People of Guana: Tracking Heritage at Risk through Monitoring, Mapping, and 3D Documentation at the GTM Research Reserve, Ponte Vedra Beach, FL

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FLORIDA PUBLIC ARCHAEOLOGY NETWORK
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Executive Summary

For over 6,000 years, people have called the Guana Peninsula home, largely due to the bountiful natural resources available of the estuary. These resources, both natural and cultural, are at risk now more than ever due to threats from climate change impacts and development. This project aimed to better understand, through a combination of archaeological investigations and applied anthropological methods, how people have used these resources in the past, as well as how people continue to use the resources today. This project is the inaugural case study of the North American Heritage at Risk (NAHAR) research pipeline for addressing heritage at risk and engaging a variety of stakeholders. The project produced predictive models of climate change impacts, 38 site assessments for 19 archaeological sites, five new archaeological sites documented, stakeholder survey and follow up interview analysis, the 1A-46 technical report that describes in detail the results of fieldwork, successful engagement of the public and outreach products, and finally 3d models of artifacts (n=60), shorelines (n=9), and point cloud comparisons of shorelines over time (n=3). The modeling, monitoring, meeting, and methodizing data are now available for Reserve staff land managers to further interpret the ecosystem services of the Guana Peninsula. We hope the data can inform management strategies for cultural and environmental resources to best fit the needs of the Reserve and the surrounding community.

Acknowledgements
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Table of Contents

List of Figures

List of Tables

Introduction

The People of Guana project combined historical and archaeological research with applied anthropological methods to better understand and address heritage at risk on the Guana Peninsula. The project area, located at the Guana Tolomato Matanzas National Estuarine Research Reserve (GTM Research Reserve), spans 2,600 acres at the peninsula's southern end and 6,000 years of continuous use by humans. It is in a fragile coastal environment experiencing impacts from development, environmental pressures, and climate change. The project served as a first case study for the research pipeline and decision-making tool developed by the North American Heritage at Risk (NAHAR) working group and was funded through a collaborative science grant from the National Estuarine Research Reserve System Science Collaborative (NERRS SC). As State owned and managed lands, archaeological research efforts were permitted through the Florida Division of Historical Resources (DHR) and included site monitoring, shoreline mapping, and 3D documentation with photogrammetry and terrestrial laser scanning. This report details the historical and archaeological research including the methods and findings of the monitoring efforts conducted under 1A.32 Permit 2122.033, and includes findings on other aspects of the project, namely modeling and meeting, in the appendices.

People of Guana Project Design

The People of Guana Project sought to understand how people have lived on and used the resources of the Guana Peninsula for over 6,000 years. The project team used historical and archaeological research to learn about past cultures and applied anthropological methods including surveys and focus groups to understand modern connections to the landscape. This work was undertaken under the auspices of coastal changes and impacts from the climate crisis to test a method of triage efforts for impacted sites. The project layered in understanding how climate change already has and will continue to impact historical resources as well as understanding community views on coastal heritage at risk. The project was the first case study for the NAHAR research pipeline, developed by the NAHAR working group as a method to assess, triage, and mitigate impacted sites while working with community stakeholders (Figure 1). This project also built on the previously funded NERRS SC study, "Planning for Sea Level Rise in the Matanzas Basin," expanding the study area to the northern boundaries of the GTM NERR and utilizing similar techniques for engaging stakeholders (Frank et al. 2015).

The project followed the steps laid out in the North American Heritage at Risk (NAHAR) research pipeline: modeling, monitoring, meeting, methodizing, and mitigating (NAHAR 2021).

Modeling included four main sub-projects: (1) review and digitization of historical documents and maps; (2) Digital Elevation Map (DEM) corrections (if necessary); (3) SLAMM production; and (4) application of an Archaeological Triage Assessment (ATA) to determine which known cultural heritage sites are most at risk and in need of survey or mitigation pending results from SLAMM. The combination of these products allows researchers to illustrate land use changes over time as well as the impacts of nearby urban and tourist destinations. This work was conducted by Dr. Lindsey Cochran at Eastern Tennessee State University. Except for ground truthing the model, this work largely fell outside of the scope of the permitted activities and as such, the methods and results of this work can be found in the report in Appendix A.

Monitoring included simple site assessments through HMS Florida, shoreline mapping at coastal sites, and digital documentation efforts via photogrammetry and terrestrial laser scanning at four sites. The details of this work are covered in depth in this report in subsequent sections.

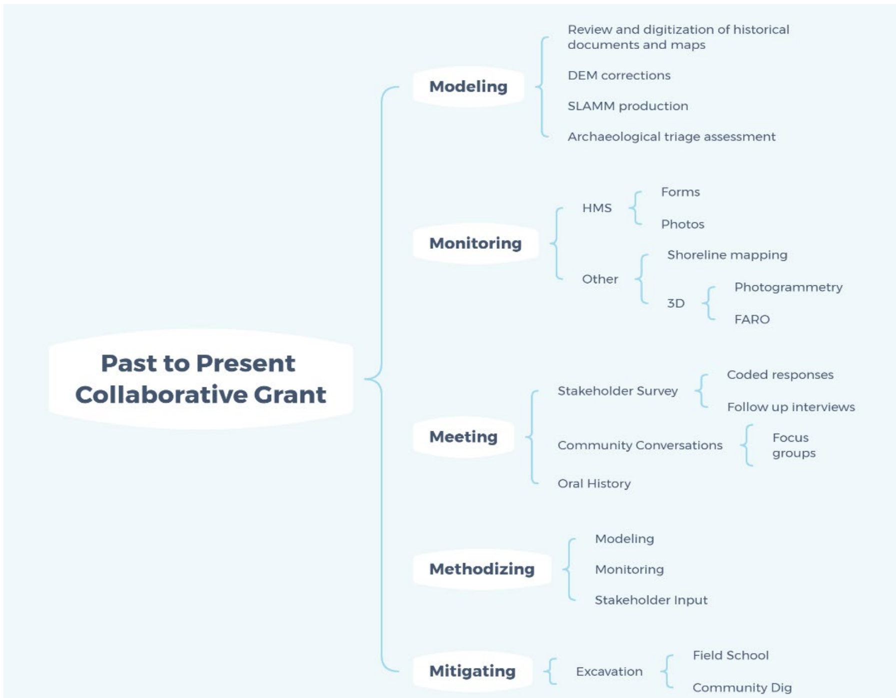

Figure 1 The People of Guana project followed the NAHAR research pipeline to address heritage at risk on the Peninsula.

Meeting involved using applied anthropological methods such as surveys, follow-up interviews, and focus groups in the form of Community Conversations about Heritage at Risk workshops. The data were gathered by the project team and compiled, coded, and analyzed at the University of Washington under the guidance of Dr. Ben Marwick. As this work largely fell outside of the scope of the permit, the results and analysis can be found in the report in Appendix B.

Methodizing included meeting with the project team, end-users, and stakeholders to discuss findings from modeling, monitoring, and meeting efforts, and offering project guidance. The full project team met monthly via Zoom, with team members offering updates on their project tasks. The project team identified the need for a phase I survey of the Peninsula as well as some of the larger multicomponent sites like Wright's Landing (SJ00003) and Shell Bluff Landing (SJ00032). This survey would help better define site boundaries and provide more context to understand the larger sites.

Mitigation efforts were limited to those that fell under continued monitoring, including shoreline mapping and digital documentation methods.

General Description of Permitted Work

A total of 26 sites within the direct management of the GTM Research Reserve were selected for monitoring (Figure 2). HMS protocols were used for these efforts and all site assessments and photographs were curated through the Arches Database. Digital techniques including GPS mapping, terrestrial laser scanning, and photogrammetry were also used at four sites to document the current conditions of shorelines and compare changes through time in a more quantifiable manner. Additionally, artifacts found on the surface at these four sites were documented in the field using photogrammetric methods to curate these items digitally. No materials were collected from the property and no ground-disturbing activities took place.

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Figure 2 Archaeological Sites permitted for monitoring on the Guana Peninsula.

Site Background

The GTM Research Reserve spans over 73,000 acres through coastal St. Johns and Flagler Counties in Northeast Florida. The Reserve has 2 components, separated by the City of St. Augustine and includes 12 distinct management units. The GTM Research Reserve directly manages approximately 2,600 acres of uplands on the Guana Peninsula (Figure 2) and around 700 acres of coastal strand in the surrounding area. This property contains 31 known archaeological sites that span 6,000 years of Florida's history (Guana Tolomato Matanzas National Estuarine Research Reserve 2009). These sites include dense shell middens and artifacts such as stone tools and pottery sherds that were left by indigenous groups such as the Timucua, remains of colonial period sites like Spanish missions, and historic refuse containing broken pottery, glass shards and architectural items from the plantations owned by British, Spanish, and Menorcan colonists. These sites have the potential to provide crucial information about many of the groups who used the area historically. However, previous research has been limited to baseline site recording, investigations ahead of proposed developments, and erosion studies at Shell Bluff Landing (Miller and Murray 2018; Miller et al. 2021).

Previous Archaeological Work

A. E. Douglass was the first to visit and record archaeological sites in what are today the boundaries of the GTM Research Reserve, most notably investigations at Sanchez Mound (Douglass 1885). John Goggin visited the Guana Peninsula in the 1950s; while he conducted no invasive fieldwork, he recorded four sites based on surface collections and historical research: Wright's Landing (SJ00003), Sanchez Mound (SJ00004), Shell Bluff Landing (SJ00032), and South of Wright's Landing (SJ00033) (Goggin and Rouse 1952; Goggin 1959; Weisman and Newman 1992).

In 1985, when the State acquired the property, Conservation and Recreation Lands (CARL) Archaeological Program (now known as the Public Lands Archaeology Program) archaeologists Louis Tesar and Henry Baker (1985) conducted a limited survey, the Guana River Tract Site Location Survey, to locate and record any previously unrecorded sites. Their survey added seven sites within the currently managed 2,500 ac. of the Guana Peninsula: NN (SJ02547), Little Orange (SJ02548), NN (SJ02549), Guana 1 (SJ02550), NN (SJ02551), Guana 6 (SJ02552), and NN (SJ02553). All sites were recorded based on surface collection and many have never been revisited with formal investigations. Tesar noted erosion issues at most of the coastal sites he surveyed. Through the 1990s, CARL archaeologists Brent Weisman and Christine Newman (Weisman and Newman 1992; Newman 1992) continued to survey parts of the parcel as improvements such as parking lots were added. They recorded four additional sites: Guana North (SJ03205), South Parking Lot (SJ03229), Guana Lake East (SJ03244), and Three Mile (SJ03486) (FMSF 1971). In 1991, the North Florida Council of the Boy Scouts of America proposed to build a 200 acre camp within a portion of the State Park's boundaries. A survey, led by Martin Dickinson and Lucy Wayne (1991) of South Arc, Inc., identified four additional sites through shovel testing in the area of potential effects, Guana 2 (SJ03235), Guana 3 (SJ03236), Guana 4 (SJ03237), and Guana 7 (SJ03238), and provided more information on several previously recorded sites.

More thorough studies of sites at the GTM Research Reserve have focused on those impacted by erosion. CARL archaeologists conducted erosion studies and more robust testing at Shell Bluff Landing (SJ00032) from 1988 to 1991. Henry Baker (1988a, 1988b) excavated around the west side of the well to gain a better understanding of its history and architecture. He also installed rebar at the site to measure shoreline loss from a fixed point to aid in documenting the erosion at the site. Christine Newman (1990a, 1990b) documented the extensive shell midden at the site during stabilization efforts in 1990.

Several investigations also documented Wright's Landing (SJ00003) and the erosion along its shoreline. In 1975, Kathleen Deagan and Charles Fairbanks conducted a pedestrian survey with field school students and excavated four wells in the tidal zone (Benton 1975). In 1991, CARL archaeologists Weisman and Newman (1992) conducted a limited survey at Wright's Landing to provide the first stratigraphic information for the site. Newman and Glowacki (2005) conducted a shovel test survey at Wright's Landing ahead of the installation of survey markers.

The St. Augustine Lighthouse Archaeological Maritime Program (LAMP) worked extensively on sites along the Tolomato River to document isolated beach finds. From 2001 to 2003, work focused on documenting tidal features including barrel wells and coquina rubble at Wright's Landing (Morris et al. 2002, 2003). In 2007, they conducted a survey in advance of the Reserve's replacement of a data sonde platform just offshore of Wright's Landing (Burke et al. 2007). From 2007-2013, LAMP extensively documented the Tolomato Bar Anchorage and Guana Ruins sites. Work included side scan sonar and target diving in the Tolomato, as well as terrestrial excavations of structural remains (Meide et al. 2010;

Meide et al. 2014; Meide et al. 2018). In 2018, LAMP recorded and led investigations on the Spring Break Wreck (SJ06572), including structural and wood sample analyses. The site originally washed ashore from the Atlantic Ocean roughly one mi. north of the Guana Dam but was soon moved by natural forces close to the Trailhead Pavilion and parking lot (Meide et al. 2019).

Most recently, many of the sites were monitored by FPAN during their 2-year DHR Special Category grant project, "Heritage Monitoring Scouts: Assessing Archaeological Sites at Risk." During this project (Miller et. al 2021), 19 sites were monitored, and 3 new sites were recorded. All coastal sites were noted as suffering from erosion, and many sites featured evidence of recent flood events, often linked to increased and intensified storm events in the area. Additionally, staff collected baselines of upland shoreline erosion across the peninsula using GPS mapping and used terrestrial laser scanning to document one site.

Research Design

Monitoring

The project included monitoring 26 archaeological sites under a 1A.32 permit (Figure 2; Table 1). All monitoring activities used the HMS Florida program to collect information about the sites, including verifying the location, assessing and reporting site conditions, and making recommendations. Sites were monitored a minimum of once annually. FPAN staff worked with the GTM Research Reserve staff to coordinate all monitoring activities, and staff from one of the organizations were present during all activities. A copy of the authorizing permit was provided to the appropriate land managing agency personnel as well as carried on-person during all fieldwork.

Protocols through HMSF Monitoring activities did not include collecting any materials from sites. Rather, protocols dictate that artifacts were photographed in situ and left in place. Photographs include characteristic overviews of the site, notable threats or impacts, and artifacts.

The survey used Heritage Monitoring Scouts (HMS Florida) protocols to work with citizen scientists and land managers to collect data on threats and impacts at archaeological sites. Volunteers attend HMS training workshops and sign up as Scouts through the HMS Florida website (http://fpan.us/projects/HMSflorida.php). When applying through the portal, they provide contact information, state their interests in monitoring, receive and read through printed instructions on how to monitor, and sign a code of ethics and program agreement. Each Scout must affirm they have read the agreement and attest they will abide by it while performing monitoring activities, underscoring the confidential nature of archaeological site location information in Florida. The agreement adopts a code of ethics outlined by the Florida Anthropological Society and provides a link for prospective Scouts to read and understand before completing the HMS application form (Florida Anthropological Society 2021).

Site monitoring data were curated in an online portal and geodatabase management system, the HMS Florida Arches Database. This system utilizes Arches, an open-source online cataloging system created in part by the Getty Foundation and World Monuments Fund. Upon registration, Scouts can access the Arches database to view locations and information on sites that are open for monitoring. The default view shows only those sites that are already open to public visitation (cemeteries and historic structures interpreted for public benefit). Archaeological sites, protected by Florida law, are individually "unlocked" in Arches by FPAN administrators so they can then be viewed in a Scout's own Arches portal. Sites are revealed to scouts upon request on a case-by-case basis and only upon approval by land managers.

Once a site is unlocked scouts can see all previous monitoring activities recorded for that site and can submit monitoring forms and photographs.

Table 1 Sites included on the permit

Site ID	Site Name	Site Type
SJ00003	Wright's Landing	Prehistoric shell midden; Mission of Spanish Colonial heritage; Plantation; British, 1763-1783; American, 1821-present
SJ00004	Sanchez Mound	Prehistoric burial mound(s)
SJ00032	Shell Bluff Landing	Prehistoric shell midden; Historic well
SJ00033	South Of Wright's Landing	Prehistoric shell midden; Plantation; British, 1763-1783; Second Spanish Period, 1783-1821; American, 1821-present
SJ02547	NN	Prehistoric shell midden
SJ02548	Little Orange	Prehistoric shell midden
SJ02549	NN	Prehistoric shell midden
SJ02550	Guana 1	Prehistoric shell midden
SJ02551	NN	Prehistoric shell midden
SJ02552	Guana 6	Campsite (prehistoric); Prehistoric shell midden
SJ02553	NN	Prehistoric shell midden
SJ03150	Guana Ruins	Building remains; Historic refuse/dump
SJ03205	Guana North	Campsite (prehistoric)
SJ03235	Guana 2	Prehistoric shell midden
SJ03236	Guana 3	Campsite (prehistoric)
SJ03237	Guana 4	Single artifact or isolated find
SJ03238	Guana 7	Prehistoric shell midden
SJ03252	On the Line	Building remains
SJ04801	Tolomato Bar Anchorage Site	Prehistoric shell midden, Spanish-First Period, 1513-1763; British, 1763-1783; Spanish-Second Period, 1783-1821; American, 1821-present
SJ05322	Evenden-Williams	Prehistoric shell midden
SJ05353	Undetermined Ancient Shipwreck Artifact	Historic Shipwreck
SJ05464	Southern Midden	Prehistoric shell midden
SJ08033	Gulliford Midden	Prehistoric shell midden
SJ08034	Shirley Midden	Prehistoric shell midden
SJ08039	Coquina Block Site	Building Remains

As part of the site monitoring protocol, FPAN staff and volunteers initiate immediate follow-up with BAR and land managers if human remains and/or site looting/vandalism is observed. Two sites included in the permit, Sanchez Mound (SJ00004) and Shell Bluff Landing (SJ00032), have documented human remains. Monitoring at these sites was limited to FPAN staff, GTM staff, and volunteers. No human remains were noted at Sanchez Mound. When potential human remains were found at Shell Bluff Landing, FPAN staff notified the State Archaeologist and followed instructions as provided.

FPAN staff also completed Florida Master Site File updates for previously recorded sites and recorded new sites as needed. FMSF updates are triggered when documentation of the site is submitted with an outdated form, significant changes at a site are observed (i.e. change in site location, approximate size, and/or visible boundaries, most likely due to change in landform), presence of human remains is noted but not previously identified in site information, or significant damage from looting and/or other impacts is observed.

Mapping

In addition to basic monitoring efforts, the project team also mapped the shorelines of the archaeological sites each year to better understand shoreline changes. The field team attempted to capture the last place where intact archaeological deposits could be found which was often an upland erosional edge where present. In areas with gentler slopes, the upland shoreline was determined by soils and types of vegetation present. This line often reflects the extent of the archaeological resources and the areas most vulnerable to impacts like erosion and boat wake action. The shorelines of 10 sites were mapped in 2022 and again in 2023 to provide a comparison of the shoreline over a year's time. These sites included Wright's Landing (SJ00003), Shell Bluff Landing (SJ00032), South of Wright's Landing (SJ00033), NN (SJ02547), Little Orange (SJ02548), NN (SJ02549), Guana 1 (SJ02550), Guana Ruins (SJ03150), Southern Midden (SJ05456), and Shirley Midden (SJ08034) (Figure 3). Guana Ruins (SJ03150) was not mapped in 2022. In previous years prior to this project, the entire shoreline of the Peninsula was mapped. In 2022, the project team started with this approach but changed tactics to mapping just the site shorelines due to time and staff constraints.

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Figure 3 Sites where shorelines were mapped.

The team used an Arrow Gold GNSS receiver and ArcGIS Collector and Field Maps apps to collect points along the upland erosional edge of each archaeological site (Figure 4). The GNSS receiver was connected to the Florida Permanent Reference Network (FPRN) to receive real-time kinematic position (RTK) corrections to achieve the most accurate data possible, sometimes down to sub-centimeter accuracy. Lines of data were collected as individual points, rather than a continuously tracked line. This method allowed the team to collect points at the shoreline while safely navigating unstable shorelines, heavy vegetation, and other obstacles. The data were downloaded from ArcGIS Online and cleaned by removing erroneous points. Lines of data for each site were combined into one file for each year of the project.

Figure 4 Project team member Emily Jane Murray holding Arrow Gold GNSS receiver to map the upland erosional edge of a site.

The lines of data were compared visually, and changes were calculated using the Digital Shoreline Analysis System v5.1 (DSAS). DSAS is an add-on tool in ArcMap created by the U.S. Geological Survey to measure shoreline change (Himmelstoss et al. 2021). The DSAS uses an arbitrary baseline to calculate shoreline measurements. The project team created this baseline by adding a 100 m buffer to a line of shoreline data collected in 2021, extending outwards from the land (Figure 5). All shoreline data were compiled into a single file in a personal geodatabase and projected in WGS 1984 Mercator Auxiliary Sphere. General parameters were defined as suggested in the DSAS manual, and the uncertainty of the shoreline placement was set to 1 m given the accuracy of the GNSS receiver. Transects were calculated at 25m apart, and some were adjusted to ensure they did not cross where shorelines cut back (see Figure 5). Outliers in the transect calculations were omitted from the analysis to provide more accurate numbers since many were in marshy areas where the shoreline was harder to define. The team also omitted measurements showing attrition since the project goal was to measure loss.

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Figure 5 The DSAS tool was used to create 25 m transects along the shoreline based off of shoreline data created during this project (and the arbitrary baseline the project team created).

3D Documentation

Sitewide

FPAN staff documented a portion of four resources using 3D digital heritage techniques including photogrammetry and terrestrial laser scanning. These sites included Shell Bluff Landing (SJ00032), Wright's Landing (SJ00003), South of Wright's Landing (SJ00033), and Little Orange (SJ02548) (Figure 6). These sites were selected because of their suitability for modeling and their documented history of erosion (Miller et al. 2021). These sites have exposed stratigraphy, minimal vegetation, and distinct erosional edges. Additionally, each site represents a slightly different environment and matrix, providing a snapshot of erosional impacts at different points on the Peninsula as well as allowing the methods to be tested in a variety of settings.

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Figure 6 Locations of areas scanned at each site.

The project team used a combination of terrestrial laser scanning and photogrammetry at Shell Bluff Landing (SJ00032) and Wright's Landing (SJ00003). At South of Wright's Landing (SJ00033) and Little Orange (SJ02548), the project team used photogrammetry alone because of the small size of the areas selected for documentation. Scan data were collected with a Faro Focus 350s and photographs captured on Canon Rebel DSLR cameras. A combination of target spheres and calibrated photo scale bars were placed at the sites to aid in data alignment (Figure 7). During terrestrial laser scanning, the team placed 12 round target spheres of varying sizes and heights at the sites. During both laser scanning and photogrammetry, the team placed between three and six calibrated scale bars, depending on the size of the area being documented. The scale bars also served to add scale to the photogrammetric models. In all locations, the calibrated scale bars were used as ground control points to georeferenced the models. The team used an Arrow Gold GNSS receiver with RTK corrections to collect these points using the ArcGIS Field Maps application.

Figure 7 Terrestrial laser scanning at Wright's Landing using a Faro Focus 350s, target spheres, and calibrated scale bars.

For sites incorporating terrestrial laser scanning, the scan data were processed through FARO's Scene software to align all scans into a single point cloud. Scans with bad alignment were removed from the data sets, and the point clouds were optimized through visual registration and software computations. A moving object filter was applied to remove stray points, and superfluous data were cleaned from the model, including instances where the project team was included in the scans. Color was applied to the point cloud from the photographs taken by the scanner. The final point clouds were exported at full resolution with an individual .ptx file for each scan.

Reality Capture (RC) was used to create point clouds and meshed models for all data sets. For the sites with terrestrial laser scanning these data were brought into RC first and aligned. Then photographs were added and the data were combined into a single point cloud. For sites without scan data, the photographs alone were used to create the point cloud. Control points were added to aid in alignment, and multiple alignments were created until the best alignment was reached. Components with bad alignment or too few images (labeled "small components" by RC) were not processed further into the main data set. The point clouds were visually inspected to ensure good alignment and multiple known measurements were checked to ensure accuracy. The point clouds were georeferenced by importing the ground control points into RC as a simple text file with a ground control point name, latitude, longitude, and altitude. The ground control points were matched up to the scale bars in the point cloud, and the cloud alignment was updated to incorporate the data. The point clouds were rendered into meshed models using a reconstruction region to set the limits of each site, and stray points and superfluous data, including target spheres, were deleted. The mesh was created by connecting individual points to form triangular faces that make the digital form (geometry) of the object. The model was simplified down to a size that the computer could render. The models were exported for post-processing in Geomagic Wrap to further refine their geometry. The model was brought back into Reality Capture and texture was applied to color the model. The geometry was created using all data, but the scanner imagery was disabled during texturing. The meshed model was used to create a variety of outputs including scaled orthomosaic images and DSMs.

The project team used Cloud Compare to compare point clouds from sites over time. For each site, point clouds from different dates were imported into Cloud Compare and the alignment was checked and refined. The Compute cloud/cloud distance tool was used to compare the more recent point cloud to the older point cloud. This tool applies a scaler field to the cloud that provides a visualization of the differences between the two point clouds, as well as a scale to determine measurements of change.

Artifacts

The project team also used photogrammetry to curate a digital collection of artifacts from the project sites. Artifacts were documented at Wright's Landing (SJ00003), Shell Bluff Landing (SJ00032), South of Wright's Landing (SJ00033), and Little Orange (SJ02548) in tandem with scanning activities. Artifacts were selected based on diagnostic information, uniqueness or rarity of objects, and general suitability for modeling. Artifacts that are very small, thin, shiny, or geometrically uniform are trickier to achieve good models, especially in field conditions where things like lighting are hard to control. Artifacts were photographed in place first and then moved to a station for photogrammetry. The project team only selected objects found on the surface, presumed displaced from their in-situ positions by erosion or other natural activities. The mobile station included a lazy Susan, a camera on a tripod, a photo scale, and a photo board to serve as a backdrop (Figure 8). The objects were placed on a lazy Susan and photographed at roughly every 10° rotation from multiple camera angles. After photographing, the artifacts were returned to their original locations.

Back at the office, the photographs of each artifact were brought into Reality Capture (RC) and aligned to create a point cloud. This point cloud was visually inspected to ensure good alignment. When necessary, control points were added to aid in alignment, and multiple alignments were created until the best alignment was reached. Components with bad alignment or too few images (labeled "small components" by RC) were not processed further into the main data set. Control points were also used to scale the objects, placing two on the photo scales and inputting the correct measurement in RC. The point clouds were rendered into meshed models using a reconstruction region, and stray triangle and superfluous data were deleted. Models were simplified to 1 million triangles to optimize for viewing on SketchFab and cleaned to remove topological errors and defects using the "Clean Model" tool. Each model was texturized and exported as an .obj file. The models of the artifacts were uploaded to SketchFab and details of the objects were included in the model description. No specific site location information was included online; the artifacts are all attributed as coming from the “GTM Research Reserve, North Florida.” The models were all curated into the People of Guana Collection. A field specimen number was assigned to each artifact and basic analysis was completed to identify materials.

Figure 8 Project team member Summer Brown documents a piece of indigenous ceramic in the field for photogrammetry.

Results

Monitoring

Assessment data were gathered during grant assessment activities through the submission of Scout Reports (HMS assessment forms) occurring between 1 October 2021 and 30 June 2023 of the grant period. Participants, including the project team, GTM staff, and volunteers, assessed 19 unique sites and submitted 38 Scout Reports for those assessment trips, including repeat visits to the same sites (Table 2, Figure 9, See Appendix C for full monitoring data). During the grant period, contributors evaluated recorded locational information, assessed site condition and priority, observed threats, and made recommendations for future actions. During the grant period, 7 volunteers, 8 project team members including FPAN staff and interns, and 3 land managers conducted assessment activity at permitted sites.

Table 2 Sites assessed

Site ID	Site Name	Condition	Priority Level	FMSF Update
SJ00003	Wright's Landing	Fair = Declining	Medium	Yes
SJ00004	Sanchez Mound	Good = Stable	Low	
SJ00032	Shell Bluff Landing	Fair = Declining	Medium	Yes
SJ00033	South Of Wright's Landing	Poor = Unstable	High	
SJ02547	NN	Fair = Declining	Medium	Yes
SJ02548	Little Orange	Poor = Unstable	High	
SJ02549	NN	Good = Stable	Medium	
SJ02550	Guana 1	Good = Stable	Low	
SJ02551	NN	N/A = Site not found	Low	
SJ02552	Guana 6	Good = Stable	Low	
SJ02553	NN	N/A = Site not found	Low	
SJ03150	Guana Ruins	Fair = Declining	Medium	
SJ03205	Guana North	Fair = Declining	Medium	
SJ03235	Guana 2	Good = Stable	Low	Yes
SJ03236	Guana 3	N/A = Site not found	Low	
SJ04801	Tolomato Bar Anchorage Site	Fair = Declining	Medium	
SJ05353	Undetermined Ancient Shipwreck Artifact	N/A = Site not found	Low	
SJ05464	Southern Midden	Fair = Declining	Medium	Yes
SJ08034	Shirley Midden	Fair = Declining	Low	

Table 3 New sites recorded

Site ID	Site Name
SJ07401	Arched Tree Midden
SJ07402	Orange Tree Midden I
SJ07403	Orange Tree Midden II
SJ07415	Red Trail Midden
SJ07416	Yellow Trail Midden

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Figure 9 Assessed archaeological sites.

Five new archaeological sites were recorded during monitoring efforts and five updates to existing sites were completed (Table 1; Table 2; See Appendix D for FMSF forms). Four of the new sites, Arched Tree Midden (SJ07401), Orange Tree Midden I (SJ07402), Orange Tree Midden II (SJ07403), and the Yellow Trail Midden (SJ07416) were discovered and bounded based on exposed shell midden on the surface. An additional site, Red Trail Midden (SJ07415), was discovered by GTM staff while creating a new path for the red trail and the site was bounded based on the exposed shell (notably, the old trail had to be closed and moved away from the shoreline due to severe erosion along the shoreline). Updates were submitted for five previously recorded sites: Wright's Landing (SJ00003), Shell Bluff Landing (SJ00032), NN (SJ02547), Guana 2 (SJ03235), and Southern Midden (SJ05464). These updates were limited to boundary updates based on shell and artifacts noted on the surface.

These summaries were created using unique site data (n=19) unless otherwise stated. When visiting sites, contributors conducted mostly afternoon visits (55.3%), but also visited sites in the morning (44.7%). Collecting this information helps FPAN staff determine the tide height at coastal sites during the time of the last visit and decide if future visits should occur during a different time of day to coincide with a different tidal cycle. Recording whether the assessment visit to a site is a participant's initial or follow-up helps FPAN staff, Scouts, and land managers track the number of times a particular person visited a site. All 38 Scout Reports submitted were marked as "follow-up" visits. Participants located sites assessed in previously recorded locations 78.9% (n=15) of the time and could not locate sites at previously recorded locations 21.1% (n=4) of the time (Figure 10).

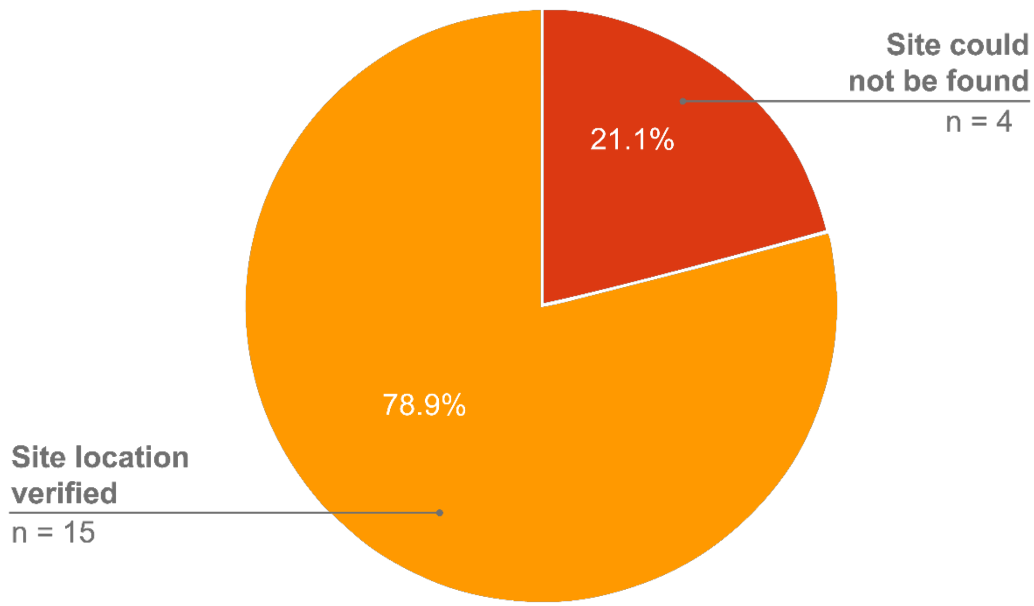

Figure 10 Site location verification.

The overall condition of sites assessed during the grant period is summarized in Figure 11. The project team recorded that nearly half (42.1%) of the sites visited were in fair-declining condition, 26.3% were in good-stable condition, 10.5% of sites were in poor-unstable condition, and 21.1% of sites were not condition assessed because they could not be found. Scout priority evaluations for unique sites assessed are outlined in Figure 12. Sites marked as low priority totaled 47.4% (n=9) of all unique sites, followed by medium priority at 42.1% (n=8), and high priority at 10.5% (n=2). Participants placed sites that were not located during the assessment visit in the priority category they felt appropriate for return visits to confirm location.

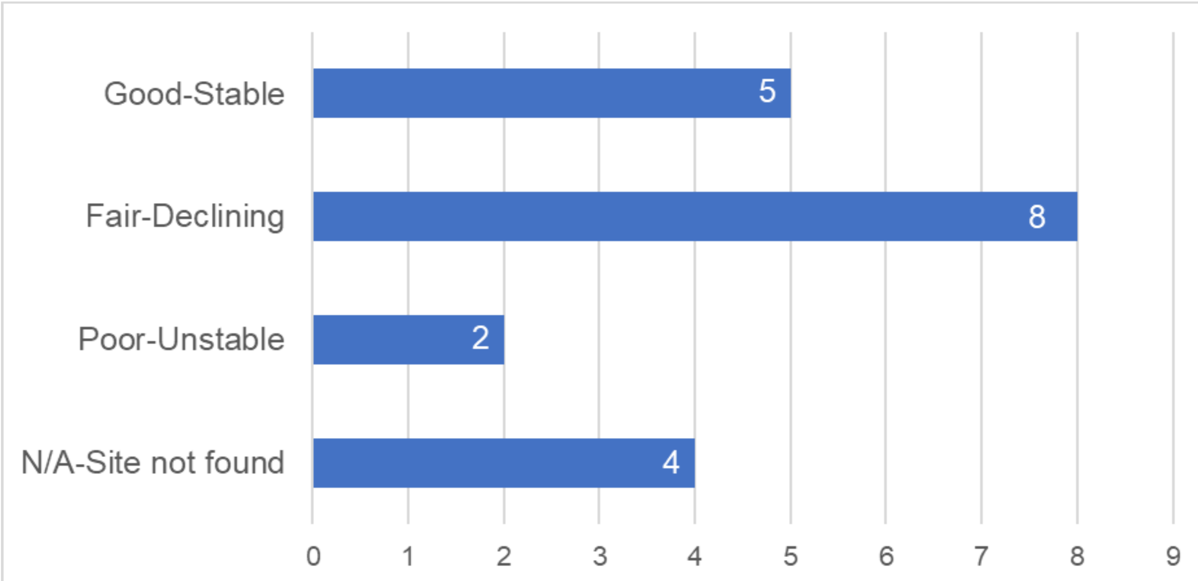

Figure 11 Overall site condition per unique site assessed.

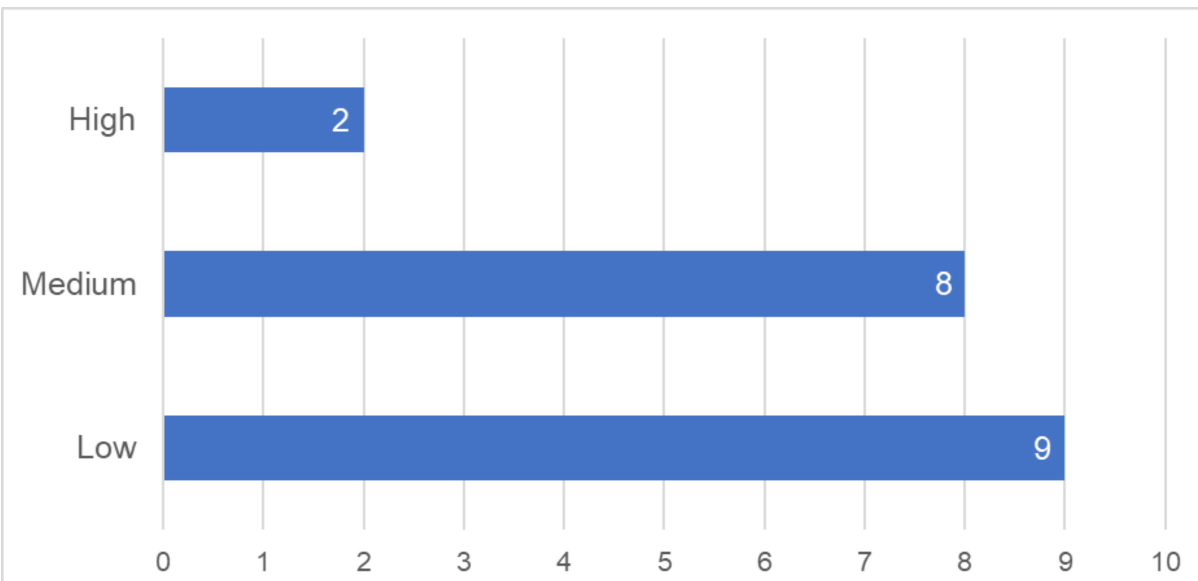

Figure 12 Site priority per unique site assessed.

Arguably the two most important variables recorded by Scouts are overall site condition and priority evaluation. These variables are compared in Figure 13. Of the 5 sites recorded as good-stable, 4 were also at low priority and 1 was recorded at medium priority. Fair-declining sites (n=8) were recorded to be at medium priority on 7 occasions and at low priority once. Less frequently, sites were observed to be in poor-unstable condition (n=2). Poor-unstable sites were recorded at high priority both times. Sites that could not be located were placed at a low priority (n=4).

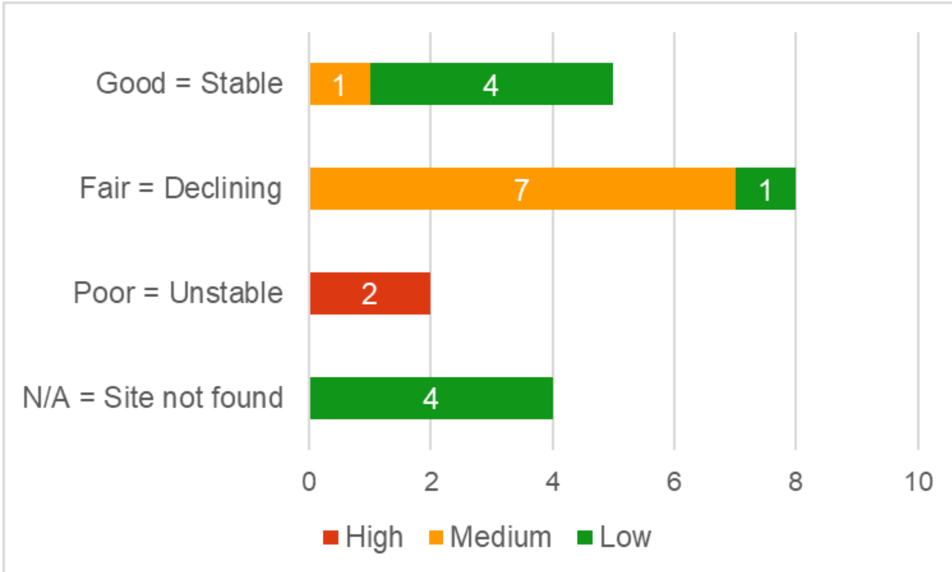

Figure 13 Overall site condition versus priority evaluation for unique sites assessed.

Participant recommendations recorded from all submitted assessment forms (n=38) are detailed in Table 4. Repeat visits to sites were recommended on 33 HMS assessment forms (87%) while FMSF updates were recommended on 4 HMS assessment forms (11%). Other recommendations, such as defending at-risk shoreline sites, were recorded on 4 HMS assessment forms (11%) while 1 HMS assessment form (3%) provided no further site recommendations. One form noted that the field crew encountered human remains on their visit. This group was FPAN employees only and the remains were documented and left in place as per consultation with BAR and THPO.

Table 4 Recommended actions at sites

Scout Recommendation	Instances Recorded	% of Forms
Repeat visit	33	87%
FMSF update	4	11%
Defense	4	11%
Other	3	8%
None	1	3%
Human Remains Encountered	1	3%

The summary of threats observed during all assessment visits is outlined in Table 5. Examples of threats observed are given in Figure 14. Active erosion was the most frequent threat recorded, observed by contributors on 27 HMS assessment forms (71%). Wave action (n=15) and animal disturbance (n=15) were observed on 39% of forms. Flooding (n=14) and storm surge (n=12) were also common threats recorded. Participants observed vegetation growth, visitor traffic, and wind as threats in similar numbers. Vehicle damage was recorded on one form while other threats like numerous tree falls were recorded on 8% of forms.

Table 5 Threats observed during monitoring visits

Threat Observed	Instances Recorded	% of Forms
Active Erosion	27	71%
Wave action	15	39%
Animal disturbance	15	39%
Flooding	14	37%
Storm Surge	12	32%
Vegetation growth	11	29%
Visitor traffic	10	26%
Wind	9	24%
Other	2	5%
Vehicle Damage	1	3%

Erosion (SJ00032)

Visitor Traffic (SJ00032)

Flooding (SJ00032)

Erosion, Vegetation Growth (SJ00032)

Vegetation Growth (SJ03205)

Hog Damage (SJ02548)

Figure 14 Examples of threats observed during monitoring visits.

By comparing site condition to the threats observed during assessment visits (Figure 15), it is possible to determine the threats most commonly recorded at sites of each condition type. All threats referenced here were recorded at various sites within all four condition categories. Good-stable sites were most often recorded to be threatened by animal disturbance (n=3), visitor traffic (n=3), active erosion (n=2), and vegetation growth (n=2). The most recorded threat at fair-declining sites was active erosion (n=7) followed by wind (n=6), vegetation growth (n=5), storm surge (n=5), flooding (n=5), wave action (n=4), and animal disturbance (n=3). Poor-unstable sites were most commonly observed to be threatened by active erosion (n=2) and animal disturbance (n=2) but also had a recorded instance of vegetation growth, storm surge, wind, flooding, visitor traffic, and wave action. A common threat at sites where condition could not be properly assessed was animal disturbance (n=3).

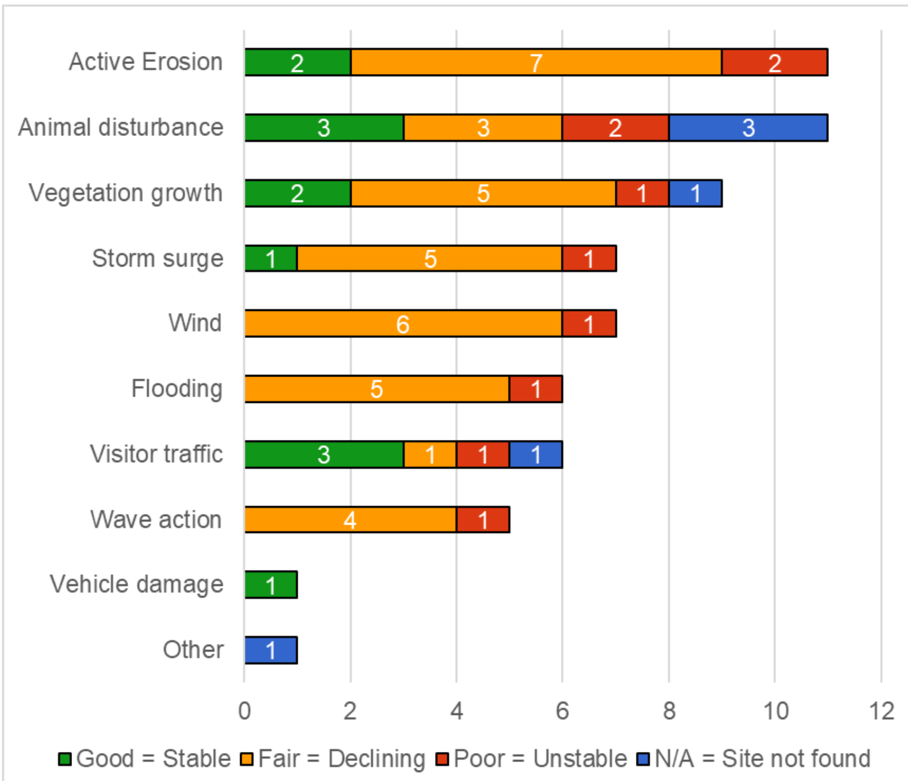

Figure 15 Overall site condition versus threats observed at sites assessed.

Data collected regarding the type of visible artifacts observed during assessment visits are outlined in Table 6. Examples of visible artifacts observed are provided in Figure 16. Scouts frequently indicated that shell midden was observed during assessment visits (n=26; 68% of forms submitted). Prehistoric pottery was indicated on many HMS assessment forms (n=23), as were architectural materials (n=17). Historic ceramics (n=16), glass (n=14), and faunal remains (n=11) were each recorded often on assessment forms. Less frequently mentioned were lithics (n=3) and shell tools (n=2). Artifacts marked as “Other” were noted in six forms and included a shell bead, ship timbers, a fork, and pier or dock pilings. No artifacts were recorded on six assessment forms.

Table 6 Visible artifacts recorded during monitoring visits

Visible Artifacts	Instances Recorded	% of Forms
Shell midden	26	68%
Prehistoric pottery	23	61%
Architectural (nails, wire, bricks)	17	45%
Historic ceramics	16	42%
Glass	14	37%
Faunal Remains	11	29%
Other	6	16%
None	6	16%
Lithics	3	8%
Shell tool	2	5%


Shell Midden (SJ00032)


Indigenous Pottery (SJ00003)


Orange Pottery (SJ02548)


Rusted Nail (SJ00003)


Historic Ceramics (SJ00032)


Blue Feather-edged Pearlware (SJ03150)

Figure 16 Examples of artifacts observed during monitoring.

Mapping

The project team was able to create two shoreline lines using data collected during 2022 and 2023. These lines allowed the team to calculate and visualize the erosion rate at archaeological sites along the shoreline of the Guana Peninsula between 2022 and 2023 using the DSAS tool (Figure 17, See for Appendix E for full data). Blue lines show transects of areas of low confidence in the data, and the calculations for these areas were omitted from the overall numbers presented here. Many of these areas are in marsh settings where the upland erosional edge was less clear during mapping. The multi-colored transects show that shoreline loss at these sites ranged from insignificant loss (0.01 m) to 3 m. The average loss along the shoreline totaled around 1 m and the median loss was 0.75 m. Of the 153 calculations of shoreline loss, most experienced between 1 and 50 cm of loss.

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Figure 17 Results of the shoreline analysis conducted using the DSAS tool. Transects are visualizing the rate of shoreline loss between 2022 and 2023 based on shoreline data collected during this project.

Areas of most meaningful change include the northern stretch of South of Wright's Landing (SJ00033) and Shell Bluff Landing (SJ00032) (Figure 18, Figure 19). Erosion at the northern portion of South of Wright's Landing ranged from insignificant to 2.94m, with most erosional rates calculated at 0.5-1.5 m and 2-3 m, and an overall average of 1.76 m. Shell Bluff Landing's erosion ranged from insignificant to 3m, with most erosional rates calculated between 0.5-2.35 m and an overall average of 1.3 m.

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Figure 18 Results of the shoreline analysis conducted using the DSAS tool at South of Wright's Landing (SJ00033).

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Figure 19 Results of the shoreline analysis conducted using the DSAS tool at Shell Bluff Landing (SJ00032).

Sites along the southeastern tip of the Guana Peninsula experienced higher erosional rates than expected given their location on the calmer Guana River and protected behind marshes (Figure 20). Rates at NN (SJ02547) and Southern Midden (SJ05464) ranged from insignificant to 2.9 m, with most rates calculated between 0.5-1.5 m and an overall average of 1 m.

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Figure 20 Results of the shoreline analysis conducted using the DSAS tool at NN (SJ02547) and Southern Midden (SJ05464).

3D Documentation

Sitewide

The project team was able to successfully document all four sites using 3D digital heritage techniques including photogrammetry and terrestrial laser scanning (See Appendix F for links to view models on SketchFab). Wrights Landing (SJ00003) was documented in March 2022 and again in November 2022 (Figure 21). Shell Bluff Landing (SJ00032) was documented in January 2022, October 2022, and March 2023 (Figure 22). Both South of Wright’s Landing (SJ00033) and Little Orange (SJ02548) were documented in March 2022 and February 2023 (Figures 23, 24). When checked for accuracy, real-world measurements on the calibrated scale bars were found to be within 2 mm or less of the measurements in all models.

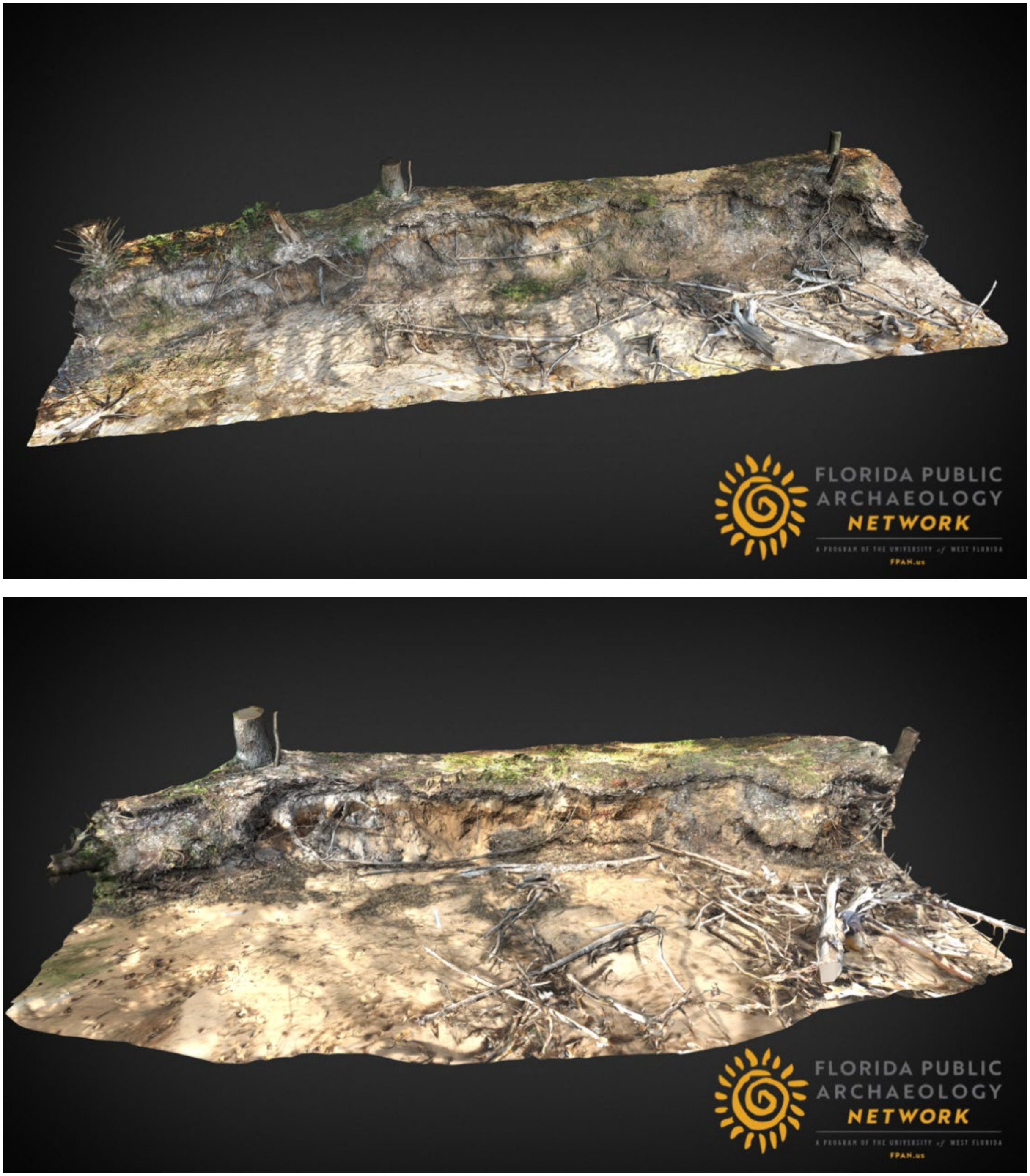

Figure 21 Wright's Landing (SJ00003) models from November 2022 (top) and March 2023 (bottom).

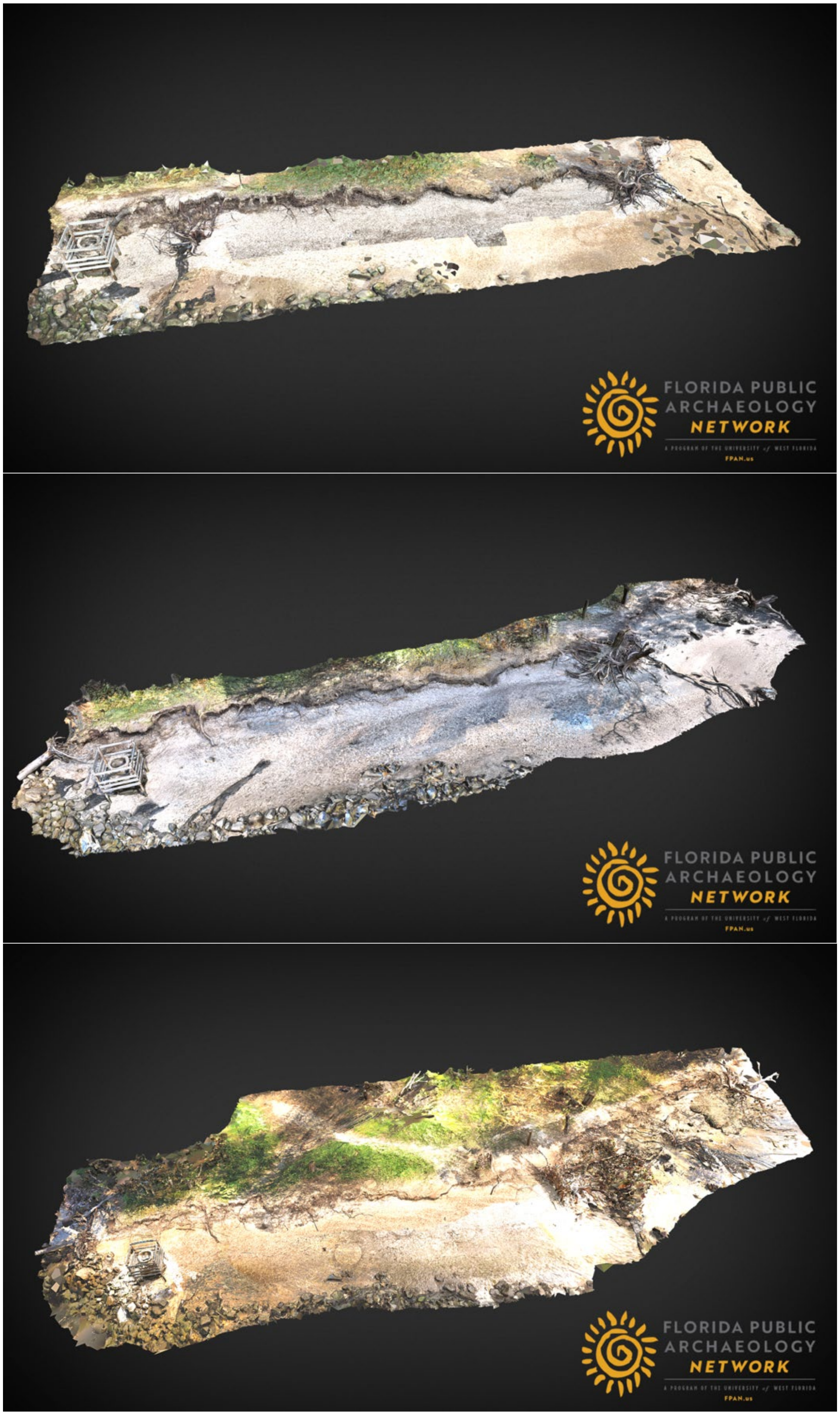

Figure 22 Shell Bluff Landing (SJ00032) models from January 2022, October 2022, and March 2023.

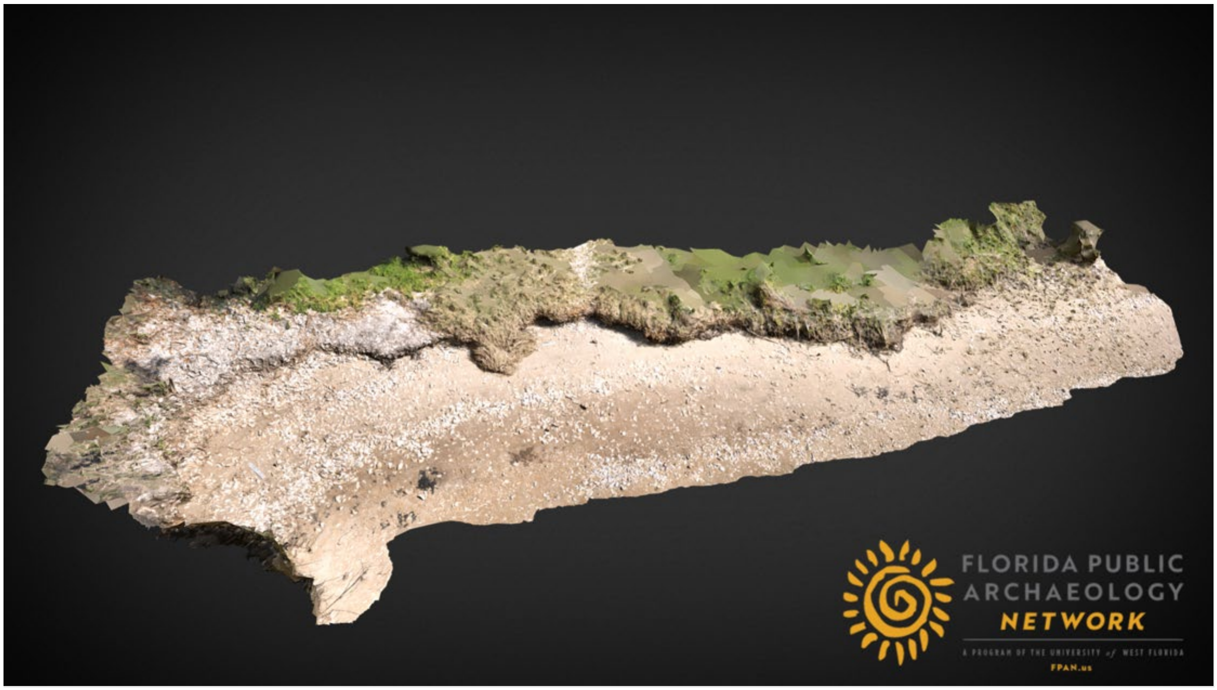

Figure 23 Models of South of Wright's Landing (SJ00033) from March 2022 (top) and February 2023 (bottom).

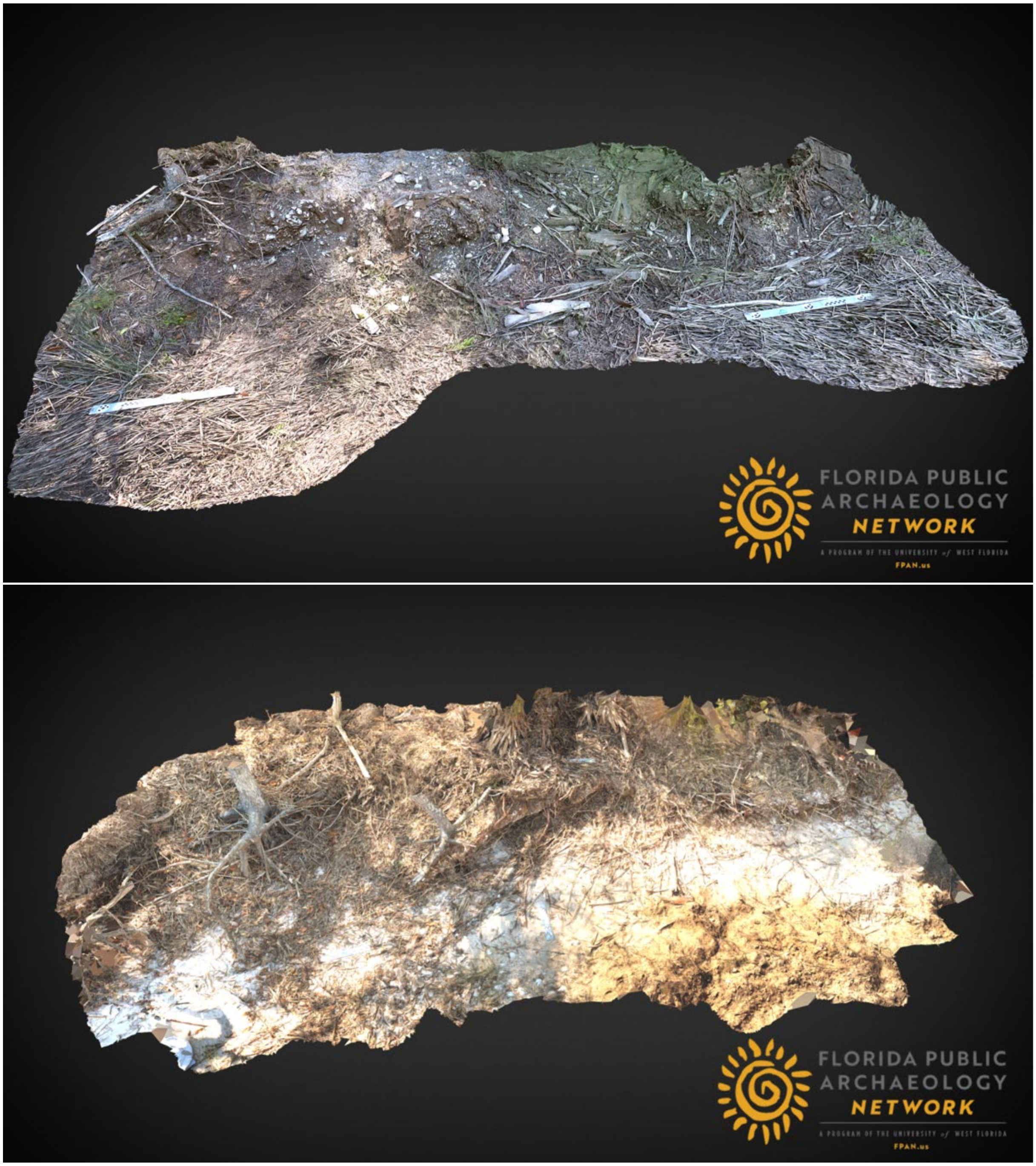

Figure 24 Little Orange (SJ02548) models from March 2022 and February 2023.

Cloud to cloud comparison was completed for three of the sites to demonstrate changes to the site through time (Figures 25, 26, 27). Unfortunately, the project team had issues with aligning the models using the GIS points. The first sets of GIS data collected during the project were not sufficient for georeferencing the model. The project team collected the data using the standard ArcGIS database used for shoreline mapping, which did not collect altitude measurements. As the models are 3-dimensional, a z-axis measurement of height is required for accurate georeferencing. The team was quickly able to create a new feature layer that included these data for subsequent scans. However, the team still encountered issues with aligning the models and was unable to fully troubleshoot the issue due to the project's shortened timeline. The team was able to provide a rough alignment for three of the sites by utilizing trees and other physical features in the cloud to refine the initial alignments based on the GIS points. However, the fourth site, South of Wright's Landing, lacked any references to refine the model and could not be compared.

At Wright's Landing, changes at the site between October 2022 and March 2023 ranged from insignificant change to over .6m of shoreline loss, with most change ranging between 25-50 cm of loss (Figure 25). The first model included more of the shoreline than the second, due in large part to two large tree falls, which caused issues with data collection and alignment. As such, the models were aligned, and the 2022 shoreline model was trimmed to the same area as the 2023 shoreline. At Shell Bluff Landing, the comparisons are limited to the October 2022 and March 2023 models. The models show shoreline change ranging from insignificant to 1.5 m of loss, with most changes ranging between 25-100 cm of loss (Figure 26). The biggest changes to the shoreline were around the well itself, where over 1m of material eroded. Additionally, two large tree falls were captured by the models. At Little Orange, changes at the site from March 2022 to February 2023 ranged from insignificant change to around 0.3 m of loss, with most changes ranging from 10-20 cm of loss (Figure 27). Vegetation changes occur across the modeled portion of the site, largely the result of rack lines from storm surges and flooding. The analysis shows severe undercutting of the site.

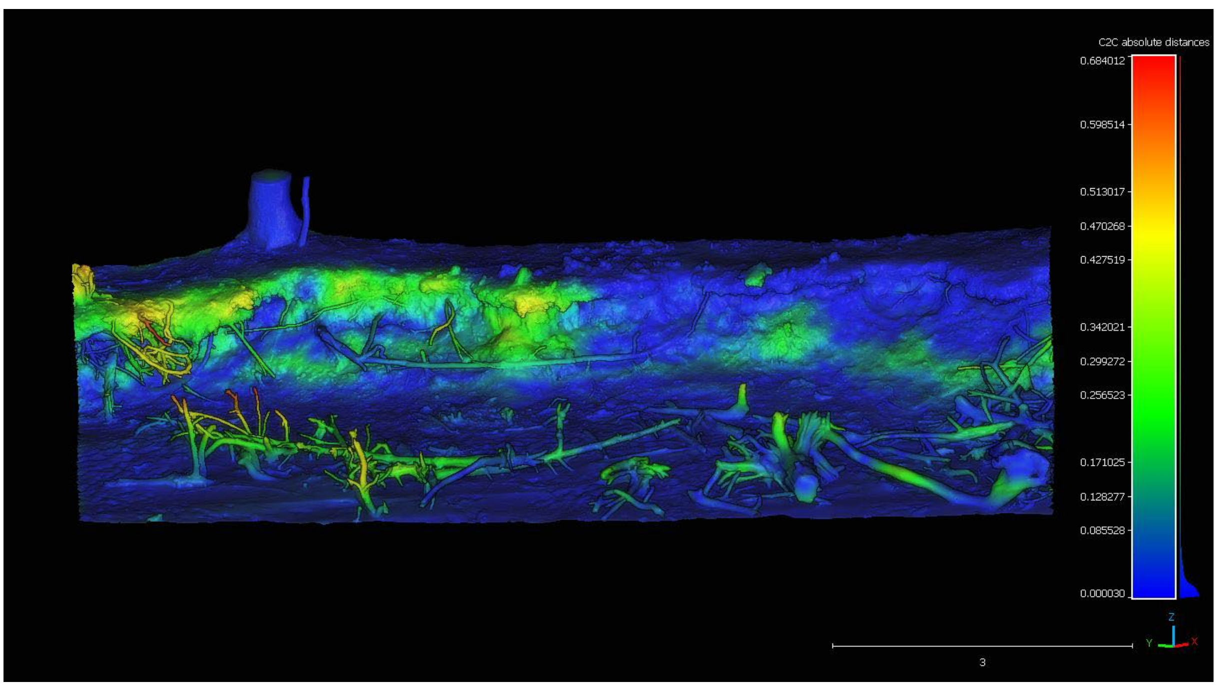

Figure 25 Cloud to cloud comparison of Wright's Landing (SJ00003) from October 2022 to March 2023 shows up to 50 cm of shoreline loss.

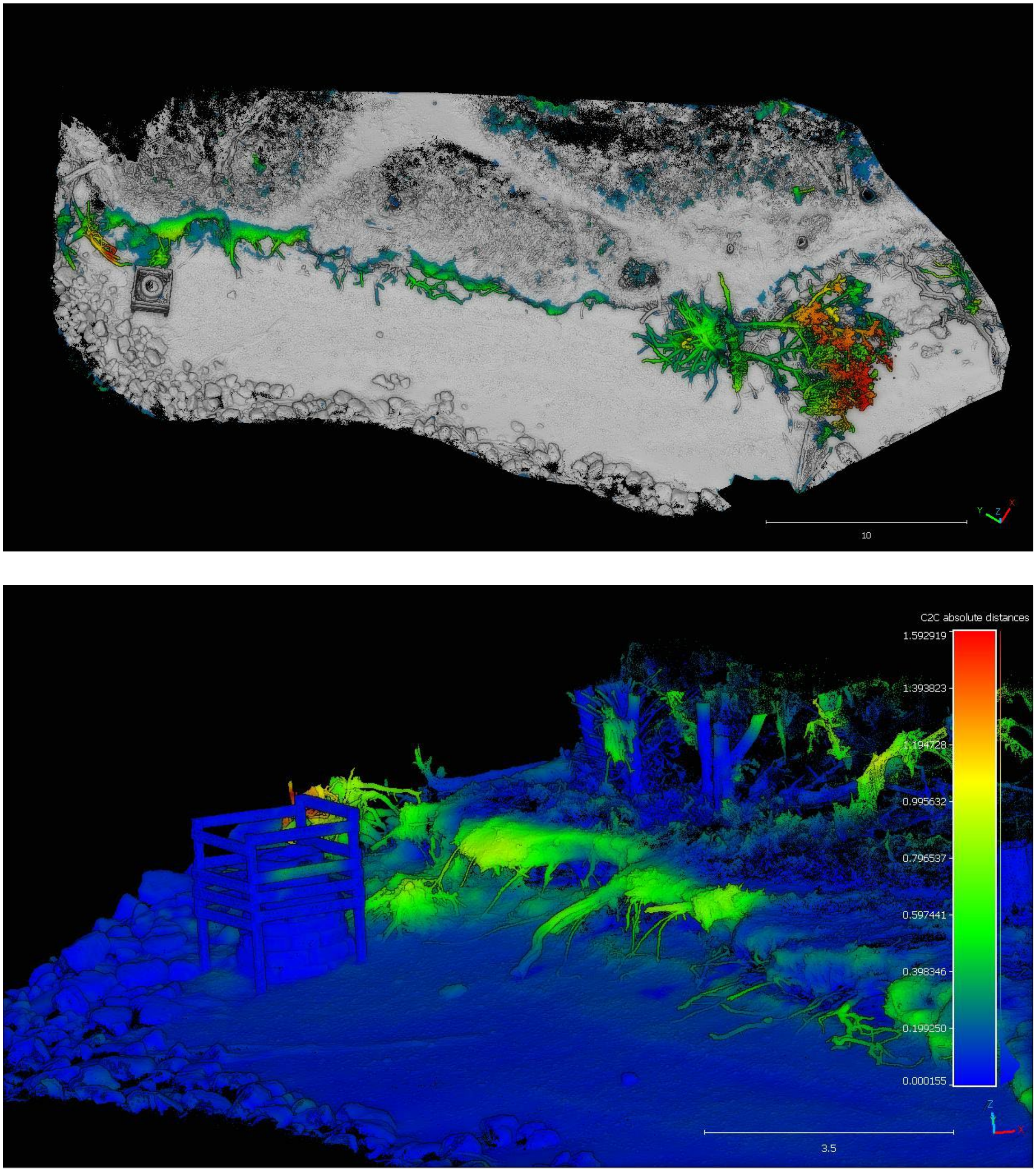

Figure 26 Cloud to Cloud comparison of Shell Bluff Landing (SJ00032) from October 2022 to March 2023 shows up to 1 m of shoreline loss, especially around the well.

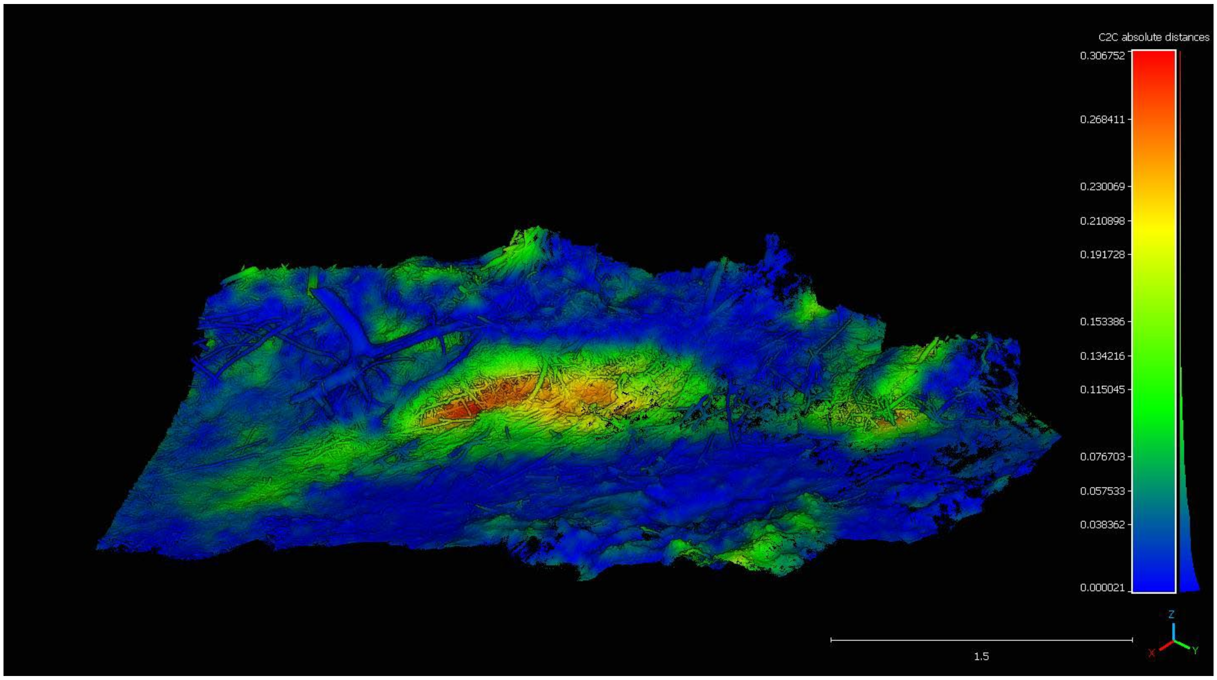

Figure 27 Cloud to cloud comparison of Little Orange (SJ02548) from March 2022 to February 2023 shows severe undercutting and up to 30 cm of shoreline loss.

Artifacts

In total, the project team documented 72 artifacts from across the 4 sites (See Appendix G for artifact table). This included 9 objects from Wright's Landing (SJ00003), 59 from Shell Bluff Landing (SJ00032), 2 from South of Wright's Landing (SJ00033), and 3 from Little Orange (SJ02548). From these, the team was able to create 60 models (Figure 28). Data collected early in the project were not sufficient for creating models, and the project team tweaked methods to ensure good models as the project progressed.

Figure 28 Selection of artifact models including (clockwise from top left) orange ceramics, lithic flakes, slip-trailed redware, and hand-painted pearlware.

The artifacts spanned all known cultural periods of the Peninsula and included lithic flakes, indigenous ceramics, shells, glass, historic ceramics, metal objects, and pipe fragments. While too few artifacts were documented at three of the sites for analysis, the items still provide some insight into the sites. Artifacts from Wright's Landing largely reflected the site's indigenous occupation. These included St. Johns, San Marcos and grit-tempered ceramics and a piece of worked lithic. Artifacts from the historical component included majolica, slipped redware, and coarse earthenware sherds. Artifacts documented at South of Wright's Landing include Orange and Deptford ceramics, suggesting a long period of use by indigenous people. Artifacts from Little Orange include Orange and grit-tempered ceramics as well as a representation of the midden material in a shark's eye filled with coquina shells.

From Shell Bluff Landing, the project team was able to conduct some analysis of the 43 ceramics they documented. Of these, seven represent the indigenous occupation of the site, ranging from 2500 BC to AD 1702. Historical ceramics ranged from 1490 to the present. A plot of ceramic date frequencies shows clusters around 1740, 1790, and between 1840-1890 (Figure 29). The first two clusters of dates align with known occupations at the site by Governor James Grant in the 1760s and Menorcan Juan Andreu in the 1790s (Newman 1992).

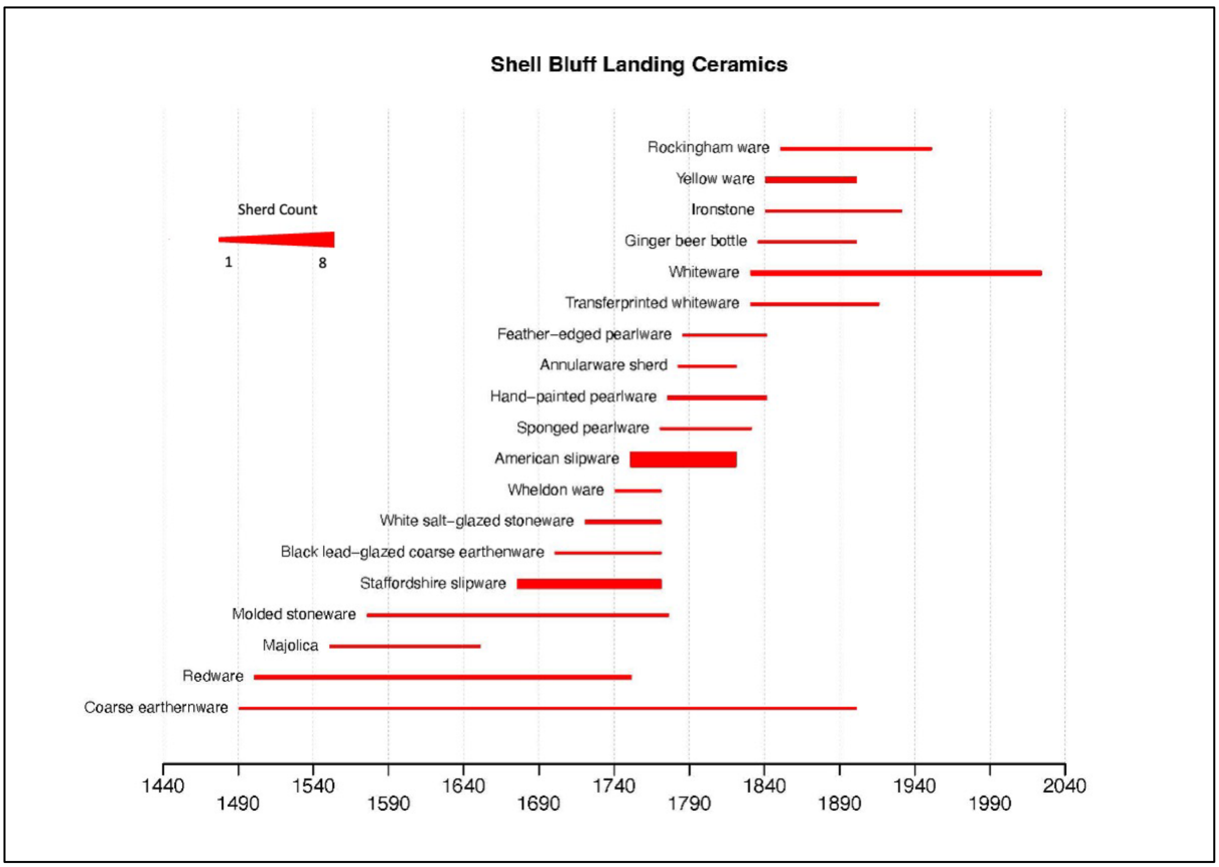

Figure 29 Historical ceramic dates for artifacts documented with photogrammetry from Shell Bluff Landing.

Discussion

The work completed under this survey, as well as the rest of the People of Guana project, helped to better define and contextualize the impacts on archaeological sites on the Guana Peninsula. Unsurprisingly, all lines of evidence suggest that the coastal sites have already experienced coastal change and that this change is being, and will continue to be, intensified by the climate crisis (Table 7). The SLAMM and ATA models predict impacts on almost all coastal sites by 2025, just 16 months away from the time of this report. Monitoring efforts show most sites are already in fair/declining or poor/unstable condition. Efforts to measure shoreline erosion through mapping and 3D documentation have provided quantifiable measurements of this loss. Community engagement shows an awareness of and concern over these impacts.

Table 7 sites affected by sea level rise with first year of anticipated impacts, according to modeling and current site condition, according to monitoring.

Site ID	Site Name	Site Type	Year of Anticipated Impacts Based on Modeling	Current Site Condition from Monitoring	Average Shoreline Loss Measured with DSAS Tool	Average Shoreline Loss Measured from Models
SJ00003	Wright's Landing	Prehistoric shell midden; Mission of Spanish Colonial heritage; Plantation; British, 1763-1783; American, 1821-present	2025	Fair = Declining	0.65 m	0.35 m
SJ00032	Shell Bluff Landing	Prehistoric shell midden; Historic well	2025	Fair = Declining	1.3 m	0.6 m
SJ00033	South of Wright's Landing	Prehistoric shell midden; Plantation; British, 1763-1783; Second Spanish Period, 1783-1821; American, 1821-present	2025	Poor = Unstable	1.75 m	N/A
SJ02547	NN	Prehistoric shell midden	2075	Fair = Declining	1 m	N/A
SJ02548	Little Orange	Prehistoric shell midden	2025	Poor = Unstable	0.75 m	0.15 m
SJ02549	NN	Prehistoric shell midden	2025	Good = Stable	0.45 m	N/A
SJ02550	Guana 1	Prehistoric shell midden	2025	Good = Stable	0.59 m	N/A
SJ02551	NN	Prehistoric shell midden	2025	N/A = Site not found	N/A	N/A
SJ03150	Guana Ruins	Building remains; Historic refuse/dump	2025	Fair = Declining	N/A	N/A
SJ03205	Guana North	Campsite (prehistoric)	2025	Fair = Declining	N/A	N/A
SJ04801	Tolomato Bar Anchorage Site	Prehistoric shell midden, Spanish-First Period, 1513-1763; British, 1763-1783; Spanish-Second Period, 1783-1821; American, 1821-present	2025	Fair = Declining	N/A	N/A
SJ05353	Undetermined Ancient Shipwreck Artifact	Historic Shipwreck	2025	N/A = Site not found	N/A	N/A
SJ05464	Southern Midden	Prehistoric shell midden	2075	Fair = Declining	0.89 m	N/A
SJ08034	Shirley Midden	Prehistoric shell midden	2025	Fair = Declining	0.87 m	N/A
SJ08039	Coquina Block Site	Building Remains	2050	N/A	N/A	N/A

The NAHAR Pipeline

The methods deployed during the People of Guana project represent a suite of ways to document at risk and impacted sites. While the project fell short of full mitigation efforts to recover more in-depth archaeological data from the most impacted sites, the project still helped show the research pipeline is a useful tool. Modeling helped the team understand and predict how the landscape could change. Monitoring helped ground truth these models and learn more about the sites themselves as well as the threats they are facing. Technology like 3D documentation and shoreline mapping help collect the quantifiable measurements of this change. Meeting with project end users and stakeholders helped to guide the research design to best fit the needs of all involved, and stakeholder surveys and CCHAR workshops provided a way for the wider community to voice their concerns.

Anecdotal evidence from the stakeholder survey illustrates visitors are noticing the impacts at sites. Respondents to the survey indicated that climate change-related threats, most notably sea level rise, increased and intensified storm events, and flooding, were among the biggest perceived threat to the cultural resources at the GTM Research Reserve (see Appendix B). Most respondents noted that they noticed or experienced increases from these impacts already. Participants at the CCHAR events commented on the impacts of climate change including sea level rise, erosion, and increased storm events. They expressed the need to better document and understand cultural resources before they are lost.

Site Monitoring and Documentation

The monitoring of archaeological sites not only provides a means of tracking the impacts and threats such as erosion and storm surge but also allows an opportunity to learn more about the sites and address immediate management issues. Several site boundaries were expanded based on the artifacts and shell midden exposed on the surface. While visiting known sites, the project team noticed several instances of shell midden on the surface and returned later for pedestrian surveys to record the areas as new sites.

Monitoring is most helpful when it occurs regularly over time. FPAN has been monitoring sites like Shell Bluff Landing and Wright's Landing since the inception of HMS Florida in 2016. As such, the data for these sites tells the stories of hurricanes, king tides, controlled burns, and bonfires. Such intimate familiarity with sites means that staff are able to notice nuanced changes through time.

While observations and photographs from monitoring can allow land managers and archaeologists to track changes over time, the use of the digital methods deployed during this project can allow for more quantifiable measurements of change. Shoreline mapping illustrated areas with the most erosion and loss over the year the team collected shoreline data. In areas of drastic erosion, the GNSS and RTK allow one to collect highly accurate data that can track the changes through time. However, the project team struggled to define the shoreline in areas with gentle slopes and would sometimes rely on the 2022 line to decide where to map the 2023 line. Some parts of the Peninsula have multiple erosional edges and it was hard to determine where intact archaeological deposits could remain. Similarly, some areas had clearly transitioned into marsh environments but could very well still contain deposits. These situations have the potential to introduce bias and error.

While the use of the DSAS analysis tool and the resultant shoreline estimates should be considered preliminary since this tool is new to the project team and the results are limited since only two annual shoreline lines were used to make these calculations, the project team found some meaningful erosional loss to the shoreline was evident. Between 2022 and 2023, the DSAS tool showed that areas of archaeological shorelines eroded at an average of 1 m a year, with as little as 0.01 m to as much as 3 m of loss in some places. Obviously, this analysis would benefit from additional annual shoreline mapping. The more shoreline lines through time that can be added to the DSAS tool, the more accurate the shoreline loss at the Guana Peninsula will be. In a future study, the 2022 and 2023 lines should be compared to the 2020 and 2021 lines collected during previous research projects (Miller et al. 2021) and plan for future data collection along these same shorelines. Though the 2020 and 2021 lines were collected with the less accurate Arrow 100 DNSS receiver, the 2022 and 2023 lines, as well as any future lines collected, use the Arrow Gold which has sub-centimeter accuracy. Combine that level of accuracy with the DSAS tool and shoreline change calculations should be accurate and reliable. The DSAS tool can, with at least four annual shorelines, project future shoreline loss based on past trends. Previous research clearly shows erosion is a huge problem along the western side of the Peninsula, but this tool could go beyond saying erosion exists and provide real data-based projections for future erosional loss at these archaeological sites. Additionally, historic shoreline estimates could be used to help understand long term changes to the shoreline.

The 3D digital heritage techniques like photogrammetry and terrestrial laser scanning allowed the project team the ability to rapidly collect large amounts of data with noninvasive methods. The products produced during this project represent the tunnel within millimeters of the actual site and were collected within four working days. These methods are less labor-intensive than traditional survey and mapping techniques and allow more thorough documentation. Digital heritage techniques are now deployed globally to document threatened and impacted sites (Kersten et al. 2008; Richter et al. 2012; Lobb 2016; Pennanen 2019; Miller et al. 2021; Murray 2023). Data collected during this project provide a record of the sites on the Guana Peninsula in 2022 and 2023 and can continue to be compared to data from shorelines in the future to help better understand erosion and shoreline change (Kincey et al. 2017; Lercari 2016). The models themselves provide a curated glimpse of the sites at the moment in time they were created. As the shorelines continue to change, future researchers and other interested stakeholders will be able to explore the sites as they were today.

Digital documentation efforts also included collecting images of notable artifacts (illustrated specimens) and significant features to help document these resources. While monitoring, best practices and regulations on State-managed land dictate that any artifacts found are photographed and left at the site (Florida Legislature 2022). Yet diagnostic artifacts are frequently encountered. Photogrammetry creates a more robust digital record of these artifacts that researchers can use for analysis for years to come (Graham et al. 2017). The process is relatively easy and will be done in the field by FPAN staff without removing the artifact. Items are photographed from all angles and these photos are processed through software such as Agisoft, Metashape, and Meshlash to create the 3D rendering. Photogrammetry can be a great option to document artifacts in lieu of collection, aiding in the ongoing curation crisis while providing more information than a few static images. This so-called “catch and release” method captures most data used in artifact analysis. For models, researchers can glean information like physical details, measurements, and use wear (Murray 2023). The project team was able to complete basic cataloging and ceramic date analysis of some of the objects documented during the grant project. An analysis of this assemblage provides some insights into the sites on the Guana Peninsula but does reflect a collection bias. For instance, small, eroded sherds, while frequently encountered during monitoring trips, are absent from the documented assemblage because of their lack of diagnostic significance, suitability for modeling, and frequent occurrence.

The project explored several methods for tracking shoreline erosion, each with its own set of benefits and constraints. The basic monitoring protocols for HMS Florida offer written observations and photographs as a means of tracking changes. While these can provide qualitative data and great visuals, this information can also be limiting and can range in depth based on who is doing the monitoring. A professional archaeologist may write paragraphs while a novice may make no notes. Change to these sites is also hard to comment on during an initial visit to a site. The shoreline mapping and DSAS calculations can provide more quantifiable numbers of shoreline loss. While the points themselves are easy to collect, even by inexperienced volunteers, the location of the shoreline can often be hard to find, especially in areas with gentle slopes. The 3D data also can provide more quantifiable measurements of shoreline loss. Cloud to Cloud comparisons have the potential to be more accurate as the laser scanner data depicts the site within millimeters of the real-time location. However, as the project team learned, the accuracy of the GIS data is crucial to getting the best alignments of subsequent scans. Additionally, this tool can calculate shoreline loss in a volumetric way while the DSAS shoreline data just represents loss on a horizontal plane. However, for larger project areas, the shoreline mapping technique may be more feasible, less time-consuming, and requires a less expensive set of tools.

Conclusion and Recommendations

Overall, the People of Guana project was a successful test case for tackling heritage at risk through the NAHAR pipeline. The five steps proved a useful framework to ensure a broad approach that considered multiple lines of evidence and a wide range of community input to help guide strategies at impacted sites. The efforts under this permit helped further define and document the breadth of impacts of the climate crisis on the cultural resources of the Guana Peninsula. The project was able to contextualize these impacts and changes into a larger historical narrative as well as into contemporary concerns of the climate crisis.

The project team recommends future efforts should start with a systematic testing strategy to understand and manage the resources on the Peninsula. Most of the known sites were recorded based on exposed material in erosional shorelines or on the surface, and the large, multicomponent, and more significant sites have never had systematic work to define or delineate them. The systematic testing that has occurred on the Peninsula has been limited to several discrete areas intended for development. Much of the interior has never had any formal investigations, and the discovery of new sites along walking trails and in tree falls suggests that more sites are probably located there. Without a better understanding of the sites, it is difficult to create a mitigation strategy to recover data from sites that are currently eroding.

Further, it is our recommendation that state regulations and guidance on cultural resources recognize impacts from the climate crisis as adverse effects to those resources. While mitigation may not include full data recovery at most sites, it’s crucial to recognize and factor the impacts of erosion, storms, flooding, and other climate-related impacts into management plans.

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Appendix A: Report: Sea Level Affecting Marshes Model of the Guana Tolomato Matanzas National Estuarine Research Reserve (GTM NERR), by Dr. Lindsey Cochran

See attached PDF (Appendix A.pdf)

Appendix B: Report on the Guana Tolomato Matanzas National Estuarine Research Reserve Stakeholder Survey, by Ben Marwick, Aoife Campbell-Smith and Kavya Shrikanth

See attached PDF (Appendix B.pdf).

Appendix C: HMS Florida Monitoring Data

See attached spreadsheet (Appendix C.xlsx). A summary of the data is below.

Site ID	Site Name	Condition	Priority Level	FMSF Update
SJ00003	Wright's Landing	Fair = Declining	Medium	Yes
SJ00004	Sanchez Mound	Good = Stable	Low	
SJ00032	Shell Bluff Landing	Fair = Declining	Medium	Yes
SJ00033	South Of Wright's Landing	Poor = Unstable	High	
SJ02547	NN	Fair = Declining	Medium	Yes
SJ02548	Little Orange	Poor = Unstable	High	
SJ02549	NN	Good = Stable	Medium	
SJ02550	Guana 1	Good = Stable	Low	
SJ02551	NN	N/A = Site not found	Low	
SJ02552	Guana 6	Good = Stable	Low	
SJ02553	NN	N/A = Site not found	Low	
SJ03150	Guana Ruins	Fair = Declining	Medium	
SJ03205	Guana North	Fair = Declining	Medium	
SJ03235	Guana 2	Good = Stable	Low	Yes
SJ03236	Guana 3	N/A = Site not found	Low	
SJ04801	Tolomato Bar Anchorage Site	Fair = Declining	Medium	
SJ05353	Undetermined Ancient Shipwreck Artifact	N/A = Site not found	Low	
SJ05464	Southern Midden	Fair = Declining	Medium	Yes
SJ08034	Shirley Midden	Fair = Declining	Low	

Appendix D: Florida Master Site File Forms, Updates and New Sites

See attached PDF (Appendix A.pdf). A list of all updated sites is below.

Site Number	Site Name	Form Type
SJ00003	Wright's Landing	Update – Location only
SJ00032	Shell Bluff Landing	Update – Location only
SJ02547	NN	Update – Location only
SJ03235	Guana 2	Update – Location only
SJ05464	Southern Midden	Update – Location only
SJ07401	Arched Tree Midden	New
SJ07402	Orange Trail I	New
SJ07403	Orange Trail II	New
SJ07415	Red Trail Midden	New
SJ07416	Yellow Trail Midden	New

Appendix E: DSAS Shoreline Data

See attached spreadsheet (Appendix E.xlsx). A list of summary data is below.

Transcect ID	Measured Shoreline Loss (in meters)	Associated Site	Transect ID	Measured Shoreline Loss (in meters)	Associated Site
1	0.37	SJ00033	76	0.89	SJ00003
10	0.67	SJ00033	77	0.11	SJ00003
17	1.63	SJ00033	78	0.48	SJ00003
18	0.68	SJ00033	81	0.3	SJ00003
20	0.84	SJ00033	82	0.48	SJ00003
23	0.04	SJ00033	83	0.17	SJ00003
26	2.22	SJ00033	84	0.29	SJ00003
32	2.12	SJ00033	85	0.15	SJ00003
36	0.67	SJ00033	86	0.63	SJ00003
37	2.44	SJ00033	87	0.03	SJ00003
38	0.98	SJ00033	88	0.37	SJ00003
39	1.23	SJ00033	90	0.52	SJ00003
40	1.08	SJ00033	91	0.28	SJ00003
41	2.26	SJ00033	92	0.09	SJ00003
42	1.12	SJ00033	96	0.83	SJ00003
43	0.43	SJ00033	99	0.46	SJ00003
44	2.1	SJ00033	100	2.09	SJ00003
45	1.85	SJ00033	101	0.05	SJ00003
46	2.15	SJ00033	103	0.48	SJ00003
47	2.94	SJ00033	104	2.01	SJ00003
48	0.77	SJ00033	105	0.19	SJ00003
49	1.22	SJ00033	106	2.69	SJ00003
50	0.94	SJ00033	108	1.84	SJ00003
51	2.71	SJ00033	115	1.29	SJ00003
52	3.01	SJ00033	118	1.25	SJ00003
53	2.91	SJ00033	119	2.88	SJ00003
54	2.68	SJ00033	120	1.7	SJ00003
58	0.03	SJ00003	121	1.06	SJ00003
59	0.28	SJ00003	122	0.01	SJ00003
60	0.61	SJ00003	124	0.18	SJ00003
61	0.73	SJ00003	125	0.38	SJ00003
62	0.34	SJ00003	126	0.48	SJ00003
63	0.3	SJ00003	127	0.32	SJ00003
64	0.1	SJ00003	131	1.06	SJ00003
65	0.28	SJ00003	149	1.43	SJ00032
66	0.51	SJ00003	150	1.72	SJ00032
67	0.25	SJ00003	151	1.28	SJ00032
68	0.64	SJ00003	152	0.56	SJ00032
69	0.57	SJ00003	154	2.27	SJ00032
70	0.79	SJ00003	155	1.13	SJ00032
71	0.5	SJ00003	156	0.35	SJ00032
72	0.56	SJ00003	157	0.43	SJ00032
73	0.43	SJ00003	158	2.36	SJ00032
74	0.4	SJ00003	159	0.74	SJ00032
75	0.67	SJ00003	160	1.68	SJ00032

Transect ID	Measured Shoreline Loss (in meters)	Associated Site	Transect ID	Measured Shoreline Loss (in meters)	Associated Site
161	1.78	SJ00032	283	0.36	SJ08034
162	1.72	SJ00032	297	0.45	SJ02549
164	2.05	SJ00032	311	1.1	SJ02548
165	2.03	SJ00032	312	0.39	SJ02548
167	0.9	SJ00032	323	0.98	SJ02547
168	1.85	SJ00032	324	0.22	SJ02547
170	0.92	SJ00032	327	0.04	SJ02547
171	1.78	SJ00032	328	1.63	SJ02547
172	0.21	SJ00032	331	0.51	SJ02547
173	0.21	SJ00032	332	0.17	SJ02547
233	0.14	SJ02550	333	0.86	SJ02547
234	0.31	SJ02550	334	0.73	SJ02547
237	1.16	SJ02550	335	1.03	SJ02547
239	0.13	SJ02550	336	2.1	SJ02547
240	1.27	SJ02550	338	2.9	SJ02547
241	0.8	SJ02550	339	2	SJ02547
242	0.3	SJ02550	340	0.38	SJ02547
257	0.78	SJ08034	341	0.11	SJ02547
260	0.71	SJ08034	342	1.24	SJ02547
261	2.66	SJ08034	344	0.87	SJ05464
262	1.12	SJ08034	346	1.29	SJ05464
263	1.69	SJ08034	347	0.07	SJ05464
264	1.38	SJ08034	348	0.46	SJ05464
267	0.36	SJ08034	349	2.13	SJ05464
270	0.22	SJ08034	351	1.2	SJ05464
272	0.5	SJ08034	352	0.59	SJ05464
274	1.09	SJ08034	353	1.66	SJ05464
275	1.34	SJ08034	354	1.19	SJ05464
278	0.11	SJ08034	357	0.12	SJ05464
280	0.43	SJ08034	363	0.58	SJ05464
281	0.38	SJ08034	364	0.4	SJ05464
282	0.71	SJ08034			

Appendix F: Links to Shoreline Models on SketchFab

General People of Guana collection: https://skfb.ly/oySQp

SJ00003 Wright's Landing

March 2022: https://skfb.ly/oASLC

November 2022: https://skfb.ly/oKoUY

SJ00032 Shell Bluff Landing

January 2022: https://skfb.ly/osDWQ

October 2022: https://skfb.ly/oB6AD

March 2023: https://skfb.ly/oJZQC

SJ00033 South of Wright's Landing

March 2022: https://skfb.ly/oASnS

February 2023: https://skfb.ly/oJSxq

SJ02548 Little Orange

March 2022: https://skfb.ly/oAUpF

February 2023: https://skfb.ly/oJYRO

Appendix G: "Catch and Release" Artifact Table

FS	Site Number	Artifact	Link to Model
1	SJ00003	St Johns sherd	N/A
2	SJ00003	Majolica sherd	https://skfb.ly/o9KTI
3	SJ00003	American slipware	https://skfb.ly/oyvyU
4	SJ00003	lithic	https://skfb.ly/oBWqq
5	SJ00003	St. Johns check stamped sherd	https://skfb.ly/ozOO8
6	SJ00003	coarse earthenware sherd	https://skfb.ly/ozORy
7	SJ00003	St. Johns Check Stamped Sherd	N/A
8	SJ00003	San Marcos complicated stamped sherd	N/A
9	SJ00003	Grit-tempered sherd	https://skfb.ly/oJHvA
10	SJ00032	Wheldonware base	N/A
11	SJ00032	feather-edged pearlware	N/A
12	SJ00032	American slipware	https://skfb.ly/oInyA
13	SJ00032	American slipware	N/A
14	SJ00032	Yellow ware	N/A
15	SJ00032	glass bottle base	https://skfb.ly/o8Xsw
16	SJ00032	bone pin tip	https://skfb.ly/oHZW7
17	SJ00032	transfer printed whiteware	https://skfb.ly/o8Xrs
18	SJ00032	Orange incised	https://skfb.ly/ov8uq
19	SJ00032	molded stoneware	https://skfb.ly/o8X8P
20	SJ00032	American slipware	https://skfb.ly/oHZVN
21	SJ00032	coarse earthenware	N/A
22	SJ00032	pipe bowl fragment	https://skfb.ly/oHZZA
23	SJ00032	black lead-glazed coarse earthenware	https://skfb.ly/ozH6Y
24	SJ00032	Rockingham ware	https://skfb.ly/ozJGZ
25	SJ00032	slipware sherd	https://skfb.ly/oJH9t
26	SJ00032	Ironstone sherd	https://skfb.ly/oIntD
27	SJ00032	punctated sand tempered sherd	https://skfb.ly/oyK6C
28	SJ00032	white salt-glazed stoneware	https://skfb.ly/oyKoF
29	SJ00032	slipware sherd	https://skfb.ly/ozJKn
30	SJ00032	slipware sherd	https://skfb.ly/oJH98
31	SJ00032	prosser button	N/A
32	SJ00032	slipware sherd	https://skfb.ly/ozNPX
33	SJ00032	barrel band	N/A
34	SJ00032	American slipware sherd	https://skfb.ly/oIqnL
35	SJ00032	white salt-glazed stoneware	https://skfb.ly/oHYTX

FS	Site Number	Artifact	Link to Model
36	SJ00032	ginger beer	https://skfb.ly/oAtHR
37	SJ00032	glass bottle base	https://skfb.ly/ozxZx
38	SJ00032	knobbed whelk shell	N/A
39	SJ00032	coarse earthenware sherd	https://skfb.ly/ozxMU
40	SJ00032	Orange sherd	https://skfb.ly/ozxUH
41	SJ00032	pipe bowl fragment	https://skfb.ly/oAtDR
42	SJ00032	American slipware	https://skfb.ly/oJH97
43	SJ00032	redware handle	https://skfb.ly/oAtHK
44	SJ00032	sponged pearlware	https://skfb.ly/oAtEO
45	SJ00032	Yellow ware	https://skfb.ly/oJH9o
46	SJ00032	whiteware	https://skfb.ly/oInA9
47	SJ00032	knobbed whelk shell	https://skfb.ly/ozxWv
48	SJ00032	American slipware	https://skfb.ly/oAuNx
49	SJ00032	shell tool	https://skfb.ly/ozwpP
50	SJ00032	Yellow ware	https://skfb.ly/oAtYV
51	SJ00032	American slipware	https://skfb.ly/oIsNV
52	SJ00032	Redware base	https://skfb.ly/oIoqK
53	SJ00032	St Johns sherd	https://skfb.ly/oJHvR
54	SJ00032	San Marcos sherd	N/A
55	SJ00032	San Marcos rim sherd	https://skfb.ly/oHYMQ
56	SJ00032	Majolica sherd	https://skfb.ly/oDpHH
57	SJ00032	St. Johns sherd	https://skfb.ly/oJH96
58	SJ00032	Annularware sherd	https://skfb.ly/oHYGI
59	SJ00032	cow bone	https://skfb.ly/oHYHu
60	SJ00032	lithic flake	https://skfb.ly/oInno
61	SJ00032	redware sherd	https://skfb.ly/oHYKN
62	SJ00032	San Marcos sherd	https://skfb.ly/oHYLS
63	SJ00032	bone pin tip	https://skfb.ly/oIrRQ
64	SJ00032	hand painted pearlware	https://skfb.ly/oHYCq
65	SJ00032	lithic flake	https://skfb.ly/oInsy
66	SJ00032	hand painted pearlware, bird	https://skfb.ly/oHYDC
67	SJ00032	slipware	https://skfb.ly/oHYF7
68	SJ00032	whiteware rim sherd	N/A
69	SJ00033	Deptford sherd	https://skfb.ly/oJH9u
70	Sj00033	Orange sherd	https://skfb.ly/oIPGE
71	SJ02548	Shark's eye with coquina midden	https://skfb.ly/oIos9
73	SJ02548	grit-tempered sherd	N/A
72	SJ02548	Orange sherd	https://skfb.ly/oISRB