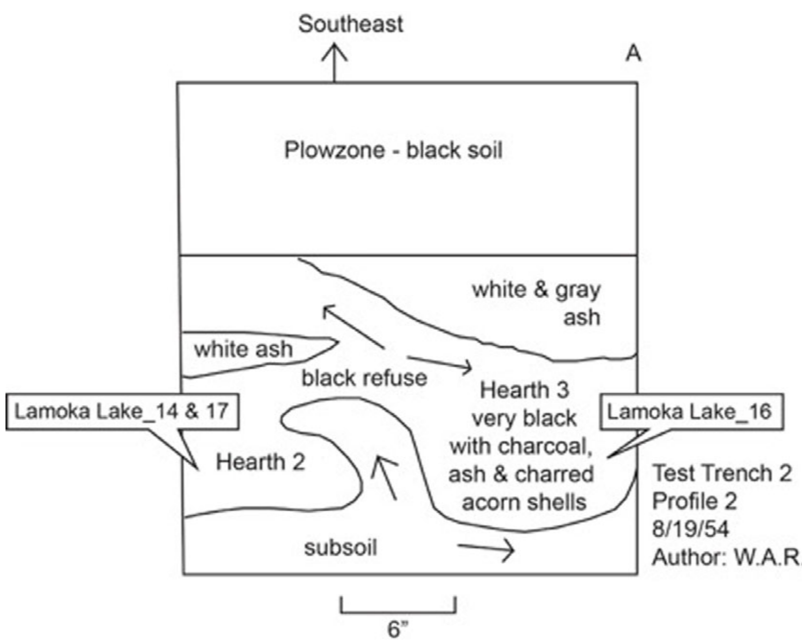

Figure 3 Profile drawing of Ritchie's 1954 Test Trench at Lamoka Lake, digitized from the original field drawings archived at the New York State Museum with identified sample locations.

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half of the 1920s (Ritchie 1932a) it rapidly gained importance not only in New York but throughout eastern North America (e.g., Fairbanks 1942). That importance is reflected by its 1961 listing as a National Historic Landmark (National Park Service 2022), its 1966 listing on the National Register of Historic Places (National Register of Historical Places 2022), and by the portion of the site not owned by the New York State Department of Environmental Conservation being purchased by The Archaeological Conservancy in 2005—one of two sites in New York currently owned by the Conservancy (The Archaeological Conservancy 2022).

Unusual for a late Middle Holocene site in northeastern North America, Lamoka Lake extends over an area of approximately 3 acres (Ritchie and Funk 1973:41). Ritchie's excavations in the 1920s measured 83 m long by 4.3–8.5 m wide across the center of the site (Ritchie 1932a:85). These excavations exposed dense distributions of features beneath up to 1.5 m of sediment, including 380 deep pits (0.9–1.8 m deep and 0.9–2.1 m in diameter) and numerous hearths, some located at the bottom of the deep pits. Also found were 13 "fire beds" measuring up to 16.7 m long, 3 m wide, and "several feet thick" filled with ash and charcoal and containing hearths. Ritchie interpreted these as structures for smoking fish and terrestrial game. Areas with 20–30 fill layers of compact sediment measuring an average of 5.5 m long and 3.7 m wide were interpreted as "lodge" floors.

Ritchie's interpretations of the Lamoka Lake site played critical roles in the development of eastern North American culture history, becoming the type site for the "Archaic period" (Ritchie 1932a, 1932b, 1936, 1944) or stage (Ritchie 1965; Ritchie and Funk 1973). His enumeration of artifacts and subsistence and settlement evidence and the absence of other traits such as pottery and evidence for agriculture, became the platform on which the "Archaic" concept was extended throughout eastern North America (Starna 1979; Wiley and Phillips 1952). The site also became the type site for the "Lamoka focus" (Ritchie 1944, 1951a, 1951b), then phase or culture (Ritchie 1965), characterized by the distinctive small-stemmed, narrow "Lamoka type" projectile point that has now been found throughout the Great Lakes region, Middle Atlantic, and New England, although it is sometimes referred to by other type names, particularly to the west (Justice 1987:127–129). Originally thought to represent New York's earliest occupations (Ritchie 1938) and categorized as "Early Archaic" (Wiley et al. 1955), as the culture history of New York and eastern North America developed, coupled with radiocarbon dating starting in the 1950s, the site was eventually placed in the "Late Archaic period" (ca. 3500–1000 BC; Ritchie and Funk 1973).

As well as locating numerous pit features and hearths, Ritchie's excavations in 1958 and 1962 resulted in the documentation of postmolds which were used to infer structure patterns of approximately the same size as the "lodge" floors documented in the earlier excavations; in some instances such compact floors co-occurred with lines of postmolds exposed in 1962 (Ritchie 1965; Ritchie and Funk 1973:44). The combination of large pit features, hearths, inferred house/lodge floors, and faunal remains led to the general acceptance that the site was occupied year-round—an unusual occurrence in northeastern North America for its time of occupation (e.g., Miroff et al. 2008; Moeller 2020:222). Since Ritchie's first report, the site has played important roles in discussions and debates about regional chronologies (Griffin 1967; Ritchie and Funk 1973; Funk 1976; Tuck 1978), subsistence and settlement systems (Caldwell 1958; Madrigal and Capaldo 1999), technology (Pagoulatos 2010), and migrations (Wiley et al. 1955; Sassaman 2010). This

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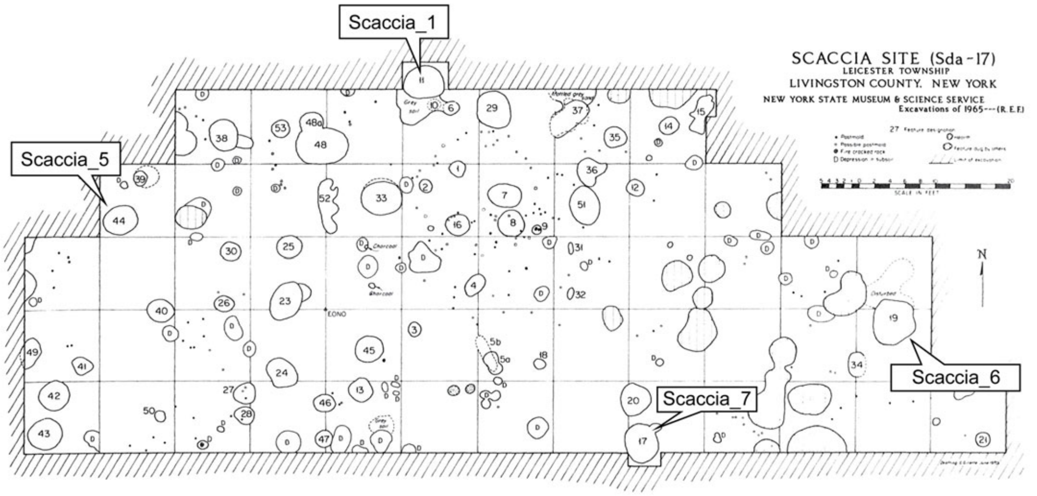

Figure 4 Map of Scaccia site excavations with identified sample locations indicated. Modified after Ritchie and Funk (1973: Figure 11).

importance has continued into the twenty-first century as reflected in regional syntheses (e.g., Sassaman 2010), masters theses and Ph.D. dissertations (e.g., Ferguson 2012; Bourcy 2018), and textbooks (e.g., Neusius and Gross 2013; Fagan 2019; Pauketat and Sassaman 2020; Gibbon 2022).

It is routine now for archaeologists to obtain multiple radiocarbon dates for individual sites and site components. However, this was not always the case. During the method's early development it was unusual for multiple dates to be obtained on a given site. The Lamoka Lake site was among the first sites in northeastern North America to be dated through multiple radiocarbon measurements (Libby 1951; Ritchie 1951b; Crane 1956). Based on a series of six solid carbon and then five gas proportional counting radiometric dates on large samples of carbonized wood and bark in the 1950s through the early 1960s (Supplemental Table 1), Ritchie (1965; Ritchie and Funk 1973) ascribed a date of 2500 BC to the occupation. More recently, others have estimated the age of the site as 3300 BC (Gibbon 2022) or 3500 BC (Sassaman 2010) based on the calibration of these dates. However, given that the dates obtained by Ritchie do not meet modern scientific dating standards, the precise timing of the site's occupation(s) remains obscure.

SCACCIA SITE

The later Scaccia site (Figures 1 and 4), located on a ridge above the Genesee River floodplain and adjacent tributary stream and marsh, is one of the largest habitation sites for its time with an occupational area estimated at one acre (ca. 0.4 ha) (Ritchie and Funk 1973:346). Seventy-five pit features, hearths, and earth ovens were exposed during avocational excavations in 1963 (Wray 1965), and an additional 53 were exposed during Funk's excavations in 1965 (Ritchie and Funk 1973). A large assemblage of early pottery, consisting of 1686 sherds was recovered during the two excavations; it is the largest early pottery collection in northeastern North America used in recent analyses (Taché 2008:124).

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While not having the broader significance of the Lamoka Lake site in eastern North America, Scaccia has been significant in the regional development of the culture-historical “Early Woodland” “Meadowood phase” and “Meadowood interaction sphere” (Ritchie 1969; Ritchie and Funk 1973; Granger 1978; Taché 2008, 2011a, 2011b). More recently, it has been important in terms of documenting the timing of early pottery use in the region (Taché and Hart 2013), in the technological analyses of early pottery (Reber and Hart 2008; Hart and Brumbach 2009; Mitchell 2017), and early pottery function through phytolith (Hart et al. 2007) and isotopic and lipid analyses (Taché and Craig 2015). Taché and Hart’s (2013) chronological assessment of radiocarbon dates associated with early pottery in northeastern North America indicated that Scaccia is the earliest site in New York, and among the oldest in the region, with pottery. Hart et al. (2007) report the recovery of squash phytoliths from the charred cooking residue directly dated to 2905 ± 35 BP (cal. 1218–998 BC 95.4%) making the site the earliest with evidence for crop use in New York, and among the earliest in northeastern North America (Petersen and Asch Sidell 1996; Hart and Asch Sidell 1997; Monaghan et al. 2006; Crawford et al. 2019). Taché and Craig’s (2015) lipid analysis indicated that unlike early pottery at many other sites in the region, there was little evidence to indicate processing of aquatic food resources at Scaccia in spite of its location adjacent to a major stream, demonstrating how early pottery use varied across the Northeast.

Ritchie and Funk (1973) reported a single radiocarbon date of 2820 ± 60 BP on wood charcoal from one of the pit features, which was used up through the 2000s to date the site in regional narratives (e.g., Taché 2008, 2011). Two dates were recently obtained on charred cooking residue adhering to the interior of pottery sherds: 2760 ± 60 BP (Taché and Hart 2013) and 2905 ± 35 BP (Hart et al. 2007). However, these dates have not been used to model an estimation of the site’s occupational span. Like Lamoka Lake, then, the precise time span for the site’s occupation(s) is unknown.

METHODS AND MATERIALS

Samples

We reviewed organic sample materials (all carbonized) available in collections associated with Ritchie’s excavations curated at the New York State Museum and selected short-lived (annual) seeds and nutshell, or—to reduce issues with in-built age—wood remains of either juvenile stems preserving the tree’s outermost (most recent) growth ring, or fragments with several annual growth rings suitable for ^{14}C wiggle-matching. All selected samples derive from feature contexts and can thus be securely associated with each site’s primary period of occupation (Table 1; Supplemental Tables 1 and 2).

Wood charcoal fragments larger than 2 mm were fractured by hand or with a steel razor blade to create fresh transverse, radial, and tangential planes, in order to examine wood anatomical features and identify the taxon as specifically as possible. After fracturing, wood samples were supported in a sand bath or modeling clay and examined under a Motic K-400P stereo microscope at ×6–×50 magnification and an Olympus Bx51 polarizing microscope at ×50–×500 magnification. Seeds and other non-wood macrobotanical samples were examined under the same set of microscopes. The macro- and micro-anatomical features of wood sections and macrobotanical samples were documented, photographed, and compared with those from modern reference collection materials in the Cornell University Tree-Ring Laboratory, standard reference texts (Martin and Barkley 1961; Panshin and De

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Table 1 AMS dates obtained for the present study.

UGAMS #	Sample material	Context as indicated in field notes	^{14}C age BP	$\delta^{13}C$ ‰
Lamoka Lake				
59361	*Quercus*, innermost 5 extant rings	Square B4 hearth along W wall of house, 9" into subsoil"	4480 ± 25	–26.1
59362	*Quercus*, outermost 5 extant rings next to bark	Square B4 hearth along W wall of house, 9" into subsoil	4400 ± 25	–27.16
59363	*Quercus*, cf "red oak" group, innermost 5 extant rings	Square D4 hearth marked X on map	4360 ± 25	–28.06
59363r	*Quercus*, cf "red oak" oak group, innermost 5 extant rings	Square D4 hearth marked X on map	4329 ± 24	
59364	*Quercus*, cf "red oak" oak group, outermost 5 extant rings	Square D4 hearth marked X on map	4450 ± 30	–26.06
59364r	*Quercus*, cf "red oak" oak group, outermost 5 extant rings	Square D4 hearth marked X on map	4389 ± 22	
60185	Bark, indeterminate taxon	Square D4 hearth marked X on map	4400 ± 25	–27.58
60186	Bark, indeterminate taxon	hearth completely enclosed in subsoil	4480 ± 25	–26.22
60187	*Carya* sp., nutshell	House 1 small hearth in wall line	4310 ± 25	–22.94
60188	*Carya* sp., nutlet pericarp	House 1 small hearth in wall line	4320 ± 25	–24.28
60189	Bark, indeterminate taxon	House 1 small hearth in wall line	4410 ± 25	–27.8
53051	*Quercus* sp., acorn pericarp	Trench 2, Hearth 3	4374 ± 25	–22.7
60190	*Quercus* sp., acorn pericarp	Trench 2, Hearth 3	4360 ± 25	–23.53
60191	Bark, indeterminate taxon	Trench 2, Hearth 2	4420 ± 25	–26.99
53052	*Quercus* sp., acorn pericarp	Test trench 2, depth 19–21 under ash and refuse deposit at base of refuse level	4352 ± 25	–24.9
Scaccia				
59359	*Fraxinus* sp., charcoal, small friable fragment from indeterminate location	Feature 44	2870 ± 25	–24.61
59360	*Fraxinus* sp., charcoal; small friable fragment from indeterminate location	Feature 44	2890 ± 25	–25.31

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Table 1 (*Continued*)

UGAMS #	Sample material	Context as indicated in field notes	^{14}C age BP	$\delta^{13}C$ ‰
60182	Seed; indeterminate pericarp fragments	Feature 11	2670 ± 25	–24.28
60183	*Ulmus* sp., charcoal; small fragments from indeterminate location	Feature 19	2720 ± 25	–25.8
60184	*Carya* sp., charcoal; small fragments from indeterminate location	Feature 17	2800 ± 20	–25.81
59359	*Fraxinus* sp., charcoal, small friable fragment from indeterminant location	Feature 44	2870 ± 25	–24.61
59360	*Fraxinus* sp., charcoal; small friable fragment from indeterminant location	Feature 44	2890 ± 25	–25.31
60182	Seed; indeterminate pericarp fragments	Feature 11	2670 ± 25	–24.28
60183	*Ulmus* sp., charcoal; small fragments from indeterminate location	Feature 19	2720 ± 25	–25.8
60184	*Carya* sp., charcoal; small fragments from indeterminate location	Feature 17	2800 ± 20	–25.81

Zeeuw 1980), and the InsideWood (http://insidewood.lib.ncsu.edu) and USDA Plants (https://plants.usda.gov/) online databases. A LEO 1550 field emission scanning electron microscope (FESEM) was used for high magnification observation of anatomical micro-features and high-quality image capture.

Short-lived samples selected from Lamoka Lake for dating include five carbonized oak (*Quercus* sp.) acorn pericarp fragments and four samples of carbonized bark from an indeterminate taxon. Two wood samples, both deciduous oak (*Quercus* sp.) with multiple narrow rings were dissected for ^{14}C wiggle-matching. From the first wood sample (Lamoka_11), the five innermost (least recent) preserved tree rings, relative years (RY) 1–5, and the five outermost (most recent) tree rings next to the bark (RY 22–26) were sampled for ^{14}C. From the second wood fragment Lamoka_15, the five innermost (RY 1–5) and five outermost (RY 17–21) extant tree rings were dissected for ^{14}C wiggle-matching (Figure 5).

The only short-lived sample from Scaccia is a seed pericarp from an indeterminate taxon. Two other dates are on samples labeled Scaccia_6 and Scaccia_7, which are (respectively) elm (*Ulmus* sp.) and hickory (*Carya* sp.) wood stem fragments (Figure 5). Finally, the five innermost preserved tree rings (RY 1–5) and five outermost preserved tree rings (RY 31–35) from sample Scaccia5, which is an ash (*Fraxinus* sp.) wood fragment, were dissected for

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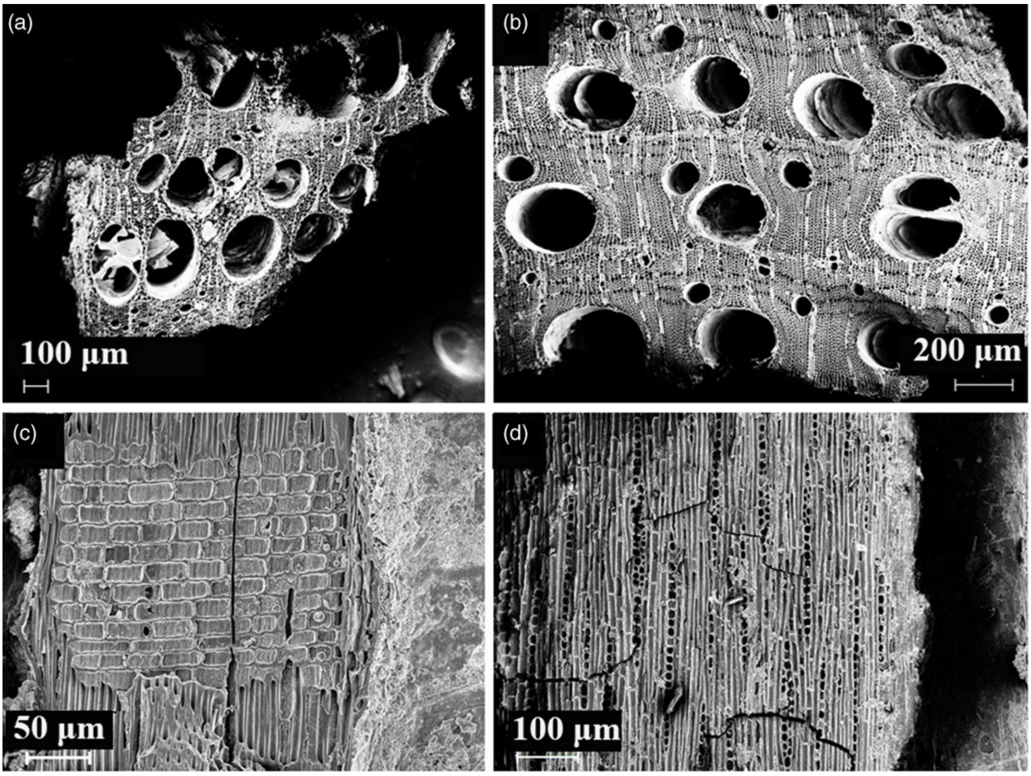

Figure 5 SEM microphotographs of identified wood samples from Lamoka Lake and Scaccia, including (a) Lamoka_15 deciduous oak (*Quercus* sp.) transverse section; and Scaccia_7 hickory (*Carya* sp.) (b) transverse, (c) radial, and (d) tangential sections.

^{14}C wiggle-matching. AMS ^{14}C dates from previous investigations (ISGS-A-0541 and ISG-A-2007) were incorporated into the chronological models for Scaccia.

Radiocarbon Dating

All samples were dated by the Center for Applied Isotope Studies at the University of Georgia. Charcoal and maize samples were treated with 5% HCl at 80°C for 1 hr, then washed with deionized water on a fiberglass filter, rinsed with diluted NaOH, treated with diluted HCL again, washed with deionized water, and dried at 60°C. The cleaned charcoal was combusted at 900ºC in an evacuated/sealed quartz ampoule in the presence of CuO. The resulting carbon dioxide was cryogenically purified from the other reaction products and catalytically converted to graphite using the method of Vogel et al. (1984). Graphite ^{14}C/^{13}C ratios were measured using the CAIS 0.5 MeV accelerator mass spectrometer. The sample ratios were compared to the ratio measured from the Oxalic Acid I (NBS SRM 4990). The quoted sample ^{13}C/^{12}C ratios were measured separately using a stable isotope ratio mass spectrometer combined with GasBench and expressed as δ^{13}C values with respect to VPDB, with an error of less than 0.1‰.

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Modeling

Modeling employed OxCal version 4.4.4 (Bronk Ramsey 2009a) and the IntCal 20 calibration curve (Reimer et al. 2020) set at 1-yr resolution. All OxCal terminology (Phase, Sequence, Date, etc.) are designated with upper-case first letters.

Lamoka Lake

Although we show the previous non-AMS ^{14}C dates (Supplemental Table 1), we only employ the 15 AMS ^{14}C dates reported here for the modeling of the date range of the site described below (Table 1; Figure 6). We make the assumption that all the samples derive from some time within the period of settlement which is regarded as a single overall Phase in OxCal. No clear intra-site/Phase sequence is evident from the site records and descriptions, although some such temporal ordering may be guessed at for those instances where the recorded site plan (see Figure 2) shows a structure superimposed (or the reverse) on another (e.g., W corner structure E and NE corner structure G). This may explain, for example, why the date determined for the wood ^{14}C wiggle-match from this area (Lamoka_11) is somewhat older than the other wood ^{14}C wiggle-match (Lamoka_15). This is because Lamoka_11 might relate to an early/earlier structure, whereas Lamoka_15, from an area of hearths and pits outside any identified structures, might not be from use in a structure but from other use, such as as firewood or other object, and thus from use during, and even use late in, the settlement Phase. However, while we may speculate, we cannot securely demonstrate this from the available evidence. Hence we make the assumption of one overall site Phase with the various dates determined, whether for a *terminus post quem* (TPQ) from wood, or likely a direct use date for short-lived material like an acorn or nutshell, all relating to some (unknown) points in time between start to end of this Phase.

Two samples offer short tree-ring-defined sequences including the stem's outermost growth ring underneath the bark, whose age corresponds to the year the stem died or was cut. Radiocarbon dates on sets of specific tree rings from each wood sample are analyzed via tree-ring-defined ^{14}C wiggle-matching (Bronk Ramsey et al. 2001) to achieve modeled dates for human use of each of these samples (Lamoka_11 and Lamoka_15, see above). These samples both offer a *terminus post quem* (TPQ) for some (unknown) point within the settlement Phase (for example, perhaps early in one case and somewhat later/late in the other). The other dates on wood samples (each containing some element of in-built age) likewise offer TPQs for some (unknown) points during the Phase. The Charcoal Outlier model in OxCal (Bronk Ramsey 2009b) is applied to each such date on a (non-wiggle-match) charcoal sample to allow for the in-built age. Dates on "bark" samples, as for example used to line pits or structures, likely also include in-built age and offer TPQ evidence since such samples include layers of inner to outer bark. The Charcoal Outlier model is applied in these cases also. Dates on acorns/seeds, nutshells, or food residues were assessed using the General Outlier model in OxCal (Bronk Ramsey 2009b), as well as for each overall wiggle-match (the data within each wiggle-match were assessed with the SSimple Outlier model: Bronk Ramsey 2009b). The overall settlement Phase is modeled inside start and end Boundaries placed within an overarching Sequence. A Date query applied to the Phase estimates the time period between the start and end Boundaries and thus offers an estimate for the overall date range that describes the settlement Phase. An Interval query applied to the Phase estimates the duration (in years) of the overall Phase between the start and end Boundaries.

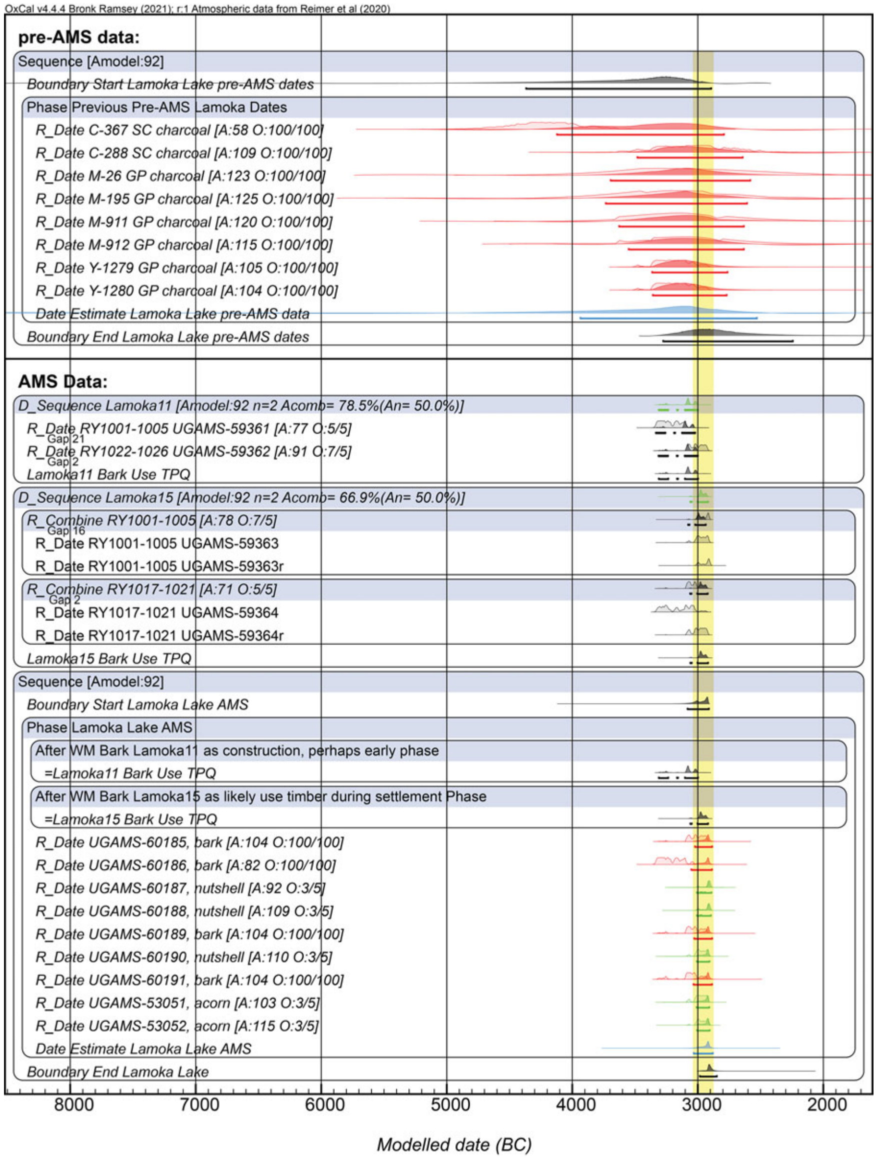

Figure 6 Lamoka Lake dating model. Top: the pre-AMS ^{14}C dates run previously on wood samples from the site as a Phase and with resultant Date query estimate. Bottom: the site dating model using the 15 AMS ^{14}C dates reported in this paper. Red shading indicates dates with the OxCal Charcoal Outlier model applied. Green shading indicates dates or wiggle-matches where the OxCal General Outlier model is applied. Blue shading indicates a Date query. For each ^{14}C date or derived probability, two distributions are shown: one in outline and light shading that is the result of simple ^{14}C calibration with no modeling, and second solid one based on the chronological model described. The lines under the distributions indicate the 95.4% hpd modelled range. The indicated groupings and OxCal keywords define the overall model exactly. The yellow bar indicates the site Date estimate range from the AMS ^{14}C data for comparison with the pre-AMS dates and Date estimate (top). The A values are individual OxCal Agreement values; the O values are the outlier probabilities (posterior/prior – note for the Charcoal Outlier model these are always 100/100). (Please see online version for color figures.)

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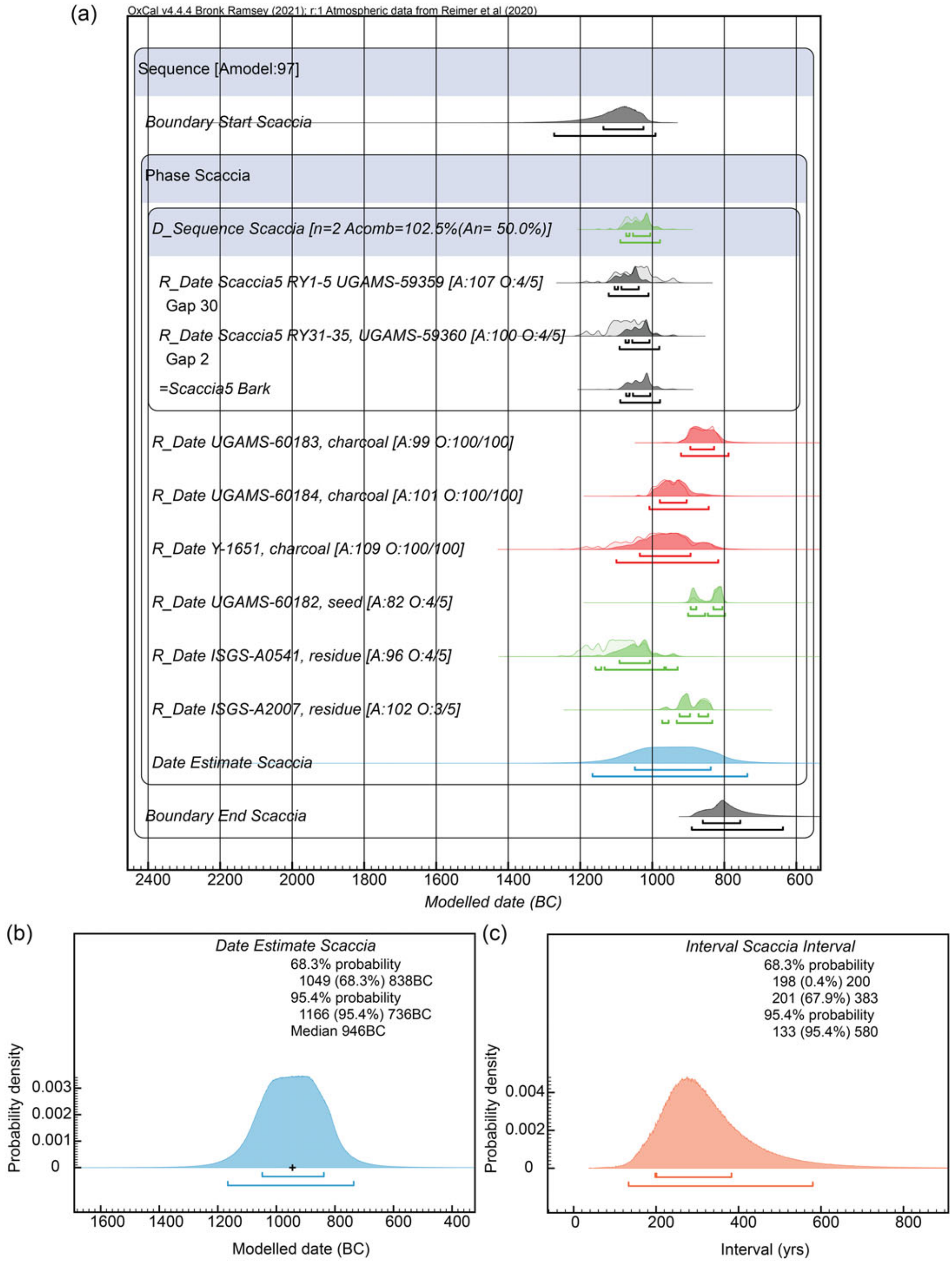

Figure 7 Scaccia dating model. (a) The overall model with all 8 dates. For the general description of the model and explanation of the colors used, see the caption to Figure 5. The lines under the modeled distributions show the 68.3% hpd and 95.4% hpd ranges. (b) Detail showing the Date query to give an estimate of the overall date of the site Phase (between the start and end Boundaries). (c) Detail showing the Interval query to give an estimate of the duration (in calendar years) of the overall site Phase (between the start and end Boundaries).

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Table 2 Lamoka Lake and Scaccia model results.

	Lamoka Lake (AMS)		Scaccia	
Overall model agreement (Am)	91.8		96.7	
	68.3%	95.4%	68.3%	95.4%
Boundary Start	3022–2995 (17.4%), 2968–2916 (50.9%) BC	3082–2912 BC	1136–1025 BC	1273–992 BC
Date estimate	2962–2902 BC	3033–2881 BC	1049–838 BC	1166–736 BC
Boundary End	2922–2887 BC	2984–2849 BC	860–756 BC	891–638 BC
Interval (years)	0–92	0–201	198–200 (0.4%), 201–383 (67.9%)	133–580

Scaccia

The Scaccia chronological model employs all the (rather fewer) 8 ^{14}C dates available from the site (Table 1; Figure 7). The model operates with the same assumptions and practices as the Lamoka chronological model described above. There is one wood sample with a set of ^{14}C dates on a defined tree-ring sequence and a wiggle-match that defines the date for the sample's outermost growth ring underneath the bark. This D_Sequence is placed within the overall settlement Phase as it is not known when within the settlement's history this sample derives.

RESULTS

The results of the chronological models for Lamoka Lake and Scaccia are summarized in Table 2 and shown in Figures 6–8. Dates are listed as either 68.3% or 95.4% highest posterior density (hpd) ranges.

Lamoka Lake

The new, much more precise AMS ^{14}C dates and the chronological model place both the start and end Boundaries for the Lamoka Lake settlement Phase at least ca. 400 yr older than the current generally assumed chronological placement for the site. As evident in Figure 6, the previous ^{14}C dates on wood fragments were not necessarily inaccurate, but of considerably lower precision than the new data presented here. Thus the site Date estimate from the pre-AMS dates shown in Figure 6 at 95.4% hpd is 3936–2529 BC with an Interval query giving 0–1833 yr, whereas the new, modeled AMS ^{14}C dates yield a much more precise Date estimate for the Phase of 3033–2881 BC at 95.4% hpd (2962–2902 BC at 68.3% hpd) and an Interval of 0–201 yr at 95.4% hpd (0–92 yr at 68.3% hpd). Details of the Lamoka Lake AMS ^{14}C dates and chronological modeling are shown in Figure 8. The site dating very much places the site occupation period within the plateau in the IntCal 20 curve ca. 3100–2900 BC (Figure 8b) and ending with the steep slope in the radiocarbon calibration curve beginning late in the 30th century BC, heading to the grand solar minimum ca. 2855 BC (Usoskin et al. 2016). It is possible climate changes associated with this grand solar

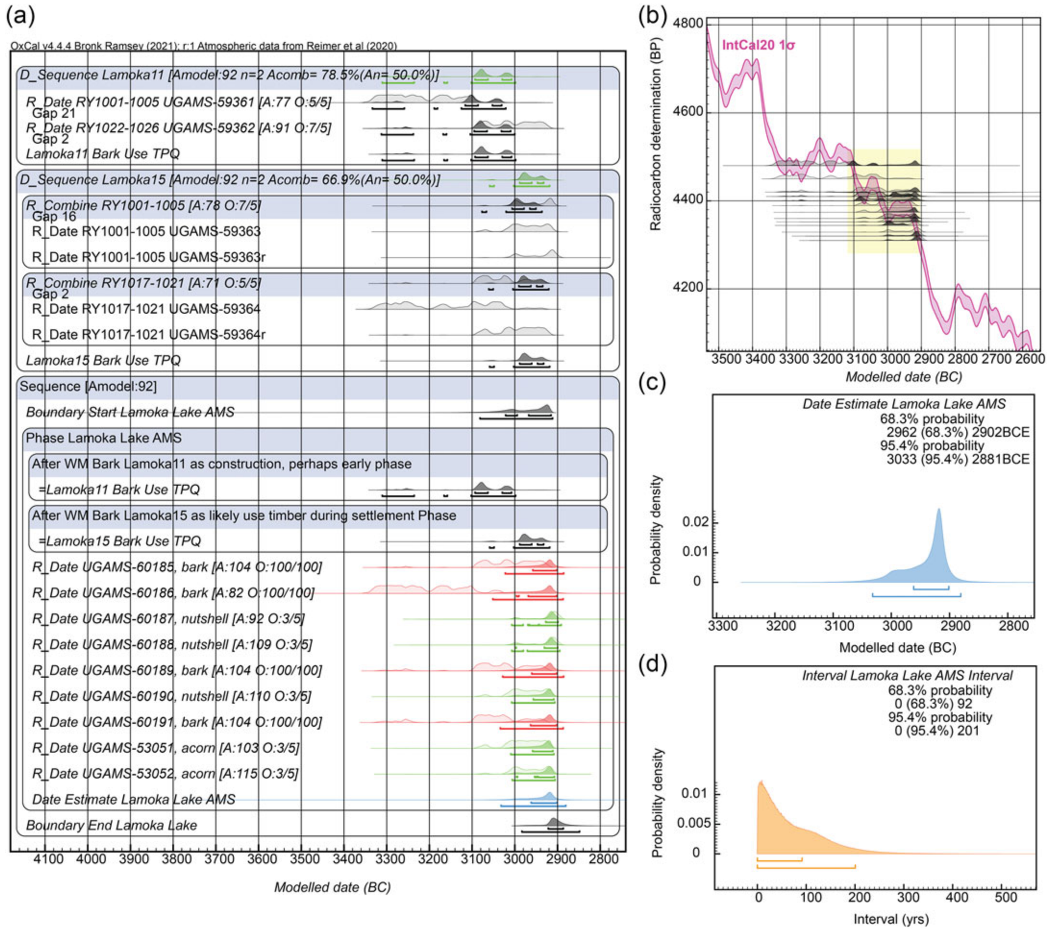

Figure 8 Model for Lamoka Lake from just the AMS ^{14}C dates (bottom part of Figure 5). (a) Overall dating model. For the general description of the model and explanation of the colors used, see the caption to Figure 5. The lines under the modeled distributions show the 68.3% hpd and 95.4% hpd ranges. (b) The relationship and placement of the ^{14}C dates in a. as placed against the IntCal20 ^{14}C calibration curve. (c) Detail showing the Date query to give an estimate of the overall date of the site Phase (between the start and end Boundaries). (d) Detail showing the Interval query to give an estimate of the duration (in calendar years) of the overall site Phase (between the start and end Boundaries).

minimum produced less attractive environmental conditions at the Lamoka Lakes site or areas critical to site subsistence. Based on high-resolution climate proxies (tree rings) from the last millennium relating to the Spörer and Maunder grand solar minima, the period leading into a grand solar minimum likely saw a general shift in the Lamoka Lake region to both cooler and drier conditions (Cook et al. 2010; Anchukaitis et al. 2017). Although the Lamoka Lakes area has more inbuilt resilience than others on account of access to wetlands, upland forest, and protected valleys and corresponding resource diversity, a sequence of harsh winters with longer cold springs (affecting tree flowering), would particularly reduce acorn and hickory nut production, especially if sustained over multiple years.

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Scaccia

The results for Scaccia, with a Date estimate of 1049–838 BC (68.3% hpd) and a median date of 946 BC are compatible with (but slightly older than) the generally accepted ninth-century BC age of the site based on a single, uncalibrated date on bulk wood charcoal. It confirms the status of the site as having as yet the earliest evidence for pottery and an agricultural crop (squash) in present-day New York. The notable feature of the dates from the site is the relatively large calendar range covered. As evident in Figure 7, some of the dates indicate ages from the 11th century BC whereas others indicate ages in the 9th century BC. There is no indication from the available site records for multiple occupation phases, hence this suggests (random) samples from quite a long period of continuous (or effectively continuous) site occupation/use over several centuries (and hence the Interval query returns estimates of 198–383 yr at 68.3% hpd or 133–580 yr at 95.4% hpd).

DISCUSSION AND CONCLUSIONS

The Lamoka Lake and Scaccia sites have had important influences on the construction of Indigenous histories in northeastern North America. Lamoka Lake is the type site for the "Archaic period" in eastern North America and the "Lamoka phase" in New York. The Scaccia site is the largest site ascribed to the "Early Woodland period" in New York and has contributed to the description of the "Meadowood phase". The chronological placements of the sites have been estimated based on uncalibrated solid carbon and gas-counting radiometric dates on bulk wood charcoal samples obtained in the first few decades of the methods' application in archaeology and on Ritchie's and Funk's interpretations of artifactual categories and types. These date estimates have contributed to established narratives of Indigenous histories created within the culture-historical framework that has held sway on northeastern North American archaeology since the early to mid twentieth century. The date estimates have continued to be used in the current century, generally without question.

Here we have modeled new date estimates for the sites using the first new radiocarbon dates for Lamoka Lake since the early 1960s and new dates for Scaccia combined with dates obtained in the 2000s. Bayesian chronological modeling provides site chronologies independent of the cultural historical scheme. The results of the modeling for Lamoka Lake indicate its occupation was ca. half a millennium earlier than Ritchie's generally accepted age estimate of the site and several hundred years earlier than more recent estimates (Sassaman 2010; Gibbon 2022). Results for Scaccia indicate a slightly earlier occupation than that based on a single uncalibrated radiocarbon date (Ritchie and Funk 1973). For both sites, the models provide multiple-century occupation interval estimates, which suggests the sites are palimpsests of multiple occupations over extended periods of time (e.g., Ellis et al. 2021). This contrasts with Ritchie and Funk's (1973:44) interpretation of Lamoka Lake as a base camp with up to 27 simultaneously occupied structures occupied by 150–200 individuals. It is consistent, however, with their interpretation of Scaccia as a base camp occupied periodically by small groups (Ritchie and Funk 1973:348). Our results suggest this occurred over the course of several hundred years. While these results might tempt some archaeologists to shift the boundaries of the culture-historical stages or phases each site is associated with (e.g., Ritchie 1965), we suggest that those phases be jettisoned entirely in favor of locating sites and associated activities and behaviors in absolute time and deriving interpretations of social, material, and cultural patterning from those new temporal baselines (Feinman and Neitzel 2020).

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Contemporary northeastern North American archaeologists often rely on legacy radiocarbon dates and original interpretations of site age estimates from decades ago when writing Indigenous histories. The current study adds to a growing list of studies that are changing understandings of site-specific histories in the region through AMS dating of curated collections combined with Bayesian modeling. The results of the current analyses provide more accurate age estimates for two significant sites located in present-day New York independent of culture-historical considerations. Many additional efforts will be needed to reassess segments of Indigenous histories in the region.

ACKNOWLEDGMENTS

Funding for this study provided by National Science Foundation Award No. 1727802. Organic materials identification work made use of the Cornell Center for Materials Research Shared Facilities which are supported through the NSF MRSEC program (DMR-1719875). Thanks also to Carla Hadden and Megan Conger at the Center for Applied Isotope Studies, University of Georgia, Samantha Sanft of Cornell University, and staff of the New York State Museum for their assistance with sample access, selection, and dating.

COMPETING INTERESTS STATEMENT

All authors contributed to the design of the work; the acquisition, analysis, or interpretation of data for the work; drafting and revision; and approved the final version of the work.

SUPPLEMENTARY MATERIAL

To view supplementary material for this article, please visit https://doi.org/10.1017/RDC.2023.37

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