Using Multistaged Magnetic Survey and Excavation to Assess Community Settlement Organization: A Case Study from the Central Peninsular Gulf Coast of Florida

Christina Perry Sampson and Timothy J. Horsley

ABSTRACT

Integrating geophysical survey with the study of community settlement patterns can be challenging because of cultural and environmental factors including (1) site formation and house preservation, (2) the coordination of domestic tasks at extra-household scales, and (3) the survey environment of the study area. In this article, we present the results of a program of geophysical survey comprising magnetic susceptibility and magnetometry at Weeden Island (8Pi1)—a shell-bearing, wooded site with nearly pure sand soils on the Gulf Coast of Florida. Combining remote sensing techniques mitigated some of the challenges of surveying forested terrain while providing insight into community organization at a site with minimal preserved structural remains. Compared with previous traditional surveys of the area, the geophysical survey extended the recognized boundaries of occupational activity, provided additional definition to the spatial structure of deposits, and allowed us to identify specific domestic features. Excavations at each area of intensive occupation provided evidence about the organization of the domestic economy at the site and showed the potential of this approach to reveal significant patterns of community settlement.

Keywords: magnetic susceptibility, magnetometer, Florida, Safety Harbor, complex hunter-gatherers, shell middens, community organization

La integración de prospecciones geofísicas con la investigación de patrones de asentamientos comunitarios puede ser desafiante por causo de algunos factores culturales y ambientales incluyendo (1) los procesos de formación de sitios y la preservación de restos domésticos, (2) la coordinación de tareas domesticas en escalas supra-domésticas, y (3) el medio ambiente moderno de la región de la investigación. En este trabajo, presentamos los resultados de una programa de prospección geofísica consta de susceptibilidad magnética y magnetomatría en el sitio de Weeden Island (8Pi1), un sitio boscoso y con cantidades de concha en la costa del Golfo de Florida. La combinación de varias técnicas geofísicas mitiga algunas desafíos de la prospección en terrenos boscosos mientras proporciona comprensión de la organización comunitaria de algún sitio sin preservación de restos arquitectónicos. Comparando conLa integración de prospecciones geofísicas con la investigación de patrones de asentamientos comunitarios puede ser desafiante por causo de algunos factores culturales y ambientales incluyendo (1) los procesos de formación de sitios y la preservación de restos domésticos, (2) la coordinación de tareas domesticas en escalas supra-domésticas, y (3) el medio ambiente moderno de la región de la investigación. En este trabajo, presentamos los resultados de una programa de prospección geofísica consta de susceptibilidad magnética y magnetomatría en el sitio de Weeden Island (8Pi1), un sitio boscoso y con cantidades de concha en la costa del Golfo de Florida. La combinación de varias técnicas geofísicas mitiga algunas desafíos de la prospección en terrenos boscosos mientras proporciona comprensión de la organización comunitaria de algún sitio sin preservación de restos arquitectónicos. Comparando con prospecciones tradicionales anteriores del área, la prospección geofísica extendió los límites de las actividades domésticas, proporcionó más definición a los patrones espaciales de los depósitos, y nos permite a identificar rasgos domésticos específicos. Excavaciones en cada área de ocupación intensiva proporcionó evidencia sobre la organización de la economía doméstica en el sitio y mostró la potencial de este método para revelar patrones significativos de asentamientos comunitarios.

Palabras clave: susceptibilidad magnética, prospección con magnetómetro, Florida, cazadores recolectores complejos, sitio conchero, organización comunitaria

Advances in Archaeological Practice 8(1), 2020, pp. 53–64

DOI:10.1017/aap.2019.45

Large-scale, high-resolution remote sensing data can be used in combination with more traditional archaeological methods to study community organization. The use of remote sensing in the study of community organization often relies on identifying and mapping house structures through geophysical survey (e.g., Barrier and Horsley 2014; Davis et al. 2015; Prentiss et al. 2008; Thompson et al. 2014). Identifying structural remains by remote sensing can support the study of archaeological households through traditional methods such as excavation or be used to create community maps that expand beyond excavated areas.

This study offers solutions to cultural and environmental challenges that converge in the study of community organization in places such as the Florida Gulf Coast. First, there are methodological challenges to geophysical survey in the terrestrial uplands of this coastal environment, including both the wooded terrain and the low magnetic susceptibility of sandy soils. Second, we focused on an archaeological context where structural remains are limited, as is information about spatial or social patterns of residential community organization. We used a multistage program of magnetic susceptibility and magnetometry to produce detailed survey data over a relatively large area of difficult terrain. Excavation results demonstrated variability in discrete cultural features with regard to faunal profiles, crafting activities, and feature type. Patterns in the relationships between magnetic anomalies and excavated features provide a basis for interpretation of community settlement patterns from the more extensive but coarser resolution magnetic susceptibility survey.

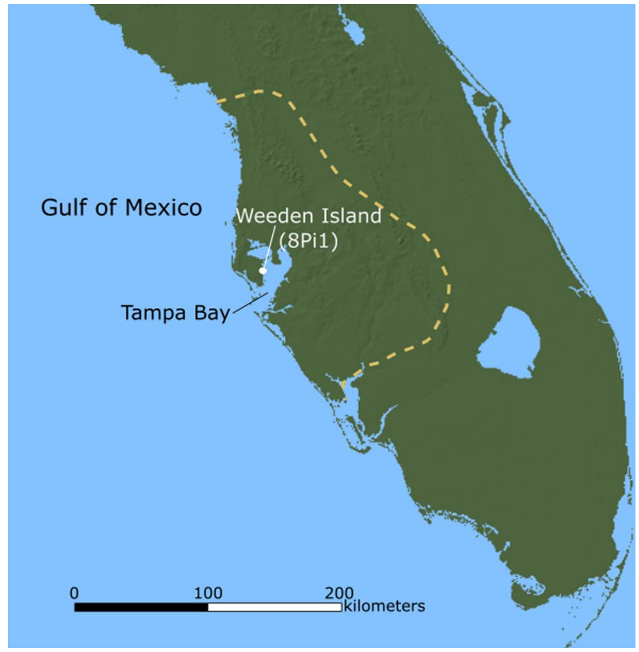

FIGURE 1. Location of the Weeden Island site. Outline of the core Safety Harbor culture area based on Mitchem 2012:173.

Our research took place at the Weeden Island site (8Pi1), which is located on a small peninsula in Pinellas County, Florida, on the western side of Tampa Bay. Most of this peninsula is managed as the Weedon[1] Island Preserve, an area of relative wilderness amid the otherwise highly urbanized landscape of St. Petersburg (Figure 1). The site covers a substantial portion of the terrestrial upland area of the preserve. Whereas twentieth-century research at the site focused on the Woodland period (ca. AD 500–900) burial mound and occupation (Fewkes 1924; Sears 1971), more recent work has examined issues of subsistence and more closely investigated Safety Harbor (ca. AD 900–1600) midden deposits (Jackson et al. 2018; Kolianos and Austin 2012; O'Donnell 2015; Weisman et al. 2005).

ENVIRONMENTAL AND ARCHAEOLOGICAL CHALLENGES

Survey Conditions

The sediments of the area include the deep, fine sands of the Paola and St. Lucie soils (USDA-NRCS 2018). The terrestrial uplands of the Weeden Island site feature wind-deposited sand dunes, which contribute visible topographic variation across the landscape. Indigenous residents deposited refuse atop these natural dune formations, resulting in ridges of mounded midden. The dunes are made up of several meters of yellow aeolian sand, probably deposited between 6,000 and 5,000 years ago, coinciding with the Middle Archaic period (Weisman et al. 2005:12). These same sediments also appear at lower elevations and are topped by white aeolian sands that vary in depth (thinner atop dune ridges, thicker at lower elevations) and may contain Late Archaic artifacts. Anthropogenic sediments dating to the late Woodland- and Mississippi-period occupations are typically found on top of the white sand deposits (Weisman et al. 2005:12). We expected that these sands would exhibit very low magnetic susceptibility values. Consequently, our initial survey and excavation were also a methodological test of the feasibility of magnetic survey techniques in this area.

The physical constraints of terrain and vegetation can also limit the utility of geophysical survey. Magnetometry is frequently the preferred geophysical technique for investigating prehistoric sites in North America, especially in the southern United States, where the magnetic properties of natural sediments provide a strong contrast with burning and pit features (Gaffney and Gater 2003:141; Johnson 2006:311–332). Magnetometry has proven useful in the detection of house remains and earthworks throughout the Southeast (e.g., Haley 2014; Henry et al. 2014; Horsley et al. 2014). However, landscapes such as wooded areas that cannot be traversed at a consistent pace along straight lines are difficult to survey effectively with magnetometers (Hodgetts et al. 2016; Kvamme 2006:224). Other commonly used techniques may also encounter problems in wooded settings. Ground-penetrating radar instruments require the antenna to stay in contact with the soil, and on wooded sites with uneven ground and obstructions, such as large tree roots, this can be challenging. Electrical resistance survey can be conducted in forested settings because readings are collected individually, but navigating around vegetation and managing cables can be difficult (Johnson 2006:311).

We demonstrate one way to manage these issues with a multistage survey program. In the present study, we first conducted topsoil magnetic susceptibility surveys at a larger scale, followed by more targeted magnetometer surveys. Magnetic susceptibility instruments are more easily maneuverable than magnetometers (Hodgetts et al. 2016), but their effective depth of collection is shallow, and the resulting maps can be relatively coarse in resolution. Targeted magnetometer survey over smaller areas of interest can therefore complement these results and allow further interpretation of the magnetic susceptibility data.

Assessing Community Settlement Patterns

The geophysical survey described here is part of a project to assess the community organization of the early Safety Harbor occupation at the Weeden Island site (8Pi1). The Safety Harbor archaeological culture is found on the central peninsular Gulf Coast area of Florida and dates to the Mississippian period through European contact (AD 900–1725; Bullen 1955, 1978; Milanich 1994:389; Mitchem 1989). Major themes of Safety Harbor research have included the significance of platform mound architecture, mortuary traditions and the use of charnel houses, continuity in subsistence strategies, the extent of involvement in Mississippian economic or ideological systems, and Spanish contact-era interactions (Austin 2000; Austin and Mitchem 2014; Hutchinson 2006; Kozuch 1986; Luer 1992, 2014; Luer and Almy 1981; Marquardt and Walker 2012:56; Milanich 1994:389–412; Milanich and Hudson 1993; Mitchem 1989, 1996, 2012; Willey 1949:475–488; Worth 2014). However, systematic survey and excavations at precontact Safety Harbor residential sites have been limited to a few locations (e.g., Austin 1995; Austin et al. 2008; Simpson 1998), especially compared to research on mounds. This has, in turn, limited investigation of issues such as the organization of craft production, the distribution of resources, and the authority of local leaders, which are foundational to the development of political integration at regional scales. A question central to our research at Weeden Island asks: how did domestic practices within Safety Harbor residential communities articulate with regional changes in settlement and intensified interactions with powerful neighbors?

Answering this question depends on recognizing domestic activity areas and understanding how they are related to one another—spatially, socially, and temporally. One way to analyze community organization is in terms of households, the groups of people (coresidential or otherwise) who shared production and consumption tasks (Blanton 1994; Wilk and Rathje 1982). Household archaeology provides a framework for studying variation and change in production, consumption, and other daily activities when these tasks are shared cooperatively by multiple separate social units within a community (Blanton 1994; Flannery 1976; Hirth 1993; Nash 2009; Wilk and Rathje 1982).

The application of household archaeology faces challenges in regions where researchers are working to understand community organization. First, the structural remains of houses are not always well preserved or readily detected, even at permanent residential sites. Issues of recovery have historically created challenges to household archaeology in parts of the southeastern United States (Pluckhahn 2010:333–334). Sites lacking detectable house remains require a different approach to interpreting geophysical survey data. Johnson (2006:306–307) describes this problem by comparing the likely results of magnetometry at a Mississippian village, where house remains can be identified based on anomaly shape (rectangles of a certain size), to the same technique used at a site consisting mostly of pit features and only ephemeral structural remains. In the latter case, one solution is to analyze the combined results of multiple survey techniques (e.g., Johnson 2006:306–307; Kvamme 2003; Kvamme et al. 2006:251–267).

In addition to recovery, cultural factors affect the potential to analyze community settlement in terms of household units. The domestic economy of small-scale societies, including those with a foraging mode of subsistence, may be organized communally rather than at the social scale of individual families or households. Production and consumption can be undertaken by multiple cooperating families, or with the entire residential community operating as a minimal economic unit (Mehrer 2000; Peregrine 1992; Wiessner 1982). Discard deposits identified archaeologically may then represent communal domestic activities rather than the activities of individual households that could be compared to one another. Settlement plans derived from architectural remains have been used to answer questions about the economic structure of communities (Flannery 1972, 2002). Without such remains, the social scale of domestic activity remains a fruitful area of study, but one that must be addressed through different methodologies.

We managed these challenges by emphasizing activity areas as sites of domestic production and consumption rather than houses. An activity area framework interprets the spatial patterning of artifacts and features in terms of the functions that different site locations served (Binford 1983; Kroll and Price 1991). Spatially contextualized features can be used to infer discrete areas of activity. In some cases, these areas might be attributable to household units—subgroups of the residential community who produce and consume together. For example, households in a village might each produce distinct pits and piles of midden through daily discard practices, and if archaeologists can parse these deposits, they can interpret the activities of individual households. In this study, we sought evidence of the ways that production and consumption activities shaped the use of space and the extent to which site structure was a product of independent households and/or a communal domestic economy.

GEOPHYSICAL SURVEY AND EXCAVATION AT WEEDEN ISLAND

The extent of our survey was based on the findings of previous work and constrained both by historic and modern disturbances and by the boundaries of the power plant at the north end of the preserve. We focused on the portion of 8Pi1 where modern development was limited, and where previous work had identified two large midden ridges (the Jeanne Mound Complex and the Three Ogres Mound), each containing materials from the Manasota Weeden Island period to the early Safety Harbor period (Weisman et al. 2005:141–177, 377–390). We surveyed an area of about 180 × 270 m, including the midden ridges and adjacent areas. Whereas a previous survey covered portions of the aforementioned midden ridges, our focus was on the adjacent flatter locations where we suspected that buried deposits representing domestic activity areas might be found. In these locations, prior survey of the preserve had identified "dark earth middens"—presumably residential activity areas that encompassed a mix of organic soil, shell, and household refuse over an area of at least an acre (Weisman et al. 2005:362–390).

FIGURE 2. Zeroing the susceptibility meter between readings under typical ground-cover conditions (left); conducting magnetometer survey in a cleared location (right).

Topsoil Magnetic Susceptibility Survey

Magnetic susceptibility (MS) is a measure of the ability of a material to become magnetized when placed in a magnetic field. In soils, this property is related to naturally occurring iron minerals, which can be converted to more magnetic forms through anthropogenic activities such as burning or through the decomposition of organic material (Aspinall et al. 2008:22–26; Fassbinder and Stanjek 1993; Linford 2004; Mullins 1974; Tite and Mullins 1971). Although magnetometer surveys measure the effect of MS contrasts on the earth's magnetic field, it is possible to measure the MS of a material directly using a susceptibility meter and field coil (Dalan 2006, 2008; Dearing 1999; Gaffney and Gater 2003:44–46).

We conducted a magnetic susceptibility survey using a Bartington MS2 susceptibility meter with MS2D field coil. We took measurements by placing the field coil directly onto the ground surface after zeroing the instrument in the air (Figure 2). When placed on a flat surface, the 18.5 cm diameter of this coil will measure to a depth of approximately 10 cm, with 50% of the signal coming from the uppermost 15 mm (Dearing 1999:Table 1.7; Gaffney and Gater 2003:44–45). Consequently, it is important that the coil be placed flat on the soil surface since leaf litter or a rough surface could significantly reduce the measured value. This shallow depth of investigation also means that it is only the uppermost centimeters of soil that contribute to the measurement, although these tend to reflect the magnetic properties of underlying soils and sediments due to bioturbation.

Readings were made at either 5 m or 10 m intervals, paced and using a handheld GPS as a guide. Although GPS can be inaccurate, especially under forest canopy, the goal at this stage was to characterize broad-scale variations and areas of occupation rather than locate discrete features. The MS instrument was set to a sensitivity of 0.1, and readings of volume susceptibility were displayed in dimensionless SI units. Where low measurements appeared to indicate background values, we increased the distance between readings to 10 m. We reduced the distance to 5 m where elevated (anthropogenic) values were recorded. Two measurements were usually made on the ground approximately 0.2–0.4 m apart in order to ensure a reliable reading, and the unit was rezeroed in the air between each reading. We removed leaf litter at each location to ensure that the field coil was placed directly onto the soil surface. One reading for each position was written down on a prepared survey sheet. No processing is required for these data, and they are presented here without interpolation. Although this results in the data having a blocky appearance, it more accurately reflects the coarse intervals at which the readings were collected.

The results of this magnetic susceptibility survey have helped to redefine the boundaries of occupational activity within the study area. Previous research used pedestrian survey and soil probes to map the area, which revealed occupational dark earth midden adjacent to both the Jeanne Mound Complex and the Three Ogres Mound (Weisman et al. 2005:36–37, Figure 11.2). Our MS results show that there is a general trend of increased occupational activity on areas of higher topography, on and around the two previously identified midden mounds, and within the previously established dark earth midden areas (Figure 3). However, there are also several well-defined areas of increased magnetic susceptibility to the west of each midden mound that go beyond the areas previously delineated as occupational midden. Adjacent to the Jeanne Mound Complex in the southern portion of the survey are two roughly discrete areas of increased magnetic susceptibility, each containing high readings with mid- to low-level readings around them. This coincides with a previously recorded feature called the Broken Foot Midden that "wraps around the Jeanne Mound Complex and extends westward to a low ridge that arcs away from the main dune ridge" (Weisman et al. 2005:176). Adjacent to Three Ogres Mound at the north of the survey area, there is an even more striking pattern of five discrete high MS readings (at a resolution of one reading per 5 × 5 m square) that approximately follow the edge of the mound. These are outside of the previously observed boundaries of occupation, the Whelk Hollow Midden, which the pedestrian survey placed primarily north of the Three Ogres Mound

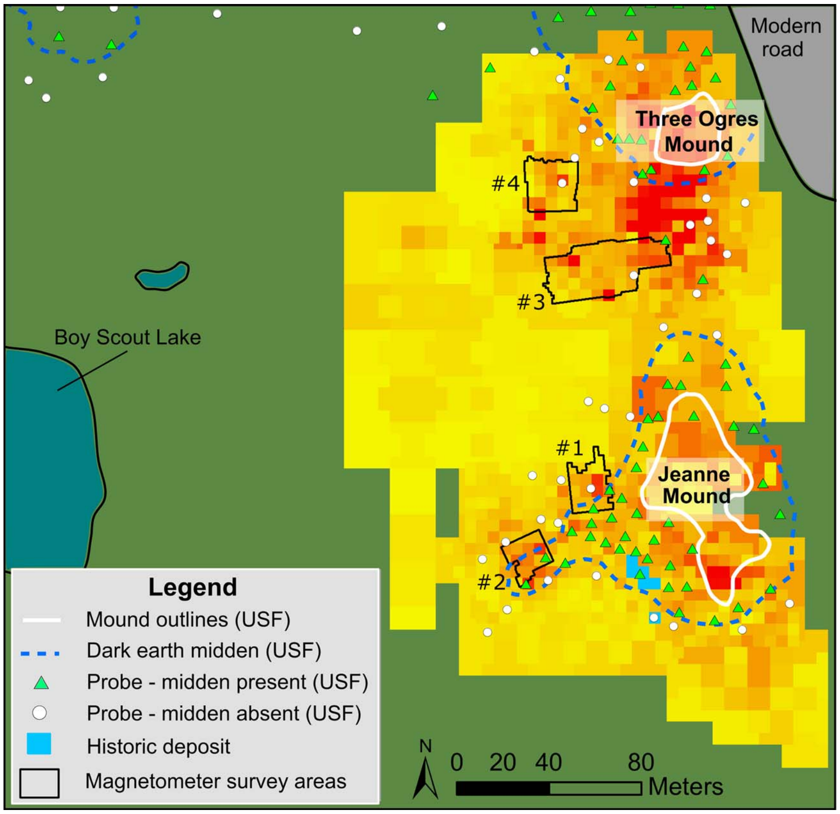

FIGURE 3. Magnetic susceptibility survey data (plotted from 1 SI to 20 SI, yellow to red) compared to the findings of pedestrian and probe survey of the preserve (based on Weisman et al. 2005:141–177, Figures 11.2 and 13.1).

Complex. We further investigated five of these high-reading areas adjacent to both midden mounds with a magnetometer survey.

Magnetometer Survey

Magnetometry is currently the most rapid geophysical method, and it can detect a broad range of both prehistoric and historic archaeological features on the basis of contrasts in magnetic susceptibility (MS) and/or the presence of a permanent magnetization (Aspinall et al. 2008; Clark 1990:64–98; Gaffney and Gater 2003:36–42; Kvamme 2006). Features associated with high-temperature processes can be detected on account of a strong thermoremanent magnetization that is retained when the iron oxides contained in those features are heated to above their Curie points (around 600–800°C, or 1,000–1,400°F) and then cooled (Aspinall et al. 2008:21–22). In addition to pits, ditches, house basins, larger postholes, and many burnt remains, it is often possible to identify areas of occupation using a magnetometer by an associated increase in the level of magnetic "noise."

We used a Bartington Grad601-2 dual fluxgate gradiometer to survey four areas: two approximately 15 × 15 m areas, one 30 × 20 m area, and one 20 × 20 m area. In each area, we cleared vegetation, including saplings and undergrowth (Figure 2). This was a time-consuming process, and the size and location of magnetometer survey areas was, in part, subject to our ability to clear the location. In 2013, while collecting data for Survey Areas 1 and 2, both gradiometer sensors were used to collect data at a sample interval of 0.125 m along traverses spaced 0.5 m apart. Each line was walked in opposite directions (sometimes referred to as bidirectional). In 2014, while collecting data for Survey Areas 3 and 4, we used just a single gradiometer sensor and collected data along traverses in one direction only. Due to the subtle nature of the archaeological anomalies and the large number of trees and other obstacles, this unidirectional methodology produced higher-quality data by reducing striping defects caused by different sensors and orientations—although survey speed is significantly slower. Processing of magnetometer data was limited to clipping of the data, sensor destripe to reduce striping in the 2013 data (survey grids 1 and 2) due to sensor mismatch (see Horsley and Wilbourn 2009), and interpolation.

The four magnetic survey areas were selected to overlap with five locations where high MS readings had been detected adjacent to the midden mounds. In each of these locations, the magnetometer survey revealed a concentration of positive anomalies. Some of the anom alies were relatively weaker (less than 3nT in strength) and others measured between 5 and 10 nT. Intense bipolar anomalies interpreted as being associated with modern or historic iron (measuring ±20–80 nT) were excluded from the interpretation of archaeological features. Based on these results, excavation locations were selected to test associations between types of anomalies and cultural (or natural) features, reveal relationships

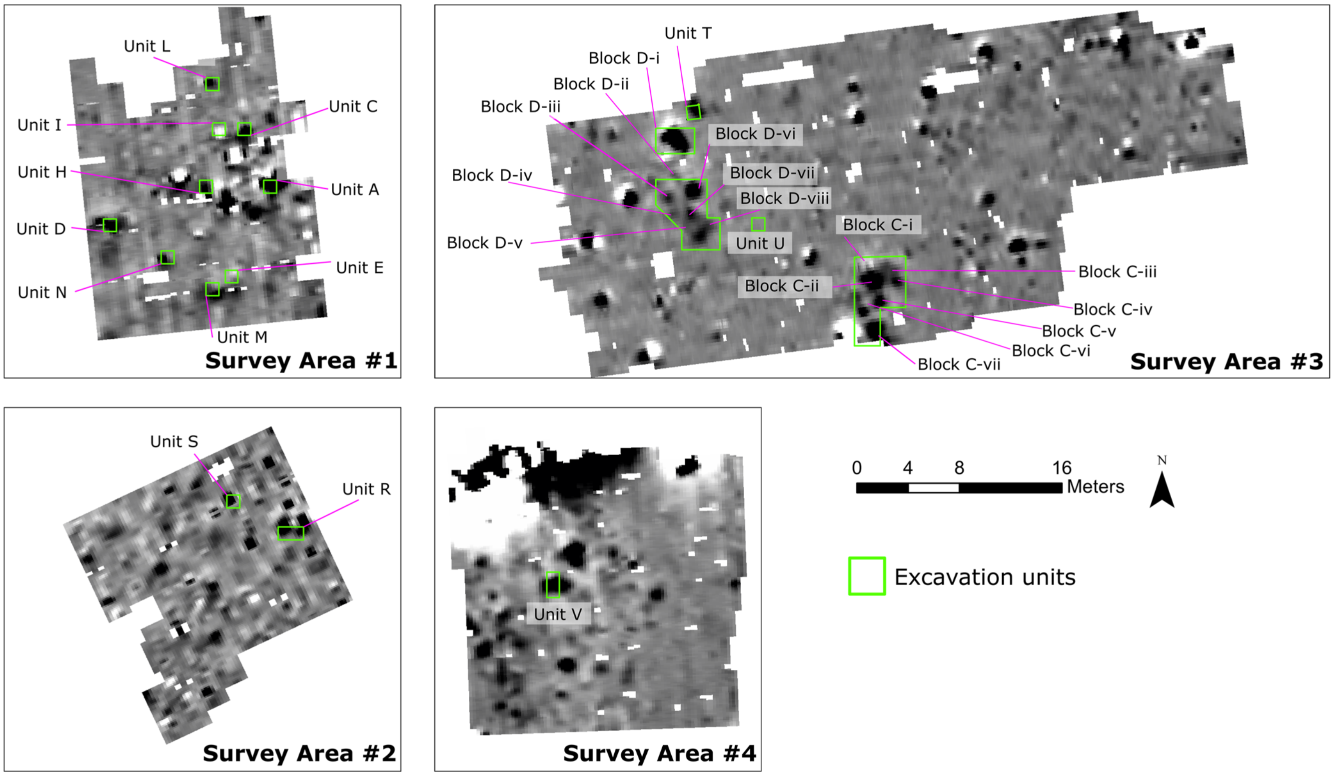

FIGURE 4. Results of magnetometer survey in four locations, plotted from –1.5nT (white) to +1.5nT (black), and UM-WIAP excavations targeting anomalies.

among features, sample their content, and recover artifacts and other materials (Figure 4).

From Anomalies to Features

The five areas of interest that we identified first in the MS survey were each characterized by a cluster of strong, positive magnetic anomalies in the magnetometer data. Such anomalies are consistent with those seen over concentrations of magnetically enhanced deposits, such as pits and hearths. The anomalies varied in size and shape, and discrete negative anomalies were also present in each area. We characterized anomalies in terms of polarity and the strength of their magnetic amplitude: strong positive, weak positive, strong negative, and weak negative. These specific categories cannot be generalized across sites because they are relative, and actual values will vary by location; however, a similar approach to classifying anomaly types could apply more broadly. In this study, "strong positive" anomalies have amplitudes measuring between 3 and 10 nT; "weak positive" anomalies have amplitudes between 0.5 and 2.9 nT; "strong negative" anomalies have amplitudes less than –1.0 nT; and "weak negative" anomalies have amplitudes between –0.1 and –0.9 nT. Anomalies also vary in size and shape, although in some cases, large or irregular anomalies may encompass overlapping anomalies or represent superimposed features.

Field crews excavated 14 1 × 1 m and 1 × 2 m test units in the locations of magnetic anomalies across the five areas of interest. Two larger excavation blocks (Block D and Block C, covering about 25 m^2 and 20 m^2, respectively) were located over the clusters of magnetic anomalies in Survey Area 3 (Figure 4). The results of the excavations provided information about how magnetic anomalies at the site correspond to archaeological features (Table 1; Figure 5).

Positive magnetic anomalies were the most extensively tested, and they corresponded most consistently to cultural features, including evidence of in situ burning (Figure 5a), pits with midden fill (Figure 5b), or areas of increased burning or organic content within more extensive middens. One anomaly in Survey Area 2 (Unit R) seems to reflect, at least in part, an accumulation of pottery fragments within the midden (sensu Kvamme 2006:216–217), as the ceramic artifact density for that unit was unusually high and fragments recovered were especially large. Negative magnetic anomalies corresponded variously to shell deposits with decreased proportions of organic material (i.e., more shell), naturally well-drained sandy sediments (i.e., lacking in soil formation and iron minerals), or historic metal (when paired with positive anomalies). Occasionally, we could not confirm the exact source of the anomaly through excavations. In most of these cases, shell midden was present in the excavation unit, and the heightened magnetic signature might reflect variation in the distribution of dispersed fired or organic materials within the midden deposit.

We intentionally placed one test unit (Unit U) over a blank or magnetically "quiet" spot identified just to the east of the cluster of anomalies on the western side of magnetometer

TABLE 1. Results of Ground-Truthing Magnetic Anomalies.

Anomaly Excavations	Anomaly Source
Strong positive (3 to 10 nT)	
Unit A	Stratified pit feature (F1)
Unit C	Unknown (shell midden present with extensive root disturbance)
Unit D	Pit feature with midden fill and evidence of burning (F2)
Unit H	Area of increased burning/organic content within shell midden (F4)
Unit L	[Iron nail]
Unit M	Unknown
Unit N	Pit feature with midden fill and charcoal (F3)
Unit R	Unknown (possibly increased burning/organic content in midden)
Unit S	Unknown (possible occupational midden)
Unit T	Pit feature with midden fill (F7)
Unit V	Pit feature with midden fill (F21)
Block D-i	Shell midden deposit with pit (F9, F23) and post (F11, F24) features
Block D-iii	Pit feature with stratified midden fill (F14)
Block D-vi	Overlapping pit with charcoal/pit with oxidized sediment/posthole (F13a–c)
Block D-vii	Pit feature with midden fill (F16)
Block C-ii	Wide shallow shell midden deposit (F20)
Block C-iv	Midden with charcoal present
Block C-v	Pit feature with stratified fill (F18b)
Block C-vii	Unknown (shell midden present with extensive root disturbance)
Weak positive (0.5 to 2.9 nT)	
Block D-ii	Pit feature with midden fill (F15)
Block D-iv	Occupational midden
Block D-v	Occupational midden
Block D-viii	Pit feature with midden fill, charcoal, and ashy sediment (F17)
Block C-iii	Pit feature with midden fill (F19)
Strong negative (less than –1 nT)	
Unit I	Deposit with elevated proportion of whole shell within midden
Weak negative (–0.1 to –0.9 nT)	
Unit E	[Well-drained sandy sediments with no in situ midden]
Block C-i	Unknown (shell midden exposed but not fully excavated)
Block C-vi	Crushed mussel shell feature (F18a)
No anomaly	
Unit U	[Thin layer of midden present with no distinct features]

Survey Area 3. A thin layer of shell midden appeared in this unit, which was of the type and depth that occurred consistently across the study area, anywhere in the vicinity of the shoreline midden ridges. Excavation did not reveal any discrete archaeological features, and the prevalence of artifacts in this midden strata was lower than in locations where magnetic anomalies corresponded with features or associated midden deposits. No lithic artifacts were recovered from midden strata in Unit U (lithic debitage was recovered from subsoil deposits, but these likely predate the Safety Harbor occupation, and they are unrelated to the magnetic signatures we recorded). The density of ceramic artifacts was lower in Unit U midden levels than in other feature or midden contexts, as was the proportion of vertebrate bone to shell by weight (Table 2). These patterns indicate that the Unit U location was the site of incidental discard but not intensive occupational activities. This supports our expectation that magnetic anomalies represent archaeological features that would not be present in magnetically quiet areas of the survey map.

SAFETY HARBOR SETTLEMENT PATTERNS AT WEEDEN ISLAND

This multistaged geophysical survey identified at least five concentrations of activity just beyond the boundaries of midden extent that had been previously observed. Ground-truthing demonstrated that many of these anomalies correspond to discrete archaeological features. These observations revealed a spatial structure to the human activity adjacent to the midden ridges, which supported the development of a framework for assessing community settlement at Weeden Island by comparing the chronology and range/social scale of activities at each area.

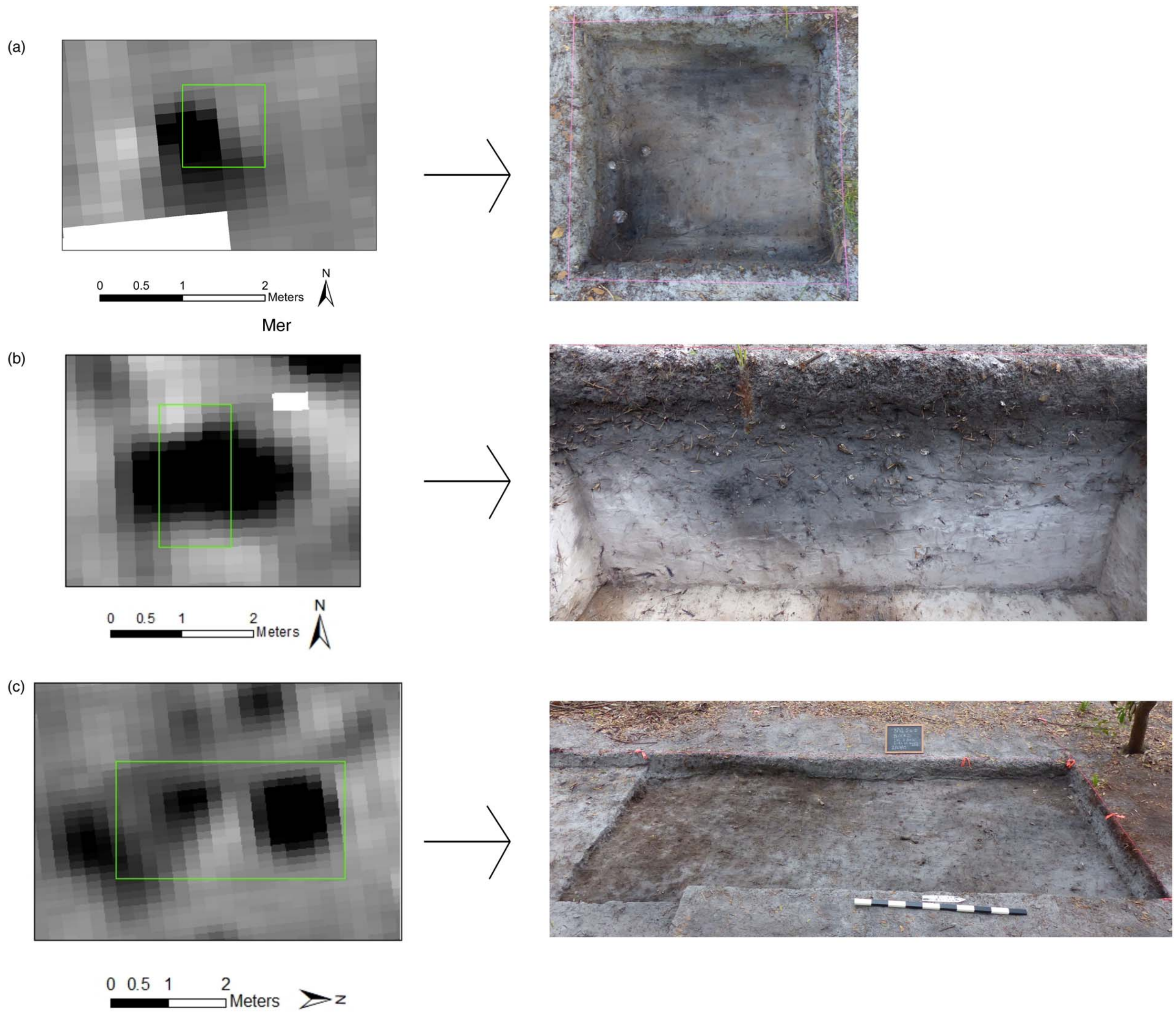

FIGURE 5. Examples of magnetic responses associated with cultural sources: (a) strong positive magnetic anomaly in Survey Area 1 and features visible in 1 × 1 m Unit N; (b) strong positive anomaly in Survey Area 4 and feature visible in 1 × 2 m Unit V; (c) overlapping strong and weak magnetic anomalies in Survey Area 3 and plan view photograph of corresponding occupational midden (left) and additional features (right).

TABLE 2. Comparison of Average Midden Content in Unit U "Blank Spot" Levels and Other Excavated Contexts.

	Unit U Midden	Features	Other Midden
Average bone:shell weight	0.0038	0.0350	0.0142
Average lithic density	0 g/m^3	50.47 g/m^3	36.91 g/m^3
Average ceramic density	375.15 g/m^3	475.20 g/m^3	555.91 g/m^3

The areas investigated represent a primarily late precolumbian occupation, based on diagnostic artifacts and radiocarbon dating (Sampson 2019). Excavating discrete features identified with the magnetometer survey allowed for more nuanced interpretations of settlement remains than we might have arrived at with other methods, such as placing excavation units near positive probes or high-yield shovel test pits. Patterns revealed through excavation at these anomaly concentrations include an activity area with evidence of shell ornament production, a distinct occupational surface, and variability in the faunal profiles of different deposits.

First, evidence for shell crafting recovered through this study suggests a possible restriction of shell ornament production that warrants further investigation. The manufacture of shell beads in the greater Safety Harbor culture area is thought to have been regionally concentrated (sensu Costin 1991) at coastal sites with convenient access to marine shell (Austin 2000:309); however, the degree to which the labor involved in bead production was coordinated or controlled *within* communities has remained unclear. A 2 × 1 m excavation labeled Unit V bisected a larger strong-positive anomaly in Survey Area 4 that measured 2.5 × 1.3 m and between 1.0 and 3.7 nT in strength (Figures 4 and 5b). Excavations revealed a large pit (Feature 21) and overlying midden. The pit contained burned materials (including soils) that likely created the magnetic response. Both the pit and associated midden also contained evidence of bead production activities, including finished ornaments, undrilled blanks, shell debitage, and half of a fossilized shark tooth with visible chipping along the edge and a drill-like tip (i.e., a possible bead-making implement). These artifacts were found alongside other anomalous items (e.g., an unusual assemblage of bird remains), as well as more typical domestic refuse. The evidence of bead production in this pit was unique compared with other midden and pit deposits excavated across the site. The Feature 21 pit and its assemblage of shell-crafting artifacts offer preliminary evidence of a spatial segregation of shell bead production activities, if not a social one as well. Although a full investigation of the organization of crafting labor is beyond the scope of this article, the geophysical survey methodology made it possible to identify discrete features such as the one in Unit V, and it suggests a pattern that could be revealed through further testing.

Second, the variety of deposits identified via geophysical survey are informative about the character of the Safety Harbor occupation at Weeden Island. Excavations targeting magnetic anomalies demonstrated variation in the content of mounded refuse middens as well as the presence of small filled-in pit features, potential cooking areas, and sheet midden. For example, in the Block D-iv area (Figure 4), excavations revealed a midden deposit corresponding to a relatively weak and more diffuse magnetic response that measured 1.2–1.5 m across and up to 1.6 nT in strength (Figure 5c). This occupational midden deposit was different from most other features (i.e., pits and mounded midden) identified at the site. It consisted of a distinctive brown soil spread over about 4 m^2, with a lower density of ceramic artifacts and faunal remains, and a lithic debitage assemblage with higher numbers of broken flakes that could indicate trampling. This occupational area was apparently the site of diverse tasks and activities. It also, however, suggests a communal activity area when viewed in the context of the surrounding deposits and the broader study area in that we encountered no comparable area of probable occupational refuse of this size, and the magnetic signature of this location—a moderately positive anomaly of irregular shape superimposed with stronger positive anomalies—does not appear regularly throughout the magnetometer survey data. There are other signals that may be comparable but that have not yet been tested with excavation: for instance, an area in magnetometer Survey Area 4 to the southeast of Unit V (Figure 3). Examining the magnetometer data as a whole, the spacing and frequency of areas like this do not suggest discrete household locations.

Third, evidence for food procurement and consumption represents another dimension of variability in the revealed deposits. Although marine resources were abundant throughout the study area, deposits and features displayed distinct faunal profiles in terms of the relative contribution of shellfish or the representation of common mollusk food remains. For example, Feature 17 corresponds to a relatively weak magnetic anomaly on the eastern edge of the occupational midden (Block D-viii in Figure 4). This measured less than 1 nT in strength and around 0.8 m in diameter, and it was either superimposed over or a part of a slightly larger and stronger response immediately to the southwest (1.2 m across and up to 1.6 nT). Excavation revealed Feature 17 to be a pit with evidence of in situ burning (burned soils). The feature also had a distinctive invertebrate faunal profile relative to surrounding deposits, with a higher abundance of oysters (*Crassostrea virginica*) than most excavated contexts (68.2% MNI compared to an average across all samples of 40.2% MNI; Sampson 2019). Different behaviors produced the nearby Feature 20, a wide, shallow deposit of shell-bearing midden associated with a magnetic anomaly with a strong positive response that measured 0.5–3.4 nT and roughly 1.4 × 1.9 m in size (Block C-i in Figure 4). Feature 20 contained substantial quantities of small or juvenile marine gastropod remains and a low ratio of fish to shellfish by MNI (0.010 compared to a site average of 0.029; Sampson 2019). The results of the geophysical survey allowed us to locate discrete features amidst shell-bearing midden throughout the site. Excavation of those features suggests that they may reflect behavior differences too.

Multistage survey data pointed us beyond a general sense of where human activity took place to an ability to recognize and investigate varied activity areas. The results discussed above show the potential for more significant patterning to be revealed through additional testing or in other applications of these methods. Furthermore, connecting this relatively small sample of excavated features with the broader scope of the geophysical survey itself begins to evoke a village setting with diverse spatial and social contexts for domestic tasks. The positive correlation between high MS readings and anomaly concentrations in the magnetometer data suggests that those areas of high magnetic susceptibility that we did not survey with the magnetometer (i.e., two elevated MS readings between magnetometer Survey Areas 3 and 4) likely represent similar clusters of anomalies. Drawing together the spatial structure of the MS readings and magnetic anomalies with interpretations of excavated features, we can propose scenarios for community settlement in terms of chronology and the spatial organization of activity.

Current evidence for the chronology of site use suggests that each concentration of magnetic anomalies corresponds to activities that spanned several generations (Sampson 2019). Dated samples from excavations in magnetometer surveys 1 and 3 indicate activities from the eleventh through the thirteenth century AD, without a clear gap in use of either area. In magnetometer survey 4, a feature pit (Feature 21) in Unit V was evidently filled between the early eleventh and mid-twelfth century AD, while overlying midden was deposited gradually during the thirteenth-century use of the area (Sampson 2019). Overall, rather than short-term intensive use of each location, magnetic anomaly concentrations indicate continuous use across generations or, in some cases, reoccupations over time. This means that the spatial extent of the occupation at a given time may have spanned the areas adjacent to both of the midden mounds within the study area. However, both seasonality data and subsequent modeling of radiocarbon dates at Weeden Island could add nuance to these interpretations of contemporaneity in the future.

In addition, while multiple areas were evidently occupied at the same time, there were also changes over time in the locations of settlement activities. Deposits excavated in Block C represent a temporally distinct occupation from nearby concentrations of activity, with dates no earlier than the AD 1300s, and a corresponding difference in ceramic assemblage profiles (Sampson 2019). This could reflect a significant gap in site use. Alternatively, this difference in timing could reflect a shift in the focus or intensity of activity in the later phases of Safety Harbor. One possibility to be tested in the future, then, is whether the high magnetic susceptibility readings between Survey Areas 3 and 4 likewise provide evidence of relatively later periods of occupation, or if they are contemporaneous with early precontact Safety Harbor deposits.

The material patterns presented above offer preliminary evidence that productive tasks such as manufacturing subsistence tools and food preparation were spatially dispersed and could have been conducted communally, whereas other tasks—including shell ornament production—were restricted and/or marked as meaningful and distinct. Variability in the faunal assemblages from different features and midden deposits could be the product of diverse factors including temporal changes in subsistence strategies, seasonality, or culturally driven patterns of preparation and disposal. These remains are the focus of ongoing research. Future field projects could systematically test the additional anomalies that we now expect to reflect different kinds of cultural deposits. One specific limitation of the present survey is its coverage, as there are further midden deposits on-site that were not captured by our survey or excavations, and this means that current interpretations of community organization are not comprehensive. Within the survey area, we focused on five areas of concentrated activity, but we have not fully investigated what patterns of activity the smaller, more dispersed anomalies might represent and how those activities could have contributed to settlement organization. The methodology presented here, however, could be used to extend coverage of the site in the future, just as future excavation at the site could investigate other anomalies revealed by the surveys to date.

CONCLUSION

This case study demonstrates the utility of a multistaged geophysical survey in a maritime forest environment. It also provides preliminary evidence for the organization of productive activities within the Safety Harbor occupation at Weeden Island. This approach could be applied in other settings with similar environmental and cultural characteristics.

The use of two sequential and complementary methods—magnetic susceptibility and magnetometer—made it possible to conduct this survey over a large area of wooded terrain. The field coil used to collect magnetic susceptibility data could be maneuvered through dense vegetation and, because data was collected at discrete intervals rather than continuously, we could navigate around obstructions such as trees and bramble without compromising data collection (see also Hodgetts et al. 2016). Compared to a pedestrian survey with probing, remote sensing in the form of magnetic susceptibility allowed us to collect a more detailed record of subsurface deposits under these conditions. The resulting data was coarse in resolution, but it nevertheless expanded the known extent of midden deposits in the survey area and drew our attention to several especially high readings adjacent to the two midden-mounds. Subsequent magnetometer surveys over five of these locations of high magnetic susceptibility readings revealed anomalies that were found to correspond to cultural deposits when targeted with excavation. Clearing vegetation in four targeted survey locations was feasible in a way that preparing larger areas of the site would not have been. The combination of magnetic susceptibility and magnetometer survey therefore allowed us to approach the kinds of site-wide interpretations that are considered a major benefit of geophysical survey (Dalan 2008; Kvamme 2006; Thompson et al. 2011).

Furthermore, this study demonstrates the utility of magnetic susceptibility survey in nearly pure sand soils that have very low magnetic-susceptibility values. In this case, there proved to be sufficient quantities of naturally occurring iron minerals for anthropogenic enhancement for measurement and identification with our initial magnetic susceptibility survey.

The methodology of geophysical survey that we used at the Weeden Island site made it possible to reach new insights about the range and spatial arrangement of the deposits and to undertake excavations that have begun to reveal patterns of Safety Harbor period community organization at the site. Methods that support nondestructive broad-scale coverage are not only logistically useful but also compatible with a conservation ethic. Assessing community patterning through a combination of geophysical survey and targeted excavation can be an alternative to the excavation of large areas. Combining magnetic susceptibility and magnetometry offers a method for surveying a large area with difficult terrain in order to identify locations to target with excavation. This approach has provided insight into community settlement patterns through the identification of nonstructural deposits and activity areas that reflect subsistence, crafting, and cooperative labor.

Acknowledgments

This project was made possible through collaboration with and support from the Alliance for Weedon Island Archaeology (AWIARE), especially Robert Austin, Phyllis Kolianos, and Brent Weisman. Fieldwork assistance was provided by Lacey Carpenter, Amanda Centeno, Kristin Hadley, Brad Lanning, Marty Menz, Holly Neville, Paul Randell, Jess Smolen, Kimi Swisher, Sierra Teegarden, Brittany Williams, Kristina Wood, and others, including volunteers from the University of South Florida and Pinellas County Parks and Conservation Resources. Lacey Carpenter provided the Spanish abstract translation. Archaeological excavations were authorized by a 2014–2015 Field Research Permit from Pinellas County Parks and Conservation Resources. Funding for fieldwork was provided by the University of Michigan Museum of Anthropological Archaeology. Funding for zooarchaeological analysis and radiocarbon dating was provided by an NSF Doctoral Dissertation Improvement Award (1639357). We are grateful for the input of three anonymous reviewers who offered thoughtful and detailed comments on a previous draft of this article.

Data Availability Statement

Data from our geophysical surveys can be accessed in the University of Michigan Deep Blue Data repository, https://deepblue.lib.umich.edu/data/concern/data_sets/0z708w50m. Additional records related to excavations are on file with the Alliance for Weedon Island Archaeological Research and Education (c/o Weedon Island Preserve Cultural and Natural History Center, 1500 Weedon Drive NE, St. Petersburg, FL 33702).

NOTE

1. The Weedon Island Preserve maintains the original spelling based on early owner Leslie Weedon. Following Jessie Fewkes's excavations and publication using the name "Weeden," the 8Pi1 site and archaeological culture became known by this alternate spelling.

REFERENCES CITED

Aspinall, Arnold, Chris Gaffney, and Armin Schmidt
2008 *Magnetometry for Archaeologists*. AltaMira Press, Lanham, Maryland.

Austin, Robert J.
1995 *Yat Kitischee: A Prehistoric Coastal Hamlet 100 BC–AD 1200*. Janus Research. Submitted to the Pinellas County Board of County Commissioners. On file with the Florida Division of Historical Resources, Tallahassee, Florida.
2000 Microlithic Drills from the Anderson Mound at Jungle Prado: Possible Evidence for Late Prehistoric Craft Production on the Gulf Coast of Florida. *North American Archaeologist* 21:291–321.

Austin, Robert J., and Jeffrey M. Mitchem
2014 Chronology, Site Formation, and the Woodland-Mississippian Transition at Bayshore Homes. *Southeastern Archaeology* 33:68–86.

Austin, Robert J., Jeffrey M. Mitchem, Arlene Fradkin, John E. Foss, Shanna Drwiega, and Linda Allred
2008 *Bayshore Homes Archaeological Survey and National Register Evaluation*. Central Gulf Coast Archaeological Society. Submitted to the Bureau of Historic Preservation, Florida Department of State. On file with the Florida Division of Historical Resources, Tallahassee, Florida.

Barrier, Casey R., and Timothy J. Horsley
2014 Shifting Communities: Demographic Profiles of Early Village Population Growth and Decline in the Central American Bottom. *American Antiquity* 79:295–313.

Binford, Lewis R.
1983 *In Pursuit of the Past: Decoding the Archaeological Record*. University of California Press, Berkeley.

Blanton, Richard E.
1994 *Houses and Households: A Comparative Study*. Plenum, New York.

Bullen, Ripley P.
1955 Archaeology of the Tampa Bay Area, Florida. *Florida Historical Quarterly* 34:51–63.
1978 Tocobaga Indians and the Safety Harbor Culture. In *Tacachale: Essays on the Indians of Florida and Southeastern Georgia during the Historic Period*, edited by Jerald T. Milanich and Samuel Proctor, pp. 50–58. University Press of Florida, Gainesville.

Clark, Anthony J.
1990 *Seeing beneath the Soil: Prospecting Methods in Archaeology*. BT Batsford, London.

Costin, Cathy Lynne
1991 Craft Specialization: Issues in Defining, Documenting, and Explaining the Organization of Production. *Archaeological Method and Theory* 3:1–56.

Dalan, Rinita A.
2006 Magnetic Susceptibility. In *Remote Sensing in Archaeology: An Explicitly North American Perspective*, edited by Jay K. Johnson, pp. 161–203. University of Alabama Press, Tuscaloosa.
2008 A Review of the Role of Magnetic Susceptibility in Archaeogeophysical Studies in the USA: Recent Developments and Prospects. *Archaeological Prospection* 15:1–31.

Davis, Jera R., Chester P. Walker, and John H. Blitz
2015 Remote Sensing as Community Settlement Analysis at Moundville. *American Antiquity* 80:161–169.

Dearing, John A.
1999 *Environmental Magnetic Susceptibility: Using the Bartington MS2 System*. Bartington Instruments Ltd., Manual OM0409. Electronic document, https://gmw.com/wp-content/uploads/2019/03/JDearing-Handbook-OM0409.pdf, accessed November 18, 2019.

Fassbinder, Jörg W. E., and Helge Stanjek
1993 Occurrence of Bacterial Magnetite in Soils from Archaeological Sites. *Archaeologia Polona* 31:117–128.

Fewkes, Jesse Walter
1924 Preliminary Archeological Explorations at Weeden Island, Florida. *Smithsonian Miscellaneous Collections* 76(13):1–26.

Flannery, Kent V.
1972 *The Origins of the Village as a Settlement Type in Mesoamerica and the Near East: A Comparative Study*. Warner Modular Publications, Andover, Massachusetts.
1976 *The Early Mesoamerican Village*. Academic Press, New York.
2002 The Origins of the Village Revisited: From Nuclear to Extended Households. *American Antiquity* 67:417–433.

Gaffney, Chris F., and John Gater
2003 *Revealing the Buried Past: Geophysics for Archaeologists*. Tempus, Stroud, United Kingdom.

Haley, Bryan
2014 The Big Picture at Hollywood: Geophysical and Archaeological Investigations at a Mississippian Mound Centre. *Archaeological Prospection* 21:39–47.

Henry, Edward R., Nicolas R. Laracuente, Jared S. Case, and Jay K. Johnson
2014 Incorporating Multistaged Geophysical Data into Regional-Scale Models: A Case Study from an Adena Burial Mound in Central Kentucky. *Archaeological Prospection* 21:15–26.

Hirth, Kenneth G.
1993 The Household as an Analytical Unit: Problems in Method and Theory. *Prehispanic Domestic Units in Western Mesoamerica: Studies of the Household, Compound, and Residence*, edited by Robert S. Santley and Kenneth G. Hirth, pp. 21–36. CRC Press, Boca Raton, Florida.

Hodgetts, Lisa, Jean-Francois Millaire, Edward Eastaugh, and Claude Chapdelaine
2016 The Untapped Potential of Magnetic Survey in the Identification of Precontact Archaeological Sites in Wooded Areas. *Advances in Archaeological Practice* 4:41–54.

Horsley, Timothy J., and D. Wilbourn
2009 Destriping Linears – A New Approach to an Old Problem. *ISAP News* 21:3–5.

Horsley, Timothy, Alice Wright, and Casey Barrier
2014 Prospecting for New Questions: Integrating Geophysics to Define Anthropological Research Objectives and Inform Excavation Strategies at Monumental Sites. *Archaeological Prospection* 21:75–86.

Hutchinson, Dale L.
2006 *Tatham Mound and the Bioarchaeology of European Contact: Disease and Depopulation in Central Gulf Coast Florida*. University Press of Florida, Gainesville.

Jackson, Kendal, Elizabeth Southard, Sharlene O'Donnell, and John Arthur
2018 Estimating Crown Conch (*Melongena corona*) Tissue Weight from Archaeological Shell Measurements: An Allometric Methodology for Coastal Historical Ecological Research. *Journal of Archaeological Science: Reports* 21:107–116.

Johnson, Jay K.
2006 A Comparative Guide to Applications. In *Remote Sensing in Archaeology: An Explicitly North American Perspective*, edited by Jay K. Johnson, pp. 305–320. University of Alabama Press, Tuscaloosa.

Kolianos, Phyllis E., and Robert J. Austin
2012 *Report on the Excavation and Preservation of a Prehistoric Dugout Canoe, Weedon Island Preserve Gateway Tract, Pinellas County, Florida*. On file with the Florida Division of Historical Resources, Tallahassee, Florida.

Kozuch, Laura
1986 An Overview of Faunal Lists from Selected Safety Harbor Sites. Manuscript on file. Department of Anthropology, Florida Museum of Natural History, Gainesville.

Kroll, Ellen M., and T. Douglas Price
1991 *The Interpretation of Archaeological Spatial Patterning*. Springer Science and Business Media, New York.

Kvamme, Kenneth L.
2003 Multidimensional Prospecting in North American Great Plains Village Sites. *Archaeological Prospection* 10:131–142.

2006 Magnetometry: Nature's Gift to Archaeology. In *Remote Sensing in Archaeology: An Explicitly North American Perspective*, edited by Jay K. Johnson, pp. 205–233. University of Alabama Press, Tuscaloosa.

Kvamme, Kenneth L., Jay K. Johnson, and Bryan Haley
2006 Multiple Methods Surveys: Case Studies. In *Remote Sensing in Archaeology: An Explicitly North American Perspective*, edited by Jay K. Johnson, pp. 251–268. University of Alabama Press, Tuscaloosa.

Linford, N. T.
2004 Magnetic Ghosts: Mineral Magnetic Measurements on Roman and Anglo-Saxon Graves. *Archaeological Prospection* 11:167–180.

Luer, George M.
1992 The Boylston Mound: A Safety Harbor Period Shell Midden; with Notes on the Paleoenvironment of Southern Sarasota Bay. *Florida Anthropologist* 45:266–279.
2014 New Insights on the Woodland and Mississippi Periods of West-Peninsular Florida. In *New Histories of Pre-Columbian Florida*, edited by Neill J. Wallis and Asa R. Randall, pp. 74–93. University Press of Florida, Gainesville.

Luer, George M., and Marion M. Almy
1981 Temple Mounds of the Tampa Bay Area. *Florida Anthropologist* 34:127–155.

Marquardt, William, and Karen Walker
2012 Southwest Florida during the Mississippian Period. In *Late Prehistoric Florida: Archaeology at the Edge of the Mississippian World*, edited by Keith Ashley and Nancy Marie White, pp. 29–61. University Press of Florida, Gainesville.

Mehrer, Mark
2000 Heterarchy and Hierarchy: The Community Plan as Institution in Cahokia's Polity. In *The Archaeology of Communities: A New World Perspective*, edited by Marcello Canuto and Jason Yaeger, pp. 44–57. Routledge, London.

Milanich, Jerald T.
1994 *Archaeology of Precolumbian Florida*. University Press of Florida, Gainesville.

Milanich, Jerald T., and Charles M. Hudson
1993 *Hernando de Soto and the Indians of Florida*. University Press of Florida, Gainesville.

Mitchem, Jeffrey M.
1989 Redefining Safety Harbor: Late Prehistoric/Protohistoric Archaeology in West Peninsular Florida. PhD dissertation, Department of Anthropology, University of Florida, Gainesville.
1996 The Old Okahumpka Site (8LA57): Late Prehistoric Iconography and Mississippian Influence in Peninsular Florida. *Florida Anthropologist* 49:225–237.
2012 Safety Harbor: Mississippian Influence in the Circum-Tampa Bay Region. In *Late Prehistoric Florida: Archaeology at the Edge of the Mississippian World*, edited by Keith Ashley and Nancy Marie White, pp. 172–185. University Press of Florida, Gainesville.

Mullins, C. E.
1974 The Magnetic Properties of the Soil and Their Application to Archaeological Prospecting. *Archaeo-Physika* 5:143–347.

Nash, Donna J.
2009 Household Archaeology in the Andes. *Journal of Archaeological Research* 17:205–261.

O'Donnell, Sharlene
2015 The Weedon Island Seascape: Zooarchaeological Findings at Weedon Island Archaeological Site (8Pi1). Master's thesis, University of South Florida, St. Petersburg.

Peregrine, Peter
1992 Social Change in the Woodland-Mississippian Transition: A Study of Household and Community Patterns in the American Bottom. *North American Archaeologist* 13:131–147.

Pluckhahn, Thomas J.
2010 Household Archaeology in the Southeastern United States: History, Trends, and Challenges. *Journal of Archaeological Research* 18:331–385.

Prentiss, Anna Marie, Guy Cross, Thomas A. Foor, Mathew Hogan, Dirk Markle, and David S. Clarke
2008 Evolution of a Late Prehistoric Winter Village on the Interior Plateau of British Columbia: Geophysical Investigations, Radiocarbon Dating, and Spatial Analysis of the Bridge River Site. *American Antiquity* 73:59–81.

Sampson, Christina Perry
2019 Safety Harbor at the Weeden Island Site: Late Pre-Columbian Craft, Community, and Complexity on Florida's Gulf Coast. Deep Blue. https://deepblue.lib.umich.edu/handle/2027.42/149830, accessed August 1, 2019.

Sears, William H.
1971 The Weeden Island Site, St. Petersburg, Florida. *Florida Anthropologist* 24:52–60.

Simpson, Terrance L.
1998 *The Narvaez/Anderson Site (8Pi54): A Safety Harbor Culture Shell Mound and Midden—AD 1000–1600.* Central Gulf Coast Archaeological Society, Pinellas Park, Florida.

Thompson, Victor D., Philip J. Arnold, Thomas J. Pluckhahn, and Amber M. Vanderwarker
2011 Situating Remote Sensing in Anthropological Archaeology. *Archaeological Prospection* 18:195–213.

Thompson, Victor D., William H. Marquardt, and Karen J. Walker
2014 A Remote Sensing Perspective on Shoreline Modification, Canal Construction, and Household Trajectories at Pineland along Florida's Southeastern Gulf Coast. *Archaeological Prospection* 21:59–73.

Tite, M. S., and Mullins, C. E.
1971 Enhancement of the Magnetic Susceptibility of Soils on Archaeological Sites. *Archaeometry* 13:209–219.

USDA-NRCS
2018 Web Soil Survey. U.S. Department of Agriculture: Natural Resources Conservation Service. Electronic document, http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx, accessed November 19, 2019.

Weisman, Brent R., Jonathon Dean, Matthew O'Brien, and Lori Collins
2005 *Comprehensive Cultural Resource Survey of the Weedon Island Preserve, Pinellas County, Florida*. University of South Florida. On file with the Florida Division of Historical Resources, Tallahassee, Florida.

Wiessner, Polly
1982 Risk, Reciprocity, and Social Influences on Kung San Economics. In *Politics and History in Band Societies*, edited by Eleanor Leacock and Richard Lee, pp. 61–84. Cambridge University Press, Cambridge.

Wilk, Richard R., and William L. Rathje
1982 Household Archaeology. *American Behavioral Scientist* 25:617–639.

Willey, Gordon R.
1949 *Archaeology of the Florida Gulf Coast*. Smithsonian Institution, Washington, DC.

Worth, John
2014 *Discovering Florida: First Contact Narratives from Spanish Expeditions along the Lower Gulf Coast*. University Press of Florida, Gainesville.

AUTHOR INFORMATION

Christina Perry Sampson ■ Department of Anthropology, University of Michigan, 610 E. University Avenue, Ann Arbor, MI 48109-1259, USA (cper@umich.edu, corresponding author)

Timothy J. Horsley ■ Horsley Archaeological Prospection LLC, 518 Park Avenue, DeKalb, IL 60115, USA