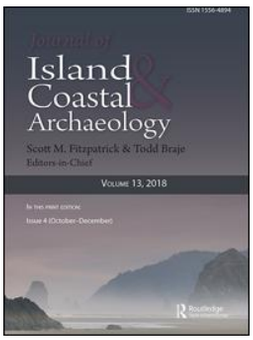

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Shell on Earth: Oyster Harvesting, Consumption, and Deposition Practices in the Powhatan Chesapeake

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ABSTRACT

*Archaeological studies of North American shell middens have recently highlighted Native societies' impacts on marine and estuarine waterscapes. Middens containing deposits of oyster shell (*Crassostrea virginica*) reveal histories of subsistence, settlement mobility, resource decline, and the long-term sustainability of fisheries. In this case study, we bring to the fore another important aspect of precolonial oyster exploitation: the habitat from which oysters were harvested. Five morphological attributes are measured to indicate whether Native fishers harvested oysters from nearshore or offshore habitats. Once combined with the archaeological context in which oyster shell was deposited, knowledge of harvesting location offers an avenue for considering* social practice*, the array of activities and pathways through which Native societies made and transformed the worlds in which they lived. In order to demonstrate the interpretive potential of this line of inquiry, we offer a comparative analysis of oyster shells from two contexts at Kiskiak, a Powhatan town in Tidewater Virginia. We hypothesize that Kiskiak fishers harvested large quantities of oysters from nearshore habitats and limited numbers of oysters from offshore reefs, casting light on social practices contributing to the oyster fishery's sustainability on a millennial timescale.*

Keywords Shell middens, social practice, sustainability, Chesapeake, Powhatan

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Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/uica.

INTRODUCTION

Archaeological studies of North American shell midden sites have added much to our understanding of human impacts on marine and estuarine environments before and after European colonization (e.g., Ceci 1984; Claassen 1986; Erlandson et al. 1999; Miller 2001; Rick and Erlandson 2008; Stein 1992; Waselkov 1982). Research in the 1960s through 1980s considered the importance of coastal settings in prehistoric settlement and subsistence, contributing to a debate over the relative merits of a "Garden of Eden" versus "Gates of Hell" model for the land's edge (Erlandson 2001). More recently, archaeologists have begun to see coastal areas not as the edges, peripheries, or backwaters of Native North America, but as centers of technological innovation, monumental construction, political complexity, and eventful social histories (Thompson and Worth 2011:85).

In part, this reorientation comes from the recognition that Native fishers altered coastal and island landscapes in significant ways, and they did so well before colonial chroniclers remarked upon the richness of local fisheries (Lepofsky et al. 2015; Rick and Erlandson 2009). This study focuses on the Chesapeake Bay region (Figure 1), and by the time Jamestown colonist John Smith (1986a:238) wrote, "Neither better fish, more plenty, nor more variety for smal fish, had any of us ever seene in any place so swimming in the water," Algonquian

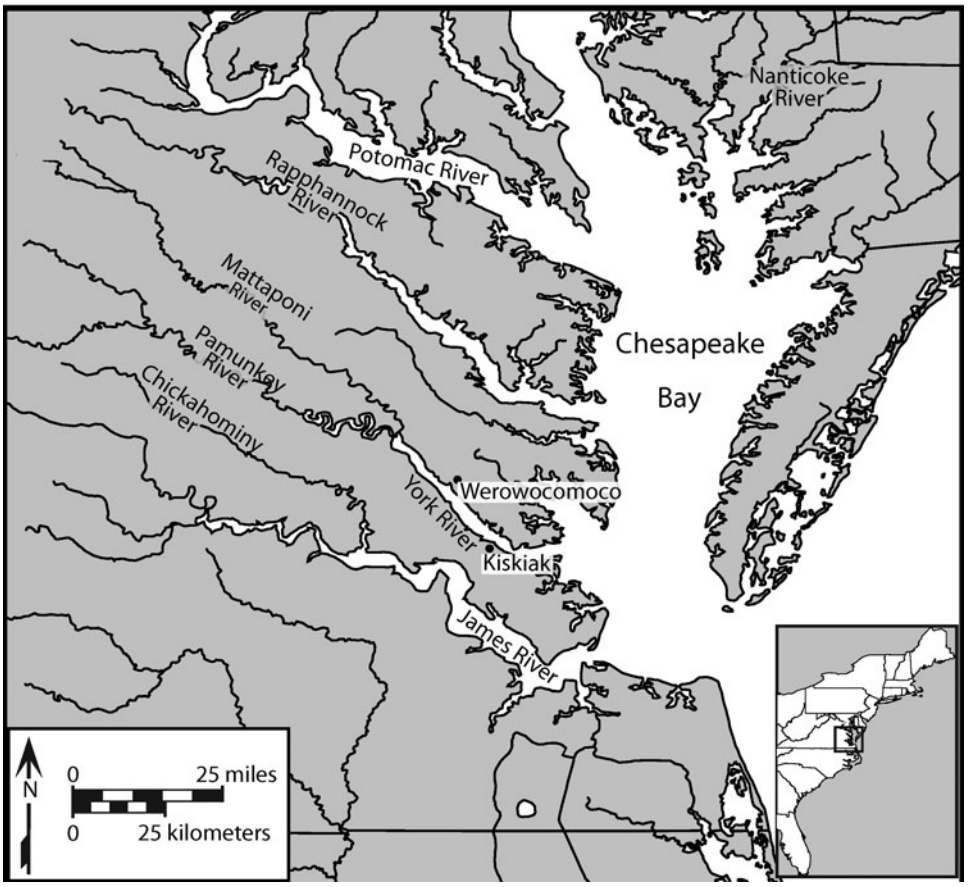

Figure 1. *Regional Map of the lower Chesapeake Bay region.*

communities had been harvesting the Chesapeake and generating middens full of oyster and clam shells, crab claws, and fish bones for at least 4,500 years (Rick and Waselkov 2015). Until the twentieth century, marine charts routinely warned of the danger that subtidal oyster reefs posed for vessels traveling the estuarine Chesapeake, underscoring the massive scale of the fishery prior to its collapse (Hargis and Haven 1999:333). In recent years, deep histories of resource use in the Chesapeake have begun to inform efforts to define ecological baselines essential to ecosystem management and restoration (Rick and Lockwood 2013).

Across the Middle Atlantic region, shells of the Eastern Oyster (*Crassostrea virginica*) typically dominate faunal assemblages from midden deposits (e.g., Custer 1989; Reeder-Myers et al. 2016; Rick et al. 2016; Waselkov 1982). As outlined below, researchers working in the Chesapeake have produced a remarkable array of shell midden studies focused on chronological methods and on evidence for the sustainability of the oyster fishery prior to the nineteenth century. Building on these studies, this paper calls attention to the habitat from which oysters were harvested. Our assessment of oyster shell attributes from two discrete contexts within a Native site in the Chesapeake indicates that habitat exploitation and the deposition of oysters varied over time and across space. We suggest that these differences may be understood best through the lens of *social practice*, i.e., the array of activities and dispositions that orient people to their world in the form of habits that become embodied through repetition (Bourdieu 1977). In this turn to practice, we are influenced by archaeology's 'historical-processual' paradigm (Pauketat 2001) and by efforts to frame social practice as a fundamentally *spatiotemporal* phenomenon (Schatzki 2010). Our intervention shifts the focus toward the oyster harvesting practices that produced a resilient fishery during the Middle and Late Woodland periods (500 BC–AD 1500), an era of rapid population growth and political centralization accompanied by a reorientation of subsistence and settlement toward estuarine settings.

Drawing from Bourdieu (1977), Giddens (1979), and Sahlins (1981), numerous anthropological and sociological studies have applied practice theory as a means of foregrounding the role of actors and of agency in social processes while also accounting for the ways cultural structures constrain and enable actions. In these approaches, the focus shifts toward people's activities as they enact, embody, and represent traditions in ways that continuously reprise and transform them. Archaeologists have likewise pivoted toward questions about practice, understood as people's actions and representations that generate change and create dynamic social traditions (Pauketat 2001:74). Rather than seeking the *ultimate* cause of cultural change in some abstract process external to the cultural and historical setting in which it occurred (e.g., social evolution, adaptation, aggrandizement, or sustainability), historical processualism focuses on the *proximate* causes and on social practice (Sassaman and Holly 2011:3).

From Bourdieu's (1977:7) initial formulation, practice has been framed in terms of temporal and spatial dimensions. Social practices are inherently *spatial* in that they depend on bodily movements along pathways (such as river routes toward oyster reefs) and within places (including shell middens along their banks) to engage with material objects (i.e., dugout canoes, oyster rakes, and burrs) (Schatzki 2010). Practices are also *temporal* in that they entail a purposeful sequence of steps, drawing motivation from the past and oriented toward a future end. The Kecoughtan's harvesting, consumption, and deposition of oysters for a diplomatic feast differed from the steps through which Native households added oysters to daily meals across the estuarine Chesapeake (Smith 1986a:245). By incorporating a notion of practice, we hope to offer a new way of thinking about oysters within waterscapes and oyster shells within landscapes.

We assess oystering in terms of three interlocking social practices: oyster harvesting, consumption, and deposition of oyster shell. To elucidate practices related to oyster *harvesting*, we divide the local oyster fishery into two zones: the nearshore and offshore (following terminology established by Rick et al. 2016). Harvesting oysters from these two zones required different sets of practices with distinct temporal rhythms and spatial orientations. We consider practices associated with the *consumption* of oysters at Kiskiak through an historical ethnography of early colonial-era meals that included shellfish. We draw evidence of *deposition* practices from a comparison of two different shell-rich contexts at Kiskiak: a deeply stratified shell midden and an oyster shell-filled ditch. Viewing deposition as a deliberate, conscious act highlights contrasts between day-to-day activities and formal, non-routine events.

A few cautions should be kept in mind with our discussion of oyster harvesting practices in the Chesapeake. First, the methods used to determine the habitat from which oysters were harvested rely on two early analyses of archaeological oyster shell (Kent 1988; Lawrence 1988). These studies draw from regionally specific observations in the lower portions of the Chesapeake estuary, and the resulting model deserves further testing. In an effort to strengthen the model, we have incorporated further ecological and biological literature and developed complementary methods for inferring harvest location, as outlined below. Second, the hypothesized harvesting locations presented here are preliminary and need additional testing and confirmation in a variety of regional settings. Future research should include modern control samples from nearshore and offshore zones for each of the attributes measured here. Finally, our study assumes a relatively stable environment. Oysters respond morphologically to changing environmental conditions, including changes in sea level and an estuary's nutrient load. The inferences regarding oyster harvesting, consumption, and deposition presented here reflect hypothesized differences in practice supported by ethnohistory, historical accounts, and oyster ecology.

A REVIEW OF OYSTER SHELL STUDIES IN THE MID-ATLANTIC REGION

Early studies of archaeological oyster shell in the Chesapeake include Gregory Waselkov's (1982, 1987) shell midden analysis at White Oak Point (44WM119) and Bretton Kent's (1989) *Making Dead Oysters Talk*. Drawing from colonial sites in Maryland, Kent developed a set of middle-range approaches to archaeological oyster shell. Kent's study also addressed the biology of the oyster, taphonomic process, sampling strategies, harvested habitats, harvest intensity, sclerochronology, and demographic analyses.

Kent's (1989) study, as well as Waselkov's dissertation (1982) and his subsequent synthesis of shell midden method and theory (1987), appeared during a period of disagreement regarding the importance of coastal settlement and subsistence in Native adaptations (Erlandson 1994, 2001). Waselkov (1987) combined historical ethnography and archaeological perspectives to explore shell midden formation, changes in technology, subsistence strategies, harvest pressure, and environmental change, demonstrating the importance of shell fishing for many coastal communities. His analysis addressed questions concerning seasonality, minimum number of individuals (MNI) in a context, and meat weight contributed by the species.

Torben Rick and Waselkov (2015) recently revisited Waselkov's earlier work to add a more refined chronology of White Oak Point using radiocarbon assays drawn from charcoal as well as directly from oyster shells using a local reservoir correction. This is one of an impressive list of papers by Rick and colleagues demonstrating the benefits of directly dating shell from oyster midden sites in the Chesapeake (Jansen et al. 2015; Reeder-Myers et al. 2016; Rick and Henkes 2014; Rick et al. 2011, 2012, 2014, 2015, 2017). Oyster shells may be

less susceptible to the taphonomic processes affecting middens that tend to relocate charred wood from its original context. As a result, directly dating oyster shells produces more accurate timelines to assess human-environmental histories. Conversely, this technique has warranted extreme caution from other researchers (e.g., Hadden and Cherkinsky, 2015, 2017; Thompson 2014).

Rick and colleagues have also examined oyster shell from Chesapeake middens to gauge the prehistoric fishery's sustainability on a millennial timescale (Reeder-Myers et al. 2016; Rick et al. 2016, 2017). Focusing on changes over time in the mean height of oyster shells, the longest measurement of the shell from the dorsal to the ventral, these studies conclude that the pre-colonial harvesting rate was, in fact, viable over centuries to millennia. The authors suggest that the fishery's sustainability resulted from several social factors, including Native societies' relatively low population densities, seasonal mobility, and broad-spectrum diets. Additionally, these researchers suggest that technological limitations restricted Native harvesting to primarily nearshore habitats, contrasting with offshore harvesting techniques introduced during the nineteenth century, most notably dredging (Rick et al. 2017). The authors also point out that studies of Native shell fishing can inform policies regarding today's degraded fishery by providing a pre-collapse baseline for restoration efforts (Rick et al. 2016). Drawing from this body of research on archaeological shell in the Chesapeake, Rick and Lockwood (2013) have proposed an innovative research program linking historical ecology to conservation biology, providing a framework for integrating historical ecological data sets with those of biologists to inform contemporary conservation efforts.

The recent spate of research into archaeological shell has focused on ecological baseline conditions in the Chesapeake, an issue with serious implications for contemporary environmental policies. Left largely unaddressed, though, are the ways that Native communities in the Chesapeake region produced their own histories as these "harvesters of the Chesapeake" increased in population, constructed riverine towns, adopted maize-based agriculture, and developed a regional chiefdom (Potter 1993:139). During the 1,400-year period preceding colonial contact, the Tidewater region saw the arrival of Algonquian speakers, a shift toward riverside settlements and estuarine resources, and significant population increases, developments central to the Chesapeake's historical ecology.

In fact, archaeological approaches in the Southeast focused on the environment often do not articulate well with notions of contingent histories and social agency for understanding the past (Thompson 2014:246). Perhaps understandably, research aimed at large-scale environmental conditions and long-term changes often pushes social histories to the background. In fact, recognizing historical sequences in terms of sustainability, resilience, or resource decline requires not only an understanding of proxy measures and ecological conditions, but also of what people did and how they negotiated with others—i.e., social practices—as these were primary engines of continuity and change (Pauketat 2001:73).

OYSTERING IN THE CHESAPEAKE

Documentary sources make relatively few references to oystering in the early colonial Chesapeake, so a broader geographic frame is useful for understanding relevant practices. Waselkov's (1987:96–99) review of the historical ethnography from Native North America concludes that hand-collecting shellfish nearshore or in the intertidal zone was the most common form of shellfish gathering on the Atlantic coast. Oysters from this habitat could be collected relatively easily by walking to the water's edge at low tide, whereas harvesting oysters from the offshore reefs required watercraft and specialized equipment such as tongs or rakes since the reefs are often submerged,

even at low tide. Women and children typically dominated task groups harvesting shellfish in the intertidal zone (e.g., Bird 2007). References to men participating in shellfish gathering typically emphasize specialized task groups that harvested offshore reefs (Waselkov 1987:96–97).

In the Chesapeake, the Kecoughtan offered John Smith (1986b:37) oysters during the fall of 1607 when he exchanged hatchets and copper for foodstuffs. The following year Smith returned to Kecoughtan and spent Christmas there. During this visit, the Kecoughtan hosted a feast that lasted a week: "Wee were never more merrie, nor fedde on more plenty of good oysters, fish, flesh, wild foule, and good bread" (Smith 1986a:245). Oysters were clearly an important staple at Kecoughtan, located on the lower James River. Like Kiskiak, such a setting in the lower portion of the estuary afforded the Kecoughtan ready access to river waters and the embayed portions of creeks with salinity levels where oysters thrive. One of the earliest colonial-era maps of the Chesapeake, Robert Tyndall's 1608 *Draught of Virginia* (Figure 2), depicts sizable oyster reefs near the mouth of the York, downstream of Kiskiak (Stephenson and McKee 2000:28).

Other references confirm the prominence of oystering in the Tidewater regions of Virginia and North Carolina. One of Roanoke colonist John White's watercolors depicted North Carolina Algonquian men fishing offshore with spears and a fire in a dugout canoe (Hulton 1984:73). The men paddled alongside a weir consisting of an enclosure of wooden stakes designed to ensnare fish. One passenger paddles the canoe, while another stands beside a landing net and wields what could be an oyster rake. This tool may have had some other purpose, though similar rakes were commonly used by Euroamericans during the eighteenth and nineteenth centuries to harvest oysters in the Chesapeake (e.g., Kappes, 1890; Schulte 2017). Shellfish

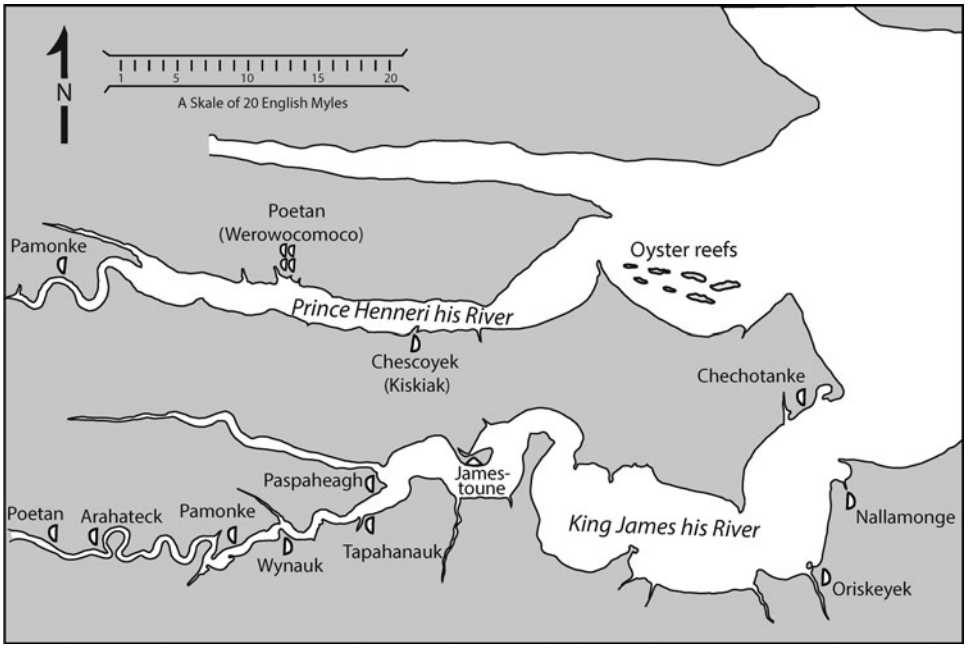

Figure 2. *Robert Tyndall's 1608 Draughte of Virginia, redrawn so that north is at the top and oyster reefs downstream from Chescoyek (i.e. Kiskiak) are labelled (Stephenson and McKee 2000:28).*

harvesting for diplomatic occasions even played a role in the interior portions of eastern Virginia where waterways lack the salinity levels necessary to support oysters. When an English party paid an unexpected visit to a town on the James River near the mouth of the Appomattox, the first task was to send a group of boys to dive for offshore mussels (Archer 1969:92).

Combined with Waselkov's ethnographic survey, these colonial-era sources offer support for several inferences regarding the practices linked to shell fishing in the Algonquian Chesapeake. As Smith and other colonists attest, the harvesting and consumption of oysters played a substantial role in the region, especially during the fall and winter months when the Powhatans offered English visitors large quantities of oysters. Communities situated in the lower estuary, including the Kecoughtan, prepared large numbers of oysters for public feasts, celebrated to mark visitors' arrival and other unusual events. Oysters also played a role in diplomatic exchanges and in gift-giving in the early colonial-era Chesapeake. For coastal Native communities more broadly, groups of women and children likely harvested nearshore oysters on a regular basis. Special task groups, possibly gendered male, appear to have collected shellfish using dugout canoes as they fished offshore or by diving for submerged beds.

CASE STUDY: HARVESTING, CONSUMPTION, AND DEPOSITION AT KISKIAK

During the early seventeenth century when English colonists wrote of the settlement, Kiskiak was a political center within the Powhatan chiefdom and the scene of several encounters with Jamestown's colonists (Figure 3). Located on the south side of the York River, Kiskiak ranged across the bluffs overlooking Indian Field Creek near its mouth when John Smith and other colonists visited the location (Gallivan 2016:79). Kiskiak was home to a *weroance* (i.e., commander) named Ottahotin and a community that played a significant role in several early colonial-era events (Smith 1986a:245). The Kiskiak had been incorporated into the Powhatan chiefdom in the decades prior to 1607, and Ottahotin was a close ally of the paramount chief when the colonists arrived at Jamestown.

An archaeological survey has traced the precolonial settlement history of the Indian Field Creek drainage, indicating that a large town initially appeared during the Late Woodland II period (AD 1200–1500) as a dispersed settlement spread across the lower, embayed portion of creek (Blanton et al. 2005:27–70). Based on the 40–50 warriors that John Smith (1986c:104) counted at Kiskiak, the settlement housed about 150 residents in 1608, approximating the average population for a Powhatan community. The survey data record a long history of settlement around Indian Field Creek prior to this, including a series of small encampments dating to the Archaic (8000–1200 BC) and Early Woodland (1200–500 BC) periods. Substantial shell midden features situated near the creek's mouth anchored three large Middle Woodland (500 BC–AD 900) base camps. Architectural features and related sheet middens dating to the Late Woodland formed an almost continuous arc across the bluffs overlooking lower Indian Field Creek after AD 1200, marking residential spaces that incorporated the shell middens within a dispersed town. While oysters grow near the shore throughout the lower portion of Indian Field Creek, optimal oyster habitat in the vicinity of Kiskiak included a series of offshore reefs located 2.7 kilometers (about 1.7 miles) across York River, near the opposite shoreline (Figure 4).

Archaeological evaluations of 12 Native American sites that comprised the dispersed settlement of Kiskiak included excavations on the east side of Indian Field Creek overlooking the York. This portion of Kiskiak, designated 44YO2, was bounded by a linear ditch (Feature 7) adjacent to two palisade lines running parallel to the bluff above the York River. One section of Feature 7 contains a dense deposit

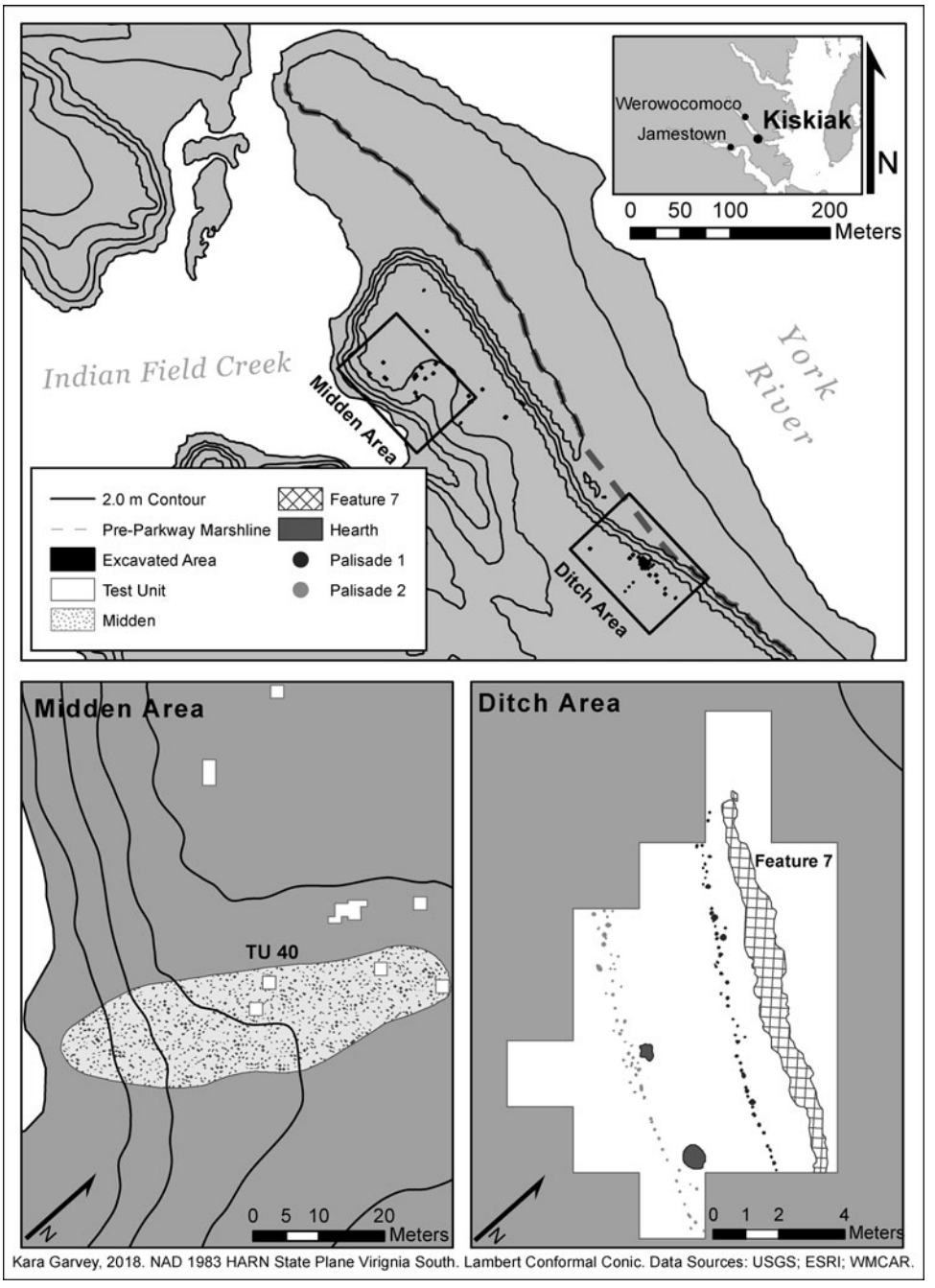

Figure 3. *Kiskiak site, including overall plan, midden area and ditch feature 7.*

of whole oyster shells (n = 312) in a discrete area measuring about two square meters in plan and extending to a depth of 40 centimeters, evidently recording a single deposition event. Located 400 meters west of this feature along the water's edge,

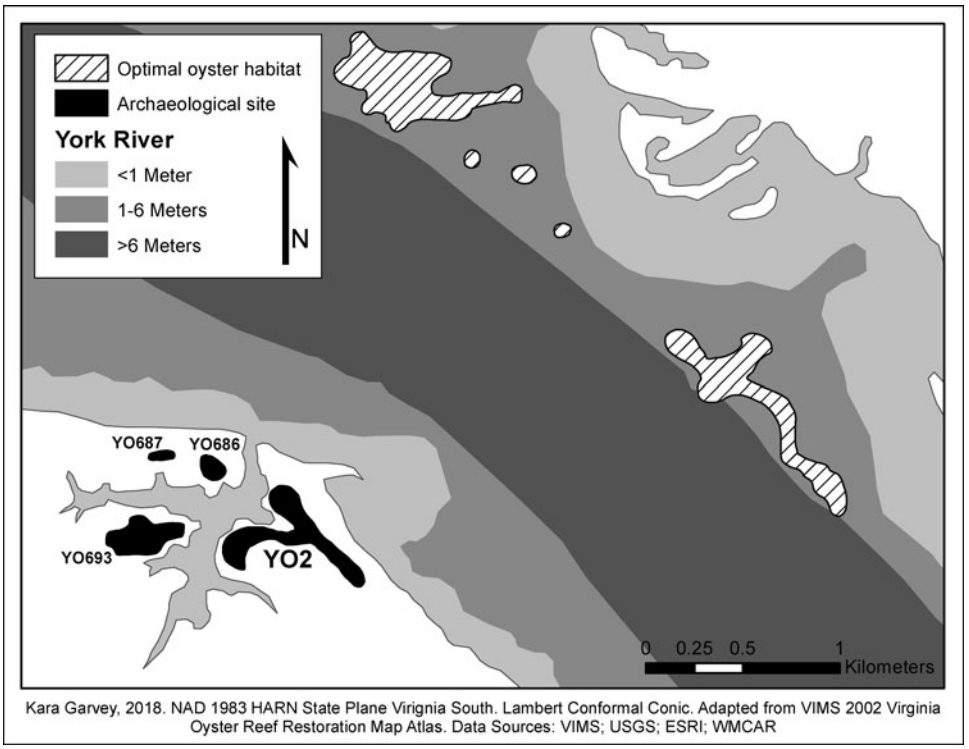

Figure 4. *Optimal oyster habitat in the vicinity of 44YO2 and other Kiskiak-related sites (Berman et al. 2009).*

a stratified midden along Indian Field Creek represented one of the three shell middens within the dispersed town of Kiskiak. The 44YO2 midden extends approximately 50 by 25 meters in plan and two meters in depth. Our assessment centers on a comparison of the oyster shells deposited in this large shell midden and in Feature 7. As detailed below, we believe that shells in the midden and in Feature 7 represent different sets of harvesting and consumption practices, with the Feature 7 oysters associated with a feasting event distinct from the regular consumption of oysters deposited in the midden.

Chronological interpretation of these deposits drew from six radiocarbon assays (Table 1 and 2). The five dates from the shell midden range from a Late Archaic (2500 BC–1200 BC) period assay at the base of the midden to a date at the Late Woodland/Contact period interface near the top of the midden. Modeled using OxCal's Bayesian model for a depositional sequence (Figure 5), the radiocarbon results provide calibrated age estimates for the sampled deposits ranging from circa 1300 BC to AD 1600 (Bronk Ramsey 2009; Reimer et al. 2013).[1] These results closely parallel the diagnostic artifacts from these deposits. A directly dated oyster shell from Feature 7 (Conventional 14C Age: 1270+/−30bp, Beta-47953) returned a calibrated two-sigma range of *AD 1180–1320*, adjusted with the reservoir correction (129 +/−22) for the weighted average for the Chesapeake Bay's Western Shore (Rick et al. 2012:207).

Field and Laboratory Methods

Excavations included four 2-by-2 meter test units within the 44YO2 midden. A

Table 1. **Depositional model for Kiskiak midden using OxCal 4.3 (Bronk Ramsey 2009).**

```
P_Sequence("Kiskiak Midden",1000)
{Boundary("Bottom");
R_Date("",3120,100) {z=1.75;};
Date("SC17") {z=1.70;};
Date("SC16") {z=1.60;};
Date("SC15") {z=1.50;};
Date("SC14") {z=1.40;};
Date("SC13") {z=1.30;};
Boundary("SC12:Bottom of shell-rich
  deposit") {z=1.20;};
Date("SC11") {z=1.10;};
R_Date("",1570,30) {z=1.05;};
Date("SC10") {z=1.00;};
R_Date("",1350,30) {z=0.95;};
Date("SC9") {z=.90;};
Date("SC8") {z=.80;};
Boundary("SC7:Top of shell-rich
  deposit") {z=0.70;};
Date("SC6") {z=.60;};
R_Date("",600,30){z=0.55;};
Date("SC5") {z=.50;};
R_Date("",340,60) {z=0.45;};
Date("SC4") {z=.40;};
Date("SC3") {z=.30;};
Date("SC2") {z=.20;};
Boundary("Top");};
```

30 × 30-cm continuous column sample was removed from the south wall of TU40 in 10-cm arbitrary levels. Sample 1 showed evidence of historic-period artifacts and likely represents a disturbed context near the modern surface, so it was excluded from our analysis. The remaining sixteen column samples (SC 2–17) were water screened through 1/16" mesh to recover small shell fragments and charred botanical remains. Recovered materials include small amounts of vertebrate fauna including small fish, deer, small mammal, and bird, invertebrates, primarily oyster, as well as *Merceneria*, fossilized scallop, and small amounts of mussel, slipper shell, barnacle, angelwing, and periwinkle, and other artifacts including coral, pottery, lithic flakes, fire-cracked rock, and charcoal. All whole, left (cupped) oyster valves were removed from SC 2–17 for further analysis (n = 947, Table 3).

Primarily using methods outlined by Lawrence (1988) and Kent (1989), we assessed all whole, left oysters from these two contexts to infer what habitats were being harvested. The attributes we measured are height, height-to-length ratio (HLR), presence, absence, and type of attachment scar, presence or absence of sponge parasitism, and left valve concavity (LVC) or "cuppyness" (Figure 6, Table 4). Oyster height is indicative of oyster habitat as oysters that grow subtidally are typically larger than those growing in the intertidal

Table 2. **Radiocarbon dates from the Kiskiak site, calibrated with OxCal 4.3 (Bronk Ramsey 2009).**

Lab code	Sampled material	Calibration curve	Conventional 14C Age (BP)	*Calibrated dates*		
				Range	**%**	**OxCal Model**
Shell midden						
Beta-163920	Maize cupule	IntCal 13	340 +/− 60	*AD 1440–1640*	*95.4%*	*P_Sequence*
Beta-408471	Nutshell	IntCal 13	600 +/− 30	*AD 1300–1410*	*95.4%*	*P_Sequence*
Beta-302724	Nutshell	IntCal 13	1350 +/− 30	*AD 640–710*	*95.4%*	*P_Sequence*
Beta-389728	Phytolith	IntCal 13	1570 +/− 30	*AD 420–550*	*95.4%*	*P_Sequence*
Beta-163922	Nutshell	IntCal 13	3120 +/− 100	*1620–1060 BC*	*95.4%*	*P_Sequence*
Ditch feature						
Beta-47953	Oyster shell	Marine 13	1270 +/− 30	AD 1180–1320	95.4%	—

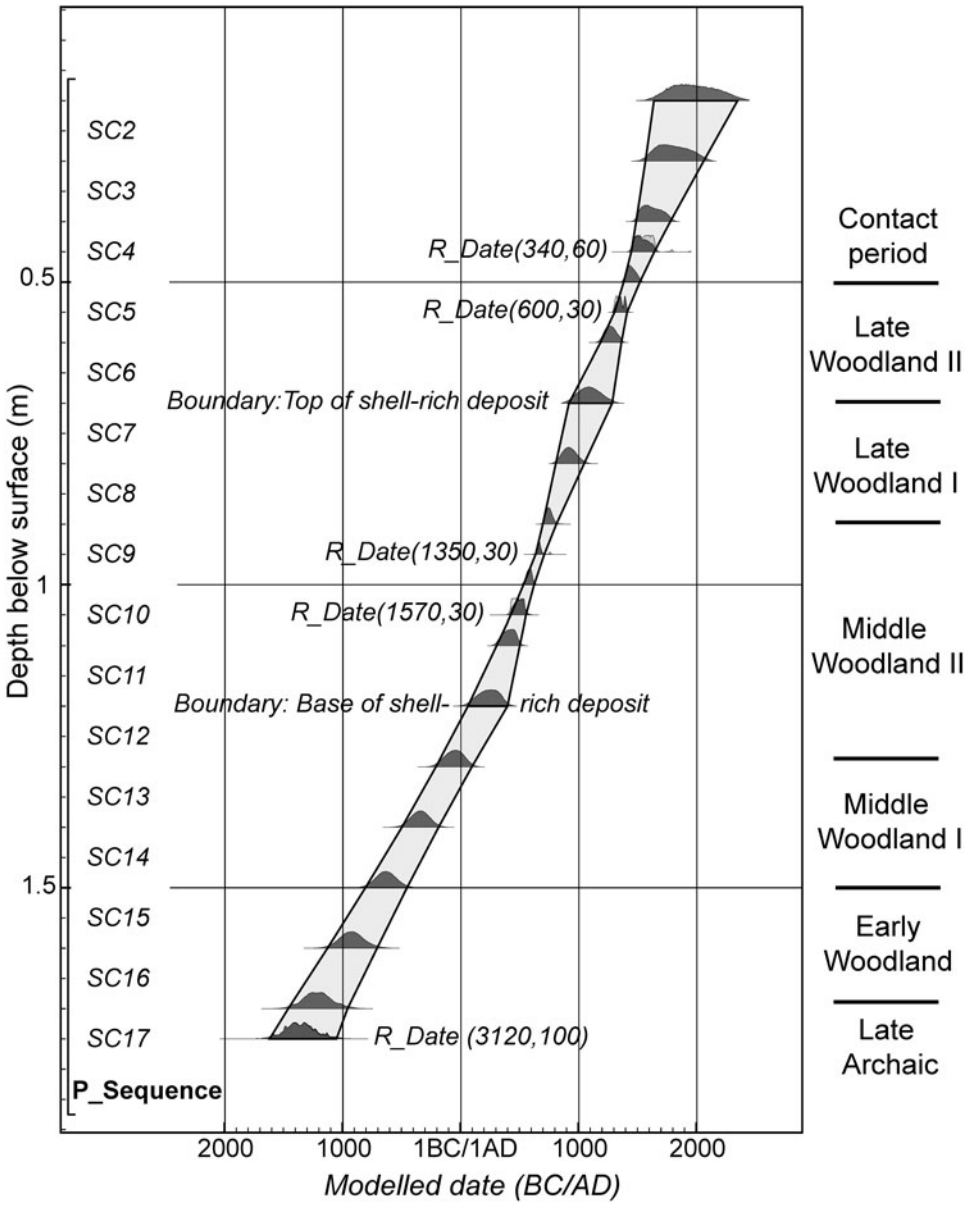

Figure 5. *Chronological model of Kiskiak shell midden generated with Oxcal 4.3's P_Sequence model and five radiocarbon dates from the midden.*

given their constant exposure to food and nutrients. Height is also a common metric used to measure human impacts on fisheries (e.g., Rick et al. 2016), although other factors can contribute to changes in oyster height through time (e.g., abundance, demographics, climate change, nitrogen loading).

Height-to-length ratio is measured by dividing the height of an oyster by its length. This metric was used by Kent (1989) to create categories of oysters by

Table 3. **Samples of left, whole oyster shells recovered from the column sample at Kiskiak.**

Sample	n	Subsistence column samples	Date range for period		
Contact	96	2–4	AD 1500	–	AD 1700
Late Woodland II	35	5–6	AD 1200	–	AD 1300
Late Woodland I	185	7–8	AD 900	–	AD 1200
Middle Woodland II	327	9–12	AD 200	–	AD 900
Middle Woodland I	110	13–14	500 BC	–	AD 200
Early Woodland	182	15–16	1200 BC	–	500 BC
Late Archaic	12	17	2500 BC	–	1200 BC
Total	947				
F.7	105		AD 1180	–	AD 1320

habitat. Kent (1989:30) describes four types of oysters that have varying rages of HLR: sand oysters, which are short and broad, and generally found in the intertidal or very shallow water; reef oysters, which are small and elongate, as they are densely clustered and frequently intertidal; channel oysters, which are large and elongated; and bed oysters, which have an intermediate HLR and are found in mixed, muddy sand. While Lawrence (1988) does not measure HLR, he does comment on the shape of oysters from different habitats, noting that due to differences in nutrient flows and exposure to air, oysters in the intertidal zone are typically smaller, longer, and thinner than those from deeper waters (Lawrence 1988:268). Kent (1989:30) warns that the categories of oysters are not exact, and there can be overlap as well as regional differences. However, it is likely that samples of oysters with significantly different HLRs were harvested from different habitats (Kent 1988:30). Observations of the HLRs of modern samples from Indian Field Creek and nearby offshore reefs would help strengthen the use-value of this variable.

Oysters that grow on offshore reefs are typically larger, rounder, and more deeply cupped (have a higher LVC value) (Kennedy, 1996). These morphological traits are largely attributed to the fact that most oysters growing on offshore reefs are typically subtidal, meaning that they are not exposed even at low tide. While their location in the water column allows them to grow larger with a constant supply of food, they are also subject to predators and parasites, including the boring sponge *Cliona*, which can only withstand subtidal conditions (Shumway 1996). Boring sponges of this species also require a salinity range above 15 parts per thousand (ppt). Therefore, if oyster shells have evidence of sponge parasitism in the form of cylindrical holes left behind on the shell, they likely lived in subtidal or deep water habitats, in high-salinity waters. Salinity levels in the lower York River near Kiskiak fluctuate between 15 and 25 ppt, depending on tides and upstream rainfall.

Noting the presence, absence, and type of attachment scar may also help determine habitat. Oysters are xenomorphic, meaning they faithfully replicate the substrate on which they grow (Lawrence 1988). In differing habitats oysters may be more likely to grow in tight clusters or burrs and have large attachment scars of other oysters, whereas in other habitats oysters may often grow singly and have no attachment scars. If oysters do have attachment scars, it indicates the substrate on which they grew.

Based on these studies, we hypothesize that if a sample of oysters is generally small, rounded (low HLR), lack sponge parasitism, are not deeply cupped (low LVC), and have attachment scars indicative

Figure 6. *Offshore, subtidal oysters from Feature 7 (left), and nearshore oysters from Kiskiak's midden (right).*

Table 4. **Expected ranges of attributes for oysters in the shallow water zone, typically nearshore, and oysters in the deep water zone, typically offshore. These attributes may be variable given local conditions.**

	Expected range	
Harvest Location Indicators	**Shallow water zone**	**Deep water zone**
Height	Typically small	Typically large
Height-to-length ratio	Elongate (reef), short and round (sand)	Rounded
Left valve concavity	Shallow cupping	Deeply cupped
Attachment scars	Present, large	Absent or small
Sponge parasitism	Absent	Present

of nearshore substrate, that they were harvested from the nearshore zone or habitat. Conversely, we hypothesize that if a sample of oysters is generally large, elongate (high HLR), has a high percentage of oysters with sponge parasitism, are deeply cupped (high LVC), and have no attachment scars that they were harvested from the offshore zone or habitat. While any given shell may vary somewhat from these trends and modern samples are required to confirm these hypotheses, we contend that height, HLR, LVC, presence, absence, and type of attachment scar, and presence or absence of sponge parasitism together offer measurable proxy values for the habitats that past people exploited.

44YO2 Midden

The 44YO2 shell midden offers a record of oyster harvesting from the Late Archaic through Contact periods. Situated

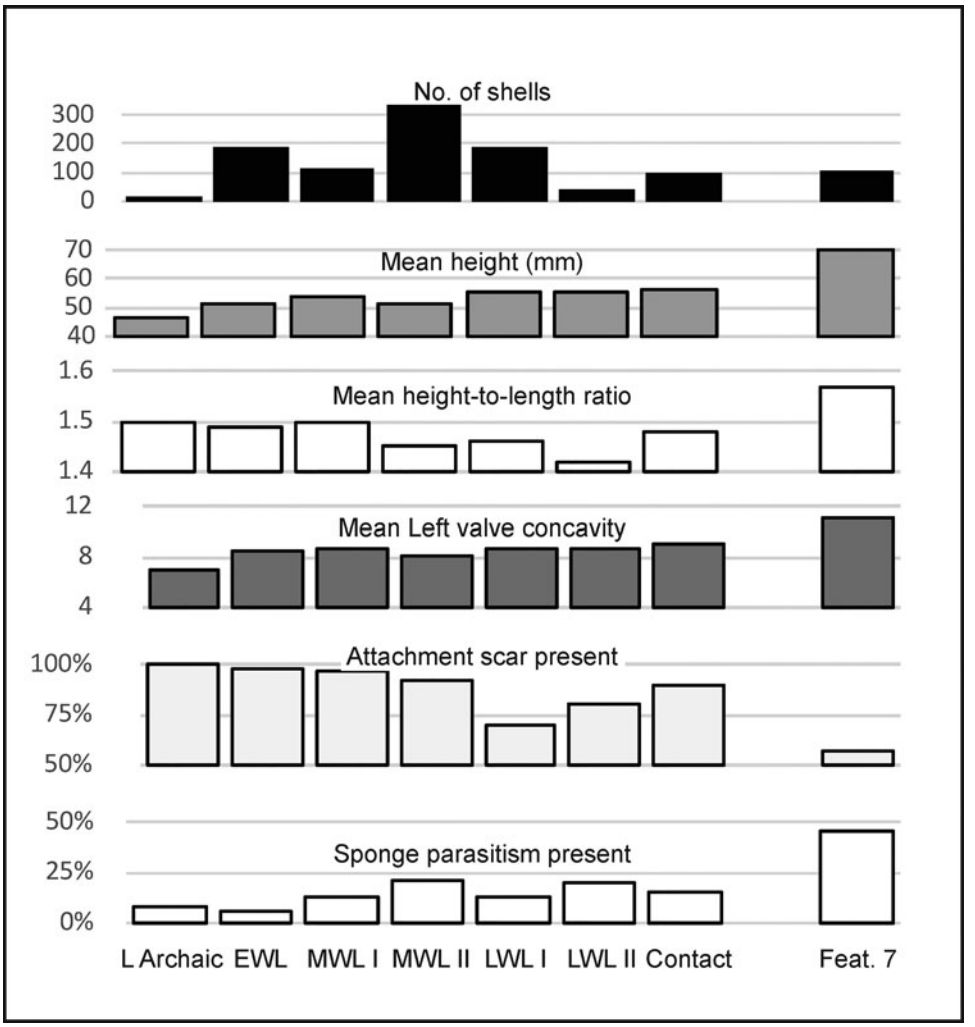

Figure 7. *Kiskiak oysters attributes by period. Midden deposits on the left, Feature 7 on the right.*

along the high tide line, the 44YO2 shell midden is located along the stretch of Indian Field Creek that today contains some of the densest concentrations of oysters in the drainage, possibly facilitated by substrate in the form of fossilized scallop shell eroding from the Yorktown Formation. The Yorktown Formation is a geological deposit dating to the Late Miocene that consists of sands and clays which are crowded with the remains of calcareous Mollusca shells (Hazel 1971). The most highly fossiliferous beds are in the Chesapeake Bay region, with the largest outcrops of the Yorktown Formation along the York River, where many fossilized shells are eroding into nearby waterways (Clark and Miller 1906:19–20). Most (89%) of the oysters from the midden have attachment scars, many of which show impressions of fossilized scallop shells from the Yorktown Formation (30%).

Despite regular harvesting of considerable quantities of oysters from the waters around Kiskiak, oysters from the midden show little evidence of overharvesting at

the site, except possibly during the Middle Woodland II period (Table 5 and Figure 7). From the midden base to its top, the mean height of oysters in the midden *increased* over time, from 46.8 mm during the Late Archaic period to 56.1 mm during the Contact period, a statistically significant pattern.[2] However, during the Middle Woodland II phase of the midden shell heights dipped significantly in the midst of this trend.[3] During this period, Kiskiak's residents deposited oyster shells in the midden at a higher rate than at any other period based on the volume of oyster shell per cubic meter. An increase in human predation pressure during Middle Woodland II centuries may account for the small, but statistically significant decrease in the mean height of the oysters.

Value ranges for five key attributes indicate that the oysters deposited in the Kiskiak midden were routinely harvested from nearshore conditions, likely the adjacent Indian Field Creek (Table 5). Although there is some variability in these measures, the midden shells tend to be small, with mean heights between 46 and 56 mm, and round. LVC values were also relatively low, with mean values between 7 and 9 mm, indicating shells that are not deeply cupped. Most of the midden shells (85%) lack sponge parasitism. Oysters deposited in the Kiskiak midden regularly attached to fossilized scallop shell, as they do today in Indian Field Creek. Our observation of oysters currently living in Indian Field Creek suggest that this type of attachment allows shells to grow rounder, as they are not competing for resources with other oysters in a burr.

If our hypotheses are correct, the evidence indicates that Native shell fishers gathered the majority of midden oysters from the nearshore habitat. Yet, there are indications that they occasionally harvested a different habitat, likely offshore reefs, also depositing these shells in the midden. The proportion of oysters deposited in the midden that we hypothesize were harvested from offshore reefs rose to 21% during the Middle Woodland II centuries and 20% during the Late Woodland II centuries (Figure 8). These two episodic shifts toward seemingly greater reliance on offshore reefs, though, do not account for the general increase in oyster heights over

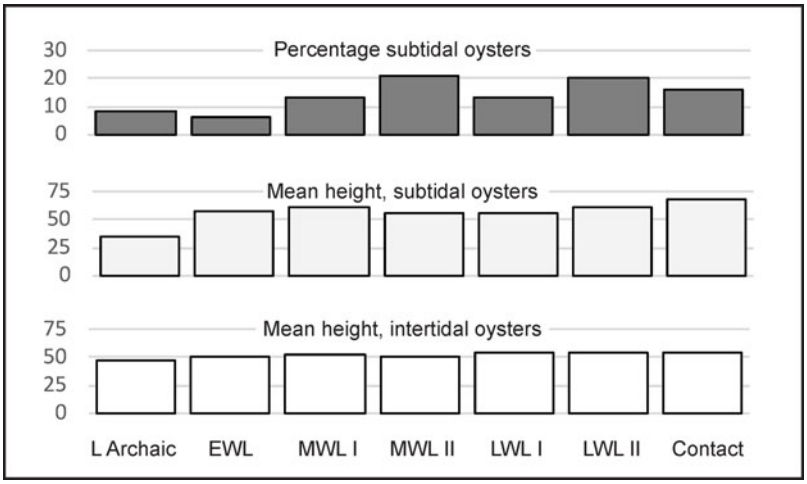

Figure 8. *Comparison of oyster shells hypothesized to be subtidal and intertidal from the Kiskiak midden by period.*

time. The 44YO2 midden saw its most intensive use during the Middle Woodland II period (AD 200–900) when oyster shell heights decreased. Greater reliance on offshore reefs during the Middle Woodland II period may have allowed the nearshore fishery to recover in subsequent centuries. The average height of what we hypothesize to be nearshore oysters rebounded during the Late Woodland I period, rising to its highest level in the midden.[4]

The percentage of what we hypothesize to be offshore oysters in the midden increased again to 20% during the Late Woodland II period, this time with no evidence of resource decline in the oyster fishery. During the Late Woodland II centuries (AD 1200–1500) the residents of Kiskiak established a substantial agricultural town around Indian Field Creek and constructed a bluff-top palisade. The heightened reliance on offshore reefs during this period occurred during a time of population increases, greater settlement permanence, and political centralization. Judging from colonial-era accounts of shellfish consumption in diplomatic contexts (e.g., Archer 1969:92; Smith 1986a:245), the pivot toward offshore oysters might be explained by periodic harvesting for diplomatic feasts or for provisioning of elites, social practices that we believe are tied to the Feature 7 ditch feature at Kiskiak.

Feature 7: Kiskiak's Ditch

We infer a sharply different set of harvesting, consumption, and deposition practices from the archaeological record of Kiskiak's shell midden and ditch Feature 7. Features associated with the midden include large roasting pits and the post patterns of racks used to elevate shellfish over a fire. In contrast with this evidence of food processing, Feature 7 marked an area surrounded by a palisade and ditch enclosure associated with a sheet midden containing domestic debris. English colonist Robert Beverley (1947:177) noted that most towns in the Chesapeake were not surrounded by a palisade, though some were:

> They often encompass their whole town; but for the most part only their king's houses, and as many others as they judge sufficient to harbor all their people when an enemy comes against them. They never fail to secure within their palisade all their religious relics, and the remains of their princes. Within this inclosure, they likewise take care to have a supply of water, and to make a place for a fire, which they frequently dance round with great solemnity.

This passage and others written by colonists suggest that Feature 7 enclosed spaces associated with political elites and with ritualized practices. Feature 7's thirteenth-century date corresponds closely with the creation of a large ditch enclosure at the Werowocomoco site, the principal town of the Powhatan paramountcy located 11 miles upstream from Kiskiak on the York River (Gallivan 2016:150–151). Werowocomoco's ditch enclosure contained a large structure dating to the early 1600s that was associated with copper squares traded from the Jamestown colonists. Based on the date, size, configuration, location within the site, and associated material, we have interpreted the structure at Werowocomoco as Powhatan's residence (Gallivan 2016:157–162). A similar association with elite residence and spaces of political power and ritual authority seems likely for Kiskiak's Feature 7.

In all measured variables, the shells from Feature 7 (n = 105) differ significantly from those deposited in the aforementioned midden (Tables 5 and 6). Shells recovered from the ditch are almost exclusively large and deeply cupped, attributes indicating that Kiskiak's residents harvested these oysters from offshore reefs. The ditch oysters are, on average, 20 mm larger than oysters from the midden and have a significantly higher rate of sponge parasitism, values that point toward offshore subtidal reefs. Fewer than half of these shells have readily apparent

Table 5 **Mean values of oyster attributes from Kiskiak site.**

Sample	*n*	Height (mm)		Height-to-length ratio		Left Valve Concavity		Attachment scar	Sponge parasitism
		Mean	SD	Mean	SD	Mean	SD		
Contact	96	56.1	20.2	1.48	0.38	9.08	4.20	89.6%	15.6%
Late Woodland II	35	55.3	20.1	1.42	0.22	8.67	3.58	80.0%	20.0%
Late Woodland I	185	55.2	15.8	1.46	0.23	8.70	3.33	69.7%	13.0%
Middle Woodland II	327	51.1	17.3	1.45	0.24	8.06	3.13	91.7%	20.8%
Middle Woodland I	110	53.8	16.4	1.50	0.27	8.58	3.48	96.4%	12.7%
Early Woodland	182	51.5	14.8	1.49	0.25	8.54	3.63	98.4%	5.5%
Late Archaic	12	46.8	18.1	1.50	0.36	7.06	3.59	100.0%	8.3%
Midden Total	947	52.9	17.0	1.47	0.26	8.45	3.46	88.7%	14.7%
F.7	105	70.6	26.9	1.57	0.29	11.09	4.53	57.1%	45.7%

Table 6 **Statistical comparison of midden and from Feature 7 oysters.**

	Test statistic	Result	df	2-tailed signif.
Height	t	−9.47	1050	<0.001
Height-to-length ratio	t	−3.75	1050	<0.001
Left valve concavity	t	−7.17	1050	<0.001
Attachment scars	$\chi 2$	76.1	1	<0.001
Sponge parasitism	$\chi 2$	62.3	1	<0.001

attachment scars, and none of them have attachment scars from fossilized scallop shells.

DISCUSSION

Our comparison of Kiskiak's oysters sought traces of social practices linked to oyster harvesting, consumption, and the deposition of oyster shell. The evidence from the midden and ditch feature records practices with markedly different spatial and temporal dimensions. Patterning in the measured attributes of oyster shell from these two contexts points toward different *harvesting* practices at Kiskiak keyed to discrete pathways and distinct engagements with the estuarine waterscape. The historical ethnography from the Chesapeake suggests that palisades enclosed ritualized spaces and elite residences. Colonial-era accounts also highlight diplomatic events and communal meals centered on bushels of oysters gathered by special task groups. These sources offer a basis for recognizing traces of distinct *consumption* practices within Kiskiak's archaeological record. Feature 7's oyster shell concentration likely resulted from a single, large meal in a palisaded space, an event tied to a very different temporal frame than

the steady accumulation of what we hypothesize to be nearshore oysters tossed into the midden for almost 3,000 years. Finally, the Feature 7 ditch marked an area of the site surrounded by palisades, highlighting differences in *deposition* practices framed by spaces that likely had different connotations for Kiskiak's residents.

The indications that Kiskiak's residents regularly harvested nearshore oysters and the absence of evidence that oyster sizes decreased in size over time are patterns consistent with Rick and colleagues' conclusions that oyster harvesting in the Chesapeake was sustainable on a millennial timescale (Rick et al. 2016). These researchers suggest that a sustainable oyster fishery during the precolonial era resulted from Native societies' relative technological limitations, low population densities, seasonal mobility, and broad-spectrum diets (2016:5). Under this model, relatively small numbers of mobile Native fishers focused on nearshore reefs, leaving offshore "parent reefs" available for reproduction.

If our hypotheses are correct, the evidence from Kiskiak confirms that the majority of oysters were indeed harvested from the nearshore zone, though Kiskiak's fishers also gathered oysters from a separate habitat, likely offshore reefs. All of the shells from Feature 7 likely originated in offshore reefs, and during two separate periods of Kiskiak's history, one in five oysters deposited in the midden are characteristic of the offshore habitat. Based on the evidence collected at Kiskiak, it appears that the primary focus on nearshore resources was not a result of limited capabilities, but was rather a product of *social practice*, specifically of decisions regarding the allocation of labor, time, and task groups. A limited number of shells with attributes matching offshore oysters are also present in most of the midden samples, demonstrating that the inhabitants of Kiskiak had the capacity to harvest this portion of the estuary, but generally chose not to. The oyster shells deposited in the midden signal the sustainable harvesting of oysters from the Late Archaic period through Contact, even as human population size and settlement orientation changed considerably. In fact, the modest increase in oyster heights over time raises the possibility that the Kiskiak actively *managed* the oyster fishery in ways that increased its productivity over time, in part by alternating their harvesting between different portions of the fishery and avoided harvesting spat, or baby oysters. Studies of oysters from the historic period in the Chesapeake offer another possible explanation for this increase in height in the Late Woodland as a byproduct of an increase in nitrogen loading from agricultural practices (Black et al. 2017; Kirby and Miller, 2005).

Despite the quantity of oysters harvested from the waters near Kiskiak, there is little evidence of overharvesting in the size of the shells deposited in the midden, with the exception of the Middle Woodland II period. These trends suggest that during the opening centuries of the Middle Woodland II period forager-fisher populations along Indian Field Creek harvested oysters intensively enough to impact the health of the fishery. During the subsequent Late Woodland centuries, human population size and settlement permanence increased at Kiskiak, yet oyster heights rebounded. Modest Native population levels and a diverse subsistence regime may help explain the sustainability of the oyster fishery during the precolonial era, yet these temporal and demographic patterns still require explanations in terms of social practice and local history. Oyster sizes rebounded after AD 400, pointing toward the oyster fishery's *resilience*, i.e., the capacity of a system to recover in size, structure, and diversity after strain caused by stress. Resilience is often understood in terms of an adaptive cycle that progresses from initial exploitation through conservation, release (i.e., collapse), and reorganization of the system (e.g., Redman 2005). The oyster fishery's resilience during the late prehistoric centuries must be understood as the product of both ecological and social factors.

Based on the numbers of oyster shells in the excavated sample and the overall

size of the feature, we estimate that between AD 200 and AD 1600 Kiskiak's residents deposited a minimum of 70,000,000 oyster shells in the midden. There are two additional middens within the Kiskiak settlement along Indian Field Creek, and preliminary testing of these suggests that they approximate the 44YO2 midden in size and use history. Assuming that these middens are similar in structure to the midden within 44YO2, we arrive at a considerable number of oysters harvested by Native communities along Indian Field Creek, over 200,000,000. If Kiskiak's residents consumed oysters during only half of the year, as indicated by the historical ethnography, then the community likely collected over 5,000 oysters per week from the waters surrounding the settlement.[5] With 150 residents living in Kiskiak circa 1607, this amounts to a consumption rate of about five oysters per person per day. This last value suggests to us that our estimates are not only reasonable, they are probably at the low end of the actual harvesting and consumption rates given the historical accounts of regular oyster consumption punctuated by communal feasts centered on massive quantities of shellfish.

How these values compare to the overall harvests of communities across the Powhatan portions of the James, York, Rappahannock, and Potomac Rivers is difficult to estimate, and relating these numbers to the maximum sustainable yield for the oyster fishery adds several additional layers of complexity. Nonetheless, the estimated Kiskiak oyster harvest provides a useful reference point for considering the history and conservation of the Chesapeake oyster fishery (Rick and Lockwood 2013). Demographic estimates place the number of Algonquian-speakers residing in Tidewater Virginia at contact at 15,000, roughly 100 times the number of residents at Kiskiak (Turner 1982). Projecting from the midden sizes at Kiskiak, these communities may have collectively harvested as many as 20 billion oysters between AD 200 and 1600, or approximately 143,000 bushels per year.[6]

The precolonial sustainability of the oyster fishery in the Chesapeake was undoubtedly linked to the lower human populations and more limited harvesting practices of the prehistoric era. However, generalizations of Native oystering in the Chesapeake as simply "artisanal-level" (e.g., Schulte 2017) overlook the deep history of sustained harvests and shifting Native practices. These harvesting practices contrasted starkly with the power dredging of the nineteenth century, which landed millions of bushels, and may offer lessons for how we can proceed in the future (Rick et al. 2016). In the wake of these disease outbreaks and the collapse of the oyster fishery in the mid-1980s, wild oyster harvests in the Chesapeake have exceeded 100,000 bushels only once, in 2005 (Schulte 2017). Likewise, efforts to reconstruct precolonial oyster demographics in the Chesapeake that ignore Native American oyster harvests overlook a key variable, leading some to mistakenly characterize the pre-1600 setting as pristine.

The shells deposited in ditch Feature 7 are extraordinary in several ways when compared to the oysters deposited in the midden: first, their deposition outside of the midden; second, their likely origin from offshore reefs; and third, their deposition as a discrete event. Harvesting oysters from offshore reefs required more labor and specialized technology than harvesting nearshore oysters such as those we contend are in the midden. The historical ethnography also suggests that the task groups harvesting offshore resources differed from those harvesting nearshore. The Feature 7 shell deposit at Kiskiak lines up well with other examples in the archaeological record of feasting debris (e.g., Dietler and Hayden 2010; Hayden and Villeneuve 2011; Mills 2004). Feasting has been defined as a ritualized activity involving the communal consumption of food and drink (Dietler 2010:65). Considered as consumption events marked as distinct from daily meals, feasts provide a setting for the expression of social relations that create, maintain, and contest positions of authority.

Archaeological studies of feasting have focused on evidence of special foods and beverages, unusual food preparation facilities, marked consumption spaces, and vessels distinct from those used to serve quotidian meals or for routine food preparation (e.g., Blitz 1993; Pauketat et al. 2002; Potter 2000). Archaeologists typically rely on a suite of such evidence to make the case that large-scale, public feasting occurred in the Native North American past, including the quantity and variety of food remains, places and occasions marked for special events, and unusual ratios of serving vessels to cooking vessels. The concentration of oysters in Feature 7 suggests the remains of a feast involving a considerable quantity of large, subtidal oysters harvested from offshore reefs consumed within a palisaded enclosure. This feature and the historical ethnography of diplomatic feasts sponsored by Powhatan leaders offer evidence that the social practices attached to oysters had repercussions beyond subsistence needs and into the political realm.

CONCLUSION

Confirming the results of earlier studies (e.g., Rick et al. 2016), our analysis indicates that Kiskiak's residents harvested primarily nearshore oysters from the Late Archaic period through the seventeenth century, patterns that contributed to the sustainability of the oyster fishery on a millennial timescale. However, our assessment of several morphological variables provides evidence that this community also harvested oysters from a separate habitat, likely offshore reefs. They did so occasionally throughout the settlement's history, including oysters harvested for an event during the thirteenth century AD that we have interpreted as a feast. Future studies should create a baseline data set for the five attributes measured in this study for oysters from nearshore and offshore habitats to solidify the hypotheses we put forth regarding how different variables we measured align with the morphology of oysters from nearshore and offshore habitats, and if these are the most meaningful local habitat distinctions. It is possible that the significant differences we see in the morphology of the oysters in the ditch and midden are the result in some other habitat distinction.

As measured by shell height, oyster sizes generally increased in the Kiskiak midden, proxy data suggesting that the oyster fishery remained relatively healthy and stable across the 3,000 years that the midden was in use. Shell sizes did not increase consistently throughout the sequence, though, as shell height declined from AD 100 to 400, the first period of intensive oyster harvesting along Indian Field Creek. In the following centuries oyster sizes rebounded even with rising populations, permanent settlement, and the establishment of a chiefly center at Kiskiak. The data from the Kiskiak site cast new light on the historical ecology of the Chesapeake oyster fishery, calling attention to Native communities' active role in shaping the precolonial waterscape. The oyster fishery's sustainability must be understood in terms of social practice, both before and after European colonists arrived in the Chesapeake. Indications from Kiskiak that the oyster fishery experienced periods of stress when Native societies affected the size of oyster shells call attention to the importance of detailed culture histories and of the contingency of human-environmental histories.

NOTES

1. OxCal 4.3's deposition models incorporate the relative depths of radiocarbon assays in a stratigraphic sequence to interpret the calibrated date ranges of deposits. The OxCal tool used to generate the Kiskiak midden chronology, the Poisson-process sequence (P_Sequence), models dates in a sequence with fluctuating rates of deposition. As depicted in Figure 5, the chronological model for the Kiskiak midden includes boundaries around a deposit with a higher density of shell within the midden since deposition

rates in this zone likely differed from those above and below.
2. While the difference was relatively modest, it was statistically significant, based on non-parametric comparison of period (an ordinal-scale variable) and oyster height ($n = 1052$; Kendall's $\tau = 0.05$, two-tailed $p = .037$; Spearman's $\rho = 0.067$, two-tailed $p = 0.038$).
3. Based on a one-way ANOVA comparing Middle Woodland I, Middle Woodland II, and Late Woodland I shell heights ($n = 621$, $F = 3.812$, $df = 2$, $p = 0.023$).
4. An Independent Samples t-test indicates that the difference between the Middle Woodland II and Late Woodland I mean approaches significance at the 0.05 level ($t = 1.948$, $df = 164$, $p = 0.053$).
5. Dividing 200,000,000 oysters by 1,400 years, and then again by 26 weeks.
6. Twenty billion oysters equals 200 million times 100. Twenty billion oysters divided by 1,400 years equals approximately 14,300,000 oysters per year. Assuming that there are 100 oysters per bushel (an industry standard), the Powhatans harvested roughly 143,000 bushels per year. Of course, this number is far from precise. The Powhatan region constitutes roughly half of the portion of the Chesapeake estuary that supports oysters, so the calculations likely underestimate the overall Chesapeake harvest by a factor of two. On the other hand, Powhatan settlements in the interior Coastal Plain did not have ready access to the waterways with salinity levels supporting oysters, meaning that the estimate may be too high if restricted to the Powhatans alone. Given the complexities of both the cultural landscape and of the ecological setting, we offer this estimate as a simple starting point for considering the conservation paleobiology of the Chesapeake oyster.

REFERENCES

Archer, G. 1969. Relyton of the discovery of our river. In *The Jamestown Voyages Under the First Charter* (P. L. Barbour, ed.):80–98. Cambridge: The Hakluyt Society.

Beverley, R. 1947. *The History and Present State of Virginia*. Chapel Hill: University of North Carolina Press.

Bird, R. B. 2007. Fishing and sexual division of labor among the Meriam. *American Anthropologist* 109(3):442–451.

Black, H. D., C. F. T. Andrus, W. J. Lambert, T. C. Rick, and D. P. Gilliken. 2017. $\Delta^{15}N$ in *Croassostrea virginica* shells provides early direct evidence for nitrogen loading to Chesapeake Bay. *Scientific Reports*. doi:10.1038/srep44241.

Blanton, D. B., J. R. Underwood, C. B. Birkett, D. W. Lewes, and W. H. Moore. 2005. *Archaeological Evaluation of Eight Prehistoric-Native American Sites at Naval Weapons Station Yorktown, Virginia*. Williamsburg, VA: William and Mary Center for Archaeological Research.

Blitz, J. H. 1993. Big pots for big shots: Feasting and storage in a Mississippian community. *American Antiquity* 58(1):80–96.

Bourdieu, P. 1977. *Outline of a Theory of Practice*. Cambridge: Cambridge University Press.

Bronk Ramsey, C. 2009. Bayesian analysis of radiocarbon dates. *Radiocarbon* 51(1): 337–360.

Ceci, L. 1984. Shell midden deposits as coastal resources. *World Archaeology* 16(1):62–74.

Claassen, C. 1986. Shellfishing seasons in the prehistoric Southeastern United States. *American Antiquity* 51(1):21–37.

Clark, W. B., and B. L. Miller. 1906. Clay deposits of the Virginia Coastal Plain. *Virginia Geological Survey Bulletin* 2(1):11–176.

Custer, J. F. 1989. *Prehistoric Cultures of the Delmarva Peninsula: An Archaeological Study*. Newark: University of Delaware Press.

Dietler, M. 2010. Theorizing the feast: Rituals of consumption, commensal politics, and power in African contexts. In *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power* (M. Dietler, and B. Hayden, eds.):65–114. Tuscaloosa: University of Alabama Press.

Dietler, M., and B. Hayden. 2010. *Feasts: Archaeological and Ethnographic Perspectives on Food, Politics, and Power*. Tuscaloosa: University of Alabama Press.

Erlandson, J. M. 1994. *Early Hunter-Gatherers of the California Coast*. New York: Plenum Press.

Erlandson, J. M. 2001. The archaeology of aquatic adaptations: Paradigms for a new millennium. *Journal of Archaeological Research* 9(4):287–350.

Erlandson, J. M., T. C. Rick, R. L. Vellanoweth, and D. J. Kennett. 1999. Maritime subsistence at a 9300 year old shell midden on Santa Rosa Island, *California.* Journal of Field Archaeology 1(1):255–265.

Gallivan, M. D. 2016. *The Powhatan Landscape: An Archaeological History of the Algonquian Chesapeake*. Gainesville: University of Florida Press.

Giddens, A. 1979. *Central Problems in Social Theory: Action, Structure, and Contradiction in Social Analysis*. Berkeley: University of California Press.

Hadden, C. S., and A. Cherkinsky 2017. Spatiotemporal Variability in ΔR in the Northern Gulf of Mexico, USA. *Radiocarbon*. 59(2) 343–353. 10.1017/RDC.2016.65.

Hadden, C. S., and A.Cherkinsky 2015. ^{14}C Variations in Pre-Bomb Nearshore Habitats of the Florida Panhandle, USA. *Radiocarbon* 57(3) 469–479. 10.2458/azu_rc.57.18353.

Hargis, W. J., and D. S. Haven. 1999. Chesapeake oyster reefs, their importance, destruction and guidelines for restoring them. In *Oyster Reef Habitat Restoration: A Synopsis and Synthesis of Approaches*. (M. W. Luckenbach, R. Mann, and J. A. Wesson, eds.):329–358. Gloucester Point: Virginia Institute of Marine Science Press.

Hayden, B., and S. Villeneuve. 2011. A century of feasting studies. *Annual Review of Anthropology* 40:433–449.

Hazel, J. E. 1971. Ostracode biostratigraphy of the Yorktown Formation (upper Miocene and lower Pliocene) of Virginia and North Carolina: U.S. *Geological Survey Professional Paper* 704(13):1–10.

Hulton, P. H. 1984. *America, 1585: The Complete Drawings of John White*. Chapel Hill: University of North Carolina Press.

Jansen, A., T. C. Rick, and D. Lowery. 2015. Reconciling cultural technologies, chronologies, and the rising tide at Fishing Bay, Maryland. *North American Archaeologist* 36(2):141–164.

Kennedy, V.1996. The Ecological Role of the Eastern Oyster, *Crassostrea virginica*, with Remarks on Disease. *Journal of Shellfish Research*. 15(1) 177–183.

Kappes, A.1890. Oystering on the Chesapeake. Photograph. Retrived from the Library of Congress, accessed June. 15, 2017.

Kent, B. 1988. *Making Dead Oysters Talk Techniques for Analyzing Oysters from Archaeological Sites*. Annapolis: Maryland Historical Trust.

Kirby, M., X. Miller, and M. Henry, 2005. Response of a benthic suspension feeder (Crassostrea virginica Gmelin) to three centuries of anthropogenic eutrophication in Chesapeake Bay. *Estuarine, Coastal and Shelf Science* 62(4) 679–689. 10.1016/j.ecss.2004.10.004.

Lawrence, D. R. 1988. Oysters as geoarchaeologic objects. *Geoarchaeology* 3(4):264–274.

Lepofsky, D., N. F. Smith, N. Cardinal, J. Harper, M. Morris, E. White, R. Bouchard, et al. 2015. Ancient shellfish mariculture on the Northwest coast of North America. *American Antiquity* 80(2):236–259.

Miller, H. M. 2001. Living along the "Great Shellfish Bay": The relationship between prehistoric peoples and the Chesapeake Bay. In *Discovering the Chesapeake: The History of an Ecosystem* (P. D. Curtin, G. S. Brush, and G. W. Fisher, eds.):109–126. Baltimore: Johns Hopkins University Press.

Mills, B. J. (ed.). 2004. *Identity, Feasting, and the Archaeology of the Greater Southwest*. Boulder: University Press of Colorado.

Pauketat, T. R. 2001. Practice and history in archaeology: An emerging paradigm. Anthropological Theory 1(1):73–98.

Pauketat, T. R, L. S. Kelly, G. J. Fritz, N. H. Lopinot, S. Elias, and E. Hargrave. 2002. The Residues of feasting and public ritual at early Cahokia. *American Antiquity* 67(2): 257–259.

Potter, J. M. 2000. Pots, parties, and politics: Communal feasting in the American Southwest. *American Antiquity* 65(3): 471–492.

Potter, S. R. 1993. *Commoners, Tribute, and Chiefs: The Development of Algonquian Culture in the Potomac Valley*. Charlottesville: University Press of Virginia.

Redman, C. L. 2005. Resilience theory in archaeology. *American Anthropologist* 107(1):70–77.

Reeder-Myers, L., T. C. Rick, D. Lowery, J. Wah, and G. Henkes. 2016. Human ecology and coastal foraging at Fishing Bay, Maryland, USA. *Journal of Ethnobiology* 36(3): 595–616.

Reimer, P. J., E. Bard, A. Bayliss, J. W. Beck, P. G. Blackwell, C. Bronk Ramsey, C. E. Buck, et al. 2013. IntCal13 and Marine13 radiocarbon age calibration curves 0-50,000 Years cal BP. *Radiocarbon* 55(4):1869–1887.

Rick, T. C., M. Barber, D. Lowery, J. Wah, and M. Madden. 2015. Early Woodland coastal foraging at the Savage Neck shell midden (44NH478), Chesapeake Bay, Virginia.

Archaeology of Eastern North America 43: 23–38.

Rick, T. C., and J. M. Erlandson (eds.). 2008. *Human Impacts on Ancient Marine Ecosystems: A Global Perspective*. Berkeley: University of California Press.

Rick, T. C., and J. M. Erlandson. 2009. Coastal exploitation: How did ancient hunter-gatherers influence coastal environments? *Science* 352:952–953.

Rick, T. C., and G. A. Henkes. 2014. Radiocarbon variability in *Crassostrea virginica* shells from the Chesapeake Bay, USA. *Radiocarbon* 56(1):305–311.

Rick, T. C., G.A. Henkes, D. L. Lowery, S. M. Colman, and B. J. Culleton. 2012. Marine radiocarbon reservoir corrections (ΔR) for Chesapeake Bay and Middle Atlantic coastal North America. *Quaternary Research* 77(1): 205–210.

Rick, T. C., and R. Lockwood. 2013. Integrating paleobiology, archaeology, and history to inform biological conservation. *Conservation Biology* 27(1):45–54.

Rick, T. C., D. L. Lowery, G. A. Henkes, and J. S. Wah. 2011. A Late Holocene radiocarbon chronology for the shell middens of Fishing Bay, Maryland. *Archaeology of Eastern North America* 39:153–167.

Rick, T. C., L. A. Reeder-Myers, M. J. Carr, and A. H. Hines. 2017. 3000 Years of human subsistence and estuarine resource exploitation on the Rhode River estuary, Chesapeake Bay, Maryland. *North American East Coast Shell Midden Research Journal of the North Atlantic* 10:113–125.

Rick, T. C., L. A. Reeder-Myers, C. J. Cox, S. T. Sperling, A. Jansen, and A. H. Hines. 2014. Shell middens, cultural chronologies, and coastal settlement on the Rhode River subestuary of Chesapeake Bay, Maryland, USA. *Geoarchaeology* 29(5):371–388.

Rick, T. C., L. A. Reeder-Myers, C. A. Hofman, D. Breitburg, R. Lockwood, G. Henkes, L. Kellogg, et al. 2016. Millennial-scale sustainability of the Chesapeake Bay Native American oyster fishery. *Proceedings of the National Academy of Sciences*: 113(23): 6568–6573.

Rick, T. C., and G. A. Waselkov. 2015. Shellfish gathering and shell midden archaeology revisited: Chronology and taphonomy at White Oak Point, Potomac River estuary, Virginia. *Journal of Island and Coastal Archaeology* 10(3):339–362.

Sahlins, M. 1981. *Historical Metaphors and Mythical Realities: Structure in the Early History of the Sandwich Islands Kingdom*. Ann Arbor: University of Michigan Press.

Sassaman, K. E., and D. H. Holly. 2011. *Hunter-Gatherer Archaeology as Historical Process*. Tucson: University of Arizona Press.

Schatzki, T. R. 2010. *The Timespace of Human Activity: On Performance, Society, and History as Indeterminate Teleological Events*. Lanham: Lexington Books.

Schulte, D. M. 2017. History of the Virginia oyster fishery, Chesapeake Bay, USA. *Frontiers in Marine Science*. doi:10.3389/fmars.2017.00127.

Shumway, S. E. 1996. Natural environmental factors. In *The Eastern Oyster:* Crassostrea virginica (V. S. Kennedy, R. I. Newell, and A. F. Eble, eds.):467–513. College Park: Maryland Sea Grant.

Smith, J. 1986a. The proceedings. In *The Complete Works of Captain John Smith (1580-1631)*. (P. L. Barbour, ed.):191–279. Chapel Hill: University of North Carolina Press.

Smith, J. 1986b. A true relation. In *The Complete Works of Captain John Smith (1580-1631)* (P. L. Barbour, ed.):5–117. Chapel Hill: University of North Carolina Press.

Smith, J. 1986c. Generall historie of Virginia. In *The Complete Works of Captain John Smith (1580–1631)* (P. L. Barbour, ed.):5–475. Chapel Hill: University of North Carolina Press.

Stein, J. K. 1992. *Deciphering a Shell Midden*. New York: Academic Press.

Stephenson, R. W., and M. M. McKee. 2000. *Virginia in Maps: Four Centuries of Settlement, Growth, and Development*. Richmond: Library of Virginia.

Thompson, V. D. 2014. What I believe: Reflections on historical and political ecology as research frameworks in Southeastern archaeology. *Southeastern Archaeology* 33(2):246–254.

Thompson, V. D., and J. E. Worth. 2011. Dwellers by the sea: Native American adaptations along the southern coasts of eastern North America. *Journal of Archaeological Research* 19:51–101.

Turner, E. R. 1982. A re-examination of Powhatan territorial boundaries and population, ca. *A.D. 1607*. Quarterly Bulletin of the Archeological Society of Virginia 37(2): 45–64.

Waselkov, G. A. 1982. *Shellfish Gathering and Shell Midden Archaeology*. Ph.D. Dissertation. Chapel Hill: University of North Carolina.

Waselkov, G. A. 1987. Shellfish gathering and shell midden archaeology. *Advances in Archaeological Method and Theory* 10: 93–210.