

**Soil Fertility and the Development of Complex Societies: Settlement Patterns of the
Upper Río Chiriquí Viejo Valley, Panama**

by

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ABSTRACT

Social inequality is a hot topic in our current society (e.g. Keister and Moller 2000; Saez and Zucman 2016) and the initial development of these inequalities within prehistoric societies continues as an important subject for archaeological investigations (Kintigh et al. 2014). My research examines the relationship between agriculture and the development of complex societies within the Upper Río Chiriquí Viejo Valley, Panama. The evidence indicates that control of agricultural production and its resulting surplus was not the primary factor in the development of social distinctions. Rather, it facilitated the creation of leadership positions by freeing individuals from subsistence activities to pursue bureaucratic endeavors. It was through social activities that leaders emerged and gained power and status.

Agricultural populations are significant in archaeological literature because they are associated with the production of surplus that could be used to free individuals to pursue activities other than food production (Bogaard 2017). One model for the development of complex societies in the Upper Río Chiriquí Viejo Valley proposed that maize agriculturalists first settled the valley (Linares et al. 1975:143) and that the spread of these maize dependent populations “initiated processes leading to rank difference...” (Linares et al. 1975:137). These scholars based the model on macrobotanical evidence of maize in the valley (Galinat 1980; Smith 1980; Spang and Rosenthal 1980).

I sampled 42 settlements within an area of 72 square km. My total sample size was 9998 ceramics and 659 lithics from surface collections/shovel tests and 866 ceramics and 53 lithics from excavations. I also incorporate data from previous investigations within the valley (e.g. Palumbo 2009). I used three lines of evidence gathered from surface survey and shovel testing to investigate whether maize agriculturalists led to the development of complex societies in the valley. First, I analyzed settlement locations in relation to fertile soil through time. Following the principle of first occupancy (McAnany 1995:98-99), the best lands are to be settled first and kept by the founding families through ties to the ancestors. The Upper Rio Chiriquí Viejo Valley is one of the most agriculturally productive locations within Panama today. Parts of the valley have rich dark soil that is a meter in depth, while other locations are less than ideal for any kind of cultivation. This variation in soils provided the perfect scenario to investigate the importance of soil fertility in settlement placement.

Second, I investigated demographic changes through time to identify any dramatic increases or decreases in population. I was interested in the demographics of the first settlers. Marked population increases could also indicate agricultural intensification (Robinson and Schutjer 1984) that is related to an increase in fertility rates (Bocquet-Appel 2011).

Finally, I calculated the percentage of restricted (storage and cooking) vessel rims out of total sherds within assemblages to identify possible changes in diet or food processing activities. Changes in the quantities of these vessel types can indicate the introduction of new foods or techniques. These percentages were also compared to the percentages of open vessel rims at each settlement.

Results of this research indicate that through time, the importance of soil fertility in the selection of settlement location increases. By the last period, the Chiriquí Period (A.D. 900 –

1500), it is evident that soils are a primary factor in settlement locations, continuing a trend from the Late Bugaba Phase (A.D. 600 – 900). This suggests a gradual increase in the importance of cultivars in the diet.

Demographic patterns did not indicate any sudden increases in the total population of the valley that were inexplicable. There was an increase from the Concepción Phase (300 B.C. – A.D. 400) to the Early Bugaba Phase (A.D. 300 – 600). But this increase fell within the population growth rates of hunters and gathers calculated using fertility rates (i.e. Hassan 1975). A settlement hierarchy was already formed by the Early Bugaba Phase and a catchment analysis indicated that there was sufficient arable and non-arable land within the catchment zone to provide sufficient resources for the valley's population.

The restricted vessel rim analysis suggested that there was a change in diet between the Late Bugaba Phase and the Chiriquí Period. There were also small nuances for each period. In the Early Bugaba Phase diets may have differed between different ecological zones of the valley. The diet may have been more uniform throughout the valley in the Late Bugaba Phase. Also, in the Late Bugaba Phase the percentage of open vessel rims out of total sherds indicate ceremonial feasting events at the village of Barriles (Palumbo 2009).

These lines of evidence suggest that controlling fertile soil, and any resulting surplus, was not a major contributor in the development of leadership roles as has been argued for other areas of the world (Elliott 2005; Kirch et al. 2004; Lombardo et al. 2015). Settlements did not follow the principle of first occupancy. Initial populations did not choose to settle on or near fertile soil, and this strongly suggests that the first populations in the valley were not agriculturalists. Rather, they were cultivating small gardens that were supplying sufficient produce to sustain a settlement hierarchy in the Early Bugaba Phase. Only once leadership positions were established, at the end

of the Late Bugaba Phase and Chiriquí Period, did occupants of the valley focus on settling near fertile soil. Surplus food production from fertile soil was not a prime mover in the development of inequalities best expressed in the Late Bugaba Phase, but it was important in the maintenance of those positions. Social factors had a stronger influence in the creation of leadership positions. The ceremonial events at Barriles suggest that feasting (Palumbo 2009) and warfare activities contributed to increasing social inequality.

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Field work was completed with the assistance from field school students attending the College of Lake County, Katherinne Guerra Cheva, and my field hand Lino. I am thankful for their hard work trudging up hills and through fallow fields, all while it was raining.

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It is cliché but true, I would not be the way I am if it weren't for the support of my family. They have been extremely supportive of this academic endeavor. For my loving parents, this path has taken me to live in distant places, traipse through jungles, and other atypical adventures. This has been extremely difficult on them and I cannot thank them enough for their love and encouragement. Finally, I dedicate this dissertation to my daughter. May she see she comes from a long line of strong, independent and successful women. When times became difficult, I was able to focus on your love and persevere.

I have only presented a small list of individuals that were integral to this dissertation, but there are countless more friends and colleagues that have made welcomed impacts on my studies and life and I thank them for that and hope they know they are not forgotten.

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Chapter 1: Soil Fertility and Developing Complex Societies in the Upper Río Chiriquí Viejo Valley, Panama

Research in the Isthmo-Colombian Area, a region spanning eastern Honduras to northern Colombia (Hoopes and Fonseca 2003; Hoopes 2005), continues to add significantly to ranked society literature (e.g. Berrey 2015; Cooke 2005; Cooke et al. 2003; Cooke and Ranere 1992; Drennan 1991; Drennan et al. 2010; Haller 2004; Hoopes 2005; Lothrop and Lothrop 1934; Mason 1940; Mayo et al. 2016; Murillo 2009; Oberg 1955; Quilter and Hoopes 2003; Sheets 1992)(Figure 1.1). Populations within this area never developed state-level societies like those found Mesoamerica or the Andes (Cooke 2005). This distinct characteristic makes the region important for investigating organizational variability in complex societies that were not on the same trajectories as their neighbors to the north and south (Sheets 1992). The area was also important in the formation of definitions for ranked societies called “chiefdoms” (Steward and Faron 1959; Helms 1992). Definitions for these complex societies have varied through time, but, in its most basic form, a chiefdom has a central decision-making, often ascribed, position of status (Peebles and Kus 1977:422; Service 1962; Wright 1984:42). Its social structure is built on the existence of social inequalities.

Inequalities within complex societies come in various forms. Central Panama’s societies, often considered the archetypes of “chiefdoms” (e.g. Creamer and Haas 1985:741-746; Haller 2004:1; Helms 1979), display robust evidence of social inequalities through the existence of rare, socially valuable artifacts in association with specific individuals or kin groups (Lothrop 1937, 1942; Mayo and Mayo 2013) and differ from the societies in western Panama that contain inequalities in more common artifacts (Palumbo 2009). These societies in western Panama are

part of the Greater Chiriquí archaeological subregion. It is these variations in the development and expressions of inequality that currently interest archaeologists and drive their investigations. Always under consideration are the circumstances in which complex societies developed and whether inequalities were expressed through materials.

Investigating social inequality is not only important for understanding ancient societies, but it is also pertinent to our current social setting. In the United States, and globally, extreme social inequality exists. Prominent divisions between the “haves” and the “have-nots” are only widening and continue to create social discord (Keister and Moller 2000; Saez and Zucman 2016). In order to understand how societies arrived at this juncture, we can use the conditions under which the first leaders emerged as case studies. Only through archaeology can we examine the first developments of leadership positions and persistent social inequality. The archaeological community recognizes this important task and continues to call upon researchers to investigate these topics (Kintigh et al. 2014). To clarify, I am not suggesting that the processes that enabled the emergence of leaders thousands of years ago are identical to those that occur in our current state-level societies. However, if we understand how inequality initially developed, we can incorporate that into research on inequality in more complex societies.

The Upper Río Chiriquí Viejo Valley is one location to study first generation leaders of a complex society. The valley and surrounding region contain an occupational record from the Archaic to shortly before the arrival of the Spaniards (Table 1.1). Research within the valley has incorporated botanical, geological, and archaeological perspectives, resulting in literature that touches upon topics such as maize agriculture, craft specialization, and feasting activities (e.g. Linares and Ranere 1980; Palumbo 2009). Focus has been on the roles of these kinds of activities in social change.

Researchers have suggested differing scenarios for the societal changes that occurred within the valley. My research investigated a theory developed by the archaeologists that completed the first regional survey of the valley. They argued that the “earliest occupation...represents the growth and territorial expansion of maize agriculturalists well adapted to semideciduous forest habitats” (Linares et al. 1975:143). The spread of these maize dependent populations “initiated processes leading to rank difference...” (Linares et al. 1975:137).

More recent investigations have analyzed changes in ceramic styles or wares, lithic production, and feasting activities in order to address social change (e.g. Palumbo 2009; Shelton 1984) and their conclusions were not always consistent with the maize agriculturalist scenario.

Table 1.1. Archaeological time periods of the Upper Río Chiriquí Viejo Valley

Time Period	Dates
Chiriquí Period	A.D. 900 – 1550
Aguas Buenas Period / Late Bugaba Phase	A.D. 600 – 900
Aguas Buenas Period / Early Bugaba Phase	A.D. 300 – 600
Concepción Phase	300 B.C. – A.D. 400
Tropical Forest Archaic	4600 – 2300 B.C.

I investigated the relationship between maize agriculture and the development of complex societies in the Upper Río Chiriquí Viejo Valley, Panama, during the formative periods (300 B.C.-A.D. 800). I analyzed whether maize agriculturalists were the first to settle the valley and caused complex societies to develop. To assess the role of maize agriculture in the social changes that occurred within the valley, I examined three lines of evidence: soil fertility, demography, and domestic activities.

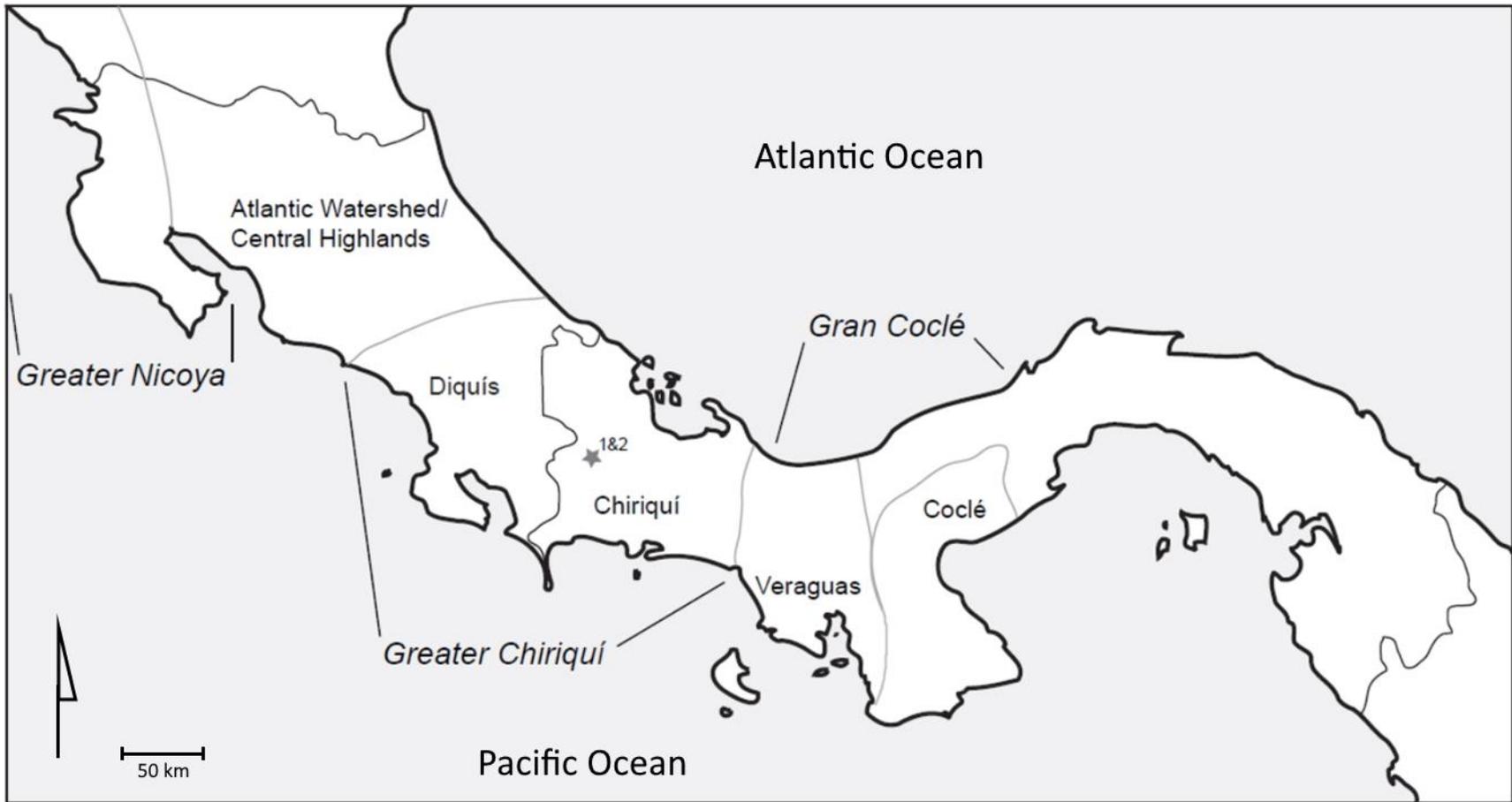


Figure 1.1. Map of the archaeological regions of Costa Rica and Panama, indicating the settlements of Barriles and Pitti-González (star) within the Upper Río Chiriquí Viejo Valley.

1.1. Soil Fertility and Agricultural Surplus

The Neolithic revolution linked increasing social complexity to agricultural surplus (Childe 1950). Currently, there exists a large body of literature on the relationships between social complexity, agriculture, and surplus (i.e. Bogaard 2017; Morehart and De Lucia 2015; Sheehan et al. 2018; Nichols 2015). These relationships are not always as V. Gordon Childe (1950) proposed. In addition to agricultural practices, scholars are now recognizing the importance of mixed subsistence strategies and the capability of these strategies to sustain complex societies in prehistory (e.g. Killion 2013; Medina et al. 2016). Important in furthering these discussions are distinguishing gardening/horticultural practices from farming/agricultural (Killion 2008:375-376).

Agriculturalists utilize larger fields, generalized tools for fieldwork, and favor cereal grains apt for storage (Killion 2008:375-376). With adequate water, sun, and fertile soil, surplus can be created. This production and consumption of surplus is integral to many social evolutionary models (Morehart and De Lucia 2015:1) where surplus production is considered a risk management practice that buffered societies against food shortages due to environmental or social factors (Flannery 1968; Halstead 1989; Kuijt 2009; Morgan 2012; O'Shea 1989). Scholars argue that once surpluses reached levels that could sustain portions of the population, it allowed individuals to expend their energy and talents on non-subsistence activities, such as bureaucratic dealings, rather than subsistence practices (Child 1950; Kenoyer 1998). Access to fertile soils for the production of surplus and/or the use of surplus in debt creating activities, such as ceremonial feasting, permitted emerging elites pathways to power and wealth (e.g. Dietler and Hayden 2001; Fleisher 2010; Rosenswig 2007). Continued access to these surpluses aided in the maintenance of leadership positions and social inequality.

I evaluated settlement locations in the Upper Río Chiriquí Viejo Valley and their relation to fertile soils to determine if there was a preference for the best agricultural lands. In the tropics it is common for habitation areas to have been multifunctional and used for cultivation (Killion 1992:4, 2008:375). Therefore, settling in locations on or near fertile soils can indicate knowledge of the best cultivating practices. This is exemplified by the settlement patterns on the Polynesian island of Maui and those of the Late Classic Maya where settlements are associated with the best agricultural lands (Ford et al. 2009; Kirch et al. 2004). Once the best soils are occupied, then the second-best locations should be occupied next, and so on. This pattern follows the “Principle of First Occupancy” (McAnany 1995:98-99) that argues founding lineages claimed the best resource locations and maintained access to those locations due to ancestry rights.

I recognize that agriculturalists may settle on non-arable lands (Wilshusen and Stone 1990) and residential architecture is often adjacent to fields, off quality farmland (e.g. Kirch et al. 2004; Wills and Dorshow 2012:146). This can be the result of practicality and utilizing all arable lands for agricultural purposes, social pressures like warfare (Field 2005; Hassig 1992; LeBlanc 1999), or other factors, such as strategically placed centers to control multiple different econiches and their resources (Wills and Dorshow 2012). These concerns are valid. My interest was in the soil fertility of the lands each settlement could access. For this reason, I conducted a catchment analysis. The analysis confirmed the soils on which the settlements within the Upper Río Chiriquí Viejo are located mimicked those in their respective catchment areas. This does not rule out social factors influencing settlement locations, but it does address the role of soil fertility.

1.2. Demography

Demographic changes can reflect multiple social and environmental conditions (Chamberlain 2006). Physical movements of individuals on the landscape over distances through immigration and/or emigration may increase or decrease populations within a certain area (Burmeister 2000; Hill et al. 2004). Disease epidemics can cause decreases in populations over short periods of time (e.g. Erlandson et al. 2001), as can the lasting effects of warfare (e.g. Hill et al. 2004), and environmental stresses. In addition to emigration, access to agricultural surplus has been argued to increase populations (e.g. Kohler et al. 2008). This change in demography due to agriculture is more widely known as the Neolithic Demographic Transition (Bocquet-Appel and Bar-Yosef 2008).

I investigated the demographic changes through time within the Upper Río Chiriquí Viejo Valley to identify any dramatic increases or decreases in population. I was interested in the demographics of the first settlers. The maize agriculturalist model suggests these were farmers. I also examined whether there were any immigrant populations that moved into the valley. An increase in population due to immigration would be accompanied by a change in material culture with the inclusion of artifacts that have no precedent to earlier cultural materials (Burmeister 2000). Marked population increases could also indicate agricultural intensification (Robinson and Schutjer 1984) that is related to an increase in fertility rates (Bocquet-Appel 2011), but that does not correlate with new material culture.

1.3. Domestic activities

Investigations into prehistoric diets have increased in frequency in the more recent decades due to changes in archaeological methodologies and techniques. These investigations

include phytolith and starch grain analyses that require a paleobotanist's expertise (e.g. Torrence and Barton 2016) or chemical analyses of residues (e.g. Dudd et al. 1999). For this research, I took a basic approach and investigated the uniformity of the valley population's diet through time. I analyzed the quantity of restricted vessels (storage and cooking vessels) within each settlement and for each time period. Changes in these vessels can indicate changes in diet and/or food preparation (Braun 1983; Mills 1999; Stahl 2014:183). I investigated whether the importance of maize in the diet of the inhabitants of the Upper Río Chiriquí Viejo Valley could be identified through changes in the percentages of restricted vessel rims out of total sherds in an assemblage. The percentages of restricted vessel rims were calculated by dividing the number of restricted rim sherds by the total number of sherds in a collection lot from the same time period. Maize kernels were not likely to have been stored in ceramic vessels, but if there was a later introduction of this food source or its importance in the diet changed, this would be indicated by changes in restricted vessels. I also analyzed open vessel rim percentages out of total sherds in collections to identify any changes in serving activities.

1.4. Research Questions and Methods Overview

Testing whether agriculturalists settled the Upper Río Chiriquí Viejo Valley and spurred the development of socially complex societies incorporates and expands upon multiple branches of theoretical literature. My research is a case study on specific environmental conditions that resulted in the emergence of elites. It also examines to what degree agriculture played a role in these developments, specifically the cultivation of maize. Finally, it investigates the topic of surplus in the valley. My central hypotheses are 1) if maize agriculturalists moved into an uninhabited valley, then I expect the earliest settlements to be located on or near fertile soils and

a uniformity in restricted vessel rim percentages through time due to the consistent importance of maize in the diet; 2) if the production of staple surplus led to the emergence of socially complex patterns, then I expect to also identify demographic growth in settlements on prime agricultural land over time. My research methods did not permit examination of specific examples of “elites” or inequality, which requires targeted household excavations or mortuary data.

I created a list of questions to guide my investigation into the relationship between settlement locations, demography, soils, and surplus. These questions included: 1) did initial settlers of the valley choose the most fertile soils to settle upon or near? 2) was soil fertility ever an important factor for settlement locations? 3) did population size increase over time for those settlements on or near fertile soils? 4) did demographic changes suggest immigration or emigration events? 5) how prevalent were restricted vessels through time? 6) were there changes in the percentages of restricted vessel rims within collections to indicate changes in diet or food preparation?

I sampled 42 small settlements in an area of 72 square km within the valley (Figure 1.2). Of these, 32 were previously identified by Linares and colleagues (1975). Within this area were two larger villages, Barriles and Pitti-González, that I did not include in my survey because they had been previously investigated by a colleague (Palumbo 2009), whose results were incorporated into this research. Most settlements within the survey zone were surface collected and/or tested in a 1970s regional survey using a post hole digger (Dahlin 1980; Linares and Ranere 1980). Although these had previously been investigated, those collections were lost over time and not readily available for re-analysis.

My teams and I completed 323 collections; 267 were surface collections and 56 were shovel tests. Of these, there were 247 surface collections and 34 shovel tests that contained

artifacts for analysis. I excavated five 1x1 m units for additional chronological control and to obtain radiocarbon dates. Four of these units were in the southwestern portion of the study zone and one was in an area called Bambito. My total sample size was 9998 ceramics and 659 lithics from surface collections/shovel tests and 866 ceramics and 53 lithics from excavations. I also incorporate data from previous investigations within the valley (Palumbo 2009).



Figure 1.2. Investigated settlements in the Upper Río Chiriquí Viejo Valley.

My focus on small settlements throughout the valley complemented research on the larger villages of Barriles and Pitti-González. These early settlements grew through time and had larger populations as time passed (Linares and Ranere 1980; Palumbo 2009). Barriles contained a small mound, cobblestone architecture, and several life-size stone statues and carved stone “barrels” (Stirling 1950). These features appeared to have emerged more prominently in the Late Bugaba Phase (Beilke-Voigt et al. 2004; Palumbo 2009).

My research furthers our knowledge of the interactions between these larger villages and surrounding populations. These peripheral populations would have been aware of the activities at the larger settlements and may have participated in them or even helped “fund” them with goods or labor. Together, both data sets provide a complete picture of the culture history of the valley.

1.5. Defining Key Terms

I use terms in this dissertation that may be considered problematic because elsewhere they have been defined vaguely or their definition is not consistent from author to author. Here, I provide my definitions for the terms: leaders, elites, surplus, persistent social inequality, and chiefdoms. These terms are briefly defined in this section and their concepts are elaborated in later chapters.

1.5.1. Leaders and Elites

In this dissertation I use the terms “leaders” and “elites” as interchangeable. I recognize there are distinctions between the two concepts and will discuss why I have conflated them for the purposes of this research. The word “leader” refers to individuals who have the power and/or

authority to make decisions for others, extending beyond kin groups (Eerkens et al. 2010). They may serve one or multiple roles within the community that legitimizes their status (Hayden 2001; Redmond 1998b, 1998c). Leaders can also make use of charisma, diplomacy, intellect, and manipulation to supersede the social forces in place that inhibit the development of leadership roles and enforce cooperation (Eerkens et al. 2010; Kantner 2010).

Leaders are not always elites, but the two are often conflated in archaeological research. Elites are individuals with wealth and status. They have control over goods, labor, knowledge, and/or networks (i.e. Ames 1995; Earle 1991; Graves and Spielmann 2000; Hayden 1995:67-69; Helms 1979, 1993; Potter and Perry 2000). This control over surplus or special knowledge creates an inequality between themselves and others, contributing to their status, which is determined by their rank in society (Carneiro 1998). There are situations where a leader does not have wealth or status and would, therefore, not be an elite. For example, in societies with temporary leadership positions, the leadership role does not last long enough for a leader to create systems of inequality and ranking.

One reason for the conflation of the two terms comes from the intertwining of wealth, status, and leadership positions (Kantner 2010). The privatization of resources that elites exploit comes with political sway and ensures the endurance of roles beyond one generation (Earle 1991; Eerkens 2010; Fried 1967; Sahlins 1972). Similarly, the ability for a leader to make decisions for the rest of a group is defined within social contexts relating to status relationships.

A second reason is that the scale of analysis is important when discussing leadership roles and social processes. Currently, household archaeology provides appropriate data sets to analyze inequalities between kin groups (Ashmore and Wilk 1988; Flannery and Winter 1976). However, the nature of archaeological data creates a situation where it is nearly impossible, without

historical references, to distinguish specific individuals and their actions. This is the scale required to identify the exact processes and contexts involved when one leadership position changes from transitory to permanent. For this reason, archaeologists have decades of research committed to identifying the development of elites through macroevolutionary processes that occurred over long periods of time in the archaeological record (Eerkens et al. 2010; i.e. Blanton et al. 1996; Creamer and Haas 1985; Peebles and Kus 1977). These macroevolutionary processes are easier to examine because once a leadership position is permanent, inherited, or institutionalized it is often distinguishable in the archaeological record from the rest of the population. Distinctions may be in the form of styles of material culture, artifacts only associated with these positions, and architectural features.

My data do not permit analyses of specific individuals in the archaeological record and so I am unable to distinguish leaders from elites. I can analyze macroprocesses and I find the relationship between elites and leaders sufficiently intertwined to use the terms interchangeably.

1.5.2. Surplus

The most common definition of surplus is “production in excess of biological necessity” (Morehart and De Lucia 2015:18). It is used to reference labor, food, raw and worked materials. I use “surplus” to reference excess foodstuffs. I recognize that the amount of goods considered to constitute surplus is a socially constructed concept and can differ among societies (Pearson 1957). Measuring exactly how much food was *thought* to be necessary before the rest was considered excess is not possible in the absence of historical records. Therefore, I rely on the concept as a biological necessity rather than a social construct (Harris 1959; Webster 1985; Halstead 1989).

1.5.3. Persistent Social Inequality

All societies contain forms of inequality, including egalitarian societies, which may differentiate members based on age, gender, and ability (Ames 2010; Cashdan 1980; Flanagan 1989). Persistent, or institutionalized, social inequality is different. It develops when certain groups or individuals have differential access to important resources and maintain their status, wealth, and power over generations, which creates permanent, inherited, and institutionalized leadership positions (see Aldenderfer 2010; Ames 2007; Baines and Yoffee 2000; Bender 1985; Carneiro 1970, 1981, 1998; Clark and Blake 1994; Earle 1991, 1997; Hayden 1990, 1995; Helms 1979, 1993; McGuire 1983; Paynter 1989:369; Redmond 1998a; Steward and Faron 1959).

I prefer the term “persistent social inequality” rather than “institutionalized social inequality” when discussing emerging elites and newly developed inequality. I find that it better reflects the tenuous situations of recently created leadership positions. Those new positions may not yet reflect the permanence implied by “institutionalized,” although they may become institutionalized after a couple generations.

1.5.4. Chiefdoms and Complex Societies

I use and prefer the term “complex society” in reference to chiefdom-level societies throughout this dissertation because it implies a ranked society. The specific definition of a “chiefdom” continues to change with time and research (e.g. Anderson 1994; Blitz 1999; Pauketat 2007; Sahlins 1958; Spencer 1987). When I do use it, I am doing so because it is still a useful heuristic tool.

The traditional definition of a chiefdom references a complex society with at least one ascribed, decision-making position associated with status (Drennan and Uribe 1987; Earle 1987; Feinman and Neitzel 1984; Hayden 1995; Peebles and Kus 1977:422; Service 1962; Wright 1984:42). These positions may have encompassed many different roles such as to redistribute goods, direct warfare campaigns, and/or act as an intermediary to the supernatural world, among others (see Chapter 3) (Hayden 2011; Redmond 1998c). Furthermore, chiefdoms integrate regional populations through alliances (Upham 1987) and may also experience “cycling”, whereby there is the, “emergence, expansion, and fragmentation of complex chiefdoms” (Anderson 1994:9).

I prefer the phrase “complex society” because it does not carry with it the same contentious debates as the term “chiefdom” (e.g. Feinman and Neitzel 1984; Pauketat 2007; Yoffee 1993). The phrase is less restrictive, and it alludes to the organizational variability of societies with persistent social inequality.

1.6. Chapter Organization

In Chapter 2 I discuss the natural environment and the culture history of the research area. This information is contextualized within the broader archaeological region of the Greater Chiriquí in Costa Rica and Panama. I present the concepts of soil fertility and the land-capability classification system, which were integral to the research and analyzing the importance of settlement locations. I drew from various previous projects in the Upper Río Chiriquí Viejo Valley and others within lower Central America to present our current knowledge of the cultural developments in the valley and key changes in the cultural record. Information about the valley is limited to archaeological research and does not include historic references because early

Spanish explorers never visited the location. I also describe the various hypotheses presented for the development of complex societies throughout the Greater Chiriquí region and how these have and have not changed over time.

Chapter 3 describes how my research questions link to physical materials that can be identified in the archaeological record. I review how elites can usurp a system in place that is meant to prevent individuals from maintaining too much authority and power. Surplus production from fertile lands is one avenue argued to have a central role in the formation of elite positions. Individuals could use surplus as a form of inequality and as a mechanism to create status and leadership positions. With time, these positions may develop into permanent positions, which can be identified in the archaeological record, and result in the development of complex societies. I explore the increasing complexity in the Upper Río Chiriquí Viejo Valley and whether agriculture had a large role in this development, as is suggested by the maize agriculturalist model. I describe my analysis of three aspects of this model using survey data (demography, settlement location, and restricted vessels), in addition to drawing upon previous studies for botanical evidence of maize in the valley (Behling 2000; Galinat 1980; Smith 1980).

In Chapter 4 I discuss my research methods that I used in the field and for laboratory work. Field methods included general surface collections, intensified surface collections, and shovel testing. Lab work relied upon previous ceramic ware categories and lithic tool categories described for the region (Linares 1980a; Palumbo 2009; Ranere 1980b, 1980d; Sheets et al. 1980; Shelton 1984; Spang et al. 1980). Crucial to this investigation was previous research within the valley that indicated the differing ceramic ware ratios between phases and periods, permitting better chronological control (Palumbo 2009). These ratios differentiated between the key periods of development, the Early Bugaba and Late Bugaba phases.

I also discuss my use of ArcGIS to aid in the exact placement of collection lots on overlays of the soil classifications within the valley. This formed a key line of evidence in the analysis of settlement locations and soil fertility. ArcGIS aided in determining the distances between collection lots and defined settlement borders by combining collection lots within 100 m of each other. My methods were crucial for the retrieval of the correct data sets for analyses.

Chapter 5 is dedicated to explaining the methods and results of my population analyses for each phase or period. Also included is my catchment analysis confirming sufficient arable and non-arable land were available to sustain the valley's population. My population estimates relied upon a value called the area-density index value that is calculated using sherd densities to produce both relative and absolute population estimates. The population trends within the valley all could be explained by population growth rates within those values calculated for hunters and gathers (Hassan 1975:42). Population growth was greatest between the first phase with permanently settled populations, the Concepción Phase, and the Early Bugaba Phase. Although there is the possibility that immigrants entered the valley at this time because of the increase in population, there are no accompanying material changes in the archaeological record to suggest this was due to an influx of population from outside the valley. Furthermore, the population growth rate still falls within that of hunter and gather populations. Population numbers within the valley were similar in both the Early Bugaba and the Late Bugaba phases until, the Chiriquí Period when there was an abandonment of the valley. The demographic changes within the valley over time were not consistent with the model of agriculturalists as the first settlers. The late timing of the increase in population in the valley indicated that the first permanent settlers of the valley were most likely the descendants of Archaic semi-sedentary populations that had been visiting and living in the area for centuries.

Chapter 6 is where I examine the relationship between settlement locations and fertile soil. Results of this research indicate that by the Early Bugaba Phase there is a settlement hierarchy and through time, the importance of soil fertility in the selection of settlement location increases. By the Chiriquí Period it is evident that soils are a primary factor in settlement locations, which continued a trend from the Late Bugaba Phase. This concept is key if considering whether an agricultural population moved into the valley. It shows a later emphasis upon soil characteristics than would be anticipated if farmers were the first to settle the valley. The settlement location of Pitti-González was the most evidentiary for the existence of a farming population beginning in the Early Bugaba and lasting until the Chiriquí Period. However, evidence also suggests that cultivation of plants was more akin to gardening and not farming in the Early Bugaba Phase. Multiple settlements still existed on non-arable soils with a push toward better soils beginning in the Late Bugaba Phase and this concept being fully applied by the Chiriquí Period. This pattern suggests an adoption of agricultural practices over centuries, rather than an immediate knowledge and acceptance of this lifestyle.

In Chapter 7 I discuss my analyses of restricted vessel rim and open vessel rim percentages in collection lots for each settlement through time. Changes in restricted vessel percentages can reveal changes in diet and food preparation. For example, at Tiwanaku the *kero* was used to store and serve *chicha*, maize beer (Goldstein 2003:150). Vessel percentages suggested that in the Late Bugaba Phase the villagers at Barriles were hosting ceremonial feasting events that drew populations to the center. Percentages of restricted vessels decreased for the Chiriquí Period and may indicate a drastic change in diet or be a product of small sample sizes.

Finally, I summarize the results of my research within the valley in Chapter 8 and discuss how the evidence does not wholly support the scenario of maize agriculturalists as the first settlers. The combination of demographic data, settlement locations, and domestic activities present a very different interpretation of the beginnings of agriculture in the valley.

1.7. Summary of Results

I investigated three lines of evidence to test the maize agriculturalist model for the development of socially complex societies within the Upper Río Chiriquí Viejo Valley. The first line of evidence was the importance of soil fertility, the second was demographic patterns, and the third was consistency of diet through restricted vessel rim percentages in collections. None of these lines of evidence supports the idea that a well-developed agricultural population was the first to settle the valley. Nor does agricultural surplus appear to be the impetus for the development of increasing complexity.

Each phase or period I examined displayed distinct settlement patterns, but the settlement pattern for the first permanent, ceramic-using occupants of the valley did not suggest that the best soils of the valley were the most prominent factor in selecting a location. This is contrary to the “Principle of First Occupation” and indicates that other factors were as, if not more, important when selecting settlement locations (McAnany 1995:98-99). It is probable that these first settlers maintained mixed subsistence economies, similar to Archaic populations, and incorporated cultivars without completely abandoning their reliance on wild resources. The Concepción Phase also saw the emergence of two small hamlets at opposing ends of the survey area, Barriles and Pitti-González, one on non-arable land and the other on arable, respectively, that continued to grow through time and become prominent archaeological locations.

It was only during the most recent period, the Chiriquí Period, that there was a preference to have settlements on or near fertile soil. This period also witnessed a significant depopulation of the valley. There were neither new settlements that developed during this period, nor did larger settlements fission on or near arable land. Instead, populations that stayed in the valley were those that were already settled on or near arable lands.

The demographic patterns within the valley did not indicate any population movements that were outside growth rates calculated for hunters and gatherers (Hassan 1975:42; Pennington 2001:198). There was a population increase across the valley during the Early Bugaba Phase. This was evident in the settling of multiple new homesteads on the landscape and in an increase in the size of the settlements already occupied during the Concepción Phase. This increase was 0.34% and well within the range of population growth rates for hunters and gatherers, casting doubt on the possibility of a large immigrant population moving into the valley at any point in time. It is possible that a small number of migrants moved into the area and this is hidden within the overall demographic analysis, but there were not any additional significant cultural changes identified to indicate this occurred.

After the Early Bugaba Phase, there were no further population increases, only re-settlements of small homestead populations into fewer larger settlements scattered throughout the landscape. These settlements continued to be occupied on varying soil classes without any significant preference for arable soil. The reason for the aggregation of the population is unknown and may have resulted from both environmental and social pressures. Eventually, in the Chiriquí Period, drastic population changes occur, and the valley is all but abandoned.

The final analysis on the average percentage of restricted vessel rims within collections indicated that their ratios remained the same for the first three phases. Throughout all time

periods, there was no statistically strong correlation between settlement size and restricted vessel percentages within an assemblage. This suggests that there was variety in the number of restricted vessels between households. The only change occurred in the Chiriquí Period, where there was a decrease in the average ratio of restricted vessel rims. This decrease suggests new preparation or storage activities were occurring within the Chiriquí Period.

Soil fertility appears most important to settlements in the valley when there is emigration of the population. Alternatively, the decrease in population could have been caused by an increase in mortality rates or decrease in fertility rates due to disease or other population limiting factors. The exact reason for the decrease in population during the Chiriquí Period is still a mystery and needs further targeted investigations. One hypothesis has already been dismissed. Volcán Barú did not have a massive eruption at that time to initiate such a movement (Behling 2000; Holmberg 2007, 2009; Sherrod et al. 2007).

The settlement patterns within the valley suggest that controlling fertile soil, and any resulting surplus, was not a major contributor in the development of leadership roles as has been argued for other areas of the world (Elliott 2005; Kirch et al. 2004; Lombardo et al. 2015). Initial populations did not choose overwhelmingly to settle on or near fertile soil. Only after leadership positions were established, by the Chiriquí Period, did occupants of the valley focus on settling near fertile soil. This indicates that surplus food production from fertile soil was not a prime mover in the development of inequalities, but it became important in the maintenance of those positions. Ceremonial events in Barriles suggest that social factors had a greater influence on the creation of leadership positions through feasting and warfare activities.

Chapter 2: Natural and Cultural Environments of the Upper Río Chiriquí Viejo Valley

The Upper Río Chiriquí Viejo Valley is located in the shadow of Volcán Barú in Western Panama. Volcán Barú, a currently active volcano, rises above the landscape as a prominent feature because it is the highest peak in Panama. In certain areas, the remnants of its blown top can be seen scattered upon the landscape. The volcano has had a long history of eruptions, with the last eruption occurring around the time of Spanish Contact (Behling 2000; Holmberg 2007, 2009; Sherrod et al. 2007). Volcán Barú is an important feature in the valley because its eruptions created areas of extremely fertile soil.

Beyond the valley's importance archaeologically, it is of national economic importance. Within Panama, the area continues to be recognized for its agricultural productivity and provides 80% of the nation's horticultural products (Hobeika and Wagner 2018). This has spurred investigations on current agricultural practices and resulted in soil studies that assign soil classes to the terrain (IDIAP 2010; Proyecto de Zonificación Agroecológica 2011). These class designations were critical for my analyses of soil fertility in relation to cultural materials in a way that was not previously possible.

My project area incorporated terrain between 1,200 and 2,300 meters above sea level (masl) and included multiple econiches. Two modern towns are situated within the survey zone. Cerro Punta is located in the northwest portion of the survey region at approximately 2,000 masl (Linares and Sheets 1980). Its annual rainfall for the years of 2004 to 2014 ranged between 1,375.8 mm and 2,873.9 mm (Estadística Panameña-121 Meteorología 2014) with no distinct "rainy season". Here, the temperatures average 15.7°C and most occupants are farmers. Crops

encountered while surveying included potatoes, carrots, onions, and cabbage. Farmers practice crop rotation and heavily fertilize with a mixture that includes chicken refuse.

About 45 minutes from Cerro Punta is the town of Volcán, in the southwestern portion of the survey zone. It is at a lower elevation, ranging from 1,200 to 1,340 masl (Linares and Sheets 1980). Rainfall was not specifically noted in the meteorological census of Panama, but it is considered to be lower than that of Cerro Punta (Linares et al. 1975). Average temperatures are milder than those of Cerro Punta at 19°C and there is a distinction between seasons. Due to the differences in temperature and soil conditions, the crops differ from Cerro Punta. We encountered coffee, corn, and green peppers as agricultural products amid large cattle farms in this southern area.

The first archaeological researchers to conduct a regional survey recognized the diversity in microenvironments within the Upper Río Chiriquí Viejo Valley. Since then, multiple archaeological projects have taken place in the valley. Olga Linares and her colleagues (Linares and Ranere 1980; Linares et al. 1975) were the first to complete a survey of the valley that consisted of a 62 km² study area. Their thorough survey included both surface collections and a form of shovel testing with a posthole digger for areas that lacked tilled soils or opportunities to view stratigraphy and artifacts below the surface (Dahlin 1980; Sheets 1980). Two excavations targeted the larger settlements of Barriles and Pitti-González (Rosenthal 1980; Spang and Rosenthal 1980). Their survey provided invaluable data on the location of settlements, although through later investigations, including my own, the sizes of many of their recorded settlements tend to err on the side of being larger than when re-investigated.

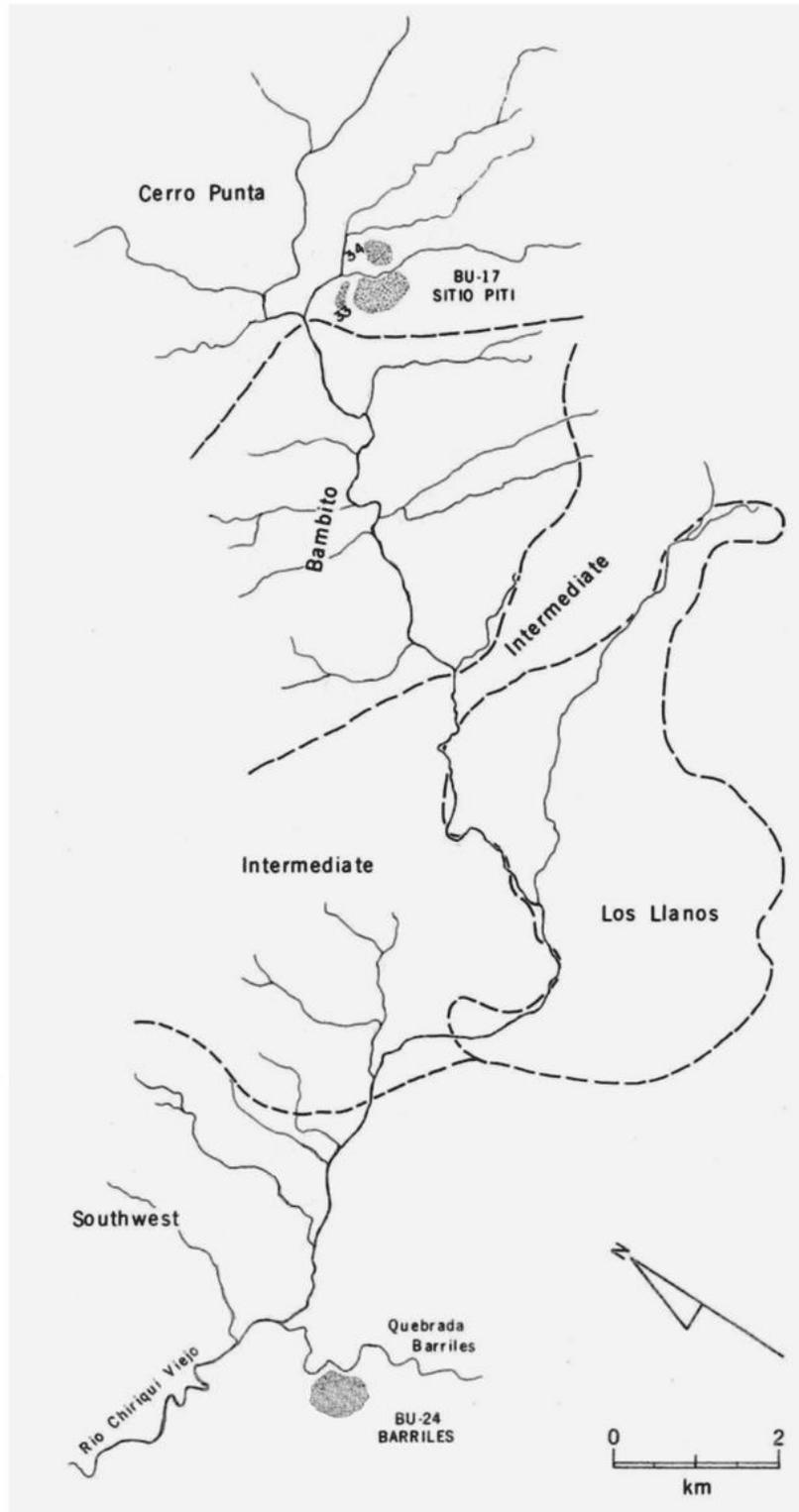


Figure 2.1. Zones designated by Linares and her colleagues (adapted from Linares et al. 1975).

These investigators were interested in the spread of agriculture and noted the different microenvironments within the valley, dividing it into five environmental zones (Figure 2.1). The northernmost sector of their survey zone was called Cerro Punta. It contains a meter or more of dark alluvial sediments (Linares et al. 1975). Much of this area is gently sloping and cultivated. The second sector, Bambito, is in stark contrast to Cerro Punta. It contains broken terrain with cliffs next to the Río Chiriquí Viejo. These sloping, cultivated areas end at sharp cliffs that overlooked the river. Elevations within Bambito can change up to 200 m in a very short distance when climbing from the river's ravine to the cultivated slopes. The third microenvironment, the Intermediate zone, is flatter with rolling hills and soils "as fertile as those of other regions" (Linares et al. 1975:139). The Los Llanos sector is more recently created from pumice and gravel with little to no loam in the soil. With little loam, the area only supported grasses and smaller shrubs. Finally, the Southwest area contains four river terraces, differing from Cerro Punta in the seasonality of rainier and drier months.

The importance of soil fertility among and within these different niches has never been the focus of investigations and has only been broadly addressed in the Upper Río Chiriquí Viejo Valley. Linares and her colleagues (1980) examined the spread of agricultural practices but did not have the benefit of more recent investigations on soils within the valley. Instead, they addressed the topic generally, concluding that "settlements were placed where the best and flattest agricultural lands were found, without regard to river irrigation" (Linares and Sheets 1980:51). This statement is true with respect to settlement locations in areas that are fairly flat. However, not all flat land is fit for agriculture. There are flat landscapes with poor soil conditions that will not produce adequate harvests at the expense of time and energy. For example, the area near the town of Volcán has wide expanses of flat land. This area is the "Intermediate" zone

designated by Linares and her colleagues, yet it is not suitable for growing vegetation. This is noted in the paucity of archaeological remains and visible in how the land is utilized today.

2.1. Soil Fertility and Settlement Patterns

Soil fertility is one factor that can contribute to settlement patterns (e.g. Killion 1992). Not surprisingly, societies that depended upon cultivars and agriculture, when possible, selected areas to settle that were near or contained better soils and climactic conditions for crop production. This is also known as the “principle of first occupancy” where the best lands are settled first and kept in founding families through ties to the ancestors (McAnany 1995:98-99). Such societies include the Late Classic Maya (Ford et al. 2009), pre-contact societies of Hawai’i (Kirch et al. 2004; Vitousek et al. 2004), and those in the Río Tonosí Valley of central Panama (Berrey 2014:105). Previous researchers argued for the importance of maize agriculture within the valley (Linares and Sheets 1980; Linares et al. 1975; Smith 1980) and I investigated whether the same principle applied to the Upper Río Chiriquí Viejo Valley. This investigation incorporated soil characterizations, classifications, and environmental factors.

The phrase “soil fertility” encompasses many physical and physiochemical properties of soil (Stockdale et al. 2013:51). Physical properties include texture, structure, profile depth, water-holding capacity, drainage, mineral content, and organic matter content (Jones Jr 2012:5). The physiochemical properties are pH, level of available essential plant elements, and cation/anion exchange capacities. To further complicate matters, it is also important to note that soil may be considered fertile from either the perspective of the properties of the soil or the crop yield. For example, soils may be fertile because of their composition, but that composition may not be the best fit for a specific crop. Considering the complexity of soil fertility, there is one

classification system that has been developed to aid farmers in land management and identify the best arable land. I have relied on this system for my research. It is called the Land Capability Classification (U.S. Department of Agriculture 1961).

2.1.1. Land-Capability Classification

The land-capability classification system is not a specific measure of soil fertility. Many soil and landscape features are considered when a class is assigned. These factors include temperature, effective moisture, soil texture, and water drainage. Many properties that make soils fertile are considered when assigning classes such as soil depth, water availability, slope of the terrain, and erosion risk. Therefore, capability classes do reflect soil fertility (Brown et al. 2008; Fenton 2006; Sys and Frankart 1971). The importance of this system lies in its standardization of topographical features and soils into a classification that provides agricultural workers information on soil limitations and aids them in determining the best land management practices.

The land-capability classification is used throughout the United States and other countries. It divides landscapes into eight classes, with each increase in class number representing more limitations on how the land should be used (Table 2.1)(U.S. Department of Agriculture 1961). Arable classes, those suited for agriculture, are labeled Classes I to IV. Soils designated Class V to VII are considered non-arable and best suited for cattle, forest plantations, and conservation.

I make one assumption by utilizing this system in my research. Classifications are based on recent soil conditions and I am using these classifications as if they have not changed in the last 2000 years. Unfortunately, there is no way around this issue other than to hire a specialist to conduct a geomorphological survey of the region to clarify whether these classifications hold

true in prehistory. This type of study was beyond the scope of the project, but it is an avenue for future investigations.

The soils of the Upper Río Chiriquí Viejo Valley had been classified using the land-capability classification system in order to aid the local inhabitants in managing their crops and resources, and investigate the possible production of coffee. The valley contained Class II to Class VIII soils, indicating a wide range of soil conditions within the valley (Figure 2.2) (IDIAP 2010; Proyecto de Zonificación Agroecológica 2011). No areas were assigned Class I or V. Therefore, the best, and most fertile, soils in the valley were Class II soils.

Table 2.1. Land-capability classes (U.S. Department of Agriculture 1961)

Class	Land-limitations and suggested usage
Class I	Arable, apt for annual cultivation. Ideal with little or no limitations. Can use for permanent cultivation, cattle, forest activities and conservation.
Class II	Arable, apt for annual cultivation. Some limitations that may reduce the choices of crops or increase the costs of production. Can use for cultivation, cattle, forest activities and conservation.
Class III	Arable, apt for annual cultivation. Terrain presents severe limitations that restrict the choices of crops or substantially increase the costs of production. Requires special conservation. Can use for cultivation, cattle, forest activities and conservation.
Class IV	Arable, apt for perennial or semi perennial cultivation. Annual crops occasionally and with intensive manual practices and conservation of soils. Presents very severe limitations that restrict the choices of crops to those of short vegetative periods. Requires careful management. Can use for cultivation, cattle, forest activities and conservation.
Class V	Non-arable, apt for cattle. Also can use for forest activities. Presents limitations and erosion risk so not apt for annual or perennial crops.
Class VI	Non-arable, apt for forest plantations. Can use for fruit tree plantations, although will require intensive manual practices (terraces, channels) and conservation. Apt for grasses. Other activities permitted in this class are the management of natural and protected forests. Present severe limitations.
Class VII	Non-arable, apt for management and conservation of natural forest. Limitations are so severe that even forest plantations are not recommended. When forest exists in this terrain it should be protected to promote regeneration. In some cases, not the general rule, it is possible to establish forest plantations with relative success and also grasslands.
Class VIII	Non-arable, the lands from this class present limitations so severe that they are not apt for any economic activity directed for the use of soils. Best to dedicate to the protection of the natural resources.

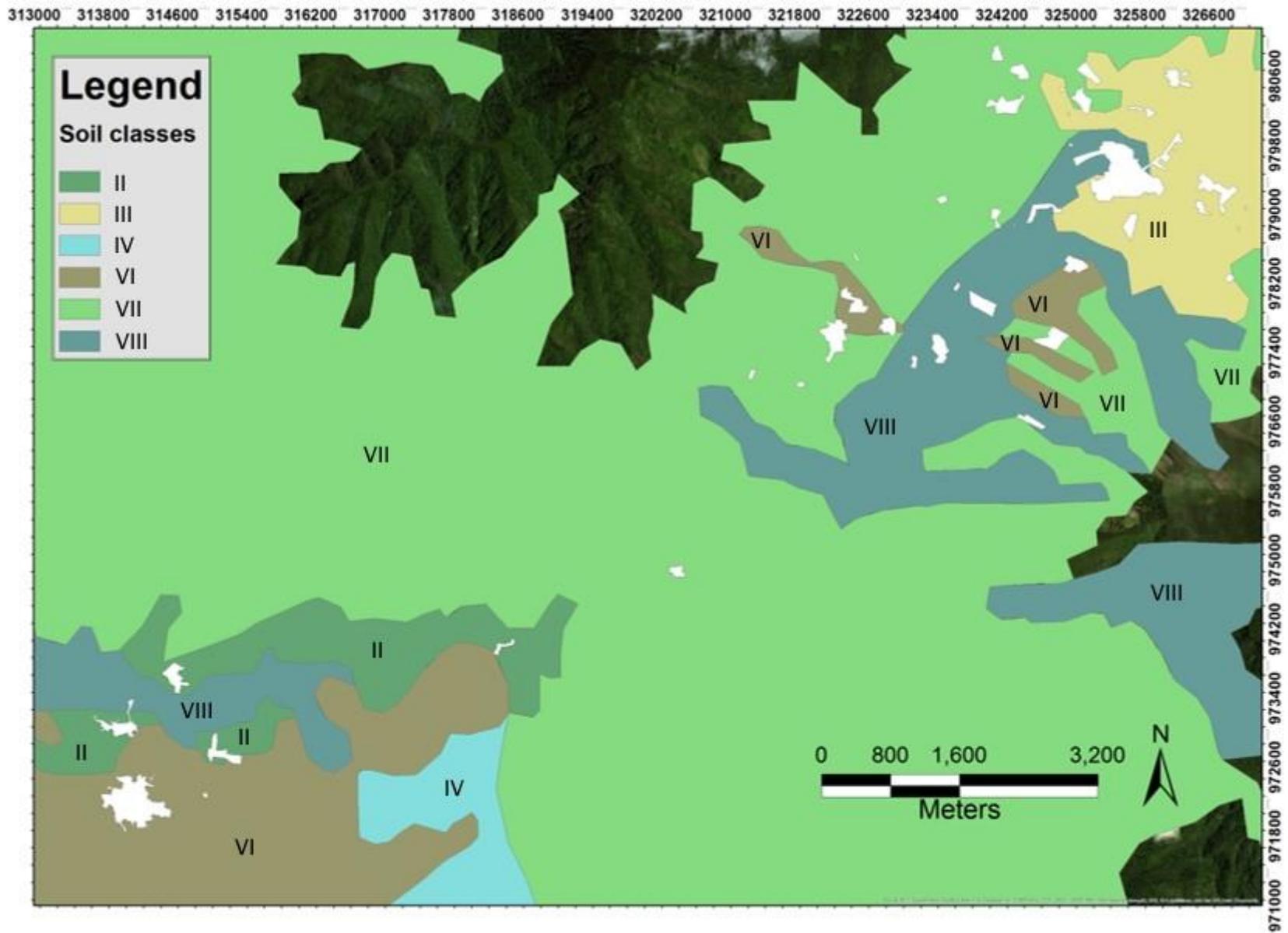


Figure 2.2 Location of settlements (white) and land classes within the Upper Río Chiriquí Viejo Valley.

2.2. Periods Prior to Complex Society Development in Greater Chiriquí (11,000-300 B.C.)

The substantial amount of current food production in the Upper Río Chiriquí Viejo Valley makes it nationally important. The valley also has a long prehistory that makes it culturally important. It is located within the larger archaeological subregion of the Greater Chiriquí. Numerous archaeological investigations in the Greater Chiriquí and, more broadly, in the Isthmo-Colombian area provide cultural interpretations and a general background for the social changes that were occurring within the valley.

There is a deep prehistory associated with the Isthmo-Colombian Area. Evidence of occupation started in the Paleoindian (11,000-7,000 B.C.) and continued to the Contact Period (A.D. 1650) (Cooke 2005; Corrales 2000). The transient nature of the Paleoindian populations within the Greater Chiriquí has left little archaeological evidence. However, archaeological regions bordering the north and south contain evidence of Paleoindian populations. These rockshelter sites are identified by the inclusion of Clovis points or Fishtail points (Cooke 2005).

Rockshelter sites to the east of the Upper Río Chiriquí Viejo Valley (Casita de Piedra, Trapiche, and Hornito), in the highlands of Chiriquí in western Panama, provide evidence of Archaic populations (6,000-100 B.C.) that survived by hunting and gathering locally available resources (Acuña 1983; Cooke 2005; Cooke and Ranere 1992; Ranere 1980a; Ranere 1980c; Sheets 1984). Their diet was further augmented by the introduction of maize and arrow-root cultivars by 5400 B.C. and manioc by 3600 B.C. (Dickau 2010:124). An example of this variable diet is demonstrated at Casita de Piedra through starch analysis which identified maize (*Zea mays*), manioc (*Manihot esculenta*), yams (*Dioscorea* sp.), arrowroot (*Maranta arundinacea*), and zamia (*Zamia* sp.). Additional macrobotanical evidence was in the form of palm nuts (*Acrocomia aculeate* and *Attalea butyracea*), annona (*Annona* sp.), algarrobo (*Hymenea*

courbaril), nance (*B. crassifolia*), and canistel (*Pouteria* cf. *campechiana*) (Dickau 2005, 2010; Dickau et al. 2007; Smith 1980).

Within the Chiriquí highlands, the Archaic has been divided into an early and late phase based on changes in the lithic tool types. The earlier Talamanca Phase (5000-2300 B.C.) is characterized by woodworking tools (e.g. choppers, bifacial wedges) while the Boquete Phase (2300-300 B.C.) includes ground and polished stone tools (e.g. celts, pestals) (Ranere 1980b, 1980d, 1980e). Celts found in the Boquete Phase are possible indicators of forest clearance for the increasing use of cultivars (Linares 1977a, 1977b). There is the possibility that the most recent radiocarbon date that places the Boquete Phase around 300 B.C. may be erroneous and associated with a ceramic level, changing the dates of the phase to 2300-1500 B.C. and placing it in line with the chronology on the Costa Rican side of the Greater Chiriquí (Corrales 2016:38).

Current data indicates that the introduction of ceramics into the Chiriquí highlands of Panama at 300 B.C. is later than that of the lowlands (1500 B.C.) and both are much later than the appearance of Monagrillo ceramics in central Panama (4500-3200 BP) (Cooke 1995, 2005). The origin of Monagrillo ceramics is still up for debate. There has been insufficient evidence to prove that it grew out of other similar South American contemporary ceramic complexes, which leaves the possibility of an independent development (e.g. Cooke 2005; Fonseca 1997; Meggers 1997).

The Costa Rican side of the Greater Chiriquí contains two contemporaneous phases within the Sinancrá Period (1500-300 B.C.). These phases are differentiated by preferences for certain ceramic types, rather than the presence and absence of those types. The first phase, Curré, is found in the Térraba River Valley while the Darizara Phase is in the Coto Colorado Valley (Corrales 1989; Herrera and Corrales 2003). A third phase that contains similar ceramics to those from the Sinancrá Period is in the southern Caribbean coast of Costa Rica (Baldí 2001; Corrales 2016). This phase is in the Gandoca zone and is called the Black Creek Phase (2000-400 B.C.).

In the General River Valley of south-central Costa Rica is the Quebradas Phase that was once considered to be part of the following Aguas Buenas Period (300 B.C.- A.D. 800) (Corrales 2000; Drolet 1992). However, reassessment of the phase places it earlier (400 B.C.- A.D. 200) and overlapping the final centuries of the Sinancrá Period in the Upper Térraba Basin of Costa Rica (Sol 2013).

The first examples of ceramics in western Panama are from the Concepción Phase (300 B.C.- A.D. 400). Shelton (1984:88-91) noted this phase as stratigraphically earlier and separate from the following Aguas Buenas Period materials at two sites near the town of San Vicente. Generally, Concepción sherds are found in the foothills of the Chiriquí highlands and are less likely in the coastal zones (Haberland 1962, 1969; Shelton 1984). The first sedentary populations in the Upper Río Chiriquí Viejo Valley were those that incorporated the use of ceramics into their daily lives (Drolet 1988; Shelton 1984; Rago 1988). These settlements were composed of small homesteads and low-density hamlets. During the early occupation of the site of Curré in southeastern Costa Rica, microlithic blades found at the site were from scrapers used in a root-crop or palm economy (Corrales 1989, 2016). It is still debated whether the first sedentary populations in the Chiriquí highlands were migrations of agricultural populations from lower elevations and coastal zones or local populations adopting a new way of life (Linares et al. 1975; see Cooke 2005; Cooke and Sánchez 2004). This is one of the questions I investigated for this research. We do know that archaic subsistence practices continued into the Sinancrá Period and later changed with anthropogenic impact in the form of forest clearance and fires occurring in the Volcán Barú area around 1145 B.C. (Behling 2000). The early human disturbance on the environment suggests cultivars were introduced prior to the evidence we have for macroremains.

2.3. Increasing Complexity in the Aguas Buenas Period (300 B.C.- A.D. 900)

The most important timeframe for social change in the Greater Chiriquí was the Aguas Buenas Period. This period contains the development of persistent social inequality. Despite the valuable information we can attain regarding emergent elites and social inequality, this period continues to be overlooked by archaeologists drawn to more recent periods that contain polychrome ceramics and gold artifacts.

The Aguas Buenas period includes the first appearances of socioceremonial centers and large stone spheres or barrels. We see these centers and stone objects emerge on the landscape between A.D. 400 and A.D. 600 and they are interpreted as indicators of social hierarchies (Drolet 1983, 1988; Hoopes 2005:21). Social distinctions are also evident in settlement hierarchies, where larger socioceremonial centers in highland zones are surrounded by dispersed settlements (Drolet 1992). Within the Upper Río Chiriquí Viejo Valley, there is a settlement hierarchy of at least three settlement levels (see Chapter 5). Hamlets with household-level craft industries are generally located on secondary rivers, streams, and lagoons (Linares and Sheets 1980; Corrales 1984). Finally, increasing inequality is inferred with the presence of polished stone pendants for specific individuals and decorated metates that sharply contrast with the undecorated versions (Lothrop 1963).

Stone spheres and stone statues are the most iconic examples used to discuss the existence of elites. The spheres are argued to have been status symbols placed at entrances of structures and arranged in configurations that reflected important celestial features (Fernández and Quintanilla 2003; Lothrop 1963; Quintanilla 1992; Thiemer-Sachse 2005). Surviving spheres range in size, from over two meters in diameter to tens of centimeters, and some include petroglyphs.

Stone statues from the Greater Chiriquí suggest the existence of social inequality because scholars claim they are depictions of elites. The best-known examples are those from Barriles that depict an individual with a conical hat seated on the shoulders of a second individual (Figure 2.3) (Drolet 1988, 1992; Hoopes 1996; Stirling 1950). Conical hats are linked to shamans and powerful leaders in ethnographic contexts (Hoopes 2007).

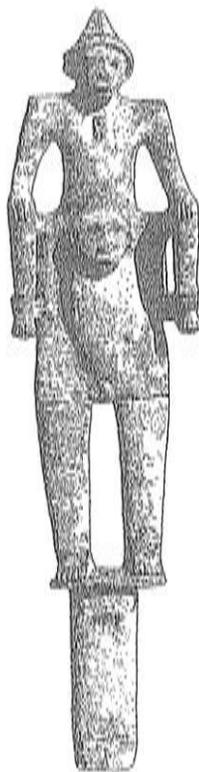


Figure 2.3. Example of a stone statue from the Barriles settlement (Hoopes 1996:21).

The Aguas Buenas Period in Panama is divided into an early and late phase. This division is based on preferences for certain ceramic types or wares, rather than the introduction of new ceramics (Herrera and Corrales 2003; Palumbo 2009; Palumbo et al. 2017; Soto and Gómez 2002). The Early Bugaba Phase (A.D. 300-600) contains higher percentages of Cerro Punta Orange wares, while the Late Bugaba Phase (A.D. 600-900) contains more Valbuena and Plain ware in assemblages, with both ceramics being identified in collections spanning the entire

Aguas Buenas Period (Palumbo 2009).

Subsistence practices during the period included the use of tree products, roots, tubers and seeds (Drolet 1983). The numbers of *manos* and *metates* in Western Panama suggest that maize and beans were important staples in that area (Linares and Sheets 1980). Yet, low percentages of maize phytoliths were present in other areas of the Greater Chiriquí, such as the in the Upper General Valley in Costa Rica (Mora 1994). This variety of foodstuffs was supplemented with marine and mangrove resources when available (Hoopes 1990, 1996).

2.4. Complex Societies of the Chiriquí Period (A.D. 800-1500)

The social changes that occurred in the Aguas Buenas continued and were elaborated upon in the Chiriquí Period. We know more about the Chiriquí Period than any other period in the Greater Chiriquí. This is because sites from this period are easily identified and investigated due to their pock-marked appearance from *huaquero* (looters) pits. These pits are the remnants of individuals looking for gold artifacts and polychrome ceramics, both unique to the period (Baudez et al. 1993; Corrales 2000). Furthermore, larger Chiriquí Period sites tend to be conspicuous on the landscape with mounded architecture. Most data come from the Costa Rican side of the Greater Chiriquí, with only early descriptive collections of artifacts from western Panama (Holmes 1888; MacCurdy 1911; Osgood 1935). This has led to a generalization of the entire region that may not hold true for coastal and lowland western Panama.

Persistent social inequality is present within settlements and the period's settlement hierarchies indicate complex sociopolitical organizations (Drolet 1983, 1988, 1992). Communities tended to be in alluvial zones along principal tributaries (Drolet 1982, 1992). These were nuclear food producing villages often divided into domestic and cemetery zones

(Drolet 1982, 1984b; Haller 2004; Linares 1980b; Menzies 2009:122; Quilter 2004). Large villages, like the site of Murciélago in Costa Rica, contained circular house foundations and internal divisions of domestic zones (Corrales 2000; Drolet 1982, 1988, 1992, 1994). Smaller hamlets were dispersed on the landscape (Drolet 1983; Linares and Ranere 1980). Separate from residential areas were large mortuary centers. The Diquís mortuary centers, in southern Costa Rica, contain examples of monumental ceremonial architecture (Frost 2009; Quilter 2004; Quilter and Blanco 1995; Quilter and Frost 2007; Sol 2013).

Architectural differentiation is found in both domestic and funerary architecture (Drolet 1983, 1992; Haberland 1984; Quilter 2004; Quilter and Frost 2007; Stone 1963, 1966). The best examples are in the Terraba Basin of Costa Rica. Large settlements contain circular house foundations, internal settlement divisions, and artificial mounds with cobblestone walls (Drolet 1983). Secondary villages lack visible architecture and are identified by archaeological material deposits (Drolet 1983; Linares and Ranere 1980).

Leaders distinguished themselves in life and death with gold adornments (Bray 1981; Corrales 2000; Frost 2009; Lothrop 1963; Quilter 2000). Gold indicated status and was primarily used for personal adornment in the forms of anthropomorphic and zoomorphic pendants (Aguilar 1972; Scott 1995; Snarskis 1985, 2003; Stone and Balser 1958, 1967). Materials were probably obtained from alluvial deposits on the Osa Peninsula of Costa Rica and then mixed with copper to create a *tumbaga* alloy (Balser 1966; Bray 1981; Fernández and Quintanilla 2003; Stone and Balser 1958). Leaders' graves also contained other socially valued goods such as decorated ceramics and carved metates.

Long-distance trade is suggested by the identification of Greater Nicoya (northwestern Costa Rica and southwestern Nicaragua) polychrome pottery on Isla del Caño, off the coast of

the Osa Peninsula, and in the Diquís Delta (Baudez et al. 1993; Corrales and León 1987; Finch and Honetschlager 1982). Central Panama ceramics have also been identified in the Diquís (Badilla et al. 1997). However, examples of long-distance trade items are few, hinting it may not have been as critical in culture change as has been argued by Helms (1979, 1993, 1994, 1998) (Palumbo 2009).

Populations practiced maize agriculture and continued to cultivate root crops (Anchukaitis and Horn 2005; Arford and Horn 2004; Baudez et al. 1993; Clement and Horn 2001; Corrales 1989; Dickau et al. 2007; Drolet 1992). Coastal and estuarine environments provided additional food resources, as is evidenced by shell mounds in the Diquís and in western Panama (Hoopes 1990; Linares 1968).

Ethnohistoric and ethnographic accounts provide additional information on Contact Period sociopolitical organizations and examples of daily life and material culture. Although heavily biased because of the authors' own presumptions, these accounts provide general information regarding political organizations and daily life. Spanish explorers mention "provinces" where only certain settlements contained chiefs adorned with gold (Corrales 2006; Drolet 1992; Fernández Guardia 1964; Ibarra 2003). This description is in concordance with our understanding of settlement hierarchies where only certain settlements contain the upper echelons of society. Accounts also describe different levels of chiefs and occurrences where multiple chiefs may have been located in the same settlement (Ferrero 1981). Warfare and disputes between areas were common enough that Juan Vázquez de Coronado (1976:97) described women taking care of the fields because the men were occupied with war. Noted cultivars included corn, beans, squash, cotton, yucca and many varieties of fruit (Corrales 2006; Fernández Guardia 1964).

The Upper Río Chiriquí Viejo Valley seems to have had its own distinct trajectory during the Chiriquí Period. Investigators in the 1970s noted a thick ash layer and suggested an eruption of Volcán Barú around A.D. 600 quickly ended the Aguas Buenas Period and prompted populations to move to the lowland coastal regions, vacating the valley (Linares 1977a:313, 1980c:245; Sheets 2012:51-52). We now know that such a catastrophic eruption never occurred (Holmberg 2007, 2009; Sherrod et al. 2007). There is significant evidence of occupation in the valley during the Late Bugaba Phase (A.D. 600-900), which becomes limited during the Chiriquí Period (A.D. 900-1500) (Palumbo 2009). The small population in the Chiriquí Period is supported by lake core evidence from Laguna Volcán that indicates around A.D. 895 there is recovering forest taxa (Behling 2000). According to the lake core, it is only after the most recent violent eruption of Volcán Barú around A.D. 1300 that there is a ceasing of agriculture practices, suggesting an abandonment of the valley.

Chapter 3: Emerging Elites and Surplus Control

Leaders are essential participants in the development of institutionalized positions in complex societies. These kinds of societies are also referred to as “middle-range societies,” “chiefdoms,” and “ranked” societies. A large portion of theoretical literature from the last fifty years is devoted to the study of these complex organizations (e.g. Beck 2003; Braun and Plog 1982; Childe 1950; Creamer and Haas 1985; DeMarrais et al. 1996; Drennan et al. 2010; Fried 1967; Peebles and Kus 1977; Redmond 1998a; Redmond and Spencer 2012; Service 1962; Upham 1987; Wright 1984; Yoffee 1993). Even with decades of literature dedicated to the investigation of complex societies, the question of how emergent leadership roles developed into permanent positions continues as one of the “grand challenges” within archaeology (Kintigh et al. 2014). A second related prominent challenge is: how and why did social inequality develop, persist, and decrease in past societies? Both questions can be applied to the social processes that were occurred within the Upper Río Chiriquí Viejo Valley between 300 B.C. and Contact Period.

3.1. The Perfect Conditions for Emergent Elites

Complex societies existed on almost every continent, demonstrating that there is no universal social or environmental condition necessary for the development of permanent leadership positions. They developed from smaller group organizations. Unlike complex societies, small-scale societies have many social mechanisms in place to support cooperation, such as gossip, physical punishment, and banishment (Boehm 1993; Eerkens et al. 2010; Winterhalder 2001). These mechanisms may not only be socially promoted, but also have an instinctual component. Cosmides (1989) has argued that there are specific nodes of our brains

that are dedicated to recognizing “cheaters”. The reaction to punish freeloaders, or those that do not cooperate, is so strong that the costs to discipline these individuals will often outweigh the benefits that would have been received (Henrich et al. 2006).

With these constraints in place, how did leaders emerge? Two proposed theories address this question. The first suggests that there was a benefit to having decision-making individuals. Leaders made decisions to assist in risk-buffering against environmental or social strains, they redistributed goods, directed communal labor activities, and any other duties that required guidance (i.e. Peebles and Kus 1977; Sahlins 1972; Service 1962; Wittfogel 1957). “Followers” saw value in having a decision-maker, while the leader probably received additional benefits (i.e. access to resources) for taking on this responsibility.

The second theory suggests that extreme circumstances (i.e. population change, surplus) permitted the social “rules” to be bent, or changed, and leaders emerged from these cracks in the system. Literature on the political economy of past societies focuses on the cracks formed from power relationships within social groups (e.g. Earle 1991). From this perspective, researchers argue leaders and elites gained and manipulated power through militaristic endeavors (Carneiro 1970; Maschner 1991), economic activities (Arnold and Munns 1994; Hayden 1990, 1995; Price and Brown 1985), and ideological activities (Hayden 1995, 2001; Helms 1979; Spielmann 2002) to form permanent positions within societies (Ames 2007:493-494; Bender 1985).

Both of these theories address how leadership positions emerged, but why would someone want to become a leader when systems are in place to work against him/her? Three possibilities exist (Kantner 2010:256-258). The first is that leaders are willing to make decisions for others because they see it is for the greater good. They believe that they have the means to

help and are not particularly interested in any additional benefits beyond those to which all others are entitled. These leaders are selfless.

Opposite the altruistic leaders are those that are driven by self-interest. These individuals are sometimes described in the literature as ambitious “aggrandizers” (i.e. Clark and Blake 1994; Hayden 1996, 2011). They are interested in advancing their agendas to ensure that they personally benefit.

The third explanation is somewhere in between the first two. This kind of leader recognizes that making decisions for the group can be mutually beneficial to those in the group and themselves. They are not selfless, because they expect to receive benefits, nor are they seeking to test the limits of their positions in order to receive excessive advantages.

It must also be stated that not everyone is fit to be a leader. A leader requires a certain skill set. One of the most important traits a leader has is charisma (Kantner 2010). This may be bestowed upon an individual or attained in one of two ways. The first is to be perceived as a deity or superhuman (Pauketat 2010). The other way is to create relationships where he/she is considered as close as a family member. The outcome of both scenarios is that potential followers have confidence in the leader, giving the leader authoritative power.

Leaders must also appear diplomatic, decisive, and open to alternatives. Their awareness of social norms and capability to anticipate and resolve issues requires a certain level of intelligence. Finally, leaders are excellent at reading people and know how to manipulate emotions and situations.

Emerging leaders use multiple strategies to overcome the social mechanisms in place to maintain the egalitarian ethos. Key to these tactics is the ability of leaders to gain control over resources (e.g. land, labor, knowledge) (Eerkens et al. 2010). Recent research has focused on

how leaders in the past: 1) used rituals or religion to modify social norms (e.g. Hollimon 2004), 2) oversaw production and distribution of goods (e.g. Vaughn 2006), 3) controlled special knowledge (e.g. Sinopoli 2003), 4) expanded social networks to access more labor pools (e.g. Arnold 2000), 5) exploited new resources that do not have social regulations in place (Eerkens 2010), and 6) produced goods in locations hidden from others. This access and control over resources provided leaders distinctive advantages that aided in the maintenance of their newly developed positions in society.

The roles that leaders play and the length of time they hold positions varies. Leadership positions are grouped into three categories: transitory, permanent, and inherited (Eerkens et al. 2010; e.g. Hayden 2001; Redmond 1998b, 1998c; Wills 2000). Transitory or temporary leaders make decisions for others only under certain circumstances. Once the situation has been resolved or no longer exists, these leaders lose their authority. Leaders in raiding parties or those in charge of seasonal ceremonial events may hold transitory positions. When a position become less contingent on certain events or circumstances it becomes permanent. These positions endure and may end with the death of the leader or become transitory or obsolete. Alternatively, the position may be inherited and institutionalized and passed from one generation to the next. The term “inherited” implies that there are kinship ties between generational leaders, whereas institutionalized signifies that the position is filled by the most qualified candidate. Those qualities are contextual and socially determined.

3.2. Indicators of Status

Emerging leaders are only beginning to be perceived as unique and important individuals within their communities. This results in fewer distinguishing traits that separate them from the main population and translates into even fewer archaeological correlates. We can more easily

identify permanent or institutionalized leaders in sociopolitical organizations by analyzing multiple correlates related to wealth and status. Wealth is the accumulation of prestige goods, land, and labor (e.g. Baines and Yoffee 1998, 2000; Kenoyer 2000; Niederberger 2000). These amassed prestige goods are valued objects whose quality and value have been determined by rareness, labor or technology, and/or decorative features (Appadurai 1986; Blick 1998:76; Lesure 1999; Smith 1987:322; Thomas 1991; Weiner 1985, 1992). Indicators of status are present during the Chiriquí Period, leading most archaeologists to presume the development of these inequalities began in the previous period, the Aguas Buenas Period, where indicators are more ambiguous.

Social inequality and elites in the archaeological record are identified with careful contextual analyses of artifacts and ecofacts. We use human remains, burials, the kinds of artifacts available, artifact styles, and architecture to discuss status and elite presence (Paynter 1989). As almost always is the case, the most robust conclusions come from multiple lines of evidence used to identify where and in which contexts social inequality can be found.

Skeletal analyses can identify physical modifications and chemical signatures acquired during the lifetime of an individual. Certain physical modifications, such as cranial and dental modifications, may have distinguished individuals within their society (Williams and White 2006). It is also important to note that in multiple societies these kinds of body modifications referenced social identity or beauty, rather than social status (Clark 2013; Geller 2009; Saul and Saul 1997; Tiesler 2001). Besides the macroanalyses of human remains, new technologies have broadened the information we can learn. Isotopic analyses permit discussions on differences in diet that can be related to status (e.g. Ambrose et al. 2003; Schutkowski et al. 1999; Somerville et al. 2013). There are limitations and preservation issues have an obvious effect as to whether

biological studies can be performed. In the Greater Chiriquí, rarely do organics remain and these lines of investigations are rare.

Burials with extravagant furnishings are one of the first images anyone outside of archaeology associates with elites and archaeology. As archaeologists we know that it is not that easy. We have come to understand that burials are complex representations of the status a person had in life, what s/he may need in death, or interments may just be a result of the necessity to dispose of a body. Contexts are critical and important distinctions come from comparisons of accompanying goods and features.

Artifact styles can be used to identify status in the archaeological record. Elites have more valuable items than others so differential distributions in prestige goods reflect wealth and status (Blanton et al. 1996; Costin 2001; Drennan 1984; Helms 1993; Lesure 1999; Robb 1998; Sinopoli 1991). Prestige goods used for performance rituals (e.g., ocarinas, elaborate *metates*, gold objects, trade goods) may be viewed as symbolic of esoteric knowledge or imbued with ideological significance (DeMarrais et al. 1996; Gabb 1875; Helms 1979, 1992, 1993; Renfrew 1994; Robb 1998; Saunders 2003; Spielmann 2002). The most widely referenced burial from the Greater Chiriquí contained 88 gold pieces (Lothrop 1963:94), a valuable material with social restrictions (Ibarra 2003). Prestige items include decorated ceramics because they required additional labor through elaborations of form and iconographic depictions (e.g. Cooke 2011; Corrales 2000; Holmes 1888; Linares 1977b; Lothrop 1937, 1942, 1963). It is important to note that not all decorated ceramics hold the same value. For example, at the site of Barriles, the decorated ceramic style of Bugaba Engraved was associated with elite households, but other forms of decorated ceramics did not similarly correlate (Palumbo 2009).

The kinds of artifacts present can be another indication of status. This method has been used to argue that individuals with status should have more artifacts and more of a variety of artifacts. In other words, a greater diversity of ceramic goods suggests status and indicates wealthy households (Clark and Blake 1994; Costin and Earle 1989; Hayden and Cannon 1983). This method is the basis of a mortuary study using data from the Tonosí Valley and Sitio Conte in Central Panama (Briggs 1989).

Finally, architectural features can indicate status. House sizes are excellent indicators of status and wealth (Smith 1987). Within burial contexts, some burials may have walls or additional interments distinguishing them from others. At the Panteón de la Reina in the General Valley of Costa Rica, there was a variety of burial styles encountered. Furthermore, differing architecture was associated with each of the two large cemeteries, argued to indicate moieties (Frost 2009; Quilter 2004). One cemetery had more built architecture, such as walls, and was larger than the other. This suggested to the investigators that one moiety had more power, or at least resources for the creation of these architectural distinctions.

The Chiriquí Period contains the most evidence supporting the existence of complex societies that have defined leaders and social differentiation. This is when we have archaeological evidence of distinct cemeteries from settlements and burials that are distinguished with gold artifacts, decorated metates, and decorated ceramics. The Panteón de la Reina is from this period as well as the Diquís burial with 88 gold artifacts. The positions elite individuals held were the products of processes that occurred in the previous generations. It is for this reason my research is focused on the Early and Late Bugaba phases, phases immediately prior to the Chiriquí Period.

Access to and the use of surplus is one pathway to elite status (Eerkens et al. 2010). Of primary interest was whether agricultural surplus was a prime mover that aided in the creation of permanent positions of power.

3.3. Farmers, Fertile Soil and Surplus

Surplus is repeatedly referenced in archaeological literature as being pivotal in the development of social complexities (Morehart and De Lucia 2015; e.g. Childe 1950; D'Altroy and Earle 1985; Halstead 1989). It incorporates multiple themes such as production, control, ethnicity, feasting, and gender, to name a few. Research conducted on food and foodways has evolved over the last 45 years (Twiss 2012). The early literature was strongly based in cultural ecology (e.g. Jochim 1976; Keene 1983; Winterhalder 1981) and later changed during the postprocessual movement to include studies on the cultural importance and meanings that food may embody (e.g. Appadurai 1981; Blitz 1993; Hastorf 1991; Miracle 2002). The most recent literature on the topic focuses on household contexts and food as an active player in social interactions (e.g. Dietler 2007; Spielmann et al. 2009). Most of this research has a combination of processual and postprocessual elements (Hegmon 2003).

Models incorporating surplus describe how emerging elites utilized surplus production, control, and distribution to solidify their social positions. Examples of societies where surplus is argued to have initiated or impacted social changes include the Hawaiian pre-contact and contact societies (Earle 1997), Chalcolithic Near Eastern societies (D'Altroy and Earle 1985), and those in Chaco Canyon (Earle 2001). The essential element of these models is that individuals, or kin groups, who had access to surplus used it to gain influence and authority (Hastorf and Foxhall 2017:27). Surplus was not only used in the initial process of differentiation but was also used to

maintain social inequalities. Societies where elites continued to use surplus to maintain their positions are often referred to in the literature as staple finance societies (Polanyi 1968).

Surplus models may be loosely grouped into two categories. The first is the eco-rational, or adaptationist, models which view surplus as part of an inevitable process that leads to complex social organizations (Brumfiel and Earle 1987; Morehart and De Lucia 2015). This outlook has leaders and elites as passive participants in a set evolutionary trajectory. The second category of models, political models, argue commoners are coerced into producing surplus to finance elites (e.g. Clark and Blake 1994; Earle 1997; Gilman 1981). These models see leaders and elites as very active in their roles and defining social rules. Models from both viewpoints presume surplus is first utilized as a risk buffer and that attachments to land for surplus production is a process that may be coopted (Morehart and De Lucia 2015).

Surplus can come in physical or intangible forms. Current research emphasizes the concept of surplus as a socially constructed idea and the importance assigned to storage locations and vessels. Vessels, caches, and storehouses are reminders of past harvests and hope for future success (Hendon 2000:49). These items and locations may also act as icons for memories and generational continuity (Hastorf and Foxhall 2017; Weiner 1992:56-60). The perception of what surplus is, archaeologists are finding, is as important as its physical existence. Those able to manipulate the definition of surplus within their societies are powerful and can create their own narrative that may not be paralleled in physical practices (Hastorf and Foxhall 2017). These types of studies are better suited for societies that have some form of a written record or history due to difficulties in assessing socially constructed ideas only through the archaeological record.

Another branch of surplus literature introduces the idea of “social storage”. This concept draws upon gift-giving (Mauss 2000) and feasting (Dietler and Hayden 2001). Food may be

gifted to kin groups, those in need, and allies. This accomplishes multiple tasks and ensures that in the future, if the giver falls on hard times, they may ask for a return on their gift. It also creates and strengthens social bonds (Bogaard et al. 2009; Halstead 1989).

Specific research on foodways can examine one or multiple stages of interactions between individuals and food. There are four stages on which archaeologists focus their attention (Twiss 2012). Each of these steps in the *chaîn opératoire* reveals information about political, economic, and social ideals.

The first stage is production. Research dedicated to this stage is most prevalent and includes cultural components such as gender (Spielmann et al. 2009; Watson and Kennedy 1991), politics (Hayden 2003), and identity (Lewis 2007), as well as adaptationist perspectives. This stage is important when considering the natural variations in soil fertility, such as this research examines. Increasing fertility correlates with an increase in the volume of products produced, otherwise known as soil productivity (Forest Service Department of Agriculture 2004; Shang et al. 2014). One can use the natural variations in soil fertility to their advantage by utilizing the best soils available or actively altering the soil composition. Soil productivity may also depend on how well suited a crop is to the soil and climate. If there is enough produce created and harvested, then a surplus exists.

The second stage is the processing of goods. Processing techniques include activities such as cutting, grinding, cooking and drying of goods in preparation for storage, transport, or immediate consumption (Twiss 2012). Within this stage, archaeologists have often explored the remains of animals and cut marks to identify useful cuts of meat. The scales and locations of processing provide fodder for research on public vs. private processing activities, labor organizations (Clarke 2001:157-158; Hayden 2001:39-40), and gender (Halstead 1999:80;

Wright 2000).

The third and fourth stages are consumption and discard. There are relatively few studies that investigate the discarding of food, even though what remains in the archaeological record is determined by these practices. Consumption, on the other hand, has a large body of literature dedicated to feasting (e.g. Dietler and Hayden 2001; Twiss 2008; Wright 2004). Research on daily meal consumption is often overshadowed by investigations on feasting and its sociopolitical implications (e.g. Blitz 1993; Clarke 2001; Dietler 2001; Hayden 1990, 1995).

Research investigating surplus in the archaeological record relies upon estimates of crop output, labor, and storage. Specifically, there are four methods that archaeologists use to examine surplus. The first method investigates the potential of agricultural systems to support nearby settlements. Steponaitis (1981) investigated in the Basin of Mexico to examine whether the catchment potential correlated with settlement size and estimated populations. Settlements that were larger than expected when compared to their agricultural potential were argued to have been maintained using surpluses from other settlements. De Lucia and Morehart (2015) have argued production from the drained field systems at Xaltocan, Mexico would have exceeded the needs of the local populations and the surplus was probably used for market exchange and other requirements. These researchers relied upon the relationship between production potential and the nearby populations.

The second method relies on estimating labor requirements for surplus production in subsistence practices and household contexts. In both areas of production, tool kits that change through time may indicate changes that permitted surplus production. For example, the density of hoes and spindle whorls increased in households after the Inka conquest, suggesting an increase in agricultural production and textile production for the state (Costin 2015). A tool kit

doesn't have to change to suggest surplus. Surplus craft production can be investigated by reviewing the ratios of finished products to production debris and tools (Costin 1991).

The previous method focuses on tangible products as surplus from labor, but labor can be investigated as a form of surplus (Kolb 1994). Mound construction is often seen as an example of surplus labor efforts (i.e. Artursson et al. 2015). The construction could result from collective actions of kin and social groups or be the result of *corvée* labor. Household constructions may also reflect the use of extra labor. Specifically, the creation of elite households exemplifies the use of others' labor as a form of wealth (Norman 2015).

Finally, the fourth method analyzes the storage capacity of households and communities (e.g. Barrier 2011). Storage of products can be done in containers of different media such as earthen pits, baskets, jars, etc. Earle and his colleagues (2011) used this technique for Bronze Age Hungary. By analyzing the frequency of storage jars, they argued that local farmers, rather than emergent elites, controlled the fruits of their labor. A second case study using this method investigated the size of Inka storage facilities and argued it indicated how much surplus they were able to acquire (D'Altroy and Earle 1992). Analysis of storage locations and holding capacity provides a measure of how much surplus may have existed and inferences as to who was controlling it. It is necessary to remember that certain storage methods preserve better than others. Storage containers comprised of organic materials are rare in the archaeological record, unless extreme conditions were present for preservation.

I conducted a catchment analyses of the Upper Río Chiriquí Viejo Valley and analyzed the percentages of restricted vessels within assemblages to measure changes in diet. Unfortunately, maize was not typically stored in vessels so an analysis of storage vessels would not reflect maize quantities (Smyth 1989; Gotthilf 1982). Instead, changes in the percentages of

restricted vessels within collections would indicate changes in storage, processing, and preparation of foodstuffs. These changes relate to changes in diet and I use them to investigate diet consistency and whether there were indications of the introductions of new foods or an increased reliance on specific cultivars, such as maize.

3.3.1. Maize and Storage

Certain food storage methods may not leave many, if any archaeological traces (e.g. Smyth 1989:104). This is where ethnographic and ethnoarchaeological studies have aided in broadening our understanding of storage methods (e.g. Smyth 1989, 1990; Gotthilf 1982). Food products must be stored at optimal conditions to prevent spoilage or contamination and these conditions differ according to the stored good. In the case of maize, it needs to be dried, but not overly desiccated, prior to long-term storage to prevent the kernels from spoiling. Too much moisture and the kernels mold, too little moisture and the seeds will not germinate, the seed coat can crack and bacteria can affect the kernels (Gotthilf 1982:52-55). Additional factors that may affect stored products are the presence and reproduction of insects. They can raise temperatures within storage, leading to further spoilage by mold and bacteria. Finally, birds and rodents can deplete the quantity of stored material by eating what was meant for human consumption or planting. Storage techniques must mitigate these forces that cause spoilage to ensure the maximum amount of goods survive for future use.

There are five documented methods for storing dried maize. These five methods are 1) platform or wooden rod storage above living quarters, 2) off-the-ground bins, platforms or rods within living quarters, 3) lean-tos, 4) detached sheds, and 5) pits (Gotthilf 1982). Some of these are difficult to identify archaeologically. One of the best-preserved archaeological sites, the site

of Cerén, in El Salvador provides prehistoric evidence of storage methods that are usually absent or difficult to discern in the archaeological record (Smyth 1990). At Cerén was a storehouse containing bins and baskets filled with whole cobs and dating to approximately A.D. 590 (Lentz et al. 1996:251-252). Ethnohistoric and ethnographic accounts elaborate on maize storage methods. In ethnographic examples from Central America, maize is not traditionally stored in pits or vessels. Instead, it is above ground and with more access to moving air (e.g. Gotthilf 1982; Lentz et al. 1996). This makes sense in areas where the soil may inhibit preservation by being too moist or not cool enough. Ethnoarchaeologists noted that storage of maize on the cob is common in Maya communities because it permits more air flow between kernels while in storage (Gotthilf 1982:50). However, this method requires more storage area, whereas shelled maize may be stored in bins (Leonard 1976; Shove 1970). There are archaeological examples of pits being used for maize storage (e.g. Bendremer et al. 1992), but this may have been to hide it from others (Gotthilf 1982) or modifications were made to aid in preservation.

There is no direct evidence for the kinds of storage methods utilized within the Upper Río Chiriquí Viejo Valley. Archaeological examples of storage pits exist to the north, in the central highlands of Costa Rica (Snarskis 1984:161), but ethnohistoric examples describe above ground storage structures (Fernández Guardia 1908:35). It is probable that maize surplus stored within the valley was done so using above ground methods, since this is the most common method employed ethnographically in Central America (e.g. Gotthilf 1982; Lentz et al. 1996). The unlikeliness of maize to be stored in ceramics does not limit the effect that its introduction into the diet would have on vessel assemblages. In other areas of the Americas the increased importance of maize and maize productions has coincided with the introduction of new vessel types. For example, in the southwestern United States, *comales* (Beck 2001) were used in the

production of tortillas, and at Tiwanaku, *keros* (Goldstein 2003:150) stored and served *chicha*, maize beer.

3.4. Diet and Available Food Sources

The focus of this research is on maize because it is mentioned as a key crop in the agriculturalist model that describes the development of complex societies within the valley. However, it is important to remember and address the other foods available to populations within the valley. Current scholars argue too much attention has been on the role of maize to produce surpluses for the development of complex societies (e.g. Killion 2013; Medina et al. 2016). Ethnobotanical evidence from Pitti-González indicates maize, the common bean (*P. vulgaris*), palm nuts (*Corozo*), and possibly sweet potatoes (*Ipomoea batatas*) were available food products (Galinat 1980; Smith 1980). Plant remains also included a legume from the *Hymenaea courbaril* L. tree. The archaeobotanical evidence from Barriles is more limited. A core taken from a modern latrine hole only produced casts of seeds for analysis that were identified as palm nuts (*Corozo pacora*) (Smith 1980).

In a neighboring valley, during the Archaic Period, botanical evidence increases the number of species that were used as food and that could have continued to be used as resources into the Aguas Buenas Period. Nance, algarrobo, *Annona* spp., and *Pouteria* spp. represent tree fruits that were eaten (Dickau 2010:119; Smith 1980). Starch grains of *Zamia* spp., two or three native yams, and *Calathea* sp. indicate multiple species of tubers were important (Dickau 2010:120). In addition to maize, exogenous domesticates recovered include manioc and arrowroot (Dickau 2010:122).

Many of the pathways to complexity have focused on the importance of agriculture (Price and Feinman 2006). However, there is a growing amount of literature and evidence that some complex societies were non-agricultural and practiced horticulture (e.g. Killion 2013; VanDerwarker 2006). Agriculture (farming) and horticulture (gardens) are best seen as two points on a continuum (Killion 2008). Gardening, or horticulture, can be done by mobile and semisedentary populations that focus on the care of plants and use cultivation activities to supplement wild resources (Killion 2013:570). Field agriculture is associated with more permanent settlements and the long-term cultivation of staples. Identification of both gardens and agricultural fields through archaeology is difficult. Both are based on cultivation, but agriculture is often at a larger scale and includes the modification of topography through the movement of soil and an association with larger permanent settlements (Killion 2013:576). Horticulturalists focus on tending to plants and may not produce notable changes in topography or cause the same habitation patterns as agriculturalists. Killion (2013:577) has laid out the general characteristics of both gardeners and farmers so archaeologists may recognize that there are correlates that can be used to discuss the kind of cultivation activities that populations practiced in the past (Table 3.1).

Table 3.1. General characteristics of gardening/horticulture and farming/agriculture (adapted from Killion 2013:577)

Garden/Horticulture	Farming/Agriculture
Closer proximity to habitation and use of small plots	Cultivation of large fields and prepping of soil, including removal of stones
Forming and mixing soil by hand	Land modification for intensification of crop yields (irrigation canals, terraces, etc.)
Tending of individual plants	Patterns of fallow and land clearing schedules
Multiple species cultivated in same plot	Less crop variety and focus on staples
Use many non-food plants in manufacturing, health, and ritual contexts	Generalized tools for agricultural tasks

These archaeological correlates are useful in examining the populations of the Upper Río Chiriquí Viejo River Valley throughout time. The model examined in this research argues that agriculturalists were the first populations in the valley so examples of large areas used for fields, large settlements, less crop variety, and, possibly, modifications of the landscape for these purposes should exist from the beginning. The correlates also provide a way to discuss horticulture and the practice of using domesticates as another food source in a suite of available wild resources.

3.5. Social Change in the Greater Chiriquí

Multiple models explain how social inequality developed during the Aguas Buenas Period within the larger archaeological region of the Greater Chiriquí. These models evolve with each new investigation (e.g. Chávez 2007; Künne and Beilke-Voigt 2009; Palumbo 2009; Palumbo et al. 2013).

One model proposes aggrandizers competed over wild resources and sponsored community events, eventually spurring the development of social inequality (Hoopes 1996). Fitting within this model is the ceremonial feasting at Barriles within the Upper Río Chiriquí Viejo Valley. Palumbo (2009) has argued that this feasting is connected to social change. Feasting activities may be performed to indicate and strengthen political ties, be part of a religious ritual, and/or create social debts between the supplier of the event and the participants (Bowser 2000; Bowser and Patton 2004; Bradley 2003; Dietler and Hayden 2001). In small-scale societies, these kinds of events can place pressure on the intensification of food production to prepare for the feast (Spielmann 2002).

Other scholars have argued warfare and/or agriculture caused social change in the region (Linares et al. 1975:141; Linares and Sheets 1980:52). Most societies participate in or have participated in warfare prior to pacification by third party interventions (Ember and Ember 1997). Warfare had (and continues to have) substantial impacts on societies of any size and sociopolitical organization (Allen and Arkush 2006; Keeley 1997; Kelly 2000). Ethnohistoric accounts suggest interpolity violence, or the practice of warfare, was common during the Conquest period in Costa Rica and Panama (Fernández Guardia 1908; Ibarra 2012). The evidence available from Greater Chiriquí archaeological region the Upper Río Chiriquí Viejo Valley includes iconographic depictions of trophy heads and prisoners, ethnohistoric accounts, possible weapons, and palisades (Ibarra 2012).

Ethnographic accounts include descriptions of double fortifications and defensive ditches around the central site of the polity named Cia in the southern Pacific area of Costa Rica (Fernández Guardia 1908:35). Vázquez de Coronado also describes the capture of women and children from neighboring polities for sacrifice as retainers upon their owner's death (Fernández Guardia 1908:35). Warriors from the Coto polity wore a form of cotton armor, used tapier-skin shields and lances or clubs for weapons and women accompanied them during confrontations (Fernández Guardia 1908:34). Outside of the Coto fort was a ritual area where Vázquez de Coronado mentions the depositing of "heads and dead bodies from those captured in war, that they sacrifice [author's translation]" (Fernández Guardia 1908:35).

Archaeological evidence within the Greater Chiriquí includes depictions of warriors and prisoners (Lothrop 1963). Statues or figures that depict individuals holding trophy heads, and sometimes axes, are often referred to as "warriors" (Hoopes 2007:455; Mason 1945). Most of the statues show male genitalia. The act of trophy head taking is often associated with warfare

and sacrificing in ethnohistoric accounts (Fernández Guardia 1908; Redmond 1994). Therefore, the depiction of individuals with trophy heads suggests participation in warfare activities.

Evidence directly associated with the Upper Río Chiriquí Valley is limited to iconographic depictions of trophy heads and the availability of dual-purpose tools as weapons. One prominent artifact to come from the site of Barriles is a stone metate that measures just over two meters long and the stone supports that remain are 30cm tall (Linares et al. 1975:Fig.5B, Fig.5C). The most interesting feature is that the metate is decorated with trophy heads around the rim and each support is holding up a trophy head in their hands. One final example is one of the double statues from Barriles where the upper individual is holding trophy heads (Stone 1972:102).

Possible tools that also served as weapons were the polished stone celts and axes. They range in size and were used for clearing forests (Ranere 1980b; Sheets et al. 1980). Outside of the Greater Chiriquí, in Costa Rica, there are statues depicting trophy heads in one hand and polished stone celts in the other (Hoopes 2007).

Other models for social change use varying combinations of social processes in their explanations of the development of complex societies (e.g. Cooke 2005; Corrales 1986; Drolet 1988; Linares and Sheets 1980; Palumbo 2009; Rago 1988). For example, Drolet (1992) has promoted artisanal craft specialization as both a product and promoter of social inequality in the Diquís, Costa Rica. He argued that elites legitimized and increased their status by using prestige goods from an already established special craft industry at the site of Las Brisas.

I do not find my research at odds with other investigations that have suggested other economic or social factors contributed to increasing inequality (e.g. Hoopes, Palumbo 2009). I recognize that multiple conditions were present for social change to be possible and view this

research as furthering discussions about whether surplus was a prominent contributing factor.

3.5.1. The Agricultural Migrant Model of the Upper Río Chiriquí Viejo Valley

The first model to explain the development of social inequality in the Upper Río Chiriquí Viejo Valley argued the first settlers were maize agriculturalists (Linares 1977a; Linares and Sheets 1980). Access to “seed culture” provided sufficient resources that then supported larger populations associated with complex societies (Linares et al. 1975). Drolet (1988:176) has elaborated by arguing that status was linked to agricultural production, artisan industries, and the construction of monumental sites within the valley. This led to the development of a chiefdom-level society with “an organized army, a hierarchy of specialized villages” and ranked leadership roles (Drolet 1988:176).

To explore the process of developing inequalities, I apply the principle of first occupancy to the valley (McAnany 1995:98-99). It argues that the first settlers to a region choose the best lands to inhabit first. Claims to these lands are then reinforced through ancestor ties. This access to the best resources created wealth and status differences. If the first settlers of the Upper Río Chiriquí Viejo Valley were maize agriculturalists and they followed the principle of first occupancy, then they should settle the best farming lands first. Once those were settled, the next best lands would be claimed. Four facets of this process are testable.

The first testable aspect of this model is that a fully sedentary population moved into a vacant valley. Demographic estimates for each time period of the valley provide clues about the mobility of populations. Sedentism can be postulated by population estimates provided for a time period. The first settlers in an area are identified through their creation of cultural refuse in locations that previously had none. If newcomers, immigrants, are comingling with already

settled populations, noted changes in style or functions of materials from prior periods may occur. Emigration events are discernable by dramatic decreases in population estimates in one area and an increase in population in another location.

A second testable characteristic of this model is that the initial population practiced agriculture. Ethnographic investigations on folk classifications of soils in the tropics demonstrates that basic information about soil fertility and productivity is conveyed through these classifications (Wilshusen and Stone 1990:109). This suggests that they would have knowledge of the best environments and soils to grow their cultivars. I do presume that agriculturalist settlers within the valley will be able to identify these soils while exploring new territories, resulting in a preference to settle on or near the best soils available to maximize harvests and create surpluses for risk buffering.

In addition to selecting the most naturally fertile soils, there are anthropogenic methods that can intensify soil fertility and crop production rates, such as fertilizer, terracing, and/or water control. Yet, if evidence of these methods exists in the Greater Chiriquí, it's linkage to agricultural purposes is tenuous. Examples of terracing are within the Greater Chiriquí, but these terraces were multifunctional and served as areas for habitation structures, locations for domestic and ritual activities, and small-scale cultivation (e.g. Palumbo et al. 2017). There is no evidence for crop irrigation like that observed in the Andes (Fairley 2003; Reyes-Knoche 2012) or Mesoamerica (Beach et al. 2008; Spencer 2000). A few sites contain aqueducts within the Isthmo-Colombian Area (e.g. Guayabo and Rosa María in Costa Rica and Pueblito in Colombia) with the purpose of channeling water to a collection pool where water could be used for human consumption, cooking, and other activities that required potable water (Fonseca 1981; Hernández 2007-2008). The primary purpose of these aqueducts was not to irrigate crops, like has been

identified in other areas of the world (e.g. Reichel-Dolmatoff 1954). Finally, slash and burn techniques may have been attempts to fertilize poorer soils throughout the year (e.g. Piperno 1994). However, this technique is temporary in its effectiveness and fields need to remain fallow for a period for them to be sustainable (Kleinman et al. 1995). Without the use of these anthropogenic modifications, the natural variations in soil fertility would have been one of the most important factors for agricultural settlers when choosing locations to live and cultivate in the Upper Río Chiriquí Viejo Valley.

Once the first agricultural settlers claimed the best lands, those seeking new homesteads would be required to settle on and work poorer soils. The implication is that over time, the best soils should all have inhabitants near them, and an increasing number of settlements should be near poorer quality soils.

A third expectation of the model is that the introduction of maize should coincide with the first settlers into the valley. Maize is identified as one of the cultivars of choice because researchers recovered maize (*Zea mays*) cobs from an excavated oval structure at Pitti-González (Smith 1980). I recognize that the initial introduction of maize into the valley was either through down-the-line trading or via the movement of people because it was not domesticated in the area.

Radiocarbon dates of maize cobs from Pitti-González suggested a time frame of A.D. 200-400, situating the cobs in the later part of the Concepción Phase and the Early Bugaba Phase (Smith 1980:159). Notable is that at Barriles and Pitti-González there was indirect evidence for the possible cultivation of maize with the presence of *manos* and *metates*.

The earliest corn pollen (*Zea maize*) identified from a lake core in Laguna Volcán, approximately 6 km west of the town Volcán, is from A.D. 120-390 (Behling 2000:391). This date verifies the same time frame as the radiocarbon dates from the macrobotanicals at Pitti-

González and suggests that the first corn stalks were present in the valley near the middle to end of the Concepción Phase.

The final testable presumption of the maize agriculturalist model is that the cultivation of maize was important throughout time. This would suggest that there were no sudden diet changes and should result in a consistency in the habits surrounding preparation and consumption of food. Changes in vessel assemblage forms would indicate otherwise.

Chapter 4: Methodology

Field methods for this research were derived from regional survey projects in Mexico (Blanton et al. 1982; Kowalewski et al. 1986), Colombia (Drennan 2006) and Mongolia (Drennan et al. 2003). Both the field and laboratory methods have been used in multiple large survey projects within the Isthmo-Colombian region (e.g., Berrey 2014; Haller 2004; Murillo 2009; Sol 2013) and Palumbo's (2009) survey in the valley. Consistency in methodology was important for data sharing (e.g. Palumbo 2009).

Archaeological surveys, especially surface surveys incorporating tilled fields, are seen by some as the "poor cousin" to excavation techniques, yet the collected data are able to address multiple research topics (Banning 2002:10). Bias of excavation data over that of survey data is exemplified by the removal of plow zone as "overburden" in order to excavate in-situ features and artifacts below (Bringelson 2004). This is a practice that creates a void by dismissing a valid data set.

Plow zone artifacts are useful. Studies on the displacement of artifacts within tilled fields indicate that artifacts usually have not moved horizontally more than 5-10 m from their original locations (Lewarch and O'Brien 1981a; Odell and Cowan 1987:481; Palumbo 2015). Small displacement distances are due to tilling patterns and the fracturing of the artifacts to a point where the tines of the tiller no longer move the object (Bringelson 2004; Odell and Cowan 1987). Furthermore, artifacts in excavation contexts have already been subject to processes affecting surface deposits if these objects were not buried immediately after discard (Dunnell and Dancey 1983; Schiffer 1987). This detail is particularly poignant within the Greater Chiriquí because trash pits were not typically utilized. Most middens are composed of surface deposits

that assembled over time and are archaeologically identified as areas of higher artifact concentrations.

My project primarily utilized surface collections. The principal reason was that most of the settlements that needed to be surveyed were currently cultivated fields and had decent surface visibility (Linares and Ranere 1980; Linares et al. 1975). Furthermore, because surface collections are completed faster than shovel tests, this led to a savings in time and money. Lastly, landowners were less suspicious of workers collecting artifacts from the surface and there was no danger of disturbing crops with shovel tests.

Settlement locations identified via previous projects were mapped onto a satellite image of the Volcán Barú region in ArcGIS. This produced the coordinates used to relocate and survey the area. The satellite images also facilitated maneuvering of the topography and gave an idea of a settlement location's current vegetation coverage prior to surveying.

The number of workers in a field team ranged from two to five and the number of teams varied throughout the project. Each artifact collection was recorded using a handheld Garmin GPS unit with an accuracy of ± 3 m. Although this error may seem large when compared to the error of a more precise device, such as a Trimble, the random nature of the error for each point, when averaged with all points, is unimportant (e.g. Palumbo 2009). GPS points were taken from the center of each collected area.

These collection lots were the basic unit of analysis. They are included in the methodology of "siteless survey" that views survey as an important tool to focus on the collection of artifacts rather than the discovery of sites (Dunnell and Dancey 1983:272). Once collections are made, and if the research requires a grouping of the collection lots into sites, then the investigator applies their requirements for defining site boundaries. Sites may be settlements

or locations that had other human activities occurring. I refer to the sites that were defined by previous researchers of the valley as settlements because the assemblages include artifacts that suggest people lived at those locations.

For my purposes, artifact collections within 100 m of each other were classified as part of the same settlement, while those of a greater distance were considered new settlements. This 100 m rule grouped some settlements together that had been registered as distinct by Linares and her colleagues (1980) (Table 4.1).

Once at a reported settlement location, workers quickly walked over part of the area to determine the best collection method to use. Soil visibility determined whether surface collections were best or if shovel testing was necessary. Both systematic and general surface collection methods were utilized when there was 15% or more surface visibility. For each surface collection the vegetation coverage was noted as heavy (15%-34% visibility), medium (35%-65% visibility), or light (66%-100% visibility). A common concern when relying on surface collections is how vegetation coverage affects artifact collection (Lewarch and O'Brien 1981b). When, in actuality, the more important factor is the contrast of an artifacts' color with the soil and vegetation (Banning et al. 2006).

In the Volcan Barú region, the reddish or orange colored ceramics contrasted greatly with the loamy dark soil. This contrast aided in the recovery of sherds during surface collections. The darker basalt artifacts tended to blend more easily with the soil color but were still distinguishable. Palumbo's (2009:61-62) previous study in the region indicates that even for collection lots with heavy vegetation, the densities of artifacts collected approximated actual surface densities.

Table 4.1. Settlement name consistencies between each project. Settlements that are separated by a comma indicates distinct entities, those separated by a forward slash are grouped into one settlement.

Settlement	Palumbo 2009	Palumbo et al. 2015	Hectares
Barriles 2/24	24	2/24	27.00
3a	2	3a, 58	6.07
3c	2	3c	0.50
4	-	4	4.80
6	-	6	1.26
7	-	46	1.42
8	8	8	1.8
9	-	9	0.61
10	-	10	0.54
11	-	11	8.42
12	12	12	3.01
13/14	-	13/14	0.84
15	18,19	15	4.45
Pitti-Gonzales 17/33/34	17, 33, 34	17, 33, 34	39.53
18	15	18	0.23
20	-	20	0.42
21	-	21	4.72
22	-	22	5.46
23/28	-	60	1.53
25/26	-	25/26	3.00
27	-	48	0.14
31	-	31	3.60
35	-	35	6.67
36	-	36	0.07
37	-	37	0.08
38	-	38	5.42
39	-	39	0.42
40	-	43	3.67
41	-	41	3.82
42/43	43	42	2.64
44	-	44	2.82
45	-	45	1.70
49	-	49	1.38
50	-	50	0.70
51	-	51	2.93
53	-	53	0.79
54	-	54	2.09
55	-	55	4.04
56	-	56	4.92
57		57	0.25
59	-	59	1.62
60	-	40	1.48
Not included	-	52	

Table 4.2. Locations of intensive surveys or excavation units

Settlement	Easting	Northing	Method
BU-3a	314040	973285	Excavation
BU-6	318282	973861	Excavation
BU-11	322149	977649	Excavation
BU-22			Intensive Surface
BU-35			Intensive Surface
BU-59	315953	969306	Excavation
BU-59	316005	969215	Excavation

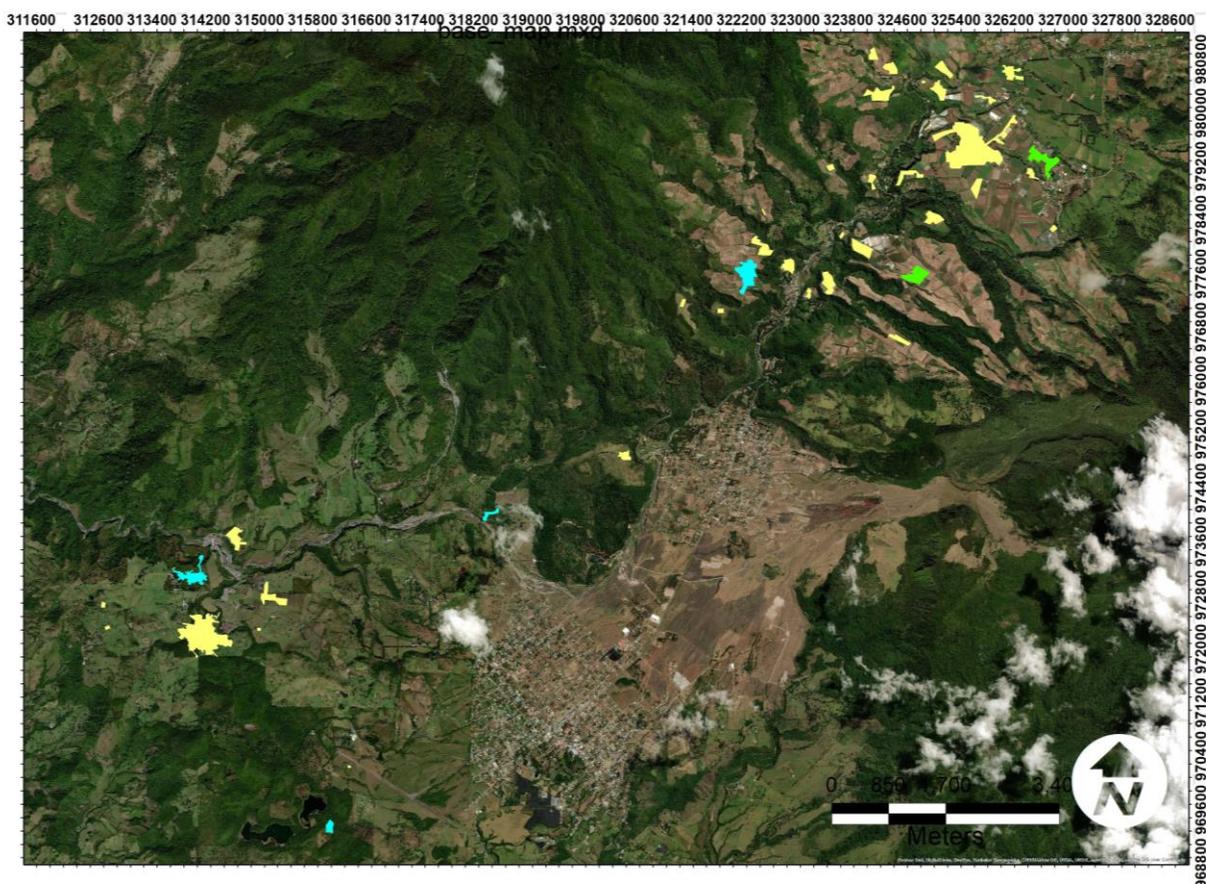


Figure 4.1. Settlements with excavation units (blue) and intensive survey (green).

Seven locations were selected for an intensive survey or excavation due to their proximity to Pitti-González or Barriles, artifact density, and/or occupation time periods (Table 4.2 and Figure 4.1). Two settlements were intensively surface surveyed at 15 m intervals. These

intensive surveys provided refined analyses of artifact densities and assemblages across the landscape. This method was selected because it was quicker than excavation and the settlements had been tilled, creating a situation where excavation would not have produced additional contextual artifact information for much of the unit.

Certain settlements were excluded from my research because owners refused to permit entrance onto their property. These included BU-5 and most of BU-18 (only one collection from road cut). Other settlements were not located such as BU-7, BU-16, BU-17, BU-29, BU-30, and parts of BU-3. Palumbo's (2009) data regarding Barriles, Pitti-González, BU-3, BU-8, BU-12, and BU-19 are used where cited and included as additional information in the summaries of the results chapters. An additional 30 hectares of land to the south of the original Linares and colleagues' (Linares and Ranere 1980; Linares et al. 1975) survey zone was added to see if locations near the town of Volcán and outside of the zone also contained habitation areas.

Table 4.3. Positive and negative collection totals.

	Positives	Negatives
Systematic surface collections	128	20
General surface collections	119	0
Shovel tests	34	22
Total	281	42

Workers collected a total of 281 (87.0%) positive systematic surface collections, general surface collections, and shovel tests out of a total of 323 collection units (Table 4.3). Surface collections made up 87.9% of the positive collections with 45.6% (128) from systematic collections and 42.3% (119) from general. Only 34 (12.1%) positive collections were shovel tests. Soil from both shovel tests and excavation units was sifted through ¼ in. screens.

4.1. Systematic Surface Collections

The utility of systematic surface collections, rather than general surface collections, is in the scale of information gathered. Systematic collections produce detailed information for a smaller area, permitting intra-settlement distinctions rather than discussing data at the settlement-level.

The systematic surface collections were employed when five or more artifacts were identified within a 10 m² area during the precursory walk-over. Workers spaced collections at 25 m intervals, unless topography or time limits required a larger spacing of 50 m intervals. The collection area was defined with two chaining pins connected by a 1.78 m string that created a 10 m² circle. With one pin anchored as a center point, the other chaining pin was pulled taught on the string and dragged along the ground to create a circle. Workers collected all artifacts within the circle, both diagnostic and non-diagnostic, to reach a target sample size of 100 artifacts. Based upon previous work (i.e. Palumbo 2009), this sample size allows us to estimate various artifact percentages at the 95% confidence level and with a confidence interval of $\pm 10\%$ (Drennan 1996:255-259). Therefore, when estimating percentages of sherds from sample sizes this large, I was very confident in the results. If 100 or more artifacts were collected within the first circle, then the team moved onto the next collection location. If the 100-artifact goal was not reached, a second circle, adjacent to the first, was placed and all the artifacts were added to the first circle's collection and the additional area noted. Workers collected artifacts from a maximum of 4 circles (40 m²), where the second, third, and fourth circles were touching the first circle. This method permitted larger, but also localized collections in areas where artifact densities were lower.

Each collection lot contained artifacts collected from one GPS point. Collection lots were

defined using aerial images in ArcGIS and following field boundaries and other topographic features, such as roads and streams. With multiple collection lots in one area, they function like Theissen Polygons (Figure 4.2). The artifact collections within each collection lot represented the data for that area.



Figure 4.2 Site BU-15 positive collection lots.

4.2. General Surface Collections

General surface collections of 1 ha were completed when there was a low density of surface artifacts (areas that did not produce 5 or more artifacts within 10 m²). This field method created a larger sample for statistical analysis and confidence levels than if systematic surface collections were utilized. However, the resolution of the data was at the hectare level. Workers distanced themselves at 25 m apart and walked transects to cover the hectare. To compensate for an inability to collect every artifact within a hectare, a minimum low artifact density value of 0.20 sherds/m² was assigned to collection lots that had artifact densities lower than the minimum. General surface collections of less than 3 artifacts were noted and the artifacts described, but they were not collected to facilitate lab work and storage. This scenario occurred only once.

Collection lots for general surface collections were delineated the same way as systematic

surface collections. In ArcGIS collection lot borders were drawn around the artifact collection using field edges and other topographic features to approximate coverage over 1 ha.

4.3. Shovel Tests

In areas with less than 15% surface visibility, workers placed shovel tests at 25 m intervals. This field method was utilized in two different locations. The first location was the Janson Coffee Farm. The second location was in a section of the Café Olé plantation. Shovel tests had a 50 cm diameter and were dug until sterile soil or a depth of 1m was reached. The volume of a shovel test combines the formulas for the volume of a cylinder and a cone. The cone was always estimated to be 20 cm in height due to the shape of the shovel head and the full depth of the shovel test was retrieved from field notes. Sterile soil was identified as dark red brown clay (Munsell 5YR 2.5/2) and often contrasted drastically with the occupation layers containing loam. Similar to surface collections, collection lots were drawn using the same methodology around shovel tests.

4.4. Stratigraphic Excavations

I conducted a total of five 1x1 m excavations. Each unit was placed in a location with undisturbed strata. These excavations provided a better diachronic look at specific settlements. Two excavation units were near lagoons (Janson Coffee units 1 and 2), two were near the Chiriquí Viejo River (Cafe Olé and Dón Alvin units) and one was on a high plateau in the area of Bambito (Bambito unit) (Figure 4.1). Units were excavated by stratigraphic layer or if the layer was more than 10 cm, excavation proceeded at 10 cm arbitrary levels within the layers.

A secondary reason for the excavations was to gather samples for radiocarbon dating. Unfortunately, no carbon samples were identified for collection and testing.

4.5. Lab and Statistical Analyses

Laboratory work was completed at a rented house in the town of Volcán. Artifact analysis followed previous typologies created for the region (Palumbo 2009; Shelton 1984; Spang et al. 1980). First, artifacts were sorted into material kinds (ceramics and lithics). Ceramics were divided into wares and vessel forms were determined by rim fragments. Jar and restricted bowl rims (Figure 4.3) were categorized restricted vessels and presumed to have been used for cooking and storage. Open bowls and plates were designated open vessels and presumed to have been used for serving activities. These categories are based on general ideas of the correlation between form and function. Furthermore, previous research within the valley identified a correlation between open/slightly restricted rims and the occurrence of decorations, which reinforces the presumption that these forms were used for serving (Palumbo 2009:83-84). To complete the ceramic analyses, ceramic fragments from each provenience were counted and weighed.

Certain artifact types were combined to create meaningful groupings for analyses. For example, Concepción, Cerro Punta, Valbuena, Plain, Biscuit, and any painted ceramic wares were included in counts of “decorated” ceramics if they had an appliqué, were engraved, incised, combed, punctated, or painted. “Fancy” ceramics were limited to Bugaba Engraved and Zoned Bichrome. These two wares were included in the decorated ceramics numbers, but also grouped separately because there was a correlation between higher percentages of Bugaba Engraved sherds in higher status residential areas of Barriles (Palumbo 2009).

Lithics were sorted into artifact types (e.g. tertiary flake, polished flake, hammerstone, celt, metate fragment). Again, to create meaningful categories for analysis, certain artifact types were grouped together. The “stonework production” category counts included primary flakes, cores, performs, and hammerstones. “Stonework repair” counts were determined by the existence of polished flakes, which suggested that a finished product was later retouched.

Once I completed analyses, all artifacts from the same provenience were placed in a labeled bag and deposited at the designated repository, the Museo de José Domingo de Obaldia in David, Panama.

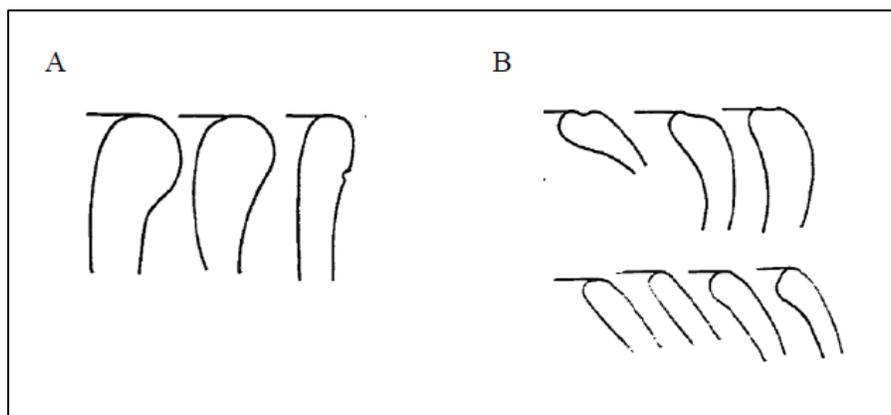


Figure 4.3. Example jar (A) and restricted bowl (B) rims (restricted vessels) (adapted from Corrales 2000:260).

4.6. Soil Fertility Analyses

I obtained a digital map of the different soil classes (IDIAP 2010) and their locations within the Upper Río Chiriquí Viejo Valley. I digitized and georeferenced it in ArcGIS for use as a database layer. This layer was overlaid by a database layer that contained my survey’s updated settlement location boundaries within the valley. These two data layers were used for the catchment analyses and the investigation on the relationship between settlement locations and soil properties.

4.7. Situating Collection Lots in Time

I determined the periods and/or phases of occupation for each collection lot using the presence of specific artifact types and their percentages within a collection (Table 4.6). A collection lot was assigned to the Concepción Phase if it contained Concepción ware sherds. Biscuit ware or Buenos Aires Polychrome ceramics were indicative of the Chiriquí Period. Previous multidimensional scaling and hierarchical cluster analyses from stratigraphic excavations at Barriles demonstrated that percentageal differences between Cerro Punta Orange, Valbuena, and Plain wares can be used to assign a phase/s within the Aguas Buenas Period (Palumbo 2009). Early Bugaba Phase collection lots contained 55% or more of Cerro Punta Orange sherds out of the total Aguas Buenas Period sherds within that collection. Late Bugaba Phase lots had 55% or more of the combination of Valbuena and Plain sherds out of the total number of Aguas Buenas Period sherds within a lot. If a collection lot did not contain a minimum of 55% Cerro Punta sherds or 55% Valbuena and Plain sherds, then the lot was determined to belong to both Early and Late Bugaba phases. Four collection lots contained only lithics and were assigned to all four time periods to provide a conservative estimate of when settlements were occupied.

Not included in my analyses is site BU-52 because it was represented by one collection lot of two artifacts, providing insufficient data to infer anything other than there were occupants at that location. Another collection lot not incorporated into project results was a shovel test near BU-59 that produced two lithics. This collection was considered an isolated find and not a new site for the report to patrimony in Panama.

Table 4.4. Conditions for designating periods or phases to collection lots using ceramics.

Time Period or Phase	Dates	Conditions
Chiriquí Period	A.D. 900 – 1550	Presence of polychrome or Biscuit Wares
Early and Late Bugaba Phases	A.D. 300 – 900	Presence of Cerro Punta Orange, Valbuena, and Plain Wares that do not meet requirements for designating either Early or Late
Late Bugaba Phase	A.D. 600 – 900	55% or more of Valbuena and Plain Wares
Early Bugaba Phase	A.D. 300 – 600	55% or more of Cerro Punta Orange Ware Sherds
Concepción Phase	300 B.C. – A.D. 400	Presence of Concepción Ware sherds

Chapter 5: Demographic Estimates

Any kind of absolute population estimates should be given with the caveat that, regardless of the method used, assumptions are a required part of the estimate. Population estimates from Panama and Costa Rica have incorporated multiple techniques. Ethnohistorical documents combined with archaeological data identified the densities of large sites, which were then used to estimate populations in smaller settlements for the Río Parita Valley of Panama (Haller 2004). In Costa Rica, a combination of ethnohistoric data, estimated roofed areas over archaeological structural foundations, and area-density index values produced population estimates (Murillo 2009; Sol 2013). Finally, within the Upper Río Chiriquí Viejo Valley, the most recent absolute population estimates were calculated using the area-density index for small homestead populations, and once extrapolated, provided estimates for larger settlements (Palumbo 2009). I followed this final same method for my relative and absolute populations within the valley to maintain consistency in data analyses within the valley.

5.1. Demographic Reconstruction Method

Reconstruction of populations in the study region utilized sherd density data rather than the area of artifact scatter. This method is derived from regional studies in Mexico (Sanders et al. 1979), Colombia (Drennan 2006), and other areas of Panama (Berrey 2014; Haller 2004). It also follows the most recent research in the region (i.e. Palumbo 2009). This type of demographic reconstruction assumes that more people equals more trash. Population estimates conducted by Linares and colleagues (Linares and Sheets 1980; Linares et al. 1975) only considered the area of

occupation. For example, BU-3 was estimated to be approximately ~50 ha and one of the larger settlements in the region. Yet, when revisited twice, once by Palumbo (2009) and also for this research, artifact densities were extremely low indicating a much smaller relative population than the nearby settlement of Barriles (~27 ha).

Previous research within the study area indicated a positive correlation between surface collection and shovel test assemblages with reference to artifact densities (Palumbo 2009, 2015). Surface collections in the Volcán Barú region provided similar demographic estimates and were not underrepresenting earlier time periods. A regression formula created from data collected in 2009 (Palumbo 2015) converts sherd densities from shovel tests to surface collections and vice versa: *Surface sherd density = 0.914 + 0.015(# of sherds in a shovel test/shovel test volume m³)*.

For example, if there are 41 sherds in a 0.16m³ shovel test, the corresponding surface sherd density is 4.76 sherds/m². The number of sherds divided by the volume is 256 (41 sherds/0.16 volume of the shovel test). Then, multiplying 256 by 0.015 and adding 0.914 equals 4.76 sherds/m², which is the expected sherd density if it were a surface collection.

All shovel tests were converted to surface collection sherd densities because there were more surface collections than shovel tests. Each collection represented a collection lot. The average area of a collection lot was 0.27 ha (median of 0.15 ha) and the average standard deviation was 0.32 ha. This large standard deviation is due to the inclusion of general surface collections of 1 ha.

Sherd density was calculated for each collection lot. Sherd density is required to calculate an area-density index value. Shovel test sherd densities were calculated using the regression formula described above to make them compatible with the surface collections. Surface

collection sherd densities were calculated using the total number of sherds collected, including the unidentified sherds, and dividing by the collection lot surface area.

I assigned time periods to each collection lot by following the method described in Chapter 4 (Table 4.4). Sherd percentages for each time period were calculated using the identified and typed sherds in each collection lot. Unidentified sherds were divided and assigned to time periods according to the percentages of each time period's identified sherds and included in the totals for each respective period. The percentage of sherds assigned to each time period was multiplied by the total sherd density to get the sherd density for that time period. It was this sherd density for each time period that was used to calculate the area-density index values for the periods of each collection lot.

Many collection lots contained more than one time period. For these lots, the percentages of the Concepción Phase and Chiriquí Period were calculated first. Then the remaining portion was assigned to either the Early or Late Bugaba Phase or to both, when necessary. Below is an example of a collection lot from Pitti-González that was assigned to the Concepción Phase, Early Bugaba Phase, and Late Bugaba Phase (Table 5.1). Since neither category of Aguas Buenas Period sherds was over 55%, the collection lot was assigned to both the Early and Late Bugaba phases.

Table 5.1. Dividing a collection lot according to time periods. The percentages of Cerro Punta Orange, Valbuena and Plain ware sherds are out of the total number of Aguas Buenas Period sherds for that collection.

Total Identified Sherds	No. Concepción Sherds	% Cerro Punta Orange	% Valbuena & Plain Ware	No. Chiriquí Period Sherds	Concepción Phase Ratio	Early Bugaba Phase Ratio	Late Bugaba Phase Ratio	Chiriquí Period Ratio
97	3	44.33%	51.55%	0	$3/97 = 0.03$	$(1-0.03)/2 = 0.48$	$(1-0.03)/2 = 0.48$	0

The area-density index value takes into consideration sherd density, collection area, and the number of centuries of occupation (Drennan et al. 2015:34-37). The sherd density for each time period was divided by the number of centuries within that time period and then multiplied by the area (in hectares) of the collection lot. One unit of the area-density index value is equal to 1 sherd/m² throughout a hectare. This value can serve as a reference for relative population information. For example, comparing area-density index values, we can say one population was twice the size of the other. Additional considerations are required to use it for absolute population estimates.

Table 5.2. Median population estimates for the area-density index values of the Upper Río Chiriquí Viejo Valley.

Area-density Index	Median Pop. Estimates
0-0.2	5
0.2-0.4	10
0.4-0.6	15
0.6-0.8	20
0.8-1.0	25
1.0-1.2	30
1.2-1.4	35
1.4-1.6	40
1.6-1.8	45
1.8-2.0	50

Estimating absolute populations requires an idea of the number of people on a landscape that will produce 1 sherd/m² throughout a hectare over 100 years. This estimate is often based on ethnographic and ethnohistoric references. Linares and colleagues (Linares and Sheets 1980:53), in their population estimates, calculated that there were 5 individuals per homestead. I used this number to estimate 5 people were responsible for low area-density index values (Table 5.2). The most settlements on the landscape were during the Early Bugaba Phase, where the median area-density index value was 0.20 (Table 5.4). I presume that these settlements were homesteads

composed of one or two households and determined that 5 people were represented by the 0.20 value. I called settlements with a median of 5-15 people homesteads, 20-100 people hamlets, and 100+ individuals as villages (Table 5.3).

I choose to differ from Palumbo's (2009) previous methods when calculating the Concepción Phase and Chiriquí Period populations. He created a "correction" by arguing certain wares distinct to those time periods were underrepresenting the actual period when compared to data from sites outside the survey zone. Regardless of whether a correction was necessary, the impact on the final calculations would not have been significant and our estimates for those time periods were similar.

Table 5.3. Settlement categories for each time period.

Concepción Phase	Early Bugaba Phase			Late Bugaba Phase		Chiriquí Period
Homestead	Homestead	Hamlet	Village	Homestead	Village	Homestead
Pitti-González (BU-33/34)	BU-3a	BU-4	Pitti-González (BU-33/34)	BU-3a	Pitti-González (BU-33/34)	Pitti-González (BU-33/34)
Barriles (BU-2)	BU-3c	BU-11	Barriles (BU-2)	BU-3c	Barriles (BU-2)	Barriles (BU-2)
BU-4	BU-6	BU-13/14		BU-6		BU-3a
BU-11	BU-9	BU-22		BU-10		BU-4
BU-21	BU-15	BU-55		BU-11		BU-11
BU-22	BU-18			BU-18		BU-35
BU-25/26	BU-20			BU-20		BU-41
BU-35	BU-21			BU-22		BU-42/43
BU-40	BU-25/26			BU-25/26		BU-56
BU-46	BU-27			BU-35		BU-59
BU-51	BU-31			BU-38		
BU-55	BU-35			BU-41		
BU-56	BU-36			BU-42/43		
BU-60	BU-37			BU-44		
	BU-38			BU-45		
	BU-39			BU-49		
	BU-40			BU-50		
	BU-41			BU-54		
	BU-42/43			BU-55		
	BU-44			BU-56		
	BU-45			BU-59		
	BU-46					
	BU-48					
	BU-49					
	BU-50					
	BU-51					
	BU-52					
	BU-53					
	BU-54					
	BU-56					
	BU-57					
	BU-59					
	BU-60					

5.2. Demographic Estimate Results

The area-density index value for each settlement is the sum of the index values of each collection lot within that settlement's boundary (Table 5.4). The values presented for Pitti-

González are only representative of part of the village (BU-33 and BU-34). This part had been considered small separate settlements in previous investigations (Linares et al. 1975; Linares and Ranere 1980). I calculated them to be within the 100 m boundary of Pitti-González and part of it. When discussing the estimated populations of Pitti-González, I have added the estimates provided by Palumbo (2009) to my estimates for BU-33 and BU-34. The site of BU-18 is also described with combined data. I have relied on the estimated populations of Barriles and BU-2 described by Palumbo (2009) for each phase.

5.2.1. Relative Population Results

The valley was occupied by homesteads, hamlets, and villages in prehistory. The median of all 82 area-density index values was very low (0.04) and the average was 0.19 (Table 5.4). This may suggest that many of these small homesteads were temporary or seasonal and vacant at times.

The Concepción Phase's total area-density index values indicate very few occupants lived in the valley and they lived in small homesteads. All the values were well below the 0.20 index value set for estimating 5 people on the landscape (Table 5.4). The median area-density index value of all the settlements for the phase (0.001) is on par with the average area-density index values (0.004), and both indicate that these sites were occupied by one or two households. Since these values are extremely low, there may have been a seasonal occupation of these locals.

Table 5.4. Area-density index values for each settlement during each period, including the two settlements now considered Pitti-González.

Settlement	Concepción Phase	Early Bugaba Phase	Late Bugaba Phase	Chiriquí Period
Pitti-González (BU-33/34)	0.002	2.809	0.101	0.001
BU-3a		0.023	0.128	0.032
BU-3c		0.017	0.017	
BU-4	0.005	0.921		0.009
BU-6		0.115	0.296	
BU-9		0.041		
BU-10			0.036	
BU-11	0.025	1.005	0.365	0.006
BU-13/14		1.215		
BU-15		0.476		
BU-18			0.012	
BU-20		0.212	0.125	
BU-21	0.007	0.310		
BU-22	0.001	0.701	0.095	
BU-25/26	0.000	0.171	0.003	
BU-27		0.121		
BU-31		0.237		
BU-35	0.000	0.209	0.198	0.002
BU-36		0.005		
BU-37		0.006		
BU-38		0.264	0.040	
BU-39		0.003		
BU-40	0.001	0.339		
BU-41		0.271	0.036	0.000
BU-42/43		0.084	0.001	0.000
BU-44		0.270	0.007	
BU-45		0.054	0.062	
BU-46	0.002	0.302		
BU-48		0.009		
BU-49		0.050	0.050	
BU-50		0.003	0.003	
BU-51	0.000	0.195		
BU-52		0.003		
BU-53		0.053		
BU-54		0.118	0.021	
BU-55	0.002	1.505	0.212	
BU-56	0.000	0.339	0.253	0.010
BU-57		0.017		
BU-59		0.416	0.254987	0.011548
BU-60	0.001	0.428		
Total	0.048	13.313	2.312	0.071
Median	0.001	0.202	0.056	0.006
Average	0.004	0.350	0.105	0.008

The Early Bugaba Phase differed from the Concepción Phase. The total area-density index value for the period was over 228 times larger than that of the Concepción Phase, not including Barriles and Pitti-González. Values increased at the homesteads previously occupied in the Concepción Phase and newly occupied settlements also appeared. Although the area-density index seems like it exponentially increased, the average settlement value was 0.350, little higher than the median value of 0.202 (the basis for calculating absolute populations). When these numbers are put into perspective, the average area-density index for a settlement in the Early Bugaba Phase is only 0.35 sherds/m² per hectare per 100 years, a fairly low number.

Area-density index values in the Late Bugaba Phase decreased within homesteads occupied in the Early Bugaba Phase and some were altogether abandoned. There are a few exceptions, such as at BU-3a, BU-6, and BU-45, where there is a slight increase in the values. The total area-density index value decreased for the period, but this value does not include the villages of Barriles and Pitti-González. At those villages there is an increase in population (Palumbo 2009).

Index values continued to decrease in the Chiriquí Period and more settlements were abandoned. The total value for the valley is larger than that of the Concepción Phase, which is still a very small value at 0.071. Three of the nine occupied settlements were inhabited from the Early Bugaba Phase and on, while the other 6 settlements have values from the Concepción Phase to the Chiriquí Period.

The area-density index values provide relative information regarding population increases and decreases through time. They are significant because it is a statistical value. However, sometimes an absolute population number is necessary.

5.2.2. *Absolute Population Results*

Absolute population estimates provide the same information as the area-density index values, but they make the data more accessible to those outside the archaeology field. I calculated the absolute population for a settlement using the summed total of its area-density index values. The total population estimates for a period are the summed total of each settlement's population estimate, rather than taking the summed total of the area-density index value and converting that into a population estimate. This worked well when out of the 82 area-density index values reported, 58 were under the 0.20 value that had been assigned a value of 5 people (Table 5.5). If I had used the total area-density index value for the valley for each time frame, there would be only 5 people in the valley during the Concepción Phase and the Chiriquí Period. This did not make sense when there were multiple locations occupied for those periods of time.

All sites during the Concepción Phase were estimated to have a median population of 5 people. These were isolated households or homesteads throughout the valley. Since these are median populations, we can provide a population range of $\pm 33\%$ to get a maximum and minimum population for each period. The settlements I investigated produced a maximum of 86 people for the Concepción Phase (Figure 5.1). Estimates for Pitti-González during this phase were 20-40 people, while Barriles was approximately double with 40-80 individuals (2009:127-128). This provides a maximum estimate for the Upper Río Chiriquí Viejo Valley of approximately 200 people. This small number supports a settlement pattern of homesteads spread throughout the valley. The only distinguishing characteristic of Pitti-González and Barriles was that those settlements probably had a few related families living in the same local.

Table 5.5. Table of estimated absolute populations. (*Totals provided are the sum of the estimates given for each settlement.)

Settlement	Concepción Phase	Early Bugaba Phase	Late Bugaba Phase	Chiriquí Period
Pitti-González (BU-33/34)	5	75	5	5
BU-3a		5	5	5
BU-3c		5	5	
BU-4	5	25		5
BU-6		5	10	
BU-9		5		
BU-10			5	
BU-11	5	30	10	5
BU-13/14		35		
BU-15		15		
BU-18			5	
BU-20		10	5	
BU-21	5	10		
BU-22	5	20	5	
BU-25/26	5	5	5	
BU-27		5		
BU-31		10		
BU-35	5	10	5	5
BU-36		5		
BU-37		5		
BU-38		10	5	
BU-39		5		
BU-40	5	10		
BU-41		10	5	5
BU-42/43		5	5	5
BU-44		10	5	
BU-45		5	5	
BU-46	5	10		
BU-48		5		
BU-49		5	5	
BU-50		5	5	
BU-51	5	5		
BU-52		5		
BU-53		5		
BU-54		5	5	
BU-55	5	40	10	
BU-56	5	10	10	5
BU-57		5		
BU-59		15	10	5
BU-60	5	15		
Total*	65	465	135	45
Total ± 33%	44-86	312-618	90-180	30-60

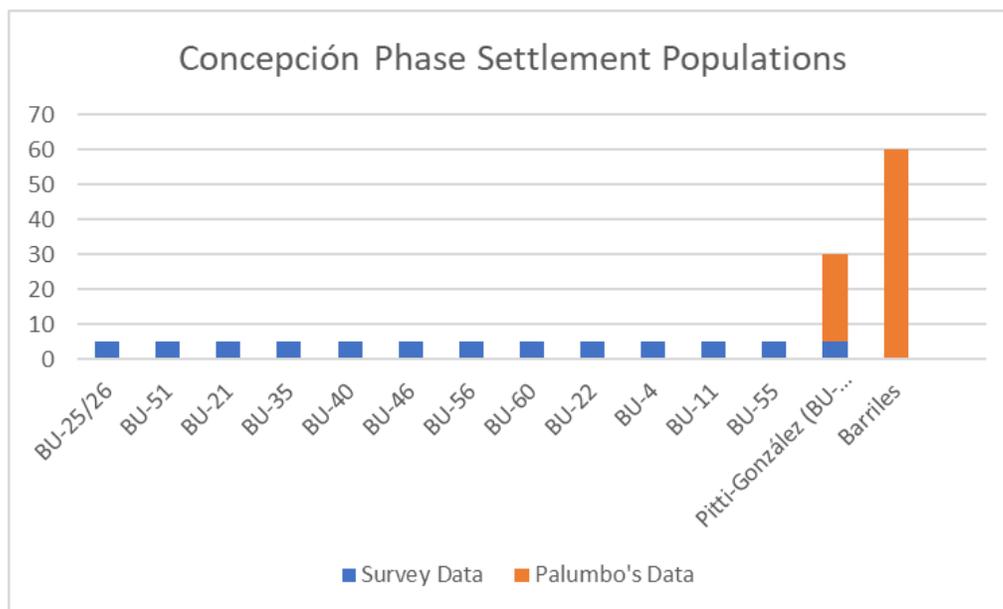


Figure 5.1. Concepción Phase settlement populations (using Palumbo's (2009) data for Barriles and Pitti-González).

The population spread across the valley during the Early Bugaba Phase. The median estimate range places approximately 450 individuals on the landscape. Unlike the Concepción Phase, there are large differences in the size of settlements. The villages of Barriles and Pitti-González both grew in population to 250-500 people each (Palumbo 2009:132). If we add the two settlements that I now consider to be Pitti-González to the previous estimates, Pitti-González may have been slightly larger than Barriles. The ephemeral settlements to Barriles and Pitti-González also differ in their sizes. Most continue to be small. For example, there were 32 homesteads (5-15 individuals) and 5 hamlets (20-100 individuals) (Figure 5.2). These numbers suggest that the largest valley-wide population for the Early Bugaba Phase would be approximately 1600 people.

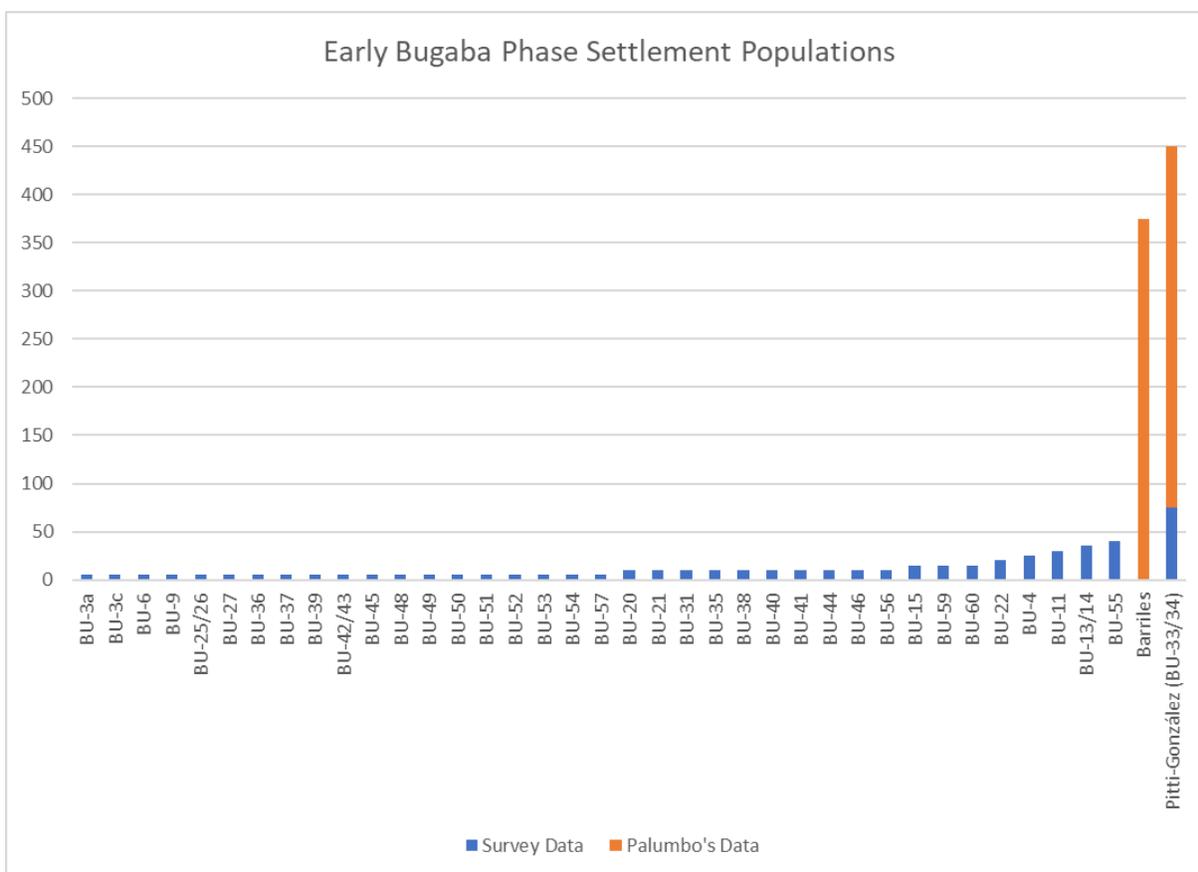


Figure 5.2 Early Bugaba Phase settlement populations (using Palumbo's (2009) data for Barriles and Pitti-González).

Populations in the Late Bugaba Phase homesteads declined, while Barriles and Pitti-González grew (Figure 5.3). All 21 occupied settlements have 10 or less individuals. This is a change from the Early Bugaba Phase where there were also hamlets on the landscape. In nine settlements that had continued occupation from the Early Bugaba Phase, the population decreased. The remaining 11 homesteads either had the same population numbers, or in the rare case of BU-6, the population slightly increased by a household or two. These small homesteads within the valley housed a maximum of 180 ($135 \pm 33\%$) individuals. Investigations at the villages of Barriles and Pitti-González suggest that the population of Barriles continued to grow and reached levels of 500-1000 while Pitti-González increased slightly (Palumbo:138). These

numbers indicate that the maximum population of the valley was similar (1880) to that of the Early Bugaba Phase, the only difference was where individuals were living.

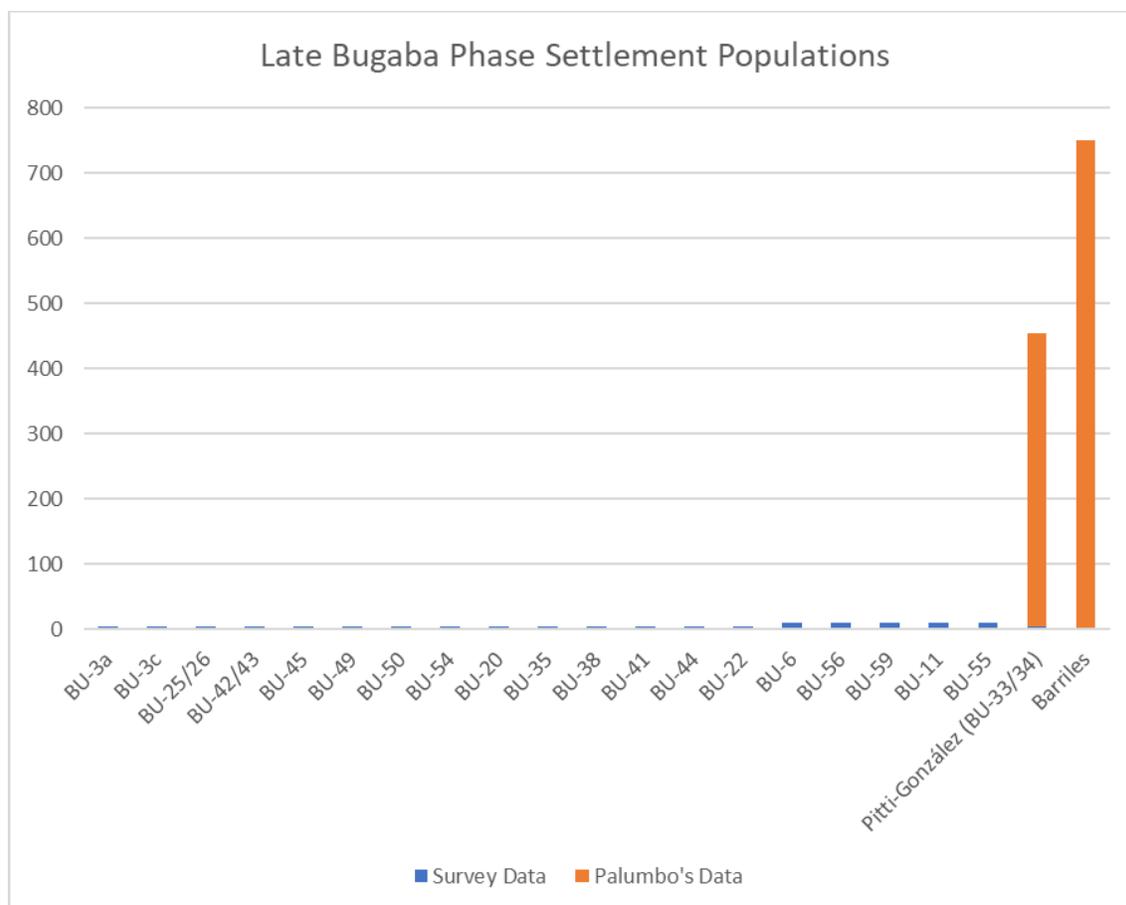


Figure 5.3. Late Bugaba Phase settlement populations (using Palumbo's (2009) data for Barriles and Pitti-González).

The most recent period, the Chiriquí Period, was characterized by a large decrease in the population of the valley. There are fewer small homesteads (9) than there had been during the Concepción Phase (13) and all of them contained an estimated 5 individuals (Figure 5.4). This is a case where the total area-density index value of the valley was higher than that of the Concepción Phase, but because I estimated the total population using individual site populations, the estimated valley population is less than the Concepción Phase, at a maximum of 60 ($45 \pm$

33%) people. The decline in population was also noted at Barriles and Pitti-González where their population estimates ranged from 30-60 and 10-20 individuals respectively (Palumbo 2009:142).

This puts the entire valley at a maximum population of 140 individuals.

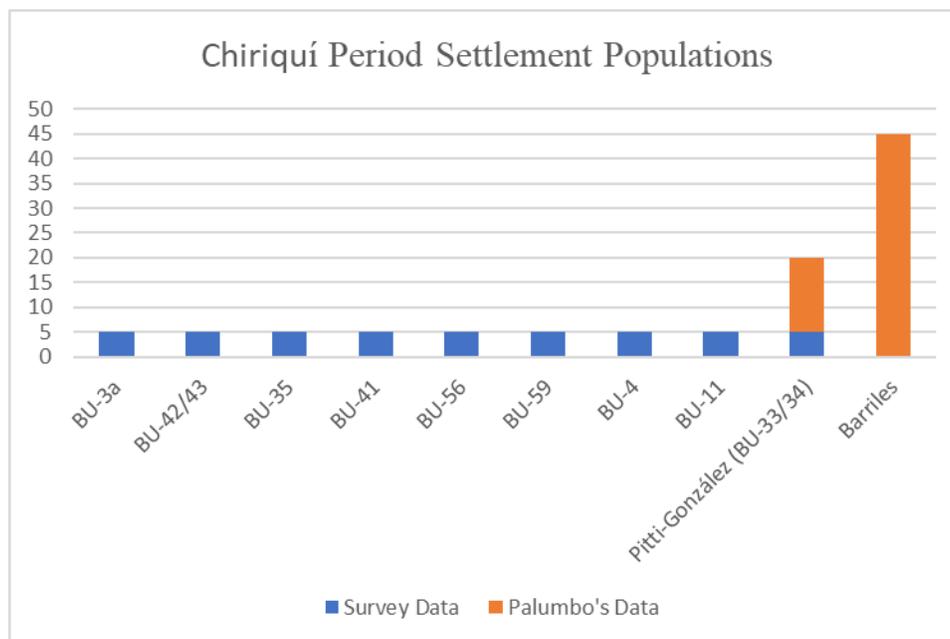


Figure 5.4. Chiriquí Period settlement populations (using Palumbo's (2009) data for Barriles and Pitti-González).

5.3. Discussion of Demographic Results

When Linares and her colleagues (Linares and Ranere 1980) put forth their explanation for the social change occurring in the Upper Río Chiriquí Viejo Valley, they argued that agricultural settlers brought with them a new way of life. These demographic results suggest that the initial populations in the valley were small households that may have occupied these locations seasonally. Movement of new populations into the valley are a possibility during the Early Bugaba Phase; however, internal population growth rates can also account for the increase.

Population growth rates are complex. Historically, the numbers provided for population growth of hunter and gatherers, most of humankind's history, is calculated at 0.01% and those after the rise of agriculture at 0.1% (Hassan 1975). Specifically, early Neolithic farmers in Europe are argued to have had an average rate of 0.1-0.2% (Bocquet-Appel 2008; Collard et al. 2010). Yet, these estimates are based on averages over multiple generations and consider environmental restrictions are in place. Reality is often messier than a simple calculation and technologies may be developed that lessen restrictions (Boserup 1979). Ranges that use fertility and mortality rates of hunter-gatherer populations span 0.4% to 2.7% (Hassan 1975:42). Others have calculated up to 3% growth rates for hunters and gathers and argue that periods of rapid growth and decline are characteristic of humans (Pennington 2001:198). Considering the variable nature of population growth rates for hunters-gatherers, populations can expand quickly if the appropriate resources are available (e.g. Jabran Zahid et al. 2016).

The population of the Upper Río Chiriquí Viejo Valley underwent periods of rapid growth and decline. During the Concepción Phase, homesteads were scattered throughout the valley, with a couple locations, Barriles and Pitti-González, composed of larger family groups. More small homesteads appeared during the Early Bugaba Phase and some grew larger into hamlets. Over half of the population was in the villages of Barriles and Pitti-González.

The difference in population between the Early Bugaba and Concepción phases provides a population growth rate of 0.42% over 500 years. This rate is within that calculated for hunter-gatherer populations (Hassan 1975:42). To calculate the annual growth rate, I used the linear growth rate formula: $PGR = \frac{P(t) - P(t_0)}{P(t_0) * (t - t_0)}$ (Savageau 1980:270). $P(t_0)$ is the initial population and the final population is indicated by $P(t)$. The amount of time that passes is t . The Concepción Phase lasted 700 years and the Early Bugaba Phase 300 years. The calculation of

500 years was the entirety of the Early Bugaba Phase plus 200 years of the tail end of the longer Concepción Phase.

It is possible that such an increase is the result of immigrant populations moving into the valley, but there is no archaeological evidence to suggest new groups arrived. Ceramic wares do not abruptly change (Corrales 2000; Palumbo 2009) and new tools are added to an established lithic kit (Ranere 1980b; Sheets et al.1980).

The population growth rate did not continue as it had for the Concepción and Early Bugaba phases into the Late Bugaba Phase. Growth appears to have been limited to the villages of Barriles and Pitti-González while homesteads disappeared from the landscape. Most probable is that these homesteaders moved to the villages of Barriles and Pitti-González and valley-wide population growth was minimal. This slowed growth suggests that there were inhibiting factors. At this moment the specific reason or reasons for the preference to live in larger settlements rather than dispersed homesteads is unknown.

After 600 years of a maximum population of 1880 individuals in the valley, there was a large decrease in population. The Upper Río Chiriquí Viejo Valley contained less than 150 individuals during the Chiriquí Period, fewer than the estimated maximum of the Concepción Phase. There are two scenarios for why the population decreased. The first is that an external factor caused a larger mortality rate than fertility rate. Examples include disease, environmental degradation, and warfare. The second scenario is that there was an emigration of the population to a new location. Unfortunately, skeletal remains from the valley do not exist for analyses of biological agents, stress, or interpersonal conflicts and the Chiriquí Period pre-dates the introduction of any Old World diseases that could have decimated populations. Currently, the valley still produces a large portion of agricultural products for Panama, suggesting that the soils

and environment may not have degraded sufficiently to cause famines. This leaves the alternative that there was an emigration of the population out of the valley.

Chapter 6: Settlement Locations and Soil Properties

Ethnographic evidence suggests that experienced farming populations should recognize and seek to place new farmsteads on or near the best lands for cultivation (Wilshusen and Stone 1990:109). Once the most productive soils have been claimed, new farmsteads will be required to settle on less than perfect soils. This settlement pattern should be evident in the archaeological record if maize agriculturalists were the first to settle in the Upper Río Chiriquí Viejo Valley. As is most often the case, the settlement pattern of the valley is more complex, but does not seem to follow this pattern.

I conducted two analyses on the collection lot data to identify occupation locations in relation to soil classes. The first analysis used all collection lots and the second analysis utilized collection lots with a total of 30 or more artifacts to provide statistically valid results. Four collection lots only contained lithics. These lots were assigned to all four periods or phases because there were no distinguishing characteristics of the lithics to be more selective. It is important to reiterate that Barriles and Pitti-González were not included in these analyses unless specified. The exceptions were the settlements of BU-33 and BU-34 that were previously considered distinct settlements and have now been included in Pitti-González.

Table 6.1. Area of each land class within the survey zone.

Arable Land		Non-Arable Land	
Class	Hectares	Class	Hectares
Class II	455	Class VI	1,510
Class III	595	Class VII	3,580
Class IV	235	Class VIII	875
Total:	1,285	Total:	5,965

Most of the area within the survey zone was considered non-arable land (Table 6.1). No settlements were located on Class IV soils. The amount of non-arable land is not surprising considering this was a river valley, and over millennia the river had etched out its path to create an uneven landscape that alternated between rock cliffs and river terraces. Quite a bit of the Intermediate and the entirety of the Los Llanos econiches that had been described by Linares and her colleagues (1975; Linares and Ranere 1980) fell within Class VII soils. This may be an explanation as to why there was little evidence of occupation if the inhabitants were cultivating the land.

Approximately one fifth of the valley was arable land. This still provided over 1,000 hectares capable of producing agricultural products. Class II soils were in the southwest portion of the survey area and Class III soils in the northeastern. Interestingly, when locals were asked whether soils near the current town of Volcán, in the southern part of the valley, or Cerro Punta, to the northeast, were more fertile, they responded with Cerro Punta. Furthermore, it is from the Cerro Punta area that most horticultural products are grown for Panama (Hobeika and Wagner 2018). This anecdote contradicts the observation that slightly more arable lands are closer to Volcán. It may suggest that some areas near the southwest are under-utilized for agriculture, or that Cerro Punta is more fertile than the class assigned it by the Land-Capability Classification system.

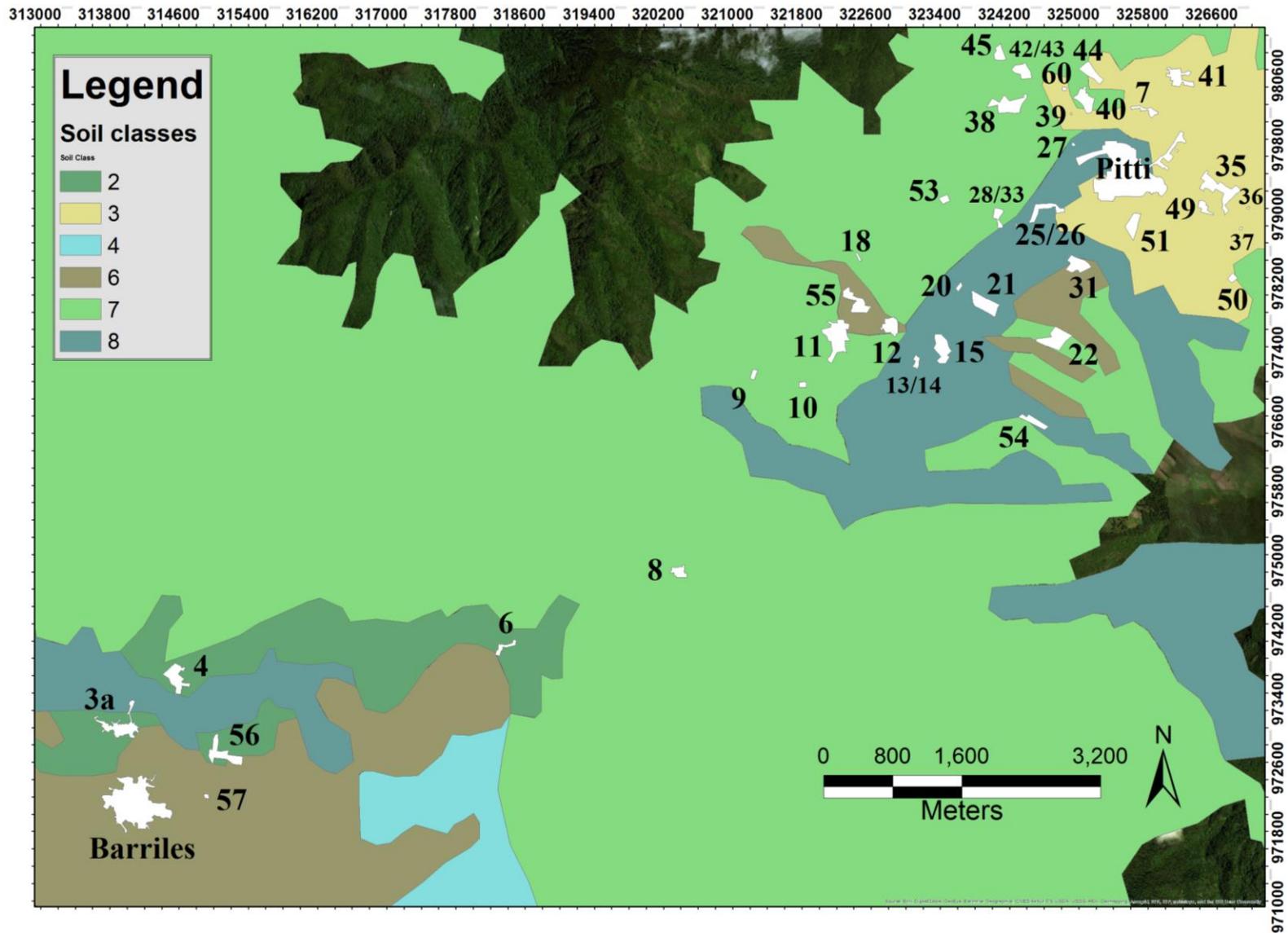


Figure 6.1. Location of settlements and land classes within the Upper Río Chiriquí Viejo Valley. Each settlement is represented by its number. One example, BU-3a is indicated by 3a.

6.1. Concepción Phase (300 B.C. – A.D. 400)

There were no single component collection lots for the Concepción Phase. A total of 33 collection lots (11.9%) contained at least one Concepción sherd or only contained lithics (4 collections). Collections with Concepción sherds occurred in 14 different settlements on soils classed II, III, VI, VII, and VIII (Table 6.2) (Figures 6.2 and 6.3). Using the 1970's survey divisions based on ecological features, settlements occurred in Cerro Punta, Bambito, and the Southwest. Palumbo (2009) identified occupation in the Intermediate area at BU-8. Barriles, in the Southwest, and Pitti-González in Cerro Punta (Palumbo 2009).

Table 6.2. Settlements that contain Concepción Phase ceramics (not including Barriles, Pitti-González, BU-8, BU-12 and BU-19).

Settlement	Soil Class	Collection Lot Area (Ha)	Total Area (Ha) by Soil Class
BU-04	II	0.735	
BU-56	II	0.846	Class II
			1.582
BU-35	III	0.010	
BU-41	III	0.102	
BU-46	III	0.400	
BU-51	III	0.606	Class III
			1.117
BU-01	VI	0.382	
BU-55	VI	0.239	Class VI
			0.622
BU-11	VII	1.289	
BU-22	VII	0.211	
BU-28/23	VII	0.264	
BU-40	VII	1.096	Class VII
			2.860
BU-21	VIII	2.996	
BU-25/26	VIII	0.584	Class VIII
			3.579

Most occupied territory was on Class VIII and Class VII soils, those considered non-arable. These settlements covered a much larger area (7.06 ha) than those that were on fertile soil (2.70 ha) (Table 6.3). A total of six settlements occupied arable land. Settlements on arable land were more uniform in size with a standard deviation from the median at 0.50 ha, whereas those on non-arable land varied from the median by 0.95 ha. The largest settlement was BU-21 in the Bambito area at almost 3 ha on Class VIII soil. The smallest settlement was BU-35 on Class III soil.

Table 6.3. Area (ha) of collection lots with Concepción Phase ceramics, grouped by land class.

Arable Land		Non-Arable Land	
Class II	1.582	Class VI	0.622
Class III	1.117	Class VII	2.860
		Class VIII	3.579
Total	2.699	Total	7.061
Median Settlement Size	0.503	Median Settlement Size	0.483
Standard Deviation	0.341	Standard Deviation	0.946

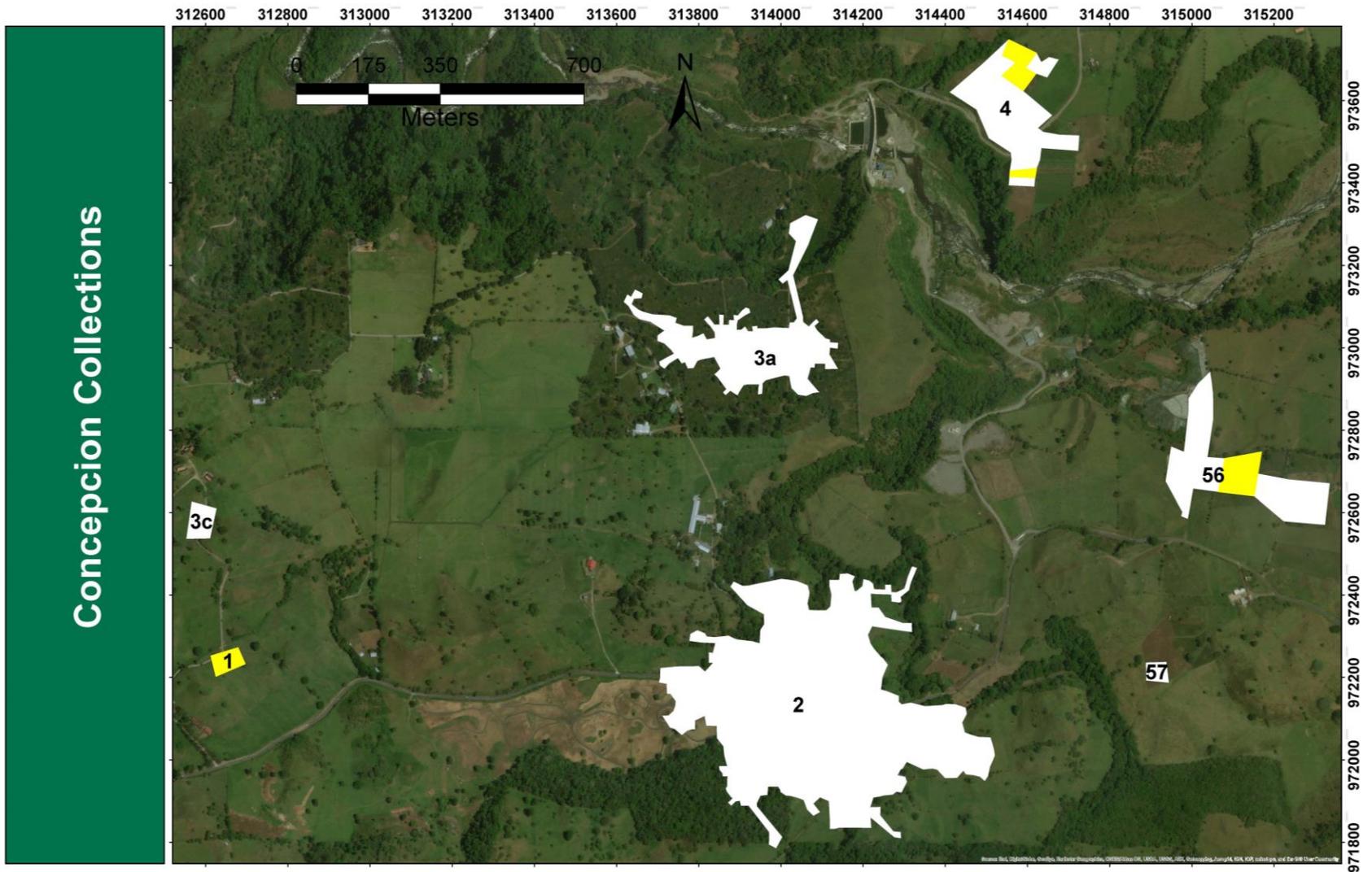


Figure 6.2. Collection lots (yellow) with a Concepción Phase component near Barriles (BU-24, number 2 on map).

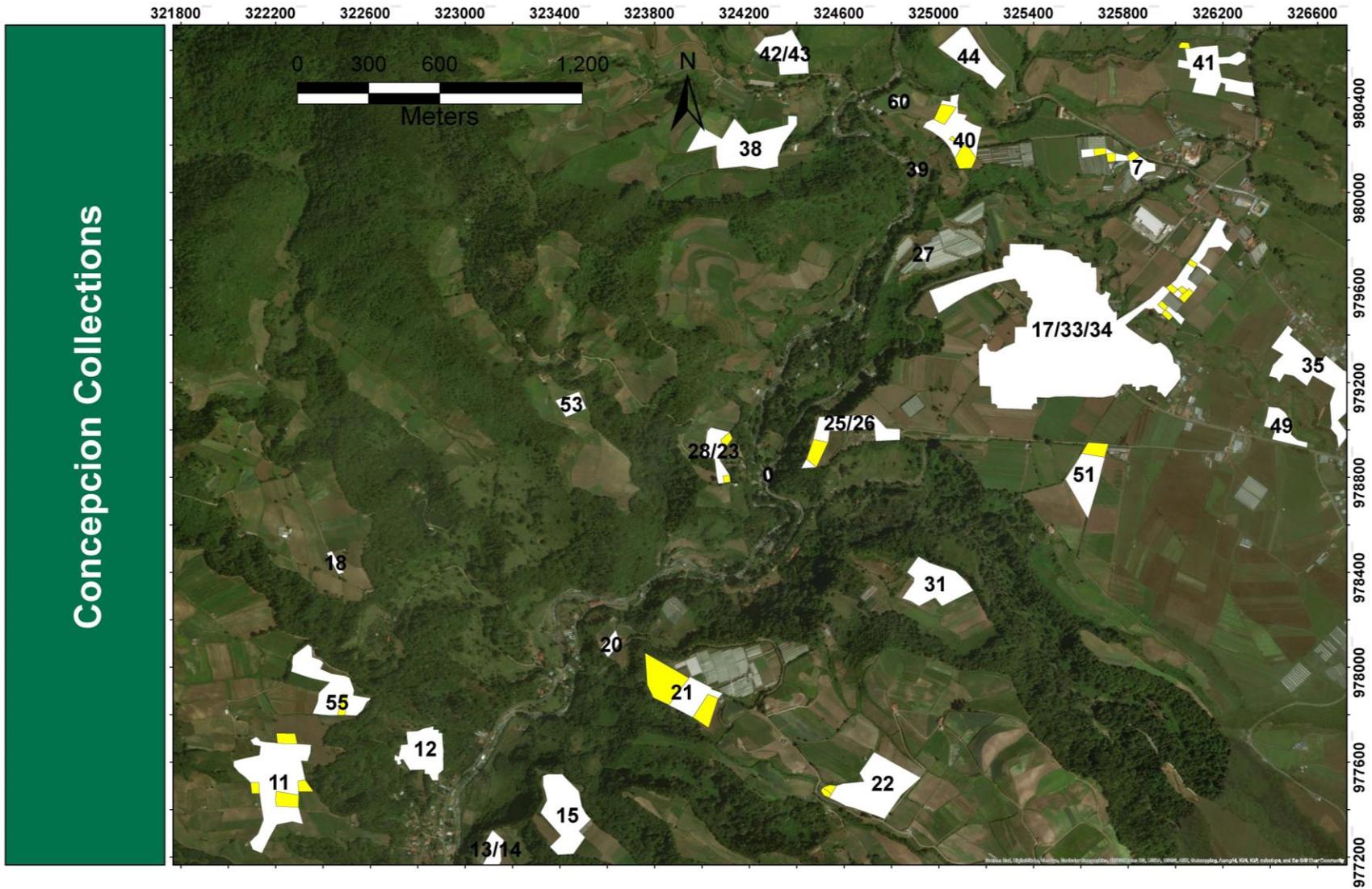


Figure 6.3. Collection lots (yellow) with a Concepción Phase component in the Cerro Punta and Bambito areas (BU17/33/34 is Pitti-González).

6.1.1. Collection Lots of 30 or More Artifacts

Analysis of collection lots with 30 or more artifacts drops the number of inhabited sites during the Concepción Phase to 11, split between arable (5 settlements) and non-arable (6 settlements) land (Table 6.4). Settlements were in Cerro Punta, Bambito, and the Southwest. The largest site was BU-56 in the Southwest area at 0.85 ha on Class II soils. The smallest settlement was the same as when all collections were considered, BU-35. The median settlement size for both arable and non-arable lands were similar and within 0.09 ha of each other, while the standard deviations were a difference of 0.16 ha. This indicates less variation in settlement size. Total area covered for arable and non-arable lands was also very close at 2.22 ha and 2.35 respectively (Table 6.5).

Table 6.4. Settlements that contain Concepción Phase ceramics within collections of 30 or more total artifacts (not including Barriles, Pitti-González, BU-8, BU-12 and BU-19).

Settlement	Soil Class	Collection Lot Area (Ha)	Total Area (Ha) by Soil Class
BU-04	II	0.735	
BU-56	II	0.846	Class II
			1.582
BU-35	III	0.010	
BU-46	III	0.133	
BU-51	III	0.500	Class III
			0.642
BU-55	VI	0.239	Class VI
			0.239
BU-11	VII	0.551	
BU-22	VII	0.116	
BU-40	VII	0.600	
BU-28/23	VII	0.264	Class VII
			1.532
BU-25/26	VIII	0.584	Class VIII
			0.584

Table 6.5. Area (ha) of collection lots with Concepción Phase ceramics and 30 or more artifacts, grouped by land class.

Arable Land		Non-Arable Land	
Class II	1.582	Class VI	0.239
Class III	0.642	Class VII	1.532
		Class VIII	0.584
Total	2.224	Total	2.355
Median Settlement Size	0.500	Median Settlement Size	0.408
Standard Deviation	0.366	Standard Deviation	0.210

6.2. Early Bugaba Phase (A.D. 300-600)

More collections were assigned to the Early Bugaba Phase than for any other phase or period. In total there were 244 collections, and, of those, 157 were single component Early Bugaba Phase collections. This phase also contained the most hectares occupied and the largest number of settlements. All soil classes were occupied, except soil Class IV, which was never occupied in any time period. Settlement locations occurred in Cerro Punta, Bambito, Intermediate, and the Southwest regions.

There were 14 settlements (37%) identified on arable land and 24 (63%) on non-arable classes (Table 6.6) (Figures 6.4 to 6.6). Settlement sizes were significantly larger than those occupied in the Concepción Phase. The largest settlement, outside of Barriles and Pitti-González, was BU-22 at 5.07 ha on Class VII soil. During the Early Bugaba Phase, settlements located on non-arable land were slightly larger than those on arable land. However, variation in the sizes of settlements was similar between those on arable and non-arable soils, with standard deviations of 1.49 ha and 1.46 ha respectively.

Table 6.6. Settlements that contain Early Bugaba Phase ceramics (not including Barriles, Pitti-González, BU-8, BU-12 and BU-19).

Settlement	Soil Class	Collection Lot Area (Ha)	Total Area (Ha) by Soil Class
BU-03a	II	0.295	
BU-04	II	4.417	
BU-06	II	0.870	
BU-56	II	2.730	Class II
			8.312
BU-35	III	3.429	
BU-36	III	0.071	
BU-37	III	0.083	
BU-39	III	0.042	
BU-41	III	3.005	
BU-44	III	1.927	
BU-46	III	0.881	
BU-49	III	1.504	
BU-50	III	0.012	
BU-51	III	2.930	Class III
			13.883
BU-01	VI	0.382	
BU-03c	VI	0.500	
BU-31	VI	2.964	
BU-55	VI	3.149	
BU-57	VI	0.250	
BU-59	VI	0.757	Class VI
			8.002
BU-09	VII	0.612	
BU-11	VII	3.559	
BU-22	VII	5.066	
BU-28/23	VII	1.267	
BU-38	VII	3.825	
BU-40	VII	2.663	
BU-42/43	VII	1.259	
BU-45	VII	1.609	
BU-53	VII	0.793	Class VII
			20.652
BU-13/14	VIII	0.840	
BU-15	VIII	1.858	
BU-20	VIII	0.418	
BU-21	VIII	4.644	
BU-25/26	VIII	2.249	
BU-27	VIII	1.820	
BU-48	VIII	0.138	
BU-52	VIII	0.043	
BU-54	VIII	1.772	Class VIII
			13.783

Total area occupied on non-arable land was almost twice as much as that on more fertile soils (Table 6.7). Class VII land was the largest land class with settlements on more than 20 ha and Class VI the smallest, with a little over 8 ha in coverage.

Table 6.7. Area (ha) of collection lots with Early Bugaba Phase ceramics, grouped by land class.

Arable Land		Non-Arable Land	
Class II	8.312	Class VI	8.002
Class III	13.883	Class VII	20.652
		Class VIII	13.783
Total	22.195	Total	42.437
Median Settlement Size	1.1923	Median Settlement Size	1.438
Standard Deviation	1.487	Standard Deviation	1.459

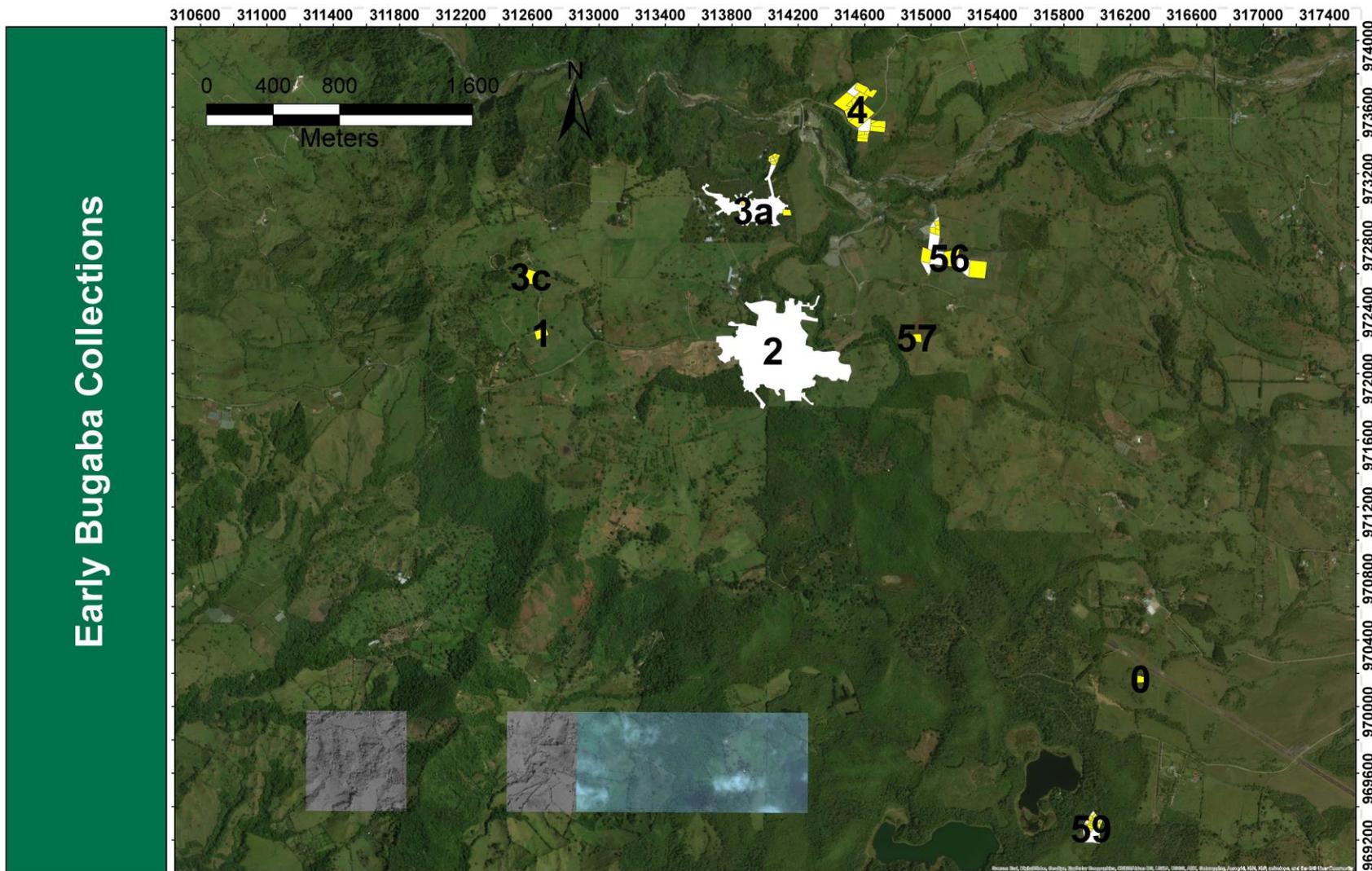


Figure 6.4. Collection lots (yellow) with an Early Bugaba Phase component near Barriles (BU-24, number 2 on map) and in the Southwest region.

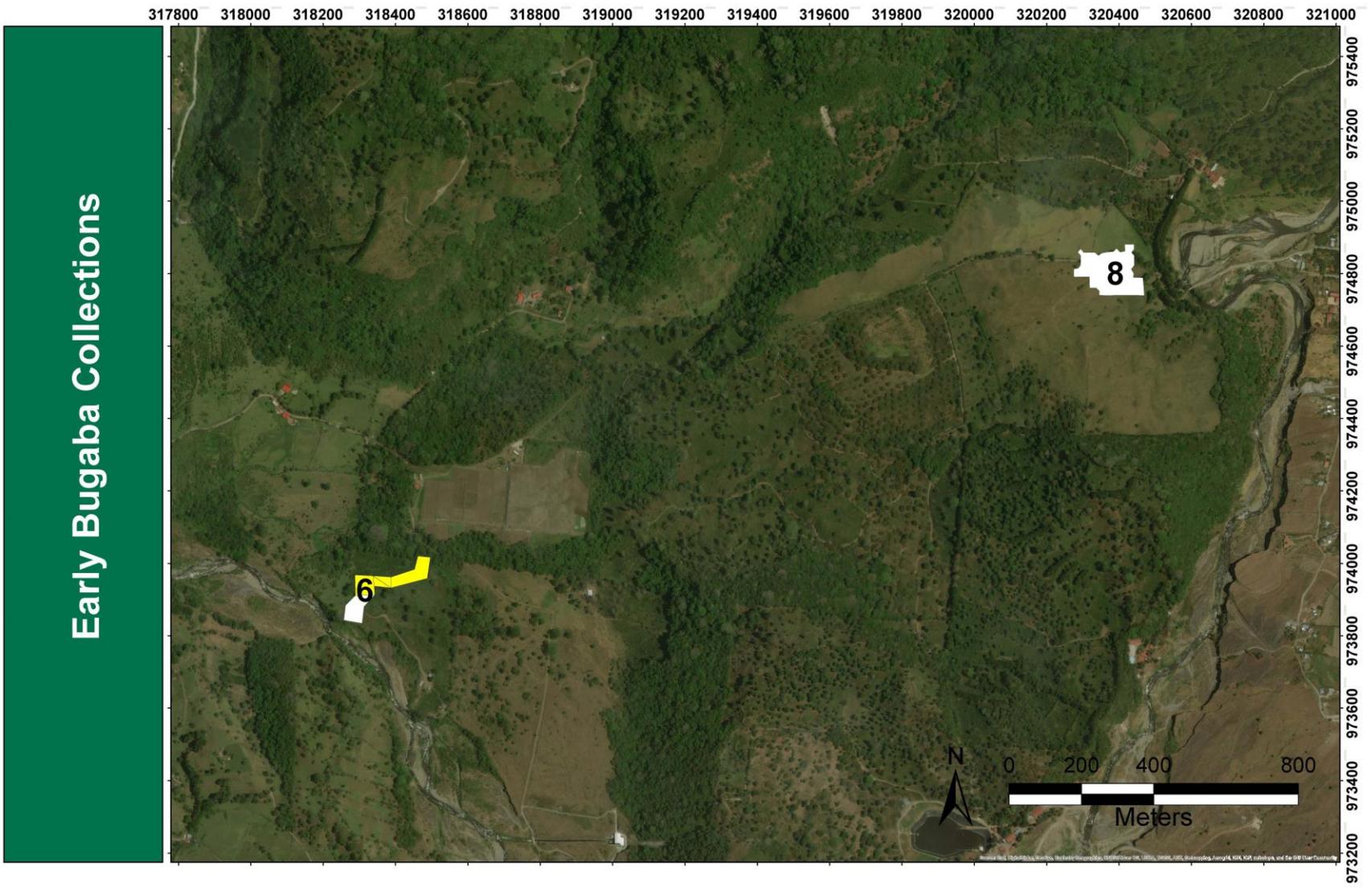


Figure 6.5. Collection lots (yellow) with an Early Bugaba Phase component in the Intermediate region.

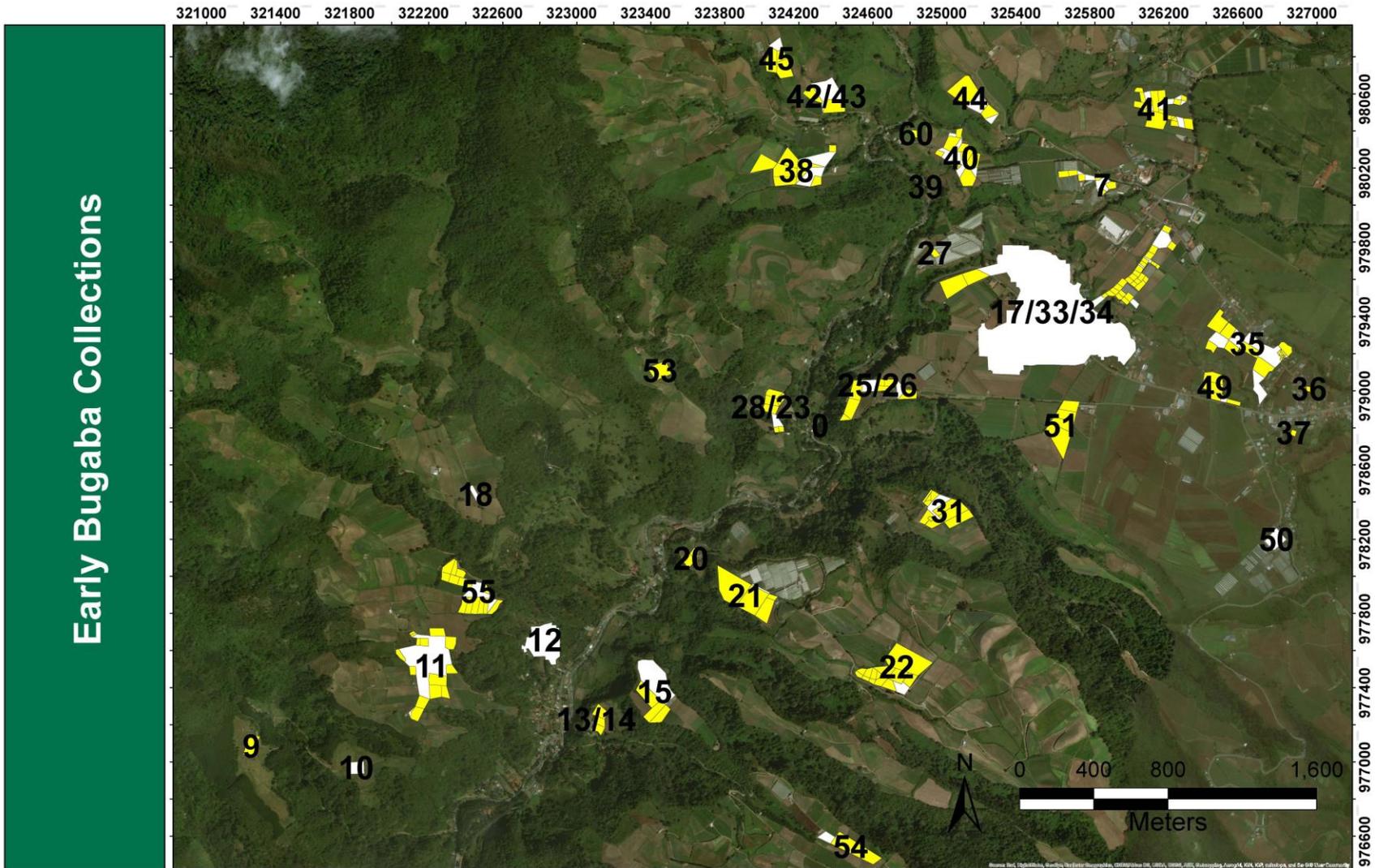


Figure 6.6. Collection lots (yellow) with an Early Bugaba Phase component in the Cerro Punta (BU-17/33/34) and Bambito regions.

6.2.1. Collection Lots of 30 or More Artifacts

The number of occupied settlements decreased to 21 when only collections of 30 or more artifacts were considered (Table 6.8). Settlements were in the Cerro Punta, Bambito, Intermediate, and Southwest zones of the survey. Nine settlements were located on arable land and the other 12 on non-arable soils. Of the total hectares occupied, over 60% of the occupied territory was on non-arable soils (Table 6.9). The largest number of hectares occupied within a class was Class III with 6.09 ha. That was closely followed by Class VIII at 6.07 ha.

Table 6.8. Settlements that contain Early Bugaba Phase ceramics within collections of 30 or more total artifacts (not including Barriles, Pitti-González, BU-8, BU-12 and BU-19).

Settlement	Soil Class	Collection Lot Area (Ha)	Total Area (Ha) by Soil Class
BU-03a	II	0.137	
BU-04	II	1.053	
BU-06	II	0.064	
BU-56	II	1.210	Class II
			2.464
BU-35	III	1.209	
BU-41	III	1.417	
BU-44	III	1.927	
BU-46	III	0.493	
BU-51	III	1.044	Class III
			6.090
BU-31	VI	0.142	
BU-55	VI	1.577	
BU-59	VI	0.181	Class VI
			1.899
BU-11	VII	1.666	
BU-22	VII	3.288	
BU-40	VII	0.697	Class VII
			5.650
BU-13/14	VIII	0.840	
BU-15	VIII	1.304	
BU-20	VIII	0.418	
BU-21	VIII	1.529	
BU-25/26	VIII	1.183	
BU-27	VIII	0.795	Class VIII
			6.068

The largest site continued to be BU-22 at 3.29 ha. Median settlement size was around 1 ha for arable and non-arable land classes (Table 6.9). Settlement sizes varied slightly more on non-arable land with a standard deviation of 0.86 ha compared to 0.61 ha on arable land classes.

Table 6.9. Area (ha) of collection lots with Early Bugaba Phase ceramics and 30 or more artifacts, grouped by land class.

Arable Land		Non-Arable Land	
Class II	2.464	Class VI	1.899
Class III	6.090	Class VII	5.650
		Class VIII	6.068
Total	8.554	Total	13.617
Median Settlement Size	1.053	Median Settlement Size	1.011
Standard Deviation	0.610	Standard Deviation	0.858

6.3. Late Bugaba Phase (A.D. 600-900)

There were fewer collections assigned to Late Bugaba Phase than to Early Bugaba Phase. A total of 88 collections were designated Late Bugaba Phase and 28 of those were single component Late Bugaba Phase collections. Settlements during the Late Bugaba Phase continued to be on all soil classes and found in Cerro Punta, Bambito, the Intermediate, and the Southwest regions. Most settlements were on non-arable land (65%), but the total hectares of occupied arable and non-arable land classes differed by only 0.67 ha (Table 6.10) (Figures 6.7 to 6.9). The total area occupied was less than during the Early Bugaba Phase. There was a vacating of previously inhabited land because 157 single component Early Bugaba Phase collection areas no longer contained inhabitants. Furthermore, occupation of arable land decreased from the previous period by 59% and for non-arable land by 77%.

Table 6.10. Settlements that contain Late Bugaba Phase ceramics (not including Barriles, Pitti-González, BU-8, BU-12 and BU-19).

Settlement	Soil Class	Collection Lot Area (Ha)	Total Area (Ha) by Soil Class
BU-03a	II	0.511	
BU-06	II	0.677	
BU-56	II	1.217	Class II
			2.404
BU-35	III	3.954	
BU-41	III	1.051	
BU-44	III	0.162	
BU-49	III	1.504	
BU-50	III	0.012	Class III
			6.683
BU-01	VI	0.382	
BU-03c	VI	0.500	
BU-55	VI	0.606	
BU-59	VI	0.685	Class VI
			2.173
BU-10	VII	0.544	
BU-11	VII	1.209	
BU-18	VII	0.234	
BU-22	VII	1.780	
BU-38	VII	0.708	
BU-40	VII	0.461	
BU-42/43	VII	0.197	
BU-45	VII	1.728	
BU-54	VII	0.322	Class VII
			7.183
BU-20	VIII	0.270	
BU-25/26	VIII	0.137	Class VIII
			0.408

The total inhabited arable and non-arable areas were similar (Table 6.11). Settlements on arable land were larger and varied more in size than those on non-arable land. The largest settlement was BU-35 at 3.95 ha on Class III land. This settlement was more than one-third of the total occupied arable land.

Table 6.11. Area (ha) of collection lots with Late Bugaba Phase ceramics, grouped by land class.

Arable Land		Non-Arable Land	
Class II	2.404	Class VI	2.173
Class III	6.683	Class VII	7.183
		Class VIII	0.408
Total	9.087	Total	9.764
Median Settlement Size	0.864	Median Settlement Size	0.500
Standard Deviation	1.248	Standard Deviation	0.520

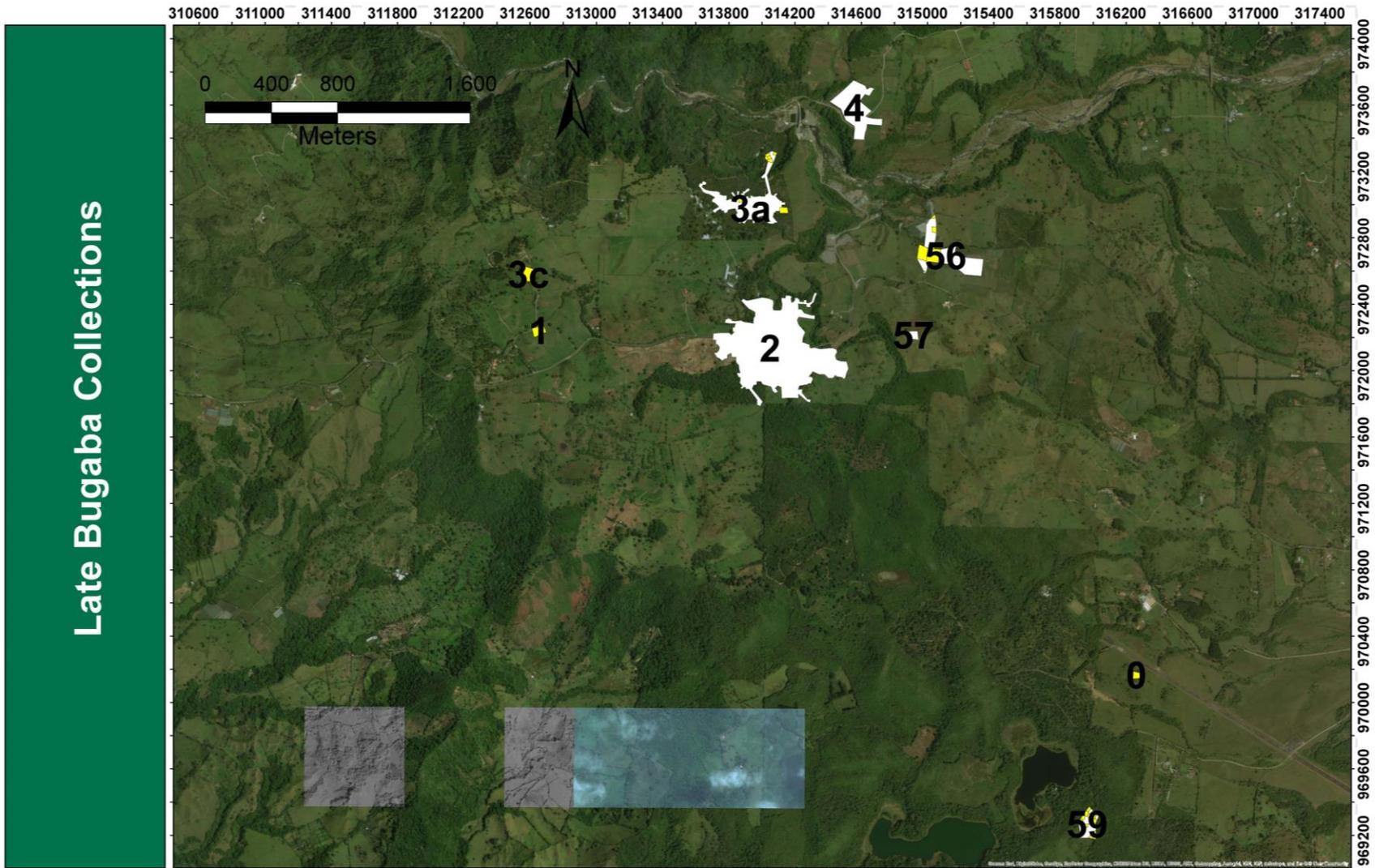


Figure 6.7. Collection lots (yellow) with a Late Bugaba Phase component near Barriles (BU-24, number 2 on map) and in the Southwest region.

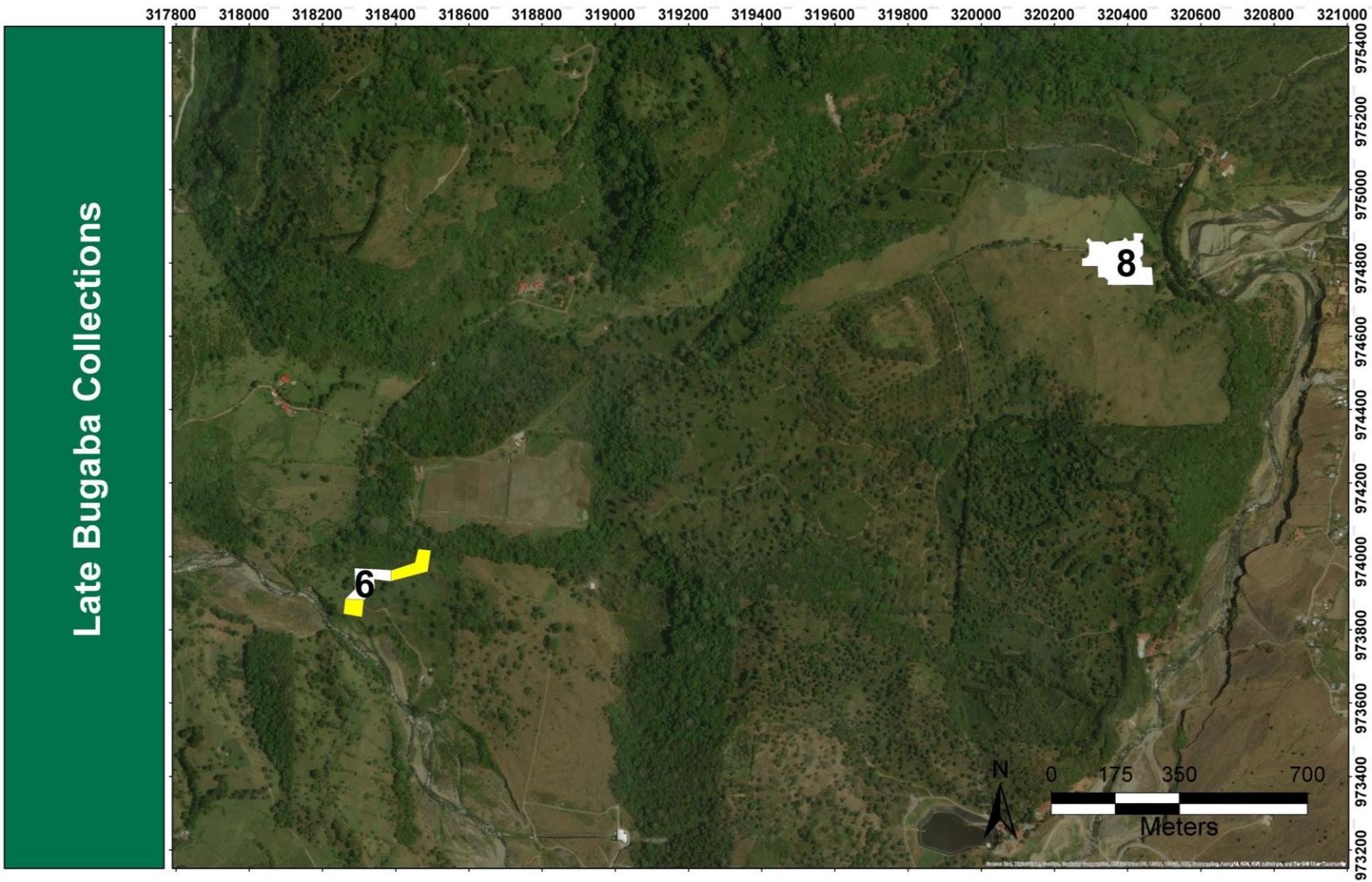


Figure 6.8. Collection lots (yellow) with a Late Bugaba Phase component in the Intermediate region.

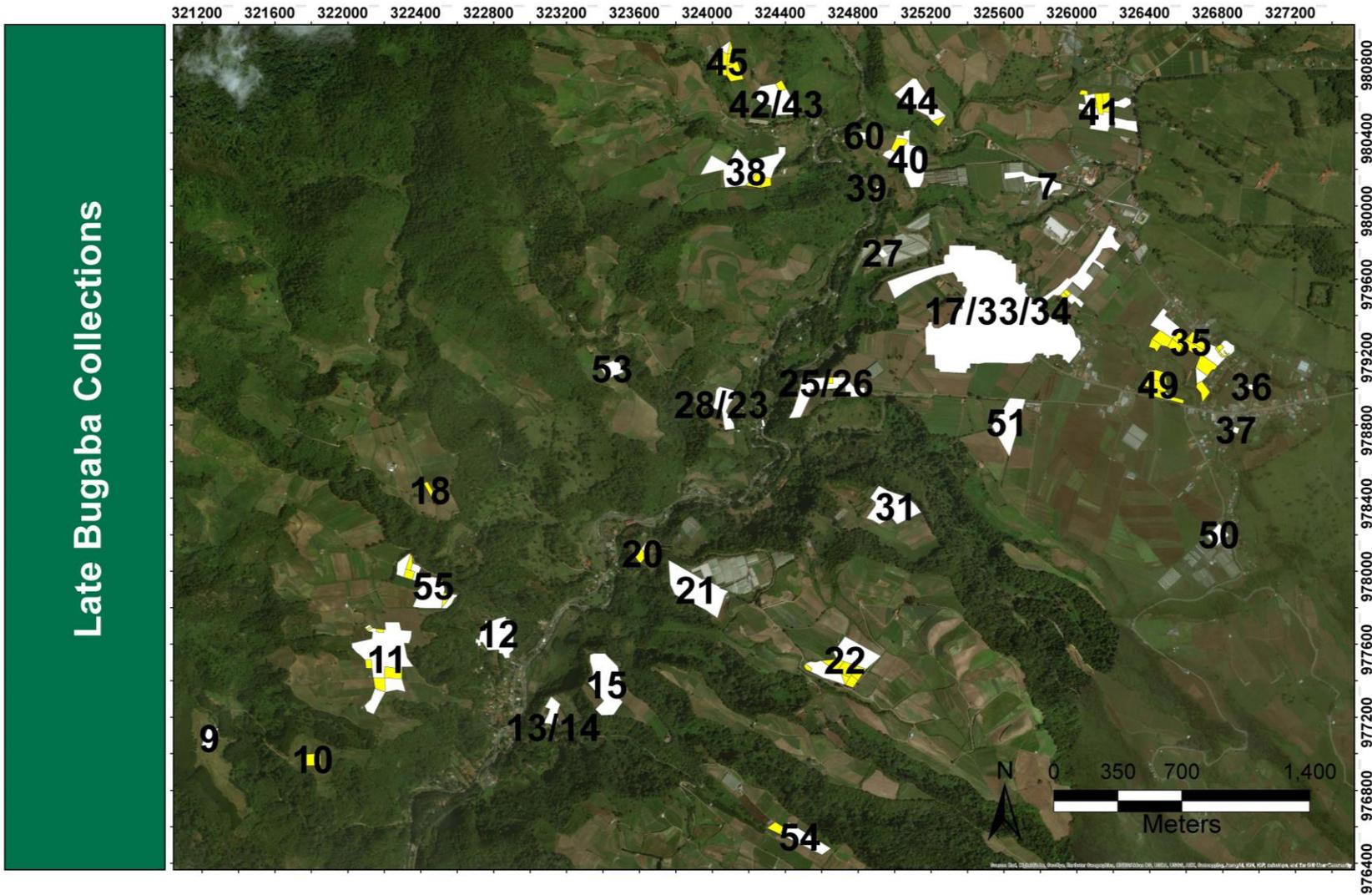


Figure 6.9. Collection lots (yellow) with a Late Bugaba Phase component in the Cerro Punta (BU-17/33/34) and Bambito regions.

6.3.1. Collection Lots of 30 or More Artifacts

A solid preference for arable land was identified when only collections with more than 30 artifacts were analyzed. Four settlements were on Class II and III soils, while five were on non-arable classes (Table 6.12). Settlements were in Cerro Punta, Bambito, and the Southwest regions. The total area of occupied arable land was over double that of non-arable soils.

Settlements on arable land tended to be larger than those on less fertile soil and varied more in size, a trend also identified in the analysis of all collections (Table 6.13). The largest settlement was BU-35 at 1.75 hectares in Cerro Punta and the smallest was BU-59 in the Southwest.

Table 6.12. Settlements that contain Late Bugaba Phase ceramics within collections of 30 or more total artifacts (not including Barriles, Pitti-González, BU-8, BU-12 and BU-19).

Settlement	Soil Class	Collection Lot Area (Ha)	Total Area (Ha) by Soil Class
BU-03a	II	0.178	
BU-56	II	0.685	Class II
			0.863
BU-35	III	1.747	
BU-41	III	0.410	Class III
			2.156
BU-55	VI	0.193	
BU-59	VI	0.100	Class VI
			0.292
BU-11	VII	0.588	
BU-42/43	VII	0.197	Class VII
			0.785
BU-20	VIII	0.270	Class VIII
			0.270

Table 6.13. Area (ha) of collection lots with Late Bugaba Phase ceramics and 30 or more artifacts, grouped by land class.

Arable Land		Non-Arable Land	
Class II	0.863	Class VI	0.292
Class III	2.156	Class VII	0.785
		Class VIII	0.270
Total	3.019	Total	1.347
Median Settlement Size	0.547	Median Settlement Size	0.197
Standard Deviation	0.693	Standard Deviation	0.188

6.4. Chiriquí Period (A.D. 900-1500)

The Chiriquí Period did not have any single component collections assigned to it and it incorporated 30 collections. There was a decrease in the occupation of arable land by 56% and non-arable by 94% from the Late Bugaba Phase. Inhabitants were on soil classes II, III, VI, and VII. No sites were occupied in the Intermediate area and only one site, BU-11, was in Bambito (Figures 6.10 and 6.11).

Table 6.14. Settlements that contain Chiriquí Period ceramics (not including Barriles, Pitti-González, BU-8, BU-12 and BU-19).

Settlement	Soil Class	Collection Lot Area (Ha)	Total Area (Ha) by Soil Class
BU-3a	II	0.511	
BU-4	II	0.917	
BU-56	II	1.406	Class II
			2.834
BU-35	III	0.715	
BU-41	III	0.410	Class III
			1.125
BU-59	VI	0.243	Class VI
			0.243
BU-11	VII	0.148	
BU-42/43	VII	0.197	Class VII
			0.345

Five settlements were located on arable land while three were on non-arable land (Table 6.14). Settlements on more fertile soils were larger than those on non-arable classes (Table 6.15). Settlements on Class II land included BU-3a, BU-4, and BU-56, all near Barriles. Those on Class III were BU-35 and BU-41, settlements near Pitti-González.

Table 6.15. Area (ha) of collection lots with Chiriquí Period ceramics, grouped by land class.

Arable Land		Non-Arable Land	
Class II	2.834	Class VI	0.243
Class III	1.125	Class VII	0.345
		Class VIII	-
Total	3.959	Total	0.588
Median Settlement Size	0.715	Median Settlement Size	0.197
Standard Deviation	0.395	Standard Deviation	0.048

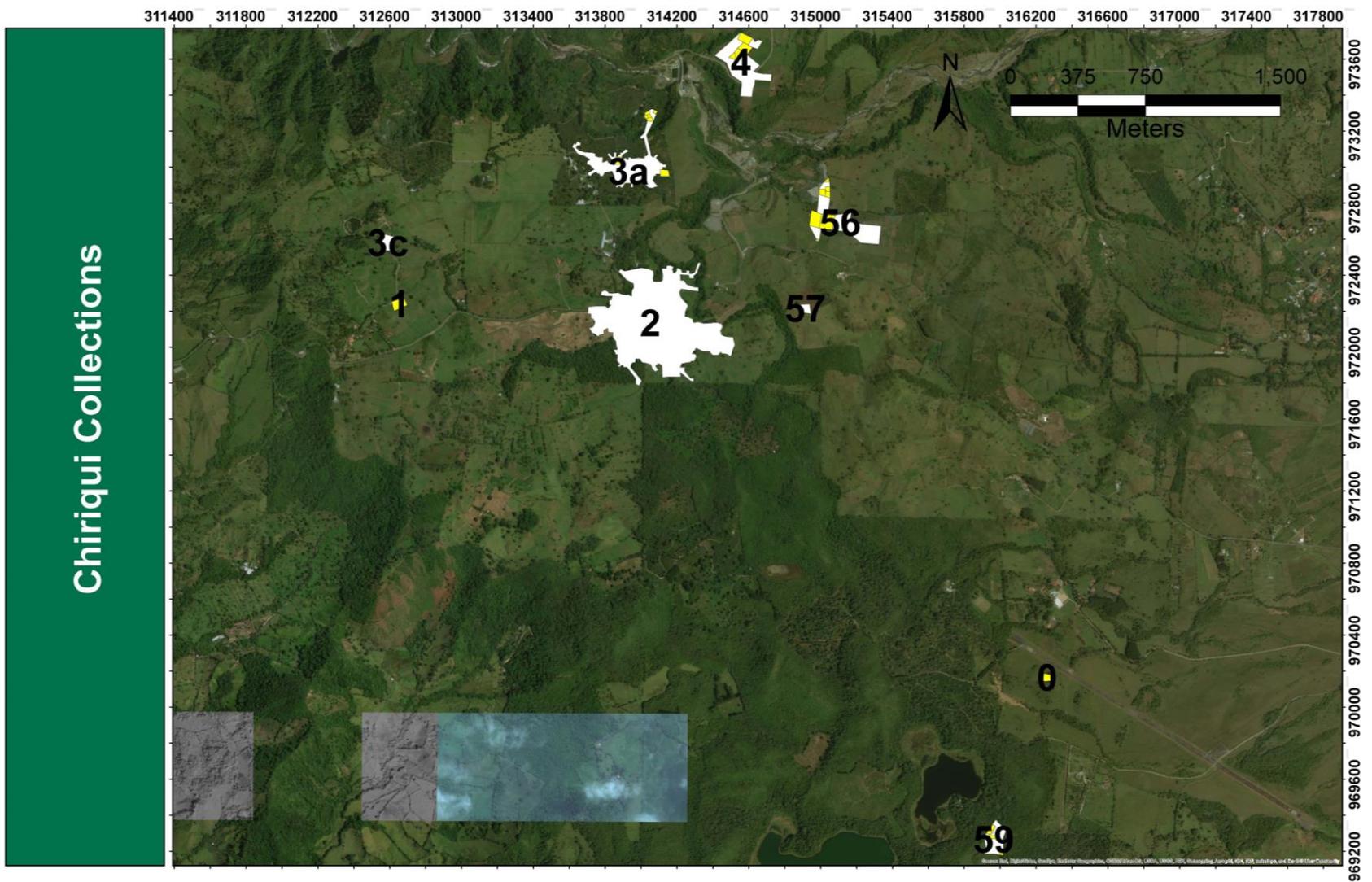


Figure 6.10. Collection lots (yellow) with a Chiriquí Period component near Barriles (BU-24, number 2 on map) and in the Southwest region.

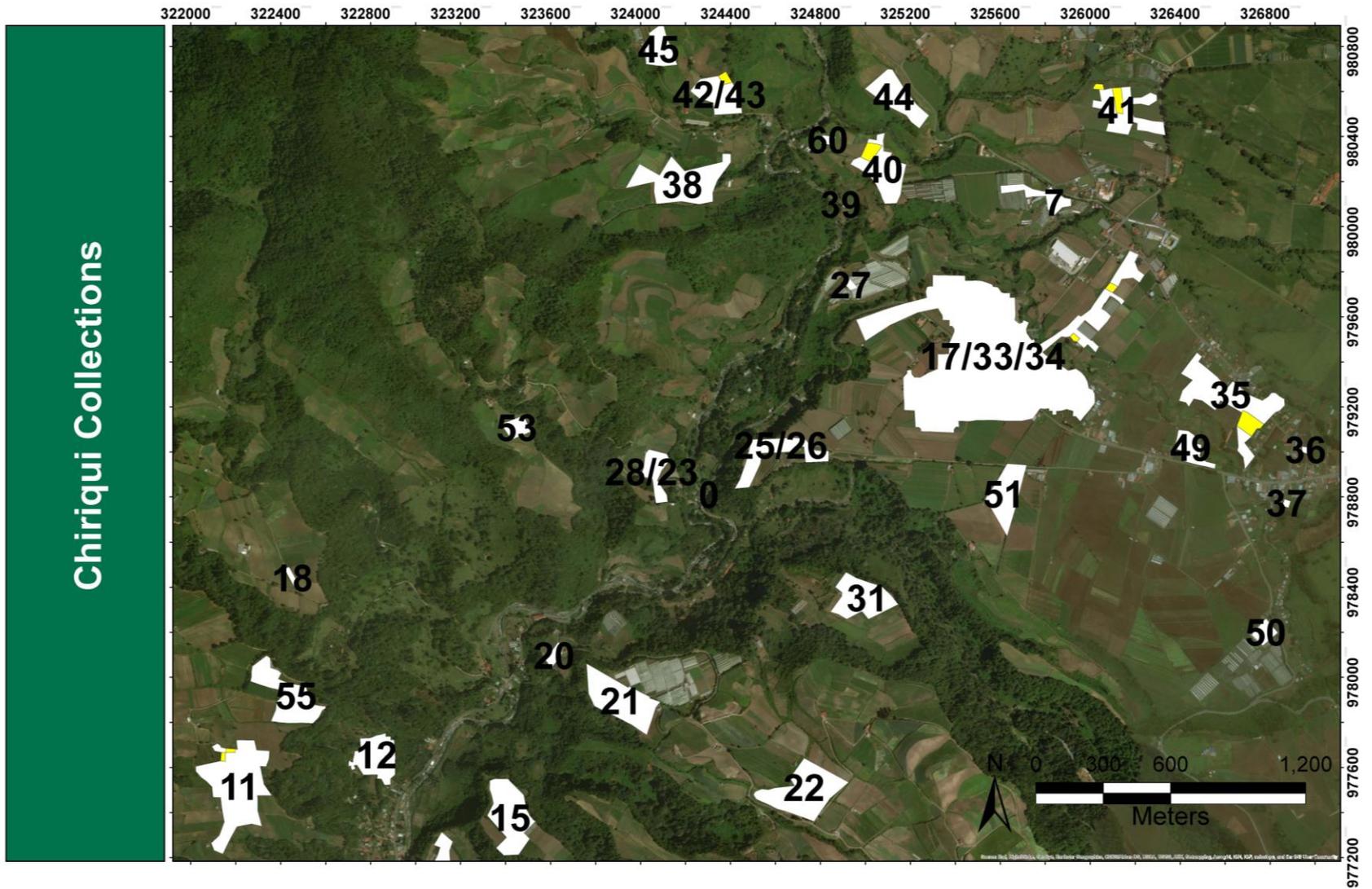


Figure 6.11. Collection lots (yellow) with a Chiriquí Period component in the Cerro Punta (BU-17/33/34) and Bambito regions.

6.4.1. Collection Lots of 30 or More Artifacts

The patterns identified in all collections assigned to the Chiriquí Period appear in the collections of 30 or more artifacts. A total of eight settlements were identified within the valley. Five of the eight settlements were on arable land and a larger total area of arable land was occupied than the non-arable parts of the valley (Table 6.16 and 6.17). Cerro Punta and the Southwest contained most of the settlements. Bambito only contained the settlement of BU-11. The largest settlement was BU-56 at less than 1 ha.

Table 6.16. Settlements that contain Chiriquí Period ceramics in collections of 30 or more artifacts (not including Barriles, Pitti-González, BU-8, BU-12 and BU-19).

Settlement	Soil Class	Collection Lot Area (Ha)	Total Area (Ha) by Soil Class
BU-3a	II	0.178	
BU-4	II	0.608	
BU-56	II	0.875	Class II
			1.660
BU-35	III	0.715	
BU-41	III	0.410	Class III
			1.125
BU-59	VI	0.134	Class VI
			0.134
BU-11	VII	0.078	
BU-42/43	VII	0.197	Class VII
			0.276

Table 6.17. Area (ha) of collection lots with Chiriquí Period ceramics and 30 or more artifacts, grouped by land class.

Arable Land		Non-Arable Land	
Class II	1.660	Class VI	0.134
Class III	1.125	Class VII	0.276
		Class VIII	-
Total	2.785	Total	0.409
Median Settlement Size	0.608	Median Settlement Size	0.134
Standard Deviation	0.271	Standard Deviation	0.060

6.5. Catchment Analyses

In addition to using the soils map for an analysis of settlement locations, I conducted a 1 km catchment analysis for each settlement. I based the 1 km catchment on research from the Malpaso Valley in Mexico, where most settlements were within 0.5 km of the best soils and all were within 1 km (Elliott 2005:311). It was more important in that case for settlements to be near excellent soils than to be shielded from possible raids.

Some settlements within the Upper Río Chiriquí Viejo Valley were very short distances from one another. To avoid overlapping catchment areas, I created Thiessen Polygons around each settlement. The catchment area for each settlement was comprised of a Thiessen Polygon and limited to a maximum distance of 1 km from the settlement (Figure 4.4).

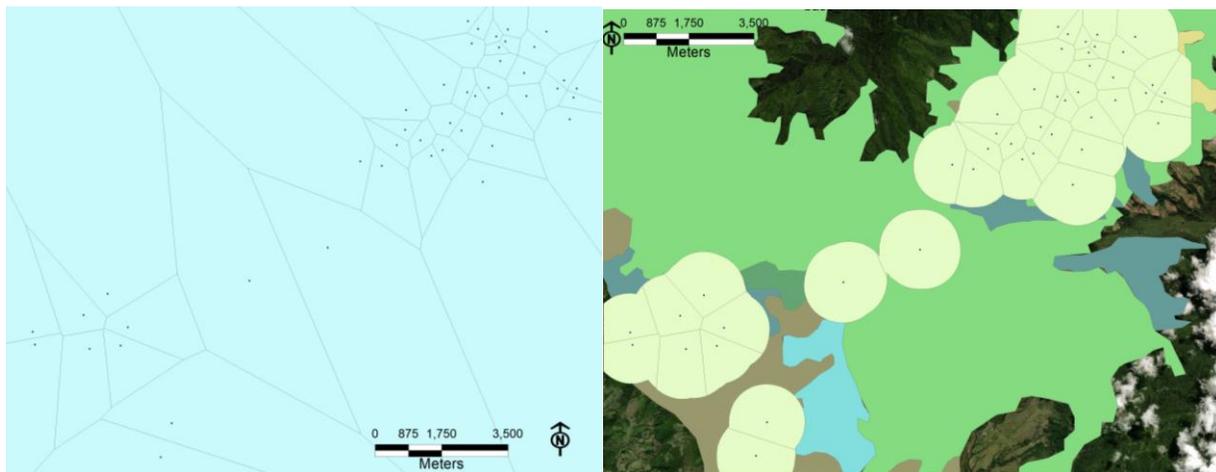


Figure 6.12. Thiessen polygons around centroids of each settlement (left) and the final polygons created for catchment analyses after overlaying a 1 km buffer zone (right).

The catchment analyses confirmed that the soil classes of the collection lots for each of these settlements mimicked the surrounding soil classes within the catchment zone (Table 4.4).

The catchment areas of 18 settlements were composed of non-arable land. Only two settlements had catchment zones entirely composed of arable land, leaving 22 settlements with a mixture of arable and non-arable land. Of these 22 settlements, 10 have catchment areas of 75% or more non-arable land and 4 with 75% or more arable land.

The catchment methods used to calculate this analysis follow Haller (2004) and Palumbo (2009) and their use permits data consistency with that of previous investigations. Haller (2004:119) drew from ethnographic examples (Young 1968:172) that calculated a Guaymí family of 5 requires 4.25 ha for farming and every two years this has to lay fallow for 12 years. Therefore, in total, a family of 5 requires 29.75 ha. These calculations were based on soils that were not very fertile, so Haller used the total of 4.25 ha for areas that contained more fertile areas and 29.75 for other areas. For his research on Barriles and Pitti-Gonzaález, Palumbo (2009) used 4.25 ha for his calculations in the Upper Río Chiriquí Valley. My calculations presume that 4.25 ha were required for a family of 5 year after year. I only calculated catchment requirements for the most populous time periods, the Early and Late Bugaba phases (Table 6.19). The population results provided in the chart are reviewed in Chapter 5.

There was sufficient total area, including arable and non-arable lands, in the catchment zone to provide cultivated products for the maximum population numbers within the valley during the Early and Late Bugaba phases (1,880 individuals). The total number of arable hectares in the catchment area would have supported a population of approximately 1,159 individuals. If 29.75 acres of non-arable land were necessary for a family of 5, the non-arable hectares within the catchment area would have supported 752 individuals. It is probable that the non-arable land in the catchment area was utilized because some of the current farms continue planting on those soils. These calculations indicate that the entire catchment area was able to support a population

of 1,911, which is more than the estimated absolute populations for the valley in both the Early and Late Bugaba phases (Table 6.18).

There was insufficient arable land in both villages' catchment areas to support their respective populations. Therefore, the villages of Barriles and Pitti-González either had individuals traveling further than 1 km to care for their lands or the smaller surrounding homesteads and hamlets were supplying villagers with surplus foodstuffs.

Table 6.18. Catchment analysis using the maximum populations of the Early and Late Bugaba phases and the total population the catchment area could support..

	<i>Total Catchment Area (ha)</i>	<i>Maximum Population Supported by Catchment Area</i>	<i>Maximum Population</i>
<i>Early Bugaba Phase</i>	5458.20	1911	1600
<i>Late Bugaba Phase</i>	5458.20	1911	1880

Table 6.19. The total catchment areas and hectares required for the Early and Late Bugaba phases' median populations. Populations with an "*" are calculated using Palumbo 2009:147 and a "-" indicates no population data.

Settlement	Soil Classes	Total Catchment Area (ha)	Arable Catchment Area (ha)	Pop. Early Bugaba	Requires (ha)	Pop. Late Bugaba	Requires (ha)
Pitti-González	3, 8	56.38	31.30	450*	382.5	380*	323
BU-1	2, 6	235.19	2.72	-		-	
Barriles/BU-2	2, 6	208.44	2.23	375*	318.75	750*	637.5
BU-3a	2, 6, 7, 8	160.97	57.08	5	4.25	5	4.25
BU-3c	2, 6	183.58	13.81	5	4.25	5	4.25
BU-4	2, 7, 8	239.63	87.87	25	21.25	0	0
BU-6	2, 4, 6, 7	379.03	127.43	5	4.25	10	8.5
BU-7	3, 7, 8	58.09	55.81	-		-	
BU-8	7	377.18	0	0*	0	0*	0
BU-9	7, 8	223.78	0	5	4.25	0	0
BU-10	7, 8	133.59	0	0	0	5	4.25
BU-11	6, 7, 8	70.88	0	30	25.5	10	8.5
BU-12	6, 7, 8	42.14	0	30*	25.5	0*	0
BU-13/14	7, 8	108.68	0	35	29.75	0	0
BU-15	8	59.64	0	15	12.75	0	0
BU-18	6, 7	167.64	0	0	0	5	4.25
BU-20	7, 8	57.80	0	10	8.5	5	4.25
BU-21	6, 7, 8	56.20	0	10	8.5	0	0
BU-22	6, 7, 8	147.14	0	20	17	5	4.25
BU-23/28	7, 8	44.96	0	-		-	
BU-25/26	3, 7, 8	52.32	13.18	5	4.25	5	4.25
BU-27	3, 7, 8	44.96	0.96	5	4.25	0	0
BU-31	3, 6, 7, 8	90.78	4.10	10	8.5	0	0
BU-35	3	73.39	73.39	10	8.5	5	4.25
BU-36	3, 7	110.00	94.6	5	4.25	0	0
BU-37	3, 7	46.39	34.73	5	4.25	0	0
BU-38	7	92.38	0	10	8.5	5	4.25
BU-39	3, 7	16.54	10.38	5	4.25	0	0
BU-40	3, 7, 8	19.09	6.73	10	8.5	0	0
BU-41	3, 7	214.36	122.72	10	8.5	5	4.25
BU-42/43	3, 7	33.56	0.04	5	4.25	5	4.25
BU-44	3, 7	108.32	17.92	10	8.5	5	4.25
BU-45	7	189.38	0	5	4.25	5	4.25
BU-49	3	42.58	42.58	5	4.25	5	4.25
BU-50	3, 7, 8	208.88	61.93	5	4.25	5	4.25
BU-51	3, 8	80.95	73.64	5	4.25	0	0
BU-53	7	148.50	0	5	4.25	0	0
BU-54	6, 7, 8	267.43	0	5	4.25	5	4.25
BU-55	6, 7	42.57	0	40	34	10	8.5
BU-56	2, 6, 8	183.70	40.62	10	8.5	10	8.5
BU-57	6	160.11	0	5	4.25	0	0
BU-59	4, 6	277.45	9.35	15	12.75	10	8.5
Totals		5,458.20	985.12	760	1028.5	880	1071.00

6.6. Summary of Settlement Pattern Results

The population within the Upper Río Chiriquí Viejo Valley went through periods of growth and decline. The earliest settlement data is useful in the analysis of whether the first populations were maize farmers. The principle of first occupancy suggests that farming households would seek to settle near the best soils for the possibilities of higher production rates. This can be more complex if there are additional environmental and/or social factors that inhibit settling in these areas. The catchment analyses indicated that the soils the settlements were on mimicked the soils in their respective catchment area. This does not negate that other social or environmental factors could have been influencing settlement locations, but it does permit conclusions regarding soil fertility's importance. The homesteads within the valley appear to have settlement patterns that change for each defined timeframe and the initial settlement of the valley does not follow the principle of first occupancy.

General observations can be made about the settlements and soils. Arable Class IV soils within the survey area were not occupied in any time period, and it was only during the most recent period, the Chiriquí Period, that non-arable Class VIII soils were vacated. All other soil classes within the valley had occupants during the time periods analyzed. The survey zones of Cerro Punta, Bambito, and the Southwest contained settlements for all four cultural periods examined. The settlements of Barriles and Pitti-González, although not included in the data analyses of this chapter in the above sections, are included in this summary using data from a previous project (Palumbo 2009).

During the Concepción Phase, small homesteads were spread throughout the river valley. Inhabitants were located on a combination of arable and non-arable terrain within the basin and homesteads seemed to be indiscriminate with regards to settling on or near the best soils. In

addition to the 14 settlements identified during this project that contained Concepción sherds, Palumbo (2009:149) collected Concepción sherds at BU-8, BU-12, Barriles, and Pitti-González. Linares (1980a:108) also mentions finding a few Concepción sherds at the settlement of Barriles.

These homesteads and hamlets covered small areas. They were most often less than 1 ha. Excluding Barriles and Pitti-González, the largest settlement was BU-21 with 2.99 ha. Both Barriles and Pitti-González grew in later periods to be multiple times larger than the rest of the settlements, but during the Concepción Phase, Barriles was composed of 4 separate homesteads with the largest at 5.4 ha. Pitti-González also contained smaller settled areas. Of the three larger settlements during the Concepción Phase, only Pitti-González was located on arable land (Figure 6.13).

Occupants of the Upper Río Chiriquí Viejo Valley did not have a clear preference for settling on or near arable land locations during the Concepción Phase. This would suggest that the population was not an experienced farming population, agriculture was not the primary source of subsistence goods, and/or other environmental or social factors had more influence on settlement locations than the importance of prime farmland. This lack of selectivity in soil fertility may indicate a continued reliance on a mixed subsistence economy that depended upon wild resources and cultivars that included root crops and maize (Corrales 1989; Dickau 2005, 2010; Hoopes 1996).

The small number of settlements containing sherds from this phase is probably representative of reality. Poor preservation could have affected the number of sherds recovered from this phase because over 1500 years have passed, yet, this is unlikely due to other researchers noting the rare appearance or small percentages of Concepción sherds within settlements in the study area (i.e. Linares and Ranere 1980; Palumbo 2009). The paucity of

sherds is probably representative of a sparsely occupied valley and the result of seasonal occupancy at some of these locations. This would further an argument against the first settlements containing agriculturally savvy individuals who would have benefitted from a sedentary lifestyle in order to care for their growing crops.



Figure 6.13. Occupied settlements in the Concepción Phase.

The long Concepción Phase was followed by two shorter phases that each had distinct settlement patterns. During the Early Bugaba Phase, there was a large increase the number of settlements and area of occupation. Settlements continued to be on multiple different soil classes with no strong preference for settling on or near the available arable land. The total non-arable

land occupied was almost double that of arable land and more settlements were located on the poorer soils.

Settlement sizes differed more during the Early Bugaba Phase than they had in the Concepción Phase. Median settlement size was still small at under 1.5 ha, but there was a distinction between smaller homesteads, medium sized hamlets, and the large villages of Barriles and Pitti-González. The largest settlement in my survey was the hamlet of BU-22 at 5.07 ha on Class VII land. This was small when compared to Barriles and Pitti-González, which became the largest settlements in the valley (Figure 6.14). Palumbo (2009) notes Barriles grew to 32 ha and Pitti-González to 26 ha. If we include the additional 4.5 ha from sites BU-33 and BU-34 into the Pitti-González total, then it covered 30 ha and was similar in size to Barriles. The hamlet of BU-22 dwarfs in comparison to these villages.

The settlement pattern of the Early Bugaba Phase does not suggest maize agriculturalists occupied the valley. Although more settlements appeared on the landscape, there was still no selectivity for better soils. More settlements were located on non-arable soils and settlement growth was not dependent upon soil fertility, as was demonstrated by Barriles' growth on non-arable, Class VI land. This pattern continues to suggest the use of a mixed economy at most settlements. Inhabitants of Pitti-González may have had more of an emphasis on cultivars and cultivation because of its exponential growth and location on arable land, but this does not seem to have been a definitive trend in other areas with good soil conditions. Nor does it seem that all the best soils were completely utilized, forcing others to work lesser soil classes. For example, the soils around BU-6 are Class II and the area was sparsely settled.



Figure 6.14. Occupied settlements in the Early Bugaba Phase.

At the end of the Early Bugaba Phase and into the Late Bugaba Phase, there was a vacating of homesteads and hamlets scattered throughout Cerro Punta, Bambito, the Intermediate, and the Southwest areas of the Upper Río Chiriquí Viejo Valley (Figure 6.15). Total area of arable land that was occupied decreased from the Early Bugaba Phase. However, those residents that decided to stay were more prone to do so if it was on arable land. This indicates a shift in the importance of soil fertility. Furthermore, analysis of larger artifact collections, those of 30 or more sherds, indicated a preference for living on or near arable land, unlike in previous phases.

The homesteads in the valley remained small in area during the Late Bugaba Phase. Median settlement sizes reverted to being smaller than 1 ha with the largest homestead at less

than 4 ha. The villages of Barriles and Pitti-González didn't expand their footprint but did grow in population (Palumbo 2009). The settlements of BU-33 and BU-34 that were incorporated into Pitti-González practically disappear and decrease the village's total occupied area down to 26 ha. The population growth at the villages is posited to be the incorporation of individuals that had abandoned their homesteads from the valley (Palumbo 2009) and my research supports this scenario.



Figure 6.15. Occupied settlements in the Late Bugaba Phase.

The importance of soil fertility suggests that the inhabitants of the valley had a new focus on cultivation and cultivars that was not evident in previous phases. Maize is one of many possible cultivars that they could have incorporated into the diet. Again, it is important to note

that only Pitti-González was on arable land, while Barriles was not. Inhabitants of Barriles may have crossed the river to farm the other side, which was more suitable for farming, or they may have relied on surplus from other settlements. Considering Barriles was not in close proximity to the best soils, there may have been social reasons for individuals to relocate from homesteads to the larger village. The Late Bugaba Phase is the first phase in the valley where cultivars may have been an important part of the diet.



Figure 6.16. Occupied settlements in the Chiriquí Period.

The abandonment of small homesteads throughout the valley continued into the Chiriquí Period (Figure 6.16). This pattern now included large portions of Barriles and Pitti-González. The reason(s) for vacating the valley is still currently unknown. What is evident is that the Upper

Río Chiriquí Viejo Valley contained even less occupied area during the Chiriquí Period than during the Concepción Phase and the inhabitants of the valley preferred to be on arable soils. This preference strongly suggests that these populations were cultivating crops.

Settlement size decreased due to the abandonment of many locations. Median settlement size was larger than during the Concepción Phase, but still less than 1 ha. There was a very small population at Pitti-González because Palumbo (2009) identified only three Chiriquí Period sherds. Barriles reverted to a small settlement, comparable to its state during the Concepción Phase.

The distinct settlement patterns for each period indicate that the factors affecting the decision of where to live changed over time. The first settlements in the Concepción Phase didn't follow the principle of first occupancy. It wasn't until the Late Bugaba Phase that soil fertility was a factor in deciding settlement locations. It is possible that other social or environmental factors inhibited settling in these locations in the prior Early Bugaba and Concepción phases. However, this doesn't seem to be the case. The Early Bugaba Phase contained the greatest number of settlements on the landscape and there doesn't appear to be any pattern to suggest alternate influences on these settlement locations, other than they were located on flatter areas of the valley.

In the Late Bugaba Phase, small homesteads and hamlets were abandoned, and their residents resettled into the larger villages. Those homesteads on fertile soil were more likely to continue into the Late Bugaba Phase than those that were not. This suggests that homesteads that re-settled did so to locations with fertile soil, but this was not always the case because Barriles' population grew. The growth of Barriles suggests that during the Late Bugaba Phase there could

have been social reasons for the resettlement of homesteads into larger villages and an increased importance to be on or near fertile soils.

The Chiriquí Period is the only period where there is unequivocal evidence for the importance of soil fertility in the decision of settlement location. This is in accordance with other researchers' claims that agriculture was the primary practice for the period (e.g. Corrales 2016; Drolet 1984a). However, this period also sees abandonment of most settlements in the valley. It is possible that the importance of maize or other cultivars in the diet drew inhabitants out of the valley to more hospitable growing environments for their choice crops. The specific reason(s) for the exodus is one area where further research is needed.

Chapter 7: Vessel Assemblages and Diet Consistency

Maize farming and its potential for generating surplus are key to the agriculturalist model that explains the development of complex societies in the Upper Río Chiriquí Viejo Valley. If agriculturalists were the first to settle in the valley and they depended upon maize for surpluses through time, there should have been little to no change in cooking and storage habits. This would be displayed through consistency in restricted vessel assemblages. Changes in the number of restricted vessel rims out of total sherds suggests a modification in the kinds of foods eaten or how the foods were prepared. The valley-wide average restricted vessel percentage, determined by the number of restricted rims in a collection lot and divided by the total number of sherds from that same collection, remained similar for three time periods and only reflected a change during the Chiriquí Period (Table 7.1). This indicates a possible change in diet or food preparation technique occurred within the Chiriquí Period. Overall, the restricted vessel rim ratios within collection lots were small in all time periods.

Table 7.1. Average percentages of restricted vessel fragments and open vessel fragments in assemblages of 30 or more sherds, excluding Barriles and Pitti-González.

Time Period	Avg Restricted Vessel Rim %	Avg Open Vessel Rim %
Chiriquí Period	2.80	2.19
Late Bugaba Phase	4.64	2.79
Early Bugaba Phase	4.40	2.70
Concepción Phase	4.12	2.08

Averages of restricted vessel rim percentages (from here on restricted vessel percentages) or open vessel rim percentages (from here on open vessel percentages) resulted from calculating each collection lot's rim percentages (ex. restricted rims divided by total sherds in the collection

lot) and averaging these percentages from each collection lot within the settlement for each time period. Restricted vessel percentages within collections were compared to open vessel percentages for each settlement to highlight any changes in serving activities.

It is possible that there are intra-settlement variations of vessel percentages within hamlets that are obscured by averaging all the collection lots within a settlement. This situation is identified at Barriles (Palumbo 2009). However, the easiest manner to make the data comparable was to use settlement averages.

Settlements were divided into categories based on their median absolute population numbers. This was to provide a comparison between settlement sizes and vessel percentages. Settlements with median populations of 15 individuals or less were labeled “homesteads”, those with 15-100 were “hamlets”, and “villages” contained more than 100 individuals. The Concepción Phase and Chiriquí Period only contained homesteads. In the Early Bugaba Phase there are also hamlets and villages. The Late Bugaba Phase includes two settlement types, homesteads and villages.

Two data sets were utilized. Comparisons were made using vessel percentage averages from all collection lots and a second data set compared vessel percentage averages from collection lots with 30 or more artifacts for more accurate statistical results. Within these data sets, settlements BU-33 and BU-34 are referred to as Pitti-González. These represent only a small area of Pitti-González.

Like my other data chapters, I incorporate data from previous research into this chapter. In the summary section of this chapter, data from Palumbo’s (2009) survey was used to calculate the vessel ratios within assemblages for Barriles and the area of Pitti-González not represented by BU-33 and BU-34.

7.1. Concepción Phase (300 B.C. – A.D. 400)

A total of 29 collection lots contained Concepción sherds and of these only 20 collections contained 30 or more sherds (Table 7.2, Figure 7.1 & 7.2). The settlement of BU-35 had the highest averaged restricted vessel percentage (8.7%) within the Concepción Phase. This held true in both the data set for all collection lots and those collection lots with 30 or more sherds. The lowest average at a site was 1.0% at BU-55, also for both data sets. The averaged percentages of all settlement's restricted vessels was 4.12% in collection lots of 30 or more sherds, slightly lower than that of the average for all collections.

Table 7.2. Averaged percentages of restricted vessels for each settlement during the Concepción Phase using all collection lots and those of 30 or more sherds.

Settlements	Restricted Vessels	Restricted Vessels (30+)
Pitti-González	5.5%	5.5%
BU-4	1.2%	1.2%
BU-11	7.5%	3.1%
BU-21	7.5%	
BU-22	3.9%	7.8%
BU-25/26	3.5%	3.5%
BU-35	8.7%	8.7%
BU-43	8.5%	4.5%
BU-46	2.4%	2.5%
BU-51	4.1%	4.1%
BU-55	1.0%	1.0%
BU-56	1.5%	1.5%
BU-60	5.8%	5.8%
Average	4.7%	4.1%
Standard Deviation	2.8%	2.5%

The percentages of restricted vessels within settlement assemblages do not correlate with the open vessel percentages (Table 7.3). In other words, the percentage of restricted vessels was

not dependent upon the percentage of open vessels. This is not surprising because these settlements are small homesteads on the landscape that are possibly seasonally occupied, providing a mixture of activities that occurred at each location and for differing seasons and creating non-standardized assemblages.

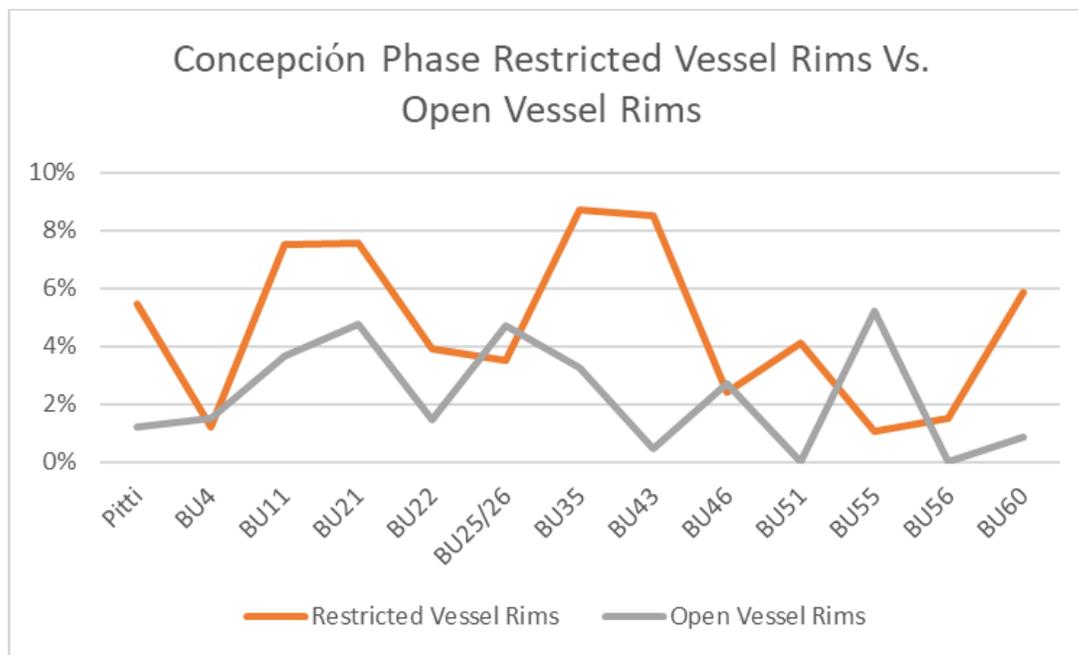


Figure 7.1 Average restricted vessel rims compared to average open vessel rims for each settlement in the Concepción Phase.

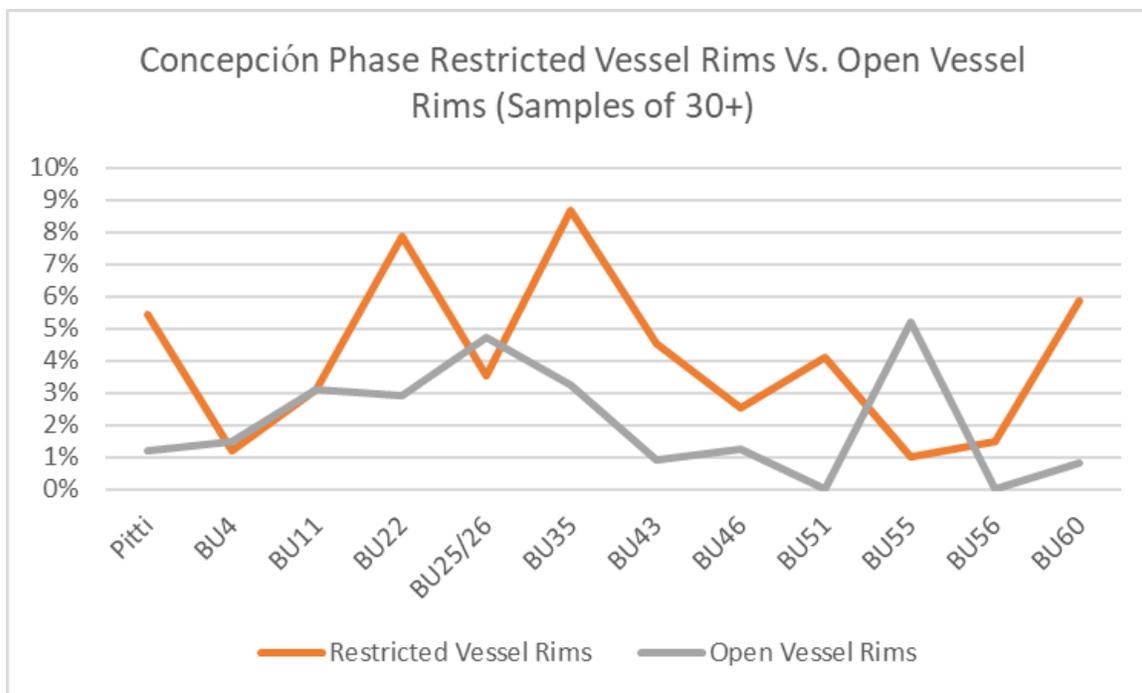


Figure 7.2. Average restricted vessel rims compared to average open vessel rims for each settlement in the Concepción Phase collection lots of 30+ sherds.

Table 7.3. Correlation values of average settlement restricted vessel ratios and average settlement open vessel ratios for the Concepción Phase.

	All Collection Lots	Collection Lots of 30+ Sherds
Multiple R	0.045	0.020
R Square	0.002	0.000
P-value	0.884	0.951
Observations	13	12

7.2. Early Bugaba Phase (A.D. 300-600)

The Early Bugaba Phase contained a total of 240 collection lots for vessel analyses. Of those, 98 lots were from collections of 30 or more sherds. The average percentage of restricted vessels for collection lots of 30 or more sherds was 4.40% (Table 7.4, Figure 7.3 & 7.4). This phase contained the largest number of homesteads throughout prehistory in the valley. It also saw the development of hamlets and villages.

Table 7.4. Averaged percentages of restricted vessels for each settlement during the Early Bugaba Phase using all collection lots and those of 30 or more sherds.

Settlements	Restricted Vessels	Restricted Vessels (30+)
Pitti-González	3.7%	3.8%
BU-3a	2.4%	0.0%
BU-3c	0.0%	
BU-4	4.3%	4.6%
BU-6	2.9%	2.2%
BU-9	0.0%	
BU-11	4.1%	5.0%
BU-13/14	4.2%	4.2%
BU-15	3.6%	5.4%
BU-20	5.5%	5.5%
BU-21	5.5%	7.0%
BU-22	9.2%	7.7%
BU-25/26	6.6%	4.8%
BU-27	0.0%	0.0%
BU-31	9.3%	5.9%
BU-35	4.5%	4.7%
BU-37	0.0%	
BU-38	0.6%	
BU-39	0.0%	
BU-40	0.0%	
BU-41	3.6%	2.3%
BU-42/43	4.3%	1.1%
BU-44	11.7%	11.7%
BU-45	0.0%	
BU-46	4.8%	5.7%
BU-48	12.5%	
BU-49	1.2%	
BU-50	0.0%	
BU-51	3.2%	2.1%
BU-52	0.0%	
BU-53	0.0%	
BU-54	14.3%	
BU-55	5.1%	5.3%
BU-56	3.0%	4.5%
BU-57	0.0%	
BU-59	0.8%	3.1%
BU-60	4.4%	5.3%
Average	3.7%	4.4%
Standard Deviation	3.8%	2.6%

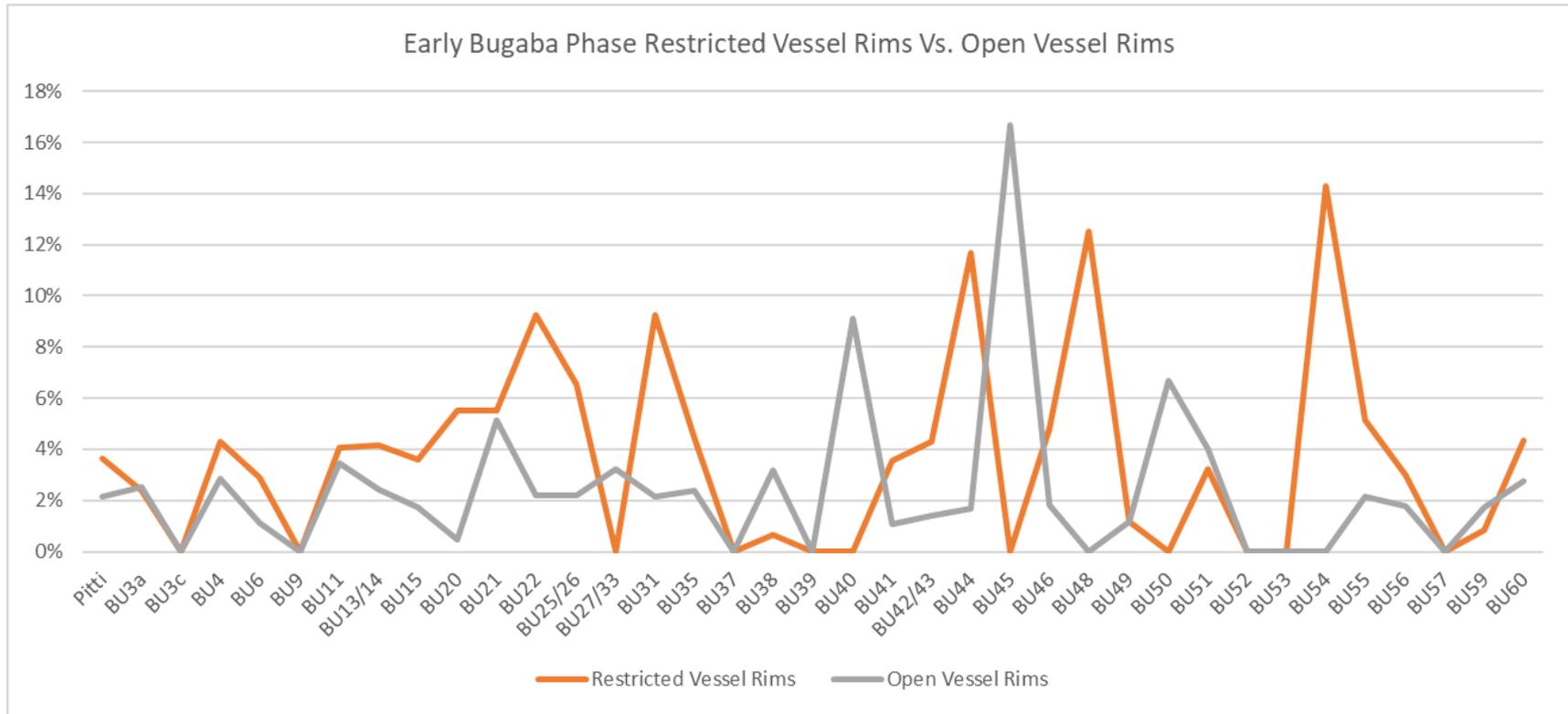


Figure 7.3. Average restricted vessel rims compared to average open vessel rims for each settlement in the Early Bugaba Phase.

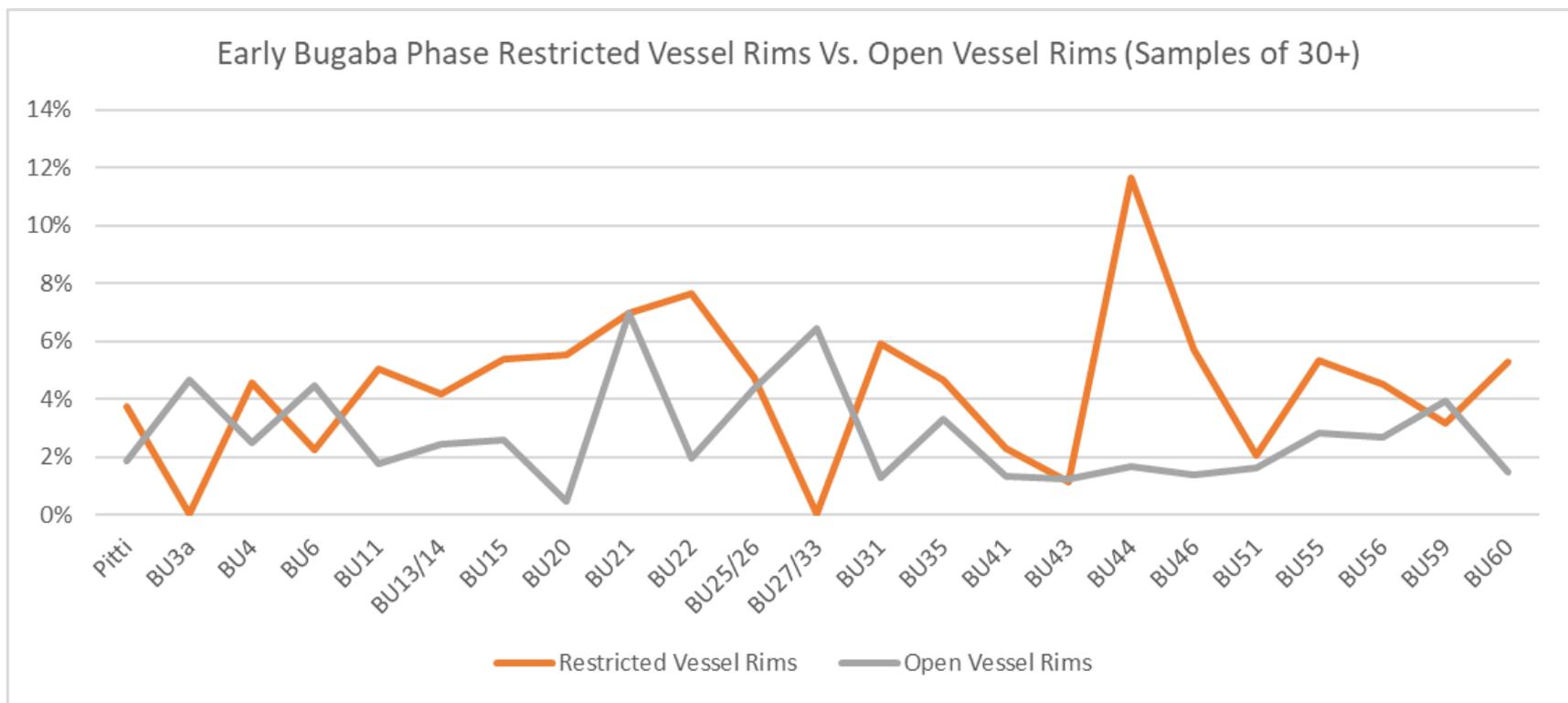


Figure 7.4. Average restricted vessel rims compared to average open vessel rims for each settlement in the Early Bugaba Phase collection lots of 30+ sherds.

BU-54 had the highest average percentage of restricted vessels at 14% while BU-44 was next at 11% for all collection lots. The large average at BU-54 was due to a small sample size because when collection lots of only 30 or more sherds were considered, BU-44 contained the largest restricted vessel percentage at 11%. Two sites, BU-3a and BU-27/33 did not have any collections with 30 or more sherds that contained restricted vessel rim sherds.

In the Early Bugaba Phase, there is no correlation between restricted vessel percentages and open vessel percentages within settlements (Table 7.5). This continues to suggest that various activities were occurring at each settlement and there was no standardization of vessel assemblages.

Table 7.5. Correlation values of average settlement restricted vessel ratios and average settlement open vessel ratios for the Early Bugaba Phase.

	All Collection Lots	Collection Lots of 30+ Sherds
Multiple R	0.204	0.272
R Square	0.042	0.074
P-value	0.225	0.209
Observations	37	23

Multiple two sample unequal variance *t*-tests indicate that the mean differences in the restricted vessel percentages of the total assemblages among each settlement type (homestead, hamlet, and village) were not statistically significant (Tables 7.6-7.8). It is worth noting that small sample sizes are not the best choice for significance tests, but there is no way to avoid them with this data. The unequal variance *t*-test was chosen because it is useful for unequal sample sizes.

Table 7.6. *T*-test comparing average settlement restricted vessel percentages from homesteads to those from hamlets and to those from villages using all collection lots and collection lots of 30+ sherds.

	Home.	Ham.	Home. 30+	Ham. 30+	Home.	Vill.	Home. 30+	Vill. 30+
Mean	0.034	0.054	0.042	0.054	0.034	0.047	0.042	0.045
Variance	0.002	0.000	0.001	0.000	0.002	0.001	0.001	0.000
Observations	31	5	17	5	31	2	17	2
Df	9		15		1		4	
p-value two-tail	0.134		0.229		0.591		0.737	

Table 7.7. *T*-test comparing average settlement open vessel percentages from homesteads to those from hamlets and to those from villages using all collection lots and collection lots of 30+ sherds.

	Home.	Ham.	Home. 30+	Ham. 30+	Home.	Vill.	Home. 30+	Vill. 30+
Mean	0.024	0.026	0.029	0.023	0.024	0.013	0.029	0.015
Variance	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.000
Observations	31	5	17	5	31	2	17	2
Df	34		20		5		4	
p-value two-tail	0.722		0.219		0.258		0.090	

Table 7.8. *T*-tests comparing 1) hamlet restricted vessel percentages to village restricted percentages, and 2) hamlet open vessel percentages to village open vessel percentages using all collection lots and collection lots with 30+ sherds.

	Ham.	Vill.	Ham. 30+	Vill. 30+	Ham.	Vill.	Ham. 30+	Vill. 30+
	Restricted		Restricted		Open		Open	
<i>Mean</i>	0.054	0.047	0.054	0.045	0.026	0.013	0.023	0.015
<i>Variance</i>	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
<i>Observations</i>	5	2	5	2	5	2	5	2
<i>Df</i>	1		3		1		1	
<i>p-value two-tail</i>	0.756		0.435		0.279		0.349	

Although none of the statistical tests revealed significant differences between data categories, there are trends that are visible through basic comparisons of the data. Restricted vessel percentages varied most in homestead collections (Table 7.9). Within collections of 30 or

more sherds, hamlets contained the largest percentages of restricted vessels, while homesteads had the smallest percentages.

Table 7.9. Comparison of restricted vessel percentages between each settlement size using all collection lots and those with 30+ sherds.

	Restricted Vessels					
	Homesteads	Hamlets	Villages	Homesteads 30+	Hamlets 30+	Villages 30+
Average	3.4%	5.4%	4.7%	4.2%	5.4%	4.5%
Median	2.9%	4.3%	4.7%	4.7%	5.0%	4.5%
Standard Deviation	4.0%	2.2%	2.2%	2.9%	1.4%	0.9%

Table 7.10. Comparison of open vessel percentages between each settlement size using all collection lots and those with 30+ sherds.

	Open Vessels					
	Homesteads	Hamlets	Villages	Homesteads 30+	Hamlets 30+	Villages 30+
Average	2.4%	2.6%	1.3%	2.9%	2.3%	1.5%
Median	1.7%	2.4%	1.3%	2.6%	2.4%	1.5%
Standard Deviation	3.4%	0.5%	0.8%	1.9%	0.4%	0.7%

A comparison of open vessel percentages between the different settlement sizes continues to show that homesteads had the greatest variations in these percentages (Table 7.10). However, opposite that of restricted vessels, homesteads contained larger percentages of open vessels and villages contained the smaller percentages.

7.3. Late Bugaba Phase (A.D. 600-900)

The Late Bugaba Phase contained 83 collection lots with restricted vessel rim sherds (Table 7.11, Figures 7.5 and 7.6). A total of 19 of these collection lots contained 30 or more sherds. BU-22 contained the greatest percentage of restricted vessel rims in collection lots at 7.6%, which seemed to be due to a small sample size because BU-35 had the highest percentage

within the larger collections at 8.0%. Similar to the Early Bugaba Phase, the site of BU-3a did not have evidence of restricted vessel rims in collections of 30 or more sherds.

Table 7.11. Averaged percentages of restricted vessels for each settlement during the Late Bugaba Phase using all collection lots and those of 30 or more sherds.

Settlements	Restricted Vessels	Restricted Vessels (30+)
Pitti-González	5.9%	5.9%
BU-3a	3.1%	0.0%
BU-3c	0.0%	
BU-6	2.6%	
BU-10	0.0%	
BU-11	6.3%	3.1%
BU-18	0.0%	
BU-20	5.4%	5.4%
BU-22	7.6%	
BU-25/26	0.0%	
BU-35	5.5%	8.0%
BU-38	0.0%	
BU-41	1.9%	3.2%
BU-42/43	5.6%	5.6%
BU-44	0.0%	
BU-45	0.0%	
BU-49	1.2%	
BU-50	0.0%	
BU-54	0.0%	
BU-55	6.8%	5.5%
BU-56	3.5%	6.8%
BU-59	0.5%	2.9%
Average	2.5%	4.6%
Standard Deviation	2.8%	2.3%

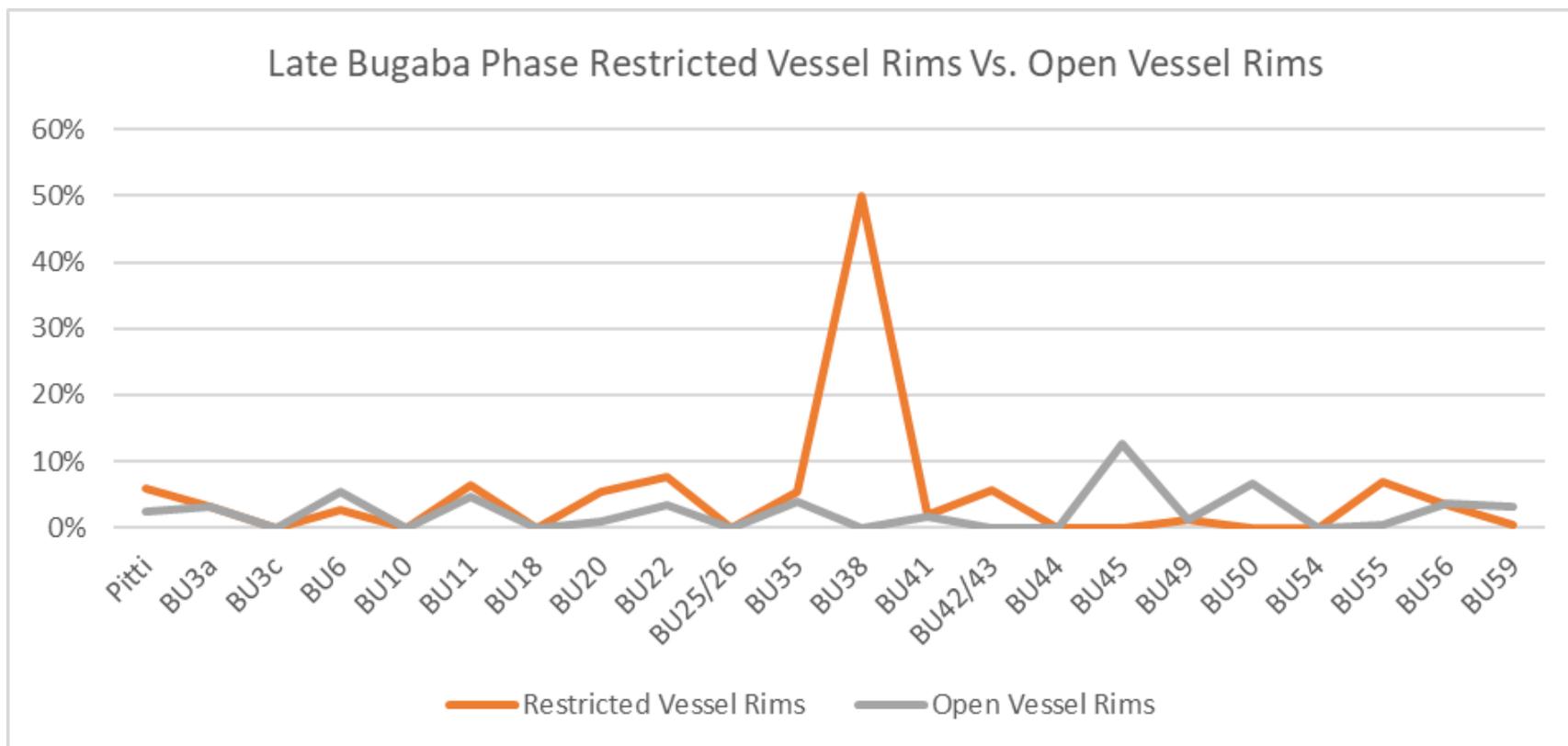


Figure 7.5. Average restricted vessel rims compared to average open vessel rims for each settlement in the Late Bugaba Phase.

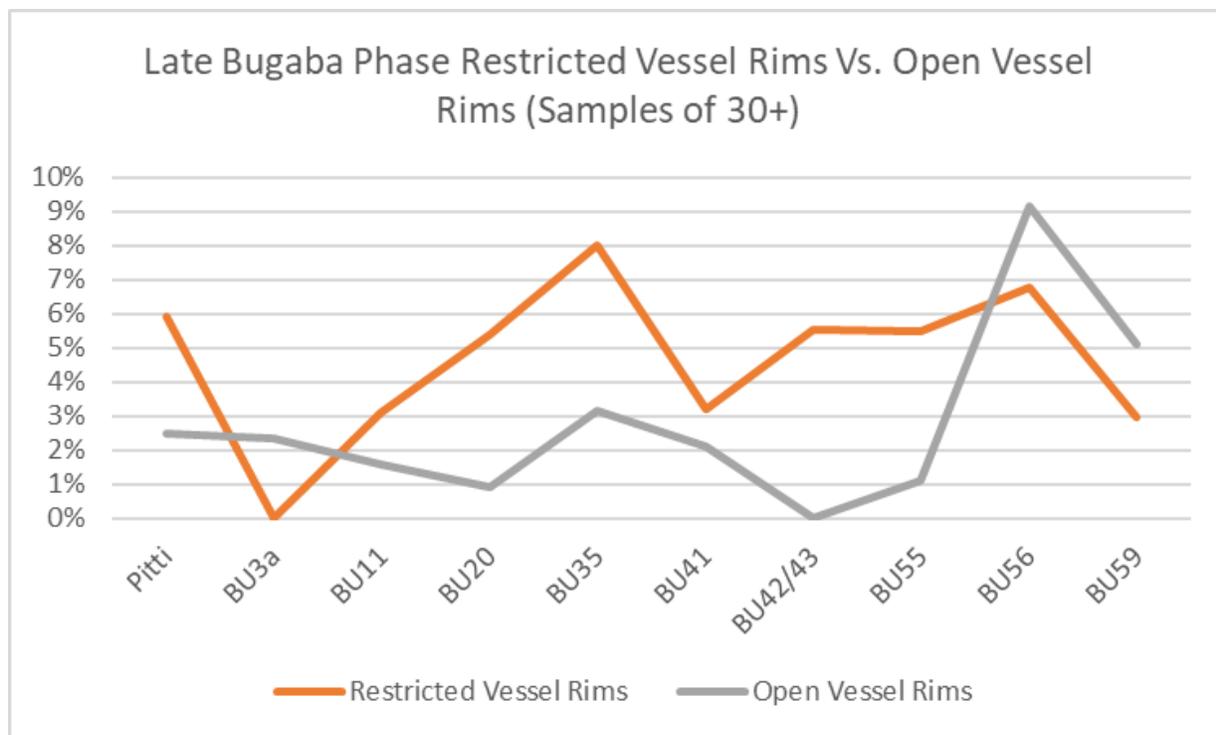


Figure 7.6. Average restricted vessel rims compared to average open vessel rims for each settlement in the Late Bugaba Phase collection lots of 30+ sherds.

Correlation values of collections with 30 or more sherds, as was the case in the Concepción and Early Bugaba phases, indicate that there is no correlation between restricted vessel percentages and open vessel percentages (Table 7.12). This is not surprising because there are two distinctly sized settlements on the landscape, homesteads and large villages. Within these two kinds of settlements different activities could be occurring. Averaging would hide intra-settlement assemblage variability in the different sectors of the villages.

Table 7.12. Correlation values of average settlement restricted vessel ratios and average settlement open vessel ratios for the Late Bugaba Phase.

	All Collection Lots	Collection Lots of 30+ Sherds
Multiple R	0.171	0.182
R Square	0.029	0.033
P-value	0.446	0.615
Observations	22	10

T-tests of homestead and village vessel percentages indicate that the differences in the mean percentages of both restricted and open vessels are not statistically significant (Table 7.13). Similar to the Early Bugaba Phase, homesteads had more variation in percentages of restricted and open vessels (Tables 7.14 and 7.15). They also contained larger percentages of open vessels relative to total sherds than did villages.

Table 7.13. *T*-tests comparing 1) hamlet restricted vessel percentages to village restricted vessel percentages, and 2) hamlet open vessel percentages to village open vessel percentages using all collection lots and collection lots with 30+ sherds.

	Home.	Vill.	Home.	Vill.	Home.	Vill.	Home.	Vill.
			30+	30+			30+	30+
	Restricted		Restricted		Open		Open	
Mean	0.048	0.045	0.045	0.046	0.024	0.013	0.028	0.015
Variance	0.011	0.000	0.001	0.000	0.001	0.000	0.001	0.000
Observations	21	2	9	2	21	2	9	2
Df	11		5		21		8	
p-value two-tail	0.928		0.906		0.131		0.226	

Table 7.14. Comparison of restricted vessel percentages between each settlement size using all collection lots and those with 30+ sherds

	Restricted Vessels			
	Homesteads	Villages	Homesteads 30+	Villages 30+
Average	4.8%	4.5%	4.6%	4.6%
Median	2.3%	4.5%	5.4%	4.6%
Standard Deviation	10.5%	1.3%	2.3%	1.0%

Table 7.15. Comparison of open vessel percentages between each settlement size using all collection lots and those with 30+ sherds

	Open Vessels			
	Homesteads	Villages	Homesteads 30+	Villages 30+
Average	2.4%	1.3%	2.8%	1.5%
Median	1.4%	1.3%	2.2%	1.5%
Standard Deviation	3.0%	0.2%	2.6%	0.6%

7.4. Chiriquí Period (A.D. 900-1500)

The same number of collection lots was assigned to the Chiriquí Period as to the Concepción Phase. A total of 29 collection lots contained Chiriquí Period ceramics (Table 7.16). The sample decreases to 16 collections for lots with 30 or more sherds. The settlement with the highest percentage of restricted vessels was BU-11 at 10%, but this lowers to 5.7% within collections of 30 or more sherds. The overall average of restricted vessel percentages in a collection lot decreased when compared to the previous phases. This change could be due to a change in food preparation or diet and it is not surprising considering that the population was emigrating out of the valley during this period, leaving only small homesteads on the landscape.

Table 7.16. Averaged percentages of restricted vessels for each settlement during the Late Bugaba Phase using all collection lots and those of 30 or more sherds.

Settlements	Restricted Vessels	Restricted Vessels (30+)
Pitti-González	0.9%	0.9%
BU-3a	3.1%	0.0%
BU-4	1.4%	0.8%
BU-11	10.0%	5.7%
BU-35	1.7%	1.7%
BU-41	3.2%	3.2%
BU-42/43	5.6%	5.6%
BU-56	3.7%	5.6%
BU-59	0.8%	1.7%
Average	3.4%	2.8%
Standard Deviation	2.9%	2.3%

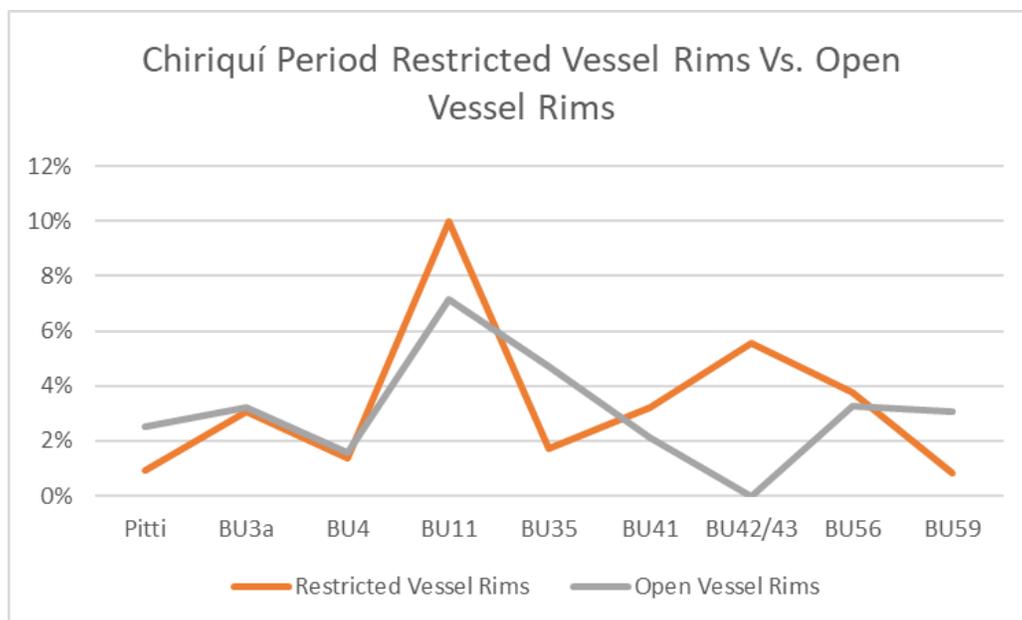


Figure 7.7. Average restricted vessel rims compared to average open vessel rims for each settlement in the Chiriquí Period.

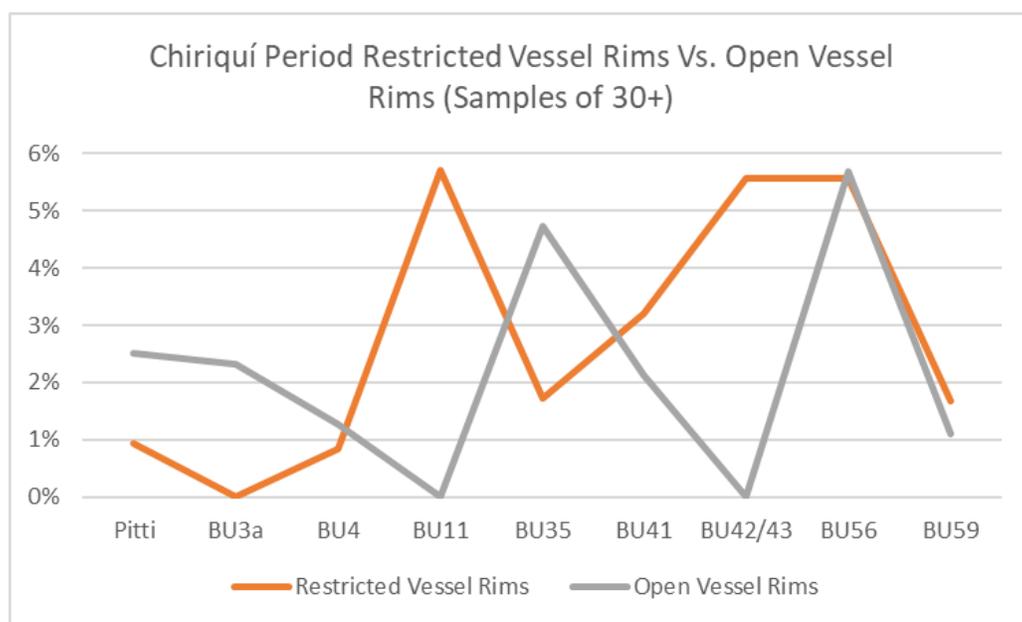


Figure 7.8. Average restricted vessel rims compared to average open vessel rims for each settlement in the Chiriquí Period collection lots of 30 or more sherds.

As has been noted for each period of the valley's prehistory, there is no correlation between the storage and cooking vessel rim percentages and the open vessel rim percentage in collections (Table 7.17, Figures 7.7 and 7.8). This continues to suggest mixed activities occurring throughout the valley and within settlements. Sample sizes are small and may affect these correlation values.

Table 7.17. Correlation values of restricted vessels and open vessels during the Chiriquí Period.

	All Collection Lots	Collection Lots of 30+ Sherds
Multiple R	0.472	0.100
R Square	0.223	0.010
P-value	0.200	0.799
Observations	9	9

7.5. Summary of Vessel Assemblages in the Upper Río Chiriquí Viejo Valley

Settlements in the Upper Río Chiriquí Viejo Valley did not have any statistically significant differences in the average percentages of restricted vessel over the first three periods of time analyzed that would suggest a major change in diet or food preference. Comparisons of average vessel percentages from different settlement sizes from the Early and Late Bugaba Phases suggest that percentages of restricted and open vessels varied most in homesteads. The only statistically significant difference was the decrease in the Chiriquí Period valley-wide average percentage of restricted vessels. This decrease may be attributed to multiple factors, including diet.

The first three phases of occupation contained restricted vessel rim averages that hovered above 4% and slightly increased from phase to phase (Table 7.1). Then, in the Chiriquí Period, this percentage decreased to an average of 2.8%. A one sample *t*-test indicates that this change is statistically significant ($p=0.01$). Sampling size errors should have minimally affected this

decrease because only collection lots with 30 or more sherds were averaged. Furthermore, the decrease in the average percentages of open vessels from the Late Bugaba Phase to the Chiriquí Period was not statistically significant ($p=0.27$).

The decrease in restricted vessels was also noted by Linares (1980a) with her excavated assemblages at the house foundation in Pitti-González. Her excavation indicated a significant drop in jar forms above the floor when compared with the floor level and below the floor level (Linares 1980a:96). This floor was bracketed by radiocarbon dates between A.D 200 and A.D. 400 (Smith 1980:159).

There are two possibilities for the change in restricted vessel percentages in the Chiriquí Period. The first is that there was a change in diet or food preparation. In other areas of the Greater Chiriquí Archaeological region, during this period, populations are agriculturalists and fully dependent upon cultivated crops, including maize (Corrales 2000, 2016). A shift from a mixed economy to agriculture would have implications in vessel assemblages. Most notable in other areas of the Americas have been the introduction of new vessel types, such as *comales* (Beck 2001) or *keros* (Goldstein 2003:150).

A second possibility is that the movement of populations out of the valley produced a complex data set that was not a true representation of vessel assemblages for the period. Small sample sizes and settlements that may have been occupied for a short period of time within the Chiriquí Period could have skewed vessel percentage analyses. Each scenario is plausible, as is the combination of both occurring and affecting the vessel assemblages.

Analysis of the data from within each period also indicates general trends of restricted vessel percentages that are notable. These distinctions occur in the Early and Late Bugaba Phase. This is because these are the phases where there are different types of settlements (homesteads,

hamlets, villages). They also happened to be the most important periods in the development of complex societies in the valley. After these phases, socially complex societies existed with persistent forms of social inequality throughout the Greater Chiriquí.

The Early Bugaba Phase contained homesteads, hamlets, and villages. *T*-tests of differences among vessel percentages within each settlement type did not reveal any statistically significant results. This indicates that cooking, storing, and serving activities did not vary significantly between the different settlement sizes. The greatest variations in cooking and storing and serving activities were within small homesteads. There is a small difference between the percentages of restricted vessels within homesteads (4.2%) and hamlets (5.4%) that may indicate the introduction of maize, which occurred at the beginning of this period.

Within the Late Bugaba Phase, hamlets disappeared and there were only homesteads and villages. The *t*-tests indicate that the differences in the median percentages of restricted vessels between homesteads and villages were not statistically significant ($p=0.93$, $p=0.91$) suggesting that similar storage and cooking activities were occurring within each type.

In both the Early and Late Bugaba Phases there were differences in open vessel percentages between settlement types. These differences were between homesteads and villages. The percentages of open vessels within homesteads (Early Bugaba 2.9%; Late Bugaba 2.8%) was larger than that within the villages (Early and Late Bugaba 1.5%) for both instances. It is possible that these small homesteads were supplementing food production with open vessel production to supply villagers. Yet, waster sherds that indicate ceramic production are extremely rare within the valley. This distinction may also be a relic of averaging. The larger villages contained multiple sectors and not all sectors served equal functions (Palumbo 2009).

Two villages developed in the Upper Río Chiriquí Viejo Valley. These were combined for the statistical analyses of settlement types for the Early and Late Bugaba, but there were also differences between Barriles and Pitti-González (Table 7.18).

Table 7.18. Average percentages of restricted vessels and open vessels out of the total number of sherds at the villages of Barriles and Pitti-González and for each settlement type, using only survey collection lots of 30 or more artifacts (data obtained with permission from Dr. Scott Palumbo and utilizes survey, but not excavation data to maintain consistency in collection methods).

	Early Bugaba Phase Restricted	Late Bugaba Phase Restricted	Early Bugaba Phase Open	Late Bugaba Phase Open
Barriles	3.9%	3.9%	1.9%	1.9%
Pitti-González	5.2%	5.3%	1.0%	1.0%
Homestead 30+	4.2%	4.5%	2.9%	2.8%
Hamlet 30+	5.4%		2.3%	
Village 30+ (Barriles & Pitti-González)	4.5%	4.6%	1.5%	1.5%

Pitti-González had a higher average percentage of restricted vessel rims for the Early and Late Bugaba phases when compared to Barriles (Table 7.18). This suggests that the population at Pitti-González possibly had a different diet or was involved in more activities related to cooking and storage. This contrasts with the averages of the open vessel percentages at each village. In this category, Barriles had a greater percentage indicating more serving activities occurred within the settlement. Palumbo (2009) argued that serving activities in the form of feasting were integral to social change at Barriles and less-so at Pitti-Gonzales. The different averages within each of these two settlements supports that argument.

Vessel percentage patterns within the valley were complex. A change occurred in the valley-wide average restricted vessel percentages between the Late Bugaba Phase and the Chiriquí Period. This may be an indication of a change in diet or food preparation, be an effect of

emigrant population movements, or some combination of both factors. This change comes late in time for the introduction of maize into the diet to have been the primary cause because maize is already within the valley at the end of the Concepción Phase and beginning of the Early Bugaba Phase (Behling 2000; Galinat 1980; Smith 1980). I posit the decrease in restricted vessels is a product of both maize becoming more important in the diet and populations moving out of the valley. In the Chiriquí Period most settlements are found in lower elevations on fertile river terraces that are more hospitable to maize agriculture (Corrales 2016; Drolet 1984b). These locations and the prevalence of *manos* and *metates* have been used as evidence to argue that these populations were agriculturalists (Drolet 1982, 1984a).

The most interesting periods of time in the valley are the Early and Late Bugaba Phases when there are different sizes of settlements on the landscape. Homesteads in the Early Bugaba Phase partook in storage and cooking activities that differed most from those in hamlets. These differences may indicate that the transition from cultivation to agriculture occurred in stages for those upon the landscape or that hamlets served a different purpose than homesteads. The Late Bugaba Phase storage and cooking activities did not differ much from the Early Bugaba Phase, suggesting a consistency in foodstuffs for both phases.

The greatest distinction within the Early Bugaba and Late Bugaba Phases vessel percentages was in open vessels. Percentages were greater within homesteads and hamlets. Homesteads and hamlets may have been producing excess open vessels for trade with villagers. This can often be the case when production requires space and can produce unwanted or unsafe conditions (smoke, fire) when inhabitants are in closer quarters to one another. Yet, there is no additional evidence to support this production.

An alternative interpretation is that the averaging of the village sites has erroneously lowered the percentages of open vessels by combining differently functioning sectors of a village. If Palumbo's (2009:217) excavation data are also included, the averages of restricted and open vessels increase in the Late Bugaba Phase. Restricted vessels at Barriles increase to approximately 6.5% while those of Pitti-González are above 5%. Open vessel percentages increase to 3.8% at Barriles, but they remain consistent with the survey data for Pitti-González at 1.5%. The Early Bugaba Phase closely approximates the survey data with both villages containing slightly more than 3% of cooking vessels in an assemblage and 1-1.5% are open vessels (Palumbo 2009:181).

Most probable is that a combination of both excess production and averaging errors is occurring. The homesteads and hamlets in the Early Bugaba Phase were producing excess vessels for the villages and this activity continued into the Late Bugaba Phase. Then, in the Late Bugaba Phase there were localized feasting events at Barriles (Palumbo 2009) that are evidenced through the excavation data.

This broad level of vessel analysis does not indicate any large disruptions in the percentages of restricted vessels from the Concepción Phase to the Late Bugaba Phase. It suggests that there was a certain level of consistency in diet and food processing techniques until the Chiriquí Period. This supports that there were no newcomers moving into the valley and introducing new subsistence practices or foods. Furthermore, the earliest physical evidence for maize in the valley is dated to the end of Concepción Phase. With no distinct changes in vessel percentages, it suggests there was a gradual incorporation of cultivars that did not cause any abrupt changes in how food was stored or prepared. The only indication of a change is in the

Chiriquí Period when restricted vessel percentages decrease, and this change may be a result of both a change in food preference and an abandonment of the valley.

Chapter 8: Summary and Conclusions

The pre-Columbian populations of the Upper Río Chiriquí Viejo Valley serve as a case study to examine the environmental and social processes involved with the development of complex societies. My research has explored the role of the environment (fertile soils) and access to surplus resources in the form of maize. The maize agriculturalist model proposed that agriculturalists were the first occupants of the valley and dependence upon agricultural products permitted surplus production, creating the right conditions for complex societies to arise. My research has demonstrated inaccuracies in this theory through the analysis of three aspects of the valley's populations: 1) demographic changes over time, 2) settlement patterns in relation to soil fertility, and 3) changes in restricted vessel percentages within assemblages that reflect changes in diet. These three lines of evidence suggest that cultivars were important in the valley, but the cooption of surplus production of foodstuffs may not have been as significant in social change as had been argued.

8.1. Demography, Settlement Patterns, and Diet in the Upper Río Chiriquí Viejo Valley

This research presents the complex nature of the multiple activities of the first sedentary populations during the Concepción Phase of the Upper Río Chiriquí Viejo Valley. Soil fertility was not a significant factor in selecting the location of the first permanent settlements in the Upper Río Chiriquí Viejo Valley. This pattern is contrary to the maize agriculturalist model and the principle of first occupancy, which suggests agriculturalists should be interested in soil properties. Preference for settling on fertile soils emerged during the Late Bugaba Phase and was

most apparent during the Chiriquí Period, once populations were already organized into complex societies and primarily living in lower elevations.

At this moment, there are no settlements identified in the valley that date to the Archaic Period. However, human disturbances connected to land clearing within the Upper Río Chiriquí Viejo Valley are reflected in the Laguna Volcán lake core and began 1145-900 B.C. (Behling 2000:391). This indicates that Archaic populations were within the valley prior to the Concepción Phase. Cultivars, in other areas of Chiriquí, Panama, appear in the Archaic (Dickau et al. 2007; Ranere 1980c). These cultivars include maize dating to 2500-1000 B.C., which was identified from starch grain analysis at the sites of Trapiche and Casita de Piedra (Dickau 2010). Maize was only one of multiple foods utilized in a diet that included tree resources and root crops. The Archaic populations within the valley would have utilized a wide variety of both wild and domesticated resources like those of Trapiche and Casita de Piedra.

The earliest pollen and macrobotanical evidence of maize within the Upper Río Chiriquí Viejo Valley is dated centuries (A.D. 120-390) after that of the Trapiche and Casita de Piedra rock shelters, to the latter part of the Concepción Phase and the Early Bugaba Phase (Behling 2000; Galinat 1980; Smith 1980). This suggests that when maize was introduced to the valley in the Concepción Phase, it was added to a varied diet that relied on wild and other cultivated resources. It also supports the theory that the first inhabitants of the valley were not maize agriculturalists. To further indicate that these were not agriculturalists, we can use the characteristics put forth by Killion (2013:577) to discuss the populations of the Concepción Phase (Table 8.1).

Table 8.1. General characteristics of gardening/horticulture and farming/agriculture (adapted from Killion 2013:577)

Garden/Horticulture	Farming/Agriculture
Closer proximity to habitation and use of small plots	Cultivation of large fields and prepping of soil, including removal of stones
Forming and mixing soil by hand	Land modification for intensification of crop yields (irrigation canals, terraces, etc.)
Tending of individual plants	Patterns of fallow and land clearing schedules
Multiple species cultivated in same plot	Less crop variety and focus on staples
Use many non-food plants in manufacturing, health, and ritual contexts	Generalized tools for agricultural tasks

In the Concepción Phase, there is little evidence to indicate that soil fertility influenced settlement locations and that populations. The few small homesteads on the landscape that were on fertile soil were slightly larger than those on less fertile land, with the majority of settlements on non-arable land. The settlement of Barriles, on non-arable land, was slightly larger than Pitti-González, located on arable land (Palumbo 2009). These two settlements were home to four or five households while the other homesteads in the valley housed one or two families. These household units are contrary to what would be expected from an agriculture dependent population, associated large and permanent settlements (Killion 2013:577).

Homesteads in the Concepción Phase may have been seasonal or only temporarily occupied due to sparse artifact remains and low population estimates. This temporary occupancy supports the argument for the use of a mixed subsistence economy that incorporated cultivars and practiced horticulture (Killion 2013:570). Agriculturalists are generally sedentary populations.

The Concepción Phase evidence indicates that these populations were not practicing agriculture. Inhabitants would have been able to select the best soils without much worry of external factors because of the quantity of arable land available in the valley and the low

population density. Yet, these semi-sedentary to sedentary populations were scattered throughout the valley on varying land classes and with disregard to soil conditions.

Settlement patterns changed during the Early Bugaba Phase. The number of settlements in the valley increased as did the population. In fact, this phase contained the largest number of settlements. The settlements of Barriles and Pitti-González grew in size and population to be the two largest in the valley with maximum populations of about 500 people (Palumbo 2009). These dwarfed smaller homesteads and hamlets throughout the valley. There were five hamlets that had populations greater than those of homesteads, but not reaching the levels of the villages of Barriles and Pitti-González. These were BU-4, BU-11, BU-13/14, BU-22, and BU-55. Only BU-4 was in the Southwest zone of the survey region, while all of the other hamlets were in Bambito. This distinction in settlement sizes indicates a settlement hierarchy developed in the phase, a characteristic of complex societies.

Consistent with the Concepción Phase, soil fertility was not a prominent factor in determining settlement locations in the Early Bugaba Phase, even though botanical evidence places maize in the valley centuries prior. Furthermore, there were no substantial fluctuations in restricted vessel percentages when compared to the Concepción Phase that would indicate significant changes in diet. However, during the Early Bugaba Phase, maize had a greater presence, which is exemplified by the cobs recovered at Pitti-González (Galinat 1980; Smith 1980).

The best evidence suggesting cultivation activities is located within Cerro Punta. These settlements were most likely to be on arable land suited for cultivation. The area also had the highest levels of lithic production activities (cores, flakes, nodules, tools) for the phase (Figure 8.1). These activities are related to the creation of tools to grind maize (*manos* and *metates*),

process plants (mortars, pedestals, and milling stones), and for forest clearance (celts) (Ranere 1980b). The village of Pitti-González, within Cerro Punta, also contained evidence for higher levels of lithic production activities (Palumbo 2009). Furthermore, percentages of celt repair activities were higher in the areas of Cerro Punta and Bambito, suggesting forest clearing activities (Figure 8.2). Lithic production and forest clearing, both activities related to cultivating, were not as prominent in the Southwest as they were in Cerro Punta and Bambito.

Higher percentages of restricted vessels at Pitti-González (5.2%) and in hamlets (5.4%) suggests slightly different food storage and preparation activities occurred in these settlements when compared to the small homesteads (4.2%) and the village of Barriles (3.9%). This difference may be the result of specific cultivars becoming more significant in the diet of those at Pitti-González and in hamlets. Homesteaders within the valley could have sustained a broader diet that still included, but was less dependent upon, cultivars.

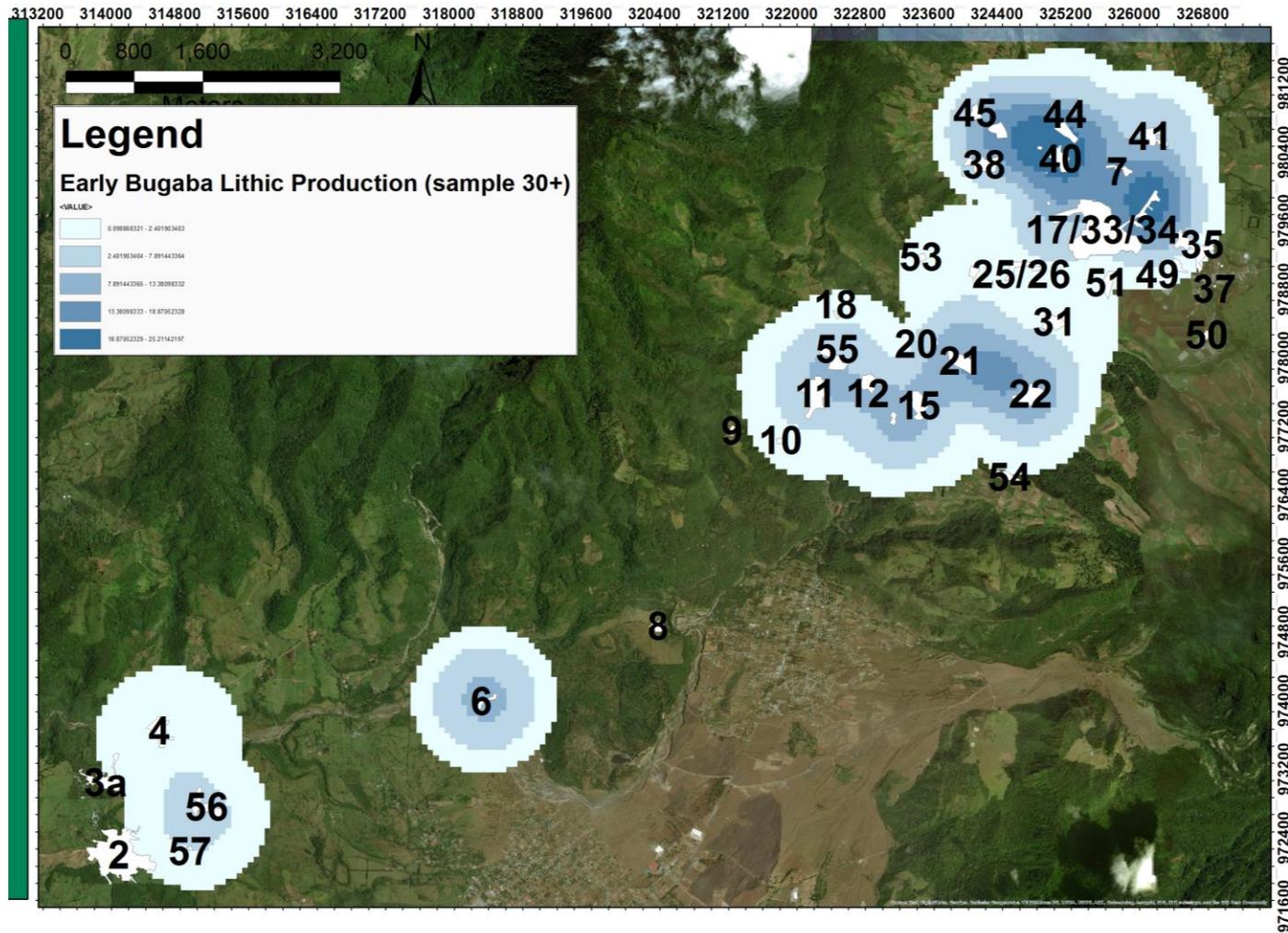


Figure 8.1. Settlements with evidence of lithic production during the Early Bugaba Phase in collections of 30 or more artifacts. Not including Palumbo's (2009) data.

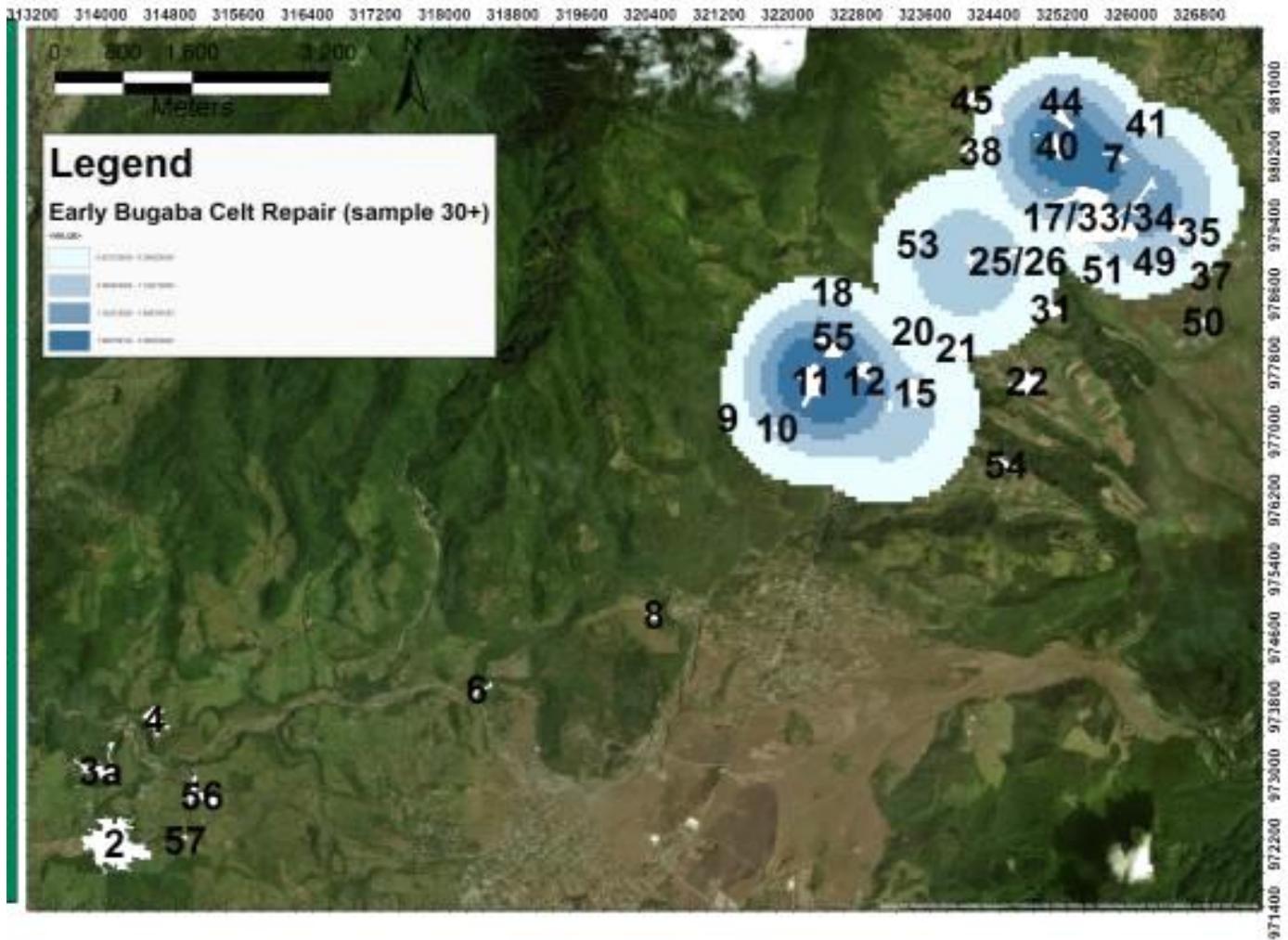


Figure 8.2. Settlements with evidence of celt repair during the Early Bugaba Phase in collections of 30 or more artifacts. Not including Palumbo's (2009) data.

Noteworthy are the soils in Bambito. They are non-arable, yet this is where four of the five hamlets were in the Early Bugaba Phase. One possibility for the development of these hamlets on poorer soils is that the populations cultivating in Cerro Punta were expanding south, looking for additional lands because the best soils were already utilized. This kind of expansion is one of the only instances where the principle of first occupancy can be used to explain settlement locations.

The combination of the presence of maize, importance of soil conditions, lithic production activities, celt repair activities, and restricted vessel percentages all suggest that the population within Cerro Punta, and to an extent, those in Bambito's hamlets, were now clearing more land for cultivation.

There was an increase in population from the Concepción Phase to the Early Bugaba Phase. This increase falls within population growth rates calculated for hunters and gatherers, which are similar to those of agricultural populations when resources are sufficient. The increase could also be due to a new focus on cultivars in Cerro Punta, providing another food source for inhabitants.

The settlement patterns and activities within the valley during the Early Bugaba Phase point to a complex pattern of multiple communities cultivating the landscape. Those at Pitti-González and in hamlets were the first to increase the level of activities related to cultivation. Evidence of the use of mixed resources and that included staple domesticates (maize, beans, sweet potato) exists at Pitti-González (Smith 1980; Galinat 1980). The remaining homesteads in the valley may have continued with a similar mixed subsistence economy but did not include cultivars at the same levels as settlements in Cerro Punta.

Populations at Barriles cultivated lands further than 1 km from their homes and/or bartered with neighbors for subsistence. Most kiln wasters were located at Barriles, indicating at least minimal production of ceramic vessels occurred there within the Early and/or Late Bugaba Phase (Palumbo 2009:261). It is also possible that different subsistence resources and/or cultivars were important in the Southwest area than in Cerro Punta due to the differences in lithic production activities.

The populations within the Early Bugaba are difficult to place on either end of the horticulture/agriculture continuum (Killion 2013). The continued importance of mixed resources and large number of small homesteads suggests that they were horticulturalists tending to their plots while also using the available wild resources.

Late Bugaba Phase settlement patterns differed from both the Concepción and Early Bugaba phases. During this period, population densities reached their peak at Barriles (Palumbo 2009:138) while homesteads and hamlets were abandoned. Two hamlets were completely abandoned while BU-11, BU22, and BU55 decreased in population to become homesteads. Pitti-González remained similar in size. The total population of the valley remained similar to that of the Early Bugaba Phase, providing evidence that inhabitants abandoned homesteads and hamlets to move to the larger villages.

Collection lots with 30 or more artifacts indicated, for the first time, there was a slight preference to settle on fertile soil. This preference may be the result of an increase in the importance of staple cultivars and those cultivating these products were seeking better soils for greater returns. Lithic production activities continued to occur in greater quantities in Cerro Punta and Bambito (Figure 8.3) as did celt repair (Figure 8.4). Specifically, at Pitti-González

lithic production activities increased in intensity when compared to the Early Bugaba Phase (Palumbo 2009:266).

Pitti-González continued to have larger percentages of restricted vessels (5.3%) than other settlements in the valley. Percentages of these vessels slightly increased in the remaining homesteads (4.5%) on the landscape and continued at Early Bugaba Phase ratios in Barriles (3.9%). This slight increase at the homesteads may be a signal that homesteaders were more reliant on cultivars in their diet.

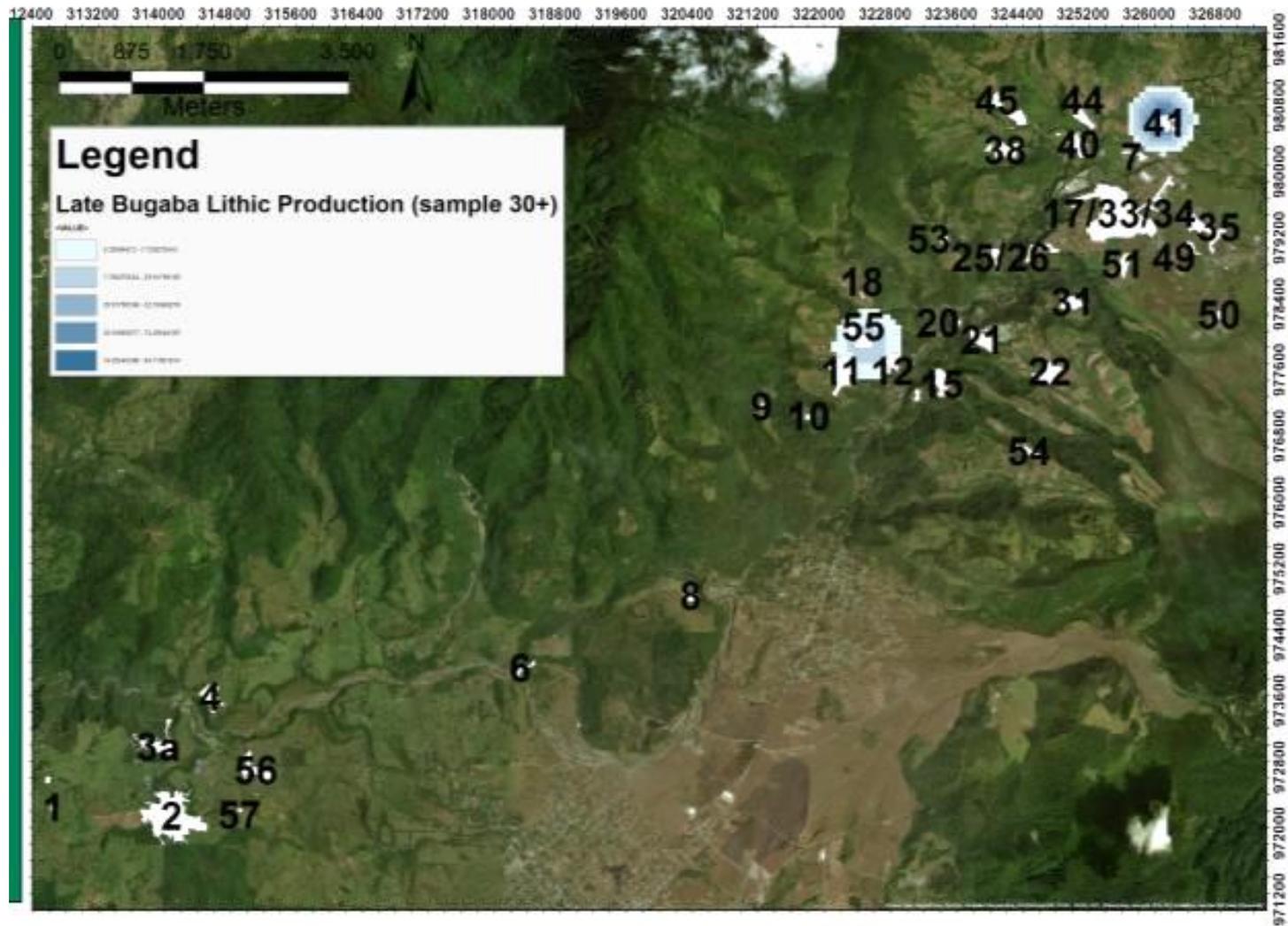


Figure 8.3. Settlements with evidence of lithic production during the Late Bugaba Phase in collections of 30 or more artifacts. Not including Palumbo's (2009) data.

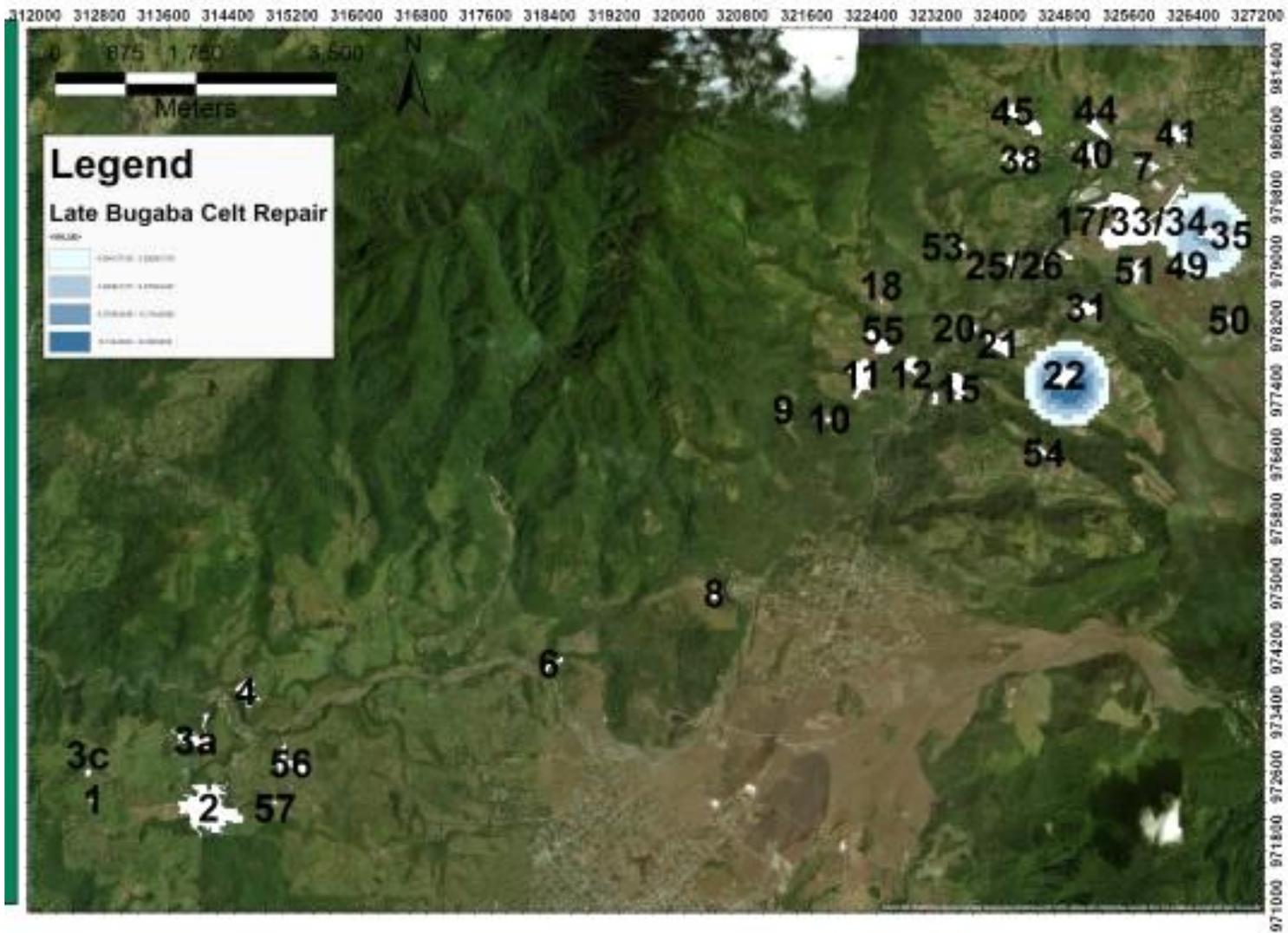


Figure 8.4. Settlements with evidence of celt repair during the Late Bugaba Phase in collections of 30 or more artifacts. Not including Palumbo's (2009) data.

Barriles almost doubled in population during this phase and an increase in the importance of good soils does not explain movement to this settlement on non-arable land. The hamlet of BU-4, across the Río Chiriquí Viejo from Barriles and on the best soils in the valley, was abandoned during the Late Bugaba Phase and indicates that additional factors must have made living in villages more attractive than in smaller homesteads and hamlets. For Barriles, this may be explained by evidence of feasting events. Open vessel percentages for the Late Bugaba Phase were greatest in homesteads, but when excavation data from Barriles is combined with survey data, percentages at Barriles reach slightly less than 4% (Palumbo 2009:217). This is larger than the 2.8% in homesteads. Restricted vessel percentages also greatly increase when both excavation and survey data are combined. This combined data set indicates that Barriles had localized feasting events (Palumbo 2009) that could have drawn populations from surrounding areas.

Larger villages may also have been appealing locations to live because they offered protection. Iconographic evidence at Barriles suggests warfare was integral to ceremonial celebrations. Ceremonial *metates* located at the settlement contained figures of warriors with axes and stylized trophy heads (Stirling 1950). Unfortunately, human remains do not survive the valley's soil conditions so confirming the frequency of interpersonal conflict is difficult.

Considering the sizable population at Barriles and evidence indicating they were involved in different activities than those from Pitti-González, the question that arises is how the villagers were obtaining food in the Late Bugaba Phase. The catchment area for Barriles was slightly over 200 ha. To feed the population at the village during the phase, over 600 ha of arable land were

necessary, demonstrating that additional resources were supplied by other settlements and/or the inhabitants were venturing further than 1 km to tend cultivars.

The catchment area for Pitti-González was also smaller than required for its population, although, not to the extent than that of Barriles. Pitti-González was over 10 ha larger than Barriles, but its catchment area was extremely small (56 ha) because it was surrounded by other settlements. If we pretend those small homesteads were incorporated into Pitti-González and overlay Barriles' catchment area, Pitti-González residents would only require an additional 120 ha of arable land to fully support the population in the Late Bugaba Phase.

Significant changes occurred within the Late Bugaba Phase. For the first time, fertile soil was a factor in settlement locations. Populations moved around the landscape abandoning homesteads and hamlets for Barriles village life. The remaining homesteaders may have depended more on cultivars within their diet because of the increase in restricted vessels. Similar to the Early Bugaba Phase, villagers were required to travel further to tend to their cultivars and/or bartered for additional resources. The focus on soils and living in large settlements suggests that these populations were changing their cultivation strategies from gardening to farming (Killion 2013:577). Furthermore, prominent activities within each village were distinct. Those at Pitti-González increased their lithic production, while those at Barriles held feasting events (Palumbo 2009).

The Chiriquí Period contained the most drastic settlement changes of all periods, an almost complete abandonment of the valley. Populations that remained were those that were on arable soils. A couple homesteads resided on non-arable soils, but of the few remaining, over half were on better soils and were larger in size than those on non-arable land.

The valley-wide population reverted to Concepción Phase numbers. This drastic decrease in population could have been caused by a disease or other biological factor that either increased death rates or decreased birth rates. However, the most plausible explanation is that there was an emigration of approximately three fourths of the population out of the valley. Pollen samples support evidence of a small population due to the recovering lower montane rain forest around A.D. 900 (Behling 2000:391-392).

Percentages of restricted vessels decreased significantly ($p=0.009$) from the previous periods, indicating a change in food preparation and storage activities. This change may indicate a shift in the diet caused by the introduction of new foods, a focus on specific cultivars, and/or a new way of cooking and storing foodstuffs. These percentages would be even smaller if one considers Biscuit Ware from the period as only a decorative mortuary ceramic due to its delicate, thin walls (e.g. Corrales and Badilla 2018),

One thing to note is that vessel percentages for the Chiriquí Period were calculated from a small number of collection lots (16), which increases the potential for erroneous conclusions. However, these were collection lots of 30 or more sherds and the difference in open vessel percentages was not significant ($p=0.27$), supporting that the calculations are representative of reality.

Abandonment of the valley in the Chiriquí Period had previously been attributed to the eruption of Volcán Barú (Linares and Ranere 1980). Current evidence negates this theory. The latest and largest eruption of Volcán Barú happened around A.D. 1300, after vegetation had already been recovering for 400 years (Behling 2000; Holmberg 2009; Sherrod et al. 2007). However, after this last eruption, any evidence of agriculture stopped, and the valley seemed to be nearly abandoned (Behling 2000:392).

8.2. Surplus and Complexity in the Upper Río Chiriquí Viejo Valley

The demographic changes, settlement patterns, and vessel percentages within the valley provide an insight into the processes involved in increasing social complexity. The maize agriculturalist theory relied heavily on the idea of agricultural surplus as the prime mover for social change. While surplus is necessary to support larger populations and free individuals to pursue activities other than subsistence procurement, it was not the sole factor in the development of inequalities. Settlement patterns and artifact evidence within the valley do not support the principle of first occupancy model, but rather indicate multiple strategies were utilized in the development of social inequalities and complex societies.

The presence of cultivars does not indicate an agricultural society. Populations within the Upper Río Chiriquí Viejo Valley changed their cultivation activities, from gardening to farming, over multiple centuries. In this case, maize was incorporated into the diet during the Archaic Period within the region, yet an increase in cultivation activities did not begin in the valley until the Early Bugaba Phase. These practices were most recognizable in the areas of Cerro Punta and Bambito with a focus on soil conditions, higher percentages of restricted vessels, more lithic production and celt repair activities. The addition of cultivars into a varied diet had the benefit of surplus production, which was necessary to feed those living in the larger villages. The development of complexity, indicated by a settlement hierarchy in the Early Bugaba, was not the outcome of an agricultural society, but one based on horticulture (Killion 2013). This is relevant to current discussions on the importance of agriculture in increasingly complex societies. Killion (2013:570) has argued that the Olmec were nonagricultural. The inhabitants of the Upper Río

Chiriquí Viejo Valley can be added as an example of increasing social complexity through horticultural practices in the Early Bugaba Phase.

The principle of first occupancy was first used as a model in Mesoamerica (McAnany 1995). It best describes the village of Pitti-González on arable land, in Cerro Punta, that grew to be larger than Barriles in the Early Bugaba Phase. Inhabitants worked all the best soils in Cerro Punta and, possibly, forced the utilization of less suitable soils in Bambito, indicated by the development of the hamlets. Yet, in the same valley, the village of Barriles formed, contrary to the principle of first occupancy. Barriles increased in size and population on non-arable land and lacked the same evidence for a focus on cultivation practices. Furthermore, despite the size of both villages, each contained only minor distinctions in status and domestic activities in the Early Bugaba Phase (Palumbo 2009).

These social distinctions strengthened in the Late Bugaba Phase and Barriles continued as evidence against the principle of first occupancy model. It contained more prominent distinctions in status, had a larger population than Pitti-González, and contained a mound in conjunction with large stonework figures (Palumbo 2009:212). Homesteaders and those in hamlets abandoned their respective settlements for village life at Barriles.

There is no evidence that the social distinctions at Barriles developed from the control of surplus foodstuffs, this pathway to power best describes the situation at Pitti-González, on arable land and with an increase in lithic production activities (Palumbo 2009). However, indicators of status remained minimal and the greatest evidence was at Barriles (Palumbo 2009). This suggests that we must look beyond the environment and at the additional social activities within Barriles that would have aided in the creation of leadership positions.

Barriles contained evidence of feasting activities (Palumbo 2009). Ceremonial feasting events at Barriles during the Late Bugaba Phase period could have drawn in participants and food tributes from surrounding areas (Dietler and Herbich 2001). The individuals presiding over the events may have used their positions to garner further wealth and status (Earle 2011; Hayden 2001; Redmond 1998c). These kinds of activities coincided with the creation of a ceremonial area that included a mound, stone statues, and ceremonial *metates* (Rosenthal 1980; Stirling 1950).

Warfare is another social factor that affected the populations within the valley. The aggregation of populations into villages during the Late Bugaba Phase may be explained by interpersonal conflict. A famous *metate* from Barriles contained iconographic depictions of trophy heads (Linares et al. 1975:Fig.5B, Fig.5C). Furthermore, the stone statues at Barriles are argued to possibly depict leaders on the shoulders of prisoners (Hoopes 1996). Warriors could achieve notoriety and use that as another pathway to power and the creation of permanent leadership positions (Earle 2011).

During the Chiriquí Period, when agriculture was practiced in other areas of the Greater Chiriquí, the valley was abandoned. Scholars have argued that populations at this time were dependent upon maize and moved to lower elevations that were more suitable for the crop (Corrales 2016; Drolet 1983, 1984a). Evidence from the valley does suggest that cultivars were important in the Chiriquí Period due to the importance of soil fertility. However, there are other considerations that must be ruled out such as disease and changes in social relations that might create buffer zones (warfare, resource control).

Furthermore, if the argument is that populations were maize dependent in the Chiriquí Period, and moved to specific areas to grow the crop, it supports the theory that mixed resources

were used and important in the Upper Río Chiriquí Viejo Valley in the previous periods. Current crops in Cerro Punta are those that do well in cooler climates.

The sociopolitical trajectories of settlements in the valley suggest that control over surplus production was not used to create leadership positions. If this had been the case, the increasing inequalities should have been most prevalent in Cerro Punta and Pitti-González. Rather, surplus went to villagers and participation in ceremonial events at Barriles. It was through these ceremonial activities that included feasting and references to warfare that the greatest social inequalities developed and were reinforced. Surplus was a necessity for maintaining a larger population in the valley and permitted villagers to pursue leadership roles.

This research furthers discussions on the importance of environmental factors in increasing complexity. In the southern American Bottom, diversity of resources is an important characteristic of the longevity of settlements (Schroeder 2004). Settlers within the Upper Río Chiriquí Viejo Valley also depended on a diverse set of resources and a settlement hierarchy developed while these populations were using multiple wild and domesticated resources in the Early Bugaba Phase (e.g. Pitti-González and the hamlets). Unlike the settlement patterns on the Polynesian island of Maui and those of the Late Classic Maya (e.g. Ford et al. 2009; Kirch et al. 2004), settlements initially were not strategically placed on or near the best agricultural land because of the importance of mixed resources. The importance of cultivars in the diet grew over centuries.

Situating this research using a comparative perspective, the societies within the valley did live within certain areas that may be considered environmentally circumscribed, but they did not have high densities where population pressure would have been a factor (i.e. Carneiro 1970). Additionally, the catchment analysis indicates that there would have been sufficient resources to

sustain the populations within the valley. We must look to other factors to address why Barriles contains the most visible signs of a social hierarchy. Religion and ceremonial events created social spaces for many kinds of relationships to develop. Ceremonial feasting events can be associated with the control of labor (Dielter 1990), the control of rituals and ritual knowledge (Aldenderfer 1993) and used to celebrate warfare activities (Johnson and Earle 1987). These kinds of events are described in the Philippines (Junker 1999) and the Protohistoric Rio Grande (Graves and Spielmann 2000). Through these events, leadership roles could have developed. Ceremonial feasting events created situations for leaders to create positions, but not necessarily maintain those positions. For example, it appears that the elites at Barriles had a short-lived existence of a few hundred years before the valley was abandoned, a changing of the sociopolitical structures that has been identified in other complex societies, such as the chiefdom cycling of the Mississippian Savannah River societies (Anderson 1994).

8.3. Future Directions

Once a project has finished, there are always more questions than answers. My research is no exception. More research is required on the diets of inhabitants of the valley and the social factors involved in the development of complex societies.

Analyses using macro- and microbotanical evidence will provide additional species present, the prevalence of these items in the valley, and contexts. These kinds of studies rely on starch grain analyses conducted on lithic tools and ceramic residue analyses. An analysis of ceramic residues and starch grains for each time period would indicate whether different foods were consumed in different areas. For example, did the Barriles population eat differently than that of Pitti-González in the Early and Late Bugaba Phases. It would also indicate how prevalent

maize was in the everyday diet of the inhabitants of the valley. With additional botanical analyses, we can have a robust discussion of the cultivars within the valley and better position populations along the horticulture/agriculture continuum.

Researchers are investigating how climate change in the last few millennia may have aided in the development of agriculture (Hassan 2009). A closer examination of the climate patterns within the valley would indicate whether changes in weather patterns created a better or more hostile environment for cultivars. Lake core samples would provide evidence of weather patterns through a complete analysis of the species in the valley.

Future research projects should also continue to explore the social factors involved in the development of complexity. Research by Palumbo (2009) examined feasting activities within Barriles and Pitti-González and a handful of smaller settlements. These activities aided in social change at Barriles. Horizontal excavations at a handful of the smaller settlements would provide information about how households outside of the town participated, or did not participate, in these activities. I encountered the fancy Bugaba Engraved ceramics associated with feasting at homesteads, but greater contextual information may be able to distinguish if participants were conducting their own feasting events at home or joining others at Barriles. Ceramic residue analyses would strengthen the comparison by examining the contents of Bugaba Engraved ceramics from Barriles and those from homesteads and hamlets.

Warfare was important in the ceremonial events at Barriles and the maintenance of leadership positions. Individuals that excelled as warriors or directed warfare raids may have emerged as prominent leaders. They may also have led ceremonial events or been important participants. Analyses on the locations of settlements with regard to buffer zones or defensible locations may further discussions on the frequency of warfare activities.

The depopulation of the valley remains an enigma and should be explored. Others argue that it was the importance of certain cultivars, including maize, that contributed to the depopulation during the Chiriquí Period in the valley. Current crop agriculture primarily includes potatoes, onions, carrots, and cabbage in the Cerro Punta area, all colder weather crops. Barriles and its surrounding area is mostly ranchland with cattle. Neither region is ideal for maize cropping, although some small plots were around Barriles. Lower elevations with alluvial soils would have had the best conditions for growing maize. This is where we find the majority of Chiriquí Period settlements in southern Costa Rica, recognized as agricultural populations (Corrales 2000; Drolet 1982, 1983, 1984b, 1986, 1988, 1989; Findlow et al. 1979). However, other scenarios such as abandonment due to increased warfare activities, disease, changes in trading networks, etc. cannot be ruled out and each should be addressed.

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Appendix

				Con	CP Orange			Valbuena			Plain			Bugaba Eng			Zon	Bis	Polych.		Unidentified		
North	East	Ty	Tot	Bod	Bod	Res	Op	Bod	Res	Op	Bod	Res	Op	Bod	Res	Op	Bod	Bod	Bod	Res	Bod	Res	Op
972580	312585	G	6	0	2	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
972258	312644	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
973040	313874	Sy	43	0	16	0	2	3	0	0	12	0	0	1	0	0	0	4	0	0	5	0	0
973284	314024	Sy	29	0	12	0	1	5	0	1	1	0	0	0	0	0	0	6	0	0	1	0	0
973296	314031	ST	14	0	2	0	0	3	1	0	0	0	0	0	0	0	0	3	0	0	3	2	0
973285	314041	ST	33	0	7	0	0	19	0	0	2	0	0	0	0	0	0	1	0	0	2	0	0
973262	314051	ST	14	0	3	0	0	6	0	0	0	0	0	0	0	0	0	4	0	0	1	0	0
973312	314062	ST	4	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
973291	314067	ST	4	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
973278	314074	ST	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
973308	314078	ST	13	0	6	0	0	1	0	0	0	0	0	0	0	0	0	4	0	0	2	0	0
972966	314126	G	9	0	1	0	1	2	0	0	0	0	0	0	0	0	0	4	0	0	1	0	0
973551	314500	Sy	23	0	20	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
973610	314507	Sy	19	0	9	0	0	4	0	0	0	0	0	0	0	0	0	2	0	0	4	0	0
973596	314509	G	17	0	11	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
973575	314532	Sy	30	0	12	3	1	7	0	0	2	0	0	0	0	0	0	0	0	0	5	0	0
973617	314542	Sy	26	0	16	1	0	2	0	0	0	0	1	0	0	0	0	1	0	0	5	0	0
973733	314554	Sy	39	1	20	0	0	3	0	0	3	0	0	0	0	0	0	0	1	0	9	0	0
973592	314573	G	21	0	20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
973663	314573	Sy	118	2	71	1	2	19	1	1	4	0	0	0	0	0	0	2	0	0	12	0	0
973449	314579	G	53	0	36	4	4	2	1	0	0	0	0	1	0	0	0	0	0	0	3	0	0
973400	314613	Sy	33	0	23	1	0	3	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0
973423	314616	Sy	50	1	39	1	1	3	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0
973448	314619	Sy	53	0	34	3	0	8	0	0	1	0	0	1	0	0	0	0	0	0	3	0	1
973512	314640	Sy	19	0	14	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
973695	314649	Sy	7	0	4	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0

973481	314680	G	64	0	47	3	1	1	0	0	1	0	0	1	0	0	0	0	0	0	3	0	0
973481	314680	G	85	0	53	3	3	12	1	0	1	0	0	0	0	0	0	0	0	0	8	0	0
972197	314895	G	8	0	4	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
972705	314977	G	18	0	7	0	0	3	0	0	4	0	0	0	0	0	1	0	0	0	3	0	0
972592	314981	Sy	31	0	20	2	1	3	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0
972593	314985	G	7	0	1	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
972861	315004	Sy	79	0	35	1	2	20	0	0	6	0	0	0	0	0	2	0	0	10	0	0	
972712	315029	Sy	42	0	8	0	1	5	0	1	14	3	0	1	0	0	0	1	0	0	4	0	3
972926	315037	Sy	25	0	9	1	0	8	0	0	3	0	0	0	0	0	1	0	0	2	0	0	
972878	315043	Sy	108	0	50	7	2	20	1	0	5	0	0	0	0	0	3	0	0	16	0	0	
972905	315043	Sy	49	0	23	2	1	7	0	0	4	0	0	3	0	0	0	0	0	0	8	0	0
972849	315044	Sy	78	0	32	4	1	18	1	3	5	0	0	1	0	1	0	4	0	0	8	0	0
972721	315121	G	132	2	80	2	0	29	0	0	4	0	0	0	0	0	0	0	0	0	14	0	0
972647	315248	G	3	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
969193	315916	ST	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
969280	315929	ST	3	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
969310	315945	ST	30	0	5	1	0	9	0	0	6	0	0	2	0	0	0	4	0	0	3	0	0
969322	315952	ST	20	0	8	0	2	7	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0
969284	315954	ST	30	0	15	1	1	10	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
969308	315954	ST	45	0	21	0	1	14	0	0	0	0	0	1	0	0	0	1	0	0	6	0	0
969293	315958	ST	41	0	26	0	0	8	0	0	0	0	0	2	0	0	0	0	0	0	3	0	0
969258	315959	ST	2	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
969309	315965	ST	13	0	9	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
969310	315977	ST	12	0	6	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
969361	315980	ST	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
969187	315983	ST	9	0	3	0	0	2	0	0	3	0	0	1	0	1	0	0	0	0	1	0	0
969353	315986	ST	17	0	7	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	5	0	0
969337	315999	ST	4	0	2	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
969285	316004	ST	5	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
969214	316005	ST	39	0	13	1	1	10	0	1	2	0	0	1	0	1	0	0	0	0	7	0	1
969191	316010	ST	8	0	1	0	0	1	0	0	1	0	0	2	0	0	0	2	0	0	1	0	0
969314	316010	ST	15	0	5	0	0	7	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
969312	316022	ST	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
970163	316262	ST	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
973859	318283	ST	19	0	3	1	0	12	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0

973950	318319	Sy	28	0	19	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
973953	318354	Sy	45	0	26	1	1	3	0	1	2	0	0	1	0	0	0	0	0	0	4	0	0
973956	318358	Sy	17	0	9	1	0	4	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0
973963	318463	G	7	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
977114	321262	G	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
976963	321806	G	3	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
977589	322033	G	21	0	14	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
977266	322104	G	14	0	7	0	1	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
977694	322104	ST	21	0	10	0	0	2	0	0	5	0	0	0	0	0	0	0	0	0	3	0	0
977498	322112	G	3	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
977685	322116	ST	32	0	11	1	0	14	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
977327	322146	G	7	0	3	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0
977391	322149	G	18	0	4	1	1	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
977648	322151	ST	35	0	19	2	0	7	0	0	0	0	0	0	0	0	1	0	0	0	6	0	0
977668	322162	ST	7	0	2	0	1	2	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
977644	322175	Sy	68	0	42	3	0	17	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0
977462	322218	Sy	96	6	27	1	2	25	1	1	6	1	0	11	0	0	0	0	0	0	9	0	0
977386	322233	G	67	0	33	1	4	16	2	0	1	0	0	0	0	0	0	0	0	0	4	0	0
977682	322241	G	26	1	12	5	1	3	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0
977987	322293	G	19	0	10	1	1	1	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0
977358	322301	G	7	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
977516	322309	Sy	26	3	16	1	1	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
977658	322315	Sy	76	0	46	5	1	12	1	0	4	0	0	0	0	0	0	0	0	0	3	0	0
978041	322317	G	23	0	17	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	2	0	0
978035	322335	Sy	13	0	5	1	0	2	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0
977966	322345	G	14	0	5	1	0	6	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
978018	322364	Sy	8	0	7	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
977857	322394	G	137	0	72	8	3	24	0	0	11	0	0	3	0	0	0	0	0	0	7	0	0
977964	322414	G	17	0	11	1	1	1	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0
977857	322418	Sy	75	0	38	4	1	14	1	0	6	0	1	0	0	0	0	0	0	0	5	0	0
978462	322442	Sy	3	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
977848	322453	Sy	93	0	48	2	1	24	0	2	3	0	0	1	0	0	0	0	0	0	9	0	0
977842	322479	Sy	96	0	44	0	5	26	1	0	7	0	0	2	0	0	0	0	0	0	5	0	0
977924	322498	G	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
977848	322503	Sy	80	0	40	5	2	26	2	0	1	0	0	0	0	0	0	0	0	0	2	0	0

977831	322531	Sy	91	0	25	4		36	1	1	12	0	0	0	0	0	0	0	0	0	10	0	0
977814	322538	G	160	0	85	9	2	44	0	0	5	3	0	0	0	0	0	0	0	0	9	0	0
977176	323087	Sy	99	0	65	3	2	24	0	0	1	0	0	0	0	0	0	0	0	0	3	0	0
977252	323127	G	31	0	26	2	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
977218	323131	Sy	99	0	70	3	2	19	0	0	3	0	0	0	0	0	0	0	0	0	2	0	0
977379	323359	G	71	0	44	6	2	13	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
977240	323371	Sy	19	0	18	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
979103	323428	G	6	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
977249	323454	Sy	85	0	65	2	2	13	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
978101	323611	Sy	111	0	48	5	0	42	1	1	2	0	0	1	0	0	0	0	0	0	7	0	0
978125	323632	Sy	53	0	38	1	0	6	1	0	1	1	0	0	0	0	0	0	0	0	4	0	0
977923	323794	G	21	2	9	1	2	6	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
977932	323989	G	43	0	27	3	3	3	0	0	1	0	0	0	0	0	0	0	0	0	3	0	0
980193	324023	G	17	0	10	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
978891	324024	Sy	92	0	68	3	1	10	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0
978955	324045	G	20	0	11	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
977856	324053	G	18	1	10	1	0	3	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0
980779	324057	G	2	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
978976	324069	G	18	0	16	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
977890	324070	Sy	25	0	12	0	1	7	0	0	3	0	0	0	0	0	0	0	0	0	2	0	0
978788	324081	Sy	32	0	22	2	1	4	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
980852	324094	G	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
980819	324099	G	4	0	2	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0
978958	324103	Sy	59	1	36	1	1	16	0	0	1	0	0	0	0	0	0	0	0	0	4	0	0
978790	324104	Sy	40	1	24	4	0	9	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
980731	324125	G	2	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
980171	324148	G	22	0	16	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0
980132	324155	G	5	0	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
980252	324158	G	5	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
980215	324194	G	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
980144	324236	G	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
980606	324246	G	3	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
978811	324282	G	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
980132	324283	G	4	0	1	0	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
980579	324292	G	19	0	13	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0

976579	324363	G	4	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
980657	324376	Sy	36	0	8	0	0	15	1	0	4	0	0	2	0	0	0	0	1	1	6	0	0
980310	324380	Sy	17	0	9	0	1	1	0	1	2	0	0	0	0	0	0	0	0	0	3	0	0
980545	324420	G	28	0	19	0	0	5	0	0	0	0	0	1	0	0	0	0	0	0	3	0	0
978848	324435	Sy	21	0	13	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
978889	324471	G	85	1	54	2	2	9	1	2	0	0	0	0	0	0	0	0	0	0	12	0	0
976548	324485	G	7	0	3	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
979018	324504	G	150	0	93	7	4	13	1	0	8	0	0	3	1	2	0	0	0	0	17	0	0
977466	324519	Sy	12	1	6	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
977484	324542	Sy	102	1	53	7	2	22	1	1	6	0	0	0	0	0	0	0	0	0	8	0	0
977440	324566	Sy	4	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
977470	324571	Sy	56	0	32	3	0	12	2	0	2	0	0	0	0	0	0	0	0	0	3	0	0
977429	324594	Sy	61	0	32	4	0	17	1	0	3	0	0	0	0	0	0	0	0	0	3	0	0
977461	324603	Sy	81	0	44	4	1	19	0	1	3	0	0	0	0	0	0	0	0	0	7	0	0
979039	324626	Sy	6	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
977461	324630	G	55	0	34	5	1	10	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
977439	324638	Sy	80	0	43	2	1	19	2	1	1	0	0	0	0	0	0	0	0	0	8	0	0
977494	324645	G	18	0	6	2	0	6	0	0	0	0	0	1	0	1	0	0	0	0	3	0	0
979013	324657	G	27	0	16	3	0	5	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0
977570	324683	G	52	0	21	4	1	10	1	0	3	0	1	4	0	0	0	0	0	0	5	0	0
977396	324705	G	15	0	10	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	3	0	0
979030	324705	Sy	28	0	14	2	0	4	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
977449	324711	G	27	0	11	3	0	10	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0
977408	324729	Sy	22	0	0	0	0	6	0	1	11	0	0	0	0	0	0	0	0	0	4	0	0
977410	324775	G	18	0	0	0	0	11	1	0	1	0	0	1	0	0	0	0	0	0	2	1	0
978982	324786	G	11	0	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
977415	324793	G	21	0	10	1	0	3	0	2	4	0	0	0	0	0	0	0	0	0	0	0	0
980387	324833	G	11	0	6	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
978420	324891	G	66	0	35	2	0	24	1	0	1	0	0	0	0	0	0	0	0	0	3	0	0
978392	324896	Sy	24	0	13	1	1	5	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0
978424	324897	Sy	31	0	20	2	0	4	0	0	0	0	0	0	0	0	1	0	0	0	4	0	0
980098	324908	G	5	0	3	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
978314	324915	Sy	18	0	9	0	1	4	1	1	0	0	0	0	0	0	0	0	0	0	2	0	0
978317	324919	G	103	0	56	4	2	23	3	2	2	0	0	0	0	0	0	0	0	0	7	0	0
978417	324930	Sy	19	0	14	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0

979732	324935	G	8	0	2	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
980280	324953	G	9	0	5	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
978365	324990	G	12	0	6	1	0	3	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
980333	325024	G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
980242	325040	Sy	6	0	4	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
978363	325041	G	21	0	11	5	0	5	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
980199	325042	Sy	101	0	68	0	1	17	0	0	0	0	0	2	0	0	0	0	0	0	12	0	0
980199	325046	ST	33	0	23	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0
980218	325062	ST	34	0	19	0	1	8	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
980219	325062	Sy	8	1	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
980391	325067	G	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
979593	325070	G	31	0	22	0	2	4	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0
978316	325084	G	24	0	12	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	7	0	0
980305	325086	G	6	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
980275	325099	G	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
980694	325108	G	30	0	16	4	1	4	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
979614	325132	G	9	0	7	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
980130	325132	G	110	7	55	5	1	32	0	0	1	0	0	0	0	0	0	0	0	0	6	0	0
980238	325155	G	23	0	15	1	1	4	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
980510	325224	Sy	50	0	23	5	0	13	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0
980451	325233	Sy	5	0	2	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
978786	325607	G	22	0	14	1	1	3	0	0	1	0	0	0	0	0	0	0	0	0	2	0	0
978822	325611	G	24	0	14	1	2	2	0	0	3	0	0	0	0	0	0	0	0	0	2	0	0
980156	325616	Sy	35	0	20	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0
978873	325641	G	31	0	20	0	0	5	0	0	0	0	1	0	0	0	0	0	0	0	5	0	0
978939	325643	G	73	1	44	2	0	14	1	0	0	0	0	0	0	0	0	0	0	0	8	0	0
980163	325676	Sy	21	1	14	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
980146	325712	Sy	29	2	13	0	2	5	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0
980164	325818	Sy	157	1	89	4	2	27	0	0	1	0	0	0	0	0	0	0	0	0	31	0	0
980060	325846	Sy	14	0	9	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
979509	325852	G	26	0	15	3	0	4	0	0	1	0	0	1	0	0	0	0	0	0	2	0	0
980103	325879	G	34	0	17	2	0	9	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0
979523	325884	Sy	7	0	5	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
979542	325900	Sy	99	0	59	5	2	18	3	1	1	0	0	0	0	0	0	0	0	0	7	0	0
979564	325917	Sy	73	0	38	4	2	12	1	1	2	0	0	1	0	0	0	0	0	0	10	0	0

979503	325921	Sy	49	0	19	0	2	17	0	0	3	0	0	1	0	0	0	0	1	0	4	0	0
979585	325939	Sy	58	0	32	4	1	11	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0
979534	325946	Sy	110	3	33	9	1	34	3	0	8	0	0	1	1	0	0	0	0	0	13	0	0
979601	325965	Sy	127	9	68	0	1	28	1	0	6	1	0	1	0	0	0	0	0	0	6	0	0
979473	325969	Sy	47	1	24	4	2	12	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
979618	325986	Sy	131	0	69	1	1	42	0	0	0	0	0	1	0	0	0	0	0	0	17	0	0
979491	325992	Sy	94	0	44	2	0	26	0	1	3	0	0	1	0	0	0	0	0	0	14	1	0
979572	325998	Sy	135	0	79	7	3	22	3	1	5	0	0	0	0	0	0	0	0	0	13	0	0
979635	326011	Sy	101	0	56	0	1	28	0	0	2	1	0	0	0	0	0	0	0	0	9	0	0
979590	326017	Sy	89	4	44	1	0	28	0	0	0	0	0	2	1	0	0	0	0	0	7	0	0
979652	326017	Sy	100	0	51	3	0	23	0	1	11	0	0	0	0	0	0	0	0	0	10	0	0
980548	326027	G	7	0	4	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
979606	326032	Sy	88	0	56	0	3	12	1	1	0	0	0	0	0	0	0	0	0	0	13	0	0
980620	326034	Sy	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
979556	326049	Sy	120	1	67	4	0	21	1	1	2	0	0	3	0	0	0	0	0	0	13	1	0
980581	326055	G	12	0	8	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
979689	326058	Sy	33	0	22	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
979694	326068	G	196	7	117	6	1	42	0	0	9	1	0	0	0	0	0	0	0	0	12	0	0
980489	326074	Sy	24	0	12	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	6	0	0
979592	326080	Sy	162	0	79	6	2	49	0	1	4	0	0	0	0	0	0	0	0	0	11	0	0
980563	326086	Sy	16	0	4	1	0	4	0	1	1	0	0	0	0	0	0	0	0	0	4	0	0
979733	326089	Sy	108	0	60	2	0	31	0	1	3	0	0	0	0	0	0	0	1	0	6	0	0
980463	326090	G	54	0	44	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
980550	326093	Sy	2	0	1	0		1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
979764	326128	Sy	22	0	16	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
979680	326132	Sy	89	0	48	2	2	29	0	0	3	0	0	0	0	0	0	0	0	0	4	0	0
980552	326133	G	94	0	31	3	0	41	0	0	0	0	1	1	0	1	0	0	1	0	13	0	0
979670	326145	Sy	72	0	38	0	2	19	0	0	1	0	0	1	0	0	0	0	0	0	11	0	0
980561	326156	G	5	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
980523	326166	Sy	4	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
980497	326171	Sy	4	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
979869	326186	G	6	0	3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
980478	326202	Sy	20	0	12	2	0	3	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0
980476	326222	Sy	24	0	16	0	2	5	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
979771	326224	G	7	0	6	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

980435	326229	Sy	83	0	51	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0
980462	326233	Sy	18	0	12	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
980556	326236	Sy	6	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
980583	326278	Sy	7	0	4	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
980451	326302	Sy	15	0	7	2	0	2	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0
979035	326394	G	6	0	2	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
979078	326410	G	8	0	3	0	0	2	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0
978976	326426	G	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
979037	326439	G	17	0	2	0	0	3	1	0	2	0	0	0	1	0	0	0	0	0	3	0	0
979338	326441	G	20	0	6	3	2	2	0	1	2	0	0	2	0	1	0	0	0	0	2	0	0
979229	326447	G	24	0	8	0	0	4	0	0	0	0	0	4	0	0	0	0	0	0	7	0	0
979266	326482	G	30	0	5	2	0	6	0	0	8	0	0	2	1	0	0	0	0	0	5	0	0
979326	326525	G	24	0	13	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0
978935	326528	G	3	0	1	0		1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
979225	326539	G	12	0	6	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0
979283	326572	G	8	0	2	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	3	0	0
979238	326606	G	74	0	27	1	2	12	0	1	11	1	1	0	0	0	0	0	0	0	12	0	0
979258	326644	Sy	5	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
978995	326675	G	4	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
979107	326689	G	233	0	78	3	5	56	0	5	10	0	0	18	1	1	0	0	10	0	43	0	0
979197	326690	Sy	6	0	1	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	2	0	0
979210	326770	Sy	4	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
979188	326786	Sy	3	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
979215	326786	Sy	2	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
979179	326795	Sy	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
979206	326796	Sy	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
979196	326803	Sy	10	0	6	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
979189	326804	G	92	1	46	4	3	21	2	0	4	0	0	3	2	0	0	0	0	0	6	0	0
979164	326807	Sy	6	0	3	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
978196	326810	Sy	15	0	5	0	0	4	0	1	0	0	0	2	0	0	0	0	0	0	3	0	0
979177	326810	Sy	59	0	16	2	0	17	0	0	10	0	1	3	0	1	0	0	0	0	8	0	0
979188	326811	Sy	24	0	13	0	0	8	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
979185	326816	Sy	57	0	23	3	1	8	1	0	5	0	0	8	1	0	0	0	0	0	4	0	0
979174	326820	Sy	6	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
979175	326821	Sy	45	0	15	0	0	16	10	1	0	0	0	1	0	0	0	0	0	0	1	0	0

979179	326822	Sy	72	0	38	1	1	17	0	0	1	0	0	6	0	0	0	0	0	0	7	0	0
979188	326822	Sy	24	0	8	1	0	10	0	0	2	0	0	2	1	0	0	0	0	0	0	0	0
979193	326826	Sy	25	0	17	0	0	5	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0
979184	326833	Sy	4	0	1	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
979223	326840	G	24	0	17	0	0	3	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0
978772	326874	G	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
979002	326945	G	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			9998	64	5271	346	163	2150	81	53	371	15	7	144	10	12	1	58	15	1	952	5	5