PROCEEDINGS

OF THE

THIRTEENTH SYMPOSIUM

ON THE

NATURAL HISTORY OF THE BAHAMAS

Edited by
Jane Eva Baxter
and
Eric Stephen Cole

Conference Organizer
Thomas Rothfus

Gerace Research Centre
San Salvador Bahamas
2011

Cover photograph -- Amanda Rubasch and Anna Thomas of St. Olaf College

Printed at the Gerace Research Centre

ISBN 0-935909-93-3

ANALYSIS OF PREHISTORIC SETTLEMENT PATTERNS ON SAN SALVADOR, BAHAMAS, USING THE SAN SALVADOR ISLAND GIS DATABASE

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ABSTRACT

There are approximately 39 prehistoric archeological sites located on San Salvador Island, Bahamas. These prehistoric sites are settlements of the indigenous inhabitants of the island, the Lucayans. Data exist for both the archaeological sites and their surrounding resources, including site location, vegetation, geology, and proximity to fresh water, coastline, wetlands, and reefs, etc. Specific application of Geographic Information Systems (GIS) to Lucayan settlements on San Salvador had not been performed in a major way prior to the present research, but was proposed by Robinson and Davis (1999). GIS data analysis required the application of a computer program, ArcGIS 9.2. In ArcGIS, a prehistoric settlement pattern model was created, enabling rapid extraction of data critical to perform analyses of resources surrounding the archaeological sites. Resulting information, displayed in various forms, primarily maps, pie charts, and data tables, helped to identify past cultural patterns, trends in prehistoric resource use, and will enable the prediction of locations of sites yet to be discovered. This study answered various anthropological and archaeological questions pertaining to San Salvador, its pre-Columbian inhabitants, and the spatial distribution of their sites across the island landscape.

INTRODUCTION

Application of GIS to archaeological data has been used commonly since the widespread popularity of the desktop computer in the early-to-mid-1980s and early 1990s (Allen, Green and Zubrow 1990, Burrough 1986, Ebert and Kohler 1988, Hay 1982, Kohler and Parker 1986, Kvamme 1986, 1989, Parker 1985, 1986, Peregrin 1988, Zubrow 1987). GIS in archaeology can be used to map site locations, to understand the locations of sites in relationship to the landscape and other resources (e.g., fresh water, wetlands, reefs, etc.), and to help generate predictive settlement pattern models that can be used to hypothesize the locations of unknown sites based upon settlement preferences of known archaeological sites. Added to these phenomena is also the dimension of time: site settlement preferences may shift over time in response to climatic, social, and other variables (Drennan, ed. 2006, Kowalewski et al. 1989, Sanders, Parsons and Santley 1979). A map of the known 39 prehistoric sites on San Salvador, dating to the period ca. A.D. 650-1550 is shown in Blick (this volume, Figure 1). The present article will explore the settlement patterns of the 39 known prehistoric sites on San Salvador in relation to the island's geology, vegetation, hydrology, and other phenomena, taking into account such concepts as site catchment analysis (Vita-Finzi and Higgs 1970), the coastal orientation hypothesis (Wing and Reitz 1982), proximity to resources such as fresh water, coastline, wetlands, and reefs, paired settlements (Keegan 1992, 1999, Sullivan 1981), and what these patterns tell us about the nature of Lucayan settlement on San Salvador prior to the arrival of the Spanish in the Western Hemisphere in the late fifteenth century.

GENERAL FACTS ABOUT SAN SALVADOR LEARNED FROM GIS

Some general facts about San Salvador, derived from the San Salvador Island GIS Database (Robinson 2001, Robinson and Davis 1999/2005), include that the island is 154 sq km in total area (Walton, Bunch and Paulette 2006) and 94 sq km in land area (Hopkins 2007). Lakes and Ponds cover some 49 sq km, and Wetlands cover ca. 19 sq km in area. The total area taken up by Tidal Creek, in this case all of Pigeon Creek, is 6 sq km (definitions of land, wetland, geology, vegetation, and hydrology classification types may be found in Robinson 2001, Robinson and Davis 1999/2005). The length of the coastline of San Salvador is 68.28 linear kilometers. The dominant geological formation of San Salvador is the Undifferentiated Pleistocene formation (87.23 sq km). Although vegetation has changed dramatically since the arrival of Europeans (Smith 1982, 1993, Winter 1987), today the dominant vegetation type on the island is Blackland Coppice (56 sq km). Whereas in some regions, archaeological sites tend to be detected in, or in proximity to, areas of high agricultural productivity (e.g., Drennan, ed. 2006, Kowalewski et al. 1989, Sanders, Parsons and Santley 1979), soils on San Salvador are generally considered poor for agriculture (Robinson 2001). Furthermore, the detection of prehistoric archaeological sites appears not to be affected by land clearing as only about one-third of prehistoric sites are located in Agriculturally Disturbed Areas (i.e., sites do not tend to be found in areas that have already been cleared and thus made easily accessible to archaeologists).

As previously mentioned, the length of the coastline of San Salvador is 68.28 linear km. Of the 39 known prehistoric sites, 29 (74.4%) are classified as "coastal" sites (within 500 m of the coast), therefore it is clear that there is a distinct trend toward coastal orientation in the settlement pattern, a fact that has been previously recognized for the Bahamas and the Greater Caribbean (Keegan 1992, 1997, Wilson 1989, Wing and Reitz 1982). With 29 coastal sites, San Salvador has 1 site per ca. 2.35 km of linear coastline (recent findings on Green Cay [Blick et al. 2009] and inspection of the Hinchinbroke Rocks at the southeast corner of the island may change this figure in the future). Given the island's total area of 154 sq km, the average spacing between prehistoric archaeological sites is ca. 3.95 per sq km; if only land area is used (94 sq km), the average spacing between sites is ca. 2.41 sq km. Statistical analysis reveals that the average nearest neighbor distance between sites is 1.15 km. Using the buffer analysis function in ArcGIS 9.2 (2007), it was also recognized that prehistoric sites on San Salvador tend to occur in pairs or "paired settlements" (Keegan 1992, 1999, Sullivan 1981) (500 m buffer = 55.3% of sites; 750 m buffer = 68.4% of sites; 1000 m buffer = 86.8% of sites). Although these buffer distances are arbitrary, and some buffer distance over 1000 m would eventually result in 100% pairing of settlements, the 750 m buffer includes more than two-thirds of all sites on the island and would seem to be a reasonable cut-off point for the paired settlement buffer given the average nearest neighbor distance of 1.15 km. The significance of paired settlements will be discussed later in relation to Lucayan social organization. Figure 1 illustrates site settlement pairs on San Salvador at the 750 m distance buffer.

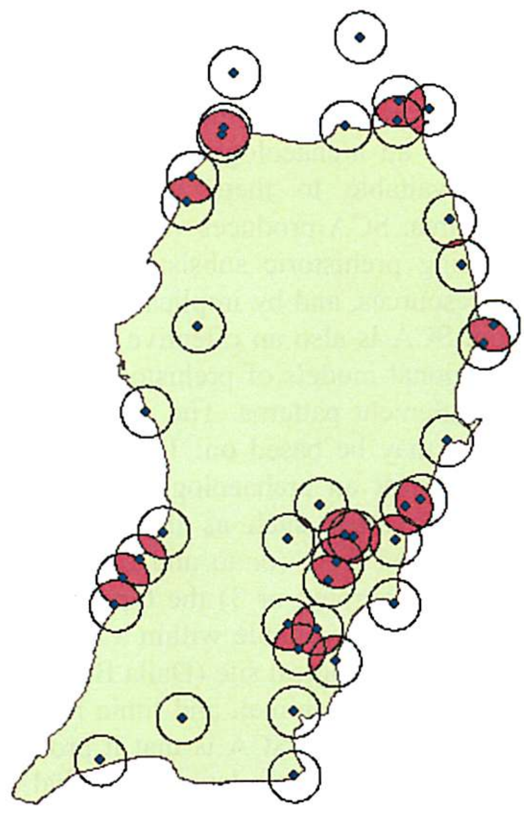

Figure 1. Site settlement pairs on San Salvador. Darker shading indicates settlement pairing (site catchment overlap) at the ≤ 750 m distance buffer. North is at top of figure.

SITE CATCHMENT ANALYSIS ON SAN SALVADOR

Site catchment analysis (SCA) involves the systematic study of an arbitrarily defined *catchment area* around a known archaeological site (or other point of interest). In this usage, a catchment area is a geographical extent of land from which a population derives its resources for survival. Catchment areas can be compared to check for patterning or regularity between archaeological sites. SCA is guided by ecological, anthropological, and geographical hypothesis testing and evaluation of patterns of prehistoric socioeconomic behavior (Williams 2004). SCA also involves examination by survey, excavation, maps, and graphs, of a contained area or areas to evaluate the availability of resources customarily exploited by the inhabitants of a settlement, typically a prehistoric one. Developed by Eric Higgs and Claudio Vita-Finzi during the late 1960s (Vita-Finzi and Higgs 1970), the purpose of SCA was to attempt to reconstruct the economy of the inhabitants of an archaeological site based upon resources available to them within a certain catchment area. SCA produces valuable information regarding prehistoric subsistence strategies, access to resources, and by implication, social organization. SCA is also an effective technique to develop regional models of prehistoric site selection and settlement patterns. The size of the catchment area may be based on: 1) the sources of material found at an archaeological site; 2) notional working areas such as the distance that could be traveled from (or to and from) the site during a day's journey; or 3) the type and abundance of resources available within a certain distance of an archaeological site (Dalla Bona 1994), such as water, plant, animal, and lithic resources, etc. The role of GIS in SCA is that it provides a means to integrate multiple layers of digital environmental and archaeological data into an effective tool for synthesizing regional archaeology and interpreting corresponding spatial patterning. GIS can quickly construct site catchment areas for arch-aeological sites and implement analyses of physical and biological attributes of catchment areas in correlation with data from archaeological sites. Standard SCA typically uses catchment areas of 500-1000 m, up to 2000 m, although there is no general rule of thumb, and the size of the site catchment area may vary due to geographical, environmental, and social phenomena.

PREHISTORIC SITE CATCHMENT ANALYSIS: GEOLOGY AND VEGETATION ON SAN SALVADOR

Analyzing the Geology layer of the San Salvador Island GIS Database (Robinson 2001, Robinson and Davis 1999/2005), we find that 30 of the 39, or 76.9%, of the known prehistoric archaeological sites are situated in geographical locations dominated by the presence of the Undifferentiated Pleistocene formation. Prehistoric sites on the leeward side of the island are more likely to have catchment areas that are predominantly composed of Undifferentiated Pleistocene deposits, while site catchments on the windward side of the island tend to be located in areas with more Unlithified Holocene deposits. Leeward site catchments are also more likely than windward sites to contain relatively larger patches of the Hanna Bay member (recent Holocene deposits). These differences are probably due to wind direction, dune building patterns, and the deposition of aeolian sediments during island formation processes. It is of interest to note that 23 of San Salvador's 39 prehistoric sites (59.0% of sites) are located on the windward, rather than the leeward, side of the island, perhaps due to the attraction of the resources of the tidal creek, Pigeon Creek, located on the southeast side of the island; or perhaps the Lucayans were attracted to the nutritional abundance provided by the nearby and plentiful coral reefs off the eastern coast of San Salvador. More will be said about access to reefs later in this paper.

Analysis of the Vegetation layer in the San Salvador Island GIS Database indicates that 51.3% (n=20) of the island's sites are located in areas that today are dominated by Blackland Coppice. Modern vegetation probably is not relevant to prehistoric settlement patterns on San Salvador since some 95-98% of the vegetation seen today is not the original vegetation that would have been found on the island in prehistoric or contact-era times (Smith 1982, 1993, Winter 1987). Only about one-third of the prehistoric archaeological sites that have been recorded to the present time are found in Agriculturally Disturbed Areas, indicating that there is no significant bias toward finding archaeological sites in areas that have already been cleared.

COASTAL ORIENTATION OF THE LUCAYANS ON SAN SALVADOR

One of the major trends noticed in Caribbean archaeology and prehistoric settlement patterns throughout the Greater Caribbean is the tendency toward settling near the coast (Keegan 1992, Newsom and Wing 2004, Wilson 1989, Wing and Reitz 1982). This is probably due to a number of factors including the principal of least effort, or as it is often referred to in anthropology, optimal foraging theory. Optimal foraging theory asserts that organisms, including humans, forage (or hunt and gather food and resources) in such a way as to maximize their energy intake per unit of time and therefore harvest and consume food containing the greatest quantity of calories while expending the least amount of time and energy in the foraging process (Charnov 1976, Emlen, 1966, Winterhalder 1981). Analysis and review of prehistoric Caribbean and Lucayan fishing techniques and species harvested clearly indicate the exploitation of near shore species for food.

It therefore comes as no surprise that San Salvador is also characterized by a settlement pattern of coastal orientation. In the 68.28 linear km of San Salvador's shoreline, one may find, on average, one prehistoric archaeological site about every 2.35 km along the coast (29 "coastal" sites per 68.28 linear km of shoreline). Using the 500 m buffer distance in ArcGIS 9.2 (2007), 29 of 39 sites (74.4% of sites) are located within 500 m of the coastline; increasing the buffer distance to 1000 m, some 32 of 39 sites (82.1%) are located within a kilometer of the coastline. Increasing the buffer to 1500 m only adds one additional site, so 33 of 39 sites (84.6%) are found within 1500 m of the coastline.

In previous studies by Blick (2006, 2007) on vertebrate faunal remains from the Minnis-Ward site (SS-3) excavations of 2004, it was found that of the archaeological fauna identified, 67% were coral reef taxa, 17% were shallow/inshore water taxa, and only 11% were pelagic (open ocean) taxa. That is, based upon the 2004 excavation at Minnis-Ward, 84% of the identified vertebrate specimens were near shore taxa taken at the shoreline, including animals such as sea turtle, jack, porgy, grouper, snapper, and parrotfish. According to Wing and Reitz (1982), "The first of these patterns [of resource utilization] is *utilization of the nearest resources*" (emphasis added). Even though he was referring to historic times, Albury's (1975:185) statement was probably just as true for the Lucayans: "From the bounteous sea, close-by everywhere, a boy in a few hours could gather sufficient nutritious protein to feed his household for a week."

PROXIMITY TO RESOURCES ON PREHISTORIC SAN SALVADOR

Of the 39 known prehistoric archaeological sites on San Salvador, 21 sites (53.8%) are located within 1000 m of a coral reef (according to the San Salvador Island GIS Database). This relatively low percentage is probably deceiving because offshore coral reefs appear to be generally closer to the coastline on the eastern, northern, and southern sides of the island than on the western side of the island (Figure 2). Coral reef systems along the Fernandez Bay to Long Bay coast appear to be further than 1000 m from the prehistoric archaeological sites as compared to sites on the eastern side of the island. Still, a short canoe voyage would place the western coral reefs within easy reach of the inhabitants living in the Fernandez Bay/Long Bay area. Coral reefs are known to be the most productive ecosystem in the ocean, and so would have been a primary source of food for the Lucayans of San Salvador. The Lucayan coastal orientation and proximity to coral reefs indicate that access to food sources (the ocean, the reefs) was a major determinant of Lucayan settlement pattern on San Salvador.

Proximity to the tidal creek, Pigeon Creek, also seems to have been a fairly significant factor in the settlement pattern of prehistoric San Salvador as 13 of the island's 39 sites (33.3%) are located within 1000 m of the tidal creek. The southeast quadrant of the island appears to be more heavily occupied compared to other portions of the island, thus access to the resources of Pigeon Creek is a likely explanation for this site distribution. It should also be noted that the Pigeon Creek site is located in one of the most diverse environments of the island (see discussion below). There is also the possibility that people may have been attracted to the southeast quadrant of the island due to the presence of the large Pigeon Creek site located at the head of the tidal creek. The Pigeon Creek site has long been considered the largest site on the island and may have been the village of a big man or chief whose influence and access to exotic trade goods may have attracted followers (Berman in press, Keegan 1997, Rose 1987).

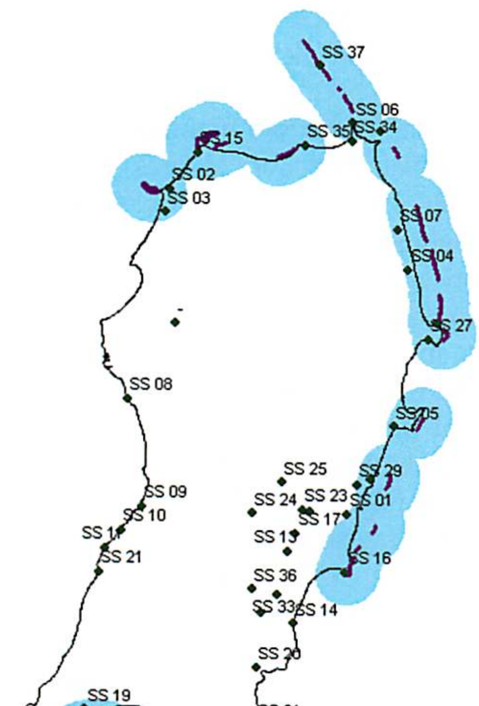

Figure 2. Prehistoric sites on San Salvador in relation to the coral reefs of the island. Darker shading indicates coral reefs with a 1000 m distance buffer. North is at top of figure.

Access to Wetlands also seems to have been a significant factor in the Lucayan settlement pattern on San Salvador as 27 of the 39 (69.2%) known prehistoric sites are located within only 500 m of Wetlands (as defined by the San Salvador Island GIS Database). Of the wetland types on San Salvador, perhaps the most important for human survival on the island would be the Freshwater Wetlands. Yet of the 39 prehistoric sites on San Salvador, only four (10.3%) are located within 500 m of Freshwater Wetlands. This would seem to suggest that access to fresh water may not have been a critical determinant in the Lucayan settlement pattern. This may be due to several factors: 1) there may have been more abundant water in the past and a more lush vegetation than is present today (Davis 2008, personal communication, Winter 1987); 2) travel distance to access fresh water may not have been a factor; 3) there may have been alternative means of collecting fresh water that were more efficient than seeking out Freshwater Wetlands (e.g., rainwater catchment from rooftops and/or in pots, access to sinkholes which may fill with water during periods of heavy rain, the presence of fresh water lenses on saline lakes, etc.); 4) fresh water may have been held in place in low lying areas by impervious paleosols making fresh water seasonally abundant and more available than it seems today (Davis 2008, Gentry 2004, Gentry and Davis 2003, 2006, Sadler 2000). While modern fresh water wells would seem to be an irrelevant factor to the Lucayans of 500-1400 years ago, it is notable that 22 of 39 (56.4%) known prehistoric sites are located within 1000 m of a modern fresh water well; nearly 70% of prehistoric sites were found to be within a 1500 m radius of a modern fresh water well. This may reflect the fact that where water exists today, it is very likely that it existed in the same place hundreds or thousands of years ago (disregarding modern deep well drilling technology).

Caves may have also been an important phenomenon to the Lucayans: caves are wet, cool, dark, and may have provided shelter during times of severe weather such as hurricanes, and caves may have provided refuge or hiding places to avoid the Spanish slave raiders in the early sixteenth century. Of the 39 known prehistoric archaeological sites on San Salvador, 22 (56.4%) are located within 1500 m of a known cave. Among the related Taíno people, caves were used as shrines for the worship of *zemis* (spirits) and caves were also used for burial purposes (Lovén 1935, Rouse 1992). Bodies, or bones, were sometimes placed on ledges or shelves within the recesses of caves (Lovén 1935). There is evidence of Lucayan cave burial on San Salvador at Major's Cave (Winter et al. 1997). It is clear that caves played an important role in Taíno and Lucayan culture and religion, including creation myths that some Taíno cultures emerged from caves; the Taíno believed that dark places were taboo and the domain of the dead, thus the frequency of bat symbolism in their pottery and art (Stevens-Arroyo 2006).

As a crude measure of the "diversity" of the geography and resources in the catchment areas of the 39 prehistoric archaeological sites, we analyzed proximity to coastline, reefs, tidal creeks, lakes, and caves. Sites were then given a rough score (d=1-5) on the diversity of resources available to them in their site catchment areas. Ranking sites in relation to these resources within a 1500 m catchment area, we find that the larger known village sites on the island tend to rank highly, including the Pigeon Creek site (d=5), Minnis-Ward site (d=4), and North Storr's Lake site (d=4). Major's Cave ranks as the site with the least geographical diversity (d=1) within a 1500 m radius, perhaps indicating its special use as a burial cave rather than a settlement. Several smaller, relatively unstudied sites rank highly on this scale and may be worth archaeological investigation in the future, including: the Two Pond site (d=5); Kerr Mount Sinkholes (d=5); Mann Head Cay (d=4); Sandy Hook site (d=4); the Davis site (d=4); and the East Snow Bay site (d=4). The Long Bay site (d=2) and the Three Dog site (d=3) rank surprisingly low on this scale. We already know that almost 70% of prehistoric sites on San Salvador were located within just 500 m of Wetlands, but there are many different variables in the San Salvador Island GIS Database that could be used to measure diversity within site catchment areas. Proximity to more specific, smaller-scale resources, such as clay deposits used for ceramic manufacture (Berman, personal communication), will have to await more detailed data collection for inclusion in the San Salvador Island GIS database.

It has already been noted that prehistoric archaeological sites on San Salvador tend to occur in pairs or "paired settlements." The average nearest neighbor distance between sites is 1.15 km and more than two-thirds (68.4%) of sites pair at the 750 m buffer distance. This percentage of paired sites increases to 86.8% when the buffer distance is extended to 1000 m. This settlement "pairing may be attributed to social and economic factors" (Keegan 1992:83) and has been observed among other prehistoric and ethnographically studied cultures in the world (Amazon, Greater Antilles, Turks and Caicos, Trobriand Islands) (Keegan 1992).

THE SIGNIFICANCE OF PAIRED SETTLEMENTS ON SAN SALVADOR

According to Keegan's (1992) analysis of Lucayan settlement patterns on several of the Bahamian islands, clustering of sites can be indicated based upon the frequency of settlement pairs, or sites that occur within each other's catchment area (Keegan 1992:83). On San Salvador, 86.8% of prehistoric archaeological sites are less than 1000 m from another site. This percentage approximates Keegan's (1992:83) figure of 90% of all sites being within 1500 m of another site in his Bahamian island study, and suggests that settlements are not randomly or regularly spaced, but that the overall settlement pattern on San Salvador tends toward clustering. At the 1500 m distance buffer, 100% of sites on San Salvador fall within the catchment area of another site.

Keegan hypothesizes that these paired settlements represent settlement clusters similar to those found in the Trobriand Islands of the Pacific and "may reflect allied matrilineal moieties" (Keegan 1992:84). Moieties are divisions of societies into halves on the basis of kinship and are commonly observed among tropical forest dwelling peoples of the Amazon (Keegan 1992), such as the Mundurucú red and white moieties (Murphy and Murphy 1985). Moiety membership requires exogamy, the custom that one must marry outside of his or her own group. Settlement pairing such as is seen on San Salvador has been observed on Middle Caicos and at other settlements in the Greater Antilles and the Amazon Basin (Keegan 1992). The evidence is convincing, as recorded by the Spanish chroniclers and as reconstructed by Keegan (Keegan 1992, Keegan and Maclachlan 1989), that Taíno, and by extension Lucayan, society was based on matrilineal descent: "In horticultural economies where land tends to be abundant in relation to seasonal labor demands, matrilineal descent provides a method for establishing rights of access to land through lineage [moiety] membership and also serves to foster cooperation among the members of a group" (Keegan 1992:103). The practice of raiding and captive taking, as noted by Columbus on his stopover on San Salvador (Dunn and Kelley 1989), and the necessity to keep related males and their in-laws nearby, would thus result in paired settlements in which males could cooperate in warfare and still be within close proximity to participate in lineage or moiety affairs and ceremonies (Keegan 1992). Chagnon (1983) notes that a man's most important ally among the Yanomamö of Venezuela/Brazil is his brother-in-law, especially when it comes to forming raiding parties and engaging in revenge warfare.

The existence of settlement pairs may also be explained by village fissioning when villages reach a critical density of social relations, or a certain number of inhabitants (Chagnon 1975, Freedman 1984), or fissioning may be the result of some intra-village conflict that is solved by establishing a new community that still maintains kinship and economic ties to the original village. The fact of the matter is that Lucayan social organization is reflected in the pattern of settlement pairs. Keegan (1992, 1999, Keegan and Maclachlan 1989) and Sullivan (1981) have argued that, "The community plan and distribution of artifacts reflects the division of the community into [different] lineages" (Keegan 1999), or moieties. Keegan (1992) has argued that paired settlements arise when one lineage or moiety becomes dominant (socially or economically). This division may be reflected in the nature of the artifacts found at the two settlements: "The quality of the artifacts found on the two plazas varies in ways that reflect the hierarchical organization of Taíno society.... Artifacts from the south side are superior in quality to those on the north" (Keegan 1999). At the site of MC-6, Middle Caicos, Grand Turk Island, Keegan reports a "two-plaza community plan that is typical of Classic Taíno settlements in the Greater Antilles.... The midden deposits (which are trash accumulations) are arranged around the two plazas" (Keegan 1999). Keegan's hypothesis that "a similar distribution of site types should obtain" (1992:84) on San Salvador, especially the paired settlement phenomenon, appears to be validated by the settlement pattern analysis performed using the San Salvador Island GIS Database.

One question that arises from this appearance of paired settlements on San Salvador is the question of contemporaneity. That is, which, and how many, of the prehistoric archaeological sites were inhabited simultaneously? Radiometric dates exist for only about nine of the 39 sites on San Salvador, but recent reviews of radiocarbon dates suggest that these sites were mostly occupied during the period ca. A.D. 850-1550 (Berman in press, Blick this volume). There appear to be earlier components dating to ca. A.D. 600-850 at Pigeon Creek (Berman in press), Three Dog (Berman and Gnivecki 1995), North Storr's Lake, and perhaps at Minnis-Ward where artifacts were recently found all the way down to bedrock (Blick et al. 2009). This evidence suggests early widespread occupation of the island with major villages in all four quadrants having early components. Radiometric dates suggest that most of the sites are contemporaneous from A.D. 850-1550.

A PREDICTIVE SETTLEMENT PATTERN MODEL FOR SAN SALVADOR

The Lucayan settlement pattern on San Salvador is highly coastally oriented (82% of sites occur within 1000 m of the coast) and 59.0% of sites are located on the windward side of the island. There is one "coastal" site (≤500 m from the coast) per every 2.35 km of linear coastline, and the average nearest neighbor distance between sites is 1.15 km. These latter two observations might suggest that there is a "regular" spatial patterning of sites across the landscape on San Salvador, but statistical analysis supports the idea that settlements are clustered on San Salvador. 76.9% of archaeological sites are located in areas dominated by the Undifferentiated Pleistocene formation. Only one-third of known prehistoric archaeological sites occur in Agriculturally Disturbed Areas. Regarding access to various resources, 53.8% of sites occur within 1000 m of a coral reef (Figure 2) and one-third of all sites are located within 1000 m of the tidal creek, Pigeon Creek. 69.2% of sites are located within just 500 m of Wetlands, yet only 10.3% of sites are located within 500 m of Freshwater Wetlands. This latter observation suggests that access to fresh water may not have been a strong determining factor for settlement, but rather access to the coast and perhaps the tidal creek were more important considerations. 56.4% of sites are located within 1000 m of a modern freshwater well; this number increases to about 70% of sites when the distance is expanded to 1500 m. Modern freshwater wells would clearly not have been a determining factor in Lucayan settlement, but where there is freshwater today it is also likely that there was fresh water in the pre-Columbian past. 56.4% of the prehistoric archaeological sites were located within 1500 m of a cave, perhaps reflecting the need for caves as places of zemi worship and human interment. Known major villages such as the Pigeon Creek site, the Minnis-Ward site, and the North Storr's Lake site have 1500 m radius catchment areas that are more diverse in regard to environmental and geographical resources (coastline, reefs, the tidal creek, lakes, and caves). Some of the lesser known sites also rank highly on this rough scale of diversity and may be worthy of future archaeological investigation to see how they compare with the known larger sites mentioned above. Settlement pairing on San Salvador appears to be significant as 68.4% of sites pair at the 750 m distance buffer and 86.8% of sites pair at the 1000 m distance buffer. Keegan (1992) argues that this degree of overlap in site catchment areas is indicative of a clustered settlement pattern based around the concept of moiety divisions or twin villages, one having fissioned from the other, but still maintaining economic and kinship ties with one another. At the 1500 m distance buffer it is readily observable that settlements on San Salvador are indeed clustered, and this interpretation is supported by statistical data analysis. K-means cluster analysis performed using SYSTAT 7.0 allows one to choose the number of clusters one wishes to inspect. Based on visual inspection of Figure 3, it is clear that settlements on San Salvador cluster into four main groups. K-means cluster analysis using the Euclidean distance metric and the nearest neighbor method on the site's UTM coordinates, determined convincingly that settlements on San Salvador are indeed clustered into four main groups (n=39, F-Ratio=31.274, p=.000). In fact, this tendency toward settlement clustering is obvious in Figure 3.

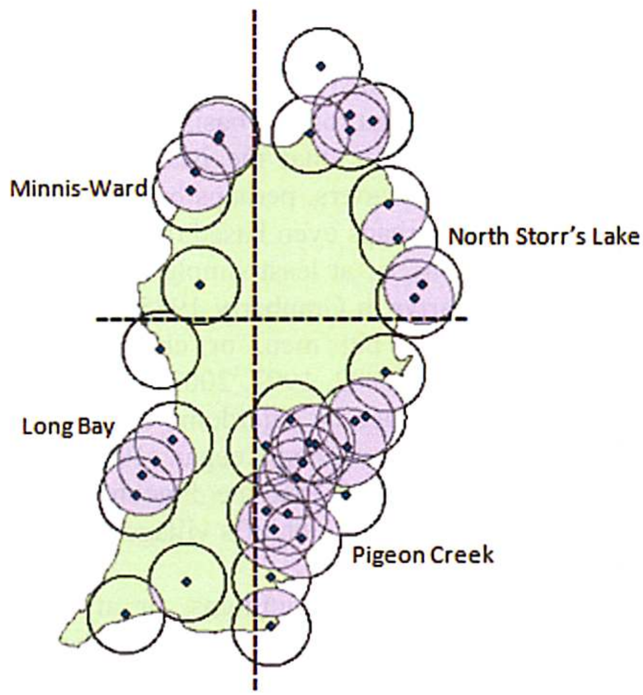

Figure 3. Prehistoric settlement clustering on San Salvador. Darker shading indicates settlement clustering at the ≤ 1500 m distance buffer. Note that settlements tend to cluster in the four quadrants of the island. North is at top of figure.

CONCLUDING THOUGHTS: THE NATURE OF LUCAYAN SETTLEMENT ON SAN SALVADOR

Now that it has been demonstrated that there are indeed settlement clusters on San Salvador, just what might this clustering tell us about Lucayan settlement and social organization on the island? First of all, note that San Salvador may be divided into four quadrants, NE, SE, SW, and NW (Figure 3). Many cultures around the world considered their territory or their cosmos to be divided up into four quadrants: the Aztecs of central Mexico conceived of their universe as divided into four quarters, each symbolized by a different god and color; the Inca of the Andean Highlands referred to their territory as Tawantinsuyu ("the Land of the Four Quarters"); the ancient Chinese referred to their empire as the Pivot of the Four Quarters, and this concept of quarters influenced their creation myths, nature of the emperor, and city planning. The number four was also significant to the Taínos who believed in a complex multi-layered cosmos of sky, earth, water, and underworld (Stevens-Arroyo 2006).

We propose that, on the basis of site clustering on San Salvador, that the island was divided up into four quarters, perhaps based on big man societies or perhaps even based on the emergence of chiefdoms, or at least simple chiefdoms or "kinglets" (Martyr in Granberry 1955:104) governed by "kings," big men, or chiefs. Rose (1987) and Keegan (1992, 1997, 2007) have long argued for the presence of chiefdoms in the Bahamas, Turks and Caicos, and Keegan (1992:110, 2007:81) even suggested that the Pigeon Creek site on San Salvador was a chief's village (see also Berman, in press).

Our scenario for chiefdoms, or at least simple chiefdoms, on San Salvador is this: the island was divided up into four settlement clusters in the NE, SE, SW, and NW quadrants of the island. Each settlement cluster had its own primary village, which may have been the seat of a big man, chief, or district chief (as opposed to the paramount chief of the Bahamas reported to have lived on Acklins Island, Keegan 1992). K-means cluster analysis indicates significant settlement clustering on San Salvador (n=39, F-Ratio=31.274, p=.000), divided into four clusters. K-means cluster analysis places Pigeon Creek and its neighboring settlements into Cluster 1, Minnis-Ward and the Palmetto Grove sites in Cluster 2, the Long Bay and Three Dog sites in Cluster 3, and the North Storr's Lake site in Cluster 4. Each settlement cluster also had its own burial cave or caves in its own quadrant of the island. This is also borne out by K-means cluster analysis which places caves in all clusters, except Lighthouse Cave in the NE which is not a recorded archaeological site. Each settlement cluster had its own offshore coral reefs for fishing (Figure 2) that may have been considered protected territories under the control of the local big man or chief, such as has been reported for many Pacific Island cultures (Luna 2003). Furthermore, each settlement cluster participated in trade and exchange with each other and with larger polities in Cuba, Hispaniola, and even Mesoamerica.

Moving clockwise around the island, the NE quadrant was centered on the large village at the North Storr's Lake site. The North Storr's Lake site appears to be at least 300 m in length N-S and ca. 150 m wide E-W. Portions of the North Storr's Lake site were located on high dunes ca. 20 m+ in elevation, providing a commanding view of the coastline from East Beach to Greene Harbour. This polity at North Storr's Lake would have had its burial cave in the NE sector of the island at Lighthouse Cave or some other nearby cave in the area. The North Storr's Lake polity had access to its own coral reef systems from at least Mann Head Cay southeastward to Greene Harbour. Evidence for several households along the primary dune ridge in association with varied food types and a sea turtle butchery locale (Blick, Zardus and Dvoracek, this volume, Blick, Creighton and Murphy 2006, Shaklee Fry and Delvaux 2007) may suggest big man or chiefly involvement in the partitioning of captured turtles and turtle products as reported for many Pacific Island cultures. Finally, the abundance of exotic trade goods at North Storr's Lake suggests that the big man or chief there was engaged in the pan-Caribbean trade and "cosmovision" (Berman, in press, Stevens-Arroyo 2006) that other local chiefs were involved in. Some of the exotic goods recovered from North Storr's Lake include: greenstone; quartz, aragonite, calcite, trade pottery, copper fragments, chert microliths for food processing, and shell beads and evidence for shell bead manufacturing (Berman in press, Blick, Creighton and Murphy 2006, Shaklee, Fry and Delvaux 2007).

The SE quadrant of the island was centered on what appears to be the island's largest village at ca. 8-10 ha, the Pigeon Creek site. The Pigeon Creek polity would have had a number of burial caves to choose from in the immediate area including Black Pond Cave, Farquharson's Cave, the Kerr Mount Sinkholes, and Stout Lake Cave. The Pigeon Creek polity would have had access to its own system of coral reefs offshore from about Dim Bay to Snow Bay and the Hinchinbroke Rocks. Evidence for numerous households along both Dune 2 and Dune 1 (which appear to be separate early and late occupations, respectively) (Berman in press), and the size of the site, certainly suggest a large village of perhaps some 80-150 people. The abundance of exotic, non-local goods from Pigeon Creek includes: greenstone or jadeite (sourced to Guatemala), highly polished celts, a black basalt petaloid ax, diorite beads, a polished stone ball, a small polished pestle made from metamorphic stone, and aragonite and calcite cone-shaped pestles; evidence for local production of shell beads has also been found at Pigeon Creek.

The SW quadrant of the island was home to two important sites that appear to have been separated by a fairly lengthy time span, the Three Dog site and the Long Bay site. The SW quadrant could have had its burial caves at Storr's Cave, Drip Cave, or other recesses along the escarpment running from approximately Grotto Beach to Sandy Point. The Long Bay polity had access to its own system of coral reefs to the south (French Bay) and west of the island (Snapshot, Telephone Pole, etc.). The earlier Three Dog site contained early Cuban pottery, chert microliths for food processing, a polished gabbro stone artifact, a quartzite sandstone artifact, and evidence for households, activity areas, and shell bead manufacturing (Berman in press, Gnivecki 2006). The later Long Bay site is notable for its Spanish trade artifacts (glass beads, pottery, metal D-rings and trade buckles, and a Henry IV *blanca* coin dating to ca. 1471-1474), and chert microliths for food processing. The Long Bay site appears to be the leading candidate for the Columbus landfall in October 1492.

Finally, the NW quadrant of the island is probably best known for the Palmetto Grove site (a smallish ca. 100 x 100 m circular site as described by Hoffman 1967, 1970), the type site for Palmetto ware pottery. But the major village in the NW settlement cluster appears to have been the Minnis-Ward site which is estimated to have contained some 15-18 houses (Blick 2004). There is at least one known burial cave in the NW quadrant of San Salvador, and that is Major's Cave, discussed previously (Winter et al. 1997). The Minnis-Ward polity near the northwestern corner of the island would have had access to its own system of coral reefs, notably off Barker's Point and Polaris Point/Rocky Point down toward Bonefish Bay. Exotic goods at the Palmetto Grove site include diorite beads, igneous rock objects, a polished gabbro celt, and a strontianite cone-shaped pestle that retained powdered red pigment (Berman in press, Hoffman 1967, 1970). Exotic goods from the Minnis-Ward site include cylindrical diorite and barrel-shaped beads, a small amount of non-local trade pottery, a crystal object, a fragment of a siltstone/sandstone palette, chert microliths for food processing, evidence for local shell bead manufacturing, and what is likely a polished serpentine *cohoba* (*Anadenanthera peregrina*) snuff grinding pestle (Blick 2004, Blick et al. 2009, Keegan, personal communication). The grinding pestle will be tested for chemical residues in the near future at the University of Georgia's Center for Applied Isotope Studies. The density of artifacts recovered in May 2009 by Blick's team indicates that the artifact density at Minnis-Ward (which reached almost 15,000 artifacts per m^3) is some 8x higher than that at Palmetto Grove, suggesting that Minnis-Ward was much more densely occupied than Palmetto Grove.

When examined in this fashion, San Salvador appears to be an island that was characterized by four relatively equivalent polities governed by, or influenced by, a big man or chief similar to those found on other islands in the Greater Caribbean and Pacific. While the Pigeon Creek site may have been the largest site on the island in size with some one-third of the island's sites in its proximity, it must be recognized that the exotic artifacts found at Pigeon Creek are similar in nature to those found at North Storr's Lake, Minnis-Ward, and Three Dog or Long Bay. One of the defining features of chiefdoms is the emergence of unequal access to goods that support life and generate influence and power. The widespread nature of shell bead production, at the very least, and the similarities in the nature of exotic trade goods found in all four major polities of San Salvador, cause us to think that the Lucayans of San Salvador were organized along the lines of a simple chiefdom rather than a complex chiefdom. The presence of a "king" or paramount chief on Acklins Island suggests a chiefdom structure for Lucayan society, with many smaller regional polities under the control of a paramount chief. Additional excavations of household remains in search of status and wealth differences between households (e.g., Blick 2004) may be the key to answer the question of the nature of social complexity among the Lucayans of the Bahamas. The model of San Salvador as being singularly dominated by the Pigeon Creek site (e.g., Craton and Saunders 1992, Keegan 1992, 1997, 2007, Pickering 1997, Rose 1987) must now be re-evaluated in light of this new evidence and this new interpretation of Lucayan settlement and social organization made possible by examining San Salvador's prehistoric settlement pattern using the San Salvador Island GIS Database.

ACKNOWLEDGMENTS

We would like to thank Dr. Donald T. Gerace, Chief Executive Officer, and Dr. Tom Rothfus, Executive Director of the Gerace Research Center, San Salvador, Bahamas, for their logistical support for this research over the last few years. Georgia College & State University (GCSU) students Hope Hopkins, Kenny Bunch, Jeremy Paulette, Jamie Walton, and P. Wyatt all contributed to this research project which was finally presented as Hopkins's Senior Capstone Project (senior thesis). Hope Hopkins performed the tedious work of the GIS analysis using ArcGIS 9.2 under the supervision of Drs. Blick and Oetter. Dr. Doug Oetter acted as the Geography student adviser and GIS technical adviser for this research. Jeffrey Blick is the primary and corresponding author for this article (jeff.blick@gcsu.edu) – Hopkins did all the hard work! Special thanks to Mary Jane Berman for a pre-publication peek at her book chapter on the aesthetic brilliance of the Lucayans. Many thanks also to Perry Gnivecki who endured my explanation of the quadripartite division of San Salvador one hot afternoon in the Archaeology Lab. Georgia College & State University libraries, computer labs, and departments of Biology (Environmental Sciences), History & Geography, and Government & Sociology, supported this research. Thanks to Dr. Larry Davis, University of New Haven, and Matthew Robinson, for access to, and assembling, the San Salvador Island GIS Database without which this research would not have been possible.

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