Addressing the problem of disappearing cultural landscapes in archaeological research using multi-scalar survey

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Abstract

Climate change and anthropogenic activities are actively destroying the archaeological record. The dramatic disappearance of archaeological landscapes becomes particularly problematic when they are also unrecorded. Hidden from view and eroding, these disappearing landscapes likely hold answers to important anthropological questions. As such, disappearing landscapes present a major challenge for 21st century archaeology. Left unchecked, this phenomenon will increase the severity of bias in our knowledge of the past. In this paper we use a case study from Pinckney Island in the American Southeast to illustrate how the problem of hidden and disappearing landscapes can be addressed through multi-scalar surveys. Specifically, by combining aerial LiDAR, pedestrian survey, and micro-artifact approaches, the identification of hidden and disappearing cultural materials (including permanent settlements and ephemeral artifact scatters) can be alleviated.

Keywords: climate change, cultural heritage, multi-scale analysis, hidden landscapes, disappearing landscapes, South Carolina

Recent studies illustrate (e.g., Evans et al. 2013; Freeland et al. 2016; Masini et al. 2018; Quintus et al. 2015) that there is a “hidden” archaeological record (*sensu* Bintliff et al 1999). When destructive forces act upon hidden cultural deposits, this material becomes the “disappeared”, whereby parts of the archaeological record are damaged, limiting our capability to learn new information. Climate change is resulting in greater risks to the preservation of archaeological materials, especially in coastal and island regions where sea levels and erosion rates are rising (Erlandson 2008, 2012; Reeder et al. 2012; Reimann et al. 2018).

Coastal and island environments are critically important for understanding human adaptive cycles and resilience in response to external pressures (see Bradtmöller et al. 2017; Douglass and Cooper 2020; Louwagie et al. 2006; Thompson and Turck 2011; Turck and Thompson 2016; Walker et al. 2004), and the field of historical ecology, in particular, has long addressed human adaptations to environmental perturbation in marine contexts (e.g., Aswani 2019; Brooks 1985; Crumley 1994; Kirch and Hunt 1997; Swetnam et al. 1999; Drew 2005; Balée 2006; Erlandson et al. 2005; Fitzpatrick and Keegan 2007; Braje and Rick 2013; Kittinger et al. 2015). The study of coastal archaeological sites, specifically, can improve our understanding of how humans respond to environmental changes with a deep-time perspective, and this information can then be applied to contemporary situations (Douglass et al. 2019; Douglass and Cooper 2020; Kittinger et al. 2015; also see Davis 2019b; Kelly 2016).

In this article, we discuss disappearing landscapes, which result in the permanent loss of cultural materials. Using a case study from Pinckney Island in the American Southeast—whose coastal heritage is increasingly at risk of disappearing (Anderson et al. 2017)— we demonstrate how multi-scalar surveys utilizing aerial and ground-based approaches provide one solution for studying disappearing materials.

The Disappearing Landscape

In 1999, Bintliff and colleagues coined the term "hidden landscape" to describe parts of the archaeological record that have avoided investigation. Hidden landscapes result from visibility issues, limits on survey locations, and the differential experience of field archaeologists, among other factors (Bintliff et al. 1999; Hawkins et al. 2003; Schiffer et al. 1978; Schon 2002) and bias our understanding of the archaeological record. Equal to—and arguably more problematic—are *disappearing landscapes*; parts of the archaeological record that are actively being damaged (Figure 1). When hidden and disappearing components overlap, unstudied cultural materials risk permanent erasure.

[Insert Figure 1]

Coastal regions are particularly vulnerable to urban development, which has been driving heritage destruction for over a century (Al-Houdalieh and Saunders 2009; Byram 2009; Ceci 1984; Cleere et al. 1984; Randall 2014; Rowland and Ulm 2012), because of the economic appeal of coastal property. Environmental forces also take a toll on cultural heritage. Erosion and inundation of coastal sites caused by sea level rise are a constant threat to the coastal archaeological record (Erlandson 2008, 2012; Fitzpatrick et al. 2006; Hilton et al. 2018; Hollesen et al. 2018; Marzieon and Levermann 2014; Reeder et al. 2012; Reimann et al. 2018; Westley et al. 2011). Thousands of archaeological sites around the world are below sea level (Bailey et al. 2017; Faught and Gusick 2011; Flemming 1983) and this number will continue to rise with sustained sea level increases.

The Hidden and the Disappearing

The major difference between hidden and disappearing landscapes is scale (Figure 2). Hidden components are obscured and are harder to recognize than other more pronounced objects (Bintliff et al. 1999, 2000), but are ultimately still identifiable. In contrast, disappearing landscapes consist of actively damaged known and hidden components of the record. Thus, disappearing landscapes themselves can be broken into two types: known and disappearing (KAD) and hidden and disappearing (HAD). In HAD landscapes, obscurity compounded by active erosion often prevents identification because materials are at a much smaller (possibly even microscopic) scale. Such facets may not retain any structural properties, which archaeologists often look for as evidence of human occupation.

[Insert Figure 2]

As such, the major change brought by disappearing landscapes is a shift in investigative scale. Viewing this problem through the lens of scalar change also provides potential solutions. One longstanding limitation of archaeology is that researchers tend to associate specific types of assemblages with equally particular kinds of deposits. For example, the term "site" ultimately favors high-density (large-scale) deposits over low-density (small-scale) deposits (Dunnell and Dancy 1983), thereby biasing our understanding of spatial distributions of human activity. However, due to depositional processes, HAD components often lack macro-scale structures that are usually associated with a "site" typology. Thinking about the concept of disappearing landscapes requires the modeling of such processes to refine expectations of what sites will look like post-deposition (see for example Magnini and Bettineschi 2019), and subsequently identify methods that can capture these cultural expressions.

One solution to this problem lies in multiscalar analyses. When thinking about archaeological landscapes, especially relating to settlement distributions, we must consider both the visible and hidden archaeological records, which in some instances are subtle or microscopic traces that are easily overlooked using traditional survey methods. Thus, the specific problem posed by HAD landscapes requires an intensive process to result in identification, including a combined strategy of aerial, ground, subsurface, and/or microscopic sampling.

Recording HAD landscapes using multiscalar analysis in the American Southeast

Eastern North America contains a vast archaeological record, a dominant component of which are mounded constructions (Anderson 2012; Marquardt 2010; Russo 2006; Sanger and Ogden 2018). While mounds have long been the focus of archaeological investigation (Ford and Willey 1941; Moore 1894; Squier and Davis 1848), many such features remain hidden (Davis et al. 2019a, 2019b; Johnson and Ouimet 2014; Witharana et al. 2018). Mounds have provided insight into demographic change, human-environmental interaction, social organization, and site formation in this region (Anderson 2012; Brennan 1977; Claassen 1986; Davis et al. 2020; Lightfoot and Cerrato 1989; Peacock and Rafferty 2013; Peacock et al. 2005; Reitz 1988; Sanger et al. 2019; Thompson et al. 2016). However, the coastline of Eastern North America is at high-risk of becoming a disappeared landscape, as sea levels continue to rise (Anderson et al. 2017; NOAA 2015; also see Mississippi River Delta Archaeological Mitigation (MRDAM) Consortium [https://userweb.ucs.louisiana.edu/~mar4160/mrdam.htm]).

Pinckney Island (Figure 3), located in Beaufort County, South Carolina, provides an excellent opportunity to evaluate the utility of multiscalar survey for uncovering HAD landscapes. The area has been extensively surveyed and over 100 archaeological sites have been recorded (Charles 1984; Kanaski 1997; Trinkley 1981). However, sea level rise and erosion continue to impact the archaeological record in this area (Kanaski 1997). The effects of depositional forces are noticeable while surveying the coasts of Pinckney Island, as midden deposits are actively eroding and weathering. As such, we can assess the degree to which traditional surveys identify archaeological deposits and the improvements that can be offered by multiscalar strategies.

[Insert Figure 3]

Methods

As part of a larger project involving the use of automated remote sensing methods, Davis et al. (2019a, 2019b) conducted a LiDAR (light detection and ranging) survey to locate mound deposits and associated cultural materials in Beaufort, South Carolina. LiDAR data are produced by a sensor that emits electromagnetic energy (i.e., light) and records the return times of each light pulse to calculate distance. By measuring the return times of multiple light pulses simultaneously, LiDAR data can capture ground surfaces, even in densely vegetated localities (Jensen 2007). While often prohibitively expensive, LiDAR is freely available for most of the Eastern U.S. coastline from the National Oceanic and Atmospheric Administration (NOAA).

To record hidden and disappearing landscapes on Pinckney Island, we undertook two phases of survey. The first phase was the automated analysis of LiDAR datasets to identify mound features (see Davis et al. 2019a, 2019b for a detailed discussion). We analyzed freely available LiDAR data from NOAA with a spatial resolution of 1.2 meters using object-based image analysis (OBIA). OBIA is a form of machine learning where features are identified based on spectral and morphological information (Davis 2019a). Mounds, in this case, were identified on the basis of elevation change, morphological properties, and textural differences with the surrounding landscape (Davis et al. 2019a).

The automated LiDAR survey aided in identifying the largest scales of human activity (i.e., mounds). However, because the LiDAR used cannot easily identify smaller scales of activity around mound structures, ground-based pedestrian survey was needed to: 1) confirm the archaeological nature of these identified structures; and 2) locate smaller deposits of artifacts (i.e., ceramics, lithics, etc.) that would signify extended human use.

Following the identification of mound features on Pinckney Island, targeted ground surveys were conducted at areas containing detected mounds and their adjacent areas. In total ground surveys covered approximately 0.25 km^2 (Figure 4). While some of these locations contained previously investigated areas, our goal was to survey outside of previously studied localities (Figure 3). We recorded all materials identified but left them *in situ* so as not to further damage these deposits. Together, the LiDAR and ground surveys provided two scales of analysis (regional and local) of the landscape.

[Insert Figure 4]

Results

Many of the mounded features identified in LiDAR were extremely subtle, and without prior knowledge of the presence of these objects, the vegetation would have obscured them from view (Figure 5). In fact, several locations surveyed had evaded detection by decades of previous investigation according to the South Carolina Archaeological Site Files. Other deposits were located in marshland where conducting systematic ground survey is difficult (Figure 6). At each confirmed archaeological deposit identified in LiDAR, smaller artifacts were usually located nearby. Such materials ranged from ceramics and glass to marine shells and tabby (a building material made by burning oyster shells) (Table 1).

[Insert Figure 5]

Ground-testing of deposits identified in LiDAR revealed five previously unrecorded archaeological deposits, dozens of recorded features on Pinckney Island (see Davis et al. 2019a), as well as cultural deposits consisting of shell and ceramics that did not fit within any currently included site boundaries (Figure 3). Overall, semi-automated LiDAR analysis identified 80 features within Pinckney Island and the true positive detection rate during ground-survey and evaluating the state archaeological site files was 75%. However, the LiDAR data had too few data points (4 per m^2) to identify objects smaller than a few meters in diameter, leaving many artifact scatters undetectable. Ground survey was able to identify nearby artifacts to these larger mound constructions, helping to map the extent of human activity in these areas (Table 1).

[Insert Table 1]

[Insert Figure 6]

Our case study indicates that landscape-scale remote sensing data, in conjunction with smaller-scale ground-survey, allows for the identification of: 1) previously unrecorded archaeological features ; 2) hidden components of the landscape at risk of disappearing; and 3) smaller scales of cultural activity (evidenced by shell debris, ceramic sherds, lithics, glass, and metal) that represent the disappearing cultural landscape of Pinckney Island.

Discussion

The case study illustrates how disappearing archaeological landscapes can be recorded using multiple scales of analysis. While LiDAR (regional-scale) methods successfully identified new and pre-recorded mounded architectural structures, surface scatters where larger deposits used to be were likewise identified on the ground nearby aerially detected features (local-scale). This includes several large middens which, because of coastal erosion, did not produce an elevation profile great enough for the LiDAR to detect. Using these case studies as a framework, we can think about the ideal research strategy for studying HAD landscapes as a multi-tier process of continuously decreasing scale (Figure 7).

[Insert Figure 7]

Remote sensing provides the ability to systematically evaluate large-scales (X >1m), helping to identify dominant cultural materials. However, for subtle traces of cultural material, these large-scale approaches must be supplemented with ground-based studies of materials (exceptions include Chiabrando et al. 2018; Herrmann et al. 2018; Orengo and Garcia-Molsosa 2019). Recently, archaeologists used kayak surveys to extend coastal investigation along Eastern North America, recording many HAD archaeological sites (Reeder-Myers and Rick 2019). For those disappearing components of the record, which consist of small (1m >X>2mm[1]) to-microscale (X<2mm) traces, only through systematic sampling of survey locations can we hope to identify these deposits.

While our study stopped at macro-artifacts, much could be gained from micro-artifact analysis. For example, a study in Kentucky emphasized that micro-artifacts tend to occur in higher densities and present more reliable evidence of buried surfaces than macro-artifact scatters (Johnson et al. 2016; Schiffer 1987). Johnson et al. (2016) demonstrate how the use of micro-artifacts can be used to both include and exclude sites from the National Register of Historic Places (NRHP) in the United States. Specifically, they show how micro-artifacts help to affirm site integrity and spatial organization, identify lithic processing strategies, and even provide insight into gendered activities (Johnson et al. 2016:48).

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[1] 2mm is the threshold for microartifacts according to Dunnell and Stine (1989).

Using microscale approaches, we can think of disappearing landscapes as a *permanent change in scale of the archaeological record*, whereby we move from dominant landscape features to subtler (sometimes microscopic) scale features. Thus, in a "perfect" study of an archaeological landscape, all three levels of investigation (regional, local, and micro) will be present to alleviate extant biases at other scales. In our study on Pinckney Island, only two of these scales were utilized (regional and local). The inclusion of micro-analysis would help to determine important site characteristics (e.g., locating living surfaces [Shahack-Gross 2011], intentional manipulation of environmental surroundings [Friesem et al. 2016], etc.) , and is important for preserving the cultural history of at-risk areas like coastal South Carolina. Microscale methods make it possible to restructure our expectations of cultural remnants towards identifying ephemeral or otherwise degraded sites, where only slight traces remain (see Friesem et al. 2016).

Conclusions

We demonstrate how the problem of HAD landscapes can be alleviated using multiscalar research designs. Researchers should also take other steps to address the issues posed by the disappearance of the archaeological record. Increased collaboration between researchers and local communities, for example, is critical. Collaborations with local communities provide new sources of funding (Simpson and Williams 2008) and information (including the locations of unrecorded cultural sites) which are vital for improving scholarly knowledge of the past (e.g., Colwell 2016; Guilfoyle and Hogg 2015; Gallivan et al. 2007). Such abilities are essential in the race to document disappearing cultural landscapes.

Increased dialogues between the public and archaeologists are also invaluable for risk mitigations, as relationships between researchers, governmental agencies, and local communities are essential for improving responses to destructive events (Peres and Deter-Wolf 2018). Because disappearing landscapes ultimately threaten erasure of past cultures, it is imperative to mitigate this threat in collaboration with local communities. The ability to work with locals improves our capacity to survey areas that are privately owned – which severely limits traditional surveys (see Ives et al. 2017) – and provides justification for why archaeology matters. Such collaborations allow researchers to work with local communities to help preserve their history and address issues of local concern.

Ultimately, climate change is increasing risks to the preservation of archaeological material, especially in coastal and island regions. Over a decade ago, Jon Erlandson (2008:169) wrote:

> Island and coastal archaeologists cannot afford to stand idle as the long and diverse history of maritime cultures around the world is lost to sea level rise and accelerating erosion… We need a concerted, collaborative, and global effort to bring the problem to the attention of resource managers, government leaders, and the general public… In coastal regions around the world, we need to accelerate our own efforts to inventory, investigate, and interpret the history of endangered coastal sites before it is lost forever.

Since then, climate-change related threats have only grown (see IPCC 2018). Nonetheless, coastal archaeologists have also been improving the techniques they use for recording the archaeological record at landscape scales using remote sensing technologies (e.g., Davis 2019a; Davis et al. 2019b; Freeland et al. 2016). Documenting and studying these at-risk sites thus becomes one of the fundamental challenges for archaeologists in the 21st century: we must uncover the disappearing archaeological record before it is forever lost.

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Figure Captions

Figure 1: Variables culminating in a disappearing archaeological landscape

Figure 2: Diagram demonstrating known and disappearing (KAD) and hidden and disappearing (HAD) components of the archaeological record. We have the total archaeological record, demonstrated by the largest, all-encompassing ellipse. Then we have the known portion of the record, and those known sections that are disappearing (KAD) or already destroyed. On the other side we have the hidden record, which also has components that are disappearing (HAD) and already destroyed.

Figure 3: Locations of cultural deposits identified during surveys and previously identified sites on Pinckney Island, SC. Many visited locations contained a mounded feature detected by LiDAR, while others contain artifact scatters located while on the ground. Most locations contained both types of deposits. Locations of previously surveyed/identified areas acquired through the South Carolina State Archaeological Database (accessed May 2018).

Figure 4: Locations of ground surveys conducted during October of 2017. Several of these areas revisited previously surveyed locations (see Figure 3), while others had not been previously investigated.

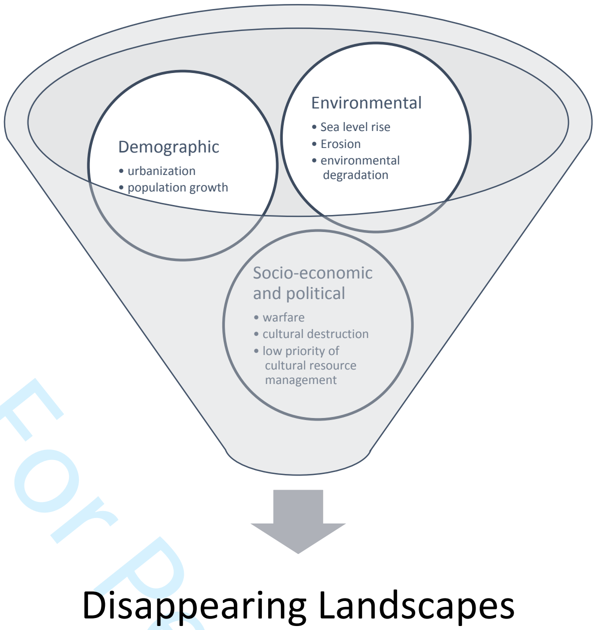
Figure 5: A previously unrecorded mound feature identified on Pinckney Island, according to the South Carolina state archaeological database (accessed May of 2018). A: the mound as seen in LiDAR data. B: the mound as seen on the ground during survey. It is clear that identifying the mound is difficult due to vegetation and limited ground visibility, but with the aid of LiDAR, the feature can be located. Shell material and historic tabby and glass were found throughout this area. Photo (B) taken by the author.

Figure 6: Previously unrecorded mound located in the marshes of Pinckney Island. Site could only be accessed during low tide. Photo taken by the author.

Figure 7: An illustration of how the study of HAD landscapes can be improved. Each subsequent method fills in gaps of the previous, and thus they are not overlapping circles, but plugs to an otherwise empty space in our knowledge of the past.

Table Caption

Table 1: Materials identified by LiDAR and ground survey on Pinckney Island in October, 2017. This list contains only those areas that contained anthropogenic materials, as other locations were investigated that yielded no artifacts. Even in locations where LiDAR misidentified a feature, cultural materials were still sometimes recovered nearby.



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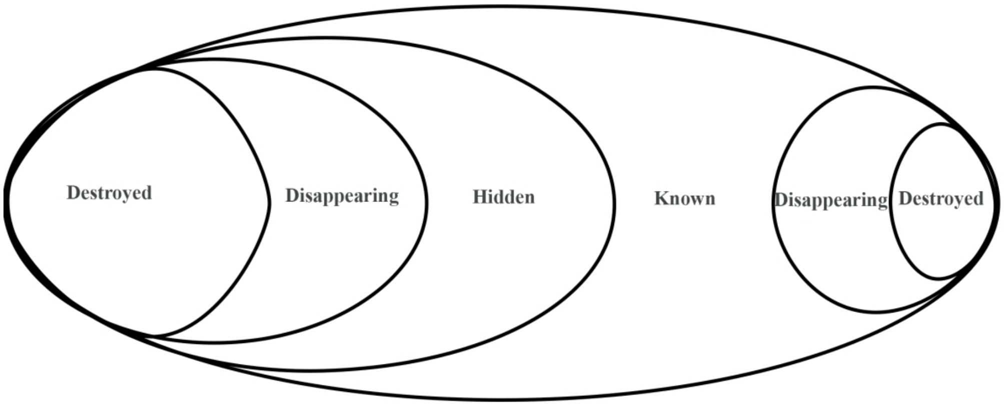

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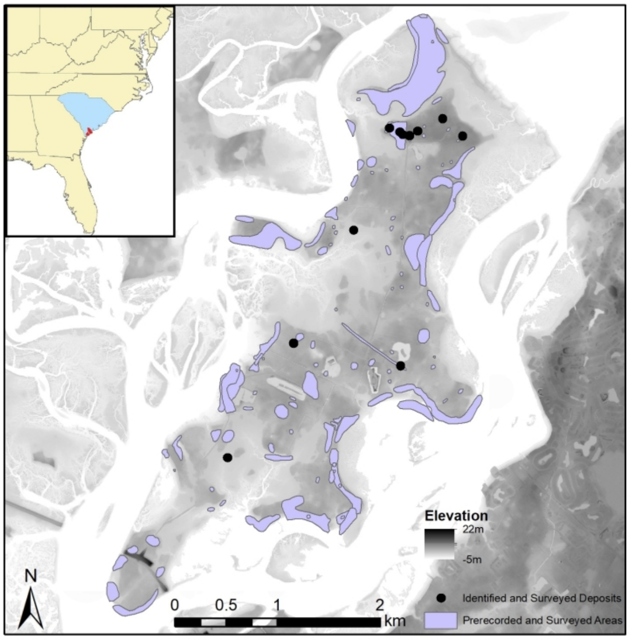

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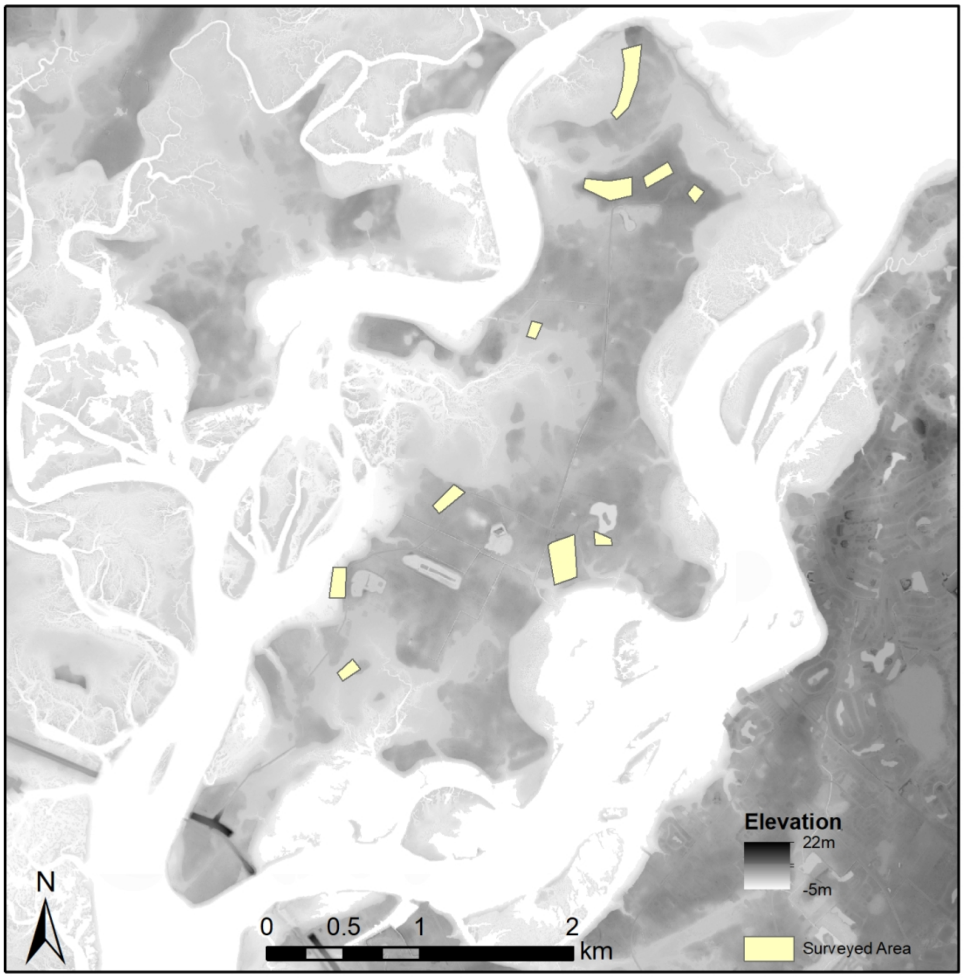

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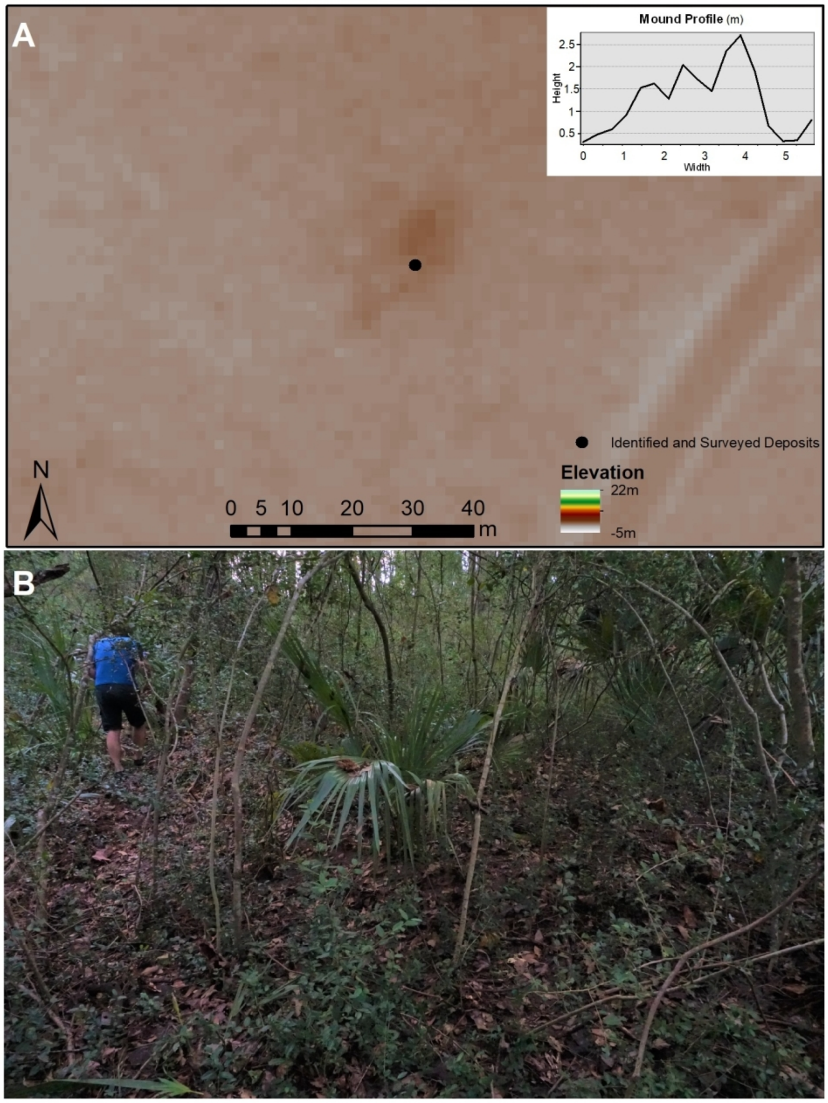

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Previously unrecorded mound located in the marshes of Pinckney Island. Site could only be accessed during low tide. Photo taken by Dylan Davis.

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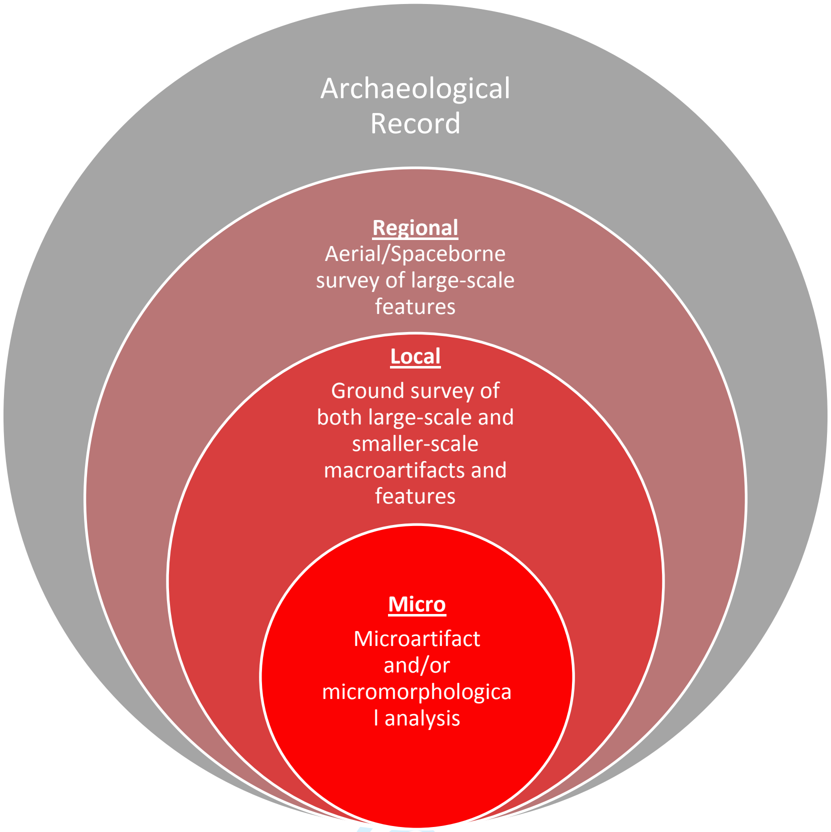

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Feature ID	Material identified in LiDAR	Size of LiDAR detection	Material identified during ground survey
2	Anthropogenic Mound	20m x 16m	Marine Shell
16	Anthropogenic Mound	17m x 13m	Ceramic, marine shell, historic bottles, tabby
19	Natural topographic rise	15m x 15m	Marine shell
20	House clearing	15m x 15m	Historic house structure, marine shells
22	Refuse pit	5m x 5m	Historic roadway, fence posts, modern refuse
26	Natural topographic rise	15m x 7m	Faunal remains
28	Anthropogenic Mound	15m x 15m	Glass, ceramic, marine shell
29	Midden	20m x 20m	Marine shell fragments, ceramics, tabby, corded tree
31	Midden	15m x 15m	Marine shell fragments, ceramics, tabby

Changes from preprint to accepted version

A few expanded explanations of key concepts and several typographical errors were corrected throughout. The core content was not substantially changed from this preprint version to the accepted manuscript.