ANCIENT HUMAN BEHAVIORAL ECOLOGY AND COLONIZATION

IN GRENADA, WEST INDIES

A Dissertation in

Anthropology

by

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ABSTRACT

The pre-Columbian colonization of the Caribbean is traditionally described as a series of migrations from coastal South America moving northward, island to island, as “stepping-stones.” As the southernmost island in the Antilles archipelago, just 90 miles off Venezuela, the island of Grenada is assumed to be the crucial first “step” in these migrations. However, too little archaeological data was available to substantiate this claim.

This dissertation project was designed to fill the gap. Using the Ideal Free Distribution (IFD), a heuristic from Human Behavioral Ecology, a predictive model was built to test areas of high-probability for early settlement on Grenada via an island-wide “radiocarbon survey” that collected artifactual, soil, and radiocarbon samples. Dated samples were refined via Bayesian methods and compared to ceramic evidence to place each site within an island-wide settlement chronology. Modern environmental data was then used to determine suitability rankings and common characteristics of settlement decisions.

At present, the results confirm site locations on Grenada followed a pattern consistent with the IFD, which not only allows prediction of previously undiscovered sites but also infers subsistence practices, ecological impacts, and certain cultural values. Grenada’s settlement chronology begins with an early, Archaic Age fisher-forager presence possibly as early as 3-4000 BC, in line with the “stepping-stone” hypothesis. However, Ceramic Age settlements (which appear in Puerto Rico and the northern Lesser Antilles by 500 BC) were not established until hundreds of years later than the northernmost islands, despite their origins in South America. This corroborates an emerging hypothesis that the southern Caribbean was largely skipped by the earliest waves
of Ceramic peoples, perhaps because the social milieu and domesticated landscapes of the northern islands were more attractive.

Grenada's peak, pre-Columbian population occurred during a time of heightened climatic unpredictability (AD 750-900), with dramatic changes in material culture (including the appearance of rock art and new ceramic styles) that mimic similar occurrences in lowland South America. Using Resilience Theory as a guide, this research suggests the influx was likely the result of continued immigration from the mainland, probably the Guianas region (comprising modern Guyana, Suriname, French Guiana, and bordering regions of Venezuela and Brazil). This may also have been the route taken by later Cayo potters (“Island Caribs”) just prior to Spanish Contact.

When the French finally settled Grenada in 1649, they reported two distinct indigenous groups—“Caraïbe” and “Galibis.” The Caraïbe were living in villages that had been continuously occupied since the earliest ceramic groups (AD 200-300), and it is argued that they were still making Suazan Troumassoid pottery. The Galibis, on the other hand, were living in sites that align with the arrival of Cayo pottery elsewhere, ~AD 1250. These sites indeed contain Cayo ceramic types.

Ultimately, this dissertation lays the baseline for more intensive studies. Now that we know where 87 of the sites are, their general character, and their general chronological placement, more targeted investigations driven by more specific types of questions can be researched.
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Preface: An Article Dissertation

Dissertations in Anthropology are traditionally expansive tomes representing half a decade or more of focused, comprehensive study. It is not uncommon to see archaeological dissertations just 20 years ago reaching over 500 pages, with huge appendices containing meticulously collated raw data. I never imagined mine would be any different. Alas, jobs and money in academia are as scarce as ever, and the university has become more and more corporatized. The need for quantifiable performance measurements has made first-author, top-ranked journal articles the gold standard.

In such an economy, it makes no sense to write a book when you need articles. Thankfully, my doctoral committee was in full agreement. This thesis is therefore organized as stand-alone articles ready to be submitted to peer-reviewed journals. As such, the chapters could be read in any order, and there is some repetition between them, given their common background and origin. The Introduction below is less an in-depth literature review than a frame for the larger study. The Appendices offer some of the raw data from the project, but far less than what I would have liked. More details on specific sites can be found in my report from last year (Hanna 2017), and if all goes well, look for a complementary tome in about 20-30 years.
ACKNOWLEDGEMENTS

Sometime in April 2011, I was walking with some other Peace Corps Volunteers in Grand Anse, Grenada, when we ran into one of our instructors from training. For whatever reason, I blurted out an idea that had recently crossed my mind: “We should talk about an archaeology camp this summer, maybe with some kids from River Road.” It was more a nervous conversation-maker than something I was adamant about, and there were many reasons for him to say no. But Mr. Jessamy just smiled and said, “Yes, we could do that. There is a site near there actually…” And as they say, the rest is history. That random encounter changed the course of my life, and the summer program that followed — and the student's impact on me at the St. John's River — are what brought me back to archaeology and ultimately to this dissertation on Grenada’s prehistory. None of this could have happened without Jessamy’s unwavering support from that moment in 2011 until this moment in 2018. In that time, we have done a lot of public outreach and written an infinite number of proposals. He introduced me to the island’s archaeology, to officials in the Ministry, and to a promising youth group (MYCEDO) in Mt. Rich. He drove me around the island and checked on me whenever he hadn’t seen me in a while (like when I had Zika!). For all this, and much more, I thank Mr. Michael Jessamy and look forward to many more years working together.

There are many other influences and anecdotes I wish space would allow. Major influences in my undergraduate years at Montclair State included Rhoda Halperin, Neeraj Vedwan, Senta German, Tom Amorosi, and Stan Walling. I had gone to Montclair, in part, because of Stan Walling's project in Belize, and — like Jessamy later — his encouragement and support grew into a true friendship and collaboration. I am fascinated by the Ancient
Maya as well, but it is Stan's passion for his site that brings me back every year. And it was on that project that I first saw the small, quotidian activities of common people, which profoundly changed my perspective of the past.

John Angus Martin also offered invaluable friendship and support during this work and was always quick to provide historical data and references. Sameem Rahaman generously offered me a room at his home in 2015 and various logistical support, as did Rolf Hoschtlealek throughout my stay. Invaluable assistance in the field was ably borne by Brendon Gulston, Kemron “Big Man” Mark, and Lorna Dale Charles. Brittany Mistretta spent many hours helping me in the field and the lab, as did John Swogger at the Montreuil excavation. I would never have gotten through any soil analysis were it not for the consistent help of Isabelle Wadai. I also thank Devon Mark and Dolton Charles for permission to survey their lands, and Kemron Daniels and Oscar Andall for their guidance reconnoitering the mosaic of properties in the Pearls area. The Maurice Bishop Airport Authority facilitated access to sites within and around the airport security perimeter. Permanent Secretaries Aaron Francois and Kevin Andall granted me research permission from the Government of Grenada.

My parents, Jack and Joanne, have remained forever supportive of my atypical life trajectory, and, along with my brother, Steve, always willing to drive up from South Jersey to meet me at JFK. My dad’s love of history and insistence that family vacations involve a museum and/or Civil War battlefield (usually both) certainly influenced my career path. My mom’s love of teaching and scholarship also left its imprint, but so too her strong religious faith, which serves as a reminder of the many different lenses we must put on to understand the world. I thank my whole family for their support during my travels.
At Penn State, I was offered a quintessential research environment with independence to pursue my project and funding opportunities to keep it going. As I transitioned from a Mesoamericanist to a Caribbeanist, excellent advice and mentorship was provided by Ken Hirth, Lee Newsom, and Doug Kennett, and less formally by Jim Woods, George (PJ) Perry, Sarah McClure, and Brendan Culleton.

Finally, many, many thanks are due to my doctoral committee for selflessly supporting this work and listening to me talk endlessly about my findings. Whatever errors exist below are entirely my own, but my committee’s generosity and guidance cannot be overstated. Following an administrative caveat, Kristina Douglass graciously agreed to join at the last minute, managing to provide not only some good questions about the research but also a bit of zen when the pressure to finish and fear of the unknown were at their highest. My outside committee member, Peter Newman, supplied his characteristic enthusiasm from the start and was instrumental in developing effective sampling methods. Many thanks also to Bill Keegan for inviting me to his project in the Bahamas and offering copious feedback and discussion. Doug Bird also offered enthusiastic discussion, helping me sort through the data and stay focused on my core topics. Lee Newsom was instrumental from the project’s genesis and always delivered perceptive, constructive feedback that helped refine the ideas presented here. And finally to my advisor, Doug Kennett, who consistently gave me the benefit of the doubt, ensured my successful progression through the Anthropology program, and was there to guide me when I needed him most.

To these folks, and many left unnamed, I cannot thank you enough!
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To my friends and family in the US and Grenada, 
and to all those who strive to make the world a better place
CHAPTER 1
Introduction

The traditional model for the colonization of the Caribbean holds that the islands of the Antillean archipelago are a series of “stepping-stones” over which waves of pre-Columbian peoples migrated, settling each island consecutively northward. The three main water-gaps that separate the Antilles from the continents are between the Yucatan and Cuba (200 km), Florida and the Bahamas (100 km), and Tobago and Grenada (125 km) (Wilson 2007:4). Thus, once past the water gap to Grenada, another island is visible almost all the way through western Cuba.¹ The stepping-stone model was therefore a natural assumption.

But that is not what happened — at least, that’s not what the current evidence indicates. Early radiocarbon dates (e.g., Bullen and Bullen 1972; Rouse and Allaire 1978) began to cast some doubt, but it was not until the 1980s that researchers started seriously questioning whether most, if not all, of the Windward Islands (southern Lesser Antilles) had been bypassed by the initial groups emigrating from South America. Even more, it seemed some groups may not have even gone through Trinidad — instead cutting straight across the Caribbean Sea for Puerto Rico and the Leeward Islands (northern Lesser Antilles). Both the Archaic Age and Early Ceramic Age groups appear to have initially skipped the Windward Islands (see maps in Figure 1.1 and also Figure 2.1).²

While these challenges to the traditional model became more apparent, they were confounded by the dearth of research conducted in the southernmost islands compared to

¹ The Anegada Passage in the Leeward Islands is another ~100 to 150 km gap, where the closest connections are either the desolate island of Somero (Anguilla) and Anegada (BVI) or Saba and St. Croix (USVI).
² Unless otherwise noted, all images (maps, photographs, and figures) were produced by the author. Color versions are available online
those in the north. For instance, a recent tally of regional radiocarbon dates offers a rough proxy for research attention in the Caribbean: over 560 \(^{14}\)C dates were catalogued for Puerto Rico alone, while just 60 were listed for the entire southern Lesser Antilles (which comprise eight island states and hundreds of subsidiary islands — each with distinct prehistoric histories) (Fitzpatrick 2006; Rodriguez Ramos et al. 2010). The absence of something is not evidence in itself, especially when so little research has been conducted. Challenges to age-old paradigms thus appeared a bit premature. This dissertation fills one of the most glaring of those gaps in the Lesser Antilles — the first “step” in the migration.

The island of Grenada has long been assumed the first stopping point for indigenous migrations into the Caribbean archipelago from lowland South America. Previous estimates for the total number of pre-Columbian sites in Grenada have ranged from Bullen’s fourteen (1964; although he mentions 20) to the 65 listed in Harris (Harris 2001:7).

Following fieldwork and a salvaging project at the Grenada Museum that uncovered paperwork and artifacts from a number of previously unknown sites, the author systematically cataloged every site, producing a total of 87 sites currently documented, and counting (Hanna 2017).\(^3\) Before this project, the chronology, persistence, and size of only a handful of these were known.

Using a predictive model for areas of high probability for early settlement, the author conducted pedestrian survey, bucket auger sampling, and preliminary phosphate

\(^3\) Since the 2017 report (which cataloged 84 pre-Columbian sites), three additional sites have been added: 1) Bagadi Bay (G-38), reported by a former SGU medical student who collected Saladoid-type pottery during the construction of MBIA in 1978; 2) Grand Bay Beach (G-22, Archaic site) and Grand Bay (G-39, Ceramic site) were split, given their apparent differences in time period; and 3) the Union Petroglyph (P-28), listed in the 2017 report as “dubious”, was inventoried after visiting (still not 100% definite but it has been known since at least 1982).
analysis to provide estimations of site chronologies and general parameters for 19 settlements, with site visits made to an additional 30. While the predictive model has helped identify previously unknown sites, it was equally useful for prioritizing sampling locations amongst known ones. The idea was to investigate the earliest sites on the island and garner information about the cultural and environmental processes occurring during that time. Building a baseline chronology of prehistoric settlement is a pivotal first step to understanding the context of subsequent human impacts on the island’s environment. While the results show that Grenada was indeed bypassed by the initial Ceramic settlers, many more findings about the pre-Columbian Caribbean were revealed in the process.

Background
The Peopling of the Caribbean

Human occupation of the Caribbean archipelago began 3-5000 BC, during the “Archaic” period, when lithic blade producers known collectively as the Casimiroid likely left Central America for Cuba (Coe 1957; Rouse 1992; Wilson et al. 1998). By 2000 BC, lithic groundstone foragers from Trinidad and Venezuela (known as the Ortoiroid) are believed to have moved into the Lesser Antilles and interacted with Casimiroid groups (Hofman and Hoogland 2003; Keegan 1994; Rouse 1992; Wilson 2007). However, just three radiocarbon (shell) dates from Barbados represent the only evidence (prior to this

4 The backbone of our knowledge of Caribbean prehistory comprises the artifact types that archaeologists have tied to specific time periods and, in some cases, ethnic groups. The foundation for this typology was laid by the late Irving Rouse, who devised a grand system of lithic and ceramic progressions for each island in the Caribbean, pulled from seriation studies by himself and others across the Caribbean and lowland South America (Rouse 1964, 1992; Rouse and Faber-Morse 1999). Criticism of the system (e.g., Curet 2003; Keegan 1995; Rodriguez Ramos et al. 2013) has mostly served to refine Rouse’s typologies, rather than overturn them. Thus, his work remains the substrate upon which we attach new evidence, so I mostly keep to the ‘Rousian’ terms here, though the more encompassing terms Early Ceramic (Saladoid) and Late Ceramic Age (post-Saladoid) are used as well.
dissertation) for either group between Montserrat and Trinidad (Drewett 2007; Fitzpatrick 2011; Rodriguez Ramos et al. 2010).

The Early Ceramic Age (500 BC–AD 750) begins more or less with the arrival of the Cedrosan Saladoid ceramic assemblage into the Antilles (Rouse 1992; Rouse and Cruxent 1963; Wilson 2007). Saladoid ceramics have been traced to the Orinoco watershed in modern Venezuela beginning by 1000 BC, perhaps preceded by other types currently thought to be derivative (Barse 2009). Regardless, their sudden appearance in the Caribbean — along with a similar agricultural repertoire and settlement plans — is believed to reflect diasporic fissioning from lowland South America (Boomert 2000; Heckenberger 2013; Keegan 2000; Roosevelt 1980; Wilson 2007). In stark contrast to Cedrosan polychrome wares, a few sites dating to this period do not reflect the Cedrosan artifact assemblage, instead falling into the Huecan Saladoid (Huecoid) series. Huecan ceramics favor incision over painting, with some zoomorphic greenstone pendants in the assemblages labelled ‘Andean condors’ (Chanlatte-Baik 2013; though see Giovas 2017a).

The existence of Huecan sites, and their apparent perseverance throughout the Saladoid Age (500 BC–AD 750) indicates several source regions for Early Ceramic Age migrations. Indeed, Keegan and Hofman (2017) suggest every island may have been initially colonized by different groups across the South American coastline, all only loosely linked by a macro-social identity expressed in the exceptionally well-preserved material culture archaeologists label as Saladoid.

Despite ample evidence that Early Ceramic pottery originated in the Orinoco watershed, the strongest evidence for its presence (from pure contexts of diagnostic ceramics with associated radiocarbon dates) comes from the northern Leeward Islands and
Puerto Rico (Fitzpatrick 2006; Keegan 2000) — not the southern Lesser Antilles. Little is currently understood about the interactions between the inflowing Ceramic horticultural groups and the earlier Archaic fisher-forager-gardener peoples in the southern Antilles, but evidence on the central Venezuelan coast (Boomert 2000:88; Rouse and Allaire 1978:455) and in the northern Antilles have offered some indication of dynamic exchange and integration (Callaghan 1990, 2003; Davis 2000; Keegan 2006, 1989a; Lalueza-Fox et al. 2003; Oliver 1999; Rivera-Callazo 2011; Rodríguez Ramos 2010, 2008; Schurr 2010; Vilar et al. 2014). It is possible, too, that Archaic and Ceramic groups interacted before the latter arrived in large numbers (Chapter 2).

While we now know that the Archaic Age peoples made low-fired pottery in the late period and practiced limited forms of plant cultivation (at the least), the Saladoid-era communities are still considered the first dedicated horticulturalists in the Caribbean, based on tools, pottery types, paleobotanical studies, and residue analyses. However, as research continues on Archaic lifeways, this distinction will likely become untenable.
Figure 1.1 Map of the Modern Circum-Caribbean Region and Major Prehistoric Migrations into the Archipelago
Past Research in Grenada

Ethnohistoric accounts from early Europeans in the region indicate that Grenada was a major stopover for indigenous mariners traveling to and from the South American mainland (Anonymous [Benigne Bresson] 1975:13; Martin 2013:25; Williamson 1926:12). Previous work at Pearls, one of the largest and earliest sites on the island, uncovered exotic gemstones, lithic tools, and faunal remains from across northern South America, as far south as eastern Brazil, and as far north as Vieques, Puerto Rico (Boomert 1987; Cody 1990a, 1993; Fandrich 1990; Hofman et al. 2011; Laffoon et al. 2014; Newsom and Wing 2004). Since Ripley Bullen’s first survey (Bullen 1964), four other projects (Cody and Banks 1986; Cody Holdren 1998; Keegan 1991; Petitjean Roget 1981) on Grenada have documented a total of 65 pre-Columbian sites (Harris 2001), to which the author has added an additional 21 (see Appendix B for site list). These sites include eight petroglyphic and twelve workstone sites (large boulders used for tool sharpening and possibly food processing) (Allen and Groom 2013; Huckerby 1921), which proved more chronologically useful than anticipated (see Chapter 4).

From these past projects, a few sites — namely, Pearls (A-1), Simon (A-5), Black Point (G-20), Grand Anse (G-7), and Grand Marquis (A-2) — were all previously associated with the end of the Early Ceramic Age (Banks 1988; Bullen 1964; Cody Holdren 1998; Harris 2001; Rouse 1992), based on material culture deemed to be Huecan Saladoid, Cedrosan Saladoid, and/or Saladoid-Barrancoid (all ~500 BC- AD 500). However, neither the ceramics nor the radiocarbon dates have borne out the Huecan association, nor even a solid Cedrosan classification, and radiocarbon dates suggest much later occupations. The author’s re-analysis of diagnostic ceramics and radiocarbon dates from these sites — along with the newly discovered Beausejour site (GREN-G-34) — found that Grenada’s earliest
ceramic types are best placed in a late “Saladoid-Barrancoid” category, circa AD 200-750 (see Chapter 3).

The above reanalysis also revealed gross errors in the reporting of radiocarbon dates from the earliest-known sites. For instance, the radiocarbon dates that supposedly showed Pearls (GREN-A-1) was settled between 15 BC to AD 100 (Cody 1988) were not calibrated. This might not make a huge difference when the sample is charcoal (though they should always be calibrated), but the Pearls samples were from shell, which are drastically affected by the marine reservoir effect (Taylor and Bar-Yosef 2014:150). Thus, when properly calibrated with the Marine13 calibration curve, the Pearls dates are ~400 years later than previously reported. So, while there may be earlier deposits that have yet to be dated at Pearls, the Beausejour site currently predates it by about a century. Nevertheless, the radiocarbon and ceramic evidence indicate Grenada was not likely settled before the first century AD, and likely closer to AD 300.5

The Island Ecosystem

Grenada is a volcanic island that lies just 90 miles north of Venezuela and is the southernmost in the Lesser Antillean archipelago (Beard 1949; Lindsay et al. 2005; Stamper et al. 2014). Filtered through the oceanic barrier, the island is believed to have been relatively depauperate of terrestrial fauna when humans arrived, with a few large rodents (e.g., hutia) as the largest mammals, followed by iguana and land crabs (Fitzpatrick

5 For all radiocarbon dates mentioned (unless otherwise noted), preference is given to modelled (Bayesian) 14C dates calibrated in OxCal v4.3.2 (Bronk Ramsey 2018) with the narrowest range for probabilities over 85% confidence interval (CI, sometimes called the “sigma”, although RC dates are not normal distributions). For instance, Cody’s Beta-85935 dated to AD 775-1020 (CI:95.4%), but AD 775-845 has very low probability (CI:5.9%); thus, the narrower range is used: AD 860-1020 (Beta-85935, CI:89.5%). Uncalibrated, calibrated, and modelled dates, as well as context and other information are presented in Table 3.1 and OxCal CQL codes in Appendix C.
and Keegan 2007; Groome 1970; Ricklefs and Bermingham 2008). Teeth of an extinct sloth species (*Megalonychidae* sp.) and previously unknown capybara (*Hydrochaeris galordi*) suggest larger mammals could have been present when humans arrived in Grenada, but the current samples are too early (by several million years) to be conclusive (MacPhee et al. 2000). In the wider Caribbean, some larger animals appear to have gone extinct shortly after the arrival of humans (e.g., sloths, giant hutias, spiny rats, and shrews), though there is debate whether these extinctions were the result of “collateral damage” from human disturbance to the fragile ecosystem (and a warming Holocene) or by direct hunting (Cooke et al. 2017; MacPhee 2009; Steadman et al. 2005).

That said, at various points, Ceramic Age peoples, and possibly the Archaic before them, did cause localized depressions and depletions of faunal (especially marine) species due to intermittent over-predation (Allendorf and Hard 2009; Carlson and Keegan 2004; Fenberg and Roy 2008; O’Dea et al. 2014; Rainey 1940; Rouse 1952; Siegel 1993; Wing and Wing 2001). There is also evidence for the translocation of mainland animals such as agouti (*Dasyprocta* sp.), guinea pigs (*Cavia porcellus*), opossum (*Didelphis* sp.), dogs (*Canis familiaris*), and deer (family Cervidae) (deFrance et al. 1996; Giovas 2017b; Giovas et al. 2011, 2016; Laffoon et al. 2013; LeFebvre and deFrance 2014; Newsom and Wing 2004; Stokes 1998; Wing 1989, 2008; Wing and Wing 1995), as well as a suite of horticultural plants and tropical root crops — some of which may have occurred in the Archaic (Newsom 1993, 2008; Pagán-Jiménez et al. 2015; Pagán-Jiménez and Carlson 2014).

In this way, prehistoric Caribbean peoples, directed by cultural adaptation and ideology, transformed the landscape and created ecosystem *niches* that entailed both
positive and negative feedbacks (Balée and Erickson 2006; Bliege Bird et al. 2013; Denevan 1992a; Erickson 2008; Janzen 1998; Laland and O’Brien 2010; Posey 1985; Rowley-Conwy and Layton 2011; Terrell et al. 2003). These niches may be considered “cultural” ecosystem services — ecological capital that increased the productivity of local resources (Alcamo et al. 2005; Costanza et al. 1997; Daily 1997; Daily et al. 2009; Daniel et al. 2012; Dunne et al. 2016; Haines-Young and Potschin 2010; Kirchhoff 2012; Maschner et al. 2009; Mulder and Coppolillo 2005; Prugh et al. 1999). Figure 1.2 provides a generalized list of ecosystem services in prehistoric Grenada with potential indicators for human impact and archaeological indicators.
<table>
<thead>
<tr>
<th>Resource/Service</th>
<th>Chert/rocks</th>
<th>Clay</th>
<th>Freshwater</th>
<th>Soil</th>
<th>Non-food plants and insects</th>
<th>Trees</th>
<th>Non-woody plants</th>
<th>Terrestrial animals</th>
<th>Nearshore &amp; Pelagic Fish</th>
<th>Crustaceans</th>
<th>Sea turtles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uses</td>
<td>Tools</td>
<td>Pottery</td>
<td>Potable water</td>
<td>Food/horticulture</td>
<td>Dyes, medicine</td>
<td>Fuelwood, timber, canoes, paddles</td>
<td>Food, hides</td>
<td>Food</td>
<td>Food, tools</td>
<td>Food, medicine</td>
<td></td>
</tr>
<tr>
<td>Human Impacts</td>
<td>Depletion</td>
<td>Maintenance</td>
<td>Propagation (increased abundance)</td>
<td>Low-level management/Semi-domestication</td>
<td>Domestication</td>
<td>Introduction of New Species</td>
<td>Size-selective pressures</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Archaeological Indicators</td>
<td>Lithics</td>
<td>Ceramics</td>
<td>Soils</td>
<td>Pot wells earthworks</td>
<td>Soils</td>
<td>Anthrosols Geochemistry</td>
<td>Botanical Remains</td>
<td>Faunal Remains</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Figure 1.2** General List of Ecosystem Services in Prehistoric Grenada, with some indicators targeted in this project
The current project aimed to identify the earliest human occupations on Grenada (see Research Design below). In order to focus these efforts, a series of predictive models were generated, the foundation of which was the Ideal Free Distribution (IFD). Put simply, the IFD states that humans prefer to settle in the most “suitable” areas first, and when those prime areas get overcrowded, new settlements will form in less preferred areas. When a second-rate area gets overcrowded, a third-rate location is settled — and so on down the resource gradient with each new settlement (Fretwell and Lucas Jr. 1969). Similar to Optimal Foraging Theory, the IFD has a neo-evolutionary focus on natural selection, holding that the distribution of a population will reflect an effort to maximize fitness (i.e. survival and fecundity) and minimize competition. It also contains hints of Game Theory, where an individual’s behavior must account for the decisions of other competitors.

The IFD model assumes a patchy landscape of resources differing in quality and that populations will vary proportionally to the desired resources. As the population fixates on an area, the quality of local resources decline. Some groups (e.g., mobile fisher-foragers) would quickly move on to the next best patch, but more sedentary groups (e.g., ceramic horticulturalists) would continue to deplete local resources a bit longer, while their population density increased. Either way, the area eventually drops below a threshold that matches the suitability of previously inferior areas, causing either migration from the original area or new individuals to settle there on their own. In this way, the model assumes a proportional distribution of the population, equalizing across the resource gradient. Contained in the model is the unique suitability curve of each area, which predicts when migration would occur as the population depletes its habitat’s resources (Figure 1.3).
An example of the IFD in archaeological context is the northern Channel Islands, which were colonized by humans at least 13,000 years ago (Jazwa 2013, Kennett 2005). Modern sea levels were reached ~5000 years ago, so sites that were once on the coast are now completely inundated, making Early Holocene sites particularly rare. Those that are known are seasonal/intermittent campsites focused on shellfish gathering. These earliest sites are well positioned for access to fresh water and high-density marine resources and many became permanent villages as early as early as 6000 BC (Kennett 2005). The lack of interior resources on the islands (with the exception of pine nuts and acorns) continued to direct settlements towards the rich marine environment on the coast, a settlement pattern maintained through historic times.

As a result, proximity to fresh water and high-density marine resources (particularly kelp forests) are excellent predictors of archaeological sites (Winterhalder et al. 2010). But it is far from random — the largest and oldest sites are focused near the highest density.
resources, conforming to the logic of the IFD. Smaller sites sprung up in the Middle Holocene, as increasing populations lowered the suitability of earlier sites, but less resourceful Anacapa and the southern coast of San Miguel had only intermittent human impact, aligning with their extremely low suitability ranking. By the later period, populations in the Channel islands had settled all the most suitable areas, which led to a different dynamic called the IDD (Jazwa 2015; Kennett et al. 2009).

*The Despotic Variant*

The main model for the IFD is “ideal” in that there are no boundaries or barriers preventing individuals from moving to a new patch. This is fine for the first colonists of an island, but as populations grow, other factors affect migration decisions. Thus, there are numerous variations that adjust for specific kinds of circumstances.

The first major variation of the IFD is interference by dominant individuals whose presence affects habitat suitability, creating an Ideal Despotic Distribution (IDD). There are many ways this can happen (e.g. hoarding, over-exploitation, access prevention, defense, aggression, etc.), but the essence is that these “ despots” out-compete others for the desired resources. In order to adjust the IFD for the presence of aggressive competitors in a patch, the IDD lowers the threshold for migration, allowing premature migration down the gradient.

However, when migration is restricted (e.g., the later period of the Channel Islands), populations continue to aggregate and the IDD model becomes an avenue for the development of socio-economic complexity (Kennett et al. 2009). Similar to the circumscription described by Carneiro (1970), when the most resourceful patches are controlled by certain individuals (usually through violence) and repressed individuals
cannot easily migrate, the differential access to resources leads to social ranking and stratification within the population.

A great example of this process comes from the island of Rapa, in the far south-east Pacific. Recent archaeological evidence has shown that the socio-political hierarchies present in other parts of Polynesia arrived with Rapa’s earliest colonizers in the early 13th Century AD (Kennett and McClure 2012). By the 14th Century, the first fortifications had been constructed, guarding the most suitable areas for pond-field agriculture (Bartruff et al. 2012). Those pond-fields were not only protected but intensively cultivated, correlating with progressive deforestation across the island and extinction of some native plants (Prebble et al. 2013). Thus, resources were constricted and the habitat’s suitability was lowered. Given Rapa’s extreme isolation and circumscribed environment, people could not easily migrate to more suitable islands. Thus, as the population continued to expand, competition for territory and resources increased, warfare and environmental degradation continued, and stark inequality and social hierarchy solidified. Eventually, a period of rapid stone fort construction occurred in the 18th and into 19th centuries, even while the first European ships were arriving in the harbor. When the British naval captain Vancouver passed by in 1791, it would appear that the population — and hostility — was actually at its zenith (Kennett and McClure 2012).

*The Allee Effect*

On the other end of the spectrum, another important variable considers the *benefits* of population thresholds. The “Allee Effect,” adjusts the IFD curve as the population improves the suitability of an area (*Figure 1.3*). That is, habitat suitability increases when reproductive needs can be met, resources can be optimally managed, enemies can be
protected against, prey can be communally hunted, knowledge shared, and (where applicable) technological improvements implemented. All these improvements increase the habitat’s suitability, but they also make it more desirable to neighbors living in previously higher-ranked habitats. Thus, an immigration influx from nearby populations could subsequently cause a newly improved habitat to undergo potential disruptions.

The Allee Effect is a natural linkage to the concept of niche construction (Codding and Bird 2015). One example comes from Valencia, Spain in the early Neolithic period (McClure et al. 2006). During Neolithic I (5600-4500 BC), a strategy of leaving fallow fields to pasture for sheep and goats led to a repression of secondary plant growth in the prime agricultural lands. Without adequate nutrient replenishment, the once rich alluvial soils of the valley were permanently degraded. Valley habitats soon matched the suitability of periphery lands where new settlements emerged with new agricultural practices and technology (e.g., terracing, fertilizing). During Neolithic II (4500-2400 BC), populations in these periphery areas increased, but the new practices allowed for soil replenishment, which reinforced a more sustainable agro-pastoral system.

The present thesis applies the IFD to one island (see Chapter 5), but Giovas and Fitzpatrick (2014) recently applied the model to the colonization of the entire Caribbean. With their larger size, the Greater Antilles offer a higher density and wider diversity of resources than the Lesser Antilles (i.e., on a regional scale, they are the most suitable habitats). During the Archaic Age, the Greater Antilles are indeed settled first (partly a result of migrants from Central America, but Puerto Rico and the northern Leeward Islands

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6 Keegan (1995) notes that, because humans are socially-dependent, the Allee Effect also sets a bottom threshold for the minimum number of people needed to successfully settle an area.
are presumably settled by Archaic groups from South America; see Chapter 2). During the
Early Ceramic Age, however, incoming Saladoid groups did not pass the Mona Passage
between Hispaniola and Puerto Rico, perhaps a result of Archaic groups further west (an
example of the IDD). Eventually, as their populations increased and previously lower-
ranked habitats became comparably suitable, the islands to the south were finally settled
(thus, an IFD explanation for the “Southward Route Hypothesis” mentioned above).
Adding to this scenario, Chapter 2 provides an example of the Allee Effect, where both
Archaic and Ceramic groups may have been drawn to areas already settled (i.e., in the
northern islands first).

Resilience Theory

Another model engaged in this dissertation is the panarchy model of resilience
theory (Chapter 4). Originally a union of systems theory and conservation biology,
resilience theory has proved useful in anthropological archaeology for thinking about how
and why socio-ecological systems changed in the past (Nelson et al. 2011, 2006; Redman
2005; Redman and Kinzig 2003; Rosen and Rivera-Collazo 2012; Thompson and Turck
2009). The resilience of a system reflects its capacity to absorb shocks and undergo change
while retaining its core functions and structure (Holling and Gunderson 2002; Walker et
al. 2004). As socio-ecological systems experience internal and external threats, their
response determines the course and severity of the next stage (e.g., innovation or
destruction). A highly resilient system may sustain many shocks, but once the threshold
for change is reached, four main stages are discernable (termed the “adaptive cycle”):

1) r-phases — periods of growth and expansion

2) K-phases — periods of conservation and rigidity
3) omega (Ω)-phases — periods of release, collapse, and destruction

4) alpha (α)-phases — periods of reorganization and innovation

The progression through these stages can be non-linear, with phases repeated or skipped. As such, the original graphic was a series of stacked, looping arrows called the panarchy model (shown in Figure 4.3). Others have likened the process to a ball rolling between two “basins of attraction” (r and K), which is useful for understanding threshold states and how a trajectory’s inertia can sometimes force change (Scheffer et al. 2001).

During ideal conditions, a socio-ecological system adapted to its environment will expand (an r/growth-phase), which might be evident archaeologically via exchange networks, size of territory, population changes, etc. A shock to the system (e.g., war, drought, epidemic disease) could trigger a conservation (K) stage of resistance where it may repair itself and re-enter an r/growth stage. However, successive r and K phases without α/reorganization-phases will ossify the system (a process termed the “rigidity trap”), reducing its flexibility and ultimately leading to catastrophic Ω/release-phase breakage (Hegmon et al. 2008; Schoon et al. 2011). Heterogeneity within a given system is usually a strong measure of flexibility and gradual change, while more homogenous systems tends to set up big precipices (Scheffer et al. 2012). In Chapter 4, it is suggested that the widespread uniformity in Saladoid ceramic styles may be an indicator of cultural rigidity. The change to the Late Ceramic was a drastic break from the previous period, but vestiges of the Early Ceramic suggest some continuity remained and successful α/reorganization again lead to an r/growth-phase.
Research Design

Aim 1: Settlement Chronology

The current project was initially formulated to address ancient human impacts on Grenada’s environment. However, so little was known of the pre-Columbian settlements— not only chronology but also where they were located— that the primary focus became site surveys and locations. Understanding the context of human impacts on the environment requires a baseline chronology of prehistoric settlement. What are the cultural characteristics of Grenada’s earliest sites? When were they settled, how persistent was settlement, and what can they tell us about early subsistence and settlement decisions in the Lesser Antilles?

Hypotheses. In order to answer these questions, a series of predictive maps were generated to help identify which areas would be most productive to focus limited archaeological field investigations (see Research Methods below). These models were based on environmental characteristics most likely preferred by the two potential first settlers: Archaic Age fisher-foragers and Early Ceramic Age horticulturalists, as summarized in the following hypotheses:

1. Archaic Age foragers would have preferred close proximity to freshwater, a diversity of terrestrial and marine resources, beach access, and perhaps chert outcroppings or water fowl nesting grounds (Armstrong 1980; Keegan 1994; Rodriguez Ramos et al. 2010).

2. Early Ceramic Age horticulturalists (and perhaps late-period Archaic groups) would have preferred similar criteria for freshwater, resource diversity, and beach access, but would have also prioritized flat land, rich agricultural soils, and perhaps proximity to clay sources (Bradford 2001a; Callaghan 2007; Hofman et al. 2004; de Waal 2006; Watters 1980).
Tests. Each of the above suitability characteristics were formatted in ArcMap 10.3 and overlaid onto Grenada’s modern topography, allowing areas to be ranked according to their corresponding variables. A total of ten highest-ranked areas (five foraging, five horticultural) were selected for survey via pedestrian walkover, auger sampling, ceramic analysis, and soil analysis (Aim 2). Each of these areas included a “known” site, whether a few sherds reported on the beach or from more systematic survey (only two selected sites had been previously studied).

Test Expectations. It was expected that the most suitable areas would have been settled first and would therefore contain artifact assemblages (and eventually radiocarbon dates) consistent with either Archaic-period or Early Ceramic (e.g. Cedrosan Saladoid) artifacts. Additionally, if the most suitable sites were settled first, then those sites should remain occupied until a change in suitability occurred. It was therefore expected that these early sites would contain later artifact assemblages in the upper levels.

Aim 2: Soil Ecology

During survey and excavation (Aim 1), the collection of soil samples allowed inquiry into some aspects of how the modern Caribbean environment was shaped by prehistoric peoples. Eventually, recovered botanical and faunal remains identified in the soil samples will be analyzed, but initial analysis focused on the soil resources themselves (Chapter 5).

Hypotheses. Since the IFD predicts that the most suitable sites should retain larger, longer occupations, human impacts on soils should be evident at the largest, longest occupied sites. Soil improvements would be less confined than middens and might include
the addition of ceramics, charcoal, organic matter, and other refuse spread across broad areas. These anthropogenic soils — like other intensive agricultural pursuits (Knapp 1985) — would contain high phosphorus content (as opposed to the low P evident from extensive farming), as well as a variety of other unique signatures (e.g., in Mg, Ca, Sr, Ba, Cl, Mn, Zn, and Cu — see da Costa and Kern 1999; Schmidt et al. 2014). Dark earths have only recently been identified in the Caribbean (Erlandson 2013; Graham 2006; Scudder 1996), with anthropogenic, shell-lined soils at the Archaic Age site of Angostura, Puerto Rico (Rivera-Collazo et al. 2015; Rivera-Collazo and Sánchez-Morales 2018) and possibly at the Late Ceramic Age site of Salto Arriba (Rivera-Collazo and Sánchez-Morales 2018).

**Tests.** Basic soil description (horizon, texture, Munsell color, consistence, structure, clay film, carbonate morphology, and clast weathering) was recorded for each soil sample, along with basic grain-size analysis using stacked sieves. Fine fraction soil (<0.063 mm) was then used to measure available phosphates (see Methods below).

**Test Expectations.** Soil analysis should help explain settlement decisions and potential desirability of specific soil attributes, particularly for the earliest settled sites. Due to funding and the difficulties of importing large quantities of soil to the US, only basic morphological analysis and field-testing of phosphorus (P) were conducted thus far.
Research Methods

Analytical methods are described in each chapter separately. However, several aspects are further expanded below.

Predictive Model

In order to build a predictive model for the settlement of Grenada, variables for measuring habitat suitability were ranked based on analysis of known settlements and ethnohistoric (i.e. cultural historical) data. In 2015, a series of environmental datasets were acquired from the GIS Unit of Grenada’s Ministry of Agriculture (MOA GIS) and areas of high probability for early settlement were identified using five variables: net primary productivity (NPP) (Zhao and Running 2010), proximities to reefs (Andréfouët et al. 2006), flat land (LP DAAC 2011), rich soils (MOA GIS 2015), and perennial freshwater (MOA GIS 2015). Because precise locations were not available at the time (and only 59 sites listed), known site locations were estimated using georectified maps from previous reports. During the summer of 2015, the preliminary model was then briefly tested in the field at six 500 km2 areas using opportunistic walkovers at construction sites, agricultural fields, and eroded beach exposures. This fieldwork resulted in the discovery of one new site near River Antoine (P-8, since investigated by the University of Leiden) and the recording (via GPS) of 15 sites whose precise location had been unknown.

Following the 2015 fieldwork, a sub-sample of 30 sites for which locational and chronological information could be confidently estimated was chosen for further analysis.  

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7 The sample set was later reduced to the 25 sites that were also likely residential (rather than shell middens, sherd scatters, etc.). This sample of 25 were used throughout the project and are sometimes referred to as SLD-25 sites (25 Settlements with known Location and Dates). See Table 4.1 for list.
One early attempt used watersheds as ranked units (similar to Winterhalder et al. 2010), finding the highest ranked watersheds contained the most number of sites, perhaps aligning with the IFD. The timing of most sites was not available, however, and it was decided that water was not adequately limited in Grenada to influence decision-making (though distance to rivers remained a baseline variable). Another exploratory attempt used IBM’s Watson, an online Artificial Intelligence program (IBM 2016), to find patterns in soils data from the MOA GIS database. Unfortunately, most of the associations identified by Watson were nonsensical (e.g., matching random site ID #s to soil types), but it did prove helpful for decoding some categories within the MOA database.

The most useful associations came from more basic descriptive statistics. Fifteen environmental variables associated with each site were measured in ArcMap 10.3 and exported to R for multivariate analysis. Of the variables considered, the highest correlations were site proximities to clay sources, beaches, coral reefs and/or seagrass, and perennial freshwater (e.g., rivers). Specifically, of the 30 sites analyzed, 85% (n=26/30) were ≤950m from a clay source, ≤700m from a coral reef, ≤740m from a river, and ≤1655m from a beach (note that these thresholds have since changed, see below). These four criteria were then used for creating an initial probability dataset of overlapping layers that ranked habitat suitabilities across the entire island, revealing areas of high probability for undiscovered sites as well as unstudied sites with high probability for early settlement.

Map features in ArcMap were then split into two separate maps to differentiate suitability differences between foraging (e.g., early Archaic) and horticultural (e.g., early Ceramic) peoples (Figure 1.4 and Figure 1.6). In addition to resource proximities, soil types and an NPP layer were added to both maps to balance terrestrial suitability.
Waterfowl and chert resources were then added to the foraging model, while flat (low slope, low erosion) lands and were added to the horticultural model, along with a special soils layer that correlated to the earliest known sites (“Period 1” soils). Regarding the latter, no single soil variable could be isolated to characterize sites of the same time period, but the “Period 1” layer was accomplished using a combination of soil type, slope class, erosion susceptibility, and elevation above sea level (altitude) that seemed to pertain to the earliest sites in the dataset (n=4). Once higher resolution data became available, however, the Period 1 layer no longer fit the data. These areas were then tested during the 2016 field survey, as described in Chapter 5.

Following the survey, an inventory of sites was made using past and recently acquired data from field-tests (Hanna 2017). Site-types were assigned to differentiate sherd scatters, conch middens, and large and small domestic middens. This dataset was subsequently integral to refining the island’s chronology (Chapter 3), better understanding changes in population and cultural material (Chapter 4), and for “training” a new set of predictive models (Chapter 5).
**Figure 1.4** The 2016 Ceramic Age Predictive Map and Areas Surveyed That Season

**Figure 1.5** The 2017 Predictive Model, with an added high-probability buffer around known sites (for use in development planning)
Figure 1.6 Highest Ranked Areas of the 2016 Archaic Age Predictive Map

Figure 1.7 Comparison of Predicted Settlement Dates of SLD-25 sites from the 2016 (Figure 1.4) & 2018 (Figure 5.5) Predictive Maps
Figure 1.8 The 2016 Predictive Map of Grand Bacolet (D-7) — one of the highest ranked areas for that model — with the site’s actual location, survey results, and phosphorus levels (see Hanna 2017 for full results)
One of the most disappointing near-failures of the models occurred at Grand Bacolet Bay (GRE-D-7) (Figure 1.8). Petitjean Roget (1981) mentioned some sherds in the area, as had the Foundation for Field Research (FFR) (Banks 1993), but the location (let alone timing) of settlement was completely unknown. Since every iteration of the predictive model consistently ranked Grand Bacolet as one of the highest probability areas, and since a site was already known somewhere in the area, this was chosen as a bellwether for the model’s effectiveness. As later reported in Hanna (2017), a site was indeed found there, but it was on the edge of the predicted area and only discovered by walking down one of the rivers. Moreover, the model was designed to identify the most suitable areas for settlement, so a high-probability site should be established early and occupied over multiple periods. What we found at D-7 was an ephemeral midden (albeit within a defined Ab horizon), limited organics for radiocarbon dating, and limited ceramic attributes that suggested settlement during the Troumassan or Suazan Troumassoid periods (post-AD 750). Repeated attempts to radiocarbon date the few charcoal remains collected returned only modern dates (see Table 3.1). Nonetheless, this was one of several failures of the 2016 model that helped strengthen subsequent versions, as described in Chapter 5.

One aspect of the predictive models that is not discussed in Chapter 5 was an attempt at using a different type of suitability analysis. Rather than overlapping environmental layers in ArcMap, the 2017 predictive map was based on a Weights of

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8 FFR was a for-profit, science-travel organization founded, in part, by Thomas Banks, who conducted a number of field-school surveys and excavations in Grenada from 1986-1994.

9 Early French texts also mention a Kalinago (either Suazan or Cayo) settlement in the area, suggesting D-7 was occupied into the Protohistoric period (AD 1492-1649) (Anonymous [Benigne Bresson] 1975:26; Angus Martin, personal communication)
Evidence (WofE) model using the Spatial Data Modelled (SDM) package for ArcGIS (Bonham-Carter 1994; Sawatzky et al. 2010). As suspected in the field, the SDM Agterberg CI tool revealed reefs and beaches to be 92.2% conditional (p=1.412), meaning they were not independent-enough to be predictive (Chapter 5 describes the implications more fully). However, when beaches or reefs were removed, much of the coast was ranked too low, so they were left in place. SLD-25 sites were again used as “training points” and a 500 meter buffer was added around wetlands and NPP cells above 10k (see Figure 1.5 for the final version). Using the Intersection tool in ArcGIS, comparison was then made between the 2016 and 2017 maps, which calculated an average of 70% overlap (i.e., 30% difference in rankings). Ultimately, however, the WofE method proved too glitchy in new versions of ArcGIS (even worse in ArcGIS Pro), so the final (2018) model in Chapter 5 employed rankings from a multilinear regression (MLR) model. Comparison between the final 2016 and 2018 suitability models can be seen in Figure 1.7.

Survey Methods

As described above, ten areas were selected for the 2016 survey (i.e., a polygon of the suitability overlay defined the survey boundaries), comprising 4.8 sq. km, onto which 380 auger tests were assigned using a Generalized Random Tessellation Stratified (GRTS) point generator (Phillipi 2016). GRTS is a formula for producing stratified, spatially-balanced (at 30m-interval), random sample points from the spsurvey package in R (Kincaid and Olsen 2011). Because of the ease of batching scripts and creating ArcGIS shapefiles in R, the GRTS approach was more functional than the “spatially-balanced point” tool native in ArcGIS (Pettebone et al. 2009; Theobald et al. 2007), although the formulas behind each tool are very similar. The sample size was initially calculated to a 95%
confidence level at 5% error margin with 25 extra (“E”) samples added in case of inaccessible locations (roads, houses, denial of access, etc.). These latter units were labeled in the order that they were generated to allow easy addition into the sampling regime as needed (or safely ignored if not). Assigned points were placed irrespective of modern development, which ultimately resulted in only a small percent (between 3-11%) of each sample population being tested on the ground. Because GRTS is designed for small (<5%) sample sizes, however, the strength of coverage was not affected (Phillipi 2016).

Every prehistoric site in Grenada (n=87) is under threat from either coastal erosion, rising sea levels, sand-mining, and/or development projects (Crock and Petersen 2001; Fitzpatrick 2010; Hanna 2017). The “radiocarbon survey” approach used in this project therefore offers a way to quickly assess and record sites as best we can before many disappear (Brown Vega et al. 2013; Erlandson and Moss 1999; Kennett, Culeton, et al. 2012). Typically, each area was tested for 2-3 days, with the first day spent in pedestrian survey and sampling opportunistic GRTS points loaded onto a Garmin eTrex 10 GPS device. After the first day, the area was re-assessed, with priorities for Days 2 and 3 placed on filling major gaps left uncovered and defining the parameters of potential sites (using non-probabilistic sampling if needed) (Redman 1987:252). Roughly 1/3 of all known sites in Grenada rest on soils that are >3’ deep, so a four-inch wide, telescoping bucket auger (up to 9’) was used to ensure that the deepest anthropogenic strata had been reached (Cannon 2000; Hoffman 1993; Stein 1986). The depth after each auger scoop was measured and the soil screened separately using a small 1/4” screen with a bottom pan that

10 These points were labeled non-probabilistic choices (NPCs).
allowed smaller matrix to be analyzed before discarding. Pint-size samples of unsieved soil were collected in sterile polyurethane bags for later botanical and geochemical analyses, depending on depth and cultural associations.

In 2017, a thorough augering survey was conducted of the two earliest Ceramic Age sites — Pearls (A-1) and Beausejour (G-34) — as well as at Galby Bay (D-3), one of the latest sites. A small excavation was also initiated at the inland site of Montreuil (P-2), and several more sites were field-checked and sampled for radiocarbon samples: Petite Bacaye Bay (D-8), Levera (P-4), Marlmont (D-24), and Grand Marquis (A-2). Laboratory work on these is ongoing, but grain-size analysis from Beausejour is presented in Chapter 5 to help explain results from that area.

Soil Analysis

From 2016-18, a total of 113 auger tests were dug at 19 sites, resulting in 467 soil samples taken (roughly every 10 cm in each test). Basic description of soil horizons (Munsell and texture) were documented during excavation in the field. In the lab, air-dried samples were further described using a general format based on Birkeånd’s “Worksheet for Recording Soil Properties in the Field” (Birkeånd 1999:350, Table A1.3), which is based on Harden’s (1982) Profile Development Index (PDI). Soils were left to dry in the open air for at least 48 hours (often quite longer) before being weighed and dry-sieved.

Grain-Size Analysis

Typically, half of each soil sample (determined by weight on a digital scale) was poured into a stacked screen and sifted for organic remains — the other half was left untouched as backup. Fine fraction was weighed and bagged separately for use in phosphate testing (below), and any artifacts removed were weighed. The remaining large
fraction was weighed, then wet-sieved through a US #230 sieve and left to dry on plastic sheets. After 48 hours, the samples were photographed, resieved for grain-size (below), scanned for additional organic remains, re-analyzed for additional soil description, and re-bagged. This process provided a check on soil descriptions from the field and allowed for potential microartifacts and botanical remains to be identified. Unfortunately, sample sizes for botanical and faunal remains proved insufficient for broader inference.\textsuperscript{11}

A rough grain-size analysis was conducted by sieving samples through a Hubbard four-sieve stacked screen. The four mesh sizes used and associated particle capture are shown in Table 1.1:

<table>
<thead>
<tr>
<th>Mesh Size (US system)</th>
<th>Pedological Particle Class</th>
<th>Geological Particle Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 mm (#5 US mesh)</td>
<td>pebbles, gravel</td>
<td>gravel</td>
</tr>
<tr>
<td>2 mm (#10 US mesh)</td>
<td>granules, clasts</td>
<td>fine gravel</td>
</tr>
<tr>
<td>0.25 mm (#60 US mesh)</td>
<td>medium/coarse sand</td>
<td>fine/coarse sand</td>
</tr>
<tr>
<td>0.063 mm (#230 US mesh)</td>
<td>fine/very fine sand</td>
<td>very fine sand</td>
</tr>
<tr>
<td>bottom pan</td>
<td>silt, clay, (loam)</td>
<td>“mud”</td>
</tr>
</tbody>
</table>

The following steps outline the procedure devised to allow for measurement of the % clasts/gravel, % medium & coarse sand (hereafter “coarse sand”), fine & very fine sand (hereafter “fine sand”), and the % of soil (Si-Cl-Lo):

1. Weigh total sample and put half back in original bag
2. Pour into short-stack sieves (#10, #230, bottom pan) and shake
3. Scan for artifacts, organics (e.g., charcoal, fauna, seeds, etc.)
4. Weigh bottom pan and bag as “fine fraction”
5. Combine remaining (#10 and #230) and weigh
6. Wet-sieve through #230 and let dry on plastic sheets

\textsuperscript{11} Recovered faunal samples are currently being analyzed by Brittany Mistretta at the Florida Museum of Natural History (FLMNH).

\textsuperscript{12} Some paperwork and labels from this project list #60 (and possibly #120) as the smallest size and #35 in the middle (the Hubbard sieves do not arrive pre-labelled). It was later confirmed (using a #40 sieve) that the smallest sieve used throughout the project was #230 and what had been called a #35 was actually a #60. At no time did I use a #35 or #120 screen.
7. Once dry, weigh post-wet-sieved sample
8. Pour sample into large stacked sieves, break up clumps, shake
9. Weigh #10 (gravel/clasts)
10. Weigh #60 (coarse sand)
11. Describe morphology, bag organics from #10 and #60
12. Weigh the #230 sieve (fine sand)
13. Weigh the bottom pan (Si-Cl-Lo) and add to fine fraction bag
14. Bag remaining as “wet-sieve remnants”

Once complete, the weights were added to an MS Access database that calculated the percentages. Note that step #5 (weighing the sample just prior to wet-sieving) is critical for accurate estimation of the Si-Cl-Lo that wash away in the wet-sieve step.

Obviously, the use of deflocculants and mechanic sieving are more accurate than the above field method (USDA 2014). However, while the above procedure does not produce absolute measurements, it does provide relative proportions of soil particles in the absence of expensive, high-tech equipment.

**Soil Phosphate (P) Testing**

Samples for geochemical testing were chosen based on depth, pH, soil type, and context (e.g. associated with cultural remains), limiting problematic samples or modern interferences (Crowther 1997). Of the many geochemical signatures for detecting past anthropogenic influence (e.g., Mg, Ca, Zn), few are, “as ubiquitous, as sensitive, and as persistent an indicator of human activity as phosphorus,” (Holliday and Gartner 2007:301). Because phosphorus quickly fixes to durable metals like iron and aluminum, it is far less mobile than other artifacts within the soilscape, allowing legacy distributions of P to be maintained over long periods, even in modern agricultural fields (Eidt 1984; Nolan 2014; Roos and Nolan 2012). This legacy, however, is more apparent at long-term settlements than hunting camps or other short-term sites (Thurston 2002:267). In normal (extensive)
cropping regimes, uptake of P results in repeated depletion of edaphic macronutrients after each harvest, where it is redeposited at processing and refuse areas (Morisada et al. 2000; Nolan 2014; Sandor et al. 1986). An increase in phosphorus (technically organic phosphate) within an archaeological site could therefore reflect middens, living spaces, burials, processing areas, or other prehistoric features (Bethell and Mate 1989; Dahlin et al. 2007; Eidt 1973, 1977; Heron 2001; Holliday and Gartner 2007; Rypkema et al. 2007; Wells 2010; Wuenscher et al. 2015).

For this project, a basic field method was used for determining “available phosphorus” (largely derived from organic sources), rather than the “total phosphorus” present in each soil sample. Available phosphorus has been shown to be as effective in identifying archaeological features and site boundaries as total P (Eidt 1984; Nolan 2014; Sandor et al. 1986), and in some cases less obscured by the “noise” of inorganic P (e.g., Parnell et al. 2001).

The lab procedure used was a modified field method outlined by Terry et al. (2000) and initially refined in 60 sample trials conducted at the Human Paleoecology and Isotope Geochemistry Lab at Penn State. Two grams of soil were mixed with 20ml of Mehlich 2 extractant (Mehlich 1978) for 5 minutes. Two milliliters of this solution were then filtered through a 0.45 μm syringe into a 10 ml cuvette and diluted with 8ml of deionized water. The cuvette was then placed in a Hanna13 HI-706 Checker colorimeter (internally calibrated to phosphate) and measured as the control sample. An ascorbic acid and molybdate-based color reagent was then added to the solution, shaken until dissolved, and

13 No relation to the author
allowed to react for five minutes before measuring again. Another 2g of each soil sample were also dissolved in 20ml of deionized water for 30 minutes and measured with a Checker Plus pH tester by Hanna Instruments. All equipment was then thoroughly rinsed between samples and wiped clean.¹⁴

All measurements were entered into a database in MS Access — connecting it to soil description data and GPS points. In some cases, it was then exported to Surfer 11 to create a 3D variogram of relative changes in P values the site (e.g. Figure 1.8). However, the results of geochemical testing (P, pH, EC, TDS) are only briefly mentioned in the proceeding chapters. It proved an excellent survey technique, particularly for identifying site boundaries that were otherwise invisible on the surface, but the time required to run all the samples, analyze the results, and depict the findings graphically was too great. Some results are shown in Hanna (2017), as well as in Chapter 5, but the bulk of findings from soils await future analysis and publication. It therefore remains an open question whether improvements were made to less-preferred soils in order to increase production capacity, similar to terra preta (“dark earths”) in the Amazon region (Novotny et al. 2009; Schmidt et al. 2014; Lehmann et al. 2003; Woods et al. 2009).

Radiocarbon Dating

Fifteen pre-Columbian sites in Grenada have been successfully radiocarbon dated: six previously reported in grey literature and nine presented here — a total of 36 dates, not

¹⁴ During initial testing at PSU, it was determined that equipment rinsed with HCl, washed with Liquinox, and DI, then rinsed three times with Nanopure and left to air-dry consistently produced the same results as equipment simply wiped clean with a wet paper towel and then reused. The resolution of this test simply did not require such extensive controls. Nonetheless, enough equipment was eventually purchased to allow washing (with Liquinox, not HCl) between each run.
including modern or historic. Samples run at Pennsylvania State University (PSUAMS) were first prepared by the author at the Human Paleoeconomy and Isotope Geochemistry Lab at Penn State, as described in Chapter 3.

All newly measured and previously reported dates presented here were calibrated in OxCal 4.3.2, using either the IntCal13 or the Marine13 Northern Hemisphere curves (Bronk Ramsey 2018), as appropriate. Marine samples were also calibrated with a regional offset (delta-R) of -28 ±25 (Wagner et al. 2009). Although the divergence of the marine carbon cycle from the atmospheric cycle has been known since the early days of radiocarbon dating (e.g., Keith and Anderson 1963; Kulp et al. 1952; Libby et al. 1949) and generalized global marine corrections have continued to improve (Reimer et al. 2013), dating shells remains problematic. Carbonates continue to chemically interact with their environment post-formation, and the majority of components dated are inorganic calcium-carbonate, rather than the small percent of organic conchiolin in mollusk shells. However, the calcium carbonate of shells is derived from suspended carbon in the water column, and there is some evidence that the Cariaco Basin (and likely entire Caribbean) has a “shallow, well-ventilated source that feeds upwelling in the basin,” (Guilderson et al. 2005). In other words, the carbon samples used for dating shells in the Caribbean should be close to the global marine curve and therefore, less problematic. Given that six of the eight conch shells dated in Grenada fit well with their contexts (the other two being Archaic, discussed below), the delta-R in Grenada does not appear to be as variable as Hadden and Cherkinsky (2015, 2017) found for the Florida panhandle. However, such a study on conch in the Lesser Antilles (ideally from each island) would be welcomed.
To be sure, estimates of regional delta-R corrections for the Caribbean range from -70 ±40 (Cooper and Thomas 2012; Reimer and Reimer 2006) to -19 ±23 (Fitzpatrick 2006) to +28 ±13 (Diaz et al. 2017). Given the confusion, Roksandic et al. (2015) recommended using two different delta-R offsets for a deeply stratified burial context in northwestern Cuba, differentiating between mid- and late-Holocene changes in local carbon cycles.

Based on these studies, as well as the current offset suggested on CALIB’s website (Reimer and Reimer 2006), it seems likely the true local reservoir is somewhere within the range of -25 ±75. However, Grenada is aligned with the southern Atlantic currents that move west-northwest through the Caribbean and up to the Gulf of Mexico. Thus, delta-Rs from this part of the southern Caribbean basin would be closer to the local correction for Grenada than, say, those in the Bahamas or Cuba. This is what Wagner et al. (2009) recommend in their reevaluation of these data, noting how source waters affect local carbon reservoirs, although the correction used here (-28 ±25) is their estimation for the entire Caribbean. However, if any of the dates were much deeper in time (e.g., early Archaic Age), I would recommend taking Roksandic’s approach of considering potential differences in source water carbon during the Early Holocene to arrive at a separate correction for that period.

Aside from basic calibration issues, dates here were also modeled using OxCal’s Bayesian statistical tools, which incorporate “prior” information about the sample (e.g., relative stratigraphy, sequential dates, etc.) into the probability distribution in order to further constrain the error range (Bronk Ramsey 2009a; Buck et al. 1996). For example, if three charcoal samples were radiocarbon dated in the same profile (and the context is intact
and not intrusive or otherwise disturbed), one can reasonably assume that the upper sample is younger and the lower sample older (i.e., the law of superposition). Bayesian techniques take this relationship into account and offer a statistical constraint on the sample distribution. Bayesian methods can also help determine if a sample fits the sequence or is likely intrusive (“outlier” modelling). Graphically, the effects of model constraints can be seen in the generated histograms, where the original, unmodeled ranges are grayed in the background and the newly constrained (posterior) ranges are darkened in the foreground (Figure 3.2).

OxCal uses a Markov Chain Monte Carlo (MCMC) sampler to approximate all possible solutions and probability outcomes (Bronk Ramsey 2000, 2008). The statistical output includes the refined probability distribution and indicators about the date’s congruency within the model. The latter is indicated by an agreement index, which has a scale of roughly 0–100% and a cutoff at 60%, correlated to the 5% confidence interval of a chi-square test (Bronk Ramsey 1995, 2009a). This indicates the agreement between a sample’s prior value and its posterior value from the model.

As also described in Chapter 3, samples taken from the same depth were tied together as a group, since they cannot be placed in sequential order. Because the group as a whole precedes or succeeds other groupings, a phase designation in OxCal was used as a container for an unordered group of dates within an otherwise ordered sequence (e.g., the Sauteurs Locus 1 dates). Similarly, the use of a boundary provides margins for an unknown span of time between two samples or phases (Bronk Ramsey 2000), an essential parameter within and between groups of dates. The exact OxCal command used for a given sample can be seen in the Notes column of Table 3.1 and Appendix C. Other techniques and
analyses were applied to the radiocarbon dates, but are described in their respective chapters, including trapezoidal models of ceramic phases (Chapter 3), sum probability distributions (Chapter 4), and 25-year bin intervals (Chapter 4).

Chapters 4 and 5 mention the use of a Gaussian sedimentation model that is referenced but not thoroughly described. In short, stratigraphic sequences (e.g., pollen or soil cores) used herein were fitted to a Gaussian (normalized) sedimentation rate, rather than a typical uniform sedimentation rate. The uniform way applies static values for the rate of sedimentation between tie-points (radiocarbon dates), resulting in drastic adjustments between each point. For instance, in Siegel et al.’s (2015) Lake Antoine core, the original sedimentation rate from 612-700 cmbs was estimated to be 28.86 yrs/cm (0.04 cm/yr) followed by a jump to 12.067 yrs/cm (or 0.08 cm/yr) from 312-612 cmbs. This means that the sedimentation rate at 612 cmbs is half that of 613 cmbs, just one centimeter deeper. Not only is this completely unrealistic, but it creates a compounding error at each tie-point, which ultimately affects the estimated ages applied to measurements between the tie-points (i.e., the age model). The problem is especially deceiving for rates after European settlement, since sedimentation rates rapidly increased during plantation agriculture (Wells et al. 2017), but too few tie points may be available to capture that.

It is therefore more realistic to assume a non-uniform distribution, where the rates before and after each tie-point are considered similar (with low error rates) and the highest error to be midway between tie-points. Some have advocated using Monte Carlo methods to achieve this (Bronk Ramsey 2009a), but Heaton et al. (2013) suggest a Gaussian process, which applies a normal curve and incorporates the necessary equifinality but does not require the heavy processing time of Monte Carlo methods. It also incorporates the error
of the radiocarbon dates themselves, allowing a more accurate standard error for each estimated age. Such errors allow ‘wiggle-matching’ each point to a higher-resolution record, if available. The Yok-I speleothem (Kennett, Breitenbach, et al. 2012) is one such record, but its location in Belize makes it less reliable for Grenada (see Chapter 4).

As with any sedimentation model, estimating the rate outside of two tie-points (e.g., the top and bottom of the core) is highly error-prone and a static sedimentation rate must be used. A cap point of 0 cmbs at the time of the core (e.g., -60 BP for Lake Antoine) was added to assist the age models. It is good practice to ignore measurements from the first ~50 cm of a core anyway, given potential modern disturbance, but the sedimentation and date at 0 cmbs are still important tie-points beyond those first 50 cmbs. Additionally, age-models in anthropogenic contexts (such as a site’s soil stratigraphy) are much more stochastic, but the combination of soil morphology and geochemistry coupled with multiple radiocarbon dates can achieve realistic estimations for the timing of certain patterns, as shown in Chapter 5.

**Broader Impacts**

A large part of this project involved working with the Grenada National Museum, the Ministry of Tourism, and local communities. Some of this was documented in the 2016 report (Hanna 2017), but I spent another 16 months on the island following that report, so a brief update is warranted.

Because of my close association with officials in the government of Grenada (principally Michael Jessamy, my counterpart in the Ministry of Tourism), I had hoped this project would be an opportunity to incorporate archaeology into Grenada’s development strategies. A report and site inventory database (the Archaeological Site Inventory of
Grenada, or ASIG) was completed and is currently being developed into an online web-database for easier use. A version of the 2017 predictive map (Figure 1.5) was given to Grenada’s Physical Planning Unit (PPU), the office that approves permits for construction and development projects. As has been shown elsewhere in the Caribbean (de Waal et al. 2015), predictive maps and inventories are invaluable for continued mitigation of development threats on cultural resources. Both ArcMap (shapefiles) and GoogleMap (kml) versions were given to the team, but the GoogleMaps version proved most useful because permit applicants must submit their applications with a GoogleMap link. This allowed the team to easily identify areas that should trigger archaeological impact assessments under the Grenada’s Museum Act of 2017 (as well as ~17 other related laws). As of this writing, no impact assessments have been triggered, but it is likely some areas have been avoided as a result of the maps.

As previously described (Hanna 2017; Mistretta 2017), an effort was also made to inventory and catalog the collections at the Grenada National Museum (GNM). While some of the collection comes from unprovenienced donations by private citizens, the vast majority are from well-documented contexts, painstakingly recovered by past archaeological investigations in Grenada (mostly by FFR). Unfortunately, the museum’s “storage” has consisted of deteriorating bags and cardboard boxes stuffed in various cavities of the building’s basement over the past 40 years. Subjected to over-stacking, insects, rodents, and fluctuating temperature/humidity for decades, these artifacts (and their provenience information) were in critical condition when I assessed them in 2016. As a result, an emergency salvaging and cataloging effort was implemented and a searchable
MS-Access database of the Amerindian collections was produced, complete with photographs and detailed provenience information.

The project proved to be much larger than expected, with an estimated 200,000 objects or more in the Amerindian collection alone. With the help of a crowd-funding effort by UF zooarchaeologist Brittany Mistretta, 70 large plastic storage bins, along with thousands of zip-lock bags, several stationary items, and a laptop computer were purchased and shipped from the US, for use in finishing the cataloging effort in 2017. Unfortunately, once the donation was made, the GNM’s management shut-down the project in order to rent out the cataloging room. As of this writing, the project remains only half-finished. Hopefully the situation can be remedied in the near future, before more information is lost.

Many other public outreach projects were engaged during this project. For instance, with the help of John Swogger, an archaeological illustrator, a series of newspaper comics about the importance of Grenada’s heritage were run in the local paper New Today, the online news website NowGrenada, and on an online Facebook Group (Swogger 2018). The comics explained the economic potential of heritage tourism and the importance of preserving Grenada’s archaeological resources.

Featured prominently in the comics was a local youth group, the Mt. Rich Youth Cultural Environmental & Development Organisation (MYCEDO). As part of my work as a Fulbright Scholar in 2017, I worked with Mr. Jessamy to help MYCEDO convert the Mt. Rich petroglyphs (GREN-P-1) into an educational center for locals and tourists alike. They had already written and received a grant from the Market Access and Rural Enterprise Development Programme (MAREP), formulated their business plan, renovated an old lookout building by the petroglyphs, and were seeking help on the content of their displays.
Knowing that such community initiative is essential for successful projects like this, Mr. Jessamy and I jumped at the chance to assist.

In the process of helping MYCEDO, Mr. Jessamy and I also created a tour of petroglyph sites on the island that we called Petroglyph Path. With the help of a grant from the Africana Research Center at Penn State, we installed a dozen signs at workstone and petroglyph sites up the western side of the island, with the “grand finale” at Mt. Rich (Hanna 2018). We would like to continue developing such products, should the political environment in Grenada allow. As discouraging as such development work can be sometimes, I do believe that we made a difference, however small, which will be magnified as time passes. As Grenada continues to develop socially, people will become more interested in their island’s heritage (akin to the “hierarchy of needs” in Maslow 1943), and hopefully more public support will be garnered for protecting Grenada’s Amerindian heritage sites.

**Organization of the Dissertation**

As mentioned in the Preface, this dissertation is organized as four stand-alone journal articles (Chapters 2-5). A major obstacle to researcher consensus on Caribbean colonization models has been the paucity of work in the Windward Islands. Yet as the first “step” in the traditional “stepping-stone” model, Grenada is well-placed to answer questions about early colonization. Chapter 2 pulls together paleoenvironmental data of Grenada during the Archaic Age (4000-100 BC) and considers various proxy evidence of anthropogenic impacts during this time. In light of four new radiocarbon dates from shell

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15 The website for Petroglyph Path is: http://www.GrenadaArchaeology.com/PetroglyphPath
middens on the south of the island, it appears there was at least a transient human presence during the Archaic. The strongest evidence comes from the Grand Bay Beach site (G-22), which suggests specialized extraction of conch, perhaps on a seasonal or less-frequent basis, similar to Archaic sites seen further north.

In the same vein, Chapter 3 addresses colonization questions during the Ceramic Age by redefining the settlement chronology of Grenada using trapezoidal models and 36 radiocarbon dates from 15 pre-Columbian sites and refined using Bayesian statistics. It is argued that Ceramic Age populations did not settle Grenada until ~AD 200-300 (the Saladoid-Barrancoid period), and that few settlements predate AD 750. The first phase of the Late Ceramic Age — the Troumassan Troumassoid — is shown to be a transitional stage between Saladoid-Barrancoid and Suazan ceramic types. Further, contrary to current thinking, Suazan types are shown to continue to the early French period, when two groups were reportedly present — “Caraïbes” and “Galibis.” It is hypothesized that, in Grenada at least, the group called “Caribs” in the early colonial period were different than presumed today. It is likely that the “Caraïbes” were Arawakan-speaking, Suazan potters, while Galibis were Cariban-speaking, Cayo-potters who fit the modern notion of Island Carib identity.

Chapter 4 addresses the period of Grenada's apparent spike in population at the start of the Late Ceramic Age, beginning AD 750-900. Again pulling paleoenvironmental data from Grenada and the surrounding region, this chapter compares data from twenty-five settlements on Grenada with the available climate and vegetation records, as well as a sum probability distribution (SPD) of relative changes in the island’s population. The influence of the environment appears quite strong in these proxies, although not in the expected ways.
Using the adaptive cycles of resilience theory as a heuristic framework, the dramatic shifts in Late Ceramic material culture (including everything from ceramics to demographics to the appearance of petroglyphs and workstones) are shown to occur during a regional drought, with a population influx likely representing incoming Arauquinoid groups from coastal South America. That is, the “decline” in ceramic types was not an \textit{in situ} phenomenon but directly reflective of events occurring on the mainland. Additionally, a depopulation event around AD 1260 appears to coincide with the arrival of Cayo (Island Carib) ceramics, which aligns with “Carib invasion” myths, although the processes behind this pattern remain an open question.

Finally, Chapter 5 discusses the predictive model used for the field survey, as well as some results of the grain-size analysis and phosphorus study. The results show that Amerindians in Grenada largely followed the parameters of an Ideal Free Distribution, but one that shifted over time as marine resources supplanted agriculture as the primary subsistence strategy around AD 750. Settlement patterns indicate that Saladoid-Barrancoid sites are slightly inland, with balanced marine and agricultural criteria. During the subsequent Troumassoid period, a wide variety of new locations were explored, perhaps reflecting the expansion of diet breadth during the period. In the succeeding Suazan period, subsistence strategies were again refocused towards coastal marine resources. Nonetheless, wetland/riparian areas remain highly ranked throughout the sequence, allowing accurate prediction of both coastal and inland site locations. It is suggested that the importance of wetland areas in prehistory may be influenced by agricultural preferences that originated in the Amazon Basin.
CHAPTER 2

The Windward Islands Archaic Age: New Data from Grenada, West Indies

Abstract:

For decades, colonization patterns have been a major topic in Caribbean archaeology, with most researchers adhering to a traditional “stepping-stone” migration theory of island settlement. This paper reanalyses evidence from Grenada, the first “step” in the traditional model, and argues that both paleoenvironmental data and four new radiocarbon dates suggest Grenada did have an Archaic Age presence, albeit much more ephemeral than the northern islands — particularly the smaller Leeward Islands. Given the similarity in assemblages, it is possible that Barbados, Tobago, and Grenada formed an Archaic Age resource cycle centered in Trinidad, but the activities of both Archaic and Early Ceramic groups in the southernmost Caribbean were transient, with substantial settlement not occurring until the Late Ceramic Age (post-AD 750). In an example of the Allee Effect in Human Behavioral Ecology, both Archaic and Ceramic Age groups were likely drawn to the domesticated landscapes of already populated areas in the north, skipping the mostly unoccupied islands in the southernmost Antilles.

Keywords: Allee Effect, Caribbean, Climate, Colonization, Lesser Antilles, Radiocarbon

Introduction

The traditional model for the colonization of the Caribbean holds that the archipelago is a series of “stepping-stones” through which waves of pre-Columbian

16 A version of this chapter is planned for submission to the Journal of Island & Coastal Archaeology.
peoples migrated, settling each island in a consecutive pattern moving northward (Rouse 1964:499). As the archaeological record has grown, however, it has also become increasingly clear that the Greater Antilles and Leeward Islands (northern Lesser Antilles) were settled thousands of years before the Windward Islands (southern Lesser Antilles), beginning 3-5000 BC (Figure 2.1). With increased evidence that early Archaic migrations occurred from Central America to Cuba (Callaghan 1990; Wilson et al. 1998), the pattern makes some sense now, but the assemblages east of Hispaniola are still aligned to contemporaneous groups in South America and Trinidad — not the Central American ones. Oddly, the pattern repeats in the Ceramic Age, with the earliest Saladoid groups emerging from the South American coastline and skipping much of the Windward Islands for hundreds of years. New evidence from Grenada now suggests Archaic groups probably did visit Grenada, but not in any substantial way.

**Archaic Colonization of the Lesser Antilles**

Human occupation of the Caribbean archipelago began 3-5000 BC, when lithic blade producers known collectively as the Casimiroid left Central America for Cuba (Rouse 1992; Wilson et al. 1998). By at least 2000 BC, lithic groundstone foragers from Trinidad and Venezuela (known as the Ortoiroid) are believed to have moved into the Lesser Antilles as well, interacting with Casimiroid groups (Hofman and Hoogland 2003; Keegan 1994; Wilson 2007). In a reflection of the origins of the two Archaic macro-groups, the earliest radiocarbon dates for the period are found in the two geographical extremes of Cuba and Trinidad (Figure 2.2).
Figure 2.1 The Lesser Antilles and the Wider Caribbean Region
Figure 2.2 Summary of Archaic Radiocarbon Dates in the Lesser Antilles, listed from north to south (dates for Grenada are from this paper; remaining dates from Giovas and Fitzpatrick, 2014); Note the gap between Grenada and Montserrat
Despite an early presence in Trinidad (which was not fully detached from the mainland until ~4250 BC) and shell middens at Milford, Tobago (Boomert 2000:41,57), the vast majority of Archaic sites in the Caribbean are north of Guadeloupe, which itself has only trace evidence (Richard 1994, and see Callaghan 2010 for a review). Previously reported sites on Martinique (Boutbois and Le Godinot, see Allaire and Mattioni 1983) have since been radiocarbon dated to the Ceramic Age (Bérard 2002; see also Rodríguez Ramos 2005), and groundstone “tools” below Ceramic Age deposits in Buccament Cave, St. Vincent (Hackenberger 1991) are now considered natural (Callaghan 2010:140; Keegan 1994:266). Aside from three radiocarbon dates from Heywoods, Barbados (Drewett 2007; Fitzpatrick 2011), there is little evidence of any Archaic presence between Trinidad and Guadeloupe.

Yet just to the north in Antigua, there are over 40 Archaic sites documented (at least nine of which are radiocarbon dated) (de Mille 2005), and the Archaic component of St. Martin has been thoroughly dated through a program of at least 42 radiocarbon dates at 8 of the 14 reported sites (Bonnissent 2008; Serrand and Bonnissent 2018). In between, Archaic sites have been documented on Barbuda, Anguilla, Saba, Montserrat, St. Thomas, and Nevis (see list in Giovas and Fitzpatrick 2014).

Previous Evidence from Grenada

While Archaic Age cultural material has remained absent in the Windwards, various proxy evidence has provided tantalizing clues. A paleolimnological coring project

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17 Charcoal from Ripley Bullen's excavation of the Buccament Cave entrance (120 cmbs and associated with Saladoid-Barrancoid ceramics) dates to calAD 5-660 (RL-73, CI:95.4%); originally reported 1670 ± 160 BP (Bullen and Bullen 1972:153)
across nine islands in the Lesser Antilles recently documented charcoal signals, decline in arboreal pollen, and other changes in vegetation beginning in Grenada ~3650 BC and progressively moving northward through the Windwards (Siegel et al. 2015). Charcoal signals could be natural (Caffrey and Horn 2015), and given Grenada’s modern and relatively recent volcanic activity over the last 10,000 years, consonance between charcoal peaks and arboreal decline could reflect volcanic activity (Arculus 1973; Fritz et al. 2011; Lindsay et al. 2005; Robertson 2005). And even if humans were present, charcoal signals could still be natural — as has been the case in the Pacific, particularly Madagascar (Douglass and Zinke 2015). However, reexamination of the Grenada cores below offers some evidence that the charcoal signals may indeed be anthropogenic.

Another, particularly misleading proxy often cited for Archaic presence are unprovenienced groundstone axes and workstones (grooved boulders) (Cody 1990a; Fewkes 1922; Wilder 1980). While these artifacts and features were likely present at some Archaic sites (e.g., Banwari Trace, Boomert 2000:58), many groundstone tools are found in Ceramic Age assemblages as well.18 Indeed, workstones are a predominantly Late Ceramic trait in the Windward Islands (Chapter 4). Isolated collections of shell tools, such as those found at Magazin Beach (GREN-G-33, Hanna 2017:141) are also out of context and may be from Ceramic Age tool kits or completely natural. That said, Magazin Beach is on the north side of Point Salines, just ~1000 meters from where a possible Archaic site has now been identified.

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18 Unfortunately, Huckerby (Fewkes 1922) and later Wilder (1980) “collected” hundreds of groundstone axes from Grenada without recording their provenience (see Hanna in rev.). For what it’s worth, four of the five remaining axes known from archaeological contexts are Ceramic Age (the fifth is an isolate).
Methods

Fieldwork

An Archaic sample from the St. John's River Site (G-8) was acquired during the St. George’s Community Archaeology Project (SGCAP), a youth summer program run by the author in 2011 and 2012 (Hanna and Jessamy 2012). As described below, several samples of charcoal and shell have been dated from this work, problematically ranging from Archaic to modern ages. The site's assignment to the Troumassignan period is derived from an attribute-based analysis of over 2500 ceramic sherds (Hanna and Jessamy 2017), and one radiocarbon date from the period (Chapter 3).

The samples from Black Point (G-20), Salt Pond (G-21), Grand Bay Beach (G-22), and Beausejour (G-34) were recovered during an island-wide survey (Hanna 2017). In 2016, a total of 71 auger tests were conducted using a 10cm-wide telescoping bucket auger with a maximum depth of 2.5 meters below surface. Basic soil description was recorded in the field (e.g., horizon, texture, Munsell color, structure, and weathering), and a total of 210 pint-sized soil samples were collected in sterile polyurethane bags for further pedogenic, botanical, and geochemical analyses. During lab work, radiocarbon samples were selected and prioritized for immediate analysis. Preliminary results from this work are presented in Hanna (2017), a review of the radiocarbon results is presented in Chapter 3, and results of the soil analysis and predictive model can be found in Chapter 5.

Radiocarbon Dating

All radiocarbon dates presented herein were calibrated in OxCal 4.3.2 (Bronk Ramsey 2018), using either the IntCal13 or the Marine13 Northern Hemisphere curves (Reimer et al. 2013). New samples were prepared by the author at the Human Paleocoeology and Isotope Geochemistry Lab at Pennsylvania State University where pretreatment for
charcoal followed standard acid-base-acid treatment and combustion in vacuum-sealed quartz tubes. Shells underwent initial scraping, standard 50% leaching, and hydrolysis with 85% H$_3$PO$_4$ immediately before graphitization. All samples were graphitized and subsequently measured at the new AMS radiocarbon facility at the Pennsylvania State University.

Marine samples were calibrated with a regional offset (delta-R) of -28 ±25 (Wagner et al. 2009). The divergence between marine and atmospheric systems has been known since the early days of radiocarbon dating (e.g., Keith and Anderson 1963; Kulp et al. 1952; Libby et al. 1949), and generalized global marine corrections have continued to improve (Reimer et al. 2013), but dating marine shells remains problematic in some contexts. Carbonates continue to chemically interact with their environment post-formation, and the majority of components dated are inorganic calcium-carbonate, rather than the small percent of organic conchiolin in mollusk shells. However, the calcium carbonate of shells is derived from suspended carbon in the water column, and there is some evidence that the Cariaco Basin (and likely entire Caribbean) has a “shallow, well-ventilated source that feeds upwelling in the basin,” (Guilderson et al. 2005). In other words, the shell samples dated in the Caribbean should be close to the global marine curve and therefore, less problematic. Given that six of the eight conch shells dated in Grenada fit well with their contexts (the other two being Archaic, discussed below), the delta-R in Grenada does not appear to be as variable as, for example, Hadden and Cherkinsky (2015, 2017) found for
the Florida panhandle. However, such a study on conch in the Lesser Antilles (ideally from each island) would be welcomed.

**Climate and Vegetation**

Several lake core projects in Grenada have helped document changes in vegetation through time — some likely anthropogenic (McAndrews 1996; Sharman 1994; Fritz et al. 2011; McAndrews and Ramcharan 2003; Siegel et al. 2015). Among other things, these studies suggest the drought-inducing, southward movement of the ITCZ in the late Holocene (Cooper 2013; Haug et al. 2001) did not affect the southern Caribbean islands as dramatically as in the northern Caribbean and Central America (e.g., Ebert et al. 2017; Gill 2001; Hoggarth et al. 2017; Kennett, Breitenbach, et al. 2012).

For this paper, three palaeoclimate proxies were selected as representative of the southern Caribbean based on relevance to the Archaic period and resolution quality of the data: *C. Boldii* ostracods from Lake Valencia, Venezuela (Curtis et al. 1999), Titanium (Tt) from the Cariaco Basin, Venezuela (Haug et al. 2001), and O$^{18}$ from Harrison’s Cave, Barbados (Mangini et al. 2007). Two other proxies from the northwestern Caribbean (Miragoane, Haiti and Macal Chasm, Belize) were also added for comparison (Hodell et al. 1991; Webster et al. 2007). Additionally, data from five paleolimnological cores previously analyzed in Grenada were included: Levera Cores A and B (Sharman 1994), Lake Antoine and Meadow Beach (Siegel et al. 2015; Siegel 2018), and Grand Etang Cores 1 and 2 (Fritz et al. 2011). Data were acquired using WebPlotDigitizer, a free online tool

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19 There are currently 13 shell dates from Grenada, eight from *Lobatus gigas* samples. All align well with associated charcoal dates, except the St. John’s River (G-8) and Black Point (G-20) samples under discussion. These two dates are therefore unlikely to reflect errors in calibration or measurement.
that digitizes graph data (Rohatgi 2018). All radiocarbon dates from lake cores were recalibrated to the most recent calibration (IntCal-13) using Bayesian sequences in OxCal 4.3, with an added endpoint to serve as a *terminus post quem* for each core (set to whenever the core was originally extracted, e.g., -42 BP for the Levera Cores) (Bronk Ramsey 2009a; Buck et al. 1996). These posterior dates were then used to estimate depths of undated levels using a Gaussian, rather than uniform, sedimentation model, employing the technique outlined in Heaton et al. (2013).

![Figure 2.3 Archaic Age Radiocarbon Dates from Grenada](image)

**Results**

**Site Contexts and Radiocarbon Results**

**St. John’s River (GREN-G-8)**

The earliest radiocarbon date associated with human activity in Grenada comes from the St. John’s River Site (GREN-G-8) — a heavily disturbed Troumassoid period settlement on the outskirts of Grenada’s capital, St. George’s (Figure 2.3). A conch shell fragment from 30-45 cmbs was radiocarbon dated to 1700-1380 BC (PSUAMS-1435, CI:95.4%), but another sample of charcoal from the same level dated to AD 1999 (i.e., a
modern date). Given the level of disturbance (see Chapter 3), it is possible that Ceramic Age occupants of the site simply used an older shell for tool-making (known as the “old shell” problem, Rick et al. 2005) — perhaps even one that washed up on the beach and was never eaten by Archaic peoples. However, this date now aligns with another shell from Black Point, eight kilometers south, suggesting (loosely) that these dates reflect an Archaic presence on Grenada. Given the association of Archaic and Troumassan sites (see below), it is also possible that GREN-G-8 is a Troumassan settlement atop an earlier Archaic site, with both too badly disturbed to differentiate today.

Black Point (GREN-G-20)

Ripley Bullen's 1962 survey of Grenada identified several sites in the Point Salines area (Figure 3.4), nearly all of which he placed in his Saline ceramic phase, now aligned to the early Troumassan period, AD 750-900 (Bullen 1964, and see Chapter 3). In 2016, two radiocarbon samples were acquired from Bullen's Locus 2 of Salt Pond (GREN-G-21), on the southwest edge of the pond. Ceramics and shell occurred from 0-55 cmbs, from which charcoal at 14-25 cmbs was dated to AD 780-900 (PSUAMS-1320, CI:87.2%) and an ark shell (Anadara sp.) at 34-45 cmbs dated to AD 745-900 (PSUAMS-3020, CI:95.4%), both of which align with the expected range of the associated Troumassan ceramics.

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20 For all radiocarbon dates mentioned (unless otherwise noted), preference is given to modelled (Bayesian) 14C dates calibrated in OxCal v4.3.2 (Bronk Ramsey 2018) with the narrowest range for probabilities over 85% confidence interval (CI, sometimes called the “sigma”). For instance, Cody's Beta-85935 dated to AD 775-1020 (CI:95.4%), but AD 775-845 has very low probability (CI:5.9%); thus, the narrower range is used: AD 860-1020 (Beta-85935, CI:89.5%). Raw, calibrated, and modelled dates, as well as context and other information are presented in Table 3.1.
The sole exception to Bullen's ceramic assemblage was his shovel test at Black Point (GREN-G-20), 130 meters southwest of Salt Pond, where he identified possible Cedrosan Saladoid ceramics that he believed were the earliest on the island (Bullen 1964:35). This was likely the result of selective sampling, since his later attempts to reproduce the Cedrosan assemblage resulted in only Saline ceramics (Bullen 1964:46). This was also the case in 2016, when ceramics collected from Bullen’s shovel-test area (now under water) all fit within a Troumassan assemblage (Hanna 2017), with the exception of three possible artifacts: a conch “celt” tool, a coral “shaft” tool, and a whole conch shell with side-cut extraction, reminiscent of (though not definitely) Archaic assemblages (Figure 2.4). However, none are conclusively cultural.

Figure 2.4 Possible Archaic Artifacts from submerged locus at Black Point (from left: whole conch with side-cut extraction, coral “shaft” tool, and a conch “celt” tool)
Above the water line, more Troumassan (Saline series) ceramics were collected 25 meters away in the eroding hillside. A conch shell fragment from this collection, however, produced an Archaic Age radiocarbon date of 1595-1405 BC (PSUAMS-3019). Like St. John’s River (G-8), the Black Point (G-20) sample was just a fragment (not a whole conch) and could be the result of Ceramic Age toolmaking with “old” shells. Nonetheless, both the G-8 and G-20 dates overlap significantly enough to be combined in an OxCal model with 113.5% (out of 120) agreement between 1595-1415 BC. It seems possible that these shells originated from Archaic Age middens that were later used by Ceramic Age peoples, as the contexts suggest. The original location of the St. John’s River midden remains unknown, but for Black Point, the source of the old shell may be just 900 meters west, on Grand Bay Beach.

Grand Bay Beach (GREN-G-22)

At Point Salines, Ripley Bullen also conducted a quick surface collection at a site he called Grand Bay (GREN-G-39), in an eroded gulley roughly 800 meters east of Salt Pond, seemingly inland at the eastern end of the Bay. All artifacts recovered fit his Saline typology for the area (Bullen 1964:35). Fifteen years later, during construction of the Maurice Bishop International Airport (MBIA), Henry Petitjean Roget excavated two test pits nearby, roughly 150 meters southwest of Bullen’s site (Unit S7 at 75 m and Unit S8 at 30 m from the beach). These excavations recovered numerous conch shells but only S7 (the inland unit) contained ceramics — a few plainware of what Petitjean Roget called Cedrosan Saladoid (1981:12), though this assignment has not been confirmed.
Along the beach at Grand Bay, there are piles of conch shells lining the shore and continuing north to Degra Bay (GREN-G-27) (Figure 2.5). Few other artifacts can be found in the middens, but in 2016 a few weathered sherds (coarse plainware) were recovered from an eroded bluff at the western end of the bay, ~500 meters away (probably part of the Salt Pond 3 locus). Close inspection of the shell middens revealed that they were indirectly exposed by nearby sand mining that occurred during (and after) construction of
the MBIA. Comparison of aerial photography taken in 1951 and 2016 confirms the change in the shoreline over a 60 year period (Figure 2.6) and shows the middens had once lined a small salt marsh, ~50 m from the beach. Meanwhile, the stratigraphy in the next beach to the east, Degra Bay (see map in Figure 3.4), suggests the sand mining allowed the sea to erode the matrix and collapse the shells on top of each other into the piles visible today (top of Figure 2.5).

Apart from the aerial photographs and stratigraphic analogy of Degra Bay, the radiocarbon dates from Grand Bay Beach also support the sand-mining scenario: a conch shell taken from the top of a midden dated to AD 85-270 (PSUAMS-3022, CI:95.4%), while a conch 20 cm below, inside the midden, dated to 760-530 BC (PSUAMS-3017, CI:95.4%). This difference of ~600 years suggest the shells should not be so close together. The method of extraction evident on these (and most shells observed at Grand and Degra Bays) appears to be via smashing or side cuts, which is different from the punched-apex method more common to the Ceramic Age (Watters 2017), although some do appear to have punched apices as well.
Figure 2.6 Aerial Images of Grand Bay in 2016 (left) and 1951 (right), showing change in shoreline following airport construction; (Degra Bay is to the east, just off the map)
Radiocarbon Dates and Vegetation History

Two separate coring projects have analyzed pollen from Lake Antoine in northeastern Grenada (McAndrews and Ramcharan 2003; Siegel et al. 2015). Both retained long sequences going back to ~10,000 BC, when the lake formed inside a volcanic crater. Siegel focused mostly on the sustained charcoal signals beginning 3-4000 BC, which he interprets as evidence of human disturbance, both in the Lake Antoine core and another just south at Meadow Beach, near the Pearls site (GREN-A-1).

As mentioned above, some signals thought to be anthropogenic in these cores could have natural explanations. One of the most compelling patterns in the Meadow Beach core is the decline of arboreal pollen ~2800 BC, perfectly aligned with a surge in charcoal from the same core (Figure 2.7). This could be a volcanic event, yet Fritz (2011) recorded volcanic tephra events in cores from Grand Etang and Lake Antoine, and none align with the decline in arboreal pollen.21 Some charcoal could also be associated with lightning ignitions, but precipitation proxies (fern pollen, Cariaco Tt, among others) suggest wet conditions during this period. Indeed, when charcoal increases, especially in the Meadow Beach core, the climate records suggest mesic — not arid — periods. That is, arboreal pollen decreases and charcoal increases during a relatively wet period, adding to the possibility that the charcoal signals represent human pursuits such as slash-and-burn agriculture.

21 Only the earliest and latest tephra events (~3500 BC and ~AD 150 respectively) loosely align with charcoal signals in the other cores.
Figure 2.7 Paleoenvironmental Record during Grenada's Archaic Age
Reexamination of Siegel’s cores and those from Levera also reveal the presence of Spondias sp. pollen, which may represent human-introduced (or maintained) tree crops like golden apple (S. dulcis), hog plug (S. mombin), and yellow plum (S. purpurea) — the only Spondias species present in Grenada today (Hawthorne et al. 2004, S. dulcis may be an historic introduction). While the Meadow Beach Spondias signal generally tracks arboreal pollen — declining as charcoal increases — the Lake Antoine Spondias signal increases with charcoal, strengthening the possibility of a horticultural signal. Given the presence of Spondias at the start of both cores, however, the signal could not represent human introduction but rather management (if at all).

In terms of the Archaic Age radiocarbon dates presented above, the G-8 and G-20 dates align with charcoal peaks at Meadow Beach and Spondias from Lake Antoine. Indeed, the first three dates align with wetter periods in the climate records (including fern pollen from Lake Antoine). The latest Archaic date (PSUAMS-3022 from Grand Bay Beach) generally aligns with a charcoal peak in Lake Antoine, a rise in Spondias in all records, and herbs from Lake Antoine. Might these correlations add credence to earlier anthropogenic charcoal peaks, such as the decline in arboreal taxa at 2800 BC?

To be sure, Siegel et al. (2015) acknowledge that there are charcoal peaks in the record that pre-date the current timing for human arrival in the Caribbean, though this cutoff is somewhat arbitrary. Nonetheless, these records do not offer conclusive evidence — while the possibility for anthropogenic causes cannot be ruled out, neither can the risk of cherry-picking patterns in the data.
Discussion: Island Hopping and the Southward Route Hypothesis

Old Shells

The Archaic dates from St. John’s River and Black Point are well-aligned but from otherwise Late Ceramic Age contexts. There is little doubt that both conches died around the same time, but how they were transposed to later assemblages can only be surmised. That both were small pieces (not whole conches), possibly broken in the process of making a tool, lends evidence to Late Ceramic toolmaking with “old shells.” The nearby shell and coral tools at Black Point (Figure 2.4), while possibly Archaic, might also be examples of Ceramic Age shell-tools (or they could be completely natural). In this case, directly dating them would not necessarily answer the question.

It is worth noting that, while shells (especially conches) are common within Grenada’s Ceramic Age middens, they are usually associated with ceramics, fauna, and other organic remains (e.g., GREN-G-15, the shell midden on Hog Island). Outside the Point Salines area, the only middens purely composed of shell are historic and/or modern (e.g., the enormous Woburn Shellmidden, GREN-G-38, is currently considered historic). Modern fisherman tend to shuck conches on their boats and toss the shells back into the water (personal observation, see also Wilson et al. 2005). The behavior in the Ceramic Age may have been similar, where only shells intended for tool use would have been carried back. Indeed, Jones O’Day and Keegan (2001) note that shells found in Ceramic Age middens are probably tools or debitage and may not have been eaten by the toolmaker. The homogenous conch middens at Grand Bay therefore suggest a different behavior.

It is also interesting that, like Heywoods in Barbados, all the Archaic dates in Grenada are associated with Late Ceramic sites. The Heywoods site consists of Suazan-Troumassoid deposits atop of Archaic middens (Drewett 2007), as has also been reported
in Antigua (Nicholson 1976). While earlier sites are present on these islands, there is no apparent mixing of Archaic and Saladoid, as reported in the Greater Antilles (e.g., Callaghan 2003; Davis 2000; Keegan 2006, 1989a; Lalueza-Fox et al. 2003; Oliver 1999; Rivera-Callazo 2011; Rodríguez Ramos 2010; Rodríguez Ramos et al. 2008; Schurr 2010; Vilar et al. 2014). One explanation could be the subsistence change in the Late Ceramic towards more coastal resources — foraging strategies that align with Archaic lifeways (Chapter 4). It could also be a consequence of the population increase during the Troumassoid, when settlements expanded into less-desirable areas (Chapter 5). And there were also changes in sea-level, which would have been higher during the wetter Early Ceramic period and lower during the dryer Troumassoid (Chapter 4). Long-abandoned (Archaic) processing areas may have been exposed during this time, allowing easy access to materials for shell tool-making. All of these explanations may have been factors in the formation of the Black Point and St. John’s River sites.

The two Archaic dates from Grand Bay Beach (G-22) are from much better contexts, though slightly later than the G-8 and G-20 samples, limiting our ability to conclusively assign them to the Archaic Age. At 760-530 BC, the earliest Grand Bay Beach date (PSUAMS-3017, CI:95.4%) is right on the cusp of the earliest Ceramic Age dates in Puerto Rico (e.g., Vieques and Angostura), and the Leeward Islands (e.g., Hope Estate and Trants), all of which are also only slightly earlier than the earliest dates at Cedros and Palo Seco in Trinidad (Boomert 2000). However, these sites are not aceramic conch middens but residential settlements with diverse middens and distinctive, well-fired pottery. They also generally contain less shell than later period sites, which led earlier researchers to presume a more terrestrial focus of the earliest settlers (e.g., Goodwin 1980; Jones 1985;
Keegan 1989b; Rainey 1940; Wing 1968). Indeed, Point Salines does not contain the rich soils and riparian habitats characteristic of the earliest Ceramic Age sites on Grenada (Chapter 5).

To be sure, the later date from Grand Bay Beach (PSUAMS-3022, AD 85-270) falls squarely in the Ceramic Age of the Leeward Islands and is on the cusp of Grenada’s earliest Ceramic Age sample from Beausejour (PSUAMS-1317, AD 325-410, CI:90.8) (Figure 2.3, see Chapter 3). Nonetheless, because PSUAMS-3022 is in the same shell midden as the much earlier date (just 20 cm above), and because it is also not associated with any other Ceramic Age assemblage (nor does it overlap with any Ceramic date in Grenada), it is reasonable to consider this a late Archaic Age deposit.22

Given the lack of other artifacts, these shell middens may have been processing areas, perhaps intermittently used by small Archaic bands. The Ceramic Age locus of Grand Bay (G-39) investigated by Bullen is ~150 meters north, but the Troumassan ceramics there (as far as we know) are much too late to be contemporaneous with the shells on the beach. Indeed, the closest Ceramic Age deposit with a radiocarbon date is Salt Pond-2, 800 meters west (see above). It is estimated that the start of the ceramics at 55 cmbs there could be no earlier than AD 600.23

22 The G-22 shells are also unlikely to be natural accumulations (c.f. Lundberg 1985; Watters et al. 1992). One would expect a natural deposition to include a diversity of shell species, whereas the homogenous distribution of conch within the Grand Bay Beach shell middens suggests human selection. Additionally, most (if not all) shells are either punched (on side or apex) in a manner typical for extraction of the animal, or otherwise highly fragmented (perhaps purposively smashed), suggesting human intervention.

23 Charcoal from 14-25 cmbs was dated to AD 780-900 (PSUAMS-1320, CI:87.2%) and a shell at 34-45 cmbs was dated to AD 745-900 (PSUAMS-3020, CI:95.4%), suggesting the entire sequence was deposited during a short timeframe. Thus, 15 cm deeper is not expected to be much earlier, if at all.
The potential overlap in Archaic and Ceramic occupations, however, presents the possibility that there may be an earlier Ceramic Age site in the Salt Pond area that was a point of interaction between early Ceramic groups moving into the Caribbean and the Archaic groups they eventually replaced.\textsuperscript{24} It is also likely that the earliest Ceramic site, Beausejour (GREN-G-34), was settled while Archaic peoples were still intermittently frequenting Point Salines.

**Shell Extraction: A Targeted Resource**

The earliest groups in the Caribbean were likely at least semi-sedentary horticulturalists. Rouse had defined the earliest period (his Lithic Age) via chert macroblades of the Courian Casimiroid in Hispaniola, supposedly the repertoire of more mobile, big (and small) game hunters, loosely tied to the Joboid paleoindians of South America (Rouse and Allaire 1978). Yet the artifactual evidence (e.g., Wilson et al. 1998) and marine simulation data (e.g., Callaghan 1990) now indicate Casimiroid types are likely derived from the Belizean Archaic (not Joboid), which exhibit more sedentary lifestyles of low-level agriculturalists engaged in both small-game hunting and agricultural domesticates (Jones 1994; Lohse et al. 2006).

It is possible that more mobile lifeways were pursued once people were in the islands, as appears evident in the Leeward islands (Armstrong 1980; Davis 2000; Hofman and Hoogland 2003; Watters et al. 1992). However, seasonal procurement of specific resources based on climate and animal cycles does not preclude permanent villages. Certainly, by about 2500 BC, there is evidence for plant management (Fitzpatrick and

\textsuperscript{24} The site of Bagadi Bay (G-38), ~1.6 km to the east, may be a Saladoid-Barrancoid site, but only a few select ceramics are known from a private collection.
Keegan 2007; Newsom 2008; Pagán-Jiménez et al. 2015), low-fired, utilitarian pottery (Fitzpatrick 2015; Rodríguez Ramos et al. 2008), and possibly even management of certain animals such as hutia (family Capromyidae) (Colten et al. 2009; Colten and Worthington 2018). Like their Belizean counterparts, these Archaic groups practiced a semi-sedentary, delayed-return economy dependent on home-garden trees and tropical root-crops (Navarrete 2008; Newsom 2008; Rodriguez Ramos et al. 2013).

On the other side of the Caribbean, Ortoiroid groups in South America are also presumed to have practiced mobile lifestyles focused on hunting, fishing, and foraging. Windbreak structures found at El Conchero, Guyana and related sites (Boomert 2000:73) have been interpreted as makeshift campsites characteristic of a highly mobile lifestyle. Yet they could easily represent seasonal procurement away from more permanent villages. The basic Ortoiroid material assemblages (shared by several different complexes over time in coastal South America, including Alaka in Guyana, Banwarian and Ortorian in Trinidad, and Manicuoaroid, Mordanoid, and Conchero in Venezuela) consist of small, percussion-based flakes and choppers with larger groundstone tools (hammerstones, axes, pestles, edge grinders, etc.) and mortars (Boomert 2000). Not only does this repertoire signify a strong focus on plant-processing, it is also less portable (Newsom and Wing 2004; Pagán-Jiménez et al. 2015).

Rather than foraging from patch to patch, encounter to encounter, Archaic sites in the Caribbean exhibit either diverse domestic middens or relatively homogenous middens indicative of specific processing areas (akin to Binford’s (1980) “collector” category). The Grand Bay Beach and Degra Bay shell middens are reminiscent of the targeted resource extraction seen at northern Archaic sites such as the Strombus Line in Barbuda (Rousseau
et al. 2017; Watters et al. 1992). There, a shell midden at least 3 km long with thousands of conch shells has been interpreted as mostly Archaic (and possibly Early Ceramic) resource extraction focused exclusively on conch meat. Shell middens in coastal Venezuela have also been characterized this way (Antczak 1998; Hofman et al. 2010), as have later-period sites such as MC-6 in Turks and Caicos (Keegan 1992). Aside from conch meat, targeted resource mobility during the Archaic has also been discussed for fish spawning and bird migrations (Espersen et al. 2017; Hofman et al. 2006) and Antiguan chert (Knippenberg 2007). It is possible that Tobago and Grenada (and possibly Barbados) formed a similar resource cycle centered in Trinidad, with only seasonal visitation (e.g., for conch meat).

This ephemeral presence on Grenada, however, would appear to contradict the charcoal record in the paleolimnological cores discussed above, which show sustained deforestation in the Archaic Age. Yet this need not require permanent settlements. Hunting with fire was quite common amongst various indigenous groups in northern South America (e.g., Roth 1924:175,183; Welch 2014), and is also known in other parts of the world (e.g., Bliege Bird et al. 2008; Cronon 1983). Whether large game were present at human arrival is an open question, but teeth of an extinct sloth species (family Megalonychidae) and previously unknown capybara (*Hydrochaeris galordi*) were found in mudstone formations at Prickly Bay (4 km east of Grand Bay), dating to ~3 mya (MacPhee et al. 2000). It has been hypothesized that the Caribbean was the last refuge for certain megafauna, such as sloths, who were finally exterminated when humans arrived (Cooke et al. 2017; MacPhee 2009; Steadman et al. 2005).
Fire is also an integral part of felling and clearing trees in the Amazon (Denevan 2001:39–40), as well as the Caribbean (Boomert 2000:66). And a number of horticultural plants likely arrived during the Archaic period, including maize (Zea mays), root crops like manioc (Manihot esculenta) and arrowroot (Maranta arundinacea), and various tree crops like papaya (Carica sp.), avocado (Persea americana), sapodilla (Manilkara sp.), among others (Farrell et al. 2018; Newsom 1993, 2008; Pagán-Jiménez et al. 2015; Pagán-Jiménez and Carlson 2014). The slash and burn (swidden) cultivation suggested by the limnological charcoal particulates may be similar to regimes seen in other semi-mobile horticulturists from the ethnographic present (e.g., Posey 1985; Tucker 2006; Yasuoka 2013), practicing low-level, sometimes unintentional planting, burning, and otherwise “domestication” of the landscape (Bird et al. 2016; Erickson 2006; Smith 2001). Such a subsistence strategy also corresponds with the climate record. Prior to 500 BC, the Cariaco climate record (which matches the Grenada records well) is extremely variable, which would have made agricultural pursuits more risky (e.g., Richerson et al. 2001) (a pattern that reoccurs during the Late Ceramic period as well). What we see in the charcoal record, then, may be casual horticultural pursuits and plant management by Archaic groups that only occasionally visited Grenada.

Regional Colonization Patterns: Ortoiroid or Casimiroid?

While we now have some potential evidence that Grenada was frequented during the Archaic Age, the evidence pales in comparison to that seen in the Leeward Islands. If anything, the evidence from Grenada confirms that the Archaic Age in the Windwards was much more transient than in the north. This regional pattern presents two additional points: 1) the reason for the late Ceramic Age settlement of the Windwards cannot be due to
avoidance of Archaic peoples who were only occasionally present, if at all; and 2) either Ortoiroid groups never migrated into the Antilles (i.e., all the Archaic sites are derived from Casimiroid peoples) or they were drawn to areas where other Archaic peoples were already living (as could also be the case for the Early Ceramic Age).

*Archaic-Ceramic Age Interactions: Attraction (not Avoidance)*

It is worth reiterating that the regional settlement pattern seen during both the Archaic and Early Ceramic could stem from the same cause. Some islands with heavy Archaic focus (e.g., Antigua) may have been initially avoided (Giovas and Fitzpatrick 2014), which might also be a factor in their standstill at the Mona Passage. However, Late Casimiroid settlements in Hispaniola containing nascent Archaic pottery, horticultural practices, and semi-permanent settlements indicate exchange and interaction between Archaic and Early Ceramic populations (Bright 2011:40; Callaghan 1990, 2003; Davis 2000; Keegan 2006, 1989a; Lalueza-Fox et al. 2003; Oliver 1999; Rivera-Callazo 2011; Rodríguez Ramos 2010, 2008; Schurr 2010; Vilar et al. 2014). Interaction on the South American coastline is also evident in the late phase of Manicuaran Ortoroid on Cubagua Island, Margarita (Punta Gorda complex) and the late phase of Conchero, Ortoroid around Barcelona, Venezuela (Pedro Garcia complex), where Saladoid “tradeware” was identified amongst the otherwise Ortoroid complex of groundstone, side grinders, flake tools, and shell gouges, supported by radiocarbon dates (Boomert 2000:88; Rouse and Allaire 1978:455).

This overlap in Archaic-Ceramic traditions may indicate that incoming Ceramic groups skipped the Windward Islands precisely because there was not a substantial Archaic population present. That is, they were attracted to the more populated northern Caribbean.
In Human Behavioral Ecology, this is known as the “Allee Effect”, where the suitability of a location can increase with the population (rather than immediately decrease) (Bliege Bird 2015; Coddin and Bird 2015; Greene and Stamps 2001; McClure et al. 2006; Kennett and Winterhalder 2006). There are good reasons for this: Archaic knowledge of the environment, increased mating pool, communal hunting/fishing, protection from enemies, technology sharing, domesticated landscapes (feral gardens and food crops), etc. Not only does this help explain Ortioroid influences further north but also the reason Ceramic Age settlers preferred to settle in the northernmost islands first as well — that is where their network in the Caribbean was centered.

Colonization of the Windwards: Southward, Northward, or Both?

The “Southward Route Hypothesis” (e.g., Callaghan 2001; Fitzpatrick et al. 2010) attempted to rectify the regional colonization patterns by suggesting that the Early Ceramic sites in the Leeward Islands slowly expanded southward. This may be the case, but there is also evidence for continued immigration from the mainland. In Grenada, the first ceramics were not purely Cedrosan-Saladoid (as would be supposed if they arrived from the north) but a strongly Barrancoid influenced variation termed Saladoid-Barrancoid (Bullen 1965, 1964; Hanna 2017). These ceramic types may signify a post-Cedrosan wave of Barrancoid migrants from the Guianas region (Allaire 1999; Granberry and Vescelius 2004; Taylor 1977), which was likely followed later by a migration of Arauquinoid settlers in the Troumassoid period (Chapter 4). Secondly, the continued translocation of South American flora and fauna throughout the Early Ceramic Age (deFrance et al. 1996; Giovas 2017b; Giovas et al. 2011, 2016; Laffoon et al. 2013; LeFebvre and deFrance 2014; Newsom and Wing 2004; Stokes 1998; Wing 1989, 2008; Wing and Wing 1995), suggests
not only continued interaction with the mainland but possibly also the *direction* of the migration—i.e., not solely a southward population expansion.

**Conclusion**

Four new Archaic Age radiocarbon dates were presented from Grenada, none without some doubt, but at least two appear to be from an intact Archaic Age context. The character of the Grand Bay Beach site suggests specialized extraction similar to that seen at other Archaic sites in Leeward Islands. Given the similarity in assemblages (conch middens), it is possible that Barbados, Tobago, and Grenada were part of an Archaic Age resource cycle centered in Trinidad. Seasonality studies on shells from these middens would be a productive future direction. It is also possible that Ortoiroid groups were more attracted to the northern islands, where larger populations were situated. Ceramic Age groups may also have skipped the southern Lesser Antilles for the same reason. Nonetheless, paleolimnological evidence from Grenada aligns with these new dates, suggesting casual manipulation of Grenada’s environment during the Archaic Age.
CHAPTER 3
Camáhogne’s Chronology:
The Radiocarbon Settlement Sequence on Grenada, West Indies

Abstract
Although 87 prehistoric sites have now been documented on Grenada, little has been formally published. This paper examines the extant radiocarbon sequence associated with fifteen pre-Columbian sites on the island, ranging from the Archaic to early French colonial periods (~1500 BC - AD 1650). Where possible, sample ranges were modelled with Bayesian techniques, and those associated with diagnostic ceramics were used in trapezoidal distribution models to help restructure the island’s local ceramic chronology. It is argued that Ceramic Age populations did not settle Grenada until ~AD 200-300, during the Saladoid-Barrancoid period, and few settlements predate AD 750. The subsequent Troumassan period is here considered a transitionary phase between Saladoid-Barrancoid and Suazan ceramic types. Contrary to current paradigms, the latter sites are shown to continue to the early French period when two groups were reportedly present — “Caraïbes” and “Galibis.” It is hypothesized that the Caraïbe were Arawakan-speaking, Suazan potters while Galibis were Cariban-speaking, Cayo-potters who fit the Island Carib identity. That is, for Grenada at least, the group called “Caribs” in the early colonial period were different than those called “Caribs”/Island Caribs today, presenting a confounding factor to efforts linking the historical “Carib” ethnicity to a pottery tradition.

Keywords: Caribbean, Cayo, Colonization, Galibi, Kalinago, Trapezoid Model, Troumassoid, Windward Islands

25 A version of this chapter is currently under review at The Journal of Anthropological Archaeology.
Introduction

Grenada is the southernmost island in the Caribbean archipelago, roughly 90 miles from Trinidad and Venezuela. Previous estimates for the total number of pre-Columbian sites on Grenada have ranged from fourteen (Bullen 1964; although he mentions 20 — see Appendix D) to sixty-five (Bright 2011; Harris 2001), although many authors simply refer to the most intensively studied site of Pearls (GREN-A-1) as a proxy for the entire island. However, a recent inventory amassed through both field survey and a salvaging project at the Grenada National Museum has tallied 87 pre-Columbian sites and counting (Figure 3.1) (Hanna 2017). Moreover, radiocarbon dates from Pearls — previously considered the earliest site — were found to be hundreds of years later than reported. Pearls is indeed an important site in the Lesser Antilles, both for its size and duration of occupation (from at least AD 300 to 1650), but several sites in Grenada deserve at least as much attention.

Background

Human occupation of the Caribbean archipelago began 3-5000 BC, during the Archaic Age, when lithic blade producers known collectively as the Casimiroid likely left Central America for Cuba (Rouse 1992; Wilson et al. 1998). By 2000 BC, lithic groundstone foragers from Trinidad and Venezuela (known as the Ortoiroid) are believed to have moved into the Lesser Antilles and interacted with Casimiroid groups (Hofman and Hoogland 2003; Keegan 1994; Rouse 1992; Wilson 2007). However, aside from the Archaic dates presented here, just three radiocarbon (shell) dates from Barbados are the only evidence of Archaic presence between Montserrat and Trinidad (Callaghan 2010; Drewett 2007; Fitzpatrick 2011).
Likewise, the earliest radiocarbon dates for Early Ceramic Age sites (500 BC- AD 750) have consistently come from Puerto Rico and islands north of Dominica, leaving a roughly 500-year gap from the earliest dates in the southernmost islands (Fitzpatrick 2006; Haviser 1997; Keegan 1995; Shearn 2017; Hofman and Hoogland 1999). Theories have abounded whether the earliest Ceramic peoples simply reached the northern islands first by sailing directly across the Caribbean Sea (known as the “Southward Route Hypothesis,” — Callaghan 2001; Fitzpatrick et al. 2010; Keegan 2000, 1985, 1989b) or whether they purposefully bypassed the southern Lesser Antilles, perhaps to avoid Archaic peoples (whose presence, as mentioned, is equally questionable) (Giovas and Fitzpatrick 2014).

Many have surmised the chronological gap is partly a product of disproportionate research on the northernmost islands, making challenges to age-old paradigms appear premature (Fitzpatrick 2006; Siegel et al. 2015). For instance, as a rough proxy for research attention, a recent tally of regional radiocarbon dates catalogued over 560 $^{14}$C dates for Puerto Rico alone, yet just 60 for the entire southern Lesser Antilles (comprising eight island states and hundreds of subsidiary islands — each with distinct pre-Columbian histories) (Fitzpatrick 2006; Rodriguez Ramos et al. 2010). For the southernmost island in the archipelago (called “Camāhogne” by its indigenous occupants) (Breton 1999:204) a large body of research had existed for Grenada, but it was largely unprocessed and relegated to type-written reports buried in the Grenada National Museum (GNM) (Hanna 2017).

The current paper draws on these and other past reports, as well as the author’s own fieldwork, to present a synthesis of the past 50 years of research in Grenada. Old and new radiocarbon dates are presented along with associated ceramic types, allowing a revised
settlement chronology for the island (Figure 3.1). The data show that, while there appears to be an ephemeral Archaic Age presence, there are indeed no Ceramic Age settlements prior to ~AD 200-300 on Grenada. This could align with the “Southward Route” hypothesis, although a separate migration from South America is also possible (Allaire 1999; Granberry and Vescelius 2004; Taylor 1977).

Methods

New radiocarbon dates presented here resulted from fieldwork in 2016 and 2017, where 113 bucket-auger tests recovered artifacts and soil samples from 19 sites (Hanna 2017). Samples were prepared by the author at the Human Paleoeconomy and Isotope Geochemistry Lab at Pennsylvania State University where pre-treatment for charcoal followed standard acid-base-acid treatment and combustion in vacuum-sealed quartz tubes. Shells underwent initial scraping, standard 50% leaching, and hydrolysis with 85% H₃PO₄ immediately before graphitization. All samples were graphitized and measured at the new AMS radiocarbon facility at the Pennsylvania State University.

A major issue with earlier chronologies for Grenada (and the Caribbean as a whole) is that radiocarbon dates are often presented in the uncalibrated form, which can have major consequences, especially for marine samples (Taylor and Bar-Yosef 2014:150). This was the case for one third of previously reported radiocarbon dates from Grenada (i.e., all dates before Cody Holdren 1998). For example, the shell samples from Pearls (described below) have been consistently reported without marine calibration, leading a generation of scholars to believe it was 400 years earlier. All new and old dates presented herein (Table 3.1) have been calibrated in OxCal 4.3.2 (Bronk Ramsey 2018), using either the IntCal13
or the Marine13 Northern Hemisphere curves (Reimer et al. 2013). Marine samples were calibrated with a regional offset (ΔR) of -28 ±25 (Wagner et al. 2009).

**Marine Shell Dates**

Although the divergence of the marine carbon cycle from the atmospheric cycle has been known since the early days of radiocarbon dating (e.g., Keith and Anderson 1963; Kulp et al. 1952; Libby et al. 1949) and generalized global marine corrections have continued to improve (Reimer et al. 2013), dating marine shells in some regions remains problematic. Carbonates continue to chemically interact with their environment post-formation, and the majority of components dated are inorganic calcium-carbonate, rather than the small percent of organic conchiolin in mollusk shells (Alves et al. 2018). The reliability of a radiocarbon-dated shell therefore depends on both the species and the context. For example, Hadden and Cherkinsky (2015, 2017) dated several museum gastropod specimens from pre-bomb contexts in the Florida Panhandle, finding the carbon in *Strombus alatus* too stochastic to formulate a reliable ΔR, which they attribute to potential freshwater inputs at the collection sites. On the other hand, *Busycon sinistrum* produced reliable delta-R correction, similar to other estimates for the area.

Estimates of regional ΔR corrections for the Caribbean range from -70 ±40 (Cooper and Thomas 2012; Reimer and Reimer 2006) to -19 ±23 (Fitzpatrick 2006) to (+)28 ±13 (Diaz et al. 2017). Based on these studies, as well the current offset suggested on CALIB’s website (Reimer and Reimer 2006), the true local reservoir is likely somewhere within -25 ±75. However, Grenada is in line with the southern Atlantic currents that move west-northwest through the Caribbean and north to the Gulf of Mexico. Thus, ΔRs from this part of the Caribbean basin would be closer to the local correction for Grenada than, say, those
in the Bahamas or Cuba (Guilderson et al. 2005:64). In reevaluating these data, Wagner et al. (2009) recommend a local correction for the Caribbean of -28 ±25, the ΔR adopted here.

**Single Dates**

Following Spriggs (1989) in Near Oceania, Fitzpatrick (2006) introduced “chronometric hygiene” to Caribbean archaeology by systematically filtering all known radiocarbon dates in the Caribbean through a set of standard criteria. Foremost among these was the need for multiple dates from each context. While ample data is ideal, given the costs associated with radiocarbon dating and the nature of survey work, this is often more aspirational than practical. For the present project, dozens (sometimes hundreds) of charcoal fragments were isolated in soil samples from each site, with each dated sample carefully selected based on contextual association with diagnostic artifacts, stratigraphy, and proximity to other samples (e.g., samples above or below in the same profile). There were often several samples prepared for each context, but for various reasons (ranging from contextual to technical) only one “good” radiocarbon date may be presently available for some sites (notably A-11, G-8, P-2, and P-7). As described below, the way the trapezoidal ceramic chronology is assembled allows dynamic refinement whenever new dates become available. Thus, more dates are always desirable, but we have to start somewhere.

**Old Dates**

Older samples had to be researched to determine the lab methods used. For example, in the case of Bullen’s shell from Savanne Suazey (RL-76), clarification was provided by Tucek (1971), which confirmed the sample was analyzed using the gas-counter technique with the conventional Libby half-life (5570 ±30) and the 1950 reference year.
Tucek does not describe RL’s pre-treatment methods, but carbonate preparation was fairly well understood by the late 1960s (Taylor and Bar-Yosef 2014:72). So much so that many labs did not see the need to “correct” marine sample measurements for δ¹³C fractionation (i.e., normalizing to -25‰ VPBD) nor to apply a marine calibration because the two effectively negate each other (Stuiver and Polach 1977:357). Thus, for the present paper, sample RL-76 was corrected using Stuiver and Polach’s table (1977:358) and a fractionation spreadsheet on the CALIB website (Stuiver and Reimer 2017) before being calibrated with the Marine-13 curve in OxCal. As expected, the final result of AD 1075-1490 (CI:95.4%) was not far from that originally reported by Bullen: AD 1290-1510 (Bullen and Bullen 1972:153).²⁶

²⁶ For all radiocarbon dates mentioned (unless otherwise noted), preference is given to modelled (Bayesian) ¹⁴C dates calibrated in OxCal v4.3.2 (Bronk Ramsey 2018) with the narrowest range for probabilities over 85% confidence interval (CI, sometimes called the “sigma”). For instance, Cody’s sample Beta-85935 dated to AD 775-1020 (CI:95.4%), but AD 775-845 has very low probability (CI:5.9%); thus, the narrower range is used: AD 860-1020 (Beta-85935, CI:89.5%). Uncalibrated, calibrated, and modelled dates, as well as context and other information are presented in Table 3.1 and OxCal CQL codes in Appendix C.
Figure 3.1 Pre-Columbian Sites on Grenada, designated by earliest occupation (enlarged sites have been radiocarbon dated)
Bayesian Modelling

Where possible, dates herein were also modelled using OxCal’s Bayesian statistical tools, which incorporate “prior” information about the samples (e.g., relative stratigraphy, sequential dates, etc.) into the calibration to help constrain the date’s error range (Bronk Ramsey 2009a; Buck et al. 1996). For example, if three charcoal samples were radiocarbon dated in the same profile, one can reasonably assume, via the law of superposition, that the upper sample should be later than the lower. Bayesian techniques take this relationship into account and offer a statistical constraint on the distribution. The statistical output includes the refined probability distribution and indicators about the date’s congruency within the model. The latter are represented by the agreement index, which has a scale of roughly 0–120% and a cutoff at 60%, correlated to the 5% confidence interval of a chi-square test (Bronk Ramsey 1995, 2009b).

For Bayesian models in this paper, samples taken from the same depth were tied together as a group, since they cannot be placed in sequential order. Because the group as a whole precedes or succeeds other groupings, a phase designation in OxCal was used as a container for an unordered group of dates within an otherwise ordered sequence. Similarly, using a boundary provides margins for an unknown span of time between two samples or phases (Bronk Ramsey 2000). Dates from the same profile were modelled as ordered sequences, while those from the same unit were included within either phases or sequences, as appropriate. The exact OxCal command used and the posterior agreement index can be seen in the Notes column of Table 3.1, and in the OxCal CQL codes in Appendix C. Visually, the modelling results can be seen in Figure 3.1, where the original histograms are lightened in the background and the posterior (modelled) ranges darkened in the foreground.
Figure 3.2 Pre-Columbian Radiocarbon Dates from Grenada
(Historic, Modern, and most Archaic dates not shown)
<table>
<thead>
<tr>
<th>Site (Site)</th>
<th>Lab ID</th>
<th>Material</th>
<th>Conventional (^{14}C) Age (BP)</th>
<th>cat (^{14}C)Aged(^{14}C)</th>
<th>C(t)</th>
<th>Modell</th>
<th>(F_{\text{int}})</th>
<th>T</th>
<th>(\Delta E_{\text{int}})</th>
<th>Context</th>
<th>Technique</th>
<th>Reported Intersect</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearls (GREEN-4-1)</td>
<td>U-14A-81</td>
<td>shell (Austraea sp.)</td>
<td>1725 ± 64</td>
<td>315-775</td>
<td>95.4</td>
<td>485-775</td>
<td>95.4</td>
<td>Unit B, 34-35 cm below shell</td>
<td>not specified</td>
<td>AD 200</td>
<td>reported as &quot;lassa shell&quot;</td>
<td>pressed, A=90.7</td>
<td></td>
</tr>
<tr>
<td>Pearls (GREEN-4-1)</td>
<td>U-14A-82</td>
<td>shell (Austraea sp.)</td>
<td>1414 ± 51</td>
<td>315-615</td>
<td>95.4</td>
<td>370-645</td>
<td>95.4</td>
<td>Unit B, 75-90 cm shell</td>
<td>not specified</td>
<td>AD 60</td>
<td>reported as &quot;tattoo shell&quot; (a member of Austraea genus)</td>
<td>phased, A=90.1</td>
<td></td>
</tr>
<tr>
<td>Pearls (GREEN-4-1)</td>
<td>U-14A-83</td>
<td>shell (Austraea sp.)</td>
<td>1711 ± 74</td>
<td>485-915</td>
<td>95.4</td>
<td>470-770</td>
<td>95.4</td>
<td>Unit B, 110-130 cm shell</td>
<td>not specified</td>
<td>AD 300</td>
<td>reported as &quot;tattoo shell&quot; (a member of Austraea genus)</td>
<td>phased, A=101</td>
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<tr>
<td>Pearls (GREEN-4-1)</td>
<td>PSAMS-1322</td>
<td>charcoal</td>
<td>830 ± 25</td>
<td>1160-280</td>
<td>95.4</td>
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<tr>
<td>Pearls (GREEN-4-1)</td>
<td>GX-14202</td>
<td>charcoal</td>
<td>1000 ± 340</td>
<td>40080-16100</td>
<td>94.9</td>
<td>4070-7900</td>
<td>94.6</td>
<td>W195, 115-113 cm shell</td>
<td>---</td>
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<tr>
<td>La Falata (GREEN-4-11)</td>
<td>PSAMS-1505</td>
<td>charcoal</td>
<td>1215 ± 20</td>
<td>725-745</td>
<td>95.4</td>
<td>795-888</td>
<td>97.1</td>
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<td>La Sargasse (GREEN-4-8)</td>
<td>PSAMS-1315</td>
<td>charcoal</td>
<td>150 ± 20</td>
<td>1690-1760</td>
<td>95.4</td>
<td>1725-1785</td>
<td>95.4</td>
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<tr>
<td>La Tarile (GREEN-4-8)</td>
<td>Beta-10928</td>
<td>charcoal</td>
<td>500 ± 40</td>
<td>1205-1440</td>
<td>95.4</td>
<td>1230-1330</td>
<td>95.4</td>
<td>Unit C-14, 60-70 cm brick, (C-14, 60-70 cm brick)</td>
<td>AD 1410</td>
<td>combined, A=75</td>
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<tr>
<td>La Tarile (GREEN-4-8)</td>
<td>Beta-10937</td>
<td>charcoal</td>
<td>770 ± 60</td>
<td>1150-1310</td>
<td>95.4</td>
<td>1195-1310</td>
<td>95.4</td>
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<tr>
<td>La Tarile (GREEN-4-8)</td>
<td>Beta-10938</td>
<td>charcoal</td>
<td>770 ± 50</td>
<td>1150-1300</td>
<td>95.4</td>
<td>1195-1300</td>
<td>95.4</td>
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<tr>
<td>Grand Anse (GREEN-4-7)</td>
<td>PSAMS-1323</td>
<td>charcoal</td>
<td>625 ± 20</td>
<td>1960-1980</td>
<td>95.4</td>
<td>2070-2070</td>
<td>95.4</td>
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<td>Grand Anse (GREEN-4-7)</td>
<td>PSAMS-3943</td>
<td>charcoal</td>
<td>615 ± 21</td>
<td>1200-1390</td>
<td>95.4</td>
<td>1250-1390</td>
<td>95.4</td>
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<td>Marigot (GREEN-4-24)</td>
<td>PSAMS-3944</td>
<td>charcoal</td>
<td>240 ± 20</td>
<td>1750-1900</td>
<td>95.4</td>
<td>1850-1950</td>
<td>95.4</td>
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<tr>
<td>[UNK, GT-1]*</td>
<td>[UNK, GT-1]*</td>
<td>shell (Lopha sp.)</td>
<td>1530 ± 60</td>
<td>685-1210</td>
<td>95.4</td>
<td>705-1040</td>
<td>95.4</td>
<td>Banks 1988</td>
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<tr>
<td>Grand Anse (GREEN-4-7)</td>
<td>PSAMS-1323</td>
<td>shell (Lopha sp.)</td>
<td>1300 ± 60</td>
<td>900-1200</td>
<td>95.4</td>
<td>925-1235</td>
<td>95.4</td>
<td>Banks 1988</td>
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<td>St. John's River (GREEN-4-6)</td>
<td>UCAMS-15973</td>
<td>shell (Hesperomurea sp.)</td>
<td>625 ± 20</td>
<td>1985-1999</td>
<td>95.4</td>
<td>1995-1999</td>
<td>95.4</td>
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<tr>
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<td>UCAMS-1431</td>
<td>shell fragment (Lopha sp.)</td>
<td>1750-1990</td>
<td>95.4</td>
<td>1750-1990</td>
<td>95.4</td>
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<tr>
<td>St. John's River (GREEN-4-6)</td>
<td>UCAMS-1423</td>
<td>bone (Cerith sp.)</td>
<td>250 ± 20</td>
<td>1650-1760</td>
<td>95.4</td>
<td>1715-1760</td>
<td>95.4</td>
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<td>St. John's River (GREEN-4-6)</td>
<td>UCAMS-1399</td>
<td>shell (of Anadara sp.)</td>
<td>1380 ± 30</td>
<td>905-1060</td>
<td>95.4</td>
<td>925-1060</td>
<td>95.4</td>
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<td>Black Point (GREEN-4-20)</td>
<td>PSAMS-1315</td>
<td>charcoal</td>
<td>700 ± 40</td>
<td>1097-1300</td>
<td>95.4</td>
<td>1097-1300</td>
<td>95.4</td>
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<tr>
<td>Black Point (GREEN-4-20)</td>
<td>PSAMS-1333</td>
<td>shell (Lopha sp.)</td>
<td>1250 ± 20</td>
<td>1750-1990</td>
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<td>1750-1990</td>
<td>95.4</td>
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<tr>
<td>Salt Pond 2 (GREEN-4-20)</td>
<td>PSAMS-1233</td>
<td>charcoal</td>
<td>770 ± 30</td>
<td>770-1000</td>
<td>95.4</td>
<td>780-1000</td>
<td>95.4</td>
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<tr>
<td>Salt Pond 2 (GREEN-4-20)</td>
<td>PSAMS-1232</td>
<td>charcoal</td>
<td>770 ± 30</td>
<td>770-1000</td>
<td>95.4</td>
<td>780-1000</td>
<td>95.4</td>
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<td>Salt Pond 2 (GREEN-4-20)</td>
<td>PSAMS-1235</td>
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*Calibrated using Marine2 marine curve (Raftery et al. 2013) and LR-04 of -28.625 (Wagstaff et al. 2003).
**Calibrated with OxCal v4.3.2 (Bronk Ramsey 2017). Unless noted, IntCal13 northern atmospheric curve (Raftery et al. 2013). All calibrations rounded to 5.
† Lab ID reported.
‡ U-series not calculated.
Figure 3.3 Ceramic Trapezoid Models of Radiocarbon Dates Associated with Diagnostic Ceramics, with Common Diagnostic Attributes for Each Phase

- Cedrosan Saladoid
  - Thin and well-fired
  - Less incision, more paint
  - White-on-Red (WOR)
  - Simple adorns
  - Bell/kettle vessels
- Saladoid-Barrancoid
  - Ornate zoomorphic adorns
  - Increase in incision
  - Zone-Incised-Crosshatching (ZIC)
  - White-on-Red (WOR)
  - Triangular rim designs
  - Slightly thicker vessel walls
- Troumassan-Troumassoid
  - Fading Saladoid-Barrancoid types
  - Higher frequency of inclusions
  - Thicker vessel walls
  - Curvilinear polychrome (increase in black)
  - Large-handles (Saline Wide-Handled)
  - Blotchy black Linear
  - Griddle feet
- Suazan Troumassoid
  - Decrease in paint, in favor of surface treatment
  - Abundant, large inclusions
  - Large, thick vessels
  - "Finger indented" rims
  - "Scratched" striations
  - "Crude" anthropomorphic adorns (e.g., Calleva "unique adorned")
- Cayo
  - Caripé temper
  - Large, unrestricted, collared vessels
  - Low relief, appliqué designs
  - Painting rare but exclusively geometric
**Trapezoidal Modelling**

Samples associated with diagnostic ceramics were included in trapezoidal model distributions *(Figure 3.3)* to simulate the more gradual changes seen in typological seriations (Brainerd 1951; Robinson 1951; Lee and Bronk Ramsey 2012, Lee et al. 2013). OxCal’s trapezoidal model uses a Student’s t-distribution to estimate the absolute beginning and end of a period, giving it a wider but more refined range than a uniform model. Three boundaries (start, middle, end) are then anchored at the beginning and end parameters. For these data, 27 posteriors from the Bayesian models associated with diagnostic ceramics (listed at the bottom of *Figure 3.3*) were saved as *prior* files in OxCal and cross-referenced in the trapezoidal plot of each ceramic phase (to ensure the modelled date was used). Samples without definitive ceramic associations were not incorporated.

An advantage to statistically modelling ceramic phases in this way is that it is completely data-driven and reproducible, so long as the same diagnostic traits are chosen for representative types. This contrasts with the usual idiosyncratic chronologies relied on for typological categories, where even seriation studies only loosely incorporate radiocarbon dates, cherry-picked by the researchers (e.g., Aimers et al. 2013:5; Rouse 1972:134; Rouse and Faber-Morse 1999:45). Eventually, more robust datasets could be statistically modelled, including those from seriation, attribute studies, or petrographic analyses, but many islands lack such comprehensive datasets. Instead of transplanting timelines from one island to the next, trapezoidal models allow easy refinement of local chronologies as new ceramic studies and radiocarbon dates become available.
Site Contexts

Fifteen sites have now been successfully radiocarbon dated for Grenada: six previously reported in grey literature and nine presented here for the first time (a total of 36 dates, not including several historic and modern dates — see Table 3.1). These dates and their associated contexts are discussed below, in the order of the revised ceramic chronology.

Archaic Age (~1500 BC- AD 200)

Until now, the strongest evidence for an Archaic presence in Grenada came from two sediment cores taken at Lake Antoine and Meadow Beach (Siegel et al. 2015). These cores exhibited sustained charcoal signals, decline in arboreal plant species, and other changes in vegetation beginning ~3650 BC. Four new radiocarbon samples from three pre-Columbian sites — St. John’s River (G-8), Grand Bay Beach (G-22), and Black Point (G-20) — have now been dated to the Archaic Age, with at least one site (Grand Bay Beach) holding great potential. A summary is offered here, with in depth discussion of these data presented separately in Chapter 2.

The earliest radiocarbon date (i.e., the earliest date associated with human activity in Grenada) comes from the St. John’s River Site (G-8) — a heavily disturbed Late Ceramic settlement on the outskirts of Grenada’s capital, St. George’s — dating to 1700-1380 BC (PSUAMS-1435, CI:95.4%). Because of numerous discrepancies, this date is considered to be Ceramic Age use of old shells for toolmaking (Rick et al. 2005). Thus, the G-8 site is not yet considered Archaic and will be discussed more fully in the section on the Troumassan period below (and see Chapter 4).
**Black Point (GREN-G-20)**

In analyzing the results of his 1962 survey of Grenada (which defined a local ceramic typology for the island), Ripley Bullen assigned the ceramics from the Salt Pond site (GREN-G-21) on Point Salines to the end of his Pearls-Simon-Saline continuum, a series that loosely aligned with the regional typology termed “Saladoid-Barrancoid” (Bullen 1964:3, though Saline types are now considered Troumassan, see below). The sole exception was a shovel test off Black Point (G-20), southwest of Salt Pond, where Bullen identified possible Cedrosan Saladoid ceramics that appeared to precede his Pearls type, but the assemblage was not reproducible (Bullen 1964:35,46), possibly the result of selective sampling (Boomert 2000:232).

In 2016, we relocated Bullen’s shovel test area (now under water) and recovered ceramics, conch, and shell tools from the area, some lodged under mudstone boulders in the water, though all appearing to fit within a Troumassan (Late Ceramic) assemblage. These sherds included Suazan “scratched” types and a cazuela with thick black tangential lines emanating from the shoulder, hereafter called “blotchy black linear” (top of Figure 3.3). The latter has also been recovered at La Filette (A-11) and Montreuil (P-2), suggesting it is a Troumassan attribute — similar to Bullen's “Caliviny Decorated Basin” type (Bullen 1964:49) but on the exterior rather than interior of the vessel.

At the eastern base of Black Point, another locus was identified inside a patch of scrubland (Hanna 2017). A promising “manatee” adorno with Cedrosan-esque simplicity was recovered in this eastern locus, but it could easily be Troumassan and the associated

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27 The black and white images in Bullen’s 1964 booklet that depict his ceramic typology have recently been re-photographed in color by Brittany Mistretta at the Florida Museum of Natural History (FLMNH) (Mistretta 2018).
charcoal was deemed modern (PSUAMS-1315). Just outside the scrub area, more Troumassan ceramics (Saline-series) were collected from a column sample in the eroding hillside. Surprisingly, a conch shell fragment here was later dated to 1595-1405 BC (PSUAMS-3019, CI:95.4%), closely aligned to the G-8 shell date — that is, ~1300 years earlier than the associated ceramics. Like the G-8 shell, then, the Black Point date is currently interpreted as the result of Ceramic Age toolmaking with old shells (see Chapter 2). This time, however, the source of the old shell may be the neighboring site at Grand Bay Beach.

*Grand Bay Beach (GREN-G-22)*

During his pedestrian survey of Point Salines, Bullen collected Saline-type ceramics about 800 m east of Salt Pond at a site he called Grand Bay (GREN-G-39) (Figure 3.4). During construction of the Maurice Bishop International Airport (MBIA) in 1978, Henry Petitjean Roget tested closer to the beach, southwest of Bullen’s Grand Bay site (1981:12), and recovered mostly shells. Today, the beach at Grand Bay is lined with shell middens recently exposed by sand-mining. A conch shell taken from the top of a midden in 2016 was radiocarbon dated to AD 85-270 (PSUAMS-3022, CI:95.4%), while a conch 20 cm below that, inside the midden, dated to 760-530 BC (PSUAMS-3017, CI:95.4%).

Like Black Point and St. John’s River, the Grand Bay Beach shells appear hundreds of years earlier than the associated settlement, but the Grand Bay sites are more spatially distinct (~300 m apart). The Grant Bay shells also appear basically *in situ* and, given the context and extraction cuts on the shells, likely processed and eaten during the Archaic Age. To be sure, the top sample (PSUAMS-3022) dates just before (possibly overlapping with) the earliest Ceramic Age sites on the island (see below), but because it is in the same
shell midden as the much earlier date (just 20 cm above), and because it is also not directly associated with any Ceramic Age assemblage, it is reasonable to consider this a late Archaic Age shell midden. Nonetheless, while no Early Ceramic sites have yet been confirmed on Point Salines, the area holds potential as a point of interaction between Ceramic groups moving into the Caribbean and the Archaic groups they eventually replaced.28

28 The site of Bagadi Bay (G-38), ~1.6 km to the east, could be a Saladoid-Barrancoid site, but only a few select ceramics are known from a private collection. The earliest radiocarbon date from a Saladoid-Barrancoid site in Grenada comes from Beausejour (G-34), 11.5 km north of Grand Bay, as described in the next section.
Figure 3.4 Pre-Columbian Sites at Point Salines (see Troumassan section for discussion of Late Ceramic contexts)
Saladoid-Barrancoid Period (~AD 200-800)

Aside from the ephemeral Archaic site at Grand Bay Beach, there were likely no permanent villages in Grenada until at least AD 200, and probably closer to AD 300. Five sites — Pearls (A-1), Simon (A-5), Black Point (G-20), Grand Anse (G-7), and Grand Marquis (A-2) — were all previously assigned to the end of the Early Ceramic Age (Banks 1988; Bullen 1964; Cody Holdren 1998; Harris 2001; Rouse 1992), based on material culture deemed to be Huecan Saladoid, Cedrosan Saladoid, and/or Saladoid-Barrancoid (~500 BC- AD 500 collectively). However, neither the ceramics nor the radiocarbon dates have borne out the Huecan association, nor even a solid Cedrosan classification — either of which would place Grenada in the earliest Ceramic colonization events.29 Though diagnostic zone-incised-crosshatching (ZIC) and white-on-red (WOR) painting on ceramics occur at these sites (see Figure 3.3), the dominant attributes (e.g. ornate zoomorphic adornos, large flanges, and polychrome designs) fit more comfortably within a later, Barrancoid-influenced category (see Boomert 2000:293; also, Petersen et al. 2004). Indeed, the sheer dominance of zoomorphic adornos (numbering well into the thousands at Pearls) suggests heavy Barrancoid influence at the few settlements from this period.

Of the five sites mentioned above, no dates yet exist for Grand Marquis (A-2), Black Point (G-20, see above), or Simon (A-5, likely a locus of Pearls). Grand Marquis was surveyed by Cody in 1992 and 1994 (Cody Holdren 1998:49-50), where ZIC and WOR

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29 In particular, the claims of a pure Huecan Saladoid level at Pearls are (at present) completely unsupported. While those from “private collections” (i.e., looted) are without provenience (Keegan and Hofman 2017:60), those seen by the author in the Grenada National Museum’s collection (e.g., zone-incised punctation) are associated with zoomorphic adornos, ZIC, and WOR — clearly later Barrancoid-influenced contexts. This should not be surprising: Huecan Saladoid continues through at least AD 600, and possibly through European Contact (Oliver 1999; Wilson 2007).
sherds were reported from the lower lens of a river profile. Assignment to the “Saladoid” period, however, has yet to be independently confirmed.

**Pearls (GREN-A-1)**

The Pearls site (Figure 3.5) was likely known before 1941, but it was not until construction of Grenada’s first airport that it became public knowledge. Though the airport caused irreparable damage, the looting that ensued (continuing to this day) has been far more destructive (Petitjean Roget et al. 2000). Adding insult to injury, from 1987 to 1989, the Cocoa Rehabilitation Project (CRP) removed truckloads of soil from the center of the site for agricultural use elsewhere (Cody 1990a:40).

Given its size (~500,000 m²), Pearls has received considerable archaeological attention. Bullen (1964:18–22) excavated two large units near the runway and conducted surface collections across the area, including at the adjacent Simon site. From 1988 to 1991, the Foundation for Field Research (FFR), a science-travel organization, conducted pedestrian surveys, augering, and eighteen excavations units (Cody and Banks 1988), teaming up with FLMNH in 1989 and 1990 (Keegan 1991; Keegan and Cody 1990). These investigations recovered beads and pendants of exotic gemstones (e.g., amethyst, pyrite, nephrite, and turquoise), and non-native faunal remains sourced from as far south as eastern Brazil to as far north as Vieques, Puerto Rico (Cody 1990a; Giovas 2017b; Hofman et al. 2011; Laffoon et al. 2014; Newsom and Wing 2004). Other notable findings included

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30 Adornos featured in Fewkes (1907:PL LXXXIV) are probably from Pearls, but the context is only listed as “Grenada” (which he uses interchangeably with Carriacou). Later, Fewkes (1922:119) mentions the similarity of (Saladoid-Barrancoid) adornos on Trinidad and Grenada, most likely referencing the same adornos (or others from the Pearls site), though the location is again not specified. It is also possible the site was so-named because pre-Columbian gemstones were found there, but the name dates at least to the 1760s, when a bill of sale mentions the area “now generally known by the name of the Pearl Estate” (Proudfoot 1772). Many thanks to J. Angus Martin for this reference.
discoidal shells, lithic tools, bone pendants, and a highly decorative ceramic assemblage of complete vessels and innumerable zoomorphic adornos, few of which have been studied in detail (though see Keegan and Byrne 1999 for a preliminary analysis).

The radiocarbon sequence from Pearls has principally focused on three consecutive samples from the same excavation (Unit B) that supposedly demonstrate an initial settlement in the first century AD (Cody 1991). Reanalysis for this paper, however, found these dates (all from shell samples) were never calibrated with a marine curve to account for the marine reservoir effect, which adds an average of 400 years to uncalibrated ranges. Thus, the (unmodeled) earliest date is AD 315-605 (UGa[A1-B2], CI:95.4%), but when modelled within a Bayesian sequence the posterior is pulled slightly later to AD 370-645. A further problem is that, while this date is the earliest, it is in the middle of the sequence.

Although consistently misreported, the radiocarbon sequence from FFR’s excavations at Pearls have occasionally been used to show the extent of disturbance overall (e.g., Keegan and Hofman 2017:58). This is because the three dates reported came from the same stratigraphic sequence but were not in sequential order: the middle sample was the earliest (AD 370-645, A1-B2), followed by the top sample (AD 485-735, UGa[A1-B1], CI:95.4%), and then the deepest (AD 475-770, UGa[A1-B3], CI:95.4%) (see distributions in Figure 3.2). Nonetheless, this apparent mixing contrasts with the description of the excavation, which was outside the CRP disturbance zone, below any potential overburden, and contained relatively complete vessels associated with each sample (Cody 1991).

31 Unlike Ripley Bullen’s sample from Savanne Suazey (RL-76), described in the Methods section, Cody’s shell dates from Pearls appear to have been corrected for δ13C fractionation. Sometimes, the term “corrected” simply refers to the use of 1950 as the reference year, but Cody specifically says, “dates are normalized to 1950 AD and are corrected,” (Cody 1991:59, n.2).
In reanalyzing these dates, a Bayesian outlier model was applied (Bronk Ramsey 2009b), which found sample A1-B2 no more intrusive than A1-B1. Indeed, given the stratigraphic information provided, it is possible these samples all came from the same general time period, since B1 and B2 were collected just a few centimeters apart (at 74 cm below datum and 75-80 cmbd, respectively). Sample B3 was roughly 30 cm lower (110-120 cmbd), but its radiocarbon date overlaps substantially with the others, especially B1. Sample B2 still remains a possible outlier, but it is likely that all three samples are from the same general period, sometime between AD 500-650. This range also aligns well with the innumerable zoomorphic adornos recovered at Pearls, characteristic of Barrancoid-influenced pottery from AD 200-750.

Lastly, the most commonly referenced floral and faunal studies at Pearls were on samples from Unit W195, which contained predominantly Suazan pottery — not the Saladoid-Barrancoid styles typically associated with Pearls (Keegan and Cody 1990:9; Mistretta and Hanna 2017).32 Fauna from this context supposedly reflected the dietary preferences of recent mainlanders (i.e., terrestrial foods) (Fandrich 1990; Lippold 1991; Wing 1968). Yet charcoal from this excavation, recently retrieved from the Grenada National Museum, was radiocarbon dated to AD 1160-1260 (PSUAMS-1322, CI:95.4%), confirming the Suazan assignment. It appears, then, that the terrestrial-focus of early Saladoid settlers at Pearls was in fact a much later (Suazan) occupation.

32 Wing’s (1968) study analyzed fauna from Ripley Bullen’s survey of Saladoid contexts at Pearls, but Bullen’s screening method (or lack thereof) biased the sample to larger faunal fragments (Newsom and Wing 2004:87). More reliable is Stokes’ (1990) study of fauna from Saladoid-Barrancoid contexts, but even then, the temporal difference between those contexts and W195 was not discussed.
Figure 3.5 Previous Excavations at Pearls (GREN-A-1)
Beausejour (GREN-G-34)

Partly because of the misreported dates, Pearls has long been regarded the earliest settlement on Grenada. However, in 2016 a construction crew uncovered Amerindian pottery and human remains on the other side of the island — the northeast part of Beausejour Bay (Hanna 2017:31,142). Concentrations of ZIC, WOR, and zoomorphic adornos were observed in the rubble, suggesting a Saladoid-Barrancoid site. Charcoal encrusted inside a flaring, red-rimmed vessel was radiocarbon dated to AD 530-635 (PSUAMS-1287, CI:90.9%). Meanwhile, charcoal from the bottom of a soil column sample (~80 cmbs) was dated to AD 325-410 (PSUAMS-1317, CI:90.8%). Interestingly, the column sample only went to the bottom of the exposed ditch — ceramics continued beyond that, implying the site could be slightly earlier (see Chapter 4).

Grand Anse (GREN-G-7)

In 1986 and 1987, FFR investigated two loci along the 2 km Grand Anse Beach: six excavations in an area under construction for the Carinex Hotel (now The Flamboyant), and another locus near today’s Camerhogne Park (Banks 1988; Banks et al. 1987). Both loci purportedly contained Saladoid-Barrancoid and historic artifacts. Cody (1990a:165) noted that none of the amethyst at Grand Anse was worked, whereas most from Pearls was finished, suggesting an economic (and possibly political) connection between the two sites. Unfortunately, the two radiocarbon dates available for G-7 reveal potential disturbance, where the deeper shell is dated AD 855-1235 ([UNK, G7-2], CI:95.4%) and the upper (roughly 30 cm above) to AD 705-1040 ([UNK, G7-1], CI:95.4%). While the ranges are quite wide, there is significant overlap, allowing them to be placed in a phased Bayesian model with over 90% agreement, well above the general 60% threshold (Bronk Ramsey
indicating they may be from the same general time period. As such, the dates still offer a rough gauge of the site's chronology, suggesting Grand Anse may be better placed in the Troumassan-Troumassoid, rather than the Saladoid-Barrancoid period.

Troumassan-Troumassoid Period (~AD 750-900)

Most sites in Grenada were settled after the Early Ceramic Age (post-AD 750). In the Windward Islands (the southern Lesser Antilles), this is the enigmatic Troumassoid period, a transitionary phase between Saladoid and Suazan ceramic types. The period also begins an upward trend in population, where a recent sample of known settlements found that 44% (n=11 of 25) were occupied during this time, culminating in roughly 80% (n=20 of 25) during the early Suazan period, prior to a decline ~AD 1260 (Chapter 4).

Troumassan ceramics retain fading Saladoid-Barrancoid attributes not present later on (e.g., some WOR and ZIC but not much) and begin a trend of increased temper density, thicker vessel walls, griddle feet, a preference for interior thickened rims, and most of Bullen’s Saline, Westerhall, and Caliviny styles (Bullen 1964). Zoomorphic adornos are the most prominent vestige of the Saladoid period, but they often include larger inclusions (Hanna and Jessamy 2017) and are eventually unseated by a “cruder” anthropomorphic adorno (Bullen’s Caliviny “unique adorned”) that increases in the Suazan period (see examples in Figure 2.3; also Bullen and Bullen 1968:Fig. 5,m-t).

The trapezoid models associated with the above diagnostic Troumassan attributes indicate convergence at AD 750-900, aligning well to the ending Saladoid-Barrancoid trapezoid, which shows a decline by AD 750 (Figure 3.3). Troumassan radiocarbon dates come from the following sites.
**Salt Pond (GREN-G-21)**

Point Salines is the tip of a peculiar peninsula that fishtails out of Grenada’s southwest corner, so named for two large salt marshes (*salinas*) where salt can be harvested in the dry season. As mentioned above, the area was surveyed by Bullen (1964) and later Petitjean Roget (1981), during construction of the MBIA airport (which also instigated the 1983 American-led military intervention). Bullen’s survey identified three loci around the main pond, with Salt Pond-1 (a northern shell midden) later subsumed under the airstrip (Figure 3.4). Similarly, an auger test in 2016 at Salt Pond-3, on the pond's eastern edge, contained ceramics and charcoal throughout, but two charcoal samples were deemed modern (one as deep as 119 cmbs, see Table 3.1), indicating substantial disturbance. Fortunately, Salt Pond-2 was found much more intact.

Bullen’s analysis of Salt Pond’s ceramics placed them all in his eponymous Saline series, which he tied to the end of the Saladoid-Barrancoid period (Bullen 1964:3; Mattioni and Bullen 1970). However, given the predominance of Saline ceramics at later sites with otherwise diagnostic Troumassan pottery, Saline types are better placed as early Troumassan rather than late Saladoid-Barrancoid. The radiocarbon dates from Salt Pond-2, on the pond’s southwestern shore, uphold this reassignment. Ceramics and shell occurred from 0-55 cmbs, at which charcoal from 14-25 cmbs was dated to AD 780-900 (PSUAMS-1320, CI:87.2%) and a shell at 34-45 cmbs was dated to AD 745-900 (PSUAMS-3020, CI:95.4%), both aligning with the expected range of early Troumassan ceramics.

As mentioned above, the Black Point site, just southwest of Salt Pond, also contained Saline ceramics, although the radiocarbon dates there have been problematic. Nonetheless, just a few meters east of Black Point, a series of at least five sandstone eolianites (naturally cemented sand) serve as natural breakwaters across Cato Bay — each
filled with ceramics, shell, and shell tools (see top left of Figure 3.4). While sea level was clearly lower during the Amerindian occupation, sand-mining during airport construction decimated the present shoreline, exposing these formations. This is likely why Bullen missed them in 1962, but during airport construction just fifteen years later, Petitjean Roget noted the “beach rocks” and rightly hypothesized that meteoric freshwater mixed with CaCO₃ from the shells, lithifying the sand with the artifacts (Petitjean Roget 1981:8; see also, Carew and Mylroie 2001). A shell pried from one of the eolianites in 2016 dated to AD 715-890 (PSUAMS-3021, CI:95.4%). Given the proximity of the sites at Black Point, Salt Pond, and Cato Beach, as well as the congruence of their radiocarbon dates and ceramics, they are likely all loci of the same settlement.

**Montreuil (GREN-P-2)**

In the north-central part of the island, the site of Montreuil is 4.5 km from the coast — one of just two confirmed inland settlements, both within Grenada’s montane rainforest. During his 1980 visit, Henry Petitjean Roget reported a large “historic Kalina” (historic Island Carib) settlement just up river from the Mt. Rich petroglyphs (Petitjean Roget 1981:39). During her 1992 survey, Ann Cody also visited Montreuil and conducted three surface collections. Much of the pottery Cody collected appeared to be Suazan Troumassoid (e.g. “scratched,” griddle feet, etc.), though she also noted a few zoomorphic adornos.
Figure 3.6 Montreuil (GREN-P-2) and the Mt. Rich Petroglyphs (GREN-P-1)
In 2016, the site was relocated and several auger tests performed (Figure 3.6). Two charcoal samples from AT-1 at 40-50 cmbs and 70-76 cmbs (both associated with Suazan ceramics) were radiocarbon dated to the late 20th Century, indicating substantial disturbance in the test areas. In 2017, more auger testing was conducted, and a large workstone was found in the river to the south (an anvil-like boulder with cupules and striated “sharpening” lines, see Figure 3.6 bottom left). A 2x1 m excavation was placed in the northern part of the concentration, yielding so many ceramics (several thousand sherds within the first 20 cm) that we were forced to reduce the unit size to 1x1 meters. While this still produced more artifacts than time allowed for thorough analysis, most sherds appeared to be Suazan (including polychrome and blotchy black linear designs, Saline wide-handled, black interior plates with red-painted rims, “scratched” cazuelas, “finger-indented” rims, and Caliviny “unique adorned” attributes). Several soil stains, including three post-holes and a possible earthen floor were also identified. Charcoal from the floor stain at 56 cmbs was radiocarbon dated to AD 765-885 (PSUAMS-3946, CI:87.1%), confirming that Montreuil was likely founded during the Troumassan and continued into the early Suazan period, if not later.

Anchoring the chronology of the Montreuil site also provides a relative date for the Mt. Rich petroglyphs, just a few hundred meters east. First studied by Sapper (1903:381) and later Huckerby (1921), numerous petroglyphs cover several boulders in the St. Patrick’s River here, one with over 60 engravings, suggesting they were carved over successive generations (Jonsson Marquet 2009).
La Filette (GREN-A-11)

La Filette is another inland site within Grenada’s montane rainforest, 3 km west of Pearls (3.5 km from the coast). It was first surveyed by Bullen (1964:23), who noted Saladoid-Barrancoid and Suazan ceramics in a deeply cut stream. A visit in 2016 relocated the stream and found Caliviny ceramics in the stream walls and scattered on the surface between cocoa trees and board houses. Intriguingly, a sample of charcoal taken just above a vessel in the stream (2 mbs) had a near identical date to Montreuil: AD 765-885 (PSUAMS-1565, CI:87.1%). This suggests the Troumassan period was when the earliest inland settlements were founded (see also, Chapter 5).

St. John’s River (GREN-G-8)

The St. John’s River site was also first reported by Bullen (1964:37), who conducted a surface collection at the site, again (like La Filette) reporting a hiatus between Saladoid-Barrancoid and Suazan ceramic occupations. In 1986, FFR conducted surface collections on the coastal sections and described the site as Saladoid-Barrancoid (Cody and Banks 1986). A cemetery and national stadium have since destroyed all but a small strip along the river (Figure 3.7). In 2011, five 1x1 m excavation units were placed here as part of the St. George’s Community Archaeology Project (SGCAP), a youth summer program run by the author in collaboration with the Grenada National Trust (Hanna and Jessamy 2017). SGCAP conducted an attribute analysis on 2500 sherds, finding vestiges of Saladoid types intermixed with characteristic “scratched” and “finger-indentated” attributes of later periods, including footed and triangular griddles. Like other sites from this period, “vestigial” Saladoid forms such as white-on-red still occurred but in more “crude” fashion on thick, coarse, and low-fired vessels (see Fitzpatrick et al. 2010 for a similar example).
The attribute analysis also allowed multivariate applications like principal components analysis (PCA) to illuminate the associations within the assemblage, as well as other sites in the region (Hanna and Jessamy 2016).

In Unit 3, a shell from 64-82 cmbs was dated to AD 905-1060 (UCIAMS-179806, CI:95.4%). However, two meters away in Unit 4 at 30-45 cmbs, charcoal (UCIAMS-158573) and a conch shell (PSUAMS-1435, mentioned above) were deemed modern and Archaic, respectively — suggesting enormous disturbance. Indeed, crab disturbance was so extreme that mixture between Strata I (0-14 cmbs) and Strata II (15-45 cmbs) in all four excavations was postulated to have been the result of crab tunneling. However, between Units 4 and 5, a dog burial was recovered at 30-43 cmbs and radiocarbon dated to AD 1640-1800 (PSUAMS-1484, CI:90.3%), perhaps explaining the deeper mixing evident in the radiocarbon dates from those units. Interestingly, analysis by Martin Welker at Penn State revealed the dog was likely a New World breed (Welker 2016), leaving open the possibility that the site was occupied during French settlement in 1649.
Figure 3.7 The St. John’s River Site (GREN-G-8)
Suazan-Troumassoid Period (AD 900-1650)

Both the Troumassan and Suazan subseries represent an influx of settlements on Grenada, with over half of all known sites occupied by ~AD 950 (n=35 of 63), at least 19 of which were founded during the Suazan phase. Ripley Bullen’s (1964) work at Savanne Suazey, Grenada (GREN-P-3) effectively defined the Suazan Troumassoid ceramic typology, although McKusic (1960) had previously described similar types in St. Lucia. Suazan pottery exhibits a continuation of Troumassan styles, consisting mostly of coarse plainware with large inclusions, thick low-fired walls, wide-diameter vessels, and an increase in tapered/direct rims. There is also a clear preference for surface treatment in lieu of painting, with diagnostic (yet ubiquitous) “scratched” striations and (less frequently) “finger-indented” rims (Figure 3.3). Researchers still use the latter two terms but understand that Bullen's descriptions were negatively-biased, reflecting his belief that Suazan represented the “artistically destitute” Island Caribs mythologized by Europeans (Bullen 1964:56). Few endorsed Bullen’s ethnic designation, though, and “Carib” pottery remained elusive until Boomert’s (1986) seminal study on Cayo types (next section).

Suazan ceramics in Grenada occur much earlier than typically ascribed — e.g., in Sauteurs Bay by AD 660-880 (Beta-85941, CI:95.4%) and at Savanne Suazey itself by AD 860-1020 (Beta-85935, CI:89.5%, see below). The Sauteurs sample (Beta-85941) is not included in the Suazan trapezoidal model, despite its association with finger-indented rims and scratched pottery (Cody Holdren 1998:102), because it is just one date and exerts

33 Of the 87 known pre-Columbian sites in Grenada, 18 have diagnostic Troumassan ceramics and 33 have diagnostic Suazan ceramics (with ~14 overlapping); another 20 are designated ‘General Post-Saladoid’ because too few diagnostic ceramics are known, and an additional 24 sites are designated ‘Unknown’ because too little information is available. Thus, not counting Unknowns, the percentage of sites that were occupied during the Suazan Troumassoid period could actually be as high as 89% (56 of 63).
inordinate influence by pulling the model a full century earlier (despite only 68% agreement with the model itself). When removed, the median mid-start and mid-end for Suazan are AD 910 to 1460, which also aligns perfectly with the end of the Troumassan model.

Nonetheless, there is considerable overlap between Troumassan and Suazan ceramics, particularly attributes of Bullen’s Caliviny type. Of the seven sites that have reported Caliviny polychrome and/or unique adorned, all also contain diagnostic Suazan traits such as scratched surface treatment and finger-indentated rims. Indeed, in his later excavation on Caliviny Island itself, Bullen acquiesced that the homogenous distribution of ceramics between each type indicated the same group probably made both Suazan and Caliviny ceramics (Bullen and Bullen 1968:36). However, polychrome generally appears slightly earlier than unique adorned, so for this paper, Caliviny polychrome is aligned with Troumassan types, while Caliviny unique adorned is placed with Suazan.

* Savanne Suazey (GREN-P-3) *

Savanne Suazey (the eponymous type site) is on Grenada’s northeastern coast, and spans ~300 meters across three separate loci: a promontory to the north (where a hotel is now located), a scrubby beach below, and a rocky outcrop to the south (Figure 3.8). Only a few sherds have been reported from the beach (Locus 2), and both Bullen’s and (later) Cody’s tests in the north (Locus 3) were less consequential. However, walkover inspections in 2016 and 2018 found exposed middens eroding off the northeastern cliff (Locus 3), largely inaccessible to retrieval. Bullen (1964:7) excavated two trenches here, about five meters from the cliff’s edge, which may have been slightly further out given the active erosion (his excavations may even have exacerbated the problem). The vast majority of
Figure 3.8 Savanne Suazey (GREN-P-3)
pottery fit his Suazan typology, but at the deepest levels, he identified Caliviny polychrome and occasional Simon series sherds. Unfortunately, no radiocarbon dates are available from this area, although it is unclear where Cody’s “NE Locus” was located (an historic deposit, probably west of Locus 3).

Most archaeological attention at P-3 has focused on the small southern promontory (Locus 1), just seven meters above sea level. Bullen placed five units here, recovering in turn, five burials: two females, two males, and a small child with a bead necklace. A decade later, Bullen and Bullen (1972:153) reported a radiocarbon date from a conch shell in one of these units that dates to AD 1075-1490 (RL-76, CI:95.4%; see the Methods section on how this date was calibrated).

In 1994, Ann Cody completed a surface collection and four excavation units at Locus 1, where at least one more burial was found, amongst an otherwise domestic midden and probable living spaces (Cody Holdren 1998:206). Two of the units were dated to AD 1150-1285 (Beta-86833, CI:90.4%) and AD 1020-1250 (Beta-86827, CI:95.4%), in line with Bullen’s date from the same area. Cody also dated a posthole to AD 860-1020 (Beta-85935, CI:89.5%), the earliest date for the site. The ceramic assemblage and radiocarbon sequence (Figure 3.2) indicates that Savanne Suazey was occupied by ~AD 900 and likely as late as French colonization in AD 1649, as corroborated by the 1667 Francois Blondel map that shows Amerindian “carbets” in the area (Martin 2013, fig 6.1).

**High Cliff Point (GREN-P-7)**

Just south of Savanne Suazey, High Cliff Point appears also to have been occupied at 1649. First mentioned by FFR (Banks 1993), the site was apparently not visited by Bullen. No diagnostic ceramics are known, but augering and phosphorus analysis in 2016
revealed a thin but diverse midden of ceramics and fauna eroding off the cliff (~50 meters asl). A few scratched sherds, black-painted interiors, and shallow, red-painted bowls with direct/tapered rims were found that seem to align tentatively with a Suazan assignment. This was also bolstered by a radiocarbon date from the midden at 22-30 cmbs, dated to AD 1445-1630 (PSUAMS-3945, CI:95.4%).

**Duquesne Bay (GREN-M-3)**

Across the island, in the northwest, Duquesne Bay (GREN-M-3) was also established by the Suazan period. Duquesne Bay is the closest site to the Duquesne Petroglyphs (GREN-M-5), a set of seven glyphs and at least three workstones on the beach ~400 m away (Figure 3.9). The glyphs are one of at least eight petroglyph sites on Grenada, all on the northwest coast except the inland Mt. Rich (GREN-P-1). The M-5 petroglyphs were first reported by Wilder (1980), who found them almost entirely submerged in the beach. He later brought Petitjean Roget (1981:36), who identified the Duquesne Bay settlement. Cody Holdren (1998:213) later conducted a small excavation and dated charcoal from an upper level to AD 1040-1265 (Beta-85938, CI:95.4%) and the lower level to AD 855-1040 (Beta-98365, CI:93.1%). This aligns with stylistic analysis of the petroglyphs, which placed them in the Late Ceramic Age (Jonsson Marquet 2009:159). However, given the incongruity between the relatively small assemblage Cody recovered (Cody Holdren 1998:75; Fradkin 1996) and the historic importance of Duquesne Bay (named after a Caraïbe “Captain” of a large village) (Anonymous [Benigne Bresson] 1975:14), much of the site likely remains uninvestigated.
Duquesne Bay (GREN-M-3) & Petroglyphs (GREN-M-5)

Figure 3.9 Duquesne Bay (GREN-M-3) & Petroglyphs (GREN-M-5)
Sauteurs Bay (*GREN-P-5*)

In 1614, the Spanish merchant Nicolas de Cardona skirmished with Island Caribs while watering his ships near an Amerindian village in northern Grenada. His description and accompanying illustration strongly suggest the settlement was Sauteurs Bay, on the northern coast of Grenada (de Cardona 1632; Martin 2013:11, 29, ill. 2.1).

Petitjean Roget (1981) first reported finding Suazan pottery near the Little St. Patrick River west of Sauteurs (*Figure 3.10*), and in 1993, FFR noted Saladoid-Barrancoid pottery there (Banks 1993). Both were probably in Cody’s Locus 2, one of three identified during an extensive investigation in 1994 (Cody Holdren 1998:185–205). Cody surmised Banks’ Saladoid material was transposed from the Cocoa Rehabilitation Project (see Pearls section), and charcoal from the nearby Unit 18.5S/7.5W dated to AD 1450-1645 (Beta-98366, CI:95.4%), seeming to confirm the pottery was too early for the site. In Unit 45N/114.5W to the west, Cody also encountered a possible hearth that dated to AD 1295-1485 (Beta-98367, CI:95.4%). East of the river, a surface collection in Locus 3 (“SW Locus”) recovered diagnostic Suazan pottery and an associated radiocarbon date of AD 660-880 (Beta-85941, CI:95.4%) — the earliest available for Sauteurs Bay and Suazan pottery overall. It would seem that the earliest components, then, are east of the river, under the modern town of Sauteurs.

Most of Cody's investigations took place in Locus 1, on the beach ~300 m northwest of the river. All three excavations contained a layer of white clay that may have been an ancient floor surface, ~90 cmbs. In the middle unit (120N/127.5W), the surface was penetrated by a burial deposit of at least nine individuals (young adults and one child), all capped by chunks of coral. Charcoal from the burial level dated to AD 885-1190 (Beta-86831, CI:95.4%), but a glass bead and three kaolin pipe fragments were also recovered.
(though not analyzed). One pipe contained a diagnostic rouletted bowl, likely of 16th century English origin (Cody Holdren 1998:106). In the southeast unit (111N/117.5W), the surface was found intact, with a posthole that dated to AD 1115-1295 (Beta-86832, CI:89.4%). Few human remains were found in Unit 111N (MNI=1), nor were there any coral blocks. Above the floor, fill contained a “drilled copper coin,” a diagnostic Cayo rim (now associated with historic Island Caribs — see below), another 16th century English pipe fragment, and European-introduced fauna, including teeth and/or cranial fragments of cat (*Felis catus*), pig (*Sus scrofa*), and goat/sheep (*Capra hircus/Ovis aries*) (Cody Holdren 1998:106–107; Fradkin 1996).

In the northwest unit (127.5N/137.5W), coral blocks were again found capping the remains of at least six disarticulated individuals, again penetrating a layer of white clay. Just below, at 130 cmbs, a mostly intact burial was found, associated with teeth from another individual, as well as a dog skull and a shell bead. Charcoal from the 127N unit (depth unknown) was radiocarbon dated to AD 960-1185 (Beta-98368, CI:95.4%). Additionally, a pipe-bowl recovered above the coral blocks was likely of 17th century Dutch origin (Cody Holdren 1998:106,197).
Figure 3.10 Sauteurs Bay (GREN-P-5)
Cody explored several possibilities for the enigmatic burial situation — an apparent mass burial of at least 18 individuals, including one child, with no markers of trauma, violence, or pathology, and all mostly (though not entirely) disarticulated and associated with late prehistoric charcoal and early historic trade goods. Articulation of some long bones indicated flesh was present at deposition though “rodent gnawing” implied some were not immediately interred (Cody Holdren 1998:197). The burials were capped by coral blocks and penetrated a clay surface that contained a post-hole to the west, suggesting a structure had been nearby.

Cody concluded these were likely primary or secondary burials that had been disturbed in historic times. However, the historic artifacts below the coral blocks were all likely from the 16th century — well before any significant European disturbance on the island. These artifacts could fall into the category of trade items while the assemblage above the blocks denoted substantial European presence. Trade with passing European ships is known to have occurred on Grenada, usually involving tobacco (and thus perhaps pipes like those recovered by Cody) (Martin 2013:11, 29).

The two radiocarbon dates from the burial level overlap enough that they could be combined in OxCal with significant agreement between AD 955-1160 (CI: 92.9%), which could suggest a single mass burial event. On the other hand, the fact that the posthole in the clay floor post-dated the burials (AD 1115-1295) implies they were deposited afterwards, although disarticulation suggests multiple exhumations before and after the floor surface. It seems more likely this was a cemetery of secondary burials, with disturbance before European settlement, such as for ancestral veneration (Hoogland and Hofman 2013).
The cemetery scenario is further supported by recent events in 2018. Between November 2017 and March 2018, rough seas — possibly exacerbated by a breakwater construction project at the town of Sauteurs to the east — eroded roughly 50 meters of the Sauteurs Bay shoreline, knocking down dozens of palm trees in the process and forcing residents to relocate (GBN 2017). In February 2018, the author and a team from Leiden University visited the site and, over the course of just a few days, collected about 20 individual burials eroding into the sea (Campbell 2018; Nexus 1492 2018). While the beach has since recovered, archaeological remains northeast of the wavecut (including the areas excavated by Cody) are now gone, replaced with sterile sand. The many burials lost during this event clarified the cemetery context, where perhaps over 100 individuals were originally interred. Analysis of the salvaged burials is still ongoing, and further testing is planned for 2019.

Cayo Period (AD 1250-1650)

Much debate in Caribbean archaeology has centered around the ceramics made by the historic Island Caribs, in part because conclusive settlements have only been identified within the last decade (Keegan and Hofman 2017). Allaire’s (1977, 1980, 1984) extensive studies of the ethnohistoric record effectively refuted Bullen’s assertion that Island Caribs made Suazan pottery. Soon after, Boomert (1986) demonstrated how a misidentified St. Vincent style (Cayo) matched the Koriabo complex in Guyana. However, it was not until later excavations in St. Vincent recovered Cayo pottery with historic trade items embedded as decoration was it confirmed that Cayo was indeed made by historic Island Caribs (Hofman and Hoogland 2012).
Yet problems remain. As explained in the Discussion below, two Amerindian groups were present in Grenada when the French settled in 1649: “Caraïbe” in the north and another group in the southeast, whom the French called “Galibis.” Additionally, while Cayo (Island-Carib) ceramics and settlements are found in Grenada, they overlap with dates for Suazan-Troumassoid ceramics, with both extending into the Protohistoric period (AD 1492-1649), just as Bullen had insisted. It is true that the mid-end median for the Suazan trapezoidal model is AD 1460, possibly signaling the decline of Suazan before the Protohistoric period, but the contexts discussed below suggest otherwise. Moreover, the mid-start and mid-end medians for the Cayo trapezoids are AD 1240 to AD 1330, also ending prematurely.

Diagnostic Suazan ceramics have also been found at several sites occupied at or just before European arrival (e.g., Pearls, La Sagesse, Artiste Point, Savanne Suazey, Sauteurs Bay, True Blue, Duquesne Bay, and Ile de Ronde-West, to name a few — see Table 4.1). Finger-indented rims and scratched pottery were even found in an underwater excavation of Fort Annunciation (GREN-UW-8) — the now submerged location of the first French settlement in 1649 (Banks 1993).

It is also notable that the one Cayo piece found at Sauteurs Bay dates after AD 1115-1295 (Beta-86832, CI: 89.4%), aligning with Boomert’s (1986:36) ~AD 1250 estimation for Cayo’s introduction to the region (also supported by the Cayo trapezoidal model). This estimation also conforms to the dates at La Tante (D-4), a site likely occupied at French colonization by Galibis. Thus, the archaeological and ethnohistoric data suggest Cayo and Suazan co-occur during the Protohistoric period. These points will be further
explored in the Discussion, after the following description of the remaining radiocarbon contexts.

*La Tante (GREN-D-4), and Galby Bay (GREN-D-3)*

La Tante and Galby Bay (both formerly “Anse des Galibis” on early maps) are on opposite sides of St. Pierre Point (*Figure 3.11*), in a heavily embayed area of St. David’s Parish where ceramic scatters are evident on nearly every beach. In that sense, the relatively small ceramic assemblage from La Tante seems insignificant, save for the associated radiocarbon dates acquired by Cody. Galby Bay, on the other hand, has a much more intriguing ceramic assemblage but no radiocarbon dates. Because of the proximity and association of these sites, they are discussed together here.

La Tante was briefly visited by Petitjean Roget (1981:22) and later excavated by Cody (1998:222). Cody’s Unit 118.S/36W recovered mixed European and Amerindian material from 85-110 cmbs, from which four radiocarbon dates were acquired from charcoal, including two dates from the same piece (Beta-86828 and 86829) — combined here in a Bayesian model to AD 1280-1395 (CI:95.4%). The other two dates are a century earlier: AD 1165-1310 (Beta-85939, CI:94.1%) and AD 1185-1300 (Beta-86830, CI:95.4%). It is assumed the latter two samples were deeper, although the report does not give stratigraphic information. Cody’s other unit (20N/6E) also recovered several prehistoric artifacts, but the associated radiocarbon date was deemed modern. No descriptions are given for any of La Tante’s pottery, though Cody notes the lack of surface treatment at both La Tante and Galby Bay, and her various multivariate analyses consistently clustered these two sites together (Cody Holdren 1998:86).
To the south at Galby Bay, Cody found ceramic scatters of non-diagnostic pottery across the beach in 1992 (Cody Holdren 1998:217–220). No report is known from Banks’ excavation (Unit A) in a wavecut later that year, but he loaned Cody pottery for analysis (Cody Holdren 1998:220). In 1994, Cody returned and conducted shovel tests and two excavations, confirming the wavecut as the main concentration. Most tests recovered minimal artifacts, though one excavation (30N/127E) found a post-hole (not dated), keeled vessel rim, and a vessel foot. Cody (1998:86) presumed the Galby Bay assemblage was mostly indeterminate, but two drawings from Banks’ Unit A (Cody Holdren 1998:87) look very similar to those of mainland Galibi pottery, including a *samaku* jar (Cornette 1991:520, fig 7.13) and a rim now identified as Cayo (Hanna 2017:80–81). An augering survey conducted in late 2017 revealed an Ab horizon 60 cmbs with ceramics and charcoal continuing through 130 cmbs, equidistant from Cody’s East and West loci, suggesting a third locus of interest. Funding is still being sought to process these samples.
Figure 3.11 La Tante (GREN-D-4) and Galby Bay (GREN-D-3), with one of the workstones at D-3

Discussion

Southward and Northward Routes

Saladoid ceramics have been traced to the Orinoco watershed in modern Venezuela beginning ~1000 BC (Antczak et al. 2017; Rouse 1992), perhaps preceded by other types currently thought to be derivative (Barse 2009). Their sudden appearance in the Caribbean — along with a similar agricultural repertoire and settlement plans — is believed to reflect diasporic fissioning from lowland South America (Boomert 2000; Heckenberger 2013; Keegan 2000; Roosevelt 1980; Wilson 2007). In stark contrast to Cedrosan decorative
wares, a few sites dating to this period do not reflect the Cedrosan artifact assemblage, instead falling into the Huecan Saladoid (Huecoid) series. Like Cedrosan, Huecan ceramics tend to be well-fired and thin, but they favor incision over painting and some zoomorphic pendants have been identified as ‘Andean condors’ (Chanlatte-Baik 2013; though see Giovas 2017a). The existence of Huecan sites, and their apparent perseverance throughout the Saladoid Age (500 BC-AD 750) indicates several source regions for Early Ceramic Age migrations. Indeed, Keegan and Hofman (2017) suggest every island may have been initially colonized by different groups across the South American coastline, all only loosely linked by a macro-social identity expressed in the preserved material culture archaeologists label as Saladoid.

Despite ample evidence that Early Ceramic pottery originated in the Orinoco watershed, the strongest evidence for its presence (from pure contexts of diagnostic ceramics with associated radiocarbon dates) comes from the northern Leeward Islands and Puerto Rico (Fitzpatrick 2006; Keegan 2000) — not the southern Lesser Antilles. Thus, the four Archaic dates from Grenada presented above offer the possibility of Archaic groups continuing to frequent the southernmost (Windward) islands even while the Ceramic Age was flourishing in the northern (Leeward) islands. Such a scenario supports the growing consensus that the earliest Ceramic Age populations of the Caribbean bypassed the Windward Islands en route from the South American mainland (e.g., Callaghan 2001; Fitzpatrick et al. 2010).

The “Southward Route Hypothesis” (Fitzpatrick 2013) attempts to rectify the regional patterns in ceramics and radiocarbon dates by suggesting that the Early Ceramic sites in Puerto Rico and the northern Leeward Islands slowly expanded southward. This
may be the case, but there is also evidence for continued immigration from South America. In Grenada, the first ceramics were not purely Cedrosan-Saladoid (as would be supposed if they arrived from the north) but a strongly Barrancoid influenced variation termed Saladoid-Barrancoid (Bullen 1965; Rouse 1992). These ceramic types may signify a post-Cedrosan wave of Barrancoid migrants from the Guianas region (Allaire 1999; Granberry and Vescelius 2004; Taylor 1977), which was likely followed later by a migration of Arauquinoid ceramicists in the Troumassoid period (Chapter 4). Additionally, the continued translocation of South American fauna throughout the Early Ceramic Age (e.g., deFrance et al. 1996; Giovas 2017b; Giovas et al. 2011, 2016; Laffoon et al. 2013; LeFebvre and deFrance 2014; Newsom and Wing 2004; Wing 2008), suggests not only continued interaction with the mainland but also possibly the direction of the migration — i.e., not solely a southward population expansion. Thus, the evidence from Grenada suggests the absolute dates associated with the identifiable ceramic types are much later than the relative dates typically ascribed to those typologies elsewhere. More dates are obviously needed, but we have 87 Ceramic Age sites documented and none date before AD 300; indeed, the vast majority were settled after AD 750.

Interaction and Integration

Of the fourteen sites for which Bullen (1964) had enough data, he thought five had been abandoned during the Saladoid period and then reoccupied during the Suazan. Only one of these sites (Pearls) is still considered Saladoid-Barrancoid — the rest all contained vestigial Saladoid mixed with Caliviny polychrome and Suazan scratched pottery, as well as occasional finger-indented rims, Caliviny unique adorned, and/or Saline wide-handled, suggesting later Troumassan contexts. Three (La Filette, St. John's River, and Salt Pond)
also have radiocarbon dates that now confirm this assignment. There was no hiatus at these sites. Like others, Bullen’s deeply drawn typological lines did not allow for the co-occurrence of disparate pottery types. Allaire (1984), too, so strongly believed that Island Carib pottery was not influenced by the Suazan subseries that he postulated a complete depopulation of the entire Lesser Antilles before their arrival (as did Rouse 1992:129). Such drastic assumptions are now rebuffed by the coexistence evident in the ethnohistorical, artifactual, and chronometric data presented above. To be sure, Suazan may not have influenced Cayo, but that would not preclude the possibility of the two types co-occurring during the Protohistoric period.

Moreover, although contact with the mainland was undoubtedly constant and new groups likely arrived throughout antiquity, the continuity in the settlement record strongly suggests integration and in situ cultural developments. Occasional population influxes still occurred, as with the surge that precipitated the Troumassan period (Chapter 4), but it seems unlikely that old abandoned sites were simply reoccupied by different people who deposited their refuse and even (in the case of Sauteurs Bay) buried their dead in the same locations as the previous occupants.

Perhaps the traditional depiction of two discrete macro-groups in the historical Caribbean (Taino and Island Carib) was an inspiration (or justification) for the uniform application of Rouse's ceramic typologies (i.e., one group at one time in one space), disallowing the co-occurrence of two ceramic series (Curet 2003; Keegan 2018; Rodríguez Ramos 2010:210). Only recently have researchers questioned the homogeneity of these groups, seeing instead a “mosaic” of cultures present in the Lesser Antilles at Spanish Contact (e.g., Hofman 2013; Hofman et al. 2008; Lenik 2012; Whitehead 1995; Wilson
The fluidity of this mosaic led Cody (1998) to propose a “reticulate model” that accommodates the interactions and influences evident in Grenada’s record, where the colonial ethnic category of “Carib” was a heterogeneous mix of peoples with both mainland and insular influences (see also Lenik 2012; Whitehead 1995).

To highlight this point further, it was mentioned above that when the first Europeans (French) permanently settled Grenada in 1649, there were purportedly two indigenous groups: “Caraïbes” in the north and “Galibis” in the south (Anonymous [Benigne Bresson] 1975:9). Most researchers have considered these to be, essentially, the same group, where Galibis were simply contemporary Kalina (Caraïbes) from the mainland.34 Indeed, Cody (1998:27) notes a sense of solidarity between the two, which is perhaps most clear in the infamous “Carib’s Leap” incident, for which the town of Sauteurs was named. As the earliest version of the event describes, the French led an attack, “to surprise the Caraïbe and the Galibis…. [who] were drinking their wine and feasting,” (Anonymous [Benigne Bresson] 1975:20, emphasis added) ultimately causing many to jump off a cliff rather than be killed by their enemies. Nonetheless, despite this solidarity, the French unequivocally observed some manifest difference between the two groups, probably linguistic, among other things (Cody Holdren 1998:3).

Allaire (1984) had predicted that Island Carib pottery would be similar to that of mainland Galibis (later confirmed as Cayo), yet in Grenada, there were both Galibis and Island Caribs present. Unsurprisingly, site assemblages show higher amounts of Cayo pottery at “Galibi” sites — suggesting they were the group producing Cayo ceramics and

34 This confusion between “Caraïbe” and “Galibis” may have existed elsewhere as well, depending on the nationality of the European chronicler (Allaire 1977:32–33; Hoff 1995, n.14).
perhaps speaking a Cariban language. Maybe both Galibis and Island Caribs on Grenada were making Cayo pottery, but those sites identified with Island Caribs (e.g., Sauteurs Bay, Duquesne, Savanne Suazey) have limited Cayo — likely just trade ware. Rather, Island Caribs on Grenada appear to have been indigenous, Suazan potters, probably speaking an Arawakan language (Davis and Goodwin 1990; Granberry and Vescelius 2004; Taylor 1977). Thus, during Grenada’s Protohistoric period there were two separate and distinct cultural groups present. Despite these differences in time and culture, however, the Galibis were clearly integrating (not conquering), just as other groups had done in prehistory — only this time, they were the last.

Conclusion

This paper highlights the lesser known prehistory of Grenada through a synthesis of the settlement chronology using radiocarbon dates, ceramic types, and a merger of the two via trapezoidal models. While there appears to be an ephemeral Archaic Age, the earliest Ceramic Age sites appear around AD 200-300, aligned with other Windward Islands but comparatively late for the region as a whole. During the early Late Ceramic Age (Troumassoid periods), Grenada’s population exploded, from four known sites in the Early Ceramic to at least 35 in the Suazan period (Chapter 4), and probably many more that have yet to be studied. The Protohistoric settlements exhibit a mixture of both Cayo and Suazan ceramics, which correspond with the multi-ethnic mosaic hinted in historical records. Yet the evidence of long occupation sequences like Sauteurs Bay indicate that in Grenada at least, the people called Island Caribs were not recent invaders but native islanders with ties to Camáhogne going back a millennium.
CHAPTER 4
Grenada and the Guianas: Demography, Resilience, and Terra Firme during the Caribbean Late Ceramic Age

Abstract

In the Lesser Antilles, the Late Ceramic Age (AD 750-1500), witnessed widespread cultural differentiation and population fluctuation, often characterized as a time of introspection, balkanization, and decline. Using the adaptive cycles of resilience theory as a heuristic framework, this paper compares data from twenty-five settlements on Grenada with the available climate and vegetation records, as well as a sum probability (SPD) model of relative changes in the island’s population to better understand the dramatic shifts in Late Ceramic material culture. The study finds this shift (including everything from ceramics to demographics to the appearance of petroglyphs and workstones) occurred during both heightened climatic instability and a population influx — likely of Arauquinoid groups from coastal South America. That is, the “decline” in ceramic types was not an in situ phenomenon but directly reflective of events occurring on the mainland. Additionally, a depopulation event around AD 1260 appears to coincide with the arrival of Cayo (Island Carib) ceramics, which aligns with “Carib invasion” myths, although the processes behind this pattern remain an open question.

Keywords: Lesser Antilles, Resilience Theory, Rock Art, Sum Probability Distribution (SPD), Demography

35 A version of this chapter is currently under review at World Archaeology.
Background

The Early Ceramic Age (500 BC–AD 750) in the Caribbean began more or less with the movement of the Cedrosan and Huecan Saladoid ceramic assemblages from coastal South America into the Leeward Islands (northern Lesser Antilles) and Puerto Rico (Petersen et al. 2004; Rouse 1992) (Figure 1.1). The groups making these types largely skipped the Windward Islands (southern Lesser Antilles) until roughly AD 200-300, when a variant of Cedrosan Saladoid arrived with a strong Barrancoid influence (thus termed Saladoid-Barrancoid) (Bullen 1964, 1965, and see Chapter 3). These latter ceramics may signify a post-Saladoid wave of Barrancoid migrants, probably from the Guianas region of northeast South America (comprising modern Guyana, French Guiana, Suriname, and bordering regions of Venezuela and Brazil) (Figure 4.1) (Allaire 1999; Granberry and Vescelius 2004; Taylor 1977).

Around AD 750, Saladoid-Barrancoid ceramics faded, marking the start of the Late Ceramic Age, which heralded major cultural changes from new ceramics to settlement patterns to subsistence strategies to burial practices (Hofman 2013; Hoogland and Hofman 2013; Siegel 1993). Ceramic assemblages diversified throughout the region, with a major split recognized between the Ostionoid series of the Greater Antilles and the Troumassoid series of the Lesser Antilles (Allaire 1999; Keegan 2000; Petersen et al. 2004; Rouse 1992; Watters 1997). Within the Lesser Antilles, a divide is further identified between the Mamoran Troumassoid ceramics of the Leeward Islands, which show greater influence from the Ostionoid series to the north, and the Troumassan Troumassoid (AD 750-900) and Suazan Troumassoid (AD 900-1650) subseries of the Windward Islands, which exhibit more influences from the mainland (Hofman et al. 2011; Rouse and Faber-Morse 1999; Wilson 1993b:150).
The change in ceramics from Saladoid to Troumassoid (essentially fine painted wares to coarse, incised types) was so dramatic that Bullen (e.g., 1964:53) presumed this was the pottery of the historic marauders known as Island Caribs. He described the ‘crude’ ceramics of his Suazan series as “the 'worst' pottery in the Lesser Antilles” (Bullen 1965:237), which fit perfectly with the supposedly militaristic (and therefore artistically destitute) Island Caribs mythologized by European chroniclers.

![Map of the Caribbean Area](image)

**Figure 4.1** Map of the Caribbean Area

Others objected to Bullen’s correlation, successfully demonstrating that ethnohistoric descriptions strongly suggested Carib pottery would be analogous to that of
the Galibi peoples of the Guianas (e.g., Allaire 1984). Bullen’s Suazan ceramics were thus re-framed as a wholly, “uninterrupted development out of the Saladoid heritage,” (Boomert 2000:245) not unlike the technological degeneration of Lapita pottery in Polynesia (Wilson 2007:35). In this vein, the drastic change in cultural material between the Early and Late Ceramic Ages is now considered, “a process of micro-regionalization or localization,” (Hofman et al. 2011:81). Borrowing a page from Marxist critique, Keegan and Hofman went so far as to call it, “a complete transformation emerging from internal contradictions,” (2017:84).

The pottery of the historic Island Caribs was eventually identified as the Cayo complex, a variant of Koriaban Marajoaroid that gained prominence in the Guianas around AD 1000 and had moved into the Antilles around AD 1250 (Boomert 1986, 2004). The association with Island Caribs was bolstered by Cayo’s occurrence (even sometimes decoration) with European trade goods (Allaire and Duval 1995; Hofman et al. 2014; Hofman and Hoogland 2012), including at the handful of sites now identified in Grenada (Cody Holdren 1998; Keegan and Hofman 2017).

Like the other Windward Islands, Grenada was not successfully colonized by Europeans until the mid-17th century (Martin 2013). When the French finally gained a foothold in 1649, two distinct indigenous groups were present — one of Cariban-speaking, Cayo (Koriaban) potters called “Galibis” in the south of Grenada, and another of (likely Arawakan-speaking) Suazan potters called “Caraïbes” in the north (Anonymous [Benigne Bresson] 1975; Martin 2013; and see Chapter 3). That is, for Grenada at least, the term
“Carib” (or Island Carib/Kalinago) actually denotes the pre-Carib group, whose ancestors arrived in the Troumassan period, if not earlier (Chapter 3).\textsuperscript{36}

**Paleoclimate Records and Resilience Theory**

The Late Ceramic Age also occurred during a drying trend throughout the region (see Cooper 2013 for a thorough review). The standard paleoclimate record for the southern Caribbean are the Cariaco Basin cores taken off the coast of Venezuela (e.g., Haug et al. 2001; Peterson et al. 1991). This paper also includes several lake core studies in Grenada (McAndrews 1996; Sharman 1994; Siegel et al. 2015) — all of which confirm a drying trend from AD 700-1300. The potential interaction between climate and culture change in the Late Ceramic is therefore a perfect dataset for the analysis of socio-ecological systems, such as with resilience theory.

Originally a union of systems theory and conservation biology, resilience theory has proved useful in anthropological archaeology for thinking about how and why socio-ecological systems changed in the past (Nelson et al. 2011, 2006; Redman 2005; Redman and Kinzig 2003; Rosen and Rivera-Collazo 2012; Thompson and Turck 2009). The resilience of a system reflects its capacity to absorb shocks and undergo change while retaining its core functions and structure (Holling and Gunderson 2002; Walker et al. 2004). As socio-ecological systems experience internal and external threats, their response determines the course and severity of the next stage (e.g., innovation or destruction). A

\textsuperscript{36} This paper will stick with the convention of associating Cayo ceramics with Island Caribs, even though the label denotes a mosaic of indigenous groups present in the Lesser Antilles during European colonization (e.g., Hofman 2013; Lenik 2012; Whitehead 1995; Wilson 1993a).
highly resilient system may sustain many shocks, but once the threshold for change is reached, four main stages are discernable (termed the “adaptive cycle”):

1) r-phases — periods of growth and expansion
2) K-phases — periods of conservation and rigidity
3) omega (Ω)-phases — periods of release, collapse, and destruction
4) alpha (α)-phases — periods of reorganization and innovation

The progression through these stages can be non-linear, with phases repeated or skipped. As such, the original graphic was a series of stacked, looping arrows called the panarchy model (shown in Figure 4.3). Others have likened the process to a ball rolling between two “basins of attraction” (r and K), which is useful for understanding threshold states and how a trajectory’s inertia can sometimes force change (Scheffer et al. 2001).

During ideal conditions, a socio-ecological system adapted to its environment will expand (r/growth-phase), which might be evident archaeologically via exchange networks, size of territory, population changes, etc. A shock to the system (e.g., war, drought, epidemic disease) could trigger a conservation (K) stage of resistance where it may repair itself and re-enter an r/growth stage. However, successive r and K phases without the innovation of an α/reorganization-phase will ossify the system, reducing its flexibility and ultimately lead to catastrophic breakage (a process termed the “rigidity trap”) (Hegmon et al. 2008; Schoon et al. 2011). More resilient systems would enter a short Ω/release-phase and incorporate changes through an α/reorganization-phase.

Determining the phase of a system at a given time requires recognition of the scale of analysis being applied. This paper will utilize a multi-decadal scale of analysis in roughly 50 year segments, to apply the logic of resilience theory to the settlement history
of Grenada, the southernmost island in the Antillean archipelago in an effort to determine whether the Troumassoid\textsuperscript{37} transition was an internal collapse of island societies or more reflective of socio-political changes on the mainland.

**Materials and Methods**

**Settlement Sample**

Settlement data for this study were derived from six months of cumulative fieldwork in Grenada between 2016 and 2017, with a comparable amount of time cataloging the pre-Columbian collection at the Grenada National Museum (Hanna 2017). Data from 87 prehistoric sites were amassed into a database, the Archaeological Site Inventory for Grenada (ASIG),\textsuperscript{38} from which a sample of 25 settlements were selected (Figure 4.1). This sample of 25 sites were chosen because sufficient locational data (e.g., GPS coordinates), chronological data (e.g., diagnostic ceramics and/or radiocarbon dates), and cultural historical data (e.g., midden components of domestic refuse, site parameters, unique features, etc.) were available — essentially 25 settlements with locations and dates (or SLD-25). Relevant details of each selected settlement are summarized in Table 4.1 and Figure 4.2.

Use of the SLD-25 sample as representative of all sites in Grenada, or at times the Caribbean, may appear to some an oversimplification of pre-Columbian settlement patterns. While the chosen SLD-25 dataset is a group of sites for which the most information is known, the information remains incomplete. For instance, the site sizes

\textsuperscript{37} Note that the words Troumassoid and Late Ceramic are used interchangeably here, whereas Troumassan and Suazan convey specific sub-periods within the Late Ceramic.

\textsuperscript{38} Version 1 of the ASIG was attached to Hanna (2017) as an MS Access database. An updated version is being converted to a web-database, available online at: http://www.GrenadaArchaeology.com/ASIG
given in Table 1 are estimates (see also, Chapter 4). And just because a site is confirmed to be a residential settlement during one period does not mean it was permanently occupied nor that it could not have an earlier, unknown component.

The SLD-25 sample size, however, is statistically significant. Error margins for Saladoid and Cayo SLDs are both 0% because all known sites from each period are included. Error margins for Troumassan and Suazan sites are higher (23% and 26%, respectively, at 95% accuracy), suggesting estimates based on SLD-25 sites for the entire Late Ceramic period may only explain ~75% of variation. Given the number of unknown sites, too, the margin of error may be even higher, but it could also be lower (see footnote #40) — such is the nature of statistical sampling. The sites chosen for the SLD-25 dataset span every period in Grenada and are the strongest dataset available for the island. Moreover, since most of the SLD sites are new to the archaeological literature (having never been published before), the sample contributes to the region's growing archaeological record.
Table 4.1 Characteristics of the SLD-25 Dataset (see Table 3.1 for complete radiocarbon dates and Hanna (2017) for full site summaries)

<table>
<thead>
<tr>
<th>Site #</th>
<th>Site Name</th>
<th>General Settlement Size*</th>
<th>Estimated Size (ha)</th>
<th>Earliest RC Date (calAD 2σ)</th>
<th>Petroglyphs</th>
<th>Workstones</th>
<th>Workstone proximity to Site</th>
<th>Workstone proximity to water</th>
<th>Salaloid Barrancoid</th>
<th>Troumassan</th>
<th>Suazan</th>
<th>Cayoid</th>
<th>Occupied at Contact?</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>G-34</td>
<td>Beausejour</td>
<td>Small</td>
<td>1.6</td>
<td>260-410</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td>Workstones at Beausejour Bay (G-5), 450m away</td>
</tr>
<tr>
<td>A-1</td>
<td>Pearls</td>
<td>Large</td>
<td>13.8</td>
<td>315-605</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>(A-3)</td>
<td>A-3 is nearby Troumassan site (not incl.)</td>
</tr>
<tr>
<td>A-2</td>
<td>Grand Marquis</td>
<td>Small</td>
<td>0.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td>unconfirmed Suazan</td>
</tr>
<tr>
<td>A-10</td>
<td>Simon Beach</td>
<td>Medium</td>
<td>5.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td>unconfirmed Suazan</td>
</tr>
<tr>
<td>G-7</td>
<td>Grand Arise</td>
<td>Large</td>
<td>24.0</td>
<td>695-1020</td>
<td>●</td>
<td>195m</td>
<td></td>
<td>in water, on beach</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G-2</td>
<td>Grand Mal Bay</td>
<td>Small</td>
<td>3.3</td>
<td></td>
<td>●</td>
<td>215m</td>
<td></td>
<td>in water, in river</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td>Montrouil is closest settlement to Mt. Rich Petroglyphs (P-1), 530m away</td>
</tr>
<tr>
<td>D-1</td>
<td>La Sagesse Bay</td>
<td>Medium</td>
<td>4.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-5</td>
<td>Sauterne Bay</td>
<td>Medium</td>
<td>7.0</td>
<td>660-880</td>
<td>●</td>
<td></td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-2</td>
<td>Montrouil</td>
<td>Medium</td>
<td>5.4</td>
<td>720-885</td>
<td>●</td>
<td>215m</td>
<td></td>
<td>in water, in river</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-11</td>
<td>La Filetta</td>
<td>Small</td>
<td>2.6</td>
<td>720-885</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G-21</td>
<td>Salt Pond</td>
<td>Large</td>
<td>13.9</td>
<td>770-965</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G-8</td>
<td>St. John's River</td>
<td>Medium</td>
<td>5.3</td>
<td>905-1060</td>
<td>●</td>
<td>160m</td>
<td></td>
<td>in water, on beach</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>(? )</td>
<td>unconfirmed workstone ~260m away at G-14</td>
</tr>
<tr>
<td>G-12</td>
<td>Calligny Island</td>
<td>Medium</td>
<td>8.5</td>
<td></td>
<td>●</td>
<td>270m</td>
<td></td>
<td>dry</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G-25</td>
<td>Westerhall Point</td>
<td>Medium</td>
<td>15.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-3</td>
<td>Savanne Suazey</td>
<td>Medium</td>
<td>6.1</td>
<td>775-1020</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-7</td>
<td>Grand Bacolet Bay</td>
<td>Small</td>
<td>2.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G-5</td>
<td>Beausejour Bay</td>
<td>Medium</td>
<td>7.0</td>
<td></td>
<td>●</td>
<td>230m</td>
<td></td>
<td>dry, on beach, near river</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td>may be larger (and earlier) given G-34</td>
</tr>
<tr>
<td>G-23</td>
<td>True Blue Point</td>
<td>Medium</td>
<td>6.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>(? )</td>
<td>May be larger site, per historical accts; Duquesne Petroglyphs are M-5</td>
</tr>
<tr>
<td>M-3</td>
<td>Duquesne Bay</td>
<td>Medium</td>
<td>8.7</td>
<td>775-1035</td>
<td>●</td>
<td>460m</td>
<td></td>
<td>dry, on beach</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-23</td>
<td>Big David Bay</td>
<td>Small</td>
<td>4.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-7</td>
<td>High Cliff Point</td>
<td>Medium</td>
<td>9.8</td>
<td>1445-1630</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P-9</td>
<td>Antique Point</td>
<td>Medium</td>
<td>9.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-4</td>
<td>La Tante Bay</td>
<td>Small</td>
<td>4.7</td>
<td>1050-1390</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D-3</td>
<td>Galby Bay</td>
<td>Medium</td>
<td>6.7</td>
<td></td>
<td>●</td>
<td>50m</td>
<td></td>
<td>in water, on beach</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-12</td>
<td>Telescope</td>
<td>Medium</td>
<td>6.1</td>
<td></td>
<td>●</td>
<td>75m</td>
<td></td>
<td>in water, near beach</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Size Estimated by Spatial Extent of Artifacts (not specific to time period); Small = < 5 ha, Medium = 5-10 ha, Large = > 10 ha
Radiocarbon Dates and Modeling

Thorough description of the radiocarbon dates and Bayesian models used to refine the chronology here can be found in Chapter 3. For this paper, the available dates were also evaluated using the sum probability distribution (SPD) model in OxCal 4.3 (Bronk Ramsey 2018), which is a loose proxy for human population. This “dates as data” approach (Rick 1987) is premised on the assumption that the amount of organic waste available for dating is relative to the number of people living in an area at a particular time. Obviously, if such a relationship exists, the strength of the association would be limited by researcher bias (non-random sampling), irregular sampling intensity (e.g., on particular contexts/sites), and
preservation biases (Contreras and Meadows 2014; Culleton 2008; Williams 2012). Moreover, humans depend on others within their social group, so organic debris (e.g., charcoal) is not directly proportional to a group's population.

Given these caveats, Freeman et al. (2018) recently showed that radiocarbon dates are a more direct proxy of energy consumption than absolute population, the latter tracking the former in a sub-linear relationship. Thus, so long as we are only concerned with relative population changes (rather than absolute ones) an SPD model can be useful for identifying population trends and potential tipping points in cultural activity (see also Bettinger 2016; Zahid et al. 2016).

For this study, the SPD plot included 30 radiocarbon dates from twelve Ceramic Age settlements in Grenada, excluding Archaic, historic, and modern dates, as well as dates with large errors or those replicated more than once (e.g., from the same sample). To minimize sampling bias, separate SPDs were made for each site first and then combined into one sequence for the entire island. This ensured that each site was equally weighted, whether there are five dates for that site or just one.39 The resultant histogram is shown under the timeline in Figure 4.3.

Behind the SPD in Figure 4.3 is also a bar graph of 25-yr binned intervals that depict a tally of the number of radiocarbon samples falling within a given 25-yr period (using individual modelled 2σ ranges). For example, the modeled, 2σ range for sample PSUAMS-3020 from Salt Pond (G-21) is AD 745–900, which means it was tallied for seven periods: AD 725–749, 750–774, 775–799, 800–824, 825–849, 850–874, and 875–899.

39 It is also worth mentioning that the majority of these dates came from Cody's study of Contact-period sites (Cody Holdren 1998) and the author's project on the earliest sites (Hanna 2017). That is, the bulk of Troumassoid-period dates were unexpected when originally taken.
Unlike SPDs, the 25-yr bins are not informed by the $^{14}$C calibration curve, giving each sample's entire probability equal weight. However, the 25-yr graph is particularly useful for identifying gaps in the radiocarbon sequence and thus the “strength” of our knowledge about each period (Rhode et al. 2014).

**Climate and Vegetation Data**

Carbone (1980) was perhaps the first to note that changes during the Late Ceramic Age coincided with climatic fluctuations shown in early paleoclimate research. Later, Keegan (1999, 2000), Blancaneaux (2009), and Petitjean Roget (2003) also pointed to droughts from AD 800-1000 as instigators of regional changes, as have numerous researchers in the Maya region (e.g., Ebert et al. 2017; Gill 2001; Hoggart et al. 2017; Kennett, Breitenbach, et al. 2012).

To better understand the climate on Grenada, this paper selected four regional paleoclimate proxies based on data resolution for AD 100-1600: $H.\ communis$ ostracods from Lake Valencia, Venezuela (Curtis et al. 1999), Titanium (Tt) from the Cariaco Basin, Venezuela (Haug et al. 2001), $C.\ boldii$ ostracods from Laguna Castilla, Dominican Republic (Lane et al. 2009), and $^{18}$O from Yok Balum Cave, Belize (Kennett, Breitenbach, et al. 2012) (the latter two proxies from the northern Caribbean are only shown in Appendix E). Additionally, four paleolimnological cores from Grenada were also chosen for comparison: Levera Cores A and B (Sharman 1994), and recent cores from Lake Antoine and Meadow Beach (Siegel et al. 2015; Siegel 2018).

Since original measurements were not accessible, climate and vegetation data points were acquired using WebPlotDigitizer, a free online tool that digitizes graph data (Rohatgi 2018). All radiocarbon dates from the paleolimnological cores were also
recalibrated to the most recent calibration curve (IntCal-13) and refined as Bayesian stratigraphic sequences in OxCal 4.3, with an added 0 BP tie-point serving as a *terminus post quem* for each core. The data were then fitted to the updated dates using a Gaussian, rather than uniform, sedimentation model (see methods outlined in Heaton et al. 2013).

**Adaptive Cycles of Resilience**

In comparing the radiocarbon SPD, regional chronologies, and environmental data, hypothetical adaptive stages were devised for Grenada's pre-Columbian settlement history. This required consistent interpretations for the expected effects of each adaptive stage with the demographic patterns in the data. For instance, any shock to the system — whether changes with mainland trading partners or the onset of a period of aridity — would trigger a delayed change (a K/conservation period usually followed by an Ω/release-phase). Meanwhile, an influx of migrants could trigger an immediate release stage, side-stepping the K/conservation phase and pushing more rapid changes (Ω/release then α/reorganization stages). Not every population jump should be interpreted as immigration, though, so more gradual population increases are translated as successful r-phase growth. Likewise, gradual decline is interpreted as the stagnation of a long-term K/conservation-phase that did not return to growth. Using this framework, phases were mapped to the SPD in Figure 4.3, with description of each phase offered in Table 4.2.
Figure 4.3 Natural and Cultural History of Pre-Columbian Grenada — comparison of regional precipitation and chronological records with local vegetation and archaeological records. The Sum Probability Distribution (SPD) depicts relative population for Grenada (from 30 radiocarbon dates of 12 sites); histogram of 25-year bins are behind SPD; periods of below-average precipitation are highlighted by the two gray overlay bars; “herbs” are herbaceous taxa identified by Siegel et al. (2015) as potential indicators of anthropogenic landscapes; chronologies of the Guianas and Orinoco modified from Boomert (2000:218); Grenada and the Windwards chronologies are from Chapter 3.
Assigning adaptive phases also required several assumptions. For one, we must accept the aforementioned caveats about absolute versus relative population in the SPD. Second, the analysis is only based on the data available — there are likely missing data and unknown factors involved in each pattern. Finally, the lines placed between ceramic phases (bottom of Figure 4.3) are much blurrier in reality, so this analysis assumes the relative order of events is correct, even if the exact dates are not.

**Results**

**Settlement Comparisons**

Of the 25 settlements chosen for this study, twenty (80%) were occupied during the Troumassan and Suazan sub-periods between AD 750-1650 (Table 1) — 18 of which were initially founded (nine Troumassan and nine Suazan). Of the five SLDs that do not date to this period, two (Grand Marquis and Beausejour) are earlier Saladoid-Barrancoid settlements adjacent to a Troumassan one, suggesting settlement relocation. The two remaining Saladoid-Barrancoid sites that continued into the Troumassan also continued into the Suazan, as did all nine SLDs founded during the Troumassan phase (Figure 4.2). The three sites not occupied during the Troumassoid sub-periods were Contact-period, Cayoid settlements. Two Suazan-period settlements in the sample also have Cayo ceramics, though at least one (Sauteurs Bay, GREN-P-5) is likely trade ware (Cody Holdren 1998, 195). Lastly, eleven of the 25 sampled sites appear to have been occupied

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40 That percentage might be even higher if a larger sample were available. Of the 87 sites in the ASIG, 18 have diagnostic Troumassan ceramics and 33 have diagnostic Suazan ceramics (with ~14 overlapping); another 20 are designated ‘General Post-Salado’ because too few diagnostic ceramics are known, and an additional 24 sites are designated ‘Unknown’ because too little information is available. Thus, not counting Unknowns, the percentage of sites that were occupied during the Suazan Troumassoid period could actually be as high as 89% (56 of 63).
at European settlement, based on ethnohistoric references, radiocarbon dates, and/or archaeological evidence (see Hanna 2017 for full site summaries).

Grenada’s Troumassan (AD 750-900) period also witnessed the expansion (and possibly, introduction) of rock art: including “workstones” (grooved boulders) and petroglyphs (Figure 4.4) — both of which, as described below, suggest ideological changes (Hayward et al. 2014; Jonsson Marquet 2009). Interestingly, the introduction of petroglyphs includes the “swaddled” types, which may be contemporaneous with similar “swaddled” figures in the Guianas, although it is unclear whether the parallels are truly equivalent (Cody 1990b; Dubelaar 1986, 1983; Roe 2009). Just two of the eight known petroglyph sites are included in the sample here, but all are peculiarly clustered in the northwest corner of the island.

Relatedly, twelve workstone sites have been documented so far in Grenada, all associated with Late Ceramic Age settlements. While similar to more portable mortars, workstones are permanent fixtures on the landscape — large boulders containing quixotic cupules and occasional “sharpening lines,” always at a distance from the nearest settlement or midden (Table 4.1). Few researchers have mentioned them, making their occurrence and distribution difficult to assess, but workstones are generally believed to have been used to make stone tools and other ground-stone items (Bednarik 2008; Kirby 1970; Loncan 1990).

The earliest settlements associated with workstones are Troumassan, comprising at least half of all workstone sites, suggesting these features arrived between AD 750-900 (see Discussion). While workstones could have arrived during the Suazan components of those sites, most appear to have been abandoned by AD 1260 (per their radiocarbon dates,
see Table 3.1) and were not occupied during the French arrival in 1649 (i.e., they are only associated with the early stage of the Suazan period). The timing of their arrival is further corroborated by the number of workstones and petroglyphs now partially or fully submerged under water — testament to times of lower sea-levels, as expected for the period of aridity from AD 730-900, described below.

The appearance of workstones during the Troumassan period could also be related to the increased use of maize (Zea mays) (ostensibly an Arauquinoid trait). While maize appears to have arrived in the Caribbean during the Archaic Age (Mickleburgh and Pagán-Jiménez 2012; Pagán-Jiménez et al. 2015), evidence suggests it was grown infrequently as a secondary — possibly higher-status — food that increased in use around AD 800-1000 (Newsom 2006). Maize starch has been recovered from Late Ceramic mortars in Puerto Rico (Pagán Jimenez and Oliver 2008) and ethnohistoric texts reference maize flour, which requires grinding stones (Coppier 1645:74; Newsom 2006, 2008; Sauer 1966:55). Placing workstones near petroglyphs and otherwise public areas may therefore signify ceremonial feasting, which also follows the possible ritual status of maize (Newsom and Deagan 1994), as well as an apparent increase in communal ceremonies during the Troumassoid generally (Hofman 2013).

Climate Results

Comparison of the settlement data to the selected climate proxies reveals a clear relationship between precipitation and local cultural changes. A generally mesic period from AD 250-730 in the Caribbean Basin ends just before the onset of the Troumassan series (around AD 750), followed by unpredictable (mostly arid) conditions from AD 730-900 and again from AD 1070-1290 (gray bars in Figure 4.3). Intriguingly, Conocarpus sp.
mangrove in the Levera cores from Grenada corresponds perfectly to a dry climate regionally, whereas *Rhizophora* sp. mangrove corresponds to a wetter climate (top of Figure 4.3). This makes sense in the restricted environment of Levera Pond, where higher sea levels would have increased salinity (conditions preferred by *Rhizophora* sp.) and lower sea levels would have disconnected the pond from the sea, allowing more brackish waters (preferred by *Conocarpus* sp.) (McAndrews 1996; Sharman 1994; Ramcharan 2004).

Unfortunately, the sediment cores from Lake Antoine and Meadow Beach were not as illuminating for the Ceramic Age as they were for the earlier Archaic Age (Siegel et al. 2015). Indeed, the decline in charcoal during the Late Ceramic dry periods contrasts with expectations of a human population increase, but the Total Concentration values are too low to be independently reliable (see Bryant and Hall 1993).

Nonetheless, the relationship between regional climate and cultural changes on Grenada (and the Windward Islands, generally) is striking. The relationship with population changes, however, is more enigmatic, particularly the apparent influx during the AD 730-900 arid phase, evident in both the SPD and site counts (Figure 4.3). Population increase is unexpected for such a dry period, which would compound stress on people and resources (e.g., Lima and Berryman 2011; Zhang et al. 2011). It is this dry-period population rise, coupled with the introduction of new ceramic types, that suggests migration rather than local development.
Discussion

Re-evaluating the Caribbean’s Late Ceramic Age

As a heuristic device, mapping the adaptive stages of resilience to Grenada’s prehistory allows all the above data on climate, vegetation, demography, and cultural sequences to be pulled together into one cohesive interpretation. This method proved enlightening not only for the transition to the Troumassoid period but also for later developments in the pre-Columbian Lesser Antilles.
The shift to Troumassan ceramics in Grenada (i.e., the decline of Saladoid-Barrancoid) occurred shortly after the onset of increased regional aridity (~AD 730), suggesting climate could be a driver. Yet it is widely accepted that this period heralded an increase in population throughout the region, as evidenced by the proliferation of contemporary habitational sites and the colonization of previously unsettled islands (Berman and Gnivecki 1995; Boomert 2000:381; Bradford 2001a; Bright 2011; Curet 2005; Fitzpatrick 2006; Hofman 2013; Keegan 1985, 1992; de Waal 2006; Wesler 2013). Likewise, the number of sites in Grenada expanded five-fold in our sample of 25, from four Saladoid-period SLDs to twenty in the Troumassoid. This rise is further supported by the sum probability (SPD) model, which depicts population “peaks” at exactly the driest points in the sequence. Demographic growth is not a natural reproductive response to a period of stress, so how could native populations have increased?

All factors (including the introduction of new ceramic types, rock art, workstones, and subsistence strategies) point to a population rise during the Troumassan that corresponds with the spread of Arauquinoid ceramics on the coastal mainland. Unlike Polynesia, archaeological evidence suggests the Caribbean islands remained in constant contact with the South American mainland throughout prehistory. Exotic gemstones, shells, tools, flora, fauna, and other goods were traded across a complex exchange network spanning the entire northern coastline of South America (Coppa et al. 2008; Hofman et al. 2010; Lathrap 1973:1973; Mol 2014). At Pearls (one of the largest and earliest sites on Grenada) cultural materials were sourced from as far south as eastern Brazil and as far north as Vieques, Puerto Rico (Boomert 1987; Cody 1990a, 1993; Fandrich 1990; Hofman et al. 2011; Laffoon et al. 2014; Newsom and Wing 2004). At the time of European contact,
these connections were still thriving, with historic accounts recording heavy traffic between the southern Lesser Antilles and South America (Anonymous [Benigne Bresson] 1975:13; Martin 2013:25; Williamson 1926:12). This regional connectedness suggest a steady flow of people and ideas — a cultural lifeline between island communities and those on terra firme.

While some changes in the Caribbean Late Ceramic Age were likely in situ developments, rarely addressed is the general contemporaneity of cultural changes with those on the mainland. Throughout the Guianas region, the number of sites multiplied while pottery types shifted from Saladoid-Barrancoid to the Arauquinoid series, which (like Troumassoid types) favored surface treatment over painted decoration — including diagnostic attributes such as finger-indented rims, scratched/combed impressions, appliqué ridges, and crude anthropomorphic adorns (Boomert 1980; Roosevelt 1980; Rostain 2008; Rostain and Versteeg 2004; Rouse and Cruxent 1963; Versteeg 2008; Zucchi 1991a, 1991b, 1985). Arauquinoid ceramics are associated with one of several complex chiefdoms on the mainland known for its intensive agricultural techniques (e.g., raised and drained fields, terra preta soils), maize as a possible staple crop, craft specialization, long-distance trade, and large settlements (Clastres 1989; Roosevelt 1999; Rostain 2008:231; Whitehead 1993). Oddly, despite the obvious similarities in material culture, the spread of Arauquinoid on the mainland has not been formally linked to the Caribbean Troumassoid (except in Trinidad where a Guayabitan Arauquinoid type is known as the Bontour complex) (Boomert 2016:46).

It is worth noting the ceramics that appear in the Late Ceramic — invariably regarded as a “decline” from finer Saladoid types — are actually part of the pan-Amazonian
Incised and Punctate Horizon.\textsuperscript{41} Indeed, Keegan (2018) recently argued that the “-oids” often co-occur in a way that mimics dual “phratries” of tribal kinship patterns (see also Spencer and Redmond 2015). As examples, he points to the co-occurrence of Cedrosan and Huecan Saladoid in the northern islands and Saladoid/Barrancoid in the southern Caribbean, but this could be expanded further to a general balance between the two macro ceramic traditions of the Amazon Basin: the Polychrome Horizon and the Incised and Punctate Horizon (Meggers and Evans 1961). The beautifully painted wares of Cedrosan Saladoid are clearly in the Polychrome tradition, while the incision and surface treatments of Huecan and Barrancoid are aligned to Incised-Punctate. During the Late Ceramic, the change to Troumassan types incorporated polychrome elements of Cedrosan (and probably Dabajuroid) with an increase in surface treatments like “scratched” wares and indented rims — clearly Incised-Punctate (probably Arauquinoid, but also with Valencioid and Guayabitojoid influences, among others) (Rouse and Cruxent 1963). Later, the painted wares of Cayo pottery (Polychrome, see Boomert 2004) co-occur with the Incised-Punctate wares of Suazan during the Protohistoric period (AD 1492-1650). There are, of course, elements of both traditions throughout, indicating integration rather than isolation (e.g., ZIC in Cedrosan, appliqué in Cayo), but it is worth considering this dual pattern of macro-pottery elements and, possibly, kinship relations. That is, we might expect the Polychrome Troumassan to be complemented by an Incised-Punctate ware such as Arauquinoid.

The drying trend beginning AD 730 is also associated with changes in settlement patterns, where the near uniform locational preference for slightly inland, agriculturally

\textsuperscript{41} The Incised and Punctate Horizon is sometimes referred to as Arauquinoid and the Polychrome Horizon as Marajoaroid, after their most distinguishable type sites.
rich areas of the Early Ceramic Age expanded to more diverse environments like dry-scrub vegetation, small islets, mountainous inland areas, and previously unsettled islands lacking freshwater (Bradford 2001a; Bright 2011). Expansion to new environments is a way to reduce pressure and competition for resources. Faunal remains also indicate an increased focus on marine foods, particularly towards nearshore taxa (e.g., Carlson and Keegan 2004; deFrance et al. 1996; Delsol and Grouard 2016; Fitzpatrick and Keegan 2007; Giovas 2016; Goodwin 1980; Keegan 2000; Newsom and Wing 2004; Rainey 1935; Reitz 2004; Serrand and Bonnissent 2018; Steadman and Stokes 2002).

It is possible the increase in site numbers could simply reflect smaller, more mobile groups exercising alternating exploitation strategies, perhaps on a seasonal basis. The shift towards nearshore marine taxa, however, is more consistent with increased territorialism than mobility. A drier climate would decrease opportunity for agricultural pursuits, putting strain on alternative resources such as marine species. With coastal settlements more closely spaced during this time (a trend that continues into the Suazan period), catchment areas were also smaller, increasing competition and putting more emphasis on less-risky resources.
Table 4.2 Major Events and Socio-Ecological Responses in Grenada’s Prehistory

<table>
<thead>
<tr>
<th>Time Period (AD)</th>
<th>Internal/External Stimulus</th>
<th>Socio-Ecological Response</th>
<th>Cycles with SPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>AD 200-700</td>
<td>Arrival of Saladoid-Barrancoid</td>
<td>successive r and K phases (rigidity)</td>
<td></td>
</tr>
<tr>
<td>AD 700</td>
<td>Arauquinoid takeover of coastal mainland</td>
<td>K/conservation</td>
<td></td>
</tr>
<tr>
<td>AD 730</td>
<td>Onset of arid period</td>
<td>K/conservation</td>
<td></td>
</tr>
<tr>
<td>AD 770</td>
<td>Population Influx</td>
<td>Ω/release and α/reorganization (emergence of Troumlassan ceramics, expansion of diet breath, testing of different environments)</td>
<td></td>
</tr>
<tr>
<td>AD 860</td>
<td>Population decline</td>
<td>Ω/release and α/reorganization (emergence of Suazan ceramics)</td>
<td></td>
</tr>
<tr>
<td>AD 900</td>
<td>Mesic period/end aridity</td>
<td>r/growth, consolidation of Suazan identity</td>
<td></td>
</tr>
<tr>
<td>AD 1000</td>
<td>Koriaban takeover of mainland</td>
<td>K/conservation</td>
<td></td>
</tr>
<tr>
<td>AD 1020</td>
<td>Population decline</td>
<td>Ω/release and α/reorganization</td>
<td></td>
</tr>
<tr>
<td>AD 1070</td>
<td>Onset of arid period</td>
<td>Ω/release and α/reorganization</td>
<td></td>
</tr>
<tr>
<td>AD 1160-1200</td>
<td>Pop influx/depopulation of Leewards</td>
<td>r/growth</td>
<td></td>
</tr>
<tr>
<td>AD 1250</td>
<td>Arrival of Cayo ceramics</td>
<td>K/conservation</td>
<td></td>
</tr>
<tr>
<td>AD 1260</td>
<td>Population decline; Mesic period/end aridity</td>
<td>Ω/release and α/reorganization</td>
<td></td>
</tr>
<tr>
<td>AD 1260-1649</td>
<td>(Unknown)</td>
<td>Several cycles of Ω/release and α/reorganization?</td>
<td></td>
</tr>
<tr>
<td>AD 1649</td>
<td>French settlements/wars</td>
<td>Ω/collapse</td>
<td></td>
</tr>
</tbody>
</table>
In terms of resilience theory, therefore, the general conformity of Saladoid designs in the Early Ceramic throughout the region (e.g., white-on-red and polychrome painting, zone-incised-crosshatching, and ornate zoomorphic adornos) represents a cultural rigidity akin to repeated K/conservation-phase responses towards external shocks. One effect of repeated K/conservation phases is the “rigidity trap” discussed above — a decline in adaptive capacity that reduces options during later periods of reorganization and renewal. While this rigidity hindered adaptive changes earlier in the cycle, the “shock” of incoming migrants was perhaps just one of many cracks in the “veneer” masking a pre-existing diversity (Keegan 2000). Perhaps as a result, the outcome of an immigration event (Ω/release-phase) was not cataclysmic but instigated an adaptive (α-phase) reorganization that integrated some vestigial Saladoid-Barrancoid features with Arauquinoid styles into the Troumassan type (Fitzpatrick et al. 2010; Hanna and Jessamy 2017; Hofman 1993; Rouse and Faber-Morse 1999). The continuity of earlier ceramic attributes — and occupational continuity of many settlements themselves — implies population integration rather than replacement.42

It is also possible the Arauquinoid signal is more related to diffusion than migration. The strongest parallels in ceramic styles are Arauquinoid, but it is not an exact replication. Other influences appear, including black-painted designs akin to Dabajuroid, adorned rod-handles similar to Valencioid, and simplistic incised lugs of Guayabitoid (Bontour), as well

42 Indeed, there is considerable overlap between Troumassan and Suazan ceramics, particularly attributes within Bullen’s (1964) Caliviny style. Of the seven sites on Grenada that have reported Caliviny polychrome and/or unique adorned, all also contain diagnostic Suazan traits such as scratched surfaces and finger-indentated rims. Even in his later excavations on Caliviny Island itself, Bullen acquiesced that the homogenous distribution of pottery from each type indicated the same group probably made both Suazan and Caliviny ceramics (Bullen and Bullen 1968:36).
as others on the mainland and nearby southern Caribbean (Allaire 1999:716,722; Bright 2011:148; Rouse and Cruxent 1963). Even in Trinidad, the Bontour tradition is considered diffusion rather than direct migration (Boomert 2016:46). Nonetheless, the appearance of Arauquinoid influences in the Late Ceramic mimics the later migration of Cayo (Island Carib) pottery into the region a few hundred years later (see below). This, too, was not an invasion but an integration likely through longstanding exchange relationships. As mentioned, it is also possible that Grenada’s first settlers during the Salado-Barrancoid phase arrived from this direction as well. It would not be surprising, then, if another group arrived during the Troumassan phase from the same area.43

By AD 900, Suazan types emerge in the islands, concomitant with a population decline at the end of an arid climatic interval. The period of gradual growth that followed suggests successful r/growth-phase adaptation during a return to regionally mesic conditions. Around AD 1020, however, another decline occurred, corresponding with the spread of Koriaban ceramics on the mainland (AD 1000), and the onset of another period of regional aridity (~AD 1070), all of which are interpreted here as two cycles of Ω/release and α/reorganization. While mostly hypothetical, such reorganizations can be seen in the consolidation of innovations from the Troumassan period (e.g., scratched pottery, griddle legs) into a more standardized Suazan assemblage. That is, while Troumassan types are more variable throughout the islands, the later Suazan types carry a relatively standard repertoire of grated/incised surface treatments, limited painting, and low-fired, thick

43 This is also the direction of ocean currents (dominated by the South Equatorial Current), which are driven by the trade winds generally running SE to NW (Callaghan 1990). Readers should also note that I am not proposing monolithic migrations of people. It is rarely a singular migration but rather one that begins with interaction, alliance, exchange, and the diffusion of ideas, sometimes culminating into the merger of disparate groups who are, eventually, themselves influenced by a new group, and so on.
vessels from Grenada through the Virgin Islands, despite Rouse’s separation of Mamoran and Suazan (Allaire 1991; Bright 2011:146; Rouse et al. 1995).

The nature of this Troumassan-Suazan transition also aligns with the consensus that Suazan was an *in situ* development (Allaire 1977, 1991; Boomert 2000; Davis and Goodwin 1990; Keegan 2000), albeit one based on a recent Arauquinoid migration rather than a degeneration from the Saladoid tradition. In this sense, Suazan Troumassoid ceramics are best understood as a fusion of Saladoid-Barrancoid and Arauquinoid types, with Troumassan as the transitionary phase. It is also possible that consolidation reified a larger Suazan identity across the southern Leeward and Windward Islands — filling in the cracks of the previous “Saladoid veneer” and challenging the increased territorialism of the Chican Ostionoid potters in the Greater Antilles.

Though speculative, such developments would have set the stage for the Protohistoric “Taino-Carib frontier” in the northern Leeward Islands (Allaire 1987) — a geo-political division observed between the Suazan-style (“final Mamoran”) territories as far north as Antigua (Rouse et al. 1995:451) and the Chican Ostionoid satellites on St. Martin, Anguilla, and Saba (Bonnissent 2008; Crock 2000; Hofman 1993; Hofman et al. 2008; Lundberg 2003). While it is debatable how entrenched this frontier division actually was (Allaire 1987; Figueredo 1978; Hofman 2013; Hofman et al. 2014; Hofman and Hoogland 2011) many islands were abandoned, possibly due to socio-political hostilities, climatic changes, and/or demographic shifts elsewhere. Current data suggests St. Kitts and Montserrat were depopulated around AD 1100, followed by St. Eustatius (AD 1200), Barbuda (AD 1300), and parts of neighboring islands (Rouse and Faber-Morse 1999; de Waal 2006). As such, the population rise in Grenada at AD 1160 could reflect refugees
from the north. That the SPD curve is steep suggests migration, but the avoidance of an $\alpha$/reorganization-phase (i.e., any obvious cultural changes) is curious — perhaps confirmation of a wider Suazan identity of shared cultural traits.

Around AD 1260, Grenada’s population again declined, amidst (paradoxically) the return of mesic conditions to the region. While the nature of this decline is ambiguous, it also aligns with the arrival of Cayo ceramics around AD 1250 (Boomert 1986), which are associated with historically documented Island Caribs. Carib invasion mythologies recorded by Europeans purport a violent takeover, yet the SPD suggests few “invaders” arrived. Arboreal pollen from Meadow Beach, fern pollen from Lake Antoine, and weed pollen from Levera all rebound, indicating primary vegetation growth and less human presence.

There is much debate regarding the violence associated with Island Caribs in the Caribbean, as both linguistic (Granberry and Vescelius 2004; Taylor 1977) and some ethnohistoric (e.g., see reviews in Allaire 1980, 2013; Boucher 1992; Hulme and Whitehead 1992; Lenik 2012; Whitehead 1995; Wilson 1993a) evidence hint at a more peaceful assimilation. There are also no mass graves or burning events recorded for this period. Even the Leeward Island depopulations mentioned above, originally associated with the “Carib invasion,” now appear to pre-date the event. It is also notable that no Cayo sites have yet been identified north of Guadeloupe, and even those in Grenada make up only half of the settlements present at European colonization (see Introduction). Given these indicators, it is perhaps unsurprising that a recent cataloging by Shafie et al. (2017) of “Carib” attacks against Europeans in the early colonial period found that the highest frequency of clashes occurred at the territorial boundaries of Antigua and Grenada —
essentially coterminous with a Suazan (rather than Cayo) domain. Yet this alliance between the two was a central reason for the successful defense of their islands for the first 150 years of European colonization (Cody 1995; Mans and Borck 2017).

One alternative interpretation is that a regional population decrease at AD 1260 (whatever the cause) would have encouraged settlement relocations to larger, more-resourceful islands (such as Grenada), as predicted by models in human behavioral ecology (Anderies 2006; Giovas and Fitzpatrick 2014; Keegan 1995; Winterhalder et al. 2010). The steepest drop in precipitation in the Cariaco Basin during the Ceramic Age occurred at this time. A brief respite is possible afterwards, but by AD 1400, the Little Ice Age is evident in the prolonged period of below-average precipitation across all regional records (e.g., Dull et al. 2010; Haug et al. 2001; Hodell et al. 2005; Hoggarth et al. 2017). As this would also correspond with lower sea levels, some depopulation might be attributable to settlement relocations now reclaimed by the sea.

By AD 1500, charcoal fragments increase in Grenada’s Meadow Beach record, suggesting a rebound in population (also evident in the SPD). However, analysis of historical texts from the late 17th century mention only about 22 indigenous settlements (Martin 2018, personal communication) — far lower than the 57+ sites occupied during the early Suazan period — indicating the rebound did not last long. More data is needed to determine the full context, but perhaps several cycles of release (Ω) and reorganization (α) precipitated the final shock to the system — the arrival of Europeans.

Conclusion

In the Lesser Antilles, the Late Ceramic Age (characterized by the Troumassoid macro series) began around AD 750 with wide-ranging changes in material culture and
lifeways typically ascribed to the implosion of a preceding, highly artistic “Saladoid” ceramic phase. This paper analyzed data from the island of Grenada that suggests changes in Late Ceramic Age cultures in the southern Lesser Antilles were largely adaptations to episodic population influxes from the mainland against a backdrop of unpredictable climate fluctuations. By using resilience theory as a heuristic, it was shown that the transition to the Late Ceramic Age was not an internal collapse of the Saladoid identity but the product of climatic stress coupled with the immigration of new Arauquindoid groups from coastal South America, triggering several cycles of reorganization that culminated in the Suazan ceramic tradition. Additionally, the arrival of historically known “Island Caribs” corresponds with a depopulation event in Grenada (and the wider Caribbean), but stronger evidence is still needed to better understand these interactions. Ultimately, genetic work (e.g., Martinez-Cruzado 2013; Schroeder et al. 2018) and isotopic signatures (e.g., Laffoon 2012) may hold more granular insights.

Interestingly, this study also highlights how events and changes in one area of the Caribbean invariably produced change in another. Given the general scale of analysis, an implicit assumption (really, a hypothesis) regards the interconnectedness of the entire region — that each cultural group and island were part of a larger whole. Profound ties to terra firme are evident throughout the archaeological record, reflecting not fractious introspection, nor purely autochthonous innovation, but an outward-looking flexibility that incorporated multi-cultural influences from each island’s past with persistent reverberations from the mainland.
CHAPTER 5
Predictive Modeling and the IFD in Pre-Columbian Grenada, West Indies

Abstract:
Predictive modeling in archaeology, a corollary to settlement pattern analysis, is often undertaken in a purely inductive manner, without explicit theoretical foundation. However, many approaches in human behavioral ecology (HBE) can be used as deductive guides in otherwise inductive predictive models. One evolutionary heuristic, the Ideal Free Distribution (IFD), is particularly well suited for archaeology. This paper presents a predictive model for pre-Columbian settlements on the island of Grenada built from inductive analysis of common environmental characteristics and guided by the IFD’s principle that people will settle in the highest resource areas first. The model was then field-tested using a radiocarbon auger survey that drew on artifact assemblages, radiocarbon dates, basic soil morphology, and soil grain-size analysis to help understand the prehistoric colonization of the island, demonstrated here through the case study of Beausejour Bay (GREN-G-34). The results show that Amerindians in Grenada largely followed the parameters of an Ideal Free Distribution, but one that shifted over time as marine resources supplanted agriculture as the primary subsistence strategy around AD 750. Nonetheless, wetland/riparian areas remain highly ranked throughout the sequence, allowing accurate prediction of both coastal and inland site locations. It is suggested that the importance of wetland areas in prehistory have been undervalued in archaeological research in the Caribbean.

Keywords: Ideal Free Distribution, Geoarchaeology, Lesser Antilles, Wetlands

A version of this chapter is planned for submission to the Journal of Archaeological Science.
Introduction

Where people choose to live is dependent on innumerable socio-cultural, economic, and environmental factors. Yet, whether the logic is purely opportunistic or stringently defined, patterns can often be identified for a given culture at a specific time. By studying these patterns through the lens of hypothetico-deductive theories, hidden cultural values can be revealed. One such theory is the Ideal Free Distribution (IFD), which offers a simple maxim for the criteria underlying human settlement patterns: when free to choose, people will settle in the most suitable area they know first. One need only identify which natural resources or ecosystem services were most valued by the target group to predict where their earliest settlements should be located. If the earliest sites are not there, then either the modelling criteria are wrong or there are other socio-cultural processes at work. Thus, failure of the model can be more enlightening than success, at least initially. Such was the case for the study below.

The IFD approach is especially useful for archaeological surveys that need to prioritize areas to be sampled within time and budget constraints. This was the situation on the Caribbean island of Grenada, where the archaeological record was not well documented and long-term, systematic studies were still needed. Researchers have long presumed Grenada was the first island colonized (around 500 BC) by Ceramic Age peoples (and perhaps the Archaic Age before them), migrating up the Antillean archipelago from South America in a “stepping-stone” manner (Rouse 1964, Siegel 2015, see also Chapter 2). Detractors of this hypothesis counter that Grenada and the southernmost (Windward) islands contain few, if any, Early Ceramic Age sites, let alone any evidence from the Archaic Age. Yet the paucity of research conducted in the Windwards, particularly Grenada, has forestalled broad conclusions either way. This paper documents an initiative
to confirm whether or not Grenada was skipped by Early Ceramic settlers by using an IFD-informed predictive model implemented through a “radiocarbon survey” to quickly assess and record sites before they are destroyed by coastal erosion or modern construction (Brown Vega et al. 2013; Erlandson and Moss 1999; Kennett, Culleton, et al. 2012).

**Background**

Settlement patterns have a long history in archaeology, but formal studies increased following Willey’s (1953) seminal research in Viru Valley, Peru. By the 1990s, the widespread availability of GIS software and large datasets of environmental characteristics made analysis of environmental surroundings standard practice in archaeology. However, relatively few studies employ deductive approaches, instead relying entirely on inductive description of environmental variables common to each site or region.

In the Caribbean, many attempts at regional settlement patterns have been hampered by over-reliance on relative dating or misunderstanding absolute dates. For instance, Haviser (1997) concludes that the earliest sites in the Antilles tended to be in the NE quadrant of each island, ostensibly facilitating continued migration up the island chain. Unfortunately, his timing of the “earliest” sites relied on a collection of variously corrected, uncorrected, calibrated, and uncalibrated radiocarbon dates that were not standardized during analysis (nor often by the original investigators).

Bradford (2001b, 2001a) conducted a systematic study of settlement patterns in the Windward Islands — as did Bright (2011), although Bradford focused on GIS data while Bright summarized the extant record for each island. Bradford found that 60% of sites in the Windward Islands are single-occupation Suazan settlements (post-AD 900), and 77% are within 800 m of a beach. She also found that sites after AD 1200 tended to be higher
elevation, although most were still below 15 masl, usually in littoral grasslands/woodlands. Meanwhile, Bright (2011) concluded there were no strong settlement patterns in the data, echoing Keegan's (2004) observation that settlement choices in the Caribbean are too stochastic to be predictable, even though they ultimately are rational (e.g., settlement for different reasons by different groups from other islands or the mainland).

Predictive models are a natural offshoot of settlement pattern analysis, engaging the findings of the former to identify high probability areas for unknown settlements. Such models are indispensable to cultural resource managers, particularly in developing countries where impact assessments are inconsistently, if ever, applied. In this vein, Reid (2008) analyzed three watersheds in southern Trinidad using a “weights-of-evidence” technique (Bonham-Carter 1994). He found that sites in this region were most likely to occur in hilly areas associated with alluvial plains and valleys with well-drained soils (i.e., the worst land closest to the best). Maaike de Waal’s (2006) survey of eastern Guadeloupe devoted a chapter to settlement patterns in each period, though she refrained from drawing predictive generalities. However, the heat maps featured in de Waal’s later predictive models for the Dutch West Indies (de Waal et al. 2015, 2017) were an inspiration for those presented here. In Cuba, Watson (2011) analyzed environmental characteristics of sites to build a predictive model, also using the weights-of-evidence approach to choose variables (elevation, slope, aspect, rivers, mangroves, limestone soil, parent material, and proximity to other sites). Most sites were found to be at low-elevation, close to mangrove areas, and facing south. She suspects the south-facing aspect may be more resilient to hurricanes, though precipitation may also have been a factor.
The few surveys previously conducted in Grenada have not been informed by settlement pattern analysis or predictive models. However, Harris (2001) usefully summarized the island's settlement patterns by organizing 65 sites into ten watersheds (though there are actually over 70 watersheds in Grenada) (USAID 1991:78). Oddly, this led Harris to propose the earliest sites were on the western side of the island, an error partly due to lack of chronological control. There are, in fact, very few sites the western side (Figure 3.1), but Beausejour (G-34) — discovered along the western highway in 2016 — may indeed be the earliest Ceramic Age settlement (Chapter 3).

As mentioned, none of the above studies sought to connect their findings to broader deductive theories of human behavior. The only such attempt in the Caribbean was the recent analysis by Giovas and Fitzpatrick (2014), which used Net Primary Productivity (NPP) to test whether the earliest settlements in the Lesser Antilles aligned with the IFD, following Codding and Jones (2013). This was not a predictive model, but rather a comparison of the IFD against regional colonization patterns. The current paper applies this approach on a more local level and integrates its predictive potential to strengthen field survey methods.

The Ideal Free Distribution (IFD)

The premise behind the Ideal Free Distribution (IFD) is that all living organisms prefer to live in the most “suitable” habitats, and when those primary areas get overcrowded, the “next best” habitat is chosen — continuing down the resource gradient with each new habitat (Fretwell and Lucas Jr. 1969). Humans are no different (Codding and Jones 2013; Fretwell and Lucas Jr. 1969; Kennett et al. 2006; McClure et al. 2006, 2006; Winterhalder et al. 2010). While some have criticized HBE for reducing humans to
environmentally-determined resource “maximizers,” (Balée and Erickson 2006:4; Smith 2014, 2009, 2015; Zeder 2014, 2016), there are good, evolutionary reasons why humans tend to follow these patterns. After all, we are all products of natural selection.\textsuperscript{45} Even so, the purpose of the IFD is not to claim human behavior can be reduced to simple formulae, but rather to help disassemble the complex processes behind human behavior and individual choice (Charnov 1976; Kelly 1995; Smith and Winterhalder 1992). This basic principle allows us to test long-held assumptions and identify hidden factors that may have affected settlement decisions (Shennan 2008; Sutherland 1996). Indeed, it should be stressed that, regardless of whether or not the model works in a specific case, it is a heuristic tool — not an explanatory one. Understanding the decisions behind each site’s location can only come from in-depth analysis of that settlement’s specific history (Bettinger 1998).

\textbf{Methods}

\textbf{The Predictive Model}

In order to identify areas where humans would have most likely settled \textit{first} in prehistoric Grenada, a series of predictive models were generated using variables determined via geospatial analysis of known sites and ethnohistoric data. The models were successively updated following each of several seasons of fieldwork (Chapter 1, and Hanna 2017).

Initially, a dataset of 25 sites for which basic data was known (from the 87 now inventoried in Grenada) were selected to build and refine the model (\textsuperscript{45} A modern example (albeit highly simplified) is a grocery store parking lot — where would the average customer prefer to park their car: in the back, or close to the entrance?)
Table 4.1). Based on their artifact assemblages, all were residential settlements with available diagnostic ceramics and/or radiocarbon dates and confirmed locations. “Settlements” here are defined as sites with (transposed) primary middens containing ceramics, organic remains, fauna, and often buried “A” (Ab) horizons that indicate former living surfaces. This sample of 25 settlements with locations and dates (or SLD-25) allowed exploratory analysis of fifteen environmental variables associated with each site using ArcMap 10.5. These variables included percent of wetlands within a 600 m buffer, total size of nearest wetland, slope and drainage quality, general forest type, Net Primary Productivity (NPP), and distances to beaches, reefs, seagrass, clay sources, rivers, wetlands, seabird rookeries, turtle nesting, and prime agricultural soils (e.g., Figure 5.1).

Some of these variables (e.g. distance to rivers, beaches, and coral) are common to settlement pattern analyses in the Caribbean. The use of seagrass, however, was based on ethnohistorical and archaeological evidence of the importance of conch (esp. Lobatus gigas) in Amerindian diets and the life-history of the animal, which lives most of its life in seagrass (Davis 2005; Egan 1985; Stoner et al. 1992; Stoner and Sandt 1992). Thus, coastal areas near seagrass were given higher probability of settlement, equal to that of reefs.

Soils data was mostly derived from a georectified version of the Vernon et al. (1959) soil survey of Grenada, acquired from the GIS Unit of Grenada’s Ministry of Agriculture (MOA GIS 2015). Prime agricultural soils were identified based on low erosion and slope, good drainage, and medium to high nitrogen and potassium (though not necessarily phosphorus). Geological data was based on a digitized version of Robertson (2005), also acquired from the MOA GIS. The “wetlands” layer was built by filtering all areas in the soil and geology shapefiles labeled swamps, salinas, marshes, mangroves, river
wash (alluvium), and areas of soil accumulation (colluvium) (see Moore et al. 2015 for a
method of identifying some of these from Landsat imagery). NPP was acquired from the
Mod17 data compiled by Terra/MODIS (Zhao and Running 2010), reefs from the
Millennium Coral Reef Mapping Project (Andréfouët et al. 2006), and various DEM-
derived layers (watersheds, forest types) based on the NCEI 1-arc DEM (NOAA NCEI
2017) and ASTER 30-arc GDEM (LP DAAC 2011). Other layers were digitized and
georeferenced by the author in ArcMap 10.5, including environmental maps in Beard
(1949) and the Country Environmental Profile for Grenada (USAID 1991). Measurements
of these data for each SLD-25 site were then exported to R for descriptive and multivariate
statistical analyses.

The 2016 version of the model (which directed much of the fieldwork here) was
split into two separate maps to differentiate suitability differences between foraging (e.g.,
early Archaic) and horticultural (e.g., early Ceramic) peoples (Figure 1.4 and Figure 1.6).
Thresholds for each variable and/or ranked criteria (set as the average of 85% of the SLD-
25 dataset) were used to create a heat map of settlement suitability across the island,
revealing areas of high probability for undiscovered sites as well as known sites with high
probability for earlier components. For the “foraging” (Archaic Age) maps, only two areas
(comprising 0.12% of the island’s area) were found to be optimal (6 of 6 variables), both
situated along the northeast coast. Near-high probability areas (5 of 6 variables) for
foraging suitability comprised ~3% of the island and overlapped with eight of the highest-
ranked areas on the horticultural (Ceramic Age) map. As such, these eight areas of overlap
and the top two “Archaic” locations were selected for field-testing in the 2016 survey.
Figure 5.1 Six Variables Measured with the SLD-25 Dataset (solid line at median for period, dashed line at 85% of all SLDs)
Field Survey Methods

From June through October 2016, surveys were conducted at ten large areas that had been identified using the predictive model (Hanna 2017). The ten areas included 13 known sites, four of which were found to be already destroyed. Six more sites were rapidly surveyed for radiocarbon samples (charcoal, shell, bone, seeds), and another eight sites were sampled from collections at the Grenada National Museum (GNM).

A total of 71 auger tests were conducted in the selected areas using an AMS 4-inch, telescoping bucket auger that could probe as deep as 2.5 m below surface, ensuring deep anthropogenic deposits could be reached (Cannon 2000; Hoffman 1993; Stein 1986). The tests were roughly 10 cm in diameter and typically extended 50-100 cm below surface, with a few going as deep at 2 m. Test points were placed using a combination of random and non-probabilistic sampling techniques and recorded using a Garmin eTrex10 GPS device (see Appendix A for raw points).

Random tests were placed using a Generalized Random Tessellation Stratified (GRTS) point generator (Phillipi 2016). GRTS is a formula for producing stratified, spatially-balanced (at 30 m minimum interval), random sample points from the spsurvey package in R (Kincaid and Olsen 2011). Because of the ease of calculating statistics, batching scripts, and creating shapefiles in R, the GRTS approach was more functional than the “spatially-balanced point” tool native in ArcGIS (Pettebone et al. 2009; Theobald et al. 2007), although the formulae behind each tool (GRTS and RRQRR, respectively) are very similar. The sample size was initially calculated to a 95% confidence level at 5% error margin, plus additional sample locations in case of inaccessible points (roads, houses, denial of access, etc.).
Fieldwork in 2017 was not guided by a predictive model but aimed instead to more fully investigate and correct some of the sites that were included in the SLD-25 sample. An augering survey was conducted at the two earliest Ceramic Age sites — Pearls (A-1) and Beausejour (G-34) — as well as Galby Bay (D-3), one of the latest sites. A small excavation was also conducted at the inland site of Montreuil (P-2), and several more sites were rapid-tested for radiocarbon samples: Petite Bacaye Bay (D-8), Levera (P-4), Marlmont (D-24), and Grand Marquis (A-2).

**Soil Analysis**

After each auger scoop, the depth was measured and the soil screened separately using a small 4 mm sifter. A total of 467 pint-size soil samples were collected in sterile polyurethane bags for later pedogenic, botanical, and geochemical analyses.

Basic soil description (horizon, texture, Munsell color, consistence, structure, clay film, carbonate morphology, and clast weathering), was recorded in the field at each auger test. Back in the lab, soil samples were left to dry in the open air for at least one week before being weighed and analyzed. Half of each soil sample (determined by weight on a digital scale) was poured into a stacked screen and sifted for organic remains — the other half remained as backup. For especially compacted/cemented samples, a mortar and pestle was used to break up soil before sieving (wiped after each use). Fine fraction from the bottom pan (<0.063 mm) was bagged separately, for use in phosphate testing, while the remaining large fraction was wet-sieved through a 0.063 mm (#230) screen and left to dry on plastic sheets before being re-sieved for grain-size analysis.
Figure 5.2 Association of Grenada's Wetland Areas and Pre-Columbian Sites
Grain-Size Analysis

After drying at least 48 hours, the wet-sieved samples were photographed and re-sieved through a set of four stacked screens with #10 US mesh (2 mm, clasts/gravel), #60 US mesh (0.25 mm, medium to very coarse sand), #230 US mesh (0.063 mm, fine and very fine sand), and a bottom pan that captured remaining silt-clay-loam (added to the fine fraction bag for use in phosphate testing, below). Weights were taken throughout the process, including just prior to wet-screening through the #230, allowing easy calculation of the amount of Si-Cl-Lo that washed away.

Generally, changes in grain size are the result of either fluctuations in depositional energy (e.g., storm events, sea-level changes) or natural sorting over time as a soil profile develops (Scudder 1996; Scudder et al. 1996). In the latter case, the finest grains will tend to sort downwards, leaving the coarsest grains on top (tectonic shearing events can also move coarser grains upwards) (Bagnold 1941:239). In less developed profiles, however, grain sizes reflect depositional energy. Aeolian processes such as saltation tend to favor finer sediments, where grain size decreases with distance travelled (Arens et al. 2002; Bagnold 1941; Sherman and Li 2012) — that is, finer grains tend to blow further.

This grain-size analysis also provided a check on soil descriptions from the field and allowed for potential microartifacts and botanical remains to be identified in the process. Including the phosphorus work below, each soil sample collected in the field averaged one hour of processing in the lab. Laboratory work on these soils is ongoing, but grain-size analysis from Beausejour is presented below.
Soil Phosphate (P) Testing

Of the many geochemical signatures for detecting past anthropogenic influence (e.g., Mg, Ca, Zn), few are, “as ubiquitous, as sensitive, and as persistent an indicator of human activity as phosphorus,” (Holliday and Gartner 2007:301). Because phosphorus quickly fixes to durable metals like iron and aluminum, it is far less mobile than other artifacts within the soilscape, allowing legacy distributions of P to be maintained over long periods, even in modern agricultural fields (Eidt 1984; Nolan 2014; Roos and Nolan 2012). This legacy, however, is more apparent at long-term settlements than hunting camps or other short-term sites (Thurston 2002:267). In normal (extensive) cropping regimes, uptake of P results in repeated depletion of edaphic macronutrients after each harvest, where it is redeposited at processing and refuse areas (Morisada et al. 2000; Nolan 2014; Sandor et al. 1986). An increase in phosphorus (technically organic phosphate) within an archaeological site could therefore reflect middens, living spaces, burials, processing areas, or other prehistoric features (Bethell and Mate 1989; Dahlin et al. 2007; Eidt 1973, 1977; Heron 2001; Holliday and Gartner 2007; Rypkema et al. 2007; Wells 2010; Wuenscher et al. 2015).

For this project, a basic field method was used for determining “available phosphorus” (largely derived from organic sources), rather than the “total phosphorus” present in each soil sample. Available phosphorus has been shown to be as effective in identifying archaeological features and site boundaries as total P (Eidt 1984; Nolan 2014; Sandor et al. 1986), and in some cases less obscured by the “noise” of inorganic P (e.g., Parnell et al. 2001).

The lab procedure used was a modified field method outlined by Terry et al. (2000) and initially refined in 60 sample trials conducted at the Human Paleoecology and Isotope
Geochemistry Lab at the Pennsylvania State University. Two grams of soil were mixed with 20ml of Mehlich 2 extractant (Mehlich 1978) for 5 minutes. Two milliliters of this solution were then filtered through a 0.45 μm syringe into a 10 ml cuvette and diluted with 8ml of deionized water. The cuvette was then placed in an HI-706 colorimeter (internally calibrated to phosphate) and measured as the control sample. An ascorbic acid and molybdate-based color reagent was then added to the solution, shaken until dissolved, and allowed to react for five minutes before measuring again.
Figure 5.3 Testing at Beausejour Bay, with Phosphate Results from 40-50 cmbs
Figure 5.4 Grain-Size Results for Beausejour Bay, with Phosphates
(3D variograms of same area in Figure 5.3, facing north, as indicated in top-right variogram)
Results

Predictive Model

Of the variables considered, the sizes of the nearest wetland areas decreased over time, as did (to some degree) percent of wetlands within a 600 meter buffer, NPP values, and distance to freshwater (Figure 5.1). Significantly, while wetland suitabilities decreased, all of the 25 sites analyzed remained near a wetland area (median distance = 0 meters), with wetlands being the closest feature measured for 68% (17/25) of sites (Figure 5.2). The maximum distance to a wetland was 424 meters, and 85% of SLDs (n=21/25) were ≤ 118 meters from the nearest wetland.

Following fieldwork, there were several problems identified with the 2016 predictive model (which did not include wetlands). First, the model was heavily biased towards marine resources, perhaps due to the inclusion of both beach and reef distance (not independent variables). This meant that areas greater than 1000 meters from the coast could be ranked no higher than moderate probability. Thus, all of the highest ranked areas were coastal. The newest model (below) includes only forest type (not reefs or beaches separately), which ensured potential inland sites could be better identified.

Another issue with the 2016 model was that nearly all sites found within the ten areas selected dated to the Late Ceramic Age (rather than the Early Ceramic). Two main reasons likely account for this. First, this period represents the height of Grenada's Amerindian population (Chapter 4), meaning the probability of stumbling onto such a site was much higher than earlier (or later) sites. Relatedly, Late Ceramic Age sites favored coastal resources (notice in Figure 5.1 that site proximities to beaches and reefs/seagrass decrease over time). Thus, there are not only more Late Ceramic sites than any other time period, but they are almost all on the coast. Lastly, all ten areas were ranked high for
foraging, which were predominantly coastal resources — sea-birds, nearshore reefs, and turtle nesting. It appears that subsistence strategies during the Suazan Troumassoid period, in particular, align closely to what would be expected of Archaic Age fisher-forager subsistence strategies. We will return to this point in the Discussion below.

Nonetheless, two sites surveyed proved earlier than any others previously documented on the island. The first was Grand Bay Beach (G-22), a possible Archaic Age shell midden associated with the Troumassoid-period site of Salt Pond (G-21, Chapter 2). The second was Beausejour (G-34), a Saladoid-Barrancoid settlement on the western coast. Like the other earliest sites (e.g., Pearls and Grand Marquis), Beausejour was several hundred meters from a modern beach, at the base of a hill, and adjacent to marshy wetlands. Though others have mentioned the slightly inland situation of many Early Ceramic sites in the Windward Islands (e.g., Bradford 2001a; Keegan 1999), the pattern in Grenada was not clear until Beausejour was discovered and Grand Marquis was relocated.

Following the 2016 fieldwork, a revised probability map was built (Figure 5.5). An attempt to use a minimal multilinear regression model (MLR) on the 15 variables analyzed indicated that only a few were statistically significant predictors of median ceramic date. Following the logic of the IFD, the median ceramic date assigned to each site was set as the MLR target. Using backward stepwise linear regression, a minimal model was then produced with just two variables: percent of wetlands within a 600 m buffer (which the model favored over other wetland variables) and maximal forest type (e.g., cactus scrub, deciduous, or evergreen).46

46 p = 0.025, R² = 0.2754, error = 275.7 on 21 degrees of freedom — that is, this model needed 21 (of 25) samples to estimate each site’s earliest settlement date within +/- 275 years. The high error is partly due to the imprecise ceramic dates (especially Suazan, which spans over 700 years).
Figure 5.5 Most Recent Predictive Model, using the minimal MLR (ESD = Earliest Settlement Date; SLD sites enlarged and labelled); note the correspondence of site periods and predicted ESD (especially for non-SLD sites)
Given the clear associations in the descriptive statistics (decreasing over time), it seems odd that distance to beaches or reefs was not selected by the minimal MLR model. However, in this case, forest type is analogous to beaches and reefs, since it incorporates proximity to coastal areas. The western side of the island (less densely occupied in prehistory) has more rocky headlands that rise immediately to deciduous forest, with substantially less beaches and reefs than the eastern coast. The co-occurrence of beaches, reefs, and cactus scrub (forest type) in Grenada therefore makes them all dependent variables, so the use of forest type in the model accounts for these other factors.\(^{47}\)

The environmental differences between windward and leeward sides of the island also likely explain (at least in part) why so few sites have been found on the western (leeward) side. The western side today is preferred by modern fisherman because of easy access to pelagic fish species, a consequence of the precipitous drop in the ocean floor just a mile west of Grenada (on the eastern side, the Grenada Bank extends some eight miles east) (Groome 1970:7). The paucity of Amerindian settlements on the western side may therefore corroborate evidence of Amerindian preference for reef taxa, more prevalent on the eastern side (Mistretta and Hanna 2017; Newsom and Wing 2004; Wing and Wing 1995, 2001). Nonetheless, the presence of seven of the island’s eight petroglyph sites on the northwestern coast remains unexplained. Likely, there is some preservation biases at work, since the western side was the first area settled by the French and has remained occupied ever since. Those few areas that have beaches, reefs, and wetlands on the western side (e.g., St. George’s, Grand Roy, Gouyave, and Victoria) are so densely occupied today

\(^{47}\) It may be that the precise distance measurements used in reefs and beaches reduced their predictive power as compared to the more generalized forest types.
that whatever prehistoric remains existed were either destroyed or are currently inaccessible (though see Keegan et al. 2018 for an example from downtown Charlotte Amalie, USVI).

**Case Study: Beausejour Bay**

In 2016 a construction crew uncovered Amerindian pottery and human remains in the northeast section of Beausejour (Hanna 2017:31,142). Concentrations of Saladoid-Barrancoid pottery (including ZIC, WOR, and zoomorphic ceramic adornos) were collected and soil samples taken in the road cut. Charcoal encrusted inside a vessel was radiocarbon dated to AD 530-635 (PSUAMS-1287, CI:90.9%), while charcoal from the bottom of a soil column sample (~80 cmbs) was dated to AD 325-410 (PSUAMS-1317, CI:90.8%), both confirming the Early Ceramic association (Chapter 3).

In 2017, several workstones (grinding cupules) reported in the 1980s were relocated on the beach 450 meters from the Saladoid site. Here, the meandering Beausejour River tracks northward around the hill at Point Beausejour/Fort du Marquis and a natural sand spit to empty at the north end of Beausejour Bay (Figure 5.3).48 Aware that workstones tend to be Troumassoid traits (Chapter 4 and Figure 4.4), we carried out a pedestrian survey of the wetland area north of the workstones. On the sand spit, a dispersed scatter of scratched-type sherds were found, confirming the presence of a Suazan Troumassoid site associated with the workstones. Auger testing later confirmed micro-ceramics and phosphorus levels continued from 0-60 cmbs (at AT-4). For naming purposes, the Suazan site kept the site number previously assigned to the workstones (Beausejour Bay, GREN-

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48 For information on Fort du Marquis, see Jessamy (1998:11).
G-5) while the new Saladoid site was given a separate name and number (Beausejour, GREN-G-34).

Behind the beach, the flat terrain and repeated river flooding have formed a sizable wetlands area that likely fluctuated with past precipitation. Auger testing confirmed the water table here was just 80 cmbs (in October 2017), with rich alluvial clay-loam atop coarse sand ~55 cmbs, indicating the beach once extended further back. East of the river, towards the G-34 site, a layer of gravel at 34-42 cmbs contained dolomite and other concretions characteristic of redoximorphic features and prolonged saturation. These are likely alluvial sediments from heavy flooding (natural secondary contexts), which overlay an Ab horizon with abundant charcoal from 42-65 cmbs. No cultural material was directly recovered in the auger test (nor have we directly dated the charcoal yet), but the G-34 site center is just 100 m away. What this suggests is that the area west of the G-34 site (towards the river) was prone to seasonal freshwater flooding.49

Grain-size analysis on the auger samples confirmed these landscape changes in finer detail. As described in the Methods section, the guiding principle for interpreting grain-size results is that larger sediments like coarse sand (between 0.25-2 mm) are indicative of close proximity to wave action. Fine sand (between 0.063-0.25 mm) are also indicative of waves but can saltate further than coarse sand via wind (aeolian processes) (Arens et al. 2002; Bagnold 1941). In the Beausejour Bay area, Si-Cl-Lo (< 0.063 mm) are mostly alluvial deposits from the Beausejour River.

49 A comparable situation appears to have been the case at the other Saladoid-Barrancoid sites of Grand Marquis and Pearls, though these soils have not yet been analyzed for grain-size.
Figure 5.6 Historic Maps of Beausejour; note change in river course between 1801 and 1959
The lack of coarse sand below 40 cmbs throughout the area suggests the beach was further west (i.e., lower sea levels) earlier in time, which was also confirmed by the high levels of Si-Cl-Lo in the western section, likely outwash deposited by the river (Figure 5.4). By 40-50 cmbs, those finer alluvial soils began to be deposited further inland, perhaps suggesting the formation of the sand-spit identified on early historic maps (from AD 1667 through at least AD 1801) (Figure 5.6). The complementary nature of the fine sand and Si-Cl-Lo levels at 40-50 cmbs may also be a feature of this change.

Regional climate proxies suggest generally mesic conditions from AD 250-730, AD 900-1050, AD 1300-1450, and AD 1670 onwards (Chapter 4, Figure 4.3). The increase in coarse sand (higher sea level) at 30-40 cmbs should align with one of these periods, most likely post-AD 1300. The absence of a drop in coarse sand (e.g., a lens of finer soil) above 50 cmbs suggests sea level has not shifted markedly since then, supporting this timing. Further, an attempt to model the sedimentation rate via a Gaussian process (using the aforementioned radiocarbon dates and methods outlined in Heaton et al. 2013) placed this level (30-40 cmbs) at AD 1190-1500, aligning with the wetter post-AD 1300 period.

One would expect the earlier mesic periods to show similar increases in coarse sand deeper in the sequence, but those periods were also characterized by lower sea levels worldwide — roughly 1-2 meters lower than today during the earliest levels of the Beausejour sequence (Cooper 2013; Keegan 1999) — so the beach was too far west to deposit coarse sand in the test area. However, since fine sand saltates further than coarse sand, mesic periods may still be reflected in the fine sand present in the western areas below 50-60 cmbs. Thus, the increase at 60-70 cmbs of fine sand may correspond to mesic
conditions during the period AD 250-700 (the sedimentation age-model places the level at AD 545-860).

The lack of coarse sand in the southwestern corner may be due to its proximity to the river mouth during this time. Historic maps from 1667-1801 show the river exited at the southern end of the beach, near AT-1. By the 1950s, however, Vernon's (1959) soil survey shows the river had been diverted to the north end of the beach (as it is today), leaving a shallow lake at the south end of the beach (15 m north of AT-1). This may have been an artificial change made to the river course during the 19th century, perhaps to reduce flooding further east (though it could also be a natural result of the growth and movement of the sand-spit).

So how was this all affecting human settlement? The presence of phosphate values throughout the sequence at STP-1 (the G-34 site) suggests no part of the sequence presented was culturally sterile. However, only STP-1 went below 70 cmbs during testing, so it is difficult to say for sure. It is also unclear why the eastern (G-34) area maintains such high P levels throughout the sequence (e.g., post-AD 1200), but it is assumed some disturbance occurred during colonial plantation agriculture.

Meanwhile, the increase of P at 40-50 cmbs in AT-1 may suggest use of the workstone there, which also aligns with the formation of the sand-spit to the north. Increase in P in the central area (AT-6) seems quixotic since no artifacts were found in that test, but it may be the edge of the G-5 site 75 m north (at AT-4), for which no data was available at 40-50 cmbs. The highest level of P at AT-4 was 60-70 cmbs, indicating it may have been in use earlier than suggested by the Suazan-Troumassoid ceramics found there, perhaps contemporaneous with and/or an extension of the G-34 site during Troumassan times.
**Discussion**

The data presented here are based on our current understanding of each site. While the chosen SLD-25 dataset represents a group of sites for which the most information is known, the information remains incomplete. As discussed below, the predictive model can highlight sites that should be earlier or later than currently assigned, but many of the current assignments remain tentative. For instance, the site of Duquesne Bay (M-3), associated with the eponymous petroglyphs (M-5), was excavated by Cody Holdren (1998), who acquired radiocarbon dates and ceramic types that correspond to Suazan Troumassoid times. The available data therefore suggest an initial settlement sometime after AD 900, and Cody's assemblage portrayed a small site, in line with other sites settled during the Suazan period. However, Duquesne is highly ranked for earlier settlement, and historical references attest that it was a large village at the time of French colonization (its very name is derived from a Caraïbe leader that lived there) (Anonymous [Benigne Bresson] 1975). It seems likely, then, that Duquesne was settled earlier, perhaps during the Troumassan period (~AD 750), as suggested by the new predictive model — a case that may fit other SLDs assigned to Suazan as well.

Another caveat is that, by their nature, predictive models are reliant on environmental data, often ignoring the palette of cultural factors that were likely involved in every settlement choice. Choices affected by push-factors like competition and violence can be included in the “despotic” variant of the IFD (Bell and Winterhalder 2014; Bird and O’Connell 2006; Jazwa et al. 2017; Kennett et al. 2009; Kennett and Winterhalder 2008), as can decisions based on pull factors like niche construction, Allee effects, conspecific aggregation, domesticated landscapes, etc. (Bliege Bird 2015; Clement et al. 2015; Codding and Bird 2015; Erickson 2006; Greene and Stamps 2001; Smith 2011; Kennett
and Winterhalder 2006). Less tangible attractions such as ritual significance cannot be adequately included in the model, although they can be inferred. This is almost certainly true of the inland sites, one of which (Montreuil) is associated with the Mt. Rich petroglyphs, a prolific series of rock art engravings 530 m away (Allen and Groom 2013; Huckerby 1921; Jonsson Marquet 2009; Sapper 1903). Yet even Mt. Rich is adjacent to the only riparian wetland within a 2 km radius (Figure 5.7), placing it as high probability in the model.

These caveats aside, the choice of settlement location is unequivocally environmental in orientation. The IFD simply provides a guiding principle for paring down potential criteria most worthwhile testing. And by applying the IFD in this way, key environmental considerations that were paramount to Grenada's prehistoric settlement locations can be revealed.
The pattern that emerges for Grenada is that Saladoid sites are slightly inland and more secluded — within reach of a beach (and reef/seagrass) but also balanced by agriculturally-oriented criteria such as wetlands and prime agricultural soils. This preference is highlighted by the association of Saladoid-era sites and large wetlands, as shown in the Beausejour example. Grain-size at Beausejour confirms the beach was further west, and soils on the other side of the river indicate a seasonally-inundated floodplain. This was part of the area’s allure.

Mangroves have been cited as a common settlement feature by other researchers (e.g., Drewett et al. 1993; Watson 2011), and this may be true of other, particularly smaller, islands. However, the dominant wetland type associated with sites on Grenada are
freshwater colluvium/alluvium soils (riparian rather than brackish water) (see Figure 5.2). Wetland areas have distinctive communities of flora, fauna, and soils, and many wetland plants have edible and medicinal uses (Hawthorne et al. 2004). However, none of the crops commonly associated with Amerindian horticulture prefer seasonally inundated floodplains (root-crops, in particular, cannot tolerate waterlogging) (Roosevelt 1980). Nonetheless, the soils in such areas are extremely rich, and dry-season planting of floodplains (“recessional agriculture”) is known to have been a productive subsistence strategy in Amazonia (McMichael et al. 2014 (and reply comment by Clement et al.); Piperno 1990; Rostain 2010) as well as Mesoamerica (Beach et al. 2009; Berry and McAnany 2007; Fedick 1996). Recessional agriculture makes use of annually refreshed alluvial soils and does not require intensive techniques (correlated to population pressure) such as ditches, canals, or raised fields (Piperno and Pearsall 1998:306).

It is likely the attraction to wetland areas evident in the predictive model here is reflective of cultural developments that occurred in South America. In the Amazon Basin today, floodplains (várzeas) are prized for their productive potential, with an estimated 30% of the region categorized as wetlands (Junk et al. 2011). In his demographic research on the pre-Columbian Amazon, Denevan (1992b) categorized várzea lands as the most productive, followed by coasts, then savannahs, then uplands, then (upland) dry savannahs, and finally terre firme (lowland forests). Many researchers believed várzeas had been intensively cultivated in prehistory (e.g., Carneiro 1970; Lathrap 1970). Yet while Denevan's ranking countered Meggers (1954, 1979) reductionist view that the entire Amazon was homogenous (and limited by poor soils), it also contravened Roosevelt (1980), who disagreed that várzeas were, in practice, any more productive than other areas.
Heckenberger et al. (1999) later showed that soil improvements like terra preta can change an area’s suitability, making upland/forested areas more productive than floodplains. Indeed, few improved areas (i.e., where terra preta has been documented) are várzeas.

It is true that várzeas are not ideal places to live, since a particularly wet year can result in unpredictable flooding of fields and houses (Sponsel 1989:39). The earliest ethnohistoric accounts suggest villages were indeed on high bluffs, not the floodplains themselves, as many terra preta studies have borne out (e.g., Denevan 2001; Erickson 2003; Myers et al. 2003). Interestingly, such a settlement pattern became more common in Grenada over time, especially by the Suazan period (e.g., the Savanne Suazey/Antoine Bay area), but middens found on these bluffs have not yet shown evidence of modified/improved soils.

A related offshoot of the above analyses is that settlement choices appear to have changed slightly after AD 750. Following the logic of the IFD, the most suitable areas should be settled first and remain occupied until a change in suitability occurs. As shown in Chapter 4, the largest settlements are multi-component and settled early, as would be predicted by the IFD. However, Saladoid-Barrancoid sites preferred slightly inland locations, compared to the succeeding Troumassoid period, indicating a slight change in suitability.

This is not to say that the earliest sites did not remain highly suitable over time, just that they were slightly relocated towards the coast, probably in conjunction with the lowering sea-levels of the more arid period post-AD 750 (Chapter 4). Indeed, the preference towards wetlands remained strong throughout the sequence. Both Beausejour (G-34) and Grand Marquis (A-2) appear to be single-period Saladoid-Barrancoid
occupations with an adjacent Troumassoid site on the beach several hundred meters away, indicating the area remained highly ranked. On the other hand, Pearls was settled early and remained occupied during the entire chronology of Grenada's Ceramic Age. The Simon site (A-5) adjacent to Pearls, could represent a relocation attempt, but Pearls itself has Suazan-period middens (see Chapter 3), and a 1667 map by Francois Blondel shows Amerindian “carbets” in the area during the early French colonial period (Martin 2013, fig 6.1).

Several changes during the early Troumassan period (AD 750-900) also likely affected the suitability of certain areas. The wide variability evident in new site locations corroborate other evidence of diet-breadth expansion (e.g., Carder et al. 2007; Keegan 1995, 2000; Petersen 1997; Wing and Wing 2001), as well as a period of population increase (Chapter 4). The Troumassan was a time when there were more settlements, exploiting more diverse environments, and exhibiting more cultural variation than ever before in the Caribbean.

Expansion to new environments (e.g., inland areas, cactus scrub) would have been a way to reduce competition over resources when population was surging. Thus, it is perhaps unsurprising that inland areas were first settled during this time. The radiocarbon dates for the two inland SLD-25 sites (Montreuil and La Filette) are exactly the same: calAD 765-885 (PSUAMS-3946 and PSUAMS-1565, respectively, CI:87.1%, Chapter 3). Both sites remained occupied into later periods, but new settlements during the proceeding Suazan Troumassoid appear much less exploratory and more targeted towards coastal resources.
As mentioned, the foraging (“Archaic”) predictive map failed to identify any actual Archaic sites, but it was excellent at identifying unknown Suazan period sites (Hanna 2017). This anomaly may simply be a consequence of the population increase and expansion of settlements into less-desirable areas during that time, but it also confirms a more coastal-orientation during the Suazan period. It may be that the Suazan-Troumassoid was the most marine-adapted time period, when — like the Archaic Age — coastal foraging was the primary subsistence strategy.

Indeed, another, admittedly speculative, line of evidence comes from Grenada's sole Archaic-period site (Chapter 2). Like Heywoods, Barbados (the only other confirmed Archaic site in the Windward Islands), Salt Pond is a Troumassoid-period settlement adjacent to an Archaic-period one. The thin, salty soils and cactus scrub vegetation of Point Salines is unsuitable for agriculture (historically, it was only used as pasture), but ancient shell middens attest to its suitability for marine foraging. The nearest high-ranked soil unit to the Salt Pond sites is at Woburn Bay, ~6 km away (Woodlands clay loam, see Vernon et al. 1959). Saladoid-Barrancoid farmers would not have preferred such poor soils, but more marine-oriented settlers during the Troumassoid apparently found it quite preferable, much as their Archaic forbearers.

**Conclusion**

Grenada's prehistoric settlements generally follow an IFD pattern, albeit one that changes in some suitability characteristics over time. Saladoid sites are slightly inland, with balanced marine and agricultural criteria. During the subsequent Troumassoid period, a

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50 The Archaic site at Grand Bay Beach (G-22) was found while surveying Salt Pond (G-21) and Black Point (G-20) — the 2016 “Archaic” model ranked the area at 66% probability (4 of 6 variables).
wide variety of new locations were explored, perhaps reflecting the expansion of diet breadth during the period. In the succeeding Suazan period, subsistence strategies were again refined and refocused towards coastal marine resources. These changes in environment and suitability criteria, coupled with the relatively low-resolution and short length of the sequence overall, makes it difficult to estimate settlement timing beyond ceramic periods (which impose large error ranges). In the future, more radiocarbon dates may help better refine the timing of each site and its associated environmental suitability. In the meantime, it is hoped that field-testing high-probability areas indicated in the new predictive model (especially highly-ranked inland areas) will help reveal more previously undiscovered sites and new information about Amerindian settlement patterns.
CHAPTER 6

Conclusion

Using heuristic tools from human behavioral ecology and resilience theory, this dissertation examined the extant radiocarbon sequence associated with fifteen pre-Columbian sites on the island (nine presented for the first time), ranging from the Archaic to early French colonial periods (~1500 BC - AD 1650), and offered a revised model of the island’s chronology.

A predictive model was created for pre-Columbian settlements on the island using inductive analysis of common environmental characteristics and guided by the Ideal Free Distribution (IFD). The model was then field-tested using a rapid auger survey technique that drew on artifact assemblages, radiocarbon dates, basic soil morphology, and soil grain-size analysis. Samples were dated, refined via Bayesian methods, and compared to ceramic evidence to better understand the prehistoric colonization of the island.

The results show that the earliest Ceramic Age sites appear around AD 200-300, aligned with other Windward Islands but comparatively late for the region as a whole — contrary to the traditional “stepping-stone” theory of Caribbean colonization (at least concerning the Ceramic Age). Paleoenvironmental and radiocarbon evidence suggests transient Archaic Age interaction with Grenada’s environment by ~1500 BC, and potentially as early as 3-5000 BC. Given the abundant evidence available in the Leewards and Greater Antilles, it is possible that Archaic and Early Ceramic groups in the Eastern Caribbean were drawn to the domesticated landscapes of already populated areas, skipping the unoccupied islands in the southernmost Antilles. Given the similarity in assemblages (conch middens), it is possible that Barbados, Tobago, and Grenada were part of an Archaic
Age resource cycle centered in Trinidad. Without additional evidence, however, little more can be said at this time.

The study also found that the early Late Ceramic Age (Troumassan period), traditionally characterized as a period of introspection, balkanization, and ceramic “decline,” was more likely a transitionary period precipitated by both extended climatic aridity and a population influx, possibly from coastal South America. Given the material culture evident from this period onwards (including the appearance of petroglyphs and workstones), it is suggested the incoming groups were Arauquinoid-related, and that their arrival triggered several cycles of socio-ecological reorganization that resulted in the Suazan ceramic tradition.

During this late phase, a wide variety of new settlement locations were explored as Grenada’s population exploded, from four known sites in the Early Ceramic to at least 35 in the Suazan period (with probably many more that have yet to be studied). This may reflect an expansion of diet breadth during the Troumassan that eventually refocused towards coastal resources in the subsequent Suazan period. Contrary to regional chronologies, Suazan pottery in Grenada likely to continue into the Protohistoric period (AD 1492-1649), when two groups were reportedly present — “Caraïbes” and “Galibis.” It is argued that the Caraïbe were Arawakan-speaking, Suazan potters while Galibis were Cariban-speaking, Cayo-potters who fit the Island Carib/ Kalinago ethnicity. That is, for Grenada at least, the group called “Caribs” were not the same as those called Island Caribs/Kalinago today.

Henry Petitjean Roget once called Grenada, “the archaeological memory of the Lesser Antilles,” (1981:1). While his premise was flawed (i.e., that Grenada was among
the first islands settled), he was not entirely wrong. Every island has unique preservation histories, and it is clear that there is still much to be learned about Grenada’s prehistory and for the wider Caribbean. This dissertation simply scratched the surface for Grenada — establishing the basic chronology, settlement patterns, and population dynamics for 87 pre-Columbian sites. Few of the sites discussed have been thoroughly investigated (even Pearls, the most heavily excavated, remains only minimally understood). It is a tragedy that every site today is threatened by unchecked “development” or has already been destroyed. Many of these sites had been relatively undisturbed — even during colonial plantation agriculture, maps indicate some were used only for grazing, logging, or left as “bush.”

As discouraging as such development work can be, I do believe the broader impacts associated with this dissertation made a difference (Chapter 1). By engaging Grenadians during the research and supporting heritage institutions as best I could along the way, I met people that shared the same values and interests, and together we will continue to tackle larger and larger projects. In this way, we can continue to protect Grenada’s archaeological resources, and more importantly, empower local people to become stewards of their cultural heritage.
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Zhao, Maosheng, and Steven W. Running


Zucchi, Alberta


APPENDICES

Appendix A: All GPS Waypoints
Appendix B: Site Locations
Appendix C: OxCal v.4.3.2 CQL Programming Codes
Appendix D: Sites Identified in Bullen 1964
Appendix E: Alternate Version of Figure 4.3, with Northern Caribbean Proxies.
Appendix F: Research Permission Letters
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<th>A</th>
<th>B</th>
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<th>Notes</th>
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<td>Paradise</td>
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<td>samples from cut in Mt. Horne stream; used as Main point for A-11</td>
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<td>12.127589</td>
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<td>RiverSF-- first sherds</td>
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<td>SF</td>
<td>RiverSF- nice scatter (photographed)-- point prob. off</td>
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<td>RiverSF- more sherds</td>
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## Appendix A: All GPS Waypoints

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## Appendix A: All GPS Waypoints

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## Appendix A: All GPS Waypoints

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Appendix B: Site Locations

As described in more detail in Hanna (2017), the site numbers used here were first established by Cody and Banks (1986). Their system begins with the island (“GREN”) followed by the first letter of the parish in which the site was located (e.g., “D” for St. David or “A” for St. Andrew), and finally a sequential numbering system based on the order in which the sites were found. Thus, GREN-G-1 (Dragon Bay) was the first site Cody and Banks studied in St. George’s (and actually, the first site they documented).

There are a few caveats to the system. Firstly, some sites were mistakenly placed in the wrong parish. For instance, GREN-D-7 (Grand Bacolet) is actually in St. Andrew’s parish. The problem appears to have occurred at every parish border (e.g., Artiste Point, St. Andrew’s was labelled P-9; Halifax Harbor-North, St. John’s was labelled G-3; Westerhall Bay, St. David’s was given G-11, etc.). However, for the sake of consistency and reducing confusion with the previous data, I have avoided re-assigning numbers.

Below is a full list of pre-Columbian site numbers and locations. In the 2017 Inventory, gaps were left for sites that were named but no record was known (e.g., P-6). The list below is an export from ArcGIS and therefore only includes sites for which the location is known. More details about each site can be found in the Archaeological Site Inventory for Grenada (ASIG) presented in Hanna (2017). The ASIG is also in the process of being converted to a web-database, available at: http://www.GrenadaArchaeology.com/ASIG
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<td>12.218679</td>
<td>-61.678363</td>
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<tr>
<td>GREN-M-4</td>
<td>Victoria</td>
<td>Petroglyph</td>
<td>Text-Estimation (Huckerby 1921)</td>
<td>12.195904</td>
<td>-61.705526</td>
</tr>
<tr>
<td>GREN-M-5</td>
<td>Duquesne Petroglyphs</td>
<td>Petroglyph</td>
<td>Garmin eTrex (2011)</td>
<td>12.219172</td>
<td>-61.681846</td>
</tr>
<tr>
<td>GREN-M-5</td>
<td>Duquesne Petroglyphs</td>
<td>Workstone</td>
<td>Garmin eTrex (2011)</td>
<td>12.219313</td>
<td>-61.681913</td>
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<tr>
<td>GREN-P-1</td>
<td>Mt. Rich</td>
<td>Petroglyph</td>
<td>Phone GPS (Samsung Galaxy S5)</td>
<td>12.193411</td>
<td>-61.642908</td>
</tr>
<tr>
<td>GREN-P-1</td>
<td>Mt. Rich</td>
<td>Workstone</td>
<td>Phone GPS (Samsung Galaxy S5)</td>
<td>12.193512</td>
<td>-61.642883</td>
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<tr>
<td>GREN-P-2</td>
<td>Montreuil</td>
<td>Troumassoid</td>
<td>Garmin eTrex 10</td>
<td>12.190217</td>
<td>-61.646272</td>
</tr>
<tr>
<td>GREN-P-2</td>
<td>Montreuil Workstone</td>
<td>Workstone</td>
<td>Garmin eTrex 10</td>
<td>12.188753</td>
<td>-61.645378</td>
</tr>
<tr>
<td>GREN-P-3</td>
<td>Savanne Suazey #2 (Center)</td>
<td>loci</td>
<td>Garmin eTrex 10</td>
<td>12.200282</td>
<td>-61.606557</td>
</tr>
<tr>
<td>GREN-P-3</td>
<td>Savanne Suazey #3 (North)</td>
<td>loci</td>
<td>Garmin eTrex 10</td>
<td>12.201259</td>
<td>-61.6065</td>
</tr>
<tr>
<td>GREN-P-3</td>
<td>Savanne Suazey #1 (South)</td>
<td>Suazoid</td>
<td>Garmin eTrex 10</td>
<td>12.199161</td>
<td>-61.606055</td>
</tr>
<tr>
<td>GREN-P-4</td>
<td>Levera</td>
<td>Troumassoid</td>
<td>Garmin eTrex 10</td>
<td>12.226682</td>
<td>-61.612431</td>
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<tr>
<td>GREN-P-5</td>
<td>Sauteurs Bay (Locus 1)</td>
<td>Troumassoid</td>
<td>Text-Estimation (Code 1998)</td>
<td>12.226216</td>
<td>-61.646226</td>
</tr>
<tr>
<td>GREN-P-5</td>
<td>Sauteurs Bay (Locus 2)</td>
<td>loci</td>
<td>Text-Estimation (Code 1998)</td>
<td>12.224984</td>
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</tr>
<tr>
<td>GREN-P-5</td>
<td>Sauteurs Bay (Locus 3)</td>
<td>loci</td>
<td>Text-Estimation (Code 1998)</td>
<td>12.224541</td>
<td>-61.643924</td>
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</tbody>
</table>
## Appendix B: Site Locations

<table>
<thead>
<tr>
<th>Site #</th>
<th>Site Name</th>
<th>Site Type</th>
<th>Point Method</th>
<th>Latitude(Y) WGS84</th>
<th>Longitude(X) WGS84</th>
</tr>
</thead>
<tbody>
<tr>
<td>GREN-P-7</td>
<td>High Cliff Point</td>
<td>Suazoid</td>
<td>Garmin eTrex 10</td>
<td>12.191944</td>
<td>-61.603254</td>
</tr>
<tr>
<td>GREN-P-8</td>
<td>River Antoine</td>
<td>Suazoid</td>
<td>Garmin eTrex 10</td>
<td>12.174461</td>
<td>-61.60455</td>
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<tr>
<td>GREN-P-8</td>
<td>River Antoine loci #2</td>
<td>loci</td>
<td>Phone GPS (Samsung Galaxy S5)</td>
<td>12.175295</td>
<td>-61.607176</td>
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<tr>
<td>GREN-P-9</td>
<td>Artiste Point (La Poterie)</td>
<td>Suazoid</td>
<td>Text-Estimation (Hofman et al. 2016)</td>
<td>12.168456</td>
<td>-61.604357</td>
</tr>
<tr>
<td>GREN-P-11</td>
<td>Calabasse River</td>
<td>Suazoid</td>
<td>2016 P variogram</td>
<td>12.193896</td>
<td>-61.606225</td>
</tr>
<tr>
<td>GREN-P-21</td>
<td>High Bluff</td>
<td>Suazoid</td>
<td>Garmin eTrex 10</td>
<td>12.196425</td>
<td>-61.605987</td>
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<tr>
<td>GREN-P-22</td>
<td>Mt. William</td>
<td>Unstudied</td>
<td>Garmin eTrex 10</td>
<td>12.217279</td>
<td>-61.677127</td>
</tr>
<tr>
<td>GREN-P-23</td>
<td>Big David Bay</td>
<td>Suazoid</td>
<td>Garmin eTrex 10</td>
<td>12.228227</td>
<td>-61.669249</td>
</tr>
<tr>
<td>GREN-P-24</td>
<td>Laurant Point</td>
<td>Suazoid</td>
<td>Phone GPS (Samsung Galaxy S5)</td>
<td>12.233095</td>
<td>-61.654116</td>
</tr>
<tr>
<td>GREN-P-24</td>
<td>Laurant Point (chert)</td>
<td>loci</td>
<td>Phone GPS (Samsung Galaxy S5)</td>
<td>12.233741</td>
<td>-61.654339</td>
</tr>
<tr>
<td>GREN-P-25</td>
<td>Irvins Bay</td>
<td>Troumassoid</td>
<td>Garmin eTrex 10</td>
<td>12.224441</td>
<td>-61.634702</td>
</tr>
<tr>
<td>GREN-P-26</td>
<td>Leaper's Hill</td>
<td>Unstudied</td>
<td>Phone GPS (Samsung Galaxy S5)</td>
<td>12.226226</td>
<td>-61.640417</td>
</tr>
<tr>
<td>GREN-P-27</td>
<td>River Sallee</td>
<td>Suazoid</td>
<td>Garmin eTrex 10</td>
<td>12.197619</td>
<td>-61.606546</td>
</tr>
<tr>
<td>GREN-P-28</td>
<td>Union</td>
<td>Petroglyph</td>
<td>Garmin eTrex 10</td>
<td>12.204285</td>
<td>-61.669815</td>
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<tr>
<td>GREN-R-1</td>
<td>Ile de Ronde- South</td>
<td>Cayo</td>
<td>Text-Estimation (Banks 1993)</td>
<td>12.298073</td>
<td>-61.589736</td>
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<tr>
<td>GREN-R-2</td>
<td>Ile de Ronde- West</td>
<td>Suazoid</td>
<td>Text-Estimation (Sutty 1978, 1983)</td>
<td>12.308626</td>
<td>-61.587977</td>
</tr>
<tr>
<td>GREN-UW-8</td>
<td>Fort Annunciation</td>
<td>Suazoid</td>
<td>Text-Estimation (Banks 1993)</td>
<td>12.044616</td>
<td>-61.749606</td>
</tr>
</tbody>
</table>
Appendix C: OxCal v.4.3.2 CQL
Programming Codes
(Only prehistoric dates)

Full Model, with Marine Priors

Plot("All dates, with marine priors-- no historic, 6-17-2018")
{
  Sequence("Grand Bay")
  {
    Boundary();
    Prior("G-22, PSUAMS-3017","Grand_Bay_PSUAMS_3017.prior");
    Boundary();
    Prior("G-22, PSUAMS-3022","Grand_Bay_PSUAMS_3022.prior");
    Boundary();
  };
  Prior("Black Point, PSUAMS-3019","Black_Point_PSUAMS_3019.prior");
  R_Date("Beausejour, PSUAMS-1317",1685,20);
  R_Date("Beausejour, PSUAMS-1287",1500,25);
  R_Date("Pearls-A, GX-14202", 1600,340);
  Sequence("Pearls, Unit B")
  {
    Boundary();
    Phase("Unit B phased")
    {
      Prior("Pearls-B-1, 74cmbd","Pearls_B_1.prior");
      Prior("Pearls-B-2, 75-80cmbd","Pearls_B_2.prior");
      Prior("Pearls-B-3, 110-120cmbd","Pearls_B_3.prior");
    };
    Boundary();
  };
  R_Date("Pearls W195, PSUAMS-1322",835,25);
  R_Date("La Fillette, PSUAMS-1565",1215,20);
  R_Date("Montreuil, (PSUAMS-3946)",1215,20);
  Sequence("Grand Anse")
  {
    Boundary();
    Phase()
    {
      Prior("Grand Anse-G7-1","Grand_Anse_G7_1.prior");
      Prior("Grand Anse-G7-2","Grand_Anse_G7_2.prior");
    };
    Boundary();
  };
  Sequence("Sauteurs 1")
  {
    Boundary();
    Phase ("Burial Layer")
    {
      R_Date("120N/127.5W (Beta-86831)",1050,90);
      R_Date("127.5N/137.5W (Beta-98368)", 980,60);
    };
    Boundary();
    R_Date("Sauteurs 1, Beta-86832 (Posthole)",790,60);
    Boundary();
  };
  R_Date("Sauteurs 2, Beta-98367",510,60);
  R_Date("Sauteurs 2, Beta-98366",340,50);
  R_Date("Sauteurs 3, Beta-85941",1270,50);
  Prior("St. John's River, G8-P4, 30-45cmbs","SJR_PSUAMS_1435.prior");
  Prior("St. John's River, G8-P3, 64-82cmbs","SJR_UCIAMS_179806.prior");
  Sequence("Salt Pond 2")
  {
    Boundary();
    Prior("G21-2, STP-7 34-45cmbs","Salt_Pond_2_PSUAMS_3020.prior");
    Boundary();
    R_Date("G-21-2, PSUAMS-1320, STP-7 14-25cmbs",1180,25);
    Boundary();
  };
  Prior("Cato Beach, PSUAMS-3021","Cato_Beach_PSUAMS_3021.prior");
}

(continued on next page)
Sequence ("Savanne Suazey")
{
  Boundary();
  Phase ("only for refining RL-76")
  {
    R_Date("Savanne Suazey S, Beta-85935",1110,40);
    R_Date("Savanne Suazey S, Beta-86827",900,60);
    R_Date("Savanne Suazey S, Beta-86833",810,50);
    Prior("P3, RL-76_corrected","Savanne_Suazey_S_RL_76_corrected.prior");
  }
  Boundary();
  R_Date("High Cliff Point, (PSUAMS-3945)",380,25);
Sequence("Duquesne Model")
{
  Boundary();
  R_Date("Duquesne, Beta-98365, lower profile",1080,50);
  Boundary();
  R_Date("Duquesne, Beta-85938, upper profile",850,40);
  Boundary();
};
Sequence("La Tante Model")
{
  Boundary();
  Phase("Unit 118.5S/36W, 85-110 cmbs")
  {
    R_Date("La Tante, Beta-85939",770,60);
    R_Date("La Tante, Beta-86830",770,50);
    Combine("Same Sample")
    {
      R_Date("La Tante, Beta-86828, radiometric",650,40);
      R_Date("La Tante, Beta-86829, AMS",550,60);
    }
  }
  Boundary();
};

Marine Samples
Plot("Marine for All_GND_models_no_historic_priors, 6-17-2018")
{
  Curve("Marine13","Marine13.14c");
  Delta_R("LocalMarine", -28,25);
  R_Date("Savanne Suazey S, RL-76 (corrected)", 957, 115);
  R_Date("St. John's River, UCAMS-179806, G8-P3-SCP2-A",1380,20);
  R_Date("St. John's River, PSUAMS-1435, G8-P4-6-SRF",3560,60);
  R_Date("Grand Anse, UNK, G7-2", 1300, 80);
  R_Date("Grand Anse, UNK, G7-1", 1520, 80);
  R_Date("Salt Pond 2, PSUAMS-3020, STP-7 34-45cmsg", 1510, 20);
  R_Date("Cato Beach, PSUAMS-3021", 1560, 15);
  R_Date("Black Point, PSUAMS-3019, wavecut", 3525, 20);
  R_Date("Grand Bay, PSUAMS-3017, 20cmbs", 2820, 20);
  R_Date("Grand Bay, PSUAMS-3022", top", 2145, 20);
  R_Date("Pearls-B-3, 110-120cmbd", 1711, 74);
  R_Date("Pearls-B-2, 75-80cmbd", 1914, 51);
  R_Date("Pearls-B-1, 74cmbd", 1725, 54);
}
Trapezoidal Model - Saladoid

Plot("Saladoid-Barrancoid")
{
    Sequence()
    {
        Boundary("Mid Start")
        {
            Start("Start Start");
            Transition("Duration Start");
            End("End Start");
        };
        Phase()
        {
            Prior("Beausejour_PSUAMS_1317", "Beausejour_PSUAMS_1317.prior");
            Prior("Beausejour_PSUAMS_1287", "Beausejour_PSUAMS_1287.prior");
            Prior("Pearls_UGa_A1_B2", "Pearls_B_2_model.prior");
            Prior("Pearls_UGa_A1_B3", "Pearls_B_3_model.prior");
            Prior("Pearls_UGa_A1_B1", "Pearls_B_1_model.prior");
        };
        Boundary("Mid End")
        {
            Start("Start End");
            Transition("Duration End");
            End("End End");
        };
    };
}

Trapezoidal Model - Troumassan

Plot("Troumassan-Troumassoid-- w/Montreuil, no SJR or G7-2")
{
    Sequence()
    {
        Boundary("Mid Start")
        {
            Start("Start Start");
            Transition("Duration Start");
            End("End Start");
        };
        Phase()
        {
            Prior("La_Fillette_PSUAMS_1565", "La_Fillette_PSUAMS_1565.prior");
            Prior("G-21_PSUAMS_1320", "Salt_Pond_2_PSUAMS_1320_model.prior");
            Prior("G-21_PSUAMS_3020\_prior", "Salt_Pond_2_PSUAMS_3020_model.prior");
            Prior("Cato_Beach_PSUAMS_3021\_prior", "Cato_Beach_PSUAMS_3021.prior");
            Prior("Grand_Anse_UNK_G7_1", "Grand_Anse_G7_1_model.prior");
            Prior("Montreuil_PSUAMS_3946\_prior", "Montreuil_PSUAMS_3946.prior");
        };
        Boundary("Mid End")
        {
            Start("Start End");
            Transition("Duration End");
            End("End End");
        };
    };
}
Trapezoidal Model - Suazan

Plot("Suazoid-- w/SJR, no Sauteurs-3 or RL-76")
{
  Sequence()
  {
    Boundary("Mid Start")
    {
      Start("Start Start");
      Transition("Duration Start");
      End("End Start");
    }
    Phase()
    {
      Prior("P5_2_Beta_98366","Sauteurs_2_Beta_98366.prior");
      Prior("P5_2_Beta_98367","Sauteurs_2_Beta_98367.prior");
      Prior("P5_1_Beta_86832_Posthole","Sauteurs_1_Beta_86832_model.prior");
      Prior("MS_98365","Duquesne_Beta_98365_lower_profile_model.prior");
      Prior("MS_85938","Duquesne_Beta_85938_upper_profile_model.prior");
      Prior("P-3_S_Beta_86833","Savanne_Suazey_S_Beta_86833.prior");
      Prior("P-3_S_Beta_86827","Savanne_Suazey_S_Beta_86827.prior");
      Prior("P-3_S_Beta_85935","Savanne_Suazey_S_Beta_85935.prior");
      Prior("Pearls_W195_PSUAMS_1322","Pearls_W195_PSUAMS_1322.prior");
      Prior("P5_Burials_Beta_86830.prior","Sauteurs_1_Beta_86831_model.prior");
      Prior("St. John's River UCIAMS 179806","SJR_UCIAMS_179806.prior");
    }
    Boundary("Mid End")
    {
      Start("Start End");
      Transition("Duration End");
      End("End End");
    }
  }
}

Trapezoidal Model - Cayo

Plot("Cayoid--with After Sauteurs 1")
{
  Sequence()
  {
    After()
    {
      Prior("P5_Posthole","Sauteurs_1_Beta_86832_model.prior");
    }
    Boundary("Mid Start")
    {
      Start("Start Start");
      Transition("Duration Start");
      End("End Start");
    }
    Phase()
    {
      Prior("D4_Same_Samples","La_Tante_Beta_868_28_29_model.prior");
      Prior("D4_Beta_85939","La_Tante_Beta_85939_model.prior");
      Prior("D4_Beta_86830.prior","La_Tante_Beta_86830_model.prior");
    }
    Boundary("Mid End")
    {
      Start("Start End");
      Transition("Duration End");
      End("End End");
    }
  }
}
## Appendix D: Sites Identified in Bullen 1964

<table>
<thead>
<tr>
<th>Site #</th>
<th>Site Name</th>
<th>Surface Collection (sherd count)</th>
<th>Excavation (sherd count)</th>
<th>Total sherds</th>
<th>Hiatus assigned?</th>
<th>Known Previously?</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>GREN-A-1</td>
<td>Pearls</td>
<td>2145</td>
<td>16171</td>
<td>18316</td>
<td>yes but not addressed (bw Pearls and Suazey)</td>
<td>yes -- at least since airport built in 1941 (e.g., artifacts in British Museum from construction)</td>
<td>table includes SC</td>
</tr>
<tr>
<td>GREN-A-10</td>
<td>Simon Beach</td>
<td>635</td>
<td>--</td>
<td>635</td>
<td>no</td>
<td>Maybe not -- he doesn't say</td>
<td></td>
</tr>
<tr>
<td>GREN-A-11</td>
<td>La Filette</td>
<td>64</td>
<td>--</td>
<td>64</td>
<td>bw Pearls and Suazey</td>
<td>says he was brought there</td>
<td></td>
</tr>
<tr>
<td>GREN-G-8</td>
<td>St. John’s River</td>
<td>26</td>
<td>--</td>
<td>26</td>
<td>bw Pearls and Suazey</td>
<td>doesn’t say, but probably brought by Hughes (who had a museum in Springs at the time)</td>
<td></td>
</tr>
<tr>
<td>GREN-G-12</td>
<td>Calivigny Island - North (1-3,5)</td>
<td>192</td>
<td>657</td>
<td>849</td>
<td>bw Pearls and Caliviny/Suazey</td>
<td>yes, he thanks the MacLeod family</td>
<td>657 from Area 3 excavation, rest is SC</td>
</tr>
<tr>
<td>GREN-G-13</td>
<td>Caliviny Island - South</td>
<td>16</td>
<td>--</td>
<td>16</td>
<td>no</td>
<td>&quot;</td>
<td></td>
</tr>
<tr>
<td>GREN-G-20</td>
<td>Black Point</td>
<td>167</td>
<td>83</td>
<td>250</td>
<td>no</td>
<td>yes, by John Groom</td>
<td>just a shovel test; 16 of subsurface at FIMNH...</td>
</tr>
<tr>
<td>GREN-G-21</td>
<td>Salt Pond 1, 2, 3</td>
<td>31</td>
<td>4495</td>
<td>4526</td>
<td>yes but not addressed (bw Saline and Suazey)</td>
<td>yes, by John Groom</td>
<td>no SC at locus 3</td>
</tr>
<tr>
<td>GREN-G-22</td>
<td>Grand Bay</td>
<td>72</td>
<td>--</td>
<td>72</td>
<td>no</td>
<td>probably Groom</td>
<td></td>
</tr>
<tr>
<td>GREN-G-24</td>
<td>Westerhall Point (#1)</td>
<td>--</td>
<td>2562</td>
<td>2562</td>
<td>no</td>
<td>yes, he thanks the Wilcox family</td>
<td></td>
</tr>
<tr>
<td>GREN-G-25</td>
<td>Westerhall Point (#2)</td>
<td>132</td>
<td>--</td>
<td>132</td>
<td>--</td>
<td>yes, he thanks the Wilcox family</td>
<td>Bulled combined the two Westerhalls</td>
</tr>
<tr>
<td>GREN-G-29</td>
<td>Chemin Bay</td>
<td>53</td>
<td>--</td>
<td>53</td>
<td>no</td>
<td>yes, thanks A.C.G. Palmer</td>
<td></td>
</tr>
<tr>
<td>GREN-P-3</td>
<td>Savanne Suazey</td>
<td>--</td>
<td>2949</td>
<td>2949</td>
<td>no</td>
<td>yes, Alistair Hughes wrote to UF about this site, which is how Bullen got involved</td>
<td></td>
</tr>
<tr>
<td>GREN-P-11</td>
<td>Calabasse River</td>
<td>43</td>
<td>--</td>
<td>43</td>
<td>no</td>
<td>probably Hughes</td>
<td></td>
</tr>
<tr>
<td>GREN-P-23</td>
<td>Big David Bay</td>
<td>552</td>
<td>--</td>
<td>552</td>
<td>bw Pearls and Suazey</td>
<td>doesn’t say, but probably brought there</td>
<td></td>
</tr>
<tr>
<td>GREN-P-21</td>
<td>High Bluff</td>
<td>1</td>
<td>--</td>
<td>1</td>
<td>--</td>
<td>probably Hughes</td>
<td>only named on map</td>
</tr>
<tr>
<td>GREN-P-27</td>
<td>River Sallee</td>
<td>1</td>
<td>--</td>
<td>1</td>
<td>--</td>
<td>unknown</td>
<td>not named</td>
</tr>
<tr>
<td>GREN-M-1</td>
<td>South of Victoria Petroglyphs</td>
<td>--</td>
<td>--</td>
<td>0</td>
<td>--</td>
<td>Huckerby 1921</td>
<td></td>
</tr>
<tr>
<td>GREN-P-1</td>
<td>Mt. Rich Petroglyphs</td>
<td>--</td>
<td>--</td>
<td>0</td>
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Appendix E: Alternate Version of Figure 4.3, with Northern Caribbean Proxies. The trends shown in the $^{18}$O analyses from Belize (Kennet et al. 2012) and Puerto Rico (Lane et al. 2009), confirm that the climatic trends in the northern Caribbean are generally aligned yet differ in substantial ways from the southern Caribbean. This is believed the result of a southward migration of the ITCZ that would have affected the northern region first, as well as typical variability within the zone itself.
Appendix F: Research Permission Letters

June 20th, 2016

Jonathan A. Hanna
Department of Anthropology
Pennsylvania State University
University Park, PA 16802 USA
jah1147@psu.edu

Dear Mr. Hanna,

The Ministry of Tourism, Civil Aviation, and Culture hereby grants you permission to conduct the archaeological research in Grenada described in your previous letter and proposal for the period July-October, 2016 and March-December, 2017. This includes permission to survey and excavate potential archaeological resources on lands managed by the Government of Grenada (GOG), and to send samples required for laboratory analysis, in the United States (U.S.A) - provided they are returned to Grenada by August 2018.

We encourage you to investigate all areas agreed upon, but advise that you must first obtain permission from the appropriate land-owners for activities conducted on privately-held lands. Mr. Michael Jessamy, Heritage Conservation Officer in the Ministry, will oversee your research activities and will function as your institutional counterpart during the period of your Fulbright grant in 2017, here in Grenada.

We look forward to working with you and wish for you the best of luck in successfully carrying out this research.

Sincerely,

[Signature]

Aaron Francois (Mr.)
PERMANENT SECRETARY
June 21, 2018

Jonathan A. Hanna
Department of Anthropology
Pennsylvania State University
University Park, PA 16802 USA
jah1147@psu.edu

Dear Mr. Hanna,

The Ministry of Youth Development, Sports, Culture & The Arts hereby grants you permission to conduct the archaeological research in Grenada described in your previous letter for the period of June 2018 through June 2019. This entails permission to survey and excavate potential archaeological resources on lands managed by the Government of Grenada (GOG)—including research at Point Salines, pending permission from the Airport Authority—and to send samples required for laboratory analysis in the United States, provided they are returned to Grenada by June 2020. The latter includes samples being processed by Ms. Brittany Mistretta of the University of Florida.

We encourage you to investigate all areas agreed upon, but advise that you must first obtain permission from the appropriate land-owners for activities conducted on privately held lands. We hope you will go beyond this requirement and work with local communities wherever you conduct research, so that Grenadians may better understand your research.

This permission is conditional upon several factors. You must share your research results with the Ministry of Culture and the Grenada National Museum within one year of completing the work. We also ask that you provide adequate storage equipment for housing the artifacts unearthed, and work with the Grenada National Museum to ensure the artifacts are properly cataloged into their system.
Thank you for your interest in Grenada, and I look forward to working with you. Best of luck with your project.

Sincerely,

Kevin Andall (Mr.)
PERMANENT SECRETARY

KA/sl-h
CURRICULUM VITAE

Jonathan Andrew Hanna

EDUCATION
Ph.D.  Department of Anthropology, Pennsylvania State University, (2018)
M.A.  Anthropology, Pennsylvania State University, (2015)

REFEREED PUBLICATIONS
I. Journal Articles

II. Journal Articles In Progress


III. Books
(In review)  Ostapkowicz, Joanna, and Jonathan A. Hanna (eds.) *Real, Recent, or Replica? Amerindian (and Neo-Amerindian) Iconography in the Caribbean*, in submission to University of Alabama Press, Tuscaloosa.

RESEARCH GRANTS, AWARDS, AND FELLOWSHIPS
2017  Dissertation Support Fellowship, RGSO, Penn State
2017  Research Grant, Africana Research Center, Penn State
2016-17  Fulbright US-Student Fellowship (Grenada, Eastern Caribbean)
2016-17  Lewis and Clark Fund, American Philosophical Society
2016  Welsh-Nagle Fellowship, College of Liberal Arts, Penn State
2016  Hill Post-Comprehensive Exam Award, Anthropology Dept., Penn State
2015  Hill Graduate Training Award, Anthropology Dept., Penn State
2014  Honorable Mention, NSF Graduate Research Fellowship Program (GRFP)