

Integration of GPR and GIS to Model the Distribution of Pre-Columbian Canoes, Florida

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Abstract

The distribution of ancient dugout canoes, which were abandoned on waterways in Florida, were mapped with GPR and their locations studied using GIS. Canoes were located using GPR reflection profiles, which were compared to 2-D forward models for interpretation. Two lakes in northern Florida were found to contain many canoes, which were concentrated in distinct areas along the shore. These were likely transit points for transportation of goods and people from east to west across the Florida Peninsula over millennia. The State's fluvial and lake navigation network was studied by determining possible transportation routes between canoe locations and contemporaneous archaeological sites, which are interpreted as population aggregation centers. A least-cost analysis was done for this water transport, which demonstrates how the two lakes that are the focus of this research were the major portage location between the west and east coasts of Florida. This regional analysis demonstrated that archeological canoes represent more than isolated artifacts and can be used to study ancient transportation networks within this complex watery landscape.

Introduction

Canoes were the primary method of transportation in ancient Florida, which allowed people and goods to move across many water ways along the coast and from east to west across the peninsula (Figure 1). This study used GPR to produce images of submerged canoes, and map their concentrations in two lakes, Santa Fe and Newnan's (Figure2). In this way the locations of many canoes could be plotted, to understand how the density of these craft and ancient water transport methods are related. These lakes are located just a few miles east of Gainesville, Florida along the topographic divide between the two coasts.



Figure 1: Location of Santa Fe and Newnan's Lakes, Florida



Figure 2. Seminoles and dugout canoes on the Miami River, Florida in the 19th century. State Library and Archives image number RC00208A.



Figure 3: Collecting data at Newnan's Lake. The GPR unit is in the stern an inflatable boat (far right). It is important that these craft not have inflatable bottoms, as the air pockets will disrupt radar waves.

The collection of GPR reflection profiles occurred in 2015 and early 2016. Data were collected with 400 MHz antennas with the base of the antennas placed on the thin plastic bottom of a small craft (Figure 3). This was tied to a large vessel where the GPR control system was located. All profiles were placed into geographic space using a GPS antenna located in the large boat.

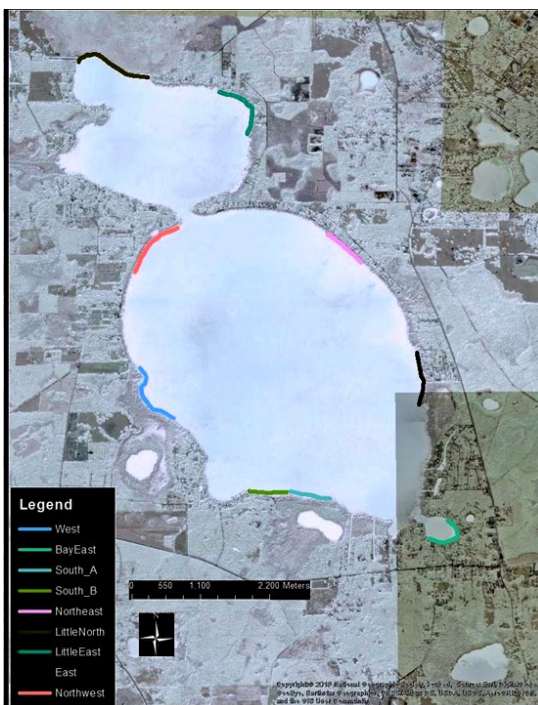


Figure 4: The locations of the GPR surveys at Lake Santa Fe Lake.

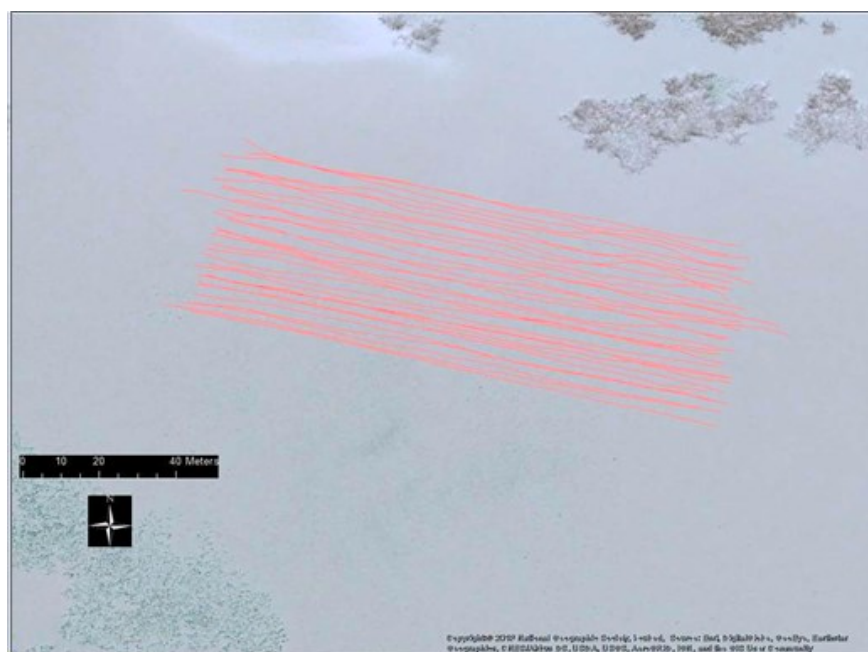


Figure 5: Transects over locations of known submerged canoes at Newnan's Lake. These transects were placed into space with GPS and separated about 1 meter apart. Similar grids of data were obtained for all the lake surveys.

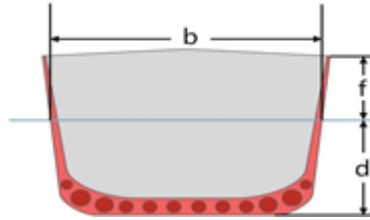


Figure 6: Approximate dimensions of a Seminole canoe from the 19th century.

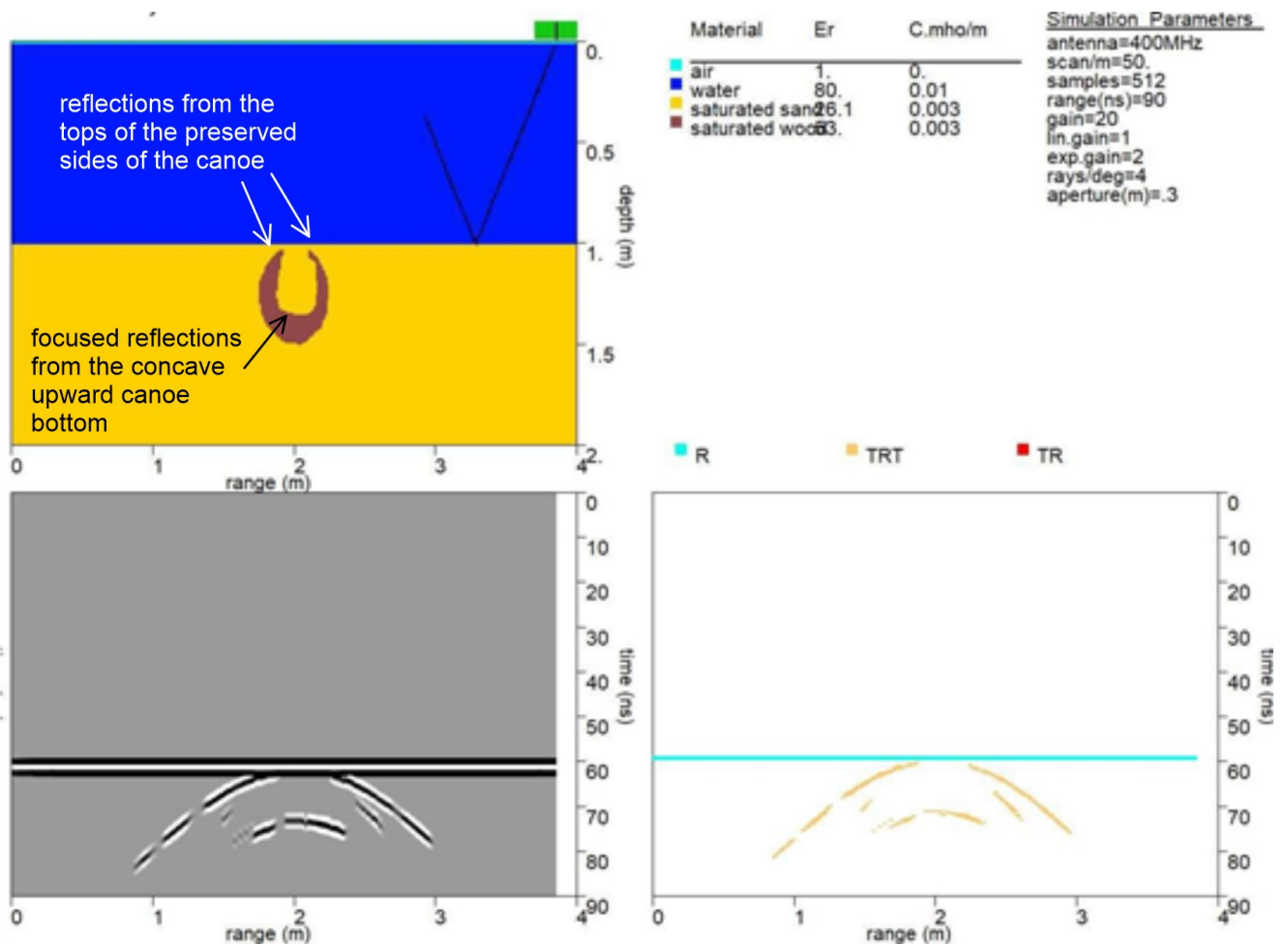


Figure 7: Synthetic computer model of a submerged canoe, with the edges just at the bottom of the lake. Reflections are created from the tops of the canoe edges (the gunnels) with only "half hyperbolas" displayed. The canoe bottom focuses radar energy and produces a high amplitude hyperbolic-shaped reflection.

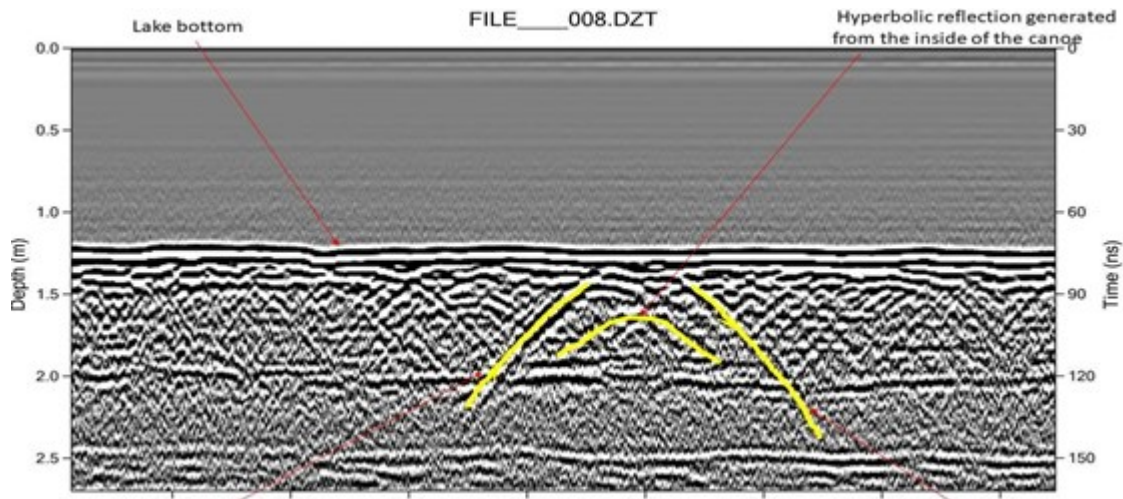


Figure 8: 400 MHz Reflection profile showing a submerged canoe with “half hyperbolas generated from the upper edges and reflections from the bottom of the canoe (annotated in yellow).



Figure 9: Locations in Santa Fe Lake with large concentrations of submerged canoes.

At Newnan’s Lake twenty-six transects were collected over the locations of known canoes within a grid of about 119x45 meters (Figure 5). At Lake Santa Fe, data were collected in nine areas (Figure 6) adjacent to the modern shoreline in somewhat larger grids. For each survey area at Lake Santa Fe, the decision was made to contain the transects within the 3 to 4 ft depth contour lines (1-1.5 meters depth), which correspond both to the depth in which other previously discovered Newnan’s canoes were located, and the depth in which other previously recorded canoes were located at Santa Fe Lake.

This discovery of canoes and their mapping produced an amazing abundance of canoe locations within the water of the lakes that was at most about 1.5 meters or less in depth. This corresponds to what the prehistoric shoreline would have been and suggests that canoes were abandoned after they became derelict along the shoreline. They were then buried by sediment and preserved. The conclusion of this canoe identification and mapping indicates that both these lakes were in some way part of a transit system between the two coasts of Florida.

GIS analysis

To produce a model of how canoe distribution, waterways, and contemporaneous archaeological sites were related, GIS was used, beginning with the canoe concentration at Newnan's and Santa Fe Lakes. The relationship between major archaeological sites and canoes could then be modeled, with meta-data including the radiometric dates of both canoes and archaeological sites, tying both canoes to their respective archaeological time-period. This was important because by knowing when these canoes were used, along with likely associated cultural components of the people who used them, patterns were revealed to obtain likely water transportation routes.

All canoe locations including those identified in this GPR study, and others that had been recognized by others and reported to the Florida State database, were placed within their temporal contexts in a GIS database. There is a Florida master log-boat database (Duggins 2019) which was incorporated into the data obtained from the two lakes where GPR was used. This was integrated with an analysis of the state's natural hydrology that could be used to represent the aquatic network where canoes could conceivably have been used (where there were navigable rivers and lakes, which connected). A navigation network was created in GIS as a spatial framework in which to calculate the most cost-efficient routes (Figure 10)

Routes were calculated for a variety of periods, two of which are presented here (the Archaic from about 5,000-2200 years ago and the Mississippian from about 1,100 years ago until European contact about AD 1550). This analysis shows an amazing continuity of canoe routes over time, with the Archaic age routes and canoes mostly concentrating along the west coast and along rivers that used the Newnan's and Santa Fe Lakes as portage locations for travel to the east coast (Figure 10).

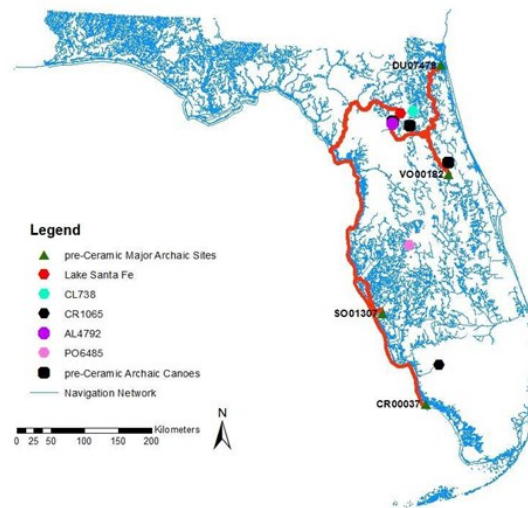


Figure 10: The least-cost routes between the earliest canoes in Florida and sites where the people who used these canoes likely traveled. These pre-ceramic (Archaic age) possible routes connect archaeological sites of this age and places where canoes of this age have been found. The least-cost route for canoe travel, which connects the west coast of Florida to the Atlantic, runs through Santa Fe Lake.

Many thousands of years later during Mississippian time, the likely canoe travel routes on the north part of the Florida peninsula were still being used. There were some minor connections inland, along the southwest, and perhaps completely around the peninsula to the east coast (Figure 11).

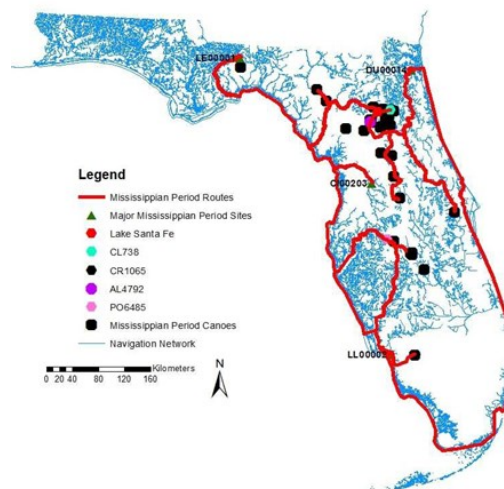


Figure 11: Locations of Mississippian age canoes and time coincident archaeological sites, with least cost routes of water travel. On the north they also go through Santa Fe Lake.

Canoe sites and especially concentrations at portage locations such as Lake Santa Fe, aggregation centers, and the routes between these places represent important aspects of the pre-Columbian physical and social landscape. People used canoe routes to connect to places of diverse social interaction, where they were introduced to new ideas, technology, and other aspects of material culture. Analysis of the locations of previously recorded canoes, their calibrated age-dates, and contemporaneous sites interpreted to be gathering places revealed that the development of canoes and transportation networks are directly related to the rise of complex societies and the networks of interaction and exchange in which these societies participated (Duggins 2019).

Through the calculation of canoe routes that connected canoe locations with important centers of population aggregation it became clear that some canoe routes persisted for millennia, themselves becoming persistent places on the landscape which facilitated their own set of social relationships and interaction. Moreover, familiarity with the earliest canoe routes that linked the Atlantic and Gulf of Mexico watersheds may have been responsible for the diffusion of ceramic technology to Florida's Gulf coast from the Atlantic, and most certainly served as a transit corridor for the movement of people, goods, and ideas to Archaic-age Poverty Point in Louisiana and other North American interior sites of importance. When archaeological canoes are viewed through a holistic viewpoint rooted in anthropological concepts of place and landscape, they become dynamic entities that represent more than just entries in a database or objects in a museum.

Conclusions

Canoes, when identified by GPR and studied spatially can be used to integrate other sites and an analysis of space over time to show important aspects of the pre-Columbian physical and social landscape. People used canoe routes to connect to places of diverse social interaction, where they were introduced to new ideas, technology, and other aspects of material culture. Analysis of the locations of previously recorded canoes, their calibrated age-dates, and contemporaneous sites interpreted to be gathering places revealed that the development of canoes are directly related to the rise of complex societies and the networks of interaction and exchange in which these societies participated.

Through the calculation of canoe routes that connected canoe locations with important centers of population aggregation it became clear that some canoe routes persisted for millennia, themselves becoming persistent places on the landscape which facilitated their own set of social relationships and interaction. Moreover, familiarity with the earliest canoe routes that linked the Atlantic and Gulf of Mexico watersheds may have been responsible for the diffusion of ceramic technology from coast to coast.

References

Duggins, Julie, 2019, Canoe Caching at Transit Points: Inferring Florida's Ancient Navigation Routes Using Archaeology and Ethnohistory. In *Iconography and Wetsite Archaeology of Florida's Watery Realms*, edited by Wheeler, Ryan J., and Joanna Ostapkowicz. University of Florida Press, Gainesville.