ARTICLE

Maritime Ritual Economies of Cosmic Synchronicity: Summer Solstice Events at a Civic-Ceremonial Center on the Northern Gulf Coast of Florida

Kenneth E. Sassaman, Meggan E. Blessing, Joshua M. Goodwin, Jessica A. Jenkins, Ginessa J. Mahar, Anthony Boucher, Terry E. Barbour, and Mark C. Donop

Places such as Poverty Point, Mound City, and Chaco Canyon remind us that the siting of ritual infrastructure in ancient North America was a matter of cosmological precedent. The cosmic gravity of these places gathered persons periodically in numbers that challenged routine production. Ritual economies intensified, but beyond the material demands of hosting people, the siting of these places and the timing of gatherings were cosmic work that preconfigured these outcomes. A first millennium AD civic-ceremonial center on the northern Gulf Coast of Florida illustrates the rationale for holding feasts on the end of a parabolic dune that it shared with an existing mortuary facility. Archaeofauna from large pits at Shell Mound support the inference that feasts were timed to summer solstices. Gatherings were large, judging from the infrastructure in support of feasts and efforts to intensify production through oyster mariculture and the construction of a large tidal fish trap. The 250-year history of summer solstice feasts at Shell Mound reinforces the premise that ritual economies were not simply the amplification of routine production. It also suggests that the ecological potential for intensification was secondary to the cosmic significance of solstice-oriented dunes and their connection to mortuary and world-renewal ceremonialism.

Keywords: ritual economy, cosmology, world renewal, feasts, summer solstice, intensification

Lugares como Poverty Point, Mound City y Chaco Canyon nos muestran que la ubicación de la infraestructura ritual que fue edificada en la antigua Norteamérica fue basada en precedentes cosmológicos. La importancia cósmica de estos lugares congregaba periódicamente a multitudes, en proporciones tales que sobrepasaban la capacidad productiva de la zona. Las economías rituales fueron intensificadas, pero, más allá de las demandas económicas de acoger a las muchedumbres, la ubicación de estos lugares y la sincronización de estas reuniones fueron actividades basadas en el cosmos, el cual preestablecía las condiciones de estos eventos. En un centro cívico-ceremonial que se remonta al primer milenio dC, ubicado en la costa norte de Florida, en el Golfo de Méjico, se percibe la lógica en la que estas festividades se fundamentaban y en el lugar en el que se celebraban: en el extremo de una duna parabólica que al mismo tiempo compartía espacio con un recinto mortuorio. La arqueofauna de las fosas grandes excavadas en Shell Mound sustenta la conclusión de que los festines fueron programados para los solsticios de verano. Las reuniones fueron masivas, a juzgar por la infraestructura empleada en la organización de estas celebraciones y los esfuerzos orientados hacia la intensificación de la producción a través de la maricultura de ostras y la construcción de una gran trampa de peces en áreas de marea. Los 250 años de historia de festines en celebración a los solsticios estivales en Shell Mound, corroboran la proposición de que las economías rituales no fueron simplemente una intensificación de la producción cotidiana. También sugieren que el potencial ecológico para la intensificación era secundario al significado cósmico de estas dunas orientadas al solsticio y su explicable conexión con el ritualismo tanto mortuorio como de regeneración.

Palabras clave: economía ritual, cosmología, reconfiguración del mundo, festines, solsticios de verano, intensificación

Kenneth E. Sassaman ■ Department of Anthropology, University of Florida, Gainesville, FL 32611, USA (sassaman@ufl.edu, corresponding author)
Meggan E. Blessing ■ Department of Anthropology, University of Florida, Gainesville, FL 32611, USA
Joshua M. Goodwin ■ Bureau of Archaeological Research, Division of Historical Resources, Florida Department of State, Tallahassee, FL 32301, USA
Jessica A. Jenkins ■ Department of Anthropology, University of Florida, Gainesville, FL 32611, USA
Ginessa J. Mahar ■ Department of Anthropology, University of Florida, Gainesville, FL 32611, USA
Anthony Boucher ■ Department of Anthropology, University of Florida, Gainesville, FL 32611, USA
Terry E. Barbour ■ Department of Anthropology, University of Florida, Gainesville, FL 32611, USA
Mark C. Donop ■ Department of Anthropology, University of Florida, Gainesville, FL 32611, USA

American Antiquity, page 1 of 29

doi:10.1017/aaq.2019.68

An archaeological site on the northern Gulf Coast of Florida with the unassuming name of Shell Mound (8LV42) illustrates the intersection of cosmology, society, and ecology in the intensification of a maritime ritual economy (Figure 1). Cosmologically, the site straddles the end of a parabolic dune arm that is oriented to the solstices and was long used to bury the dead. Socially, communities from across the region gathered at Shell Mound for summer solstice feasts and related activities. Ecologically, solstice feasts over a 250-year span (ca. AD 400–650) went beyond the productivity of nearshore estuarine resources to include offshore resource patches and the infrastructure of mass fish capture. Here we examine the connections between religious practice and economic intensification at Shell Mound in the context of a history of sea-level change that altered not only the relationship between inhabitable land and nearshore resources but also the relationship between the living and the dead.

The long arc of climatic history on the northern Gulf Coast of Florida spans more than 80 m of sea-level rise and more than 200 km of shoreline retreat since people of the late Pleistocene colonized the peninsula. Shell Mound and its ritual economy are but one small segment of that arc, linked to all that came before and after by the common experience of transgressive sea. In its particular geomorphology, the landscape surrounding Shell Mound connected climate events spanning centuries, arguably millennia. Across the greater locality of Shell Mound were parabolic dunes up to 2 km long and 17 m tall that rose out of the southwesterly winds of the Pleistocene (Wright et al. 2005). As they eroded with rising sea, dunes provided the sand necessary for offshore seagrass beds and aggrading nearshore marshes. In addition, the tops of dunes offered elevated refuge from rising water. Beyond their practical value, dunes were an integral part of a sacred landscape, one that indexed solar cycles by virtue of solstitial alignments and thus predisposed places like Shell Mound to gather people for solstice events (Supplemental Text 1).

Here we present the archaeological residues of these solstice gatherings and situate them in the cosmological context of a maritime ritual economy. The deep historical context of cosmology involving solstice-oriented dunes extends back to the Late Archaic period (ca. 3000–1200 BC), when coastal communities appear to have relocated cemeteries landward to the ends of dune arms in advance of shoreline retreat (Randall and Sassaman 2017; Sassaman 2016). Later, the practice of Hopewell religion in the Midwest (ca. AD 1–400) and its counterparts in the Southeast (ca. AD 200–650) figured prominently as nonlocal things, persons, and ideas influenced the traditions of indigenous coastal communities. We refer repeatedly to these precedents and impingements in the discussion that follows, but our focus in this article is the 250-year period of ritual intensification at Shell Mound.

We introduce Shell Mound as a locus of summer solstice gatherings with special attention to the vertebrate faunal assemblages recovered from massive pits. Reported here for the first time, these pit assemblages provide unusually specific seasonal indicators for feasting events. Among the bones of these assemblages are elements of avian species that were taken in mid- to late June (Goodwin 2017; Goodwin et al. 2019). The remains of many other taxa support the summer timing of the events. These same faunal assemblages point to the mass collection of intertidal and subtidal resources from locations as much as 12 km distant. We also review details on the infrastructure of feasting events, including processing pits, cooking and serving vessels, and fish traps, as well as evidence for oyster mariculture. All such data support the inference that feasts were relatively large-scale events requiring more than the amplification of daily subsistence. Finally, in a discussion of the broader contexts for Shell Mound feasts, we consider the environmental conditions under which this 10-generation span of gathering started and stopped. We conclude that the ritual economy that structured human gatherings at Shell Mound was an effective means of risk aversion—notably in affording options to relocate landward during severe climate events—but only to the extent that movements of the sun, gathered

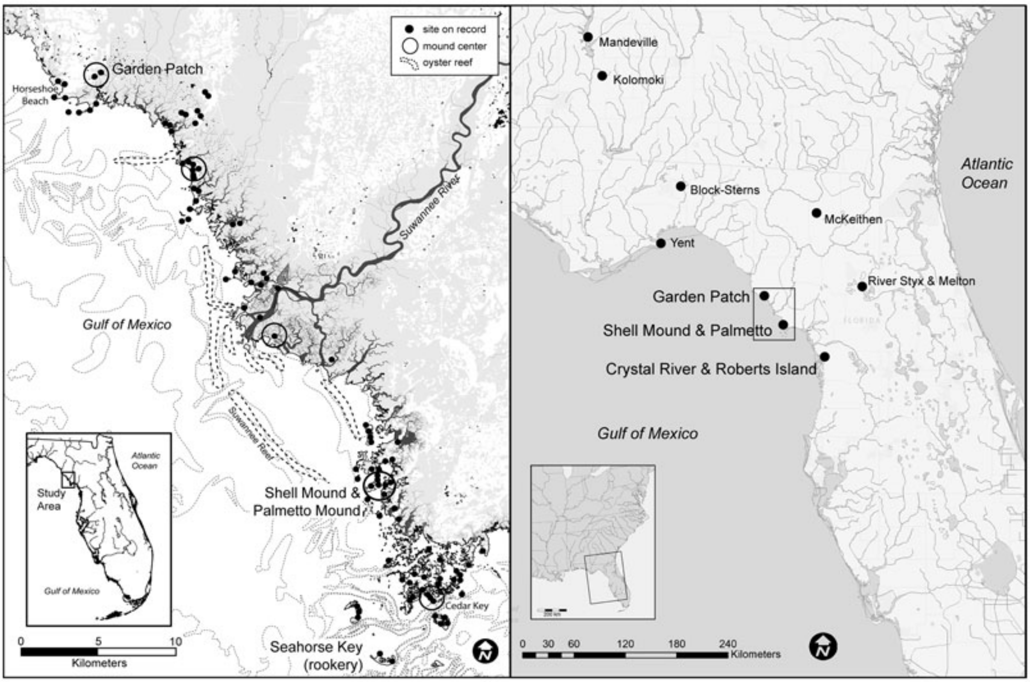


Figure 1. Locator map of the study area on the northern Gulf Coast of Florida (left) and regional map (right) showing locations of civic-ceremonial centers of the Woodland period.

communities, objects of cosmic value, and the dead remained in sync or could be brought into balance. Before presenting the evidence to support these inferences we review briefly the theory of ritual economy that guides our interpretation, followed by background on civic-ceremonial centers in the Southeast.

Ritual Economy

Inspired by the ethnographic work of Roy Rappaport (1968), the concept of "ritual economy" or "ritual mode of production" privileges the connections between religious belief and economic practice in reproducing and changing society. Archaeological investigations of ritual economies turn on the material residues of ritual activities, such as ceremonial feasting; the production, distribution, and deposition of socially valued things; and the construction and use of ritual infrastructure (Spielmann 2002, 2008). A robust literature on cases worldwide illustrates how these sorts of practices inflect the economic tempo of everyday life, a process referred to generally as intensification (Bender 1985; Lourandos 1988; McNiven 2016; Morgan 2015; Roberts et al. 2016; Spielmann 2002). In systems-serving terms like those Rappaport envisioned for the Tsmebaga Maring, ritual intensification reproduces society beyond the household, a sort of political economy embedded in religious practice. In this sense, feasting brings together people who are otherwise dispersed, exchanging socially valued things nurtures extralocal alliances, and building infrastructure spatially anchors gatherings and exchanges. The benefit in systems-serving terms is a network of shared risk for buffering against failure from environmental stresses such as drought (e.g., McNiven 2016).

Later in his career Rappaport (1999) acknowledged that the systems-serving aspects of a ritual economy fell short of explaining the religious motivations for intensification. Although emergent properties of systems—homeostasis, resiliency, entropy—give analytical perspective on material or energetic processes playing out over many generations, they provide little insight on the intentions and interventions of all the agents they subsume. This is not so much a commentary on the precedence of agency over structure as it is a recognition of the subjectivity of experience. Influenced by the idealist versus materialist debate of the late 1960s and 1970s (e.g., Friedman 1974; Sahlins 1976), Rappaport's distinction between the "cognized environment" and the "operational environment" led him and his students to deeper consideration of the mutuality of mind-body, object-subject, and nature-culture. The "new ecologies" that arose from reconciliation of these dichotomies insists that any explanation for the objective material needs of people (i.e., operational environment) recognize that such needs are the subjective product of sociohistorical circumstances (i.e., cognized environment). In this regard, nature and culture exist in dialectical, not dichotomous, relationships (Biersak 1999).

A perspective on ritual economy that foregrounds cosmology brings into focus the symbolic and historical substance of a cognized environment. McAnany and Wells point us in this direction in defining ritual economy as "the process of provisioning and consuming that materializes and substantiates *worldview* for managing meaning and shaping interpretation" (2008:3; emphasis ours). In rituality, they suggest, beliefs about the order and process of the cosmos are laid bare. This opportunity invites questions about the timing and siting of ritual acts that help to situate ritual in operational terms. For example, to the extent that ritual feasts were eventful, when did these events take place? Likewise, to the extent that feasts involved gatherings of dispersed people, where did people gather? It seems reasonable to suggest that answers to these questions are to be found in the time-space variation of the material demands of ritual practice, notably the availability of abundant food (e.g., Weissner 2001). However, that may be the last place to look if what mattered was not the ecological qualities of a particular place but rather its relationship to other realms, other places, and other times.

A cosmological perspective on ritual economy shifts the analytical focus from the reproduction of particular societies to world renewal writ large (Supplemental Text 2). At this level of abstraction, cosmic relations (i.e., religion) extend beyond humans to all manner of non-human agents, a nexus of relations that Hardenberg (2016) calls the sociocosmic field. The material demands attending sociocosmic obligations can be substantial and impact activities over months or years. For instance, it is not unusual for ritual events involving ancestors or otherworldly forces to require provisions of extraordinary scale and substance (e.g., Claassen 2010; DeBoer 2001; Gamble 2017; Kassabaum 2014; Luby and Gruber 1999; Wallis and Blessing 2015). Likewise, feasts in which "guests from the spirit world also had a seat at the feasting table" involved the production of material surpluses to meet cosmic debt (Cobb and Stephenson 2017:147). Whereas relations with supernatural forces are subject to politicization and competition among would-be ritual leaders, in their fundamental power to affect futures, rituals of world renewal tend to be communal and integrative. The mound-top feasts of civic-ceremonial centers in the American Southeast exemplify these sorts of cosmic relations.

Civic-Ceremonial Centers and World Renewal

First-millennium AD mound centers in the American Southeast that housed a resident population as well as regional gatherings are known as civic-ceremonial centers (Anderson and Sassaman 2012:127–128). They have affinity to ceremonial centers of the Ohio Hopewell in their mortuary purpose and associated ritual objects, many from nonlocal sources and thus indicative of the geographic scope of periodic gatherings (Wright 2017). However, Hopewell centers of Ohio were not occupied throughout the year, at least not in ways that left an indelible mark (e.g., architecture and middens of domestic living). In contrast, counterparts in the Southeast provide evidence of residential communities ranging from a few dozen to a few hundred people (e.g., Milanich et al. 1984; Pluckhahn 2003). Communities were arranged mostly in U-shaped compounds of variable orientation. Erected astride open plazas were mounds with at least one—usually conical—dedicated to human interment.

Prominent at civic-ceremonial centers in the Southeast are quadrilateral flat-topped mounds, essentially truncated pyramids made of earth.

This type of mound has a deep history in the region and was succeeded in the last millennium by the truncated pyramids of the Mississippian era. Despite similarities in form, flat-topped mounds were built and used for different purposes over time (Kassabaum 2019; Lindauer and Blitz 1997). Those of the Mississippian era and its institutions of social rank were platforms for elite housing and ceremony, not accessible to common persons. Those of the Middle Woodland era were platforms of communal ritual, including world renewal.

Knight (2001) makes the case that Middle Woodland platform mounds were elevated surfaces for world-renewal events involving feasting. Mounds were themselves staged constructions. Emplaced on successive platforms were multiple pits, large posts, and occasionally buildings that have been interpreted as charnel houses (e.g., Milanich et al. 1984), much like those of Hopewell. Connections between mound-top feasts and interaction with the dead are ambiguous but likely strong. However, flat-topped mounds were not burial mounds. As Knight emphasizes, "Burial-mound ceremonialism was segregated from a second kind of ceremonialism" (2001:328), namely, world renewal (see also Hall 1997). Akin to the Green Corn ceremonialism of Mississippian people and their descendants (Witthoft 1949), world-renewal rituals of the Middle Woodland period emphasized inclusion and integration, ultimately in the interest of establishing and maintaining intervillage alliances (Knight 2001:327; see also Kassabaum and Nelson [2016] for a similar view of the rituality of Late Woodland platform mounds in the lower Mississippi Valley).

Green Corn ceremonies were and still are conducted in ceremonial areas that are consecrated as world symbols or cosmograms (Hudson 1976:368–375; Lankford 2004; Witthoft 1949). Like those of the Mississippian era, ceremonial grounds of Hopewell and its Southeast counterparts involve geometry and orientations of apparent cosmological relevance. Although we may never know completely the cosmic significance of the built environment, a variety of solar alignments are evident at Middle Woodland mound complexes (e.g., Milanich et al. 1984; Williamson 1987:258–262). Likewise, connections among mound centers and other features of the "natural" terrain suggest relational qualities manifest in movements of bodies, celestial and earthly (e.g., Romain 2015; Wallis 2018). In what Urton (1981) has called the "crossroads" of sky and earth, features on the landscape, both natural and built, are made meaningful through ritual acts that are oriented to places and times on earth where the sun, moon, or other celestial bodies traverse the ground. The Hopewell road connecting Newark with Mound City as an earthly equivalent of the Milky Way is a case in point (Romain 2015). With earthly connections this vast, the implications for the movement and emplacement of bodies and things are legion. As Robert Hall once wrote, "Astronomical alignments served . . . to magically gather and direct powers from nature for the benefit of the people" and enable "communication between cosmic levels, including those of the sky and the Underworld" (1985:191).

Shell Mound is not a typical civic-ceremonial center, because it lacks a flat-topped mound. Nevertheless, the mound-like dune that it occupied was penetrated by numerous large pits that contain the remains of what arguably were summer solstice feasts. Other attributes of Shell Mound compare favorably with other civic-ceremonial centers in the region, including an associated cemetery, Palmetto Mound, that preceded solstice gatherings by centuries; and after 100 years of such gatherings, Shell Mound was reconfigured into an arcuate shell ridge with a central plaza (Randall and Sassaman 2017:23–24; Sassaman et al. 2019).

Beyond these comparisons, long-term experiences with rising sea and shoreline retreat help to explain why coastal civic-ceremonial centers were sited where they were. As noted earlier, emplacement of the dead on the ends of parabolic dune arms goes back at least 4,000 years, when sea level was down more than 1 m and the shoreline was westward 5 km from its present location (Sassaman 2016). As rising sea threatened cemeteries, they were relocated to the distal ends of landward dune arms. Likewise, an overstep event involving 2–3 km of shoreline retreat occurred around the beginning of the first millennium AD (Goodbred et al. 1998; McFadden

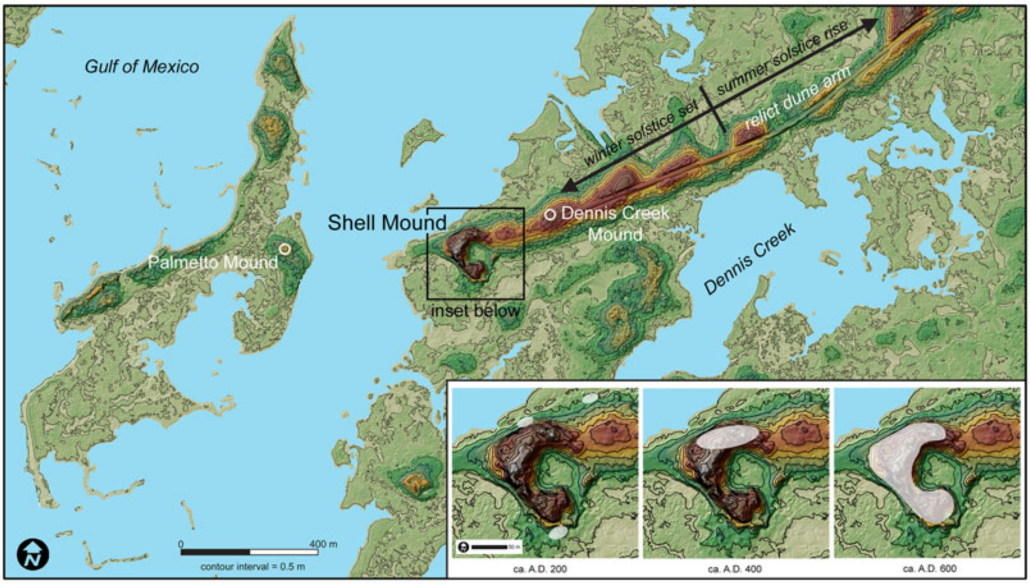


Figure 2. Topographic map of the area surrounding Shell Mound (8LV42) and Palmetto Mound (8LV2). Note the relief and orientation of the relict dune arm on which Shell Mound sits. Inset to the bottom right illustrates the history of occupation starting with ephemeral use of the landform at low elevation at AD 200, followed by occupation of the dune arm and pit digging after AD 400 and terraforming of the south ridge by AD 600.

2015; Wright et al. 2005) and may have influenced the establishment of civic-ceremonial centers at Crystal River (Pluckhahn and Thompson 2018) to the south of Shell Mound and Garden Patch (Wallis et al. 2015) to the north (Supplemental Text 3). Both were preceded by mortuaries, and both were sited back from the coast, 7 km for Crystal River and 2 km for Garden Patch. This same overstep event is likely to have separated Palmetto Mound from the landward portion of a dune arm, where Shell Mound arose two centuries later as a locus of summer solstice gatherings. The convergence of a history of rising sea with a landscape of solstice-oriented dunes led to what Herva and Ylimaunu (2014) call "horizontal temporality," where a changing shoreline was indexed to cycles of renewal. In this regard, the siting of Palmetto Mound, and in turn Shell Mound, was influenced by a worldview that ascribed ritual value to landforms that materialized the cycles of the sun. Given that solar standstills were marked by the orientation of dunes (summer solstice rise [~60 degrees E/N]:winter solstice set [~240 degrees E/N]), solstices were probable times of world renewal at Shell Mound.

Shell Mound and Its Pit Assemblages

In its current configuration, which was achieved about 1,400 years ago, Shell Mound is an arcuate (C-shaped) ridge-and-mound complex of mostly oyster shell roughly 180 × 170 m in plan and 7 m tall at an apex opposite an opening to the southeast (Figure 2). Its enclosed, plaza-like central space is roughly 60 m in diameter. In its geometry and relief, Shell Mound resembles some of the shell rings of the lower Southeast, although these generally date to the Late Archaic period (ca. 3000–1200 BC; Russo and Heide 2001; Saunders 2017). Ring-shaped middens resulting from circular or semicircular villages of the first millennium AD have been documented along the Gulf Coast of Florida (Russo et al. 2014), but none express the topographic relief of Shell Mound.

Until recently, Shell Mound was the subject of only limited controlled excavation, a 10 × 10 ft. unit dug into the apex of the shell ridge (Bullen and Dolan 1960). Sustained archaeological investigations at Shell Mound began in 2012 (Sassaman et al. 2013) and benefited from the assistance of students of the Lower Suwannee Archaeological Field Schools in 2014 (Sassaman et al. 2015) and 2015 (Sassaman et al. 2019). The enduring goal of testing has been to sample the site widely to establish the range of variation of subsurface deposits, with emphasis on both the deep stratigraphic profiles of the shell ridge and feature assemblages in the central plaza and dune arm.

The structure and sequence of mounded shell and associated matrix at Shell Mound are complex but relatively well known to us. Before the arcuate ridge was erected, occupation of the top of the dune arm resulted in the accumulation of thick organic midden. At the same time, many large pits were dug and backfilled along the side slope of the arm. At about AD 550, midden and pit fill from the base of the side slope was mined and redeposited to the south of the arm to form the arcuate ridge. Pits continued to be excavated and backfilled in the dune arm during this phase of "terraforming" (Randall and Sassaman 2017). In addition, two mortuary mounds in the vicinity of Shell Mound must be counted as components of this terraformed landscape. Dennis Creek Mound—250 m to the northeast, along the dune arm—was small and short-lived (Boucher 2017). Palmetto Mound—500 m to the west, across intertidal water—was the locus of intensive mortuary practice since at least 400 BC (Donop 2017). Growing over the centuries to become the densest bundle of persons, pots, and other objects in the region, Palmetto Mound was the likely impetus for siting ritual gatherings on the nearby dune arm where Shell Mound would later arise.

The north ridge of Shell Mound owes much of its topographic relief to aeolian process. Beneath a veneer of emplaced shell midden is a 3–4 m thick mantle of dune sand. As noted above, large pits were dug into the dune sands and backfilled. Twenty-two such pits have been uncovered in two locations on the southeast side slope tested to date (Figure 3). At least 1 m wide and up to 2 m deep, cylindrical and hemispherical pits were backfilled with organic matrix that stands in sharp contrast to the inorganic yellow-brown dune sand into which they were dug. Contained in the pit fill are shell and abundant vertebrate faunal remains dominated by the bones of mullet and other fish, sea turtle, wading birds, and white-tailed deer, among other taxa. Accompanying the bones and shell are sherds from large cooking vessels and small serving vessels. Occasional exotic items such as mica and quartz crystal have been unearthed. Extrapolating the density of pits exposed in test excavations to the expanse of the southeast side slope, at least 675 pits were excavated and backfilled (Sassaman et al. 2019). The analyses we report below focus on the fill of six pits divided between two locations on the side slope.

The use of pits before they were backfilled is unknown, but earth oven cooking is a possibility. Irrespective of their initial use, large pits must have been backfilled soon after being dug because deep vertical cuts into dune sands are inherently unstable. Large pits were thus short-lived and not likely reused. However, those documented to date were intercepted by other pits, so the activities during which they were dug, used, and backfilled were protracted over many events. The six relatively discrete pits for which we have accelerator mass spectrometry (AMS) assays span a 250-year period of about AD 400–650 (Sassaman et al. 2019:Appendix B), roughly mirroring the history of Shell Mound before and during the period of terraforming (Figure 4). Although pits generally are not stratified, those with distinct layers also appear to have been infilled quickly. Three AMS age estimates on charcoal from successive strata of Feature 25, for example, overlap at one sigma and are thus statistically coeval (Supplemental Text 4).

We hypothesize that the pit fill was deposited in conjunction with ritual feasting and that these events took place during solstices. As we review in detail below, the preponderance of vertebrate faunal evidence points to summer events. Accretional midden from coeval deposits at Shell Mound provides limited but insightful evidence of depositional events at other times of the year. After summarizing the vertebrate assemblages of pits, we review the remains of infrastructure and practices that enabled intensified production.

Vertebrate Assemblages in Pits

Excavation of pit features was not standardized, owing to the complexities of intersecting pits in confined space, but all were sampled in bulk

Figure 3. Sample of large infilled pits that were exposed in test excavations on the southern slope of the dune arm at Shell Mound. All excavation units of profiles shown here are 2 × 2 m in plan.

for flotation, and the remaining fill was passed through ¼-inch or ⅛-inch screens. For our purposes here only the ¼-inch fraction of pit fill is reported. We also note that the volume of pit fill passed through screens was not measured and thus comparisons must be restricted to relative frequencies of taxa. Despite the lack of data to calculate the density of vertebrate faunal remains in screened fill, both the volume of fill and frequency of bony elements were sizable, in keeping with the large size of the pits.

A total of 25,241 bony elements ¼ inch or greater in size were identified from the screened fill of six pit features at Shell Mound (Table 1). These account for a minimum number of individuals (MNI) of 953 distributed across 86 taxa. Fish account for the vast majority of individuals, a total of 723, or 76.4% by MNI. Mullet constitute nearly half of all the fish (45.6% by MNI), followed by lesser fractions of jack (9.8%), sheepshead (7.1%), red drum (7.1%), sea trout (6.9%), and hardhead catfish (5.4%). Black

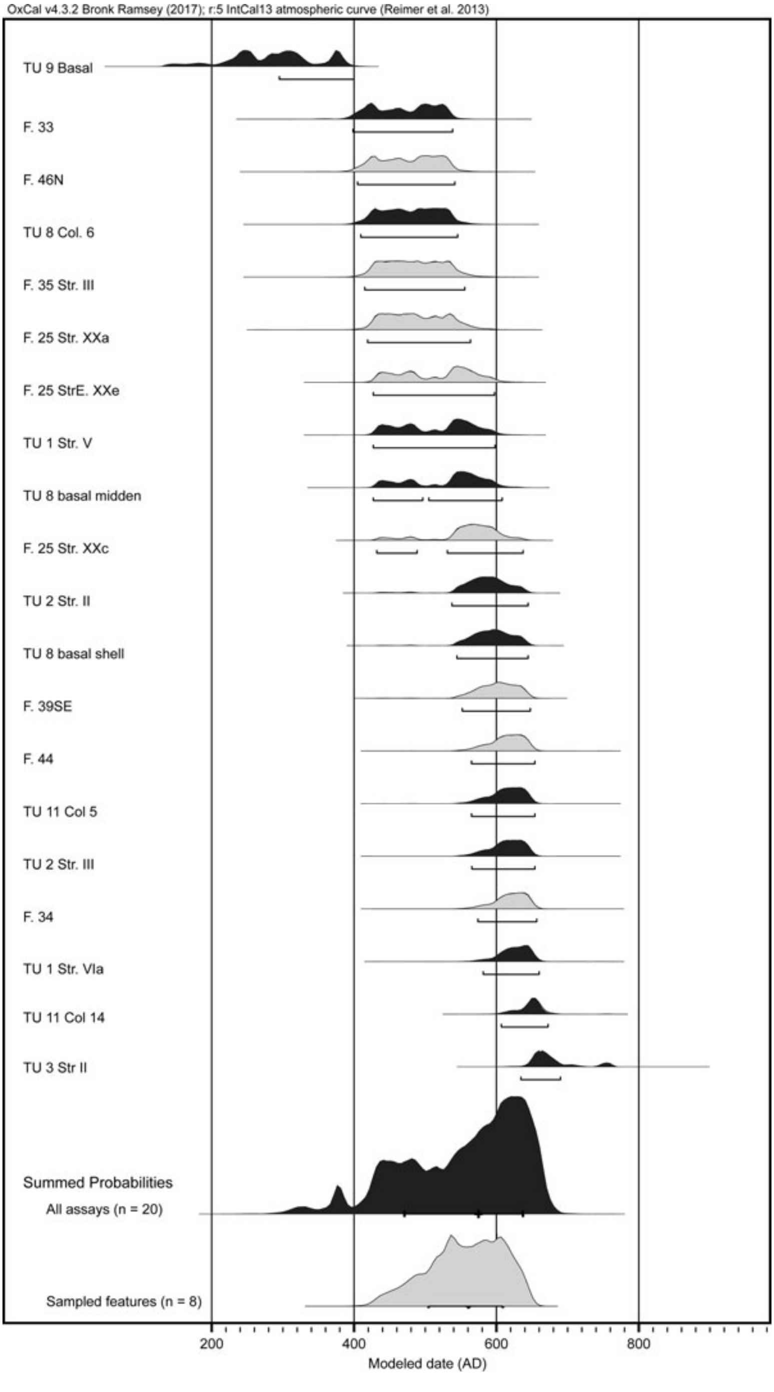


Figure 4. Individual and summed probability distributions of 20 accelerator mass spectrometry assays on charcoal from sampled features (in gray) and accretional midden at Shell Mound (8LV42). OxCal v4.3.2 Bronk Ramsey (2017); r:5 IntCal13 atmospheric curve (Reimer et al. 2013).

Table 1. Absolute Frequency of the Minimum Number of Individuals (MNI) and Number of Individual Specimens (NISP) for Vertebrate Taxa in Six Pit Features at Shell Mound (8LV42).

		F.46		F.35		F.25		F.39		F.44		F.34		Total	
Taxon	Common Name	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP
Vertebrata	Vertebrate		184		158		150		116		114		107		829
Euselachii	Shark								3	1	1			1	4
Carcharhinidae	Requiem shark			1	2	2	6	1	1			1	3	5	12
Galeocerdo culvieri	Tiger shark					1	3	1	1					2	4
Rajiformes	Ray	1	1	1	2	1	3	2	4					5	10
Aetobatus sp.	Eagle ray											1	1	1	1
Rhinoptera bonasus	Cow-nosed ray					1	1							1	1
Actinopterygii	Ray-finned fish		738		1,606		2,367		841		961		606		7,119
Acipenser oxyrinchus desotoi	Gulf sturgeon	1	5	1	7	1	34	1	40	1	32	1	2	6	120
Lepisosteus sp.	Gar	2	7	2	18	3	25	2	15	2	4	1	5	12	74
Amia calva	Bowfin	1	3	1	4	2	23	2	9	2	12	1	5	9	56
Elops saurus	Ladyfish			1	1	1	4	1	5	1	2	1	6	5	18
Clupedidae	Shad/herring					1	1							1	1
Siluriformes	Catfish				7				1				3		11
Ictaluridae	Freshwater catfish			2	2	1	3					1	4	4	9
Ameiurus natalis	Yellow bullhead			1	1									1	1
Amieurus nebulosus	Brown bullhead			1	1									1	1
Ariidae	Sea catfish		20		5		42	3	59		14		1	3	141
Ariopsis felis	Hardhead catfish	6	80	6	35	10	93	13	176	5	34	10	45	50	463
Bagre marinus	Gaff-topsail catfish					1	1	1	1					2	2
Esox sp.	Pickerel							1	1					1	1
Opsanus sp.	Toadfish					2	9	1	4	1	1			4	14
Lepomis microlophus	Shellcracker											1	1	1	1
Micropterus salmoides	Largemouth bass					2	8			1	1			3	9
Carangidae	Jack		83		211		162		218		106		54		834
Caranx sp.	Crevalle jack	10	122	18	250	16	269	11	197	7	99	9	56	71	993
Caranx crysos	Blue runner			1	1			1	1			1	1	3	3
Lobotes surinamensis	Tripletail					1	11			1	1			2	12
Orthopristis chrysoptera	Pigfish			1	3	2	9			1	1	1	1	5	14
Sparidae	Porgies		4										1		5

Archosargus probatocephalus	Sheepshead	5	25	12	53	14	115	7	56	5	65	9	65	52	379
Calamus sp.	Porgy			1	1	1	1					1	1	3	3
Lagodon rhomboides	Pinfish	1	1	1	1	5	10	1	1	2	2	1	2	11	17
Scaienidae	Drum		11		18		18		44		8		10		109
Cynoscion sp.	Sea trout	11	30	5	14	8	59	8	39	5	22	13	37	50	201
Pogonias cromis	Black drum	3	30	2	13	4	18	7	49	4	12	2	4	22	126
Sciaenops ocellatus	Red drum	5	29	9	24	11	54	10	49	8	44	9	40	52	240
Mugil sp.	Mullet	29	917	35	733	111	3,153	71	1,617	51	1,591	35	1,283	332	9,294
Paralichthys sp.	Flounder	4	12	3	8	3	30	2	10	3	31	3	12	18	103
Chilomycterus sp.	Burrfish					1	1	1	1					2	2
Lithobates sp.	Frog	1	1	1	1							1	1	3	3
Siren sp.	Siren											1	3	1	3
Testudines	Turtle		112		92		324		160		98		70		856
Chelydra serpentina	Snapping turtle					3	5	1	1	2	8			6	14
Kinosternon sp.	Mud turtle	4	34	4	64	5	68	4	56	4	98	4	53	25	373
Emydidae	Pond turtle/box turtle/terrapin		6				1		8		2		1		18
Malaclemys terrapin	Diamondback terrapin	1	2			1	1	1	2					3	5
Pseudemys sp.	Pond turtle	2	2	1	1	2	3					1	2	6	8
Terrepene carolina	Box turtle	1	2	1	2	2	8	4	52	2	7	1	2	11	73
Gopherus polyphemus	Gopher tortoise			1	3	2	23	1	5	1	5	1	9	6	45
Cheloniidae	Sea turtle	3	154	8	195	8	217	6	209	6	257	6	145	37	1,117
Apalone ferox	Softshell turtle							1	3	1	1			2	4
Serpentes	Snake		3	1	3		1		4	1	2		1	2	14
Colubridae	Nonvenomous snake	1	5			1	8	1	4			1	3	4	20
Aves (medium)	Medium bird						25		2		4		1		32
Aves (medium-large)	Medium-large bird	1	14		29		19		1		6		1	1	70
Gavia immer	Loon	1	1											1	1
Podiceps auritus	Horned grebe					1	1							1	1
Podilymbus podiceps	Pied-billed grebe			1	1	1	4	1	2			1	3	4	10
Phalacrocorax auritus	Double-crested cormorant	1	3											1	3
Ardeidae	Heron							1	1					1	1
Ardea herodias	Blue heron			2	22	1	2			1	1	1	1	5	26
Nyctanassa violacea	Yellow-crowned night heron					1	3							1	3

Table 1. Continued.

Taxon	Common Name	F.46		F.35		F.25		F.39		F.44		F.34		Total	
		MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP
Eudocimus albus	White ibis	4	56	7	35	12	188	2	9	11	119	3	9	39	416
Platalea ajaja	Spoonbill					1	1							1	1
Anatidae	Duck			1	3	1	1	1	3	1	3	1	1	5	11
Meleagris gallopavo	Turkey							1	1					1	1
Larus argentatus	Herring gull					1	1							1	1
Corvus sp.	Crow											1	1	1	1
Mammalia	Mammal												5		5
Mammalia (small-medium)	Small-medium mammal		3						1						4
Mammalia (medium)	Medium mammal				1		2				1				4
Mammalia (medium-large)	Medium-large mammal		4		20		28						2		54
Mammalia (large)	Large mammal				1										1
Didelphis virginiana	Opossum	1	1	1	1	1	8	2	5			1	1	6	16
Sylvilagus sp.	Rabbit	1	4			3	27	1	6	1	7	1	1	7	45
Cricetidae	Mouse/rat									1	1			1	1
Neotoma floridana	Eastern wood rat					1	1							1	1
Sigmodon hispidus	Hispid cotton rat					1	2							1	2
Mephitis mephitis	Striped skunk	1	1											1	1
Procyon lotor	Raccoon	1	2	1	2			1	2			1	1	4	7
Puma concolor	Panther					1	1							1	1
Odocoileus virginianus	White-tailed deer	2	31	2	59	2	244	6	105	2	140	3	90	17	669
Delphinidae	Dolphin					1	1	1	1					2	2
Total		105	2,743	137	3,714	261	7,901	184	4,202	135	3,918	131	2,763	953	25,241

drum, flounder, pinfish, and gar contribute between 1.5% and 3.0% each. Bowfin, Gulf sturgeon, ladyfish, toadfish, pigfish, freshwater catfish, and largemouth bass each occur as more than a trace. The bones of sharks and rays are few but occur in nearly all pits.

Turtles and tortoises make up just over 10% of the total MNI, most of which are sea turtles ($n = 37$), mud turtles ($n = 25$), and box turtles ($n = 11$). Snapping turtles, pond turtles, and gopher tortoises are represented by six individuals each, and diamondback terrapin and softshell turtle each by two. Snakes are represented in all pits in trace frequencies.

Birds account for about 6.6% of all MNI. Well over half of the 63 birds identified are white ibis ($n = 39$), at least two-thirds of which are juveniles, providing our most precise measure of season of capture (see below). The only other avian taxa to occur as more than a trace are ducks ($n = 5$), pied-billed grebes ($n = 4$), and blue herons ($n = 5$), the latter of which are all juveniles. Loon, horned grebe, double-crested cormorant, yellow-crowned night heron, spoonbill, herring gull, turkey, and crow are each represented by a single individual, most by only a single element.

All pits contain the bones of white-tailed deer. We count at least 17 individuals among the 669 elements and note that some, maybe most, were young. Rabbit ($n = 7$), opossum ($n = 6$), and raccoon ($n = 4$) occur across most pits in low but appreciable frequencies. Single elements of panther, skunk, wood rat, and cotton rat round out the modest inventory of terrestrial mammals, and we count two dolphins by single elements in each of two pits.

In sum, vertebrate bone from Shell Mound is dominated by mullet but also includes appreciable numbers of other saltwater fish taxa, as well as sea turtles, mud turtles, juvenile white ibises, and white-tailed deer. The condition of bone recovered from the pits is uniformly excellent. Traces of gnawing or weathering are scarce, as is the incidence of burning. Bone from accretional midden at Shell Mound is not always so well preserved, owing presumably to prolonged surface exposure or redeposition. In contrast, the infilling of pits with bone and other materials must have been relatively quick.

Comparing Pit Assemblages

The contents of large pits at Shell Mound are not identical, but they are very similar. With minor exceptions, the proportions of taxa across general categories vary by only a few percentage points from aggregate values (Table 2). Across pit assemblages, ray-finned fish consistently constitute ~76% of MNI; reptiles (turtles/tortoises), ~11%; birds, ~7%; mammals, ~4%; and cartilaginous fish, ~2%. Again, all assemblages contain abundant mullet bone, accounting for 25.6% (Feature 35) to 42.5% (Feature 25) of all vertebrate taxa by MNI. The average percentage of mullet across pits, 34.8%, has the least amount of variance of any taxon. As might be expected, taxa of low frequency show the greatest variation across features, but those with at least 10 individuals collectively express limited variance across features. Shown in Figure 5 are the relative frequencies of taxa by MNI that meet this criterion, less mullet, which strongly diminish the relative values of all other taxa. This subset of 467 individuals across 14 taxa makes up 49.0% of all MNI. Individuals of each of these taxa, like mullet, are represented by bone in each of the pits and generally in like proportions. Individuals of seven of the taxa (crevalle jack, sheepshead, red drum, sea trout, hardhead catfish, white ibis, sea turtle) account for ~8%–15% each of the MNI of this subset. Notable exceptions include the higher fraction of jack in Feature 35, the spikes in sea trout in Features 46 and 34, and the diminished fraction of white ibis in Feature 39. Another four taxa (mud turtles, black drum, flounder, white-tailed deer) each contribute ~4%–5% of the MNI per pit, with a few exceptions (e.g., spikes in back drum and white-tailed deer in Feature 39). The final three taxa of this subset (gar, pinfish, box turtle) each account for another ~2%–3% of MNI. Minor variations notwithstanding, vertebrate taxa from Shell Mound pits are consistent in type and relative frequency.

Values for the diversity and equitability of taxa are also comparable across pit assemblages (Table 2). Diversity values for all MNI are relatively high, ranging from 2.57 to 2.83 across taxa totaling from 29 to 50 per pit. Owing to the high frequencies of mullet, equitability

Table 2. Absolute and Relative Frequencies of Minimum Number of Individuals (MNI) and Number of Individual Specimens (NISP) of Vertebrate Faunal Remains >¼ Inch by Feature and General Taxon, Shell Mound (8LV42).

		F.46		F.35		F.25		F.39		F.44		F.34		Total	
Taxon	Common Name	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP
Absolute Frequency															
Vertebrata	Unidentified vertebrate		184		158		150		116		114		107		829
Condrichthyes	Cartilaginous fish	1	1	2	4	5	13	4	9	1	1	2	4	15	32
Actinopterygii	Ray-finned fish	78	2,117	103	3,017	203	6,520	144	3,434	100	3,043	100	2,245	728	20,376
Amphibia	Amphibian	1	1	1	1							2	4	4	6
Reptilia	Reptile	12	320	16	360	24	659	19	504	17	478	14	286	102	2,607
Aves	Bird	7	74	11	90	19	245	6	19	13	133	7	17	63	578
Mammalia	Mammal	6	46	4	84	10	314	11	120	4	149	6	100	41	813
Total		105	2,743	137	3,714	261	7,901	184	4,202	135	3,918	131	2,763	953	25,241
Relative Frequency															
Vertebrata	Unidentified vertebrate		6.71		4.25		1.90		2.76		2.91		3.87		3.28
Condrichthyes	Cartilaginous fish	0.95	0.04	1.46	0.11	1.92	0.16	2.17	0.21	0.74	0.03	1.53	0.14	1.57	0.13
Actinopterygii	Ray-finned fish	74.29	77.18	75.18	81.23	77.78	82.52	78.26	81.72	74.07	77.67	76.34	81.25	76.39	80.73
Amphibia	Amphibian	0.95	0.04	0.73	0.03							1.53	0.14	0.42	0.02
Reptilia	Reptile	11.43	11.67	11.68	9.69	9.20	8.34	10.33	11.99	12.59	12.20	10.69	10.35	10.70	10.33
Aves	Bird	6.67	2.70	8.03	2.42	7.28	3.10	3.26	0.45	9.63	3.39	5.34	0.62	6.61	2.29
Mammalia	Mammal	5.71	1.68	2.92	2.26	3.83	3.97	5.98	2.86	2.96	3.80	4.58	3.62	4.30	3.22
Total		100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Number of taxa (MNI)		29		35		50		40		31		37		71	
Diversity[a]		2.74		2.80		2.63		2.64		2.57		2.83		2.84	
Equitability[b]		0.81		0.78		0.67		0.72		0.75		0.78		0.67	

Note: Diversity and equitability values calculated with absolute frequencies of MNI.
[a] Calculated using the Shannon-Weaver function (Reitz and Wing 1999:105).
[b] Calculated as the Shannon-Weaver function/log of total number of taxa (Reitz and Wing 1999:105).

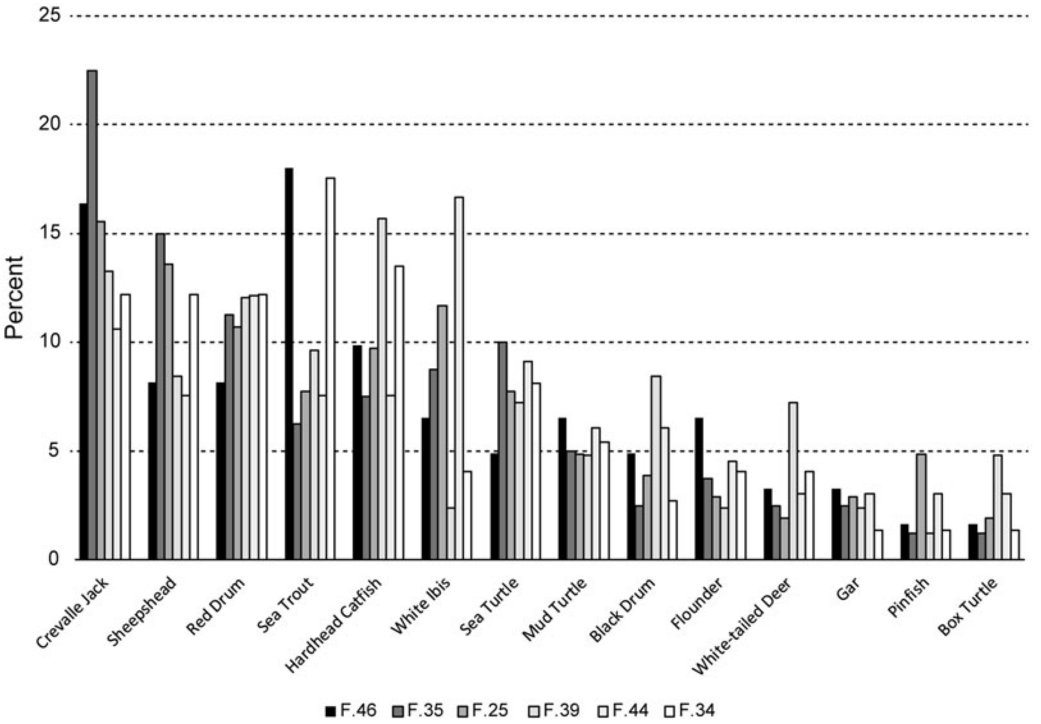


Figure 5. Relative frequency of minimum number of individuals (MNI) of major taxa (>10 MNI), excluding mullet, in six pit features, Shell Mound (8LV42), ¼-inch fraction. Combined MNI (*n* = 467) by taxa: jack (*n* = 71), sheepshead (*n* = 52), red drum (*n* = 52), sea trout (*n* = 50), hardhead catfish (*n* = 50), white ibis (*n* = 39), sea turtle (*n* = 37), mud turtle (*n* = 25), black drum (*n* = 22), flounder (*n* = 18), white-tailed deer (*n* = 17), gar (*n* = 12), pinfish (*n* = 11), and box turtle (*n* = 11).

values are moderate, ranging from 0.67 to 0.81. Limited variation in these values across pits is consistent with the frequency data we just reviewed and stands in contrast with values for nonfeature midden assemblages we review below after considering the seasonality of pits.

Inferring Season of Capture/Deposition

Among the avian remains in each of the six pits in our sample are the bones of a species with an unusually specific indicator of season of capture. The bones of at least two and as many as 12 white ibises (*Eudocimus albus*) per pit are dominated by elements whose immature level of development indicates capture in early summer. Details of this evidence are presented by Goodwin (2017; Goodwin et al. 2019), who also delves into the symbolic import of birds and bird imagery in the cultural milieu of Middle Woodland rituality. Without repeating these details, it bears mentioning that the strength of this inference is predicated on a longitudinal study of the breeding ecology of white ibises in an offshore rookery 12 km from Shell Mound (Rudegeair 1975). Although we cannot be certain that this or another offshore rookery was the locus of juvenile white ibis capture at the time of Shell Mound feasts, we are certain that they were taken in the summer, more specifically, mid- to late June.

Other taxa in Shell Mound pits lend support to the timing of ibis capture. Regarding the fish we note the usual frustration of ascribing season of capture to any Gulf Coastal fish because members of each species can be taken any time of the year, if not also in the same location. However, there are notable exceptions to this tendency, and when we consider data on seasonal variation in capture rates as well as allometry, support for the inference of summer capture abounds.

With respect to variation in capture rates, data from the long-standing Florida Fish and Wildlife

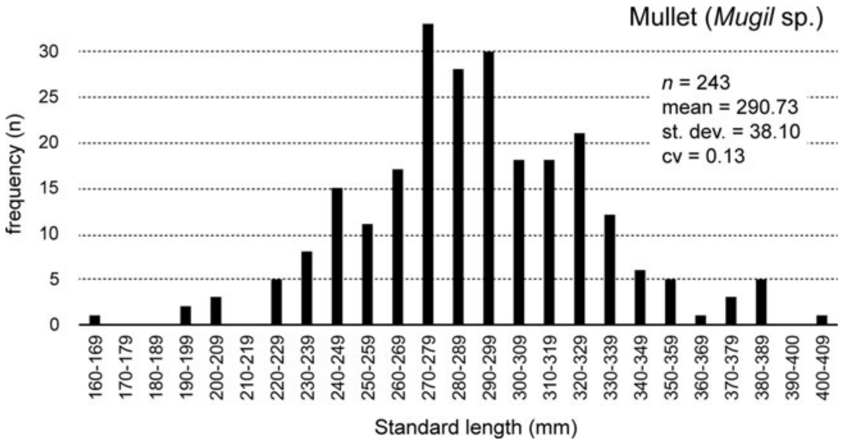


Figure 6. Absolute frequency distribution of mullet by estimated standard length (mm) from six pit features at Shell Mound (8LV42; *n* = 243).

(FWC) fish collection program provide some basis for comparisons across seasons (FWC 2016). Data used by Palmiotto (2016) to construct "effective seasons" include seine net captures from 1996 to 2012 across thousands of randomly selected sample sites in the greater vicinity of Shell Mound. Collection trips over this span averaged about six per month, with eight sampling locations per trip. More than 430,000 fish were captured on these trips, each identified to taxon and size.

In her analysis of monthly capture data from FWC, Palmiotto (2015, 2016) concludes that effective seasons must take into account annual variations in both temperature and precipitation. She infers from these data four seasons: (1) the warm-dry season of April through May, (2) the warm-wet season of June through September, (3) the cool-dry season of October through January, and (4) the cool-wet season of February through March.

With reference to these effective seasons, six of the eight high-frequency fish taxa found in Shell Mound pits were taken at the greatest frequencies during the warm-wet season. The exceptions are mullet and red drum. Given the high frequency of mullet in Shell Mound pits, the FWC data would seem to undermine the inference of capture around June. To the contrary, allometric data on mullet from Shell Mound pits support summer timing (Mahar 2019). An estimate of standard length for a combined 243 mullet from all six pits (31–51 per pit) averages 290.73 mm, with a standard deviation of 38.10 mm (Figure 6). The low variance (cv = 0.13) of this population points to same-age capture. As Palmiotto (2015:78) notes from FWC data, mullet express the least variation in size during the warm-wet season. Striped mullet that are 300 mm in length are roughly three years of age, just reaching sexually maturity and on the verge of their first offshore spawning run in the fall (Florida Museum of Natural History 2019). It stands to reason that same-age capture of this size fish targeted nearshore schools as they were fattening up during the summer.

In contrast to mullet, which vary most in size during cool months, jack vary most in size during warm months. Allometric data on jack from the pits tend to support this expectation: jack in pits express more size variation than mullet (Mahar 2019:232, 298). Sea turtles can also be taken year-round, but they are concentrated in the nesting season of summer, which begins in May. The beaches of offshore islands are nesting sites today.

On balance, multiple lines of evidence point to a warm-wet season of deposition for the fill of large pits at Shell Mound. Given the timing afforded by the immature bones of juvenile white ibises, these activities likely took place in mid- to late June, the time of summer solstice. Before turning to the infrastructure and practices that supported summer solstice feasts, a comparison of pit assemblages with those of accretional

Table 3. Absolute Frequency of the Minimum Number of Individuals (MNI) and Number of Individual Specimens (NISP) of Vertebrate Taxa in Accretional Midden at Shell Mound (8LV42).

		TU1 Upper		TU1 Lower		TU9 Upper		TU9 Lower		Total	
Taxon	Common Name	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP
Vertebrata	Vertebrate		101		81		166		48		396
Euselachii	Shark					1	5	1	17	2	22
Carcharhinidae	Requiem shark	1	1							1	1
Rajiformes	Ray		28	2	11		18		1	2	58
Rhinoptera bonasus	Cow-nosed ray	1	1			1	1			2	2
Actinopterygii	Ray-finned fish		1,836		217		599		266	0	2,918
Acipenser oxyrinchus desotoi	Gulf sturgeon	1	23					1	2	2	25
Lepisosteus sp.	Gar	1	3	1	8			2	4	4	15
Elops saurus	Ladyfish	4	5	1	1	1	1			6	7
Clupeidae	Shad/herring	1	1			1	1			2	2
Siluriformes	Catfish	1	4						1	1	5
Ictaluridae	Freshwater catfish	1	1			2	2			3	3
Ariidae	Sea catfish		34		9		70	1	18	1	131
Ariopsis felis	Hardhead catfish	7	124	3	12	11	164	4	21	25	321
Bagre marinus	Gaff-topsail catfish	2	7	1	2	1	7	1	1	5	17
Opsanus sp.	Toadfish	3	12			1	1			4	13
Belonidae	Trumpet fish	1	1							1	1
Epinephalus sp.	Grouper	1	1							1	1
Micropterus salmoides	Largemouth bass	1	1							1	1
Rachycentron canadum	Cobia	1	2							1	2
Carangidae	Jack		468		36		176		70		750
Caranx sp.	Crevalle jack	44	574	6	20	9	63	10	42	69	699
Caranx crysos	Blue runner	2	2					1	2	3	4
Orthopristis chrysoptera	Pigfish	2	13	1	1	1	1		1	4	16
Sparidae	Porgies		2		2						4
Archosargus probatocephalus	Sheepshead	7	30	2	12	12	129	7	54	28	225
Calamus sp.	Porgy	1	2	1	1			1	1	3	4
Lagodon rhomboides	Pinfish			1	1	1	1			2	2
Scaienidae	Drum		57		4		20		8	0	89
Cynoscion sp.	Sea trout	13	104	2	4	10	26	4	13	29	147
Leiostomus xanthurus	Spot					2	5	1	1	3	6
Micropogonias undulatus	Atlantic croaker			1	1	2	4	1	1	4	6
Pogonias cromis	Black drum	2	44	2	13	5	75	2	13	11	145
Sciaenops ocellatus	Red drum	12	77	3	8	8	47	7	24	30	156
Mugil sp.	Mullet	46	1,046	6	51	13	105	10	68	75	1,270
Paralichthys sp.	Flounder	4	28	1	3	2	25	3	9	10	65
Chilomycterus sp.	Burrfish	4	12	4	8	2	3			10	23
Testudines	Turtle		35		17		198		67		317
Chelydra serpentina	Snapping turtle	1	3			1	24	1	13	3	40
Kinosternidae	Mud/musk turtle			1	4	1	1			2	5
Kinosternon sp.	Mud turtle	3	28	1	4	1	14	1	11	6	57
Emydidae	Pond turtle/box turtle/ terrapin	2	7				13	1	9	3	29
Malaclemys terrapin	Diamondback terrapin			1	1	2	2			3	3
Pseudemys sp.	Pond turtle	2	6	2	9	2	70	2	24	8	109
Terrepene carolina	Box turtle	1	2	1	10	1	4	2	2	5	18
Gopherus polyphemus	Gopher tortoise	1	12					1	3	2	15
Cheloniidae	Sea turtle	2	9	1	1			1	6	4	16
Serpentes	Snake			1	1		2			1	3

Table 3. Continued.

Taxon	Common Name	TU1 Upper		TU1 Lower		TU9 Upper		TU9 Lower		Total	
		MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI	NISP
Colubridae	Nonvenomous snake					1	2	1	2	2	4
Alligator mississippiensis	Alligator	1	1							1	1
Aves (small)	Small bird		2								2
Aves (small-medium)	Small-medium bird					1	1			1	1
Aves (medium)	Medium bird		2		1		4	2	3	2	10
Aves (medium-large)	Medium-large bird	1	2			1	3			2	5
Aves (large)	Large bird	1	1						2	1	3
Podilymbus podiceps	Pied-billed grebe	1	1							1	1
Phalacrocorax auritus	Double-crested cormorant	1	2	1	8			1	1	3	11
Ardea herodias	Blue heron							1	1	1	1
Eudocimus albus	White ibis	6	50	1	2	3	8	1	1	11	61
Anatidae	Duck	1	1							1	1
Mammalia	Mammal		2								2
Mammalia (small)	Small mammal						2				2
Mammalia (small-medium)	Small-medium mammal								2		2
Mammalia (medium)	Medium mammal						4		2		6
Mammalia (medium-large)	Medium-large mammal				14		4		3		21
Mammalia (large)	Large mammal				23		1		15		39
Didelphis virginiana	Opossum	1	4	1	2	1	2	1	3	4	11
Sylvilagus sp.	Rabbit	1	1			1	1	1	1	3	3
Procyon lotor	Raccoon	1	2	1	1	1	9			3	12
Odocoileus virginianus	White-tailed deer	1	5	2	9	3	78	2	17	8	109
Delphinidae	Dolphin	1	1		2	1	1	1	10	3	14
Total		193	4,824	52	615	107	2,163	77	884	429	8,486

midden at Shell Mound corroborates the seasonal specificity of pit fill.

Vertebrate Faunal Remains in Accretional Midden

Most of the anthropogenic deposits at Shell Mound consist of accretional midden that accumulated along the top of the relict dune arm and its margins. Much of the south ridge and some of the north ridge consist of redeposited fill, including former pit fill. Beneath redeposited fill on top of the dune arm and along the south ridge are autochthonous midden deposits. Testing in several locations of accretional midden resulted in the recovery of vertebrate faunal remains that can be compared with those of the pit assemblages. Such comparisons serve more than simply to corroborate that pits contain the fill of summer solstice feasts. If Shell Mound was a civic-ceremonial center that supported a resident population, as well as ritual gatherings, then we ought to be able to locate deposits that were emplaced during times other than mid- to late June.

Two test units—one each on the north and south outer ridges of Shell Mound—provide provisional evidence for cool-season procurement and deposition (Table 3). Test Units 1 and 9 exposed well-stratified oyster midden with abundant vertebrate fauna. The lower macro-unit of Test Unit 1 and both macro-units of Test Unit 9 are coeval with pit activity at Shell Mound. The upper macro-unit of Test Unit 1 consists of redeposited fill, a pattern repeated at other locations on the south ridge. For the observations that follow, this redeposited fill is exempted and we refer to the nonpit, accretional deposition simply as "midden."

The most marked difference between pit and midden vertebrate fauna is the diminished frequency of mullet in the latter. Mullet constitutes only about 11% of MNI in midden contexts. Jack make up another 9%–12% of MNI,

Figure 7. Rim portions and profile drawings of large cooking vessels from pit features at Shell Mound (8LV42).

comparable to pits, and are typically larger in midden fill. Other fish taxa in midden deviate between the two units in ways not seen in the pit fill. Sea trout, hardhead catfish, and sheepshead are twice as common in Test Unit 9 as in Test Unit 1. Collectively these taxa occur at about twice the frequency observed in pits. Black drum, red drum, and white-tailed deer are all proportionately more common in midden than in pits. White ibis occur in all midden contexts but at considerably lower frequency than in pits; some of the individuals in midden are juvenile. Remarkably, sea

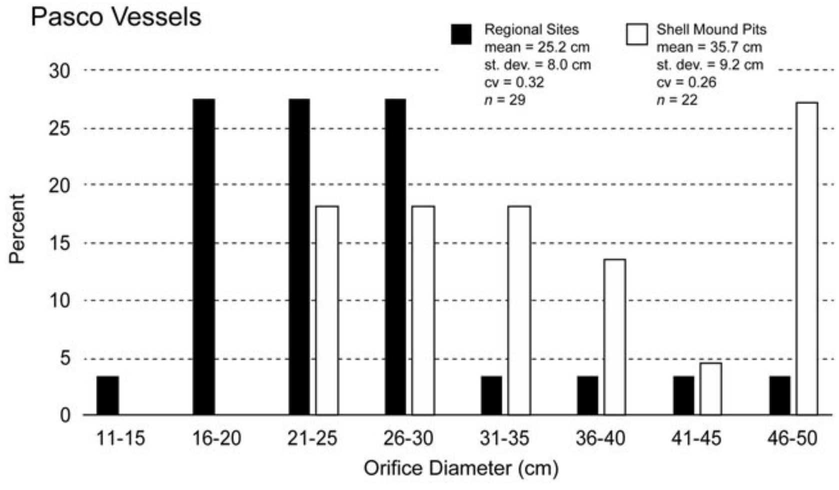


Figure 8. Comparison of the frequency distributions of the orifice diameters of limestone-tempered Pasco vessels from pits at Shell Mound (8LV42) and from other sites in the region.

turtle is completely absent from midden in Test Unit 9, and mud turtles appear as only a trace. Two fish species that are rare or absent in pits, Atlantic croaker and burrfish, are represented by several individuals in midden.

Overall, midden vertebrate assemblages are more diverse (3.07–3.21) and considerably more equitable (0.86–0.94) than those from pits. Subtle but meaningful trends in fish taxa suggest that midden includes cool-weather deposits (e.g., bones of spot; Palmiotto 2015:274). More cautiously, we suggest that the midden assemblages analyzed to date are not as season-specific as the pit assemblages and thus reflect activities aside from summer solstice events.

Technology of Feasts

Beyond the bony remains of pits are a variety of material residues of technologies and practices geared toward the ritual intensification of summer solstice feasts and other interventions to enhance production. In the sections that follow we briefly review evidence for (1) the pottery technology of feasts, (2) a tidal fish trap for harvesting mullet and other fish, and (3) the management of oysters.

Pottery

All contexts at Shell Mound contain sherds of pottery, and the vast majority of these are from limestone-tempered vessels of the Pasco tradition (Goggin 1948). Widespread along the northern Gulf Coast, Pasco pottery dates as early as 200 BC and continued to be used until at least AD 700. Vessels of this tradition vary from open bowls to tall jars, and they are predominately plain. The distinguishing feature of Pasco ware is its limestone temper, an abundant substance in the region.

Sherds of Pasco pottery from pits are distinguished from sherds in other contexts by their larger-than-average size and by surfaces indicative of expedient manufacture (Figure 7). Pits tend to contain larger sherds than accretional midden for taphonomic reasons alone, but many sherds from pits are from unusually large vessels. Shown in Figure 8 is the frequency distribution of all Pasco vessels for which rim portions are large enough to estimate orifice diameter. This sample of 22 vessels has an average orifice diameter of 35.7 cm and a modal tendency of 46–50 cm. Although we do not have comparable data on the height of these vessels, the largest shown in Figure 7 is estimated to be at least 40 cm tall.

There are few large rim portions from accretional midden to compare against those from pits. However, a sample of 29 large Pasco rim sherds from surface collections of sites in the vicinity of Shell Mound is characterized by a mean orifice diameter of only 25.2 cm and a modal range of 16–30 cm (O'Donoughue

Figure 9. Rim portions, profile drawings, and orifice plan drawings (gray) of four serving vessels from pits at Shell Mound (8LV42).

2009). Despite the small samples, Pasco vessels represented by sherds in pits have orifices that are more than 10 cm on average larger than the general population of Pasco vessels (Figure 8). Several of those from Shell Mound pits bear traces of soot on exterior surfaces, direct evidence for use over open fire. These were thus large cooking vessels, the largest capable of holding more than 50 L. Although cooking large quantities of food may not have conferred social advantage in the context of communal feasting (cf. Blitz 1993), big pots evidently served the needs of big events (see Kassabaum 2014 for another example of large vessels produced for communal feasts).

Further details on the condition of Pasco sherds from pits suggest that the production of large cooking vessels was expedient, evidently for the express purpose of feasting events. Pasco pottery in general is not refined, but some of the large vessels from feasting pits are especially unrefined. Exterior surfaces tend to be only roughly smoothed, with some so weakly smoothed that joints between coils are exposed. Despite the vulnerability of uneven surfaces to thermal shock, these unrefined vessels clearly were drafted into thermal uses. We infer from this that large vessels in pits were not intended to last long. One, in fact, has a radial impact fracture in its sidewall and possibly was deliberately "killed" before being deposited in a pit (Figure 7, Vessel 1). Cooking vessels appear to have been made, used, and discarded in the span of single feasting events.

Serving vessels tell a different story (Figure 9). Although they are infrequent, the sherds of small bowls from pits tend to be either spicule- or sand-tempered. They are also well crafted and occasionally eccentric in design. At least one of the spicule-tempered bowls was painted or slipped with a red substance, a characteristic of the Dunns Creek Red type common to northeast Florida. Whereas this example might imply that feasts at Shell Mound were attended by visitors from afar, a recent provenance study of spicule-tempered pottery in Florida points to predominately local manufacture, even on the Gulf Coast (Bloch et al. 2019). Nonetheless, serving vessels in Shell Mound pits

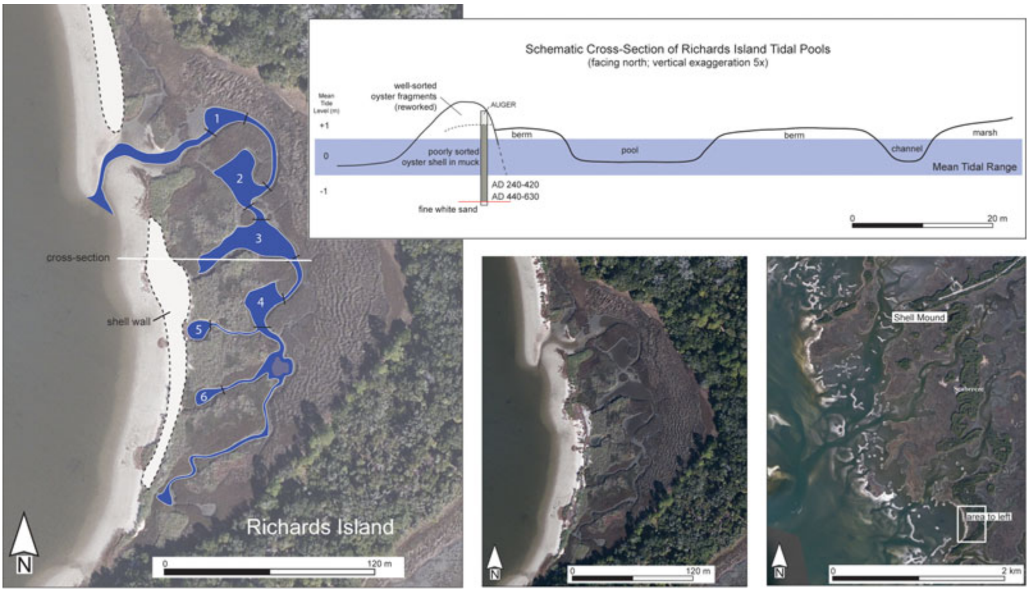


Figure 10. Tidal pools and shell seawall of Richards Island (left), with inset of schematic cross section (upper right) of these features, and Google Earth image of the greater vicinity (bottom right), showing the location of Shell Mound.

deviate from cooking vessels not only in form and function but also in paste, manufacture, and surface treatment. Even if not from far away, serving vessels in feasting pits likely include examples that were carried to Shell Mound by guests.

Tidal Fish Trap

Whether or not they were cooked in pots, mullet were captured, brought to Shell Mound, and deposited in pits in large quantities. With a projected population of 675 pits and an average of 53.3 mullet per pit, an estimated 37,328 mullet were harvested and deposited over a 250-year period. If events were annual, this comes to a modest 149 mullet per event, but it is much more likely that the actual rate of capture fluctuated from year to year. A fish trap south of Shell Mound gives us reason to assume that harvests were at least occasionally quite large.

Before modern prohibitions on the use of certain mass capture technologies (i.e., gill nets; Anderson 2002), commercial mullet fisherfolk targeted schools heading out to the Gulf of Mexico to spawn. This was a fall activity, when schools in the thousands were harvested with nets stretched across the outlet of the Suwannee River. Today recreational and subsistence fishing for mullet involves the use of cast nets or small beach seine nets, which are deployed year-round with a bag limit of 50 per person (FWC 2019). Nearshore locations are often productive, although schools are much more dispersed during the summer, when they are feeding on zooplankton, algae, plant detritus, and other small marine resources before the fall spawning runs.

Like those of the fall, summer harvests of mullet in large quantities would have benefited from, perhaps required, some means of mass capture (Mahar 2019). Large seine nets are one possibility, but we suspect that a series of tidal pools 2 km south of Shell Mound were used as a tidal fish trap (Figure 10). Enclosing these pools are two seawalls consisting mostly of oyster shell. The upper stratum of these walls consists of reworked shell "hash," the result of repeated tidal surge. To the extent the walls consisted entirely of shell hash, they are not likely to have involved human engineering, although the outcome would have been beneficial for trapping fish that entered the pools at high tide. However, below about 60 cm of shell hash is a 2+ m thick mantle of poorly sorted oyster shell in muck. Our preliminary assessment is that this mantle was emplaced deliberately to create the seawall and hence the fish trap (Sassaman et al. 2019). We have no information on the source of the shell and muck, but two radiometric dates on oyster shell from the base of the mantle correspond to the time of feasting activities at Shell Mound, and they are in reverse order, which is a common pattern of terraforming with extant midden (Randall and Sassaman 2017). Moreover, an ephemeral midden on a hammock to the immediate north of the tidal pools returned a calibrated two-sigma AMS age estimate of AD 550–650 (Sassaman et al. 2019:Appendix B).

In the near future we plan to conduct more testing at the Richards Island tidal pool complex, as well as acquire high-resolution lidar data to more accurately characterize the morphology of the seawalls, the pools, and the berms that separate them. For now we can only hypothesize how this probable trap was used. Although it resembles the technology of tidal traps in coastal South Africa (Avery 1975), the current tidal range in the Lower Suwannee area (<1 m) is insufficient to breach the seawall. It is more likely that water and fish entered the pools via the opening seen today and then were trapped by a net or gate that prevented fish from escaping as the tide receded. Recalling the size and age of mullet in Shell Mound pits, schools of three-year-old mullet would have frequented the nearshore waters of the area to fatten up before moving toward the Suwannee Delta and the Gulf in the fall. Of course, smaller and larger fish would have entered the pools too, but the size of fish harvested would have been constrained by the gauge of netting or fencing that was used at the tidal outlet.

Oyster Mariculture

Oyster shell is by far the most numerous animal remains at Shell Mound, even if it does not constitute much of the fill of large pits. As described earlier, shell accumulated on the top and side slopes of the dune ridge and in primary and secondary deposits of the arcuate ridge. Extrapolating the density of shell in bulk samples of accretional midden, Shell Mound contains an estimated 1.2 billion oyster shells (Sassaman et al. 2019). We have no basis for arguing that oysters were harvested in large quantities for summer solstice feasts, but clearly they factored significantly in the subsistence of year-round residents, and they were the chief substance of terraforming. Historically, the Lower Suwannee region was an exceptional oyster habitat, notable for subtidal reefs that were both the product of and precedent for estuarine conditions (Berquist et al. 2006; Seavey et al. 2011). Since 4,500 years ago, when reefs now in need of restoration took shape, the productivity of oyster (and the fisheries they support) could have been enhanced, or at least sustained, with nominal human intervention.

Evidence for oyster mariculture during the occupation of Shell Mound is described elsewhere (Jenkins 2017) and need not be repeated here in detail. In short, shells from subtidal reefs in certain contexts bear evidence for culling, and the deposits in which these shells are concentrated are dominated by left valves. Right valves presumably were left at or returned to reefs to encourage growth. This amounts to indirect evidence for culling and shelling, two common maricultural practices of the modern era (Jenkins 2016; US National Research Council 1992:29). Shells bearing this evidence were recovered from a 50 cm thick stratum near the apex of Shell Mound dating from ∼AD 550–650. Arguably, this stratum accumulated quickly, as it consists of little other than shell. Similar "clean shell" strata at Late Archaic shell rings of the Atlantic coast have been interpreted as evidence for feasting (e.g., Russo 2004; Saunders 2017; Thompson and Andrus 2011). Against the ambient collection of intertidal oysters at Shell Mound—proximate to the site and ubiquitous in most depositional contexts—the collection of cultured oysters was likely more eventful. We have yet to collect data on the seasonality of the mass deposition of oyster shell at Shell Mound, but judging from isotopic results from shells of a later civic-ceremonial center to the south (Roberts Island), winter is likely (Lulewicz et al. 2018).

If collected and deposited in winter, cultured oyster shells are not expected to have accumulated in the pits of summer feasts, but we must bear in mind that shell was often mounded and thus dissociated from coeval counterparts of bone and other matter. Timing of events aside, oyster mariculture likely sustained or even enhanced the health and productivity of subtidal reefs. In comparing the sizes of shells from early and later contexts Jenkins (2016, 2017) finds no evidence for resource depression but rather an increase in height and height-to-length ratio of shell over time.

Discussion

To summarize, large pits dug into the relict dune arm of Shell Mound contain vertebrate fauna remains indicative of large-scale feasts that took place around the time of summer solstices. Harvested in mass, mullet were the mainstay of solstice feasts, accompanied by other fish, sea turtles, juvenile ibises, and deer, among other resources. Accretional midden at Shell Mound contains most of the same taxa as pits, but with much less emphasis on mullet and indicators for subsistence activities throughout the year. We imagine that the events materialized in the fill of large pits punctuated the otherwise everyday activities of Shell Mound residents. The scale of food harvesting and processing suggests that nonresidents regularly gathered at Shell Mound for these annual events (Supplemental Text 5).

Attention to the cosmological rationale for the ritual economy of Shell Mound turns our focus away from the ecological capacity of the place to sustain gatherings and toward the larger time-space context of feasting events. In this regard, we come to understand why feasts were held at Shell Mound and why they were timed to the summer solstice. It is not because this place and this time were more abundant with food than any other place and time (cf. Weissner 2001:117). Indeed, if mullet were needed in quantity, the fall spawning runs would have been targeted, and if gatherings were sited proximate to places where juvenile birds, marine turtles, and large fish were most abundant, they would have taken place on the offshore islands.

The deeper history and regional context of Shell Mound point to a cosmological significance that overshadowed ecological constraints. As outlined earlier, a history of shoreline retreat going back millennia contributed to a horizontal temporality (sensu Herva and Ylimaunu 2014) that was experienced in repeated abandonment and resettlement but also indexed to solar cycles. Because the most prominent landforms of the region were parabolic dunes with solstitial orientations, it may have been inevitable that dune arms would garner attention as materialized solar standstills. At the intersection of sky and earth, these features were likely regarded as portals between realms of the cosmos, basically a tripartite scheme of Upper, Middle, and Lower Worlds (Hudson 1976:122–128). Ensuring that these worlds remain in balance through a cycle of rejuvenation is the work of world-renewal ceremonialism. As discussed earlier, Knight (2001) argues convincingly that communal feasting at civic-ceremonial centers of the Woodland Southeast was a matter of rejuvenation. Although the timing of such feasts eludes detection in most cases, Knight draws a comparison with the Green Corn ceremonies of ethnohistory, communal summer events even for societies with histories of social inequality.

Beyond the parallel between Green Corn ceremonialism and communal feasts of the Woodland period, there may be another reason that summer solstice was the time of world renewal. Because summer solstice is the longest day of the year, the ensuing six months of increasingly shorter days would not appear to be a trend toward renewal. However, the Lower World of the cosmos was, among many things, the realm of future time (Hudson 1976:127–128). Increasingly longer nights and shorter days meant that the sun spent more time each day in the Lower World. As water was associated with the Lower World in ethnohistoric accounts of the native Southeast (Hudson 1976:122–128), the long-term encroachment of water over land lent a horizontal quality to the cyclical process of world renewal.

Shell Mound is unlike any other civic-ceremonial center in the region in form, and now it stands alone as the only place providing evidence for summer events (Supplemental Text 6). Roughly coeval civic-ceremonial centers to the north and south of Shell Mound provide evidence for winter events of extradomestic scope, such as mounding (Lulewicz et al. 2018; Neill J. Wallis, personal communication 2019). Rather than seeing these as incomparable data points, we think it is worth considering that all such centers were parts of a constellation of ritual involving the synchronized movement of persons and things (e.g., Bernardini 2004; Howey and O'Shea 2006; Pauketat 2013; Pauketat et al. 2017). A circuit of movement separating rituals of the winter and summer solstices in place comports with a distinction between mortuary (winter) and world-renewal (summer) ceremonialism (e.g., Hall 1997; Knight 2001). It may also explain the geographic displacement of mortuary pottery that is well documented by geochemical sourcing (e.g., Wallis et al. 2016).

This brings us to one final observation. The six pits of our current sample span a 250-year period and thus signal in their relative consistency an enduring practice of summer solstice feasting. To the extent that pit fill contains small fish and other resources that were taken in nearshore, intertidal waters, variations in these taxa over time may in fact register environmental changes that contributed to the abandonment of Shell Mound after AD 650. It is certainly reasonable to suggest that environmental change posed challenges to a tradition that required so much provisioning, but we suspect that the range of tolerance for change was wide. Thus, changes in the nearshore habitats of Shell Mound may have had little impact on the ritual economy of solstice feasts; people were willing and able to travel farther to provision feasts, to build infrastructure to increase production, and to manage oysters to sustain residency. Arguably a more impactful measure was changing spatial relationships between the dead and the living as shorelines retreated. The one overstep event that is well documented in the region resulted in the landward siting of civic-ceremonial centers to places already established as cemeteries (Pluckhahn and Thompson 2018; Wallis et al. 2015). Shell Mound is the exception in that it went upward, not inward, to the top of a dune arm with a cemetery to the west that was evidently cut off from the mainland by rising sea. It is worth considering that this event alone precipitated intense world-renewal ceremonialism on the landward dune arm (future Shell Mound) and the establishment of a new mortuary mound (Dennis Creek Mound, to the northeast) as active interments and caching ceased in the now water-encased cemetery. Likewise, an apparent drop in sea level between about circa AD 600 and 850 (Sassaman et al. 2017) may have reconnected Palmetto Mound to the dune arm and been the impetus for the abandonment of Shell Mound at circa AD 650. Notably, mortuary activity at Palmetto Mound intensified in the centuries following abandonment (Donop 2017).

Conclusion

Shell Mound illustrates how a ritual economy synced to solar cycles preconfigured the time and place of intensification. Place in this sense was not simply a matter of "persistence" but rather anticipated by its relational qualities in the cosmos, in this case its relationship to standstills of the sun. Places such as Poverty Point, Mound City, and the Great Houses of Chaco Canyon were sited where they were not because of intrinsic ecological potential but because of their connections to other times and places. Shell Mound never had the elaborate ritual architecture of these other places, or even the platform mounds of its counterparts in the Southeast, but it shared with places worldwide the materialization on earth of movements and events of the sky. Which astronomical events gather meaning through ritual practice in any particular place is a matter of history and culture. However, by virtue of the eventfulness of solstices, equinoxes, lunar standstills, and the like, the timing of ritual practices synced to astronomical cycles is preordained. At Shell Mound the ritual practices we can infer from archaeological remains were timed to summer solstices. It is not likely coincidental that summer solstice feasts took place on a parabolic dune oriented to the solstices or that the distal ends of dune arms in the area had been used to bury the dead for millennia. Both history and sacred geography predisposed Shell Mound for these events.

Summer solstice feasts at Shell Mound were relatively large events judging from the scale of the infrastructure and consumption involved. Insofar as the timing and siting of these events were a matter of cosmological precedent—as opposed to ecological or economic potential—proximate, nearshore food resources may not have been sufficient to provision these feasts. We do not know whether the procurement of offshore resources was a matter of necessity or preference, although we doubt that juvenile ibises were merely an abundant, albeit distant, food for feasting (Goodwin et al. 2019). No matter, the construction of a fish trap to harvest mullet at the time of year when they were the least abundant in nearshore locations underscores the economic demands of ritual whose timing and siting were not determined by abundance or the ease of resource collecting. In the systems-serving terms of Rappaport, summer solstice feasts served to reproduce a network of communities that were dispersed across the region. They traveled to Shell Mound routinely in the summer, as they likely did to other places of ritual events at other times of the year, some on the coast, some far to the interior. If the comparison with Green Corn ceremonialism bears relevance, summer solstice feasts were communal events of world renewal. For communities whose experience on the coast included shoreline retreat and other disruptive consequences of changing sea level, world-renewal rituality served to reproduce alliances with communities of lesser vulnerability, such as those of interior Florida. Irrespective of its practical value, the cosmic work of world renewal that synchronized movements of the sky and earth was not to be constrained by the ecological limitations of ritually charged times and places. As Rappaport came to understand, religion in non-Western societies is not the epiphenomenon of ecosystems but instead the rationale for negotiating relationships between people and environment through ritual practice.

Acknowledgments. Excavations at Shell Mound were conducted under Archaeological Resources Protection Act permits with the U.S. Fish and Wildlife Service. We thank Fish and Wildlife Service archaeologist Richard Kanaski and refuge managers Andrew Gude and Larry Woodward for their support of our efforts. Funding for this research was provided by the Hyatt and Cici Brown Endowment for Florida Archaeology, Department of Anthropology, University of Florida. Mahar's research was supported by National Science Foundation Doctoral Dissertation Improvement Grant 1764138. We thank Neill Wallis, Tim Pauketat, and three anonymous reviewers for comments on a draft of this article that helped to clarify important points and *American Antiquity* editor Lynn Gamble for guidance with our revision. We are grateful for the expert help of Miriam E. Domínguez in translating our abstract into Spanish.

Data Availability Statement. All archaeological materials from Shell Mound (8LV42) reported herein are curated at the Laboratory of Southeastern Archaeology, Department of Anthropology, University of Florida, at the behest of the U.S. Fish and Wildlife Service.

Supplemental Materials. For supplementary material accompanying this article, visit https://doi.org/10.1017/aaq.2019.68.

Supplemental Text 1. Astronomical alignments of parabolic dunes.

Supplemental Text 2. World-Renewal.

Supplemental Text 3. Overstepping events.

Supplemental Text 4. Depositonal history of pits.

Supplemental Text 5. Sampling for everyday subsistence.

Supplemental Text 6. Shell Mound as anomalous.

References Cited

Anderson, David K.
2002 Understanding the Impacts of the Florida Net Ban (Article X, Section 16 of the State Constitution). *Proceedings of the Gulf and Caribbean Fisheries Institute* 53:378–392.

Anderson, David G., and Kenneth E. Sassaman
2012 *Recent Developments in Southeastern Archaeology: From Colonization to Complexity*. SAA Press, Washington, DC.

Avery, Graham
1975 Discussion on the Age and Use of Tidal Fish-Traps (Visvywers). *South African Archaeological Bulletin* 30:105–113.

Bender, Barbara
1985 Emergent Tribal Formations in the American Midcontinent. *American Antiquity* 50:52–62.

Bernardini, Wesley
2004 Hopewell Geometric Earthworks: A Case Study in the Referential and Experiential Meaning of Monuments. *Journal of Anthropological Archaeology* 23:331–356.

Berquist, Derk C., Jason A. Hale, Patrick Baker, and Shirley M. Baker
2006 Development of Ecosystem Indicators for the Suwannee River Estuary: Oyster Reef Habitat Quality along a Salinity Gradient. *Estuaries and Coasts* 29:353–360.

Biersak, Aletta
1999 Introduction: From the "New Ecology" to the New Ecologies. *American Anthropologist* 10:5–18.

Blitz, John H.
1993 Big Pots for Big Shots: Feasting and Storage in a Mississippian Community. *American Antiquity* 58:80–96.

Bloch, Lindsey, Neill J. Wallis, George Kamenov, and John M. Jaeger
2019 Production Origins and Matrix Constituents of Spiculate Pottery in Florida, USA: Defining Ubiquitous St Johns Ware by LA-ICP-MS and XRD. *Journal of Archaeological Science: Reports* 24:313–323.

Boucher, Anthony
2017 Paths of the Past: An Off-Mound Survey of Shell Mound's (8LV42) Northeastern Peninsula. Master's thesis, Department of Anthropology, University of Florida, Gainesville.

Bronk Ramsey, Christopher
2017 OxCal 4.3.2. Electronic document, https://c14.arch.ox.ac.uk/oxcalhelp/hlp_contents.html, accessed October 3, 2018.

Bullen, Ripley P., and Edward M. Dolan
1960 Shell Mound, Levy County, Florida. *Florida Anthropologist* 13:17–23.
Claassen, Cheryl
2010 *Feasting with Shellfish in the Southern Ohio Valley: Archaic Sacred Sites and Rituals*. University of Tennessee Press, Knoxville.
Cobb, Charles R., and Keith D. Stephenson
2017 Cosmic Debt and Relational Consumption. In *Foreign Objects: Rethinking Indigenous Consumption in American Archaeology*, edited by Craig N. Cipolla, pp. 143–161. University of Arizona Press, Tucson.
DeBoer, Warren R.
2001 The Big Drink: Feast and Forum in the Upper Amazon. In *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power*, edited by Michael Dietler and Brian Hayden, pp. 215–239. Smithsonian Institution, Washington, DC.
Donop, Mark C.
2017 Bundled Ancestor: The Palmetto Mound (8LV2) on the Florida Gulf Coast. PhD dissertation, Department of Anthropology, University of Florida, Gainesville.
Florida Fish and Wildlife
2016 *Fisheries-Independent Monitoring Program Using Stratified-Random Sampling*. Vol. 2016. Florida Fish and Wildlife Conservation Commission, Tallahassee.
2019 Mullet. Electronic document, https://myfwc.com/fishing/saltwater/recreational/mullet/, accessed June 14, 2019.
Florida Museum of Natural History
2019 Striped Mullet. Electronic document, https://www.floridamuseum.ufl.edu/discover-fish/species-profiles/mugil-cephalus/, accessed June 30, 2019.
Friedman, Jonathan
1974 Marxism, Structuralism, and Vulgar Materialism. *Man* 9:444–469.
Gamble, Lynn H.
2017 Feasting, Ritual Practices, Social Memory, and Persistent Places: New Interpretations of Shell Mounds in Southern California. *American Antiquity* 82:427–451.
Goggin, John M.
1948 *Some Pottery Types from Central Florida*. Bulletin 1. Gainesville Anthropological Association, Gainesville, Florida.
Goodbred, Steven L., Albert C. Hine, and Eric E. Wright
1998 Sea-Level Change and Storm Surge Deposition in a Late Holocene Florida Salt Marsh. *Journal of Sedimentary Research* 68:240–252.
Goodwin, Joshua M.
2017 When the Ocean Meets the Sky: An Analysis of Avian Remains from a Civic-Ceremonial Center on the Florida Gulf Coast. Master's thesis, Department of Anthropology, University of Florida, Gainesville.
Goodwin, Joshua M., Kenneth E. Sassaman, Meggan E. Blessing, and David W. Steadman
2019 Birds of Summer Solstice: World-Renewal Rituality on the Northern Gulf Coast of Florida. *Cambridge Archaeological Journal*, in press.
Hall, Robert L.
1985 Medicine Wheels, Sun Circles, and the Magic of World Center Shrines. *Plains Anthropologist* 30:181–193.
Hall, Robert L.
1997 *An Archaeology of the Soul: North American Indian Belief and Ritual*. University of Illinois Press, Urbana.
Hardenberg, Roland
2016 The Study of Socio-cosmic Fields (Introduction). In *Approaching Ritual Economy: Socio-cosmic Fields in Globalized Contexts*, edited by Roland Hardenberg, pp. 7–36. CRC 1070, Tübingen, Germany.
Herva, Vesa-Pekka, and Timo Ylimaunu
2014 Coastal Cosmologies: Long-Term Perspectives on the Perception and Understanding of Dynamic Coastal Landscapes in the Northern Baltic Sea Region. *Time and Mind* 7:183–201.
Howey, Meghan, and John O'Shea
2006 Bear's Journey and the Study of Ritual in Archaeology. *American Antiquity* 71:261–282.
Hudson, Charles
1976 *The Southeastern Indians*. University of Tennessee Press, Knoxville.
Jenkins, Jessica A.
2016 Archaeological Evidence of Oyster Mariculture in the Lower Suwannee Region of Gulf Coastal Florida. Master's thesis, Department of Anthropology, University of Florida, Gainesville.
2017 Methods for Inferring Oyster Mariculture on Florida's Gulf Coast. *Journal of Archaeological Science* 80:74–82.
Kassabaum, Megan C.
2014 Feasting and Communal Ritual in the Lower Mississippi Valley, A.D. 700–1000. PhD dissertation, Department of Anthropology, University of North Carolina, Chapel Hill.
2019 Early Platforms, Early Plazas: Exploring the Precursors to Mississippian Mound-and-Plaza Centers. *Journal of Archaeological Research* 27:187–247.
Kassabaum, Megan C., and Erin Stevens Nelson
2016 Standing Posts and Special Substances: Gathering and Ritual Deposition at Feltus (22JE500), Jefferson County, Mississippi. *Southeastern Archaeology* 35:134–154.
Knight, Vernon James
2001 Feasting and the Emergence of Platform Mound Ceremonialism in Eastern North America. In *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power*, edited by Michael Dietler and Brian Hayden, pp. 311–333. Smithsonian Institution, Washington, DC.
Lankford, George E.
2004 World on a String: Some Cosmological Components of the Southeastern Ceremonial Complex. In *Hero, Hawk, and Open Hand: American Indian Art of the Ancient Midwest and South*, edited by Richard F. Townsend and Robert V. Sharp, pp. 206–217. Yale University Press, New Haven, Connecticut.
Lindauer, Owen, and John H. Blitz
1997 Higher Ground: The Archaeology of North American Platform Mounds. *Journal of Archaeological Research* 5:169–207.
Lourandos, Harry
1988 Palaeopolitics: Resource Intensification in Aboriginal Australia and Papua New Guinea. In *Hunters and Gatherers 1: History, Evolution and Social Change*, edited by Tim Ingold, David Riches, and James Woodburn, pp. 148–160. Berg, Oxford.
Luby, Edward M., and Mark F. Gruber
1999 The Dead Must Be Fed: Symbolic Meanings of the Shell Mounds of San Francisco Bay Area. *Cambridge Archaeological Journal* 9:95–108.
Lulewicz, Isabelle H., Victor D. Thompson, Thomas J. Pluckhahn, C. Fred T. Andrus, and Oindrila Das
2018 Exploring Oyster (*Crassostrea virginica*) Habitat Collection via Oxygen Isotope Geochemistry and Its

Implications for Ritual and Mound Construction at Crystal River and Roberts Island, Florida. *Journal of Island and Coastal Archaeology* 13:388–404.

Mahar, Ginessa J.
2019 The Practice of Fishing: Investigating the Sociality of Mass-Capture Fishing along the North Florida Gulf Coast. PhD dissertation, Department of Anthropology, University of Florida, Gainesville.

McAnany, Patricia A., and E. Christian Wells
2008 Toward a Theory of Ritual Economy. In *Dimensions of Ritual Economy*, edited by E. Christian Wells and Patricia A. McAnany, pp. 1–16. Research in Economic Anthropology Vol. 27. Emerald Group, Bingley, UK.

McFadden, Paulette M.
2015 Coastal Evolution and Pre-columbian Human Occupation in Horseshoe Cove on the Northern Gulf Coast of Florida. *Geoarchaeology* 31:355–375.

McNiven, Ian J.
2016 Increase Rituals and Environmental Variability on Small Residential Islands of Torres Strait. *Journal of Island and Coastal Archaeology* 11:195–210.

Milanich, Jerald T., Ann S. Cordell, Vernon J. Knight Jr., Timothy A. Kohler, and Brenda J. Sigler-Lavelle
1984 *McKeithen Weeden Island: The Culture of Northern Florida, A.D. 200–900*. Academic Press, New York.

Morgan, Christopher
2015 Is It Intensification Yet? Current Archaeological Perspectives on the Evolution of Hunter-Gatherer Economies. *Journal of Archaeological Research* 23:163–213.

O'Donoughue, Jason M.
2009 Limestone-Tempered Wares from the Northern Peninsular Gulf Coast of Florida. Paper on file at the Laboratory of Southeastern Archaeology, Department of Anthropology, University of Florida, Gainesville.

Palmiotto, Andrea
2015 Effective Seasons and Mobility Practices in the Lower Suwannee Region, Florida: A Zooarchaeological Study. PhD dissertation, Department of Anthropology, University of Florida, Gainesville.
2016 Indicator Groups and Effective Seasons on the Coast: Zooarchaeology of Fish in the Lower Suwannee Region of Florida. *Journal of Archaeological Science: Reports* 7:330–343.

Pauketat, Timothy R.
2013 *An Archaeology of the Cosmos: Rethinking Agency and Religion in Ancient America*. Routledge, London.

Pauketat, Timothy R., Susan M. Alt, and Jeffery D. Kruchten
2017 The Emerald Acropolis: Elevating the Moon and Water in the Rise of Cahokia. *Antiquity* 91:207–202.

Pluckhahn, Thomas J.
2003 *Kolomoki: Settlement, Ceremony, and Status in the Deep South, A.D. 350 to 750*. University of Alabama Press, Tuscaloosa.

Pluckhahn, Thomas J., and Victor D. Thompson
2018 *New Histories of Village Life at Crystal River*. University of Florida Press, Gainesville.

Randall, Asa R., and Kenneth E. Sassaman
2017 Terraforming the Middle Ground in Ancient Florida. *Hunter Gatherer Research* 3:9–29.

Rappaport, Roy A.
1968 *Pigs for the Ancestors: Ritual in the Ecology of a New Guinea People*. Yale University Press, New Haven, Connecticut.
1999 *Ritual and Religion in the Making of Humanity*. Cambridge University Press, Cambridge.

Reimer, Paula J., Edouard Bard, Alex Bayliss, J. Warren Beck, Paul G. Blackwell, Christopher Bronk Ramsey, Caitlin E. Buck, Hai Cheng, R. Lawrence Edwards, Michael Friedrich, Pieter M. Grootes, Thomas P. Guilderson, Haflidi Haflidason, Irka Hajdas, Christine Hatté, Timothy J. Heaton, Dirk L. Hoffmann, Alan G. Hogg, Konrad A. Hughen, K. Felix Kaiser, Bernd Kromer, Sturt W. Manning, Mu Niu, Ron W. Reimer, David A. Richards, E. Marian Scott, John R. Southon, Richard A. Staff, Christian S. M. Turney, and Johannes van der Plicht
2013 IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0–50,000 Years cal BP. *Radiocarbon* 55:1869–1887.

Reitz, Elizabeth J., and Elizabeth S. Wing
1999 *Zooarchaeology*. Cambridge University Press, Cambridge.

Roberts, Amy, Adrian Mollenmans, Quenten Agius, Fred Graham, Jeffrey Newchurch, Lester-Irabinna Rigney, Fred Sansbury, Lindsay Sansbury, Peter Turner, Greg Wanganeen, and Klynton Wanganeen
2016 "They Planned Their Calendar . . . They Set Up Ready for What They Wanted to Feed the Tribe": A First-Stage Analysis of Narungga Fish Traps on Yorke Peninsula, South Australia. *Journal of Island and Coastal Archaeology* 11:1–25.

Romain, William
2015 Adena-Hopewell Earthworks and Milky Way Path of Souls. In *Tracing the Relational: The Archaeology of Worlds, Spirits, and Temporalities*, edited by Meghan E. Buchanan and B. Jacob Skousen, pp. 54–82. University of Utah Press, Salt Lake City.

Rudegeair, Thomas J.
1975 The Reproductive Behavior and Ecology of the White Ibis (Eudocimus albus). PhD dissertation, Department of Biology, University of Florida, Gainesville.

Russo, Michael
2004 Measuring Shell Rings for Social Inequality. In *Signs of Power: The Rise of Cultural Complexity in the Southeast*, edited by Jon L. Gibson and Philip J. Carr, pp. 26–70. University of Alabama Press, Tuscaloosa.

Russo, Michael, Craig Dengel, and Jeffrey Shanks
2014 Northwest Florida Woodland Mounds and Middens: The Sacred and Not So Secular. In *New Histories of Precolumbian Florida*, edited by Neill J. Wallis and Asa R. Randall, pp. 121–142. University Press of Florida, Gainesville.

Russo, Michael, and Gregory Heide
2001 Shell Rings of the Southeast US. *Antiquity* 75:491–492.

Sahlins, Marshall
1976 *Culture and Practical Reason*. University of Chicago Press, Chicago.

Sassaman, Kenneth E.
2016 A Constellation of Practice in the Experience of Sea-Level Rise. In *Knowledge in Motion: Constellations of Learning across Time and Place*, edited by Andrew P. Roddick and Ann B. Stahl, pp. 291–298. University of Arizona Press, Tucson.

Sassaman, Kenneth E., Terry E. Barbour II, Meggan E. Blessing, Anthony Boucher, Mark C. Donop, Charles Trevor Duke, Joshua M. Goodwin, Jessica A. Jenkins, Ginessa J. Mahar, and Micah P. Monés
2019 *Lower Suwannee Archaeological Survey 2014–2016: Shell Mound and Cedar Key Tracts*. Technical

Report 25. Laboratory of Southeastern Archaeology, Department of Anthropology, University of Florida, Gainesville.

Sassaman, Kenneth E., Ginessa J. Mahar, Mark C. Donop, Jessica A. Jenkins, Anthony Boucher, Cristina I. Oliveira, and Joshua M. Goodwin
2015 *Lower Suwannee Archaeological Survey 2013–2014: Shell Mound and Cedar Key Tracts*. Technical Report 23. Laboratory of Southeastern Archaeology, Department of Anthropology, University of Florida, Gainesville.

Sassaman, Kenneth E., Andrea Palmiotto, Ginessa J. Mahar, Micah P. Monés, and Paulette S. McFadden
2013 *Archaeological Investigations at Shell Mound (8LV42), Levy County, Florida: 2012 Testing*. Technical Report 16. Laboratory of Southeastern Archaeology, Department of Anthropology, University of Florida, Gainesville.

Sassaman, Kenneth E., Neill J. Wallis, Paulette S. McFadden, Ginessa J. Mahar, Jessica A. Jenkins, Mark C. Donop, Micah P. Monés, Andrea Palmiotto, Anthony Boucher, Joshua M. Goodwin, and Cristina I. Oliveira
2017 Keeping Pace with Rising Sea: The First 6 Years of the Lower Suwannee Archaeological Survey, Gulf Coastal Florida. *Journal of Island and Coastal Archaeology* 12:173–199.

Saunders, Rebecca
2017 Archaic Shell Mounds in the American Southeast. Archaeology of North America, *Oxford Handbooks Online*. DOI:10.1093/oxfordhb/9780199935413.013.75.

Seavey, Jennifer R., W. E. Pine III, P. Frederick, L. Sturmer, and M. Berrigan
2011 Decadal Changes in Oyster Reefs in the Big Bend of Florida's Gulf Coast. *Ecosphere* 2:1–14.

Spielmann, Katherine A.
2002 Feasting, Craft Specialization, and the Ritual Mode of Production in Small-Scale Societies. *American Anthropologist* 104:195–207.
2008 Crafting the Sacred: Ritual Places and Paraphernalia in Small-Scale Societies. In *Dimensions of Ritual Economy*, edited by E. Christian Wells and Patricia A. McAnany, pp. 37–72. Research in Economic Anthropology Vol. 27. Emerald Group, Bingley, UK.

Thompson, Victor D., and C. Fred T. Andrus
2011 Evaluating Mobility, Monumentality, and Feasting at the Sapelo Island Shell Ring Complex. *American Antiquity* 76:315–344.

Urton, Gary
1981 *At the Crossroads of Earth and Sky: An Andean Cosmology*. University of Texas Press, Austin.

US National Research Council
1992 *Marine Aquaculture: Opportunities for Growth*. Committee on Assessment of Technology and Opportunities for Marine Aquaculture in the United States. National Academy Press, Washington, DC.

Wallis, Neill J.
2018 Powers of Place in the Predestined Middle Woodland Village. In *The Archaeology of Villages in Eastern North America*, edited by Jennifer Birch and Victor D. Thompson, pp. 36–53. University Press of Florida, Gainesville.

Wallis, Neill J., and Meggan E. Blessing
2015 Ritualized Deposition and Feasting Pits: Bundling of Animal Remains in Mississippi Period Florida. *Cambridge Archaeological Journal* 25:79–98.

Wallis, Neill J., Paulette S. McFadden, and Hayley M. Singleton
2015 Radiocarbon Dating the Pace of Monument Construction and Village Aggregation at Garden Patch: A Ceremonial Center on the Florida Gulf Coast. *Journal of Archaeological Science: Reports* 2:507–516.

Wallis, Neill J., Thomas J. Pluckhahn, and Michael D. Glascock
2016 Sourcing Interaction Networks of the American Southeast: Neutron Activation Analysis of Swift Creek Complicated Stamped Pottery. *American Antiquity* 81:717–736.

Weissner, Polly
2001 On Feasting and Value: Enga Feasts in a Historical Perspective (Papua New Guinea). In *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power*, edited by Michael Dietler and Brian Hayden, pp. 115–143. Smithsonian Institution, Washington, DC.

Williamson, Ray A.
1987 *Living the Sky: The Cosmos of the American Indian*. University of Oklahoma Press, Norman.

Witthoft, John
1949 *Green Corn Ceremonialism in the Eastern Woodlands*. Occasional Contributions 13. Museum of Anthropology, University of Michigan, Ann Arbor.

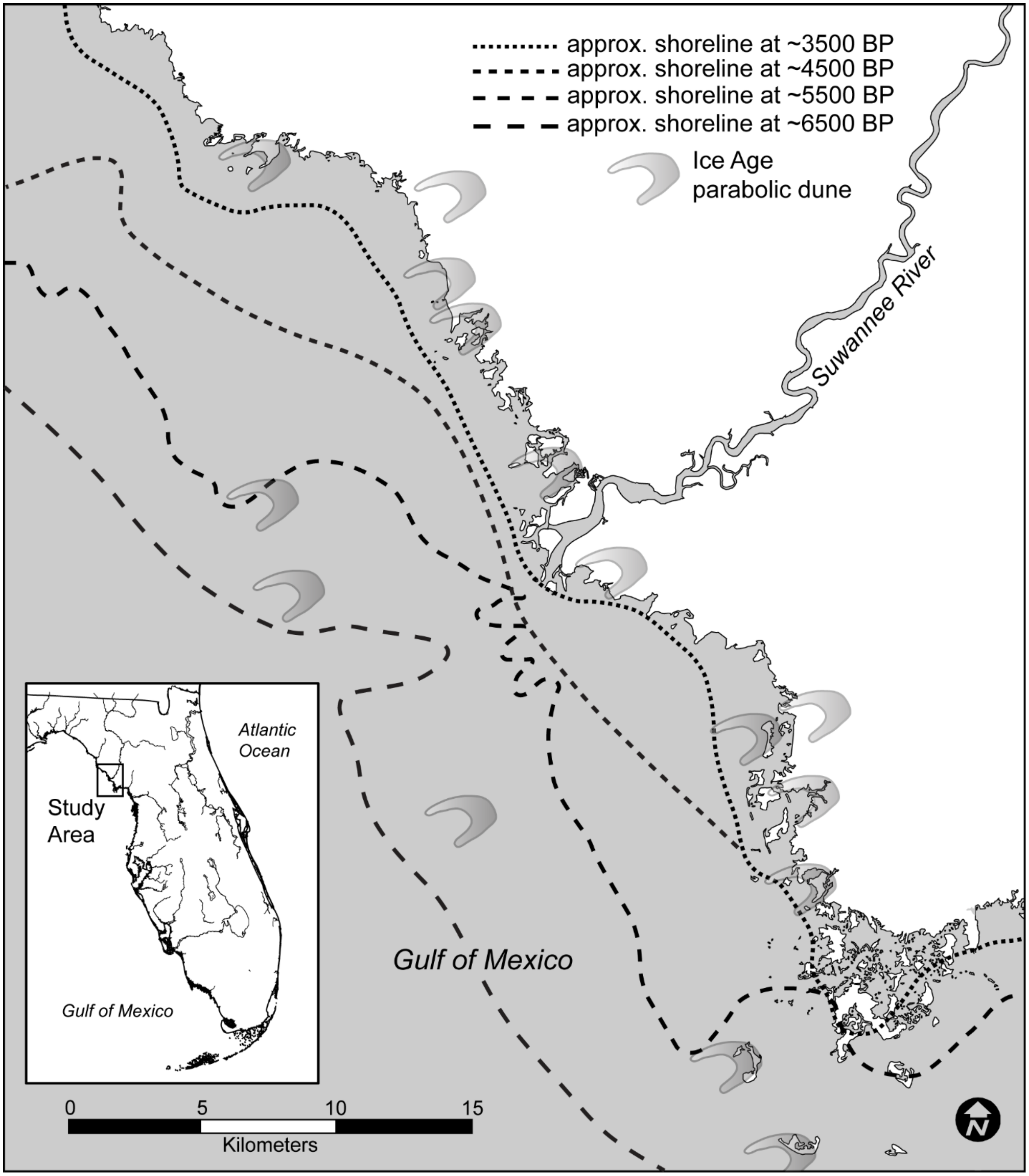
Wright, Alice P.
2017 Local and "Global" Perspectives on the Middle Woodland Southeast. *Journal of Archaeological Research* 25:37–83.

Wright, Eric E., Albert C. Hine, Steven L. Goodbred Jr., and Stanley D. Locker
2005 The Effect of Sea-Level and Climate Change on the Development of a Mixed Siliciclastic-Carbonate, Deltaic Coastline: Suwannee River, Florida, U.S.A. *Journal of Sedimentary Research* 75:621–635.

Submitted March 4, 2019; Revised July 5, 2019; Accepted July 5, 2019

SUPPLEMENTAL TEXT

Supplemental Text 1. It is beyond the scope of this paper to examine in detail how the landscape of the study area indexed movements of the sun, but several points warrant mention. First, when we assert that the landscape of the study area was predisposed to solstice gatherings we mean that geomorphic alignments on the earth's surface coincided with the azimuths of solar standstills, the solstices. Prevailing winds during the Pleistocene, when the study area was over 200 km from the coastline, blew from the southwest, forming over time parabolic dunes of variable size, but consistently oriented along a southwest-northeast axis (Supplemental Figure 1). There were scores of dunes in the study area before rising sea transmuted them (Wright et al. 2005). Few exist today in nearshore terrestrial settings but those that do—such as the dune arm on which Shell Mound was sited— preserve solstitial alignments. From a position at the head of any dune at winter solstice (December 21), the sun would have slipped below the horizon at a point equidistant between the parallel arms of the dune, ~240 degrees east of north. From a positon between the arms of the dune on June 21 the sun would have risen directly over the head of the dune, its highest point, ~60 degrees east of north. We emphasize that there is nothing intrinsic about this earth-sun connection; its value awaited recognition and signification by observers on the ground. All such value or meaning is contextual and contingent, but inarguably movements of the sun have held significance for people worldwide and throughout history (Aveni 2001; Pauketat 2013:61-69; Williamson 1984). Due to the tilt of the earth relative to its orbit around the sun, the rising and setting sun migrates along a meridian, halting and reversing its northerly route at the summer solstice, and halting and reversing its southerly route at the winter solstice. Any observer of these cycles may notice landmarks on the horizon that reference the standstills; it is in this sense that such features awaited "discovery" and were then mobilized for ritual or political purposes (e.g., Ashmore 1991; Pauketat 2013). The "built" environment of temples, plazas, henges, and other architecture materializes all variety of celestial bodies and their movements, but here we are concerned with the larger scale of citation enabled by landscapes of solar alignment. For example, the buildings of Chaco Canyon are oriented with respect to both solar and lunar standstills (Sofaer 2008), but were they built in this particular canyon because of its solstitial orientation and position along a meridian (Lekson 1999)? Similarly, the moundscape of Poverty Point expresses a variety of solar alignments (Romain and Davis 2013), but is its location a matter of relational solar geography spanning much of the Southeast and two millennia of dwelling (Sassaman and Randall 2020)? At this larger scale of orientation, the precision of modern astronomy may not apply, which is to say that naked-eye astronomy need not attend to subdegree measurement or modest shifts in declination. Since the time parabolic dunes formed in the study area, they have materialized solstice alignments within a couple of degrees of deviation.

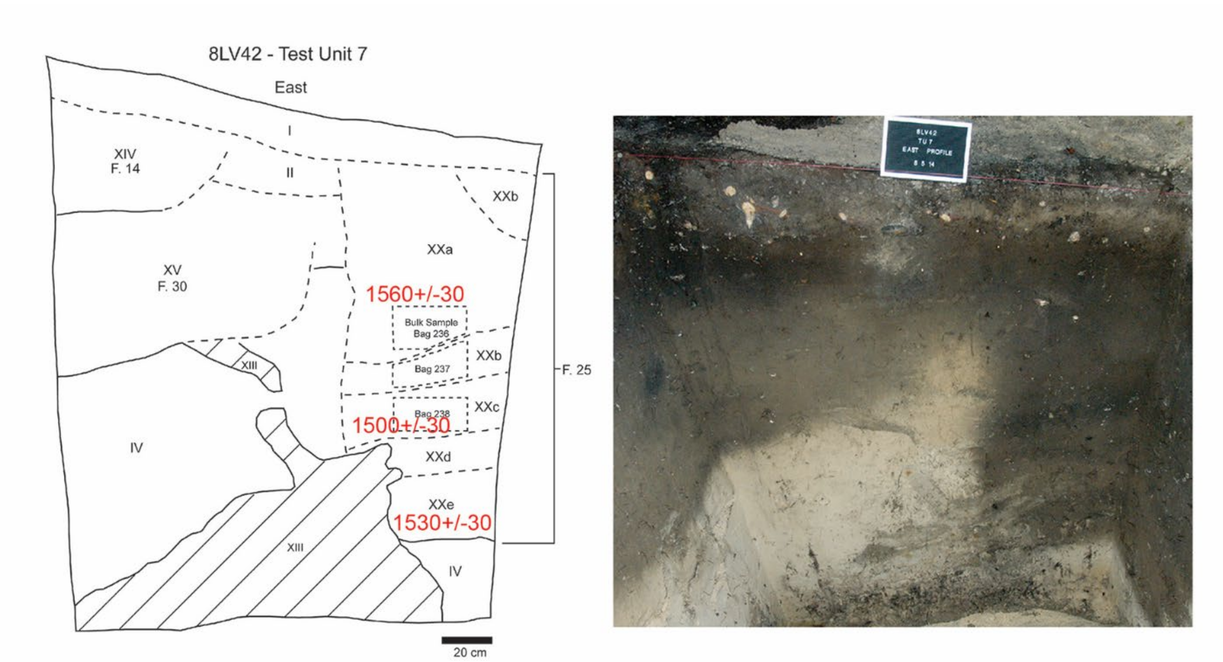


Supplemental Figure 1. Schematic map of the Lower Suwannee study area showing the locations of parabolic dunes both extant and extinct against projected backdrop of retreating shorelines over past ~6,500 years (following Wright et al. 2005).

Supplemental Text 2. Our use of the term "world renewal" follows from Knight's (1986) interpretation of ethnohistoric accounts of Mississippian mound construction and mound-related rituals, particularly his sense that incarnations of platform mound rituality going back to Middle Woodland times "may be seen as a conservative, long-term complex of world-renewal ritual" (Knight 2001:312). These were routinized and repetitive rituals, such as the annual Green Corn ceremonies of Mississippian communities (Hudson 1976:365-375; Witthoft 1949), which were communal rites of purification and replenishment at the turning point of an annual cycle. Our use of the concept of world renewal goes beyond connotations related to revitalization or millennial movements as conceptualized by Wallace (1956) in the context of European colonialism. Looking beyond those historical particulars, we find it worthwhile to consider that climate events that disrupted coastal living could have been ameliorated by ceremonialism that carried the weight of social memory about intermittent disruptions by routinely gathering together regional communities for collective intervention. This perspective comports with recent theorizing over Native American religion that privileges practice over belief (e.g., Fowles 2013; Pauketat 2013)

Supplemental Text 3. In the dynamic relationship between coastal shorelines and the sea, overstepping is the process by which water breaches a barrier (shoreline proper, barrier islands, even oyster reefs) during a climate event (e.g., hurricane) and alters shoreline morphology through mass erosion and deposition. In the study area, salt marsh has aggraded with rising sea over the past few millennia, but occasional overstep events resulted in rapid shoreline retreat (Goodbred et al. 1998; Wright et al. 2005). A critical variable in this history is the health of the Great Suwannee oyster reef, which acts as a barrier to shoreline erosion. As with the marsh, oyster reefs have the potential to keep pace with rising sea; however, when reefs are diminished under changing conditions or overexploitation, storm surges have greater potential for overstepping shorelines. The recent downturn in the health of the Great Suwannee reef is owed to increased salinity, which traces to freshwater extraction far upriver (Seavey et al. 2011), an example of local-scale outcomes attending regional-scale processes.

Supplemental Text 4. The fill Feature 25 was stratified and thus possibly indicative of sequential, prolonged back-filling or possibly reuse (Supplemental Figure 2). However, AMS age estimates of 1530 ± 30 B.P. (lower), 1500 ± 30 B.P. (middle), and 1560 ± 30 B.P. (upper) are statistically coeval suggesting that the fill of Feature 25 was emplaced quickly after the hole was dug and thus represents a more-or-less single depositional event. The vertical walls of Feature 25 and other steep-walled pits could not have stood for long without collapsing. We observed no evidence of collapse in the profiles of any of the features (Sassaman et al. 2019). We did however observe dune sands deposited on the surface from which pits were dug, suggesting that not all excavated fill was returned to pits, which is not surprising given the volume of organic matter deposited in pits. All this goes to the likelihood that the back-filling of pits was part of the ritual activity of summer solstice feasts.



Supplemental Figure 2. Stratigraphic drawing (left) and photograph (right) of the east profile of Test Unit 7, showing Feature 25 and three AMS assays on charcoal from successive strata.

Supplemental Text 5. The "everyday" at Shell Mound has yet to be investigated for lack of discrete contexts, such as the features of domestic structures. We acknowledge that accretional middens offer opportunities for developing data on quotidian life, perhaps best sampled with finer fractions of vertebrate fauna than those we analyzed for this paper. We are aware that our emphasis on the ¼-inch fraction biases against the recovery of small fish. But fine-fraction recovery has its own biases, generally those associated with the reality that as screen size shrinks from 1/4-inch to 1/8-inch to 1/16-inch or finer, the volume of fill that can be analyzed shrinks too, given the usual constraints of time and funding. Our emphasis on the 1/4-inch fraction enabled us to examine large samples of pit and midden fill, but it is certainly reasonable to ask what we missed. As might be expected from prior studies of coastal sites in the Southeast (e.g., Colannino 2011; Reitz 2004; Reitz et al. 2009), fine-fraction samples of accretional midden from Shell Mound reveal a preponderance of small fish (e.g., pinfish and killifish) (Palmiotto 2015). Fine-fraction recovery rightfully reflects the use of near-shore, intertidal resources, and yet the larger samples of 1/4-inch fill from Shell Mound—whether from pits or midden—shows that procurement involved boat travel to patches 12 km or more distant. They also reflect the use of infrastructure to intensify the capture of schooling fish. We agree that fine-fraction samples are needed to characterize the use of local, near-shore resources, but samples constrained by the volumetric limits of fine-fraction analyses would not have begun to characterize the economic intensification of solstice events. Similarly, after decades of research on the subsistence economies of the Calusa of southwest Florida, Marquardt (2014) commented on the limited number of mullet remains, a species that in historic times was fished intensively in the Charlotte Harbor region (Edic 1996:111–112). He attributes the lack of mullet bone to an analytical emphasis on fine-fraction samples as opposed to coarser-fraction but more widely sampled excavated fill. The point is not that mullet remains are never recovered in finer fractions, because they are, but that the events that reproduced the social and cosmological significance of Shell Mound, and perhaps the sacred sites of the Calusa, have archaeological distributions that are unlikely to be revealed with an emphasis on column samples in accretional midden.

Supplemental Text 6. That Shell Mound would be considered anomalous in the landscape of Middle Woodland civic-ceremonial centers goes more to the site-centric and typological proclivities of modern practitioners that it does the intrinsic qualities of the site. The lack of a platform mound at Shell Mound obviously did not preclude the hosting of ritual events, suggesting that it was the *practice*, not the infrastructure, of ritual that reproduced Middle Woodland society over the centuries. Granted, inasmuch as platform-mound building was itself connected to world-renewal ceremonialism, as Knight (2001) argues, the absence of a platform mound at Shell Mound begs explanation. The elevated dune arm on which Shell Mound was built may have been a surrogate for a platform mound although given the precedence of the dunes over the mounds, the reverse may be true.

REFERENCES CITED

Ashmore, Wendy
1991 Site Planning Principles and Concepts of Directionality among the Ancient Maya. *Latin American Antiquity* 2:199–226.

Aveni, Anthony
2001 *Skywatchers* (revised edition). University of Texas Press, Austin.

Colannino, Carol E.
2011 Examining Ichthyofaunal Remains for Evidence of Fishing Technologies Employed in Georgia Estuaries during the Late Archaic Period. *Southeastern Archaeology* 30:337–350.

Edic, Robert F.
1996 *Fisherfolk of Charlotte Harbor*. Institute for Archaeology and Paleoenvironmental Studies, University of Florida, Gainesville.

Fowles, Serevin
2013 *An Archaeology of Doings: Secularism and the Study of Pueblo Religion*. School for Advanced Research Press, Santa Fe.

Knight, Vernon James
1986 The Institutional Organization of Mississippian Religion. *American Antiquity* 51:675–687.

Lekson, Stephen H.
1999 *The Chaco Meridian: Centers of Political Power in the Ancient Southwest*. AltaMira, Walnut Creek, California.

Marquardt, William H.
2014 Tracking the Calusa: A Retrospective. *Southeastern Archaeology* 33:1–24.

Palmiotto, Andrea
2015 *Effective Seasons and Mobility Practices in the Lower Suwannee Region, Florida: A Zooarchaeological Study*. Ph.D. dissertation, Department of Anthropology, University of Florida, Gainesville.

Pauketat, Timothy R.
2013 *An Archaeology of the Cosmos: Rethinking Agency and Religion in Ancient America*. Routledge, London.

Reitz, Elizabeth J.
2014 Continuity and Resilience in the Central Georgia Bight (USA) Fishery between 2760 BC and AD 1580. *Journal of Archaeological Science* 41:716–731.

Reitz, Elizabeth J., Irvy R. Quitmyer, and Rochelle A. Marrinan
2009 What Are We Measuring in the Zooarchaeological Record of Prehispanic Fishing Strategies in the Georgia Bight, USA? *Journal of Island and Coastal Archaeology* 4:2–36.

Romain, William F., and Norm L. Davis
2013 Astronomy and Geometry at Poverty Point. Website article, Louisiana Archaeological Society. http://www.laarchaeology.org/articles.html, accessed October 21, 2013.

Sassaman, Kenneth E., and Asa R. Randall
2020 Cosmic Abandonment: How Detaching from Place was Requisite to World Renewal in the Ancient American Southeast. In *Detachment from Place: Beyond an Archaeology of Settlement Abandonment*, edited by Maxime Lamoureau St-Hilaire and Scott MacRae. University of Colorado Press, Boulder (in press).

Sofaer, Anna
2008 Chacoan Architecture: A Solar-Lunar Geometry. In *Chaco Astronomy: An Ancient American Cosmology*, edited by Anna Sofaer, pp. 115-126. Ocean Tree Books, Santa Fee, New Mexico.

Wallace, Anthony F. C.
1956 Revitalization Movements. *American Anthropologist* 58:264–281.

Williamson, Ray A.
1987 *Living the Sky: The Cosmos of the American Indian*. University of Oklahoma Press, Norman.

Wright, Eric E., Albert C. Hine, Steven L. Goodbred Jr, and Stanley D. Locker
2005 The Effect of Sea-level and Climate Change on the Development of a Mixed Siliciclastic-carbonate, Deltaic Coastline: Suwannee River, Florida, U.S.A. *Journal of Sedimentary Research* 75:621–635.