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Geoarchaeology and Coastal Morphodynamics of Harbor Key (8MA15): Indigenous Persistence at a Partially Inundated Native Shell Mound Complex in Tampa Bay, Florida

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Abstract

Applying a coastal-geoarchaeological approach, we synthesize stratigraphic, sedimentological, mollusk-zooarchaeological, and radiometric datasets from recent excavations and sediment coring at Harbor Key (8MA15)—a shell-terraformed Native mound complex within Tampa Bay, on the central peninsular Gulf Coast of Florida. We significantly revise the chronological understanding of the site and place it among the relatively few early civic-ceremonial centers in the region. Analyses of submound contexts revealed that the early first millennium mound center was constructed atop a platform of sand and ex situ cultural shell deposits that were reworked during ancient storm landfalls around 2000 BP. We situate Harbor Key within a seascape-scale stratigraphic and paleoenvironmental framework and show that the shellworks comprise an artificial barrier protecting the leeward estuary basin (and productive inshore wetlands) from high-energy conditions of the open bay and swells from the Gulf of Mexico. The sedimentary and archaeological records attest to the long-term history of morphodynamic interaction between coastal processes and Indigenous shell terraforming in the region and suggest that early first millennium mound building in Tampa Bay was tied to the recognition and reuse of antecedent shellworks and the persistent management of encompassing cultural seascapes.

Resume

Aplicando un enfoque geoarqueológico costero, analizamos la combinación de datos estratigráficos, sedimentológicos, molusco-zooarqueológicos y radiométricos procedentes de excavaciones recientes y de la extracción de sedimentos en Harbor Key (8MA15) —un montículo de conchas terraformadas dentro de la bahía de Tampa, en la costa peninsular central del Golfo de Florida. Analizamos en profundidad la cronología del yacimiento y lo situamos entre los pocos centros cívico-ceremoniales tempranos de la región. El marco de los submontículos revela que la estructura pertenece a principios de la Era Común, construyéndose sobre una plataforma de arena, y que los depósitos de conchas culturales ex situ fueron modificados durante antiguas tormentas, ca. 2000 aP. Situamos Harbor Key dentro de un marco estratigráfico y paleoambiental a escala del paisaje marino y demostramos que la estructura formada por conchas constituye una barrera artificial que protege la cuenca del estuario de sotavento (y los humedales costeros) de las condiciones de alta energía de la bahía abierta y de las marejadas del Golfo de México. Los registros sedimentológicos y arqueológicos atestiguan la larga historia de interacción morfodinámica entre los procesos costeros y la terraformación indígena de conchas en la región y sugieren que la construcción de montículos a principios de la Era Común en la bahía de Tampa estaba ligada al reconocimiento y reutilización de los montículos ya existentes y a la gestión del paisaje cultural marino circundante.

Keywords: Indigenous shellworks; estuaries; sedimentology; civic-ceremonial centers; Florida Gulf Coast

Palabras clave: montículos de conchas Indígenas; estuarios; sedimentología; centros cívico-ceremoniales; Costa del Golfo de Florida

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Cultural shellworks (or shell mounds, *sensu lato*) are among the most conspicuous and durable material features of ancient coastal Indigenous lifeways in the Americas (Grier et al. 2017; Klokler 2017; Sanger et al. 2020; Schwadron 2017). Recognizing repeated or continuous occupation at many Native shell mounds spanning centuries to millennia, archaeologists have come to understand them as “persistent places” that preserve social memory and reinforce social relationships by linking people to ancestors and ancestral landscapes (Gamble 2017; Schlanger 1992; Thompson 2010). This is particularly true along the Gulf Coast of Florida, where many Native shell mounds were constructed at monumental scale and were situated at prominent points on the landscape bearing histories of ancestral land use (Figure 1). Among these sites are several elaborately terraformed civic-ceremonial centers featuring platform mounds, mortuaries, middens, and plazas (Pluckhahn and Thompson 2018; Sassaman et al. 2020; Wallis and McFadden 2016; Wallis et al. 2022). These mound centers were repeatedly altered and expanded through large-scale coordination of resources and labor over centuries to millennia, representing what Thompson and Pluckhahn (2012:50) term “persistent monumental

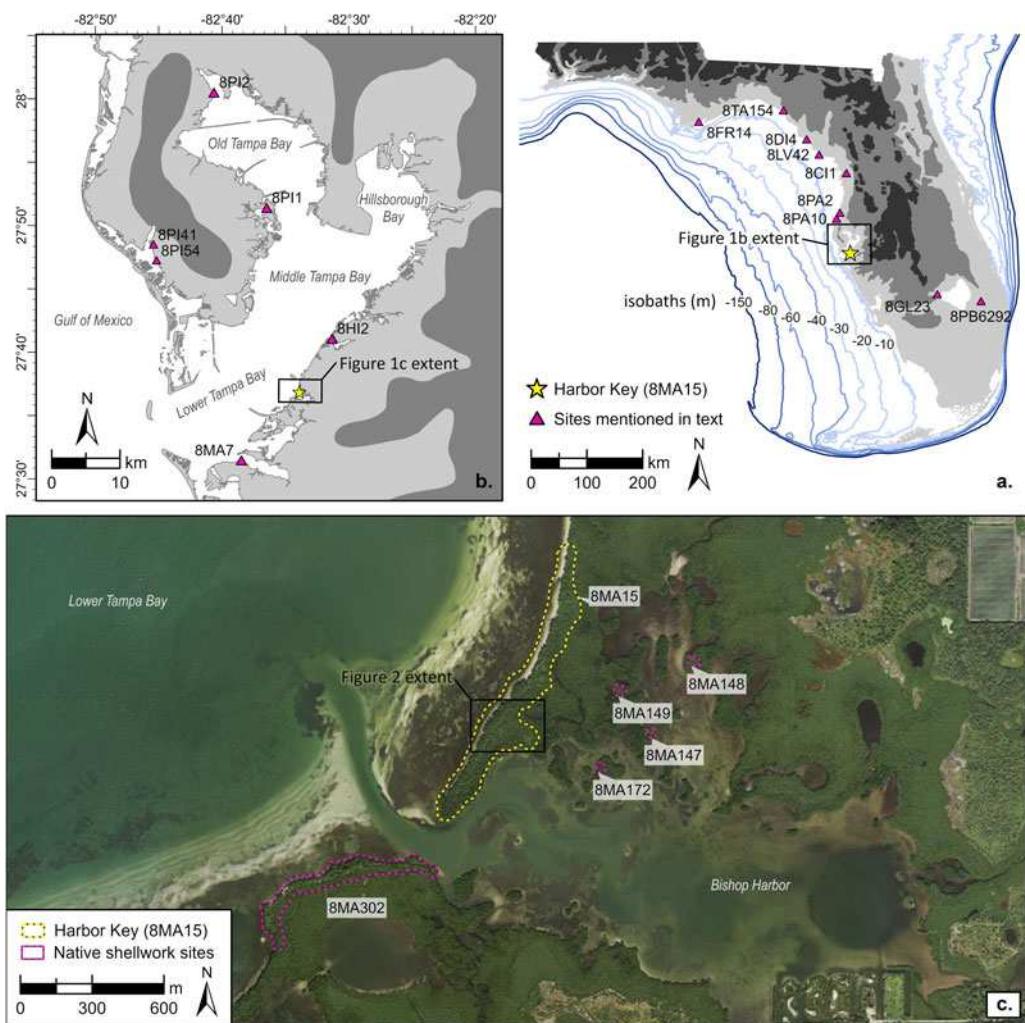


Figure 1. Reference maps depicting the physiographic setting and locations of sites mentioned in text: (a) map of Florida with bathymetric contours and relic marine terraces displayed in grayscale. Light-gray regions are less than 10.5 m, medium-gray regions are more than 10.5 and less than 30.5 m, and dark-gray regions are more than 30.5 m; (b) map of Tampa Bay depicting major sub-basins and the locations of sites mentioned in text; (c) modern orthophotography of Bishop Harbor, Harbor Key (8MA15) and associated Native shellwork sites. (Color online)

places” where ceremonial aggregations involved mound building and other terraforming. By terraforming we mean the anthropogenic construction and modification of durable physical environments to suit the builders’ broader vision of the landscape (Grier et al. 2017). Such actions serve economic and political purposes, imbue the landscape with symbolic power, and significantly modify topography and sedimentary properties—producing dialectical relationships between civic-ceremonial infrastructure and ecological conditions (Randall and Sassaman 2017).

Within coastal-estuarine contexts, long-term histories of occupation, ceremonial aggregation, and shell terraforming are inherently intertwined with morphodynamic processes—time- and scale-dependent feedback loops between topography and fluid dynamics—where sea-level rise, hurricane landfalls, tidal flow, and waves influence the formation and taphonomy of shell-bearing sites (see Cowell and Thom 1995). In turn, we propose that long-term interactions between coastal processes and shellworks alter biophysical conditions within encompassing coastal systems and influence trajectories of estuary development. However, although Gulf Coast archaeologists have amply considered how ancient Native societies adapted settlement patterns and subsistence strategies to trends and perturbations of Holocene coastal evolution (e.g., Marquardt et al. 2022; McFadden 2016; Sassaman et al. 2020), the roles of coastal processes in site formation histories are poorly understood, and the effects of shell-terraformed sites on biophysical conditions within estuaries have gone essentially uninvestigated.

We attribute this problem to several interrelated issues. First, many Gulf Coast shell mounds were destroyed during the late nineteenth and early twentieth centuries to produce material for road construction, and major portions of Gulf Coast estuaries have been heavily altered by dredge-and-fill operations, seawall construction, ditching, and other civil-engineering impacts. Second, although detailed stratigraphic-sedimentary analyses have advanced the geoarchaeological understanding of terraformed earthworks throughout the Eastern Woodlands (e.g., Arco et al. 2006; Sherwood and Kidder 2011; Van Nest et al. 2001), there is a lack of rigorous sedimentological research on shell mounds, which drastically limits their empirical categorization, comparison, and interpretation. For example, we note that Marquardt’s (2010:551) call for a “sediment-oriented approach to the study of [shell] mound deposits” has gone largely unanswered (for an exception, see McFadden 2016). Third, normative interpretations of Indigenous shellworks as unintentional accumulations of quotidian subsistence refuse predominated in the archaeological literature from the mid-nineteenth century until the 1990s (Claassen 1991; Waselkov 1987). Late nineteenth-century explanations for shell mound formation on the Florida Gulf Coast by Stearns (1870, 1872) and Walker (1880:416–418) proposed that they formed “due to chance rather than design” through refuse disposal on the periphery of settlements and the intermittent relocation of habitation areas to higher ground atop previous refuse dumps—resulting in the accumulation of massive “shell heaps” on natural points or islands where settlement footprints were spatially constrained. Although seldom cited, these early explanations continue to function as implicit null models for shellwork studies on the Florida Gulf Coast (see Marquardt 2010) and discourage the conceptualization of Native shellworks as planned architecture or coastal infrastructure. Lastly, despite early observations by Cushing (1897) that shell-terraformed islands in southwest Florida altered tidal flow, sediment transport, and estuarine habitat distributions, archaeologists in the region have historically sampled and studied coastal shellworks in relative isolation from their surrounding coastal environments (for exceptions, see Cook-Hale et al. 2019; McFadden 2016). We see this as part of a larger methodological disjuncture between terrestrial and aquatic/marine archaeological practice (see Halligan 2021) and as a manifestation of the entrenched dualism in Western thought between land and sea that parallels deeper problematic dualisms between nature and culture or subject and object (Collingwood 1945:7; Sharp 2002:152–177).

In this study, we apply a coastal-geoarchaeological approach drawing from Sherwood and Kidder’s (2011) integrated geoarchaeological approach, coastal morphodynamic principles (Cowell and Thom 1995), and longitudinal study of surficial and buried sediments in the region. Our approach emphasizes (1) seascape-scale sampling and analyses, (2) the application of well-supported sea-level reconstructions, (3) sampling across the modern tidal frame, and (4) rigorous sedimentological and mollusk-zooarchaeological analyses that enable quantitative categorization, comparison, and interpretation of sediment deposits. Our study is centered at Bishop Harbor, an inshore sub-basin of Tampa

Bay on the central peninsular Gulf Coast of Florida (Figure 1). Like many of Tampa Bay's inshore bayous, Bishop Harbor is partially blocked from the open bay by supratidal landforms bearing Indigenous shellworks, and most conspicuously by Harbor Key (8MA15)—a Native shell mound complex containing a steep-sided, 5.5 m tall pyramidal platform mound, a lower (1.5 m tall) platform mound, a sand mortuary mound, a well-defined plaza, and a linear ridge of shell-bearing deposits along the bay shoreline (Burger 1979). We synthesize stratigraphic, sedimentological, mollusk-zooarchaeological, and radiometric datasets from sediment cores, test excavations, and auger probes to meet three major research objectives: (1) situating the Harbor Key shellworks within a seascape-scale stratigraphic and paleoenvironmental framework, (2) resolving the composition and chronostratigraphy of the Harbor Key mound complex, and (3) reconstructing cultural and natural site-formation processes, with a focus on interactions among shellworks, coastal processes, and Late Holocene coastal evolution.

Tampa Bay Estuary

Tampa Bay is a large (1,000 km²) and shallow (4 m mean depth) microtidal estuary on the central peninsular Gulf Coast of Florida (Figure 1). The estuary system is situated near the center of the Florida carbonate platform (Scott 2011), which forms a vast low-gradient continental shelf extending westward beneath the Gulf of Mexico. Much of this shelf was sub-aerially exposed during the Last Glacial Maximum and was subsequently inundated by deglacial and Holocene sea-level rise (Joy 2019). Tampa Bay's enigmatic morphology was formed by the estuarine flooding of antecedent karst depressions, which produced numerous interconnected sub-basins separated by areas of more durable limestone (Hine et al. 2009). Before incipient marine flooding about 7500 BP, Tampa Bay's karst landscape supported persistent freshwater wetlands, including a paleo-lake system that once occupied the Middle Tampa Bay basin (Cronin et al. 2007; Willard et al. 2007). Consistent with Thulman's (2009) settlement model, artifact and site distributions suggest significant human occupation of the Tampa Bay region during the terminal Pleistocene and Early Holocene (Anderson et al. 2019; Wisenbaker and Daniel 1987). A widespread transition to estuarine conditions in Tampa Bay during the mid-Holocene, about 6500 BP (Cronin et al. 2007; van Soelen et al. 2010), corresponded with a climatic optimum that drove pine-forest expansion and the establishment of vast estuarine wetland systems (Jackson et al. 2023; van Soelen et al. 2012). Although older sites may be preserved in submerged contexts, the earliest preserved Indigenous shell-bearing sites in the region date to the mid-Holocene, yielding fiber-tempered ceramics along with shell- and bone-tool technologies (Saunders and Russo 2011). Continued sea-level rise throughout the Late Holocene—particularly after AD 200—exposed estuarine sub-basins to increased wave forcing and converted marsh-dominated tidal creek systems to open sand flats and seagrass meadows, which currently dominate shallow subtidal and intertidal zones (Jackson et al. 2023; also see Goodbred et al. 1998). Most large shell-terraformed Native settlements on the peninsular Gulf Coast were constructed during the first millennium, with major intensifications in mound building after around AD 500 (Austin et al. 2014; Pluckhahn and Thompson 2018; Wallis and McFadden 2016). Within Tampa Bay, shell mound sites are commonly situated at prominent points near the mouths of major tidal bayous; in many cases they armor or comprise the seaward-most supratidal landforms that protect inshore sub-basins from relatively energetic open bay waves. As noted by Pluckhahn and colleagues (2022a), this pattern appears exaggerated on the bay's southeastern shoreline.

Bishop Harbor and the Harbor Key Mound Complex (8MA15)

Bishop Harbor is a shallow estuarine sub-basin on the southeastern shore of Tampa Bay encompassing an approximately 3.5 km² water body dominated by tidal flats, oyster reefs, and mangrove swamps (Figure 1; Supplemental Figure 1). All supratidal landforms within the basin are associated with shell-bearing archaeological sites (Burger 1979). Bishop Harbor is connected to Tampa Bay by a narrow (150 m wide) inlet that is constricted on both ends by Native shellworks: on the southwest by the Mariposa Key (8MA302) and on the northeast by Harbor Key (8MA15).

Despite the unusual integrity and conspicuous arrangement of Harbor Key's mound features, as well as a significant amount of previous digging, our work represents the first systematic testing at

the site. Prolific and widely read antiquarians of the late nineteenth-century Gulf Coast did not mention Harbor Key. Although both Sylvanus T. Walker (1880) and Clarence B. Moore (1900) excavated at shell mounds along the southeastern shore of Tampa Bay (e.g., Shaw's Point [8MA7] and Cockroach Key [8HI2]), both parties appear to have sailed past Harbor Key without taking note. The 1874 Coast and Geodetic Survey topographical chart depicting Bishop Harbor (T-sheet #1346B; Supplemental Figure 2) shows that the site was shrouded in dense mangrove forest (much as it remains today), such that the mounds were probably not visible from the navigable waters of the open bay.

Correspondence dated 1920–1921 between local collector Charles Theodore Earle Jr. and Jesse W. Fewkes of the Bureau of American Ethnology (BAE) contains the earliest known sketch map of Harbor Key (Supplemental Text 1). Earle's letters report digging into the ancestral burial mound and the removal of the southern quarter of the large platform mound during a short-lived shell-mining operation (Supplemental Figure 3). Correspondence from 1934 reveals that the prolific antiquarian Montague Tallant visited Harbor Key in the spring of that year, oversaw the excavation of a 4.5×6 m (15×20 ft.) trench into the burial mound, and reported his findings to Matthew Stirling, then director of the Smithsonian Institution (Supplemental Text 2). Ultimately, although brief reports of contact period funerary objects piqued the interest of Fewkes and Stirling, local collectors failed to inspire BAE or Smithsonian investigations, which instead focused on more accessible Tampa Bay mound sites at Weedon Island (8PI1) and Safety Harbor (8PI2): those sites would become widely known for assemblages of ornate mortuary ceramics and be considered as type-sites for regional archaeological cultures (Willey 1949).

Ripley Bullen visited Harbor Key in 1952 after collectors disturbed ancestor burials at the base of the platform mound ramp. Bullen toured the site's central complex, made a small collection of artifacts, and proposed an age in the late precolumbian/Safety Harbor period (around AD 1000–1500), based solely on coetaneous typologies for platform mounds and mound-plaza complexes. The ceramic assemblage Bullen analyzed contained nondiagnostic check-stamped and plain sand-tempered sherds (Bullen et al. 1952:22). Burger (1979) produced the first topographic map of the site (Figure 2). Comparison with our 2021 lidar-derived topobathymetric map underscores the accuracy of Burger's work. After clearing dense brush, Burger determined that the short landward shell ridge described vaguely by Earle comprises a low, flat-topped mound. Burger speculated that this mound was constructed in the form of a bird, soaring westward. Although it is difficult to evaluate this interpretation of the mound form and orientation, especially given the rarity of effigy mounds in the region (but see Walker 1880:402–404), the form and cardinal orientation of the mound are prominent; in the absence of published mound names or codes, we adopt Burger's nomenclature in referring to this feature as the Bird Mound. In 1995, Burger's research and longitudinal advocacy at Harbor Key led to the protection of the site and numerous others within the Terra Ceia Preserve State Park—a 2,000-acre estuarine preserve along Tampa Bay's southeastern shoreline.

Most recently, Wheeler (2002) visited Harbor Key with Burger to document and backfill a 2 m deep vandal pit dug into the platform mound summit, exposing a complex stratigraphy of secondary shell fill, thin primary midden layers, and ash lenses. The team collected four carbon samples from strata representing probable mound-summit activity surfaces and were surprised by the Middle Woodland dates (about 200 BC–AD 400), which they found “much too old for the presumably Safety Harbor [i.e., Mississippian] mound.” The team attributed these dates to potential contamination from leached humic materials or their mistaking of secondary mound fill as in situ top-soil horizons (Wheeler 2002:5).

Methods

Field Methods

Fieldwork involved sediment coring, test-unit excavations, and auger probing (Figure 3). To investigate Holocene paleoenvironmental history in Bishop Harbor, we collected six vibracores along a cross-shore transect running from the seaward edge of the tidal shelf to the landward head of the sub-basin. Vibracoring protocol followed standard methods (Lanesky et al. 1979) using 7.6 cm diameter

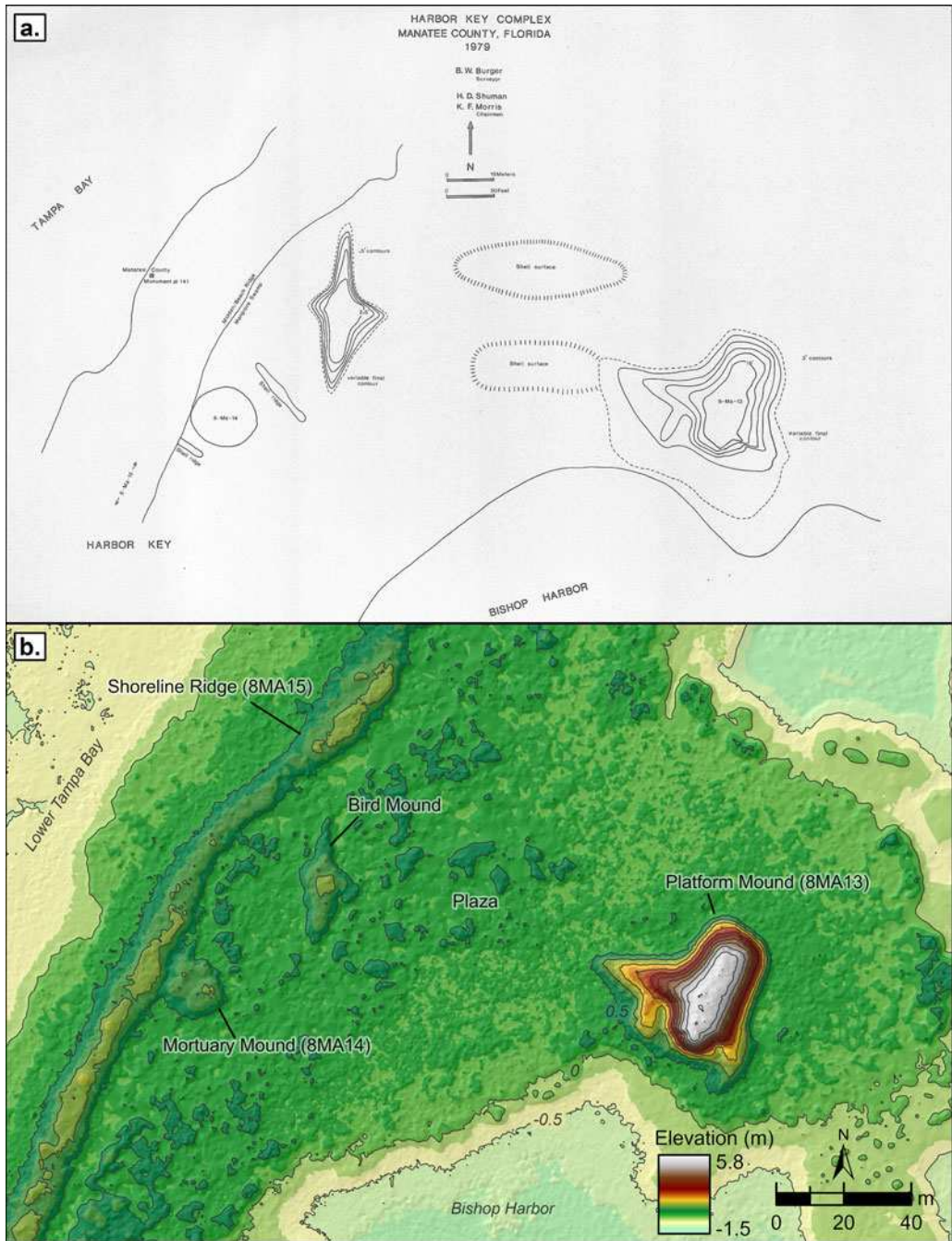


Figure 2. Comparison of topographic maps for Harbor Key mound complex: (a) topographic map of Harbor Key by Burger (1979); (b) 2021 aerial lidar-based digital elevation model of Harbor Key, 50 cm contour interval. (Color online)

aluminum pipes. At Harbor Key, we excavated six 50 × 50 cm test units: four along the shoreline ridge (STPs 1–4), one atop the platform mound summit (STP7), and one into the center of the Bird Mound (STP8). Excavations proceeded in 10 cm levels within observed strata until reaching the tidal water level. STPs 1, 3, and 4 were extended by auger probing (7.6 cm diameter) in 20 cm levels to a maximum of 1.5 m depth, enabling us to document stratigraphy and collect samples below the limit of open

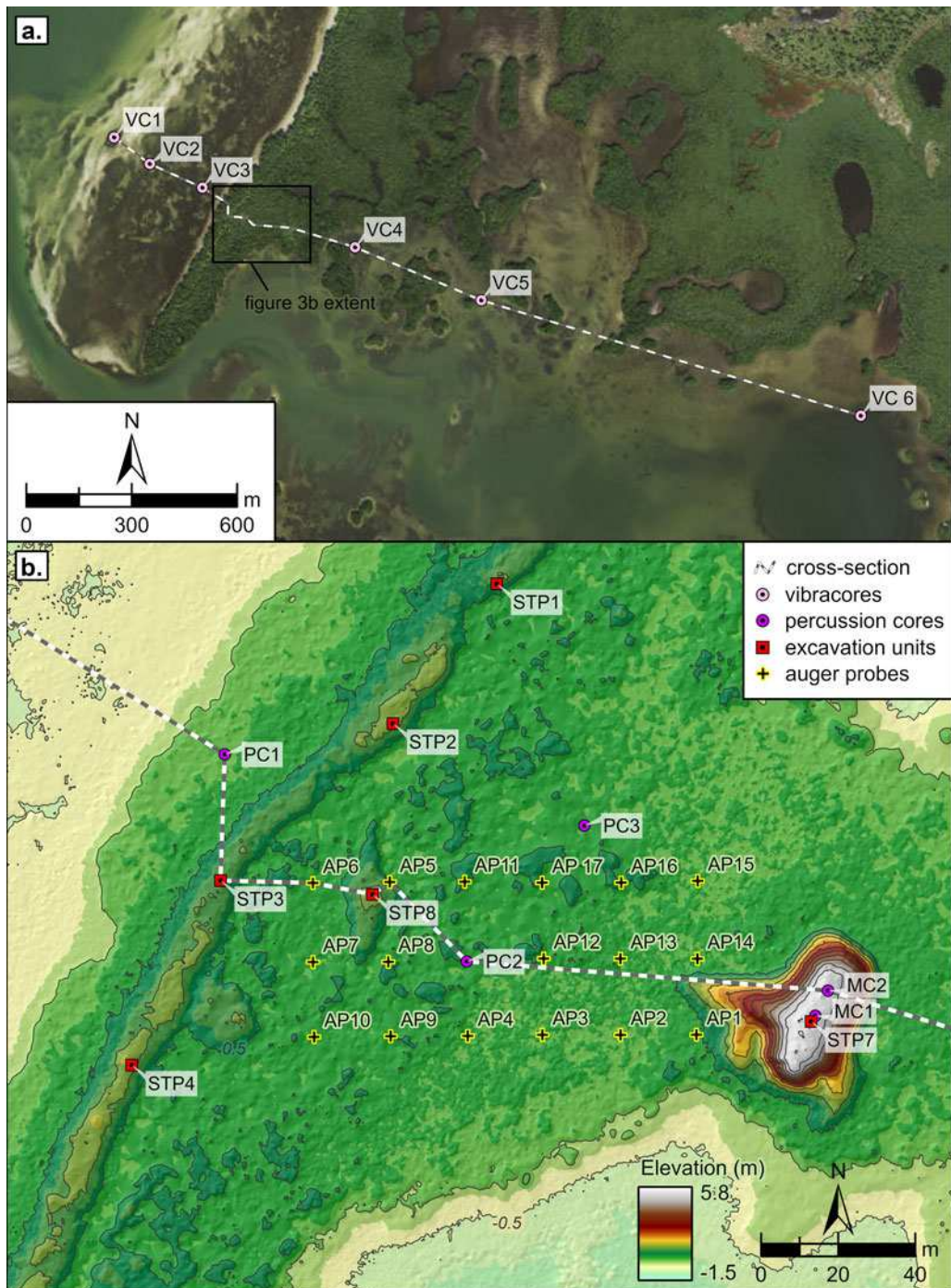


Figure 3. Maps of subsurface sampling across Bishop Harbor and Harbor Key: (a) vibracore locations; (b) sampling locations at Harbor Key. (Color online)

excavation. Attempted auger probing into unit floors at STPs 2, 7, and 8 was blocked by large mollusk shells. We processed the excavated sediments through a 3.2 mm (0.125 in.) screen and collected all observed artifacts and vertebrate faunal remains. Mollusk shell was rough sorted in the field. Due to the large volume of oyster (*Crassostrea virginica*) shell, we counted, weighed, and sampled left

(i.e., bottom) oyster valves bearing a hinge, whereas oyster fragments and right valves were weighed in aggregate. This strategy enabled us to produce accurate taxonomic composition data while also leaving material for backfilling. Small bulk-sediment samples were collected from recognized strata within excavation units for sedimentological analyses.

We collected three percussion cores at Harbor Key using a standard single-section method and 7.6 cm diameter aluminum pipe: one core was in a fringing mangrove swamp seaward of the shoreline ridge (PC1), another was in a mangrove swamp near the center of the plaza (PC2), and a third was in an oblong area of raised shell midden that defines the northern extent of the plaza (PC3). We collected two additional percussion cores from the platform mound summit using a multisection JMC subsurface probe, which enabled us to sample to a maximum depth of 4.5 m. A systematic 20 m grid of auger probes was excavated across the plaza area. Auger probes measured 7.6 cm in diameter and were excavated in 20 cm levels to a maximum depth of 1.5 m. Auger-excavated sediments were processed through 3.2 mm (0.125 in.) mesh, and all captured materials were collected for laboratory sorting and analyses. Surface elevation data for cores, auger probes, and excavation units were corrected to NAVD88; tidal frame elevations were derived from the NOAA datum at Port Manatee (station 8726384).

Laboratory Analyses

After splitting, core samples were described using qualitative assessments of sediment texture, Munsell color, and macrofossil content. Macrobotanical inclusions and organic sediments suitable for AMS-radiocarbon dating were collected; subsequently, cores were subsampled stratigraphically for granulometric, loss-on-ignition, and macrofossil analyses.

Sediment samples from cores and shovel tests were analyzed to produce grain-size distributions for stratigraphic interpretation. Subsamples were dispersed into a sodium hexametaphosphate solution (50 g/L) and agitated regularly over a 12-hour soaking period. After soaking, the samples were wet-sieved through 63 micron (4 phi) mesh, separating coarse and fine fractions. Coarse fractions were dried and processed through standard sieves to yield percent-composition values for sand-sized particles at 0.25 phi intervals. Mean grain size and sorting statistics were calculated by the moment method (i.e., weighted averaging) following Balsillie (1995).

Total organic matter (TOM) and carbonate content (CaCO_3) were derived by sequential loss-on-ignition following established methods (Dean 1974). Crucibles were prepared, weighed, and loaded with 1.5 cm³ of sediment before being weighed again and dried at 60°C for 48 hours. After measuring dry sediment weights, we combusted the samples in a muffle furnace for five hours at 550°C and measured the loss of mass, yielding TOM values. The samples were then combusted again for five hours at 900°C and weighed once more to yield CaCO_3 values.

Analyses of mollusk shell assemblages followed established protocols (Reitz and Wing 2008) and identified all collected shell (>3.2 mm) to the lowest possible taxonomic unit. Intact and fragmentary shells were analyzed to estimate the minimum number of individuals (MNI) for each taxon within an assemblage through the identification of nonrepeating shell features (Mason et al. 1998:307). Because oyster fragments without hinge elements (i.e., not contributing to MNI) were weighed and discarded in the field, we cannot derive reliable estimates of number of identified specimens (NISP) for oysters.

A total of 35 plant-macrofossil and organic-sediment samples were analyzed at the Center for Applied Isotope Studies at the University of Georgia to produce AMS radiocarbon assays. We calibrated raw ¹⁴C dates in OxCal software version 4.4.4 and used IntCal20 to derive probability distributions for calendar ages (Reimer et al. 2020).

To correlate our work with past sea-level dynamics, we used two well-resolved sea-level reconstructions developed from salt-marsh sediment deposits on Florida's Atlantic and Gulf Coasts: a study from the northeast Florida coast by Hawkes and colleagues (2016) that modeled sea-level rise across 25 conservative index points (i.e., basal marsh peats) spanning about 8000–2000 cal BP and a study from Tampa Bay by Gerlach and coworkers (2017) that analyzed botanical and foraminifera datasets to track salt-marsh accretion and model sea-level rise across the common era.

Results

Our program of sampling and analyses enabled us to set the Harbor Key site within a seascape-scale stratigraphic framework, establish chronostratigraphy of the mound complex, and reconstruct site-formation processes. Figure 4 displays a cross-sectional stratigraphic diagram of the major sampling transect across Bishop Harbor and Harbor Key, representing depositional environments and cultural features extending from about -5 m elevation at the base of the deepest vibracore (BH-VC5) to about $+5$ m at the summit of the Harbor Key platform mound (e.g., STP7, MC1, MC2). Radiocarbon dates are presented in Table 1; in this section we report calibrated radiocarbon ages with corresponding 2-sigma error ranges.

Estuarine Sediment Cores

The seaward set of vibracores (VC1, VC2, and VC3) encountered estuarine sediments overlying a sharp contact with Miocene-age limestone (Figure 5). The relatively shallow base rock in the area, coupled with the exposure of the bay's southeastern shoreline to waves from the Gulf of Mexico, has resulted in relatively poor preservation potential for Late Pleistocene and Holocene depositional environments. However, as is typical of the region, karst processes created an uneven limestone surface, and VC2 intersected a depression feature containing well-preserved organic-rich seagrass beds that accumulated between 5380 ± 79 cal BP and 4676 ± 144 cal BP. Sand-flat and shoal deposits bearing layers of shell hash overlie a sharp contact with these buried tidal wetland beds, making up the major portion of the estuarine sedimentary unit seaward of Harbor Key and representing the considerable influence of large waves on the open shoreline during normal and storm conditions. Core VC3 encountered a buried seaward section of the Harbor Key shellworks that overlies a thin paralic or terrestrial soil dated to the mid-Holocene (4467 ± 58 cal BP).

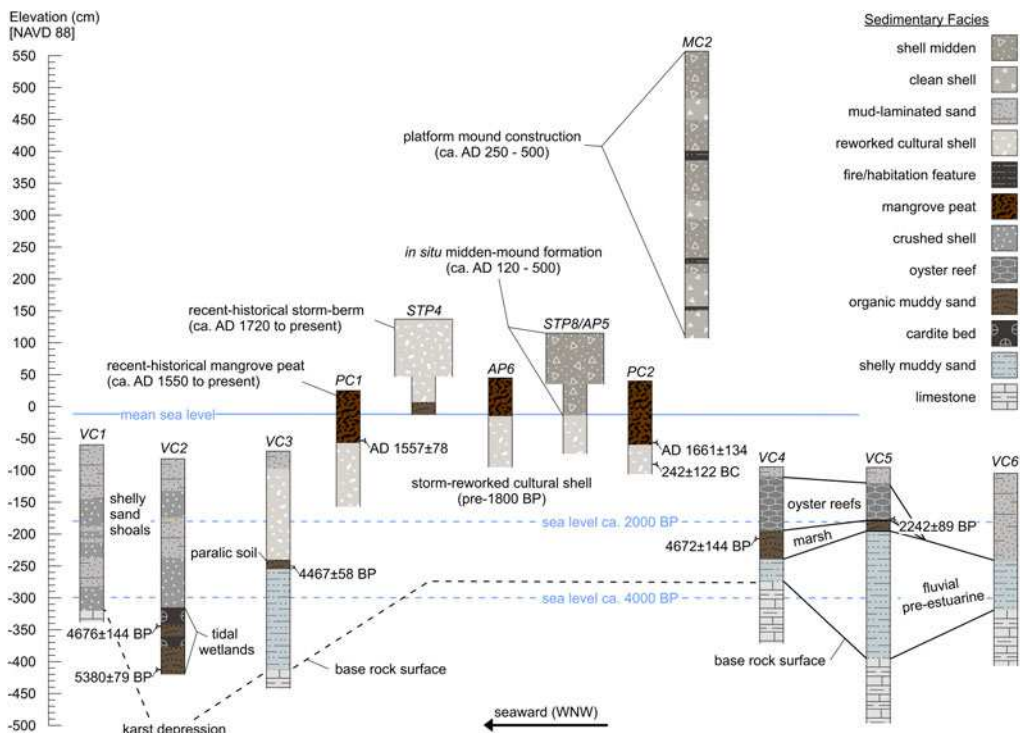


Figure 4. Cross-sectional stratigraphy and interpretation of samples from Bishop Harbor and Harbor Key depicting sedimentary facies and chronostratigraphy. (Color online)

Table 1. Radiocarbon Results from Subsurface Samples Collected at Bishop Harbor and Harbor Key.

Lab-ID (UGAMS#)	Provenience	Material	¹³ C, ‰	¹⁴ C BP	±	pMC	±	68.2% Probability	95.4% Probability	cal BP (2-sigma)
53228	BH-VC2, 262cmbs	Organic sediment	−18.8	4130	25	59.79	0.18	2856–2630 BC	2869–2582 BC	4819–4532 BP
53229	BH-VC2, 330cmbs	Organic sediment	−19.61	4620	25	56.27	0.17	3493–3362 BC	3508–3351 BC	5458–5301 BP
53230	BH-VC3, 182cmbs	Organic sediment	−20.56	3980	25	60.92	0.18	2563–2468 BC	2574–2459 BC	4524–4409 BP
53231	BH-VC4, 112cmbs	Marobotanical	−27.00	4120	25	59.90	0.18	2850–2626 BC	2866–2578 BC	4816–4528 BP
53232	BH-VC5, 80cmbs	Macrobotanical	−25.59	2230	20	75.77	0.21	365–209 BC	381–203 BC	2331–2153 BP
53233	BH-VC6, 135cmbs	Organic sediment	−21.45	790	20	90.62	0.24	AD 1228–1268	AD 1222–1273	728–677 BP
53224	MA15-PC1, 78cmbs	Macrobotanical	−26.00	340	20	95.79	0.25	AD 1497–1631	AD 1479–1635	471–315 BP
53225	MA15-PC2, 96cmbs	Marobotanical	−26.90	260	20	96.85	0.26	AD 1638–1660	AD 1527–1795	423–155 BP
53226	MA15-PC2, 130cmbs	Charcoal	−26.37	2180	30	76.19	0.25	352–174 BC	364–120 BC	2314–2070 BP
53227	MA15-PC3, 120cmbs	Charcoal	−23.58	2090	25	77.11	0.23	149–51 BC	174–1 BC	2124–1951 BP
52467	MA15-STP1, 10–20cmbs	Wood charcoal	−25.24	2110	20	76.91	0.21	165–59 BC	193–50 BC	2143–2000 BP
53973	MA15-STP1, 70–80cmbs	Wood charcoal	−26.10	2010	25	77.84	0.24	BC 43–AD 25	51 BC–AD 77	2001–1873 BP
53974	MA15-STP2, 60–70cmbs	Wood charcoal	−23.06	230	20	97.20	0.27	AD 1650–1795	AD 1640–1800	310–140 BP
53975	MA15-STP3, 70–80cmbs	Wood charcoal	−24.60	190	20	97.70	0.27	AD 1665–1940	AD 1659–1925	291–25 BP
52468	MA13-STP7, 0–10cmbs	Wood charcoal	−26.01	1570	20	82.29	0.23	AD 436–547	AD 431–556	1519–1394 BP
52469	MA13-STP7, 20–30cmbs	Deer bone collagen	−20.42	1680	20	81.12	0.22	AD 365–415	AD 262–420	1688–1530 BP
52470	MA13-STP7, 30–40cmbs	Carya nutshell	−26.75	1660	20	81.30	0.23	AD 382–423	AD 262–528	1688–1432 BP
53977	MA13-STP7, 50–60cmbs	Wood charcoal	−26.94	1750	20	80.41	0.23	AD 250–345	AD 242–375	1708–1575 BP
53978	MA13-STP7, 70–80cmbs	Wood charcoal	−25.24	2010	20	77.89	0.22	41 BC–AD 23	BC 47–AD 62	1997–1888 BP
53979	MA13-STP7, 80–90cmbs	Wood charcoal	−23.02	1850	20	79.41	0.22	AD 134–236	AD 129–238	1821–1712 BP
54624	MA15-STP8, 10–20cmbs	Wood charcoal	−24.76	1560	20	82.36	0.23	AD 438–556	AD 433–566	1517–1384 BP
52466	MA15-STP8, 20–30cmbs	Deer bone collagen	−20.61	1540	20	82.51	0.22	AD 481–575	AD 436–595	1514–1355 BP
53976	MA15-STP8, 70–80cmbs	Wood charcoal	−24.10	1920	25	78.75	0.23	AD 67–201	AD 29–207	1921–1743 BP
53962	MA13-MC1, str.5	Wood charcoal	−23.49	1980	25	78.10	0.24	28 BC–AD 76	41 BC–AD 118	1991–1832 BP

(Continued)

Table 1. Radiocarbon Results from Subsurface Samples Collected at Bishop Harbor and Harbor Key. (*Continued.*)

Lab-ID (UGAMS#)	Provenience	Material	¹³ C, ‰	¹⁴ C BP	±	pMC	±	68.2% Probability	95.4% Probability	cal BP (2-sigma)
53963	MA13-MC1, str.7	Wood charcoal	−25.86	1910	25	78.84	0.23	AD 81–203	AD 61–213	1889–1737 BP
53964	MA13-MC1, str.21	Wood charcoal	−23.01	1810	25	79.87	0.23	AD 215–311	AD 164–332	1786–1618 BP
53965	MA13-MC2, str.4	Wood charcoal	−25.47	1720	25	80.76	0.23	AD 258–383	AD 251–410	1699–1540 BP
53966	MA13-MC2, str.5	Wood charcoal	−24.64	1770	25	80.18	0.24	AD 244–329	AD 231–361	1719–1589 BP
53967	MA13-MC2, str.14	Wood charcoal	−17.64	1900	25	78.98	0.23	AD 89–204	AD 70–215	1880–1735 BP
53968	MA13-MC2, str.17	Wood charcoal	−23.51	1760	20	80.28	0.23	AD 247–337	AD 236–375	1714–1575 BP
53969	MA13-MC2, str.25	Wood charcoal	−23.24	13310	100	19.08	0.24	14210–13896 BC	14352–13763 BC	16302–15713 BP
53970	MA13-MC2, str.36	Wood charcoal	−26.37	2270	25	75.34	0.22	392–234 BC	397–209 BC	2347–2159 BP
53971	MA13-MC2, str.41	Wood charcoal	−25.24	1980	25	78.13	0.23	AD 125–203	AD 80–225	1870–1725 BP
53972	MA13-MC2, str.44	Wood charcoal	−26.31	2090	25	77.12	0.22	149–51 BC	175–1 BC	2125–1951 BP

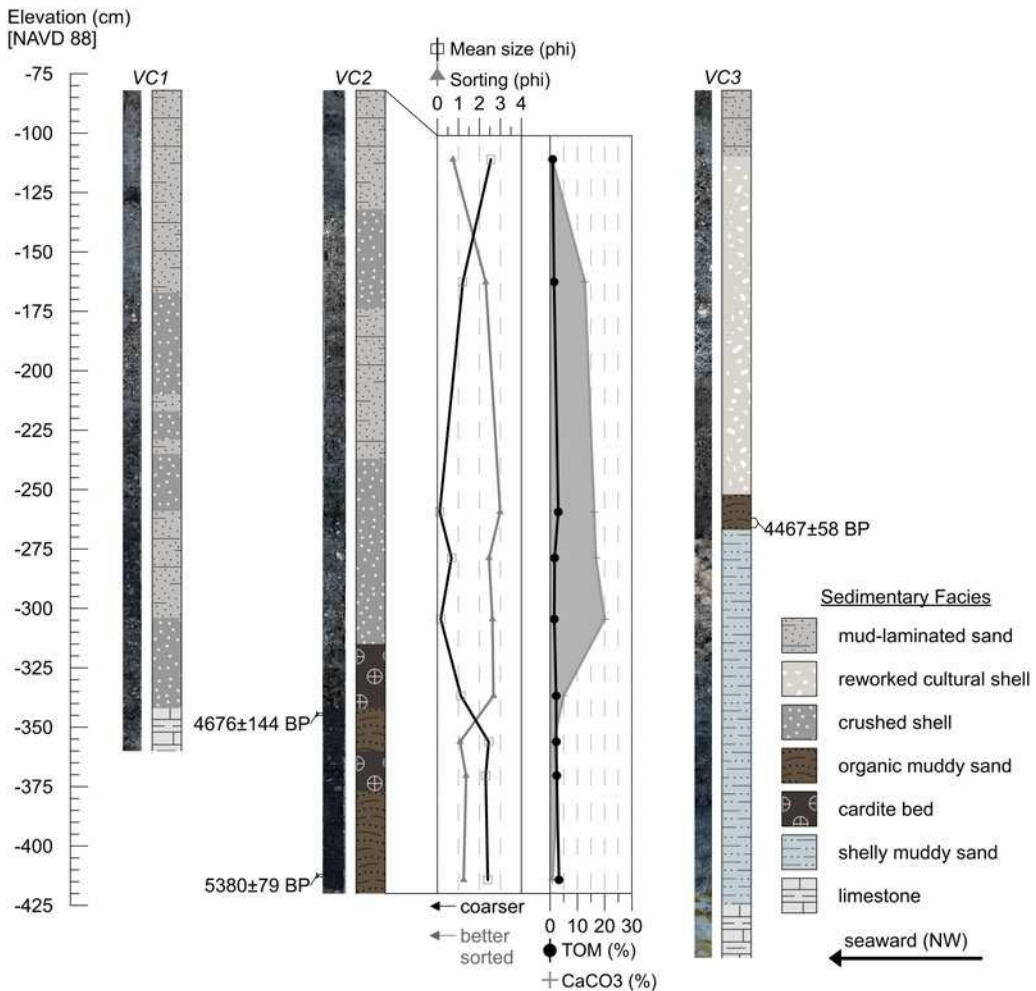


Figure 5. Core photos and diagrams of seaward vibracores (VC1, 2, and 3), with sedimentological data from VC2. (Color online)

Vibracores landward of Harbor Key (VC4, VC5, and VC6) also intersected an uneven limestone surface, overlain by unconsolidated shelly muddy sand beds that represent the reworking of Pleistocene shell deposits within deglacial / Early Holocene fluvial environments (Figure 6). Fluvial marsh sediments accumulated atop the more consolidated shelly substrates at VC4 and VC5 during the mid-Holocene (4672 ± 144 cal BP). Subsequently, after 2242 ± 89 cal BP, oyster bioherms became established at these locations and accreted approximately 1 m of reef before conversion to the modern sand-flat environment (likely around 1000 cal BP). The estuarine unit encountered in VC6, at the head of Bishop Harbor, lacks preserved wetland beds and attests to the relatively recent reworking of unconsolidated sediments by wave action and bioturbation in open areas of the bayou.

Harbor Key Mound Complex (8MA15)

Figure 7 displays the cross-sectional stratigraphy of the Harbor Key site corrected to NAVD88 and set against past and present sea-level stands following Hawkes and colleagues (2016) and Gerlach and coworkers (2017). Cultural shell-bearing deposits extend from about -2.5 m (VC3) to +5.5 m elevation (STP7, MC1, MC2), with approximately 3 m of the site situated below the present mean sea level (MSL)—indicating a deep history of interaction between shellwork formation and coastal dynamics. The buried cultural shell stratum encountered in VC3 and the preserved mid-Holocene estuarine

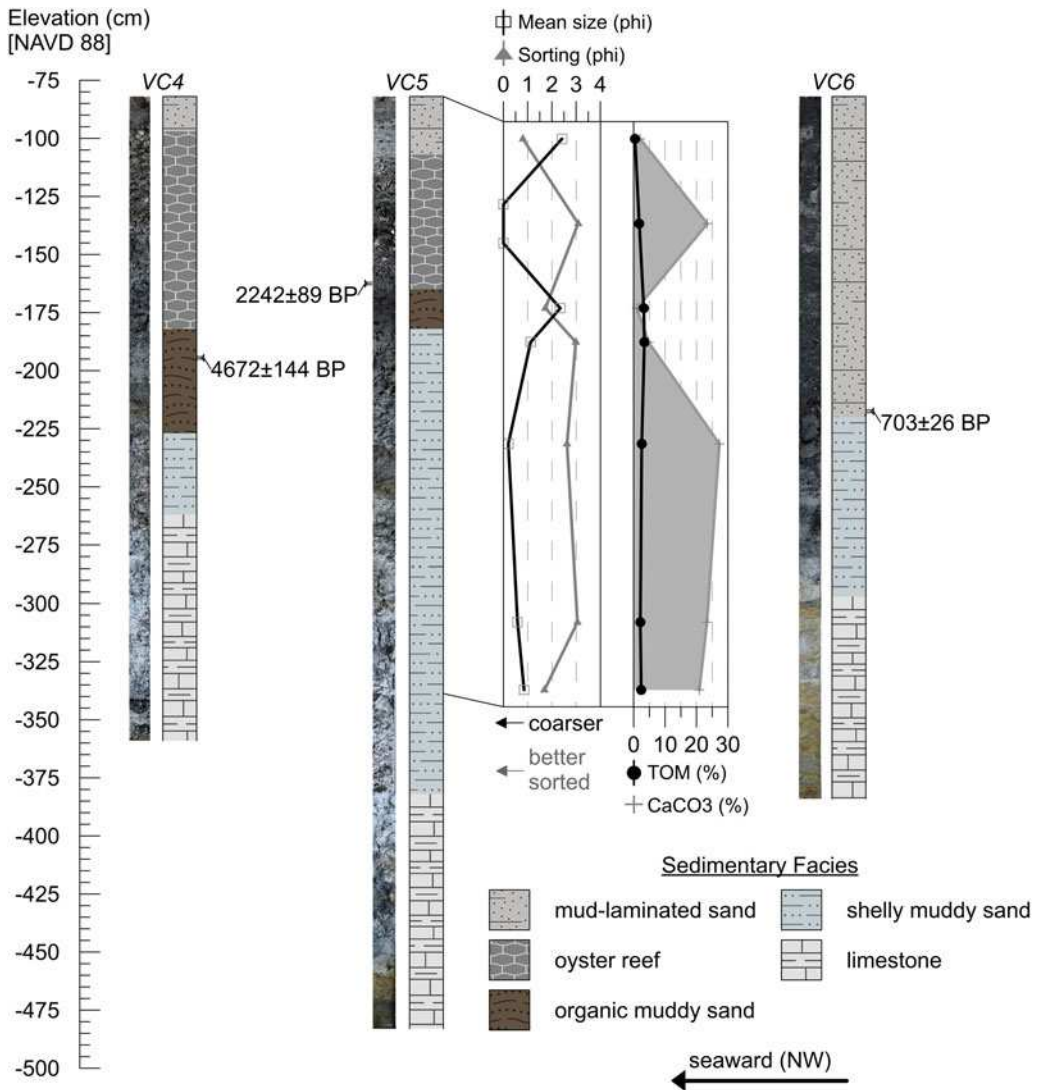


Figure 6. Core photos and diagrams of landward vibracores (VC4, 5, and 6), with sedimentological data from VC5. (Color online)

deposits recovered in VC2 suggest that the settlement at Harbor Key once extended between 100 and 200 m seaward from the present shoreline. In the following subsections we draw on sedimentological, mollusk-zooarchaeological, radiometric, and artifact data to describe site features and reconstruct site-formation processes at Harbor Key.

Harbor Key Platform Mound

The most conspicuous cultural feature at Harbor Key is the approximately 5.5 m tall pyramidal platform mound. The stratigraphy (STP7, MC1, and MC2) and sedimentological data (MC2) from the platform mound reveal numerous layers rich in fine organic sediments consistent with primary mid-dens, buried-A (Ab) horizons, and fire features alternating with larger packages of secondary shell-rich mound fill (Figure 8). STP7 encountered dense deposits of whole and fragmentary shell (538 kg/m³) in a dark-gray sand matrix. The unit produced an assemblage of 7,042 individual mollusks dominated by oyster (63.8%) but also containing an appreciable percentage (21.1%) of large gastropods (principally *Melongena corona*, 15.4%) and an unusual abundance (6.9%) of *Balanus* sp. (Table 2). A thin layer of

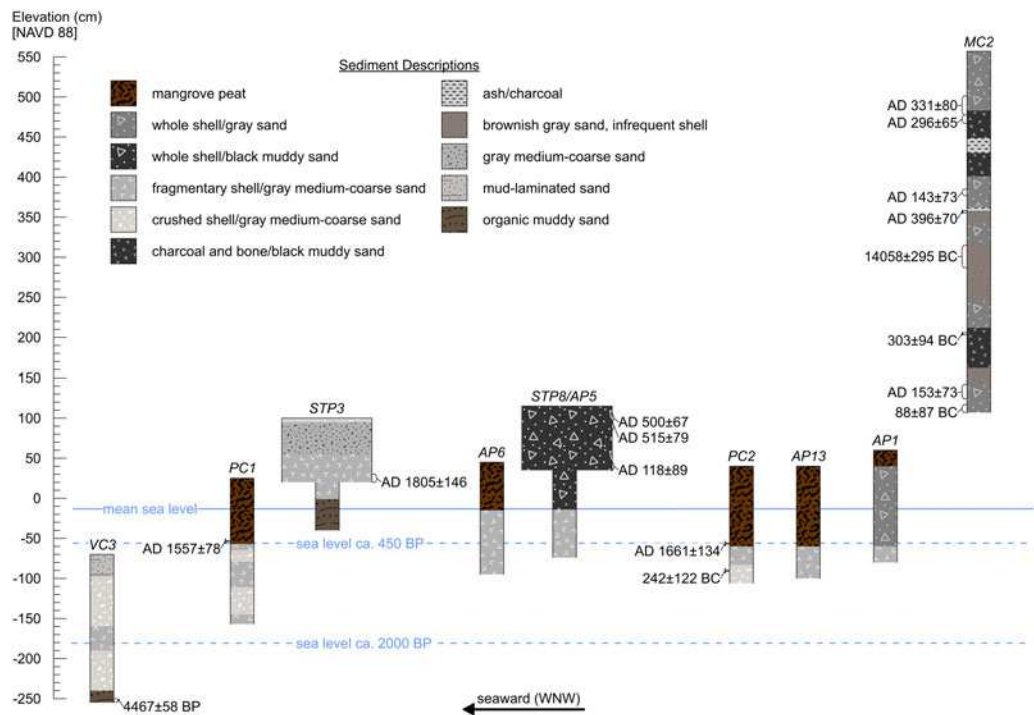


Figure 7. Cross-sectional stratigraphy of subsurface samples from Harbor Key. (Color online)

Table 2. Mollusk-Zooarchaeological Data in MNI and Percent MNI, Aggregated by Site Feature.

Mollusk Taxa	Platform Mound		Bird Mound		Shoreline Ridge		Submound Shell Platform	
	MNI	%	MNI	%	MNI	%	MNI	%
<i>Crassostrea virginica</i>	4,500	63.8	2,289	76.4	6843	52.7	461	46.8
<i>Macrocallista nimbosa</i>	35	0.5	51	1.7	157	1.2	8	0.8
<i>Geukensia</i> sp.	92	1.3	11	0.4	7	0.1	0	0.0
<i>Anomalocardia auberiana</i>	0	0.0	2	0.1	206	1.6	8	0.8
<i>Cardites floridana</i>	84	1.2	24	0.8	454	3.5	22	2.2
<i>Neverita</i> sp.	15	0.2	5	0.2	16	0.1	1	0.1
<i>Crepidula</i> sp.	55	0.8	18	0.6	78	0.6	8	0.8
<i>Cerithium muscarum</i>	12	0.2	45	1.5	2,138	16.5	374	38.0
<i>Prunum apicinum</i>	3	0.0	0	0.0	1,229	9.5	15	1.5
<i>Polygyra</i> sp.	185	2.6	30	1.0	467	3.6	8	0.8
<i>Balanus</i> sp.	492	7.0	41	1.4	33	0.3	2	0.2
<i>Sinistrofulgur sinistrum</i>	161	2.3	101	3.4	283	2.2	1	0.1
<i>Melongena corona</i>	1,089	15.4	143	4.8	352	2.7	14	1.4
<i>Cinctura hunteria</i>	106	1.5	25	0.8	87	0.7	3	0.3
<i>Strombus alatus</i>	38	0.5	123	4.1	115	0.9	11	1.1
Rare mollusk taxa*	182	2.6	88	2.9	527	4.1	48	4.9
Total MNI	7,049	100.0	2,996	100.0	12,992	100.0	984	100.0

* Rare mollusk taxa are those that make up less than 1% of any site feature assemblage.

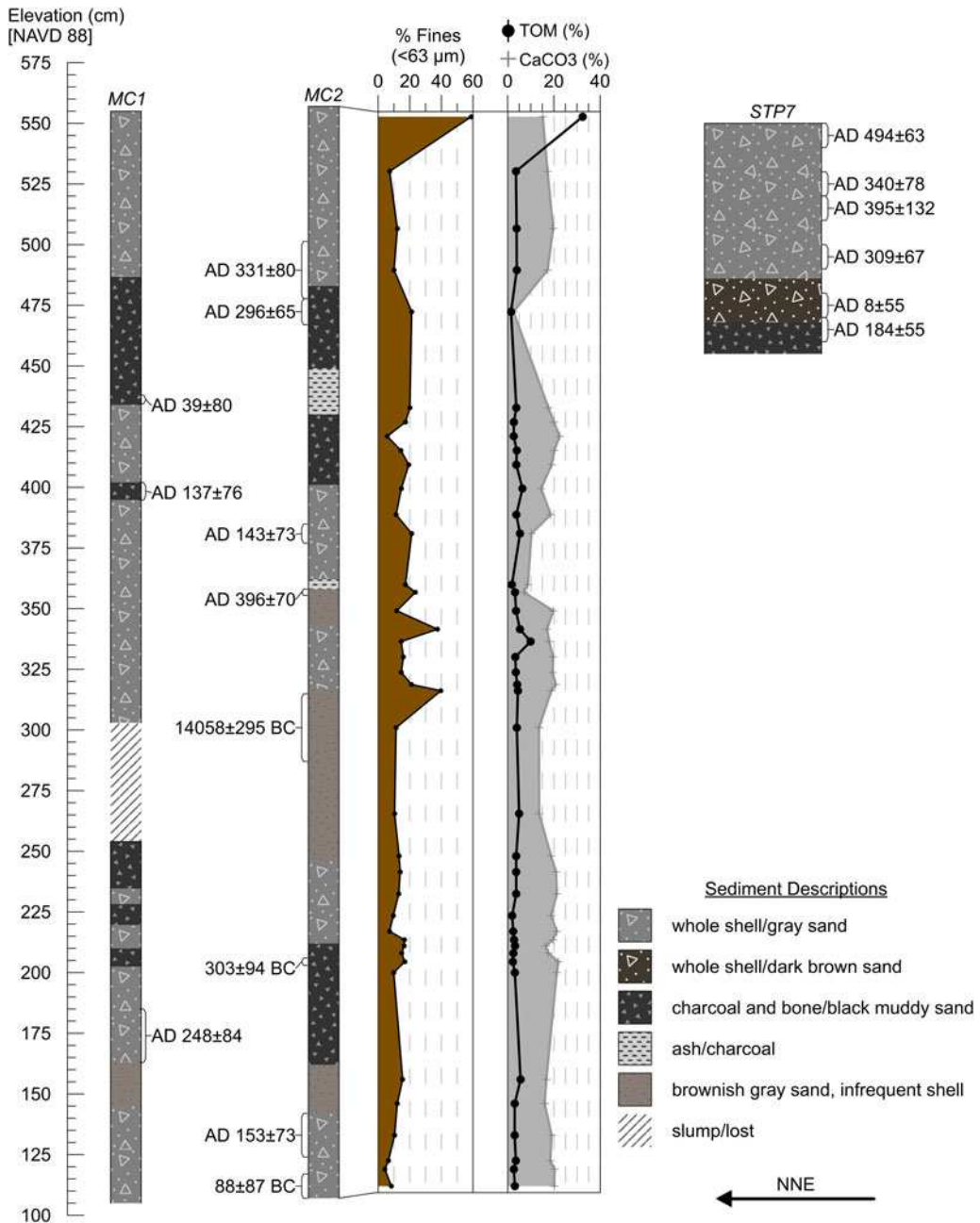


Figure 8. Stratigraphic diagram of subsurface samples from Harbor Key platform mound with sedimentary data from core MC2, displaying numerous fine organic layers consistent with possible activity surfaces. (Color online)

compact charcoal-rich clayey sand with relatively few shells (level 9, 82–85 cmbs) in STP7 yielded an atypical abundance (31.7%) of soil-dwelling terrestrial snails (*Polygyra* sp.) and likely represents a previous platform mound stage. Ceramics were recovered in moderate concentration (750 g/m³) and included smooth and gritty varieties of plain sand-tempered ware. Vertebrate faunal remains were found in greater concentration in STP7 (about 2 kg/m³) than in other site features. Seventeen AMS radiocarbon dates from the upper 4.5 m of the platform mound show several inversions characteristic of mound building with mined secondary fills; however, internal consistency among the dates constrains the construction interval, conservatively, to the first six centuries AD and most likely between

about AD 200 and 600. Notably, our work produced a complete absence of Safety Harbor period dates and justifies the reclassification of Harbor Key platform mound as Middle Woodland period architecture (about AD 200–600).

Bird Mound

Excavations into the Bird Mound (STP8 and AP5) encountered dense whole and fragmentary shell (500 kg/m³) in a dark gray-to-black muddy sand matrix situated between about +1.1 to −0.1 m elevation and exhibiting a distinctive greasy texture typical of primary midden. These sediments, as well as those of adjacent areas at 8MA15 where shell midden features peek through the mangrove-forest floor (e.g., PC3), comprise 59%–71% shell, 21%–37% sand, and 4%–11% mud, with considerable (2%–9%) organic content. Excavation of STP8 produced a total mollusk assemblage of 3,396 individuals dominated by oyster (79.1%), with minor percentages of *M. corona* (4.2%), *Strombus alatus* (3.6%), and *Sinistrofulgur sinistrum* (3%; Table 2). Pottery was recovered in moderate concentration (1,165 g/m³) from STP8 and included gritty sand-tempered plain wares. Three radiocarbon assays from STP8 fall between cal AD 118 ± 89 and 515 ± 79, indicating that Bird Mound and the larger platform mound across the plaza may have been constructed simultaneously.

Shoreline Ridge / Coastal Berm

Excavations along the low (about 1 m tall) shore-parallel ridge were intended to document and sample in situ domestic contexts given that such shoreline midden features in the region have long been interpreted as areas of concentrated occupation (e.g., Luer and Almy 1982). However, our testing revealed that the original morphology and distribution of midden features at Harbor Key were significantly obscured by coastal taphonomy. Within the shoreline ridge we encountered a distinctive reworked sediment unit comprising medium-fine quartz sand (27%–97%) and shell (315 kg/m³), with superimposed fining-upward sequences and buried lenses of weathered wrack (Figure 9). ANOVAs confirm that sand (0.063–2.0 mm) and medium sand (0.0125–0.5 mm) are significantly more abundant within the shoreline ridge than in adjacent mound or midden contexts (Supplemental Tables 1 and 2). Excavations into the shoreline ridge produced a total mollusk MNI of 12,992 (Table 2). The most striking pattern within the assemblage is the relative abundance of small tidal-zone gastropods (27.8%), including *Cerithium* sp. (17%), *Prunum apicinum* (9.5%), and several rarer taxa (1.8%). ANOVAs confirm that shoreline ridge sediments contain significantly higher relative frequencies of small tidal-zone snails than mound or midden contexts (Supplemental Table 3). These small gastropod shells frequently retain their natural pigments, suggesting rapid burial, whereas the remainder of the mollusk assemblage (53% *C. virginica*, 2.7% *M. corona*, and 2.1% *S. sinistrum*) has been sub-aerially weathered much like the cultural shell within the adjacent mound and midden features. Pottery, bone points/pins, and shell scoops/spoons occur within the shoreline ridge in a low to moderate concentration (e.g., pottery = 624 g/m³). Almost without exception, artifacts recovered from the shoreline ridge exhibit substantial rounding and polish by wave-induced abrasion (Supplemental Figure 4). Radiocarbon assays on buried charcoal inclusions from near-surface and basal levels of STP1 produced inverted dates, and charcoal inclusions recovered from buried contexts at STP2 (60–70 cmbs) and STP3 (70–80 cmbs) yielded recent-historical dates. Synthesizing these characteristics and drawing on experience monitoring post-storm effects at estuarine shellworks in the region, we interpret the shoreline ridge at Harbor Key as a coastal berm produced under storm conditions—where tidal surge and large waves entrain seaward-lying sediment beds (including cultural deposits eroding from the sand flats) and small tidal-zone gastropods (clustered within fringing mangrove forest habitats) and deposit them landward.

Supra-Plaza Mangrove Peat Bed

The plaza at Harbor Key is a low-lying (i.e., intertidal) and flat area (about 9,000 m²) bounded by the site's mounded features that supports a dense forest of mature mangroves (*Avicennia germinans* and *Rhizophora mangle*). Our survey of the area consistently located the uppermost surface of the former plaza beneath about 0.5 m of mangrove peat. Basal peat samples collected near the contact with the

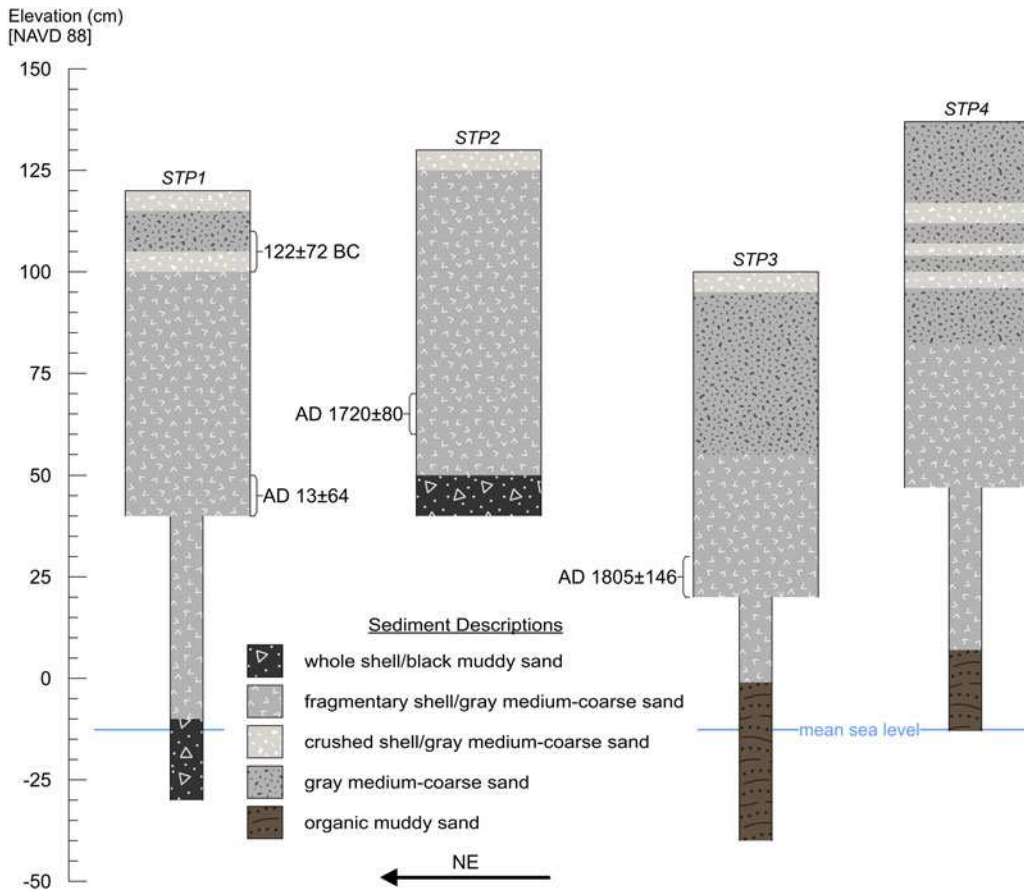


Figure 9. Stratigraphic diagram of subsurface samples from the shoreline ridge / coastal berm. (Color online)

buried plaza surface in PC1 and PC2 (about -0.55 m elevation) yielded radiocarbon ages (cal AD 1557 ± 78 and cal AD 1661 ± 134 , respectively) consistent with the expected incipient tidal inundation of the ancient plaza following the sea-level curve by Gerlach and colleagues (2017).

Submound Shell Platform

Extending beneath the plaza surface (PC2, AP2-4, AP6-17) we encountered a shell-rich (310 kg/m^3) sedimentary unit exhibiting striking similarity to the shoreline ridge/coastal berm. Importantly, we also documented this same reworked sediment deposit beneath the base of the platform mound (AP1), the base of the Bird Mound (AP5), raised midden areas (PC3, PC15), and the modern tidal flat (VC3). Our mapping and analyses of this sediment deposit suggest that the sub-aerial (currently inter- and supratidal) features of the Harbor Key mound complex were built atop a previously undocumented platform of sand and reworked cultural shell. Within these buried (currently subtidal) deposits, total sand (45%–82%) and medium sand (17%–40%) are conspicuously abundant, and the samples group with coastal berm sediments in ANOVA-based comparisons of site features (Supplemental Tables 1 and 2). Submound platform sediments also exhibit the superimposed fining-upward sequences observed in the coastal berm, consistent with deposition during high-energy storm conditions (Figure 10). Cores and auger probes from the submound platform produced a total mollusk MNI of 984 (Table 2). As within the shoreline ridge assemblage, these deposits contain a conspicuously high relative abundance of small tidal-zone gastropods (42%), particularly *Cerithium* sp. shells (38%) with preserved pigments (suggesting rapid burial). The ANOVA-based comparison of small tidal-zone gastropod abundance among site features grouped the submound platform samples with those from the

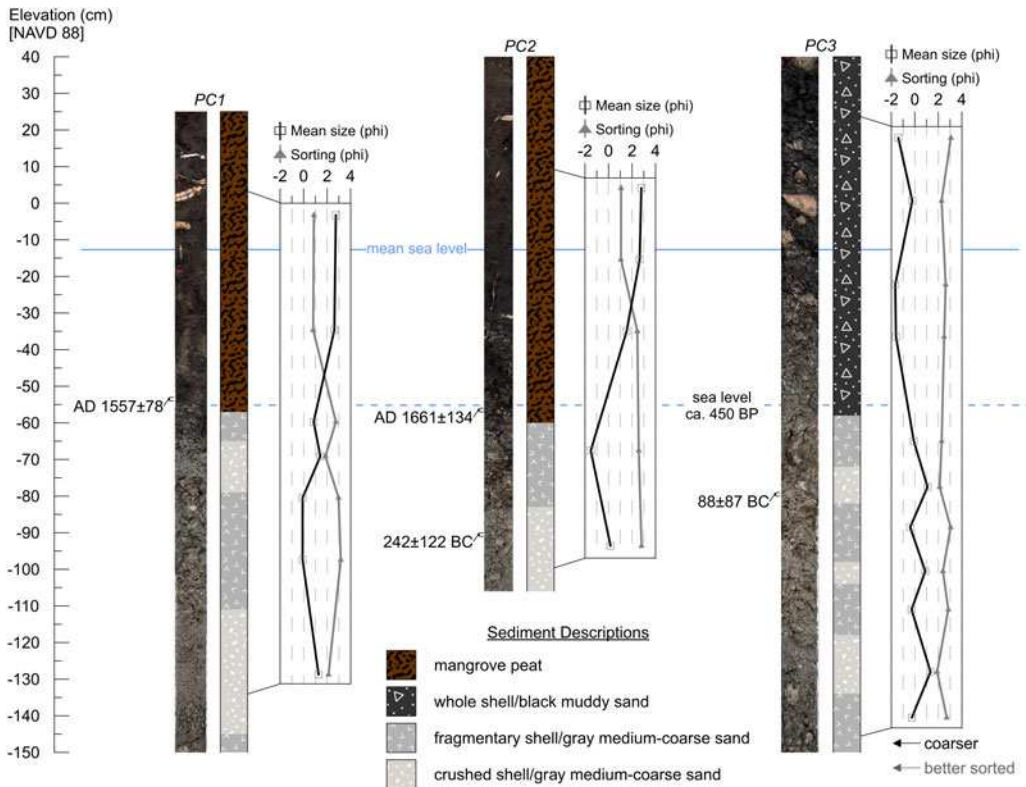


Figure 10. Core photos and diagrams of subsurface samples from lower-elevation areas at Harbor Key (PC1, 2, and 3) with granulometric data depicting superimposed fining-upward sequences (high-energy event bedding) in the submound shell platform feature. (Color online)

coastal berm and showed significant differences from mound and midden sediments (Supplemental Table 3). Submound platform deposits also contain ceramics and vertebrate faunal material throughout (ubiquity = 0.82), and all recovered pottery sherds exhibit rounding and polish consistent with wave-induced abrasion (Supplemental Figure 5). Charcoal inclusions recovered from submound platform deposits in PC2 and PC3 yielded dates (cal 242 ± 122 BC and 87 ± 87 BC, respectively) that precede the construction of the Bird Mound and platform mound (Figure 10). Given the recovery of predominantly modern/recent-historical charcoal inclusions from the extant coastal berm/shoreline ridge feature, these late BC dates from the buried reworked deposits may best indicate the interval of disturbance and redeposition. Although the submound platform deposits extended below the maximum sampling depth in the plaza area and beneath mounds (about 1.5 m), core VC3 intersected this sedimentary unit and located a basal contact at about a -2.5 m elevation atop a paralic soil dated 4467 ± 58 cal BP—suggesting a thickness of approximately 2 m and providing a tentative terminus post quem for the early shellwork deposition. Much like the extant coastal berm feature forming the shore-parallel ridge, our testing suggests that the buried shell-rich sedimentary unit underlying the mound center is composed of antecedent cultural shell deposits (about 2450–1 BC) that were reworked by ancient storms. Given the level upper surface of this feature, we presume that Native people recontoured and otherwise artificially prepared the submound shell platform to provide a raised foundation for the Middle Woodland mound complex.

Discussion

Sedimentary records preserved within the Bishop Harbor sub-basin reveal that productive and relatively low-energy estuarine habitats (for example, seagrass beds and coastal marsh) were established

both landward and seaward of Harbor Key by the mid-Holocene—contemporaneous with the broader expansion of paralic wetlands within central peninsular Gulf Coast estuaries. New stratigraphic data from buried—now subtidal—contexts at Harbor Key attest to Native occupation during the Mid- to Late Holocene (likely 2450–1 BC), which is consistent with the recovery of fiber-tempered ceramics from seaward tidal flats (Burger 1979). Major transformations of the inshore estuarine zone by about AD 200 into more open, wave-dominated environments brought on by sea-level rise and increased hurricane landfall resulted in the erosion and reworking of early shell-bearing components at Harbor Key—producing coastal berm-like features composed of quartz sand, *ex situ* cultural mollusk shell, taphonomic mollusk-inclusions (small tidal-wetland dwelling gastropods), and wave-abraded artifacts. With subsequent sea-level rise and continued terraforming by Indigenous people, these features came to make up the major topographic barrier protecting Bishop Harbor’s shallow estuarine habitats from the energetic conditions of the open bay and swells from the nearby Gulf of Mexico during storms. As marine transgression transformed Bishop Harbor from a restricted tidal creek system into a shallow open-water basin, Indigenous shellworks constrained the mouth of the drainage to form a relatively deep and narrow (and thus, stable) tidal inlet. While the transition to open estuarine conditions generated significant erosional forcing in exposed areas of the sub-basin, Indigenous shellworks at Harbor Key provided protection for landward inshore zones where oyster reefs and seagrass meadows established and proliferated.

Radiocarbon dates on the sub-aerial shell mound architecture at Harbor Key indicate that Native peoples reinitiated mound building by about AD 200 and continued using the ceremonial center until around AD 600. These data falsify at least 70 years of faulty interpretation based on the uncritical typological association of flat-topped pyramidal platform mounds (or “temple mounds”) with the Safety Harbor period (after AD 1000) and Native societies described in early European accounts from the region (Bullen 1955; Luer and Almy 1981). Our chronological revision at Harbor Key parallels a larger trend in southeastern archaeology toward recognizing the early emergence of platform mound ceremonialism (Kassabaum 2021; Thompson et al. 2022) and early monumental architecture in general (e.g., Saunders et al. 2005; Schwadron 2017). The temporality, monumental scale, arrangement, and elaborate morphology of the shellwork complex place Harbor Key among relatively few early civic-ceremonial centers documented on the Florida peninsula where relatively dense populations aggregated around ritually charged locations bearing evidence of ancestral—Late Archaic to Early Woodland—land use (Lawres and Colvin 2021; Pluckhahn and Thompson 2018; Sassaman et al. 2020; Wallis and McFadden 2019; Wallis et al. 2022). Previously studied early civic-ceremonial centers in the region are concentrated along Florida’s northern Gulf Coast, with conspicuous inland peninsular examples (e.g., 8GL23, 8PB6292) set within the Lake Okeechobee basin (Figure 1). The present study at Harbor Key, along with recent work at Cockroach Key (8HI2; Pluckhahn et al. 2022b) and Bayshore Homes (8PI41; Austin and Mitchem 2014), indicates that mound centers on the central peninsular Gulf Coast may have served as important nodes of interaction and exchange within ritual and political economies that connected Native peoples from the southern peninsula to the greater southeastern coastal plain and farther afield (Pluckhahn et al. 2020). Our findings call for further investigation of understudied mound centers on the central and southern Florida Gulf Coast, particularly sites at the mouths of the Anclote (e.g., 8PA10) and Pithlachascotee Rivers (e.g., 8PA2), as well as shell mounds within Charlotte Harbor, Pine Island Sound, and Estero Bay.

Despite compelling temporal and architectural similarities, Harbor Key demonstrates previously unrecognized variation in the stratigraphy and formation histories of early civic-ceremonial centers. At Spring Warrior (8TA154), Garden Patch (8DI4), Shell Mound (8LV42), and Crystal River (8CI1), common era mound complexes were built atop quartz-sand substrates associated with relic marine terraces or remnants of terminal Pleistocene parabolic dune ridges where ancestral peoples had developed mortuaries. In contrast, Native peoples constructed the civic-ceremonial complex at Harbor Key atop a large platform of storm deposits comprising largely *ex situ* ancestral shellworks. At a seascape scale, the Late Holocene geoarchaeological record from Bishop Harbor suggests that morphodynamic interactions between Indigenous shell terraforming, storm landfalls, and sea-level rise conditioned estuarine development in the leeward bayou by limiting fetch, attenuating waves,

and detaining terrestrial freshwater input—all of which likely aided the establishment and persistence of inshore tidal wetland systems, such as oyster reefs and sea-grass meadows. Research on modern artificial reefs (e.g., Donadi et al. 2013; Hancock and zu Ermgassen 2019) and First Nations' terraformed estuarine terrace-gardens (e.g., Augustine and Dearden 2014; Grosbeck et al. 2014) demonstrates that anthropogenic coastal-estuarine barriers can modify habitats and augment ecological production at spatially extended scales; that is, tens to hundreds of meters leeward. Along the Northwest Coast, such features came to play important roles within Indigenous systems of proprietorship, sea tenure, and resource redistribution (Deur and Turner 2005; Grier et al. 2017). We propose that, by altering the character and distribution of leeward estuarine habitats, Native shell-terraforming at Harbor Key coproduced spaces in which subsequent social relations took/take place and in which relationships between humans and nonhuman biota were/are negotiated. Renewed/sustained civic-ceremonial aggregation and mound building at Harbor Key during the early common era indicates that Native peoples recognized and took advantage of the morphodynamic effects produced by reworked ancestral sites and the associated augmentation of inshore estuarine production. Indeed, Middle Woodland-period ceremonial provisioning—feasting—at Harbor Key almost certainly involved harvesting leeward resources supported by centuries to millennia of ancestral land use and terraforming.

Despite the apparent ecological suitability of the seascape for continued intensive settlement, as observed at civic-ceremonial centers along the Northern Gulf Coast, archaeological evidence suggests the decline of depositional activities—habitation, mound building, and the like—at Harbor Key after around AD 600, as well as apparently scrupulous avoidance by descendant Safety Harbor period peoples. However, there is compelling and unambiguous ethnohistoric evidence from the sixteenth century that Native peoples in Lower Tampa Bay used large artificial estuarine enclosures—much like the artificially enclosed Harbor Key / Bishop Harbor sub-basin—to facilitate the mass capture of fishes and other fauna (see Pluckhahn et al. 2022a), suggesting that ancestral terraformed sites like Harbor Key continue to function as durable coastal infrastructures.

Conclusions

In this study, we apply a coastal-geoarchaeological approach to the shell-terraformed Indigenous mound complex at Harbor Key and the Holocene sedimentary record preserved within Bishop Harbor, an inshore sub-basin of Tampa Bay on the central peninsular Gulf Coast of Florida. Synthesizing sedimentological, mollusk-zooarchaeological, and chronostratigraphic data, we set the Harbor Key shellworks into a seascape-scale geologic and paleoenvironmental framework, significantly revising the chronological and stratigraphic understanding of the site and reconstructing a complex history of interaction between coastal processes—sea-level rise, hurricane landfalls, and wave forcing—and Native American land use. These interactions played out through the erosional reworking of early (Late Archaic to Early Woodland, about 2450–1 BC) shell-bearing sites by ancient storms. The resulting landform provided a supratidal barrier that protected Bishop Harbor from energetic conditions and produced recursive biophysical effects in the leeward bayou that were favorable for the establishment and proliferation of inshore oyster reefs and other tidal wetland habitats. Subsequently, across the first half-millennium AD, Native peoples took advantage of these conditions to provision civic-ceremonial aggregations and construct a shell mound complex at Harbor Key atop a large platform composed of antecedent storm-reworked cultural deposits. We contend that the construction of the early common era mound center at Harbor Key represents monumental placemaking that materializes the recognition and reuse of ancestral shellworks, as well as the persistent management of the encompassing seascape.

Acknowledgments. We dedicate this article to the memory of archaeologist B. W. Burger (1951–2022) in recognition of his lifelong devotion to the preservation and study of Tampa Bay's natural and historical resources. We also thank Jeff Moates, Libby Royer, Chandler Burchfield, and Morrison Hatlen for invaluable assistance with field and laboratory work. Finally, we thank two anonymous reviewers for insightful comments that improved the quality of this article. Sampling permits were granted by the Florida Department of Environmental Protection (permit 10301914) and the Florida Division of Historical Resources (permit 1920.045).

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Data Availability Statement. The data used in this study are available online at tdar.org on request from the corresponding author.

Competing Interests. The authors declare none.

Supplemental Material. For supplemental material accompanying this article, visit <https://doi.org/10.1017/aaq.2023.45>.

Supplemental Figure 1. 2021 Aerial lidar derived topobathymetric model of Bishop Harbor, Lower Tampa Bay.

Supplemental Figure 2. 1874 US Coast and Geodetic Survey Topographic Chart No. 1346B depicting Bishop Harbor, Lower Tampa Bay.

Supplemental Figure 3. 2021 Aerial lidar derived topographic model of Harbor Key Platform Mound, 50 cm contour intervals.

Supplemental Figure 4. Wave-abraded artifacts from the shoreline ridge/coastal berm.

Supplemental Figure 5. Wave-abraded artifacts from the submound shell platform.

Supplemental Text 1. 1920–1921 correspondence between C. T. Earle Jr. and Jesse W. Fewkes.

Supplemental Text 2. 1934 correspondence between Montague Tallant and Matthew Stirling.

Supplemental Table 1. Results of ANOVA Comparing Percent Sand (0.063–2.0 mm) by Site Feature.

Supplemental Table 2. Results of ANOVA Comparing Percent Medium Sand (0.125–0.25 mm) by Site Feature.

Supplemental Table 3. Results of ANOVA Comparing Percent MNI for Small Tidal-Zone Gastropods by Site Feature.

References Cited

- Anderson, David G., David Echeverry, D. Shane Miller, Andrew A. White, Stephen J. Yerka, Eric Kansa, Sarah Whitcer Kansa, et al. 2019. Paleoindian Settlement in the Southeastern United States: The Role of Large Databases. In *New Directions in the Search of the First Floridians*, edited by David K. Thulman and Garrison G. Ervan, pp. 241–275. University Press of Florida, Gainesville.
- Arco, Lee J., Katherine A. Adelsberger, Ling-yu Hung, and Tristram R. Kidder. 2006. Alluvial Geoarchaeology of a Middle Archaic Mound Complex in the Lower Mississippi Valley, U.S.A. *Geoarchaeology* 21:591–614.
- Augustine, Skye, and Philip Dearden. 2014. Changing Paradigms in Marine and Coastal Conservation: A Case Study of Clam Gardens in the Southern Gulf Islands. *Canadian Geographer* 58(3):305–314.
- Austin, Robert J., and Jeffrey M. Mitchem. 2014. Chronology, Site Formation, and the Woodland-Mississippian Transition at Bayshore Homes, Florida. *Southeastern Archaeology* 33(1):68–86.
- Austin, Robert J., Jeffrey M. Mitchem, and Brent R. Weisman. 2014. Radiocarbon Dates and the Late Prehistory of Tampa Bay. In *New Histories of Pre-Columbian Florida*, edited by Neil J. Wallis and Asa R. Randall, pp. 94–120. University Press of Florida, Gainesville.
- Balsillie, James H. 1995. *William F. Tanner on Environmental Clastic Granulometry*. Special Publication No. 40. Florida Geological Survey, Tallahassee.
- Bullen, Ripley P. 1955. Archaeology of the Tampa Bay Area. *Florida Historical Quarterly* 34:51–63.
- Bullen, Ripley P., Graham R. Reeder, Bonnie Bell, and Blake Whisenant. 1952. The Harbor Key Site, Manatee County, Florida. *Florida Anthropologist* 5(1–2):21–23.
- Burger, B. William. 1979. Man in the Coastal Zone: Bishop Harbor/Terra Ceia Island, Manatee County, Florida. Master's thesis, Department of Anthropology, New College of Florida, Sarasota.
- Claassen, Cheryl. 1991. Normative Thinking and Shell-Bearing Sites. *Advances in Archaeological Method and Theory* 3:249–298.
- Collingwood, Robin G. 1945. *The Idea of Nature*. Clarendon, Oxford.
- Cook-Hale, Jessica W., Nathan L. Hale, and Ervan G. Garrison. 2019. What Is Past Is Prologue: Excavations at the Econfinia Channel Site, Apalachee Bay, Florida, USA. *Southeastern Archaeology* 38:1–22.
- Cowell, Peter J., and Bruce G. Thom. 1995. Morphodynamics of Coastal Evolution. In *Coastal Evolution: Late Quaternary Shoreline Morphodynamics*, edited by R. W. G. Carter and C. D. Woodroffe, pp. 33–86. Cambridge, Cambridge University Press.
- Cronin, Thomas, Gregg Brooks, David Hastings, Rebekka Larson, Albert Hine, Stanley Locker, Beau Southard, et al. 2007. Sea-Level Rise in Tampa Bay. *EOS* 88(10):117–118.
- Cushing, Frank H. 1897. Explorations of Ancient Key-Dweller Remains on the Gulf Coast of Florida. *Proceedings of the American Philosophical Society* 35:329–448.
- Dean, Walter E. 1974. Determination of Carbonate and Organic Matter in Calcareous Sediments and Sedimentary Rocks by Loss on Ignition: Comparison with Other Methods. *Journal of Sedimentary Petrology* 44:242–248.
- Deur, Douglas, and Nancy Turner (editors). 2005. *Keeping It Living: Traditions of Plant Use and Cultivation on the Northwest Coast of North America*. University of Washington Press, Seattle.
- Donadi, Serena, Tjisse van der Heide, Els M. van der Zee, Johan S. Eklof, Johan van de Koppel, Ellen J. Weerman, Theunis Piersma, Han Olf, and Britas Klemens Eriksson. 2013. Cross-Habitat Interactions among Bivalve Species Control Community Structure on Intertidal Flats. *Ecology* 94(2):489–498.
- Gamble, Lynn H. 2017. Feasting, Ritual Practices, Social Memory, and Persistent Places: New Interpretations of Shell Mounds in Southern California. *American Antiquity* 82(3):427–451.

- Gerlach, Matthew J., Simon E. Engelhart, Andrew C. Kemp, Ryan P. Moyer, Joseph M. Smoak, Christopher E. Bernhardt, and Niamh Cahill. 2017. Reconstructing Common Era Relative Sea-Level Change on the Gulf Coast of Florida. *Marine Geology* 390:254–269.
- Goodbred, Stephen, Eric Wright, and Albert Hine. 1998. Sea-Level Change and Storm Surge Deposition in a Late Holocene Florida Salt Marsh. *Journal of Sedimentary Research* 68:240–252.
- Grier, Colin, Bill Angelbeck, and Eric McLay. 2017. Terraforming and Monumentality as Long-Term Social Practice in the Salish Sea Region of the Northwest Coast of North America. *Hunter-Gatherer Research* 3(1):107–132.
- Groesbeck, Amy S., Kirsten Rowell, Dana Lepofsky, and Anne K. Salomon. 2014. Ancient Clam Gardens Increased Shellfish Production: Adaptive Strategies from the Past Can Inform Food Security Today. *PLoS ONE* 9(3):e91235.
- Halligan, Jessi J. 2021. Crossing the Waterline: Integrating Terrestrial and Submerged Site Investigations in the Aucilla River, Florida. *Journal of Island and Coastal Archaeology* 16:46–63.
- Hancock, Boze, and Philine zu Ermgassen. 2019. Enhanced Production of Finfish and Large Crustaceans by Bivalve Reefs. In *Goods and Services of Marine Bivalves*, edited by Aad C. Smaal, Joao G. Ferreira, Jon Grant, Jens K. Petersen, and Øivind Strand, pp. 295–312. Springer, Cham, Switzerland.
- Hawkes, Andrea D., Andrew C. Kemp, Jeffrey P. Donnelly, Benjamin P. Horton, W. Richard Peltier, Niamh Cahill, David F. Hill, et al. 2016. Relative Sea-Level Change in Northeastern Florida (USA) during the Last ~8.0 ka. *Quaternary Science Reviews* 142:90–101.
- Hine, Albert C., Beau C. Suthard, Stanley D. Locker, Kevin J. Cunningham, David S. Duncan, Mark Evans, and Robert A. Morton. 2009. *Karst Sub-Basins and Their Relationship to the Transport of Tertiary Siliciclastic Sediments on the Florida Platform*. International Association of Sedimentologists. Special Publication 41. IAS, Ghent, Belgium.
- Jackson, Kendal, Ping Wang, Thomas J. Pluckhahn, Jaime A. Rogers, and Victor D. Thompson. 2023. Stratigraphic Framework, Paleoenvironments, and Indigenous Terraforming of Inshore Estuarine Subbasins in Tampa Bay, Florida, USA. *Journal of Coastal Research* 39(5).
- Joy, Shawn. 2019. The Trouble with the Curve: Reevaluating the Gulf of Mexico Sea-Level Curve. *Quaternary International* 525:103–113.
- Kassabaum, Megan C. 2021. *A History of Platform Mound Ceremonialism: Finding Meaning in Elevated Ground*. University Press of Florida, Gainesville.
- Klokler, Daniela. 2017. Shelly Coast: Constructed Seascapes in Southern Brazil. *Hunter-Gatherer Research* 3(1):87–105.
- Lanesky, Douglas E., Brian W. Logan, Raymond G. Brown, and Albert C. Hine. 1979. A New Approach to Portable Vibracoring Underwater and on Land. *Journal of Sedimentary Research* 49:654–657.
- Lawres, Nathan R., and Matthew H. Colvin. 2021. Variability in Belle Glade II Period (A.D. 200–1000) Monumental Construction: Big Gopher Mound Complex, Architectural Morphology, and the Timing of Construction. *Florida Anthropologist* 74(1):27–46.
- Luer, George R. and Marion M. Almy. 1981. Temple Mound of the Tampa Bay Area. *Florida Anthropologist* 34(1):127–155.
- Luer, George R. and Marion M. Almy. 1982. A Definition of the Manasota Culture. *Florida Anthropologist* 35(1):34–58.
- Marquardt, William H. 2010. Shell Mounds in the Southeast: Middens, Monuments, Temple Mounds, Rings or Works? *American Antiquity* 75(3):551–570.
- Marquardt, William H., Karen J. Walker, Victor D. Thompson, Michael Savarese, Amanda D. Roberts Thompson, and Lee A. Newsom. 2022. Episodic Complexity and the Emergence of a Coastal Kingdom: Climate, Cooperation, and Coercion in Southwest Florida. *Journal of Anthropological Archaeology* 65:101364.
- Mason, Roger D., Mark L. Peterson, and Joseph A. Tiffany. 1998. Weighing vs. Counting: Measurement Reliability and the California School of Midden Analysis. *American Antiquity* 63(2):303–324.
- McFadden, Paulette, S. 2016. Coastal Dynamics and Pre-Columbian Human Occupation in Horseshoe Cove on Northern Gulf Coast, Florida, USA. *Geoarchaeology* 31:355–375.
- Moore, Clarence B. 1900. Certain Antiquities of the Florida West Coast. *Journal of the Academy of Natural Sciences of Philadelphia* 11:349–394.
- Pluckhahn, Thomas J., Kendal Jackson, and Jaime A. Rogers. 2022a. “Let Us All Enjoy the Fish”: Alternative Pathways and Contingent Histories of Collective Action and Governance among Maritime Societies of the Western Peninsular Coast of Florida, USA, 100–1600 CE. *Frontiers in Political Science* 4:804084.
- Pluckhahn, Thomas J., Kendal Jackson, and Jaime A. Rogers. 2022b. Hidden in Plain Sight: Digital Documentation of Cockroach Key (8HI2), a First Millennium Native American Mound Complex on the Western Coast of Florida, USA. *Studies in Digital Heritage* 5(2):107–130.
- Pluckhahn, Thomas J., and Victor D. Thompson. 2018. *New Histories of Village Life at Crystal River*. University Press of Florida, Gainesville.
- Pluckhahn, Thomas J., Neill J. Wallis, and Victor D. Thompson. 2020. The History and Future of Migrationist Explanations in the Archaeology of the Eastern Woodlands with a Synthetic Model of Woodland Period Migrations on the Gulf Coast. *Journal of Archaeological Research* 28:443–502.
- Randall, Asa, and Kenneth Sassaman. 2017. Terraforming the Middle Ground in Ancient Florida. *Hunter-Gatherer Research* 3(1):9–39.
- Reimer, Paula J., William E. N. Austin, Edouard Bard, Alex Bayliss, Paul G. Blackwell, Christopher Bronk Ramsey, Martin Butzin, et al. 2020. The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0–55 cal kBP). *Radiocarbon* 62:725–757.
- Reitz, Elizabeth J., and Elizabeth Wing. 2008. *Zooarchaeology*. 2nd ed. Cambridge University Press, New York.
- Sanger, Matthew C., Irvy R. Quitmyer, Carol E. Colaninno, Nicole Cannarozzi, and Donna Ruhl. 2020. Multiple-Proxy Seasonality Indicators: An Integrative Approach to Assess Shell Midden Formations from Late Archaic Shell Rings in the Coastal Southeast North America. *Journal of Island and Coastal Archaeology* 15:333–363.

- Sassaman, Kenneth E., Meggan E. Blessing, Joshua M. Goodwin, Jessica A. Jenkins, Ginessa J. Mahar, Anthony Boucher, Terry E. Barbour, and Mark C. Donop. 2020. Maritime Ritual Economies of Cosmic Synchronicity: Summer Solstice Events at a Civic-Ceremonial Center on the Northern Gulf Coast of Florida. *American Antiquity* 85(1):22–50.
- Saunders, Joe W., Rolfe D. Mandel, C. Garth Sampson, Charles M. Allen, E. Thurman Allen, Daniel A. Bush, James K. Feathers, et al. 2005. Watson Brake, a Middle Archaic Mound Complex in Northeast Louisiana. *American Antiquity* 70(4):631–568.
- Saunders, Rebecca, and Michael Russo. 2011. Coastal Shell Middens in Florida: A View from the Archaic Period. *Quaternary International* 239:38–50.
- Schlanger, Sarah H. 1992. Recognizing Persistent Places in Anasazi. In *Space, Time, and Archaeological Landscapes*, edited by Jacqueline Rossignol and LuAnn Wandsnider, pp. 91–113. Plenum, New York.
- Schwadron, Margo. 2017. Shellworks: Prehistoric Terraformed Communities of the Ten Thousand Islands, Florida. *Hunter-Gatherer Research* 3(1):31–63.
- Scott, Thomas M. 2011. Geology of the Florida Platform: Pre-Mesozoic to Recent. In *Gulf of Mexico Origin, Waters, and Biota: Vol. 3, Geology*, edited by Noreen A. Buster and Charles W. Holmes, pp. 17–31. Texas A&M University Press, College Station.
- Sharp, Nonie. 2002. *Saltwater People: The Waves of Memory*. University of Toronto Press, Toronto.
- Sherwood, Sarah C., and Tristram R. Kidder. 2011. The DaVincis of Dirt: Geoarchaeological Perspectives on Native American Mound Building in the Mississippi River Basin. *Journal of Anthropological Archaeology* 30:69–87.
- Stearns, R. E. C. 1870. Rambles in Florida. *American Naturalist* 3:349–470.
- Stearns, R. E. C. 1872. Remarks on Mound and Shell Heaps of Tampa Bay. *Proceedings of the California Academy of Sciences* 1:214–215.
- Thompson, Victor D. 2010. The Rhythms of Space-Time and the Making of Monuments and Places during the Archaic. In *Trend, Tradition, and Turmoil: What Happened to the Southeastern Archaic*, edited by David Hurst Thomas and Matthew C. Sanger, pp. 217–227. American Museum of Natural History, New York.
- Thompson, Victor D., Jacob Holland-Lulewicz, Raelynn Butler, Turner Hunt, LeeAnn Wendt, James Wettstaed, Mark Williams, et al. 2022. The Early Materialization of Democratic Institutions among the Ancestral Muskogean of the American Southeast. *American Antiquity* 87(4):704–723.
- Thompson, Victor D., and Thomas J. Pluckhahn. 2012. Monumentalization and Ritual Landscapes at Fort Center in the Lake Okeechobee Basin of South Florida. *Journal of Anthropological Archaeology* 31:49–65.
- Thulman, David K. 2009. Freshwater Availability at the Constraining Factor in the Middle PaleoIndian Occupation of North-Central Florida. *Geoarchaeology* 24:243–276.
- Van Nest, Julieann, Douglas K. Charles, Jane E. Buikstra, and David L. Asch. 2001. Sod Blocks in Illinois Hopewell Mounds. *American Antiquity* 66(4):633–650.
- van Soelen, Elizabeth E., Gregg R. Brooks, Rebekka A. Larson, Jaap S. Sinninghe Damste and Gert-Jan Reichart. 2012. Mid- to Late-Holocene Coastal Environmental Changes in Southwest Florida, USA. *Holocene* 22(8):929–938.
- van Soelen, Elizabeth E., Emmy I. Lammertsma, Holger Cremer, Timme H. Donders, Francesca Sangiorgi, Gregg R. Brooks, Rebekka Larson, et al. 2010. Late Holocene Sea-Level Rise in Tampa Bay: Integrated Reconstruction Using Biomarkers, Pollen, Organic-Walled Dinoflagellate Cysts, and Diatoms. *Estuarine, Coastal, and Shelf Science* 86(2):216–224.
- Walker, Sylvanus T. 1880. Report on the Shell Heaps of Florida. In *Annual Report of the Board of Regents of the Smithsonian Institution for the Year 1879*, pp. 413–422. Government Printing Office, Washington, DC.
- Wallis, Neil J., Michelle J. LeFebvre, Meggan E. Blessing, and Paulette S. McFadden. 2022. Exploring the Origins of Coastal Villages: New Discoveries at the Spring Warrior Civic-Ceremonial Center on Florida's Gulf Coast. *Journal of Island and Coastal Archaeology*, in press.
- Wallis, Neill J., and Paulette S. McFadden. 2016. Recovering the Forgotten Woodland Mound Excavations at Garden Patch (8DI4). *Southeastern Archaeology* 35:194–212.
- Wallis, Neill J., and Paulette S. McFadden. 2019. A Woodland Period Environmental and Settlement History of Horseshoe Cove, Northern Gulf Coast of Florida. *Florida Anthropologist* 71(3–4):191–206.
- Waselkov, Gregory A. 1987. Shellfish Gathering and Shell Midden Archaeology. *Advances in Archaeological Method and Theory* 11:93–210.
- Wheeler, Ryan J. 2002. *Harbor Key Temple Mound (8MA13): Vandal Pit Profile*. Report filed at the Bureau of Archaeological Research, Tallahassee, Florida.
- Willard, Debra A., Christopher E. Bernhardt, Gregg R. Brooks, Thomas M. Cronin, Terence Edgar, and Rebekka Larson. 2007. Deglacial Climate Variability in Central Florida, USA. *Palaeogeography, Palaeoclimatology, Palaeoecology* 251:366–382.
- Wiley, Gordon R. 1949. *Archaeology of the Florida Gulf Coast*. Smithsonian Miscellaneous Collections 113. Smithsonian Institution, Washington, DC.
- Wisnabaker, Michael, and Daniel, I. Randolph. 1987. *Harney Flats: A Florida Paleoindian Site*. Baywood, Farmingdale, New York.

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