Towards an Understanding of the Ancient Maya Plant Resources in the Ka’kabish-Lamanai Corridor

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CHAPTER 1: INTRODUCTION

The plant resources of a culture have tremendous potential to provide insight into a variety of topics such as agriculture, trade, ritual, and diet. The small site of Ka'kabish in Belize, first identified in the late 1980s, continues to provide more questions than answers to excavators. Research on Ka'kabish has focused mainly on cultural aspects such as political status (Haines 2011, 2008; Haines et al. 2016), organization (Haines and Sagebiel 2019; McLellan 2020), and ceramics (Sagebiel and Haines 2018, 2015) to name a few, with no research focused on the plant resources or possible agricultural and agroforestry endeavours of the site. The only biological research at the site thus far focuses on bats (Ingala et al. 2019; Oelbaum et al. 2019), leaving a gap for potential research on the plant species in the region, and more specifically the question of what agricultural and agroforestry practices could have been used by the Maya in the Ka'kabish-Lamanai (KKB-LAM) corridor.

The goal of this thesis is to provide foundational knowledge of the potential agricultural and agroforestry practices of the region with the intent for future studies specifically at Ka'kabish. This project aims to provide an avenue from which researchers may gain further insight into the cultural practices of Ka'kabish, specifically the agricultural practices, diet, economy, and religious practices of the site and examine how they compare to the neighbouring sites in northern Belize. This research also has the potential to provide valuable insight into the agricultural potential of the land surrounding Ka'kabish and aid local communities in creating more effective agricultural practices inspired by the actions of the ancient Maya residents. Specifically, the local Mennonite community has expressed interest in learning more about the ancient Maya, with a focus on agricultural practices that create the most effective and sustainable crop yields (Helen Haines, personal communication 2022).

To determine which plant resources were potentially used at Ka'kabish, a variety of research questions were asked in order to create a predictive model. This included questions on which plants were found at surrounding sites, and which plants held cultural significance based on previous research on Maya practices and the surrounding regions.

To address these questions, I explored a variety of data types that identified specific plant species at specific archaeological sites surrounding Ka'kabish, including the Birds of Paradise, Blue Creek, Chan Cahal, Akab Muclil, Lamanai, El Pozito, and Cuello (Figure 1). This data was then correlated with the information gathered on Maya culture to create a list of most plant species most likely found in the KKB-LAM corridor and utilized at Ka'kabish.

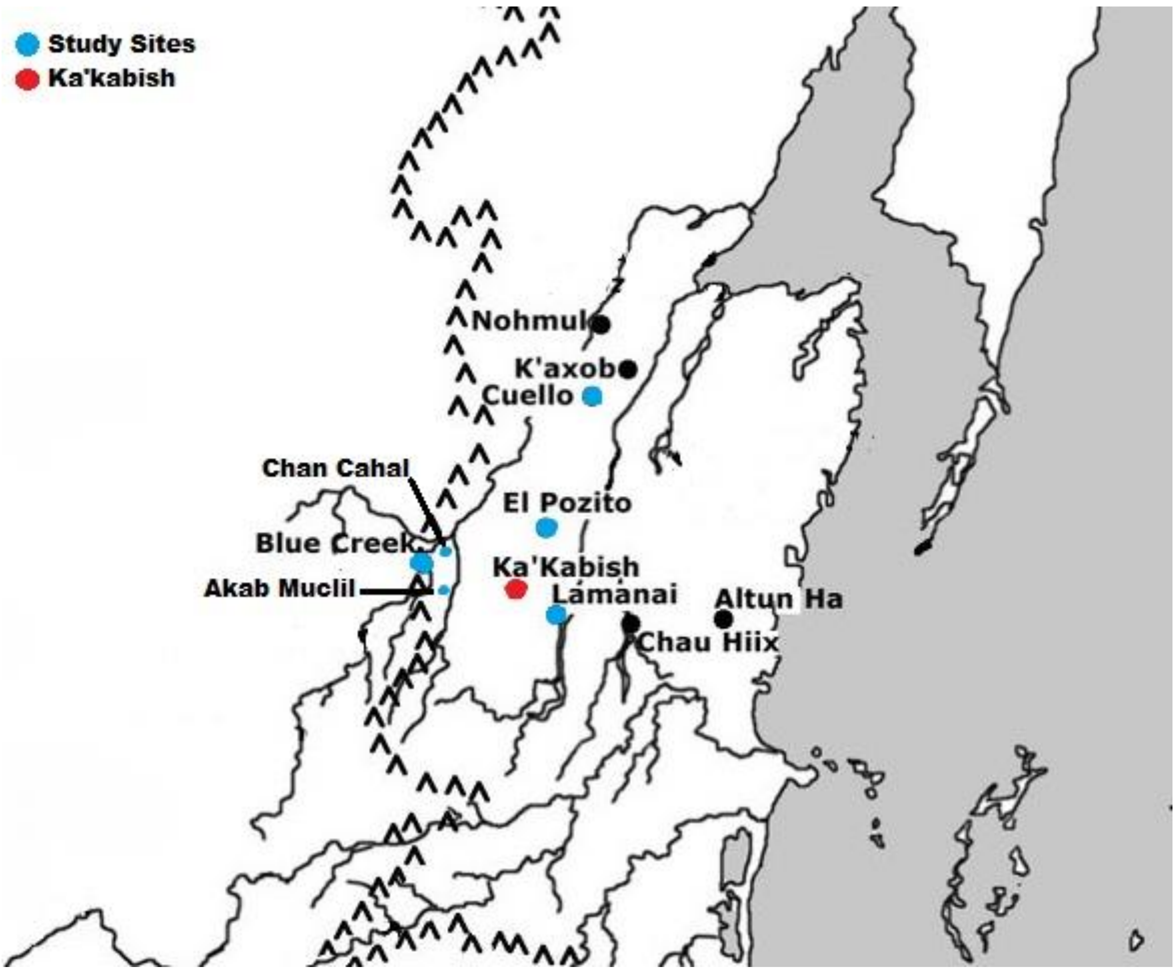

Figure 1. Map of Northern Belize showing sites discussed.

Chapter Summaries

Chapter 2 provides a brief introduction to the Maya of the Classic Period including agricultural practices. It also includes background on the site of Ka'kabish, specifically its occupation and status. Chapter 2 also includes a brief summary of previous work done in the surrounding regions to the West, North, and East.

Chapter 3 provides background information on specific Maya cultural elements which relate to the use and significance of plant species. This chapter covers various data types that describe the Maya uses of plants including iconography, text, ethnographic work, and diet.

Chapter 4 contains all relevant data for the investigation into the plant resources from the surrounding regions, along with the Ka'kabish-Lamanai corridor. The chapter provides data from historical surveys and archaeological investigations and identifies correlations between the data types. The chapter also covers limitations encountered with the data and the current Belize environment.

Chapter 5 provides the correlations found between the data collected in Chapter 4 and the known cultural information from Chapter 3. This chapter summarizes the most likely plant resources to have been possibly used and/or grown at Ka'kabish based on frequency, religious relevance, cultural importance, and remnant populations.

The final chapter re-addresses the research questions posed, along with a summary of the most important findings. The chapter also covers the limitations and challenges of the research and suggests future investigations and avenues to further our understanding of the plant resources at Ka'kabish.

CHAPTER 2: BACKGROUND

Archaeologists break the ancient Maya history into three large sections: Formative (2000 BC-AD 250), Classic period (AD 250-950), and the Post-Classic period (AD 900-1539) (Estrada-Belli 2011: 3; Houston and Inomata 2009). This research focuses on the Classic period which is when the site of Ka'kabish was at its height.

The Classic Period

The Classic period (250-900CE) was a time of great change within the Maya lowlands with fluctuations in population, rulership, political networks, and social organization. The Classic period saw the beginnings of regional diversity while still maintaining cultural continuity in shared practices across space and time.

Culture and Socio-Political Organization

The Classic period, commonly divided into the Early Classic (250-600CE) and the Late Classic (600-900CE) saw an increase in evidence for state/network integration across the landscape based on ceramic types and trade goods (McLellan 2019: 33). The political landscape was one of newly emerging political centres, which intensified competition and encouraged alliances (Masson 2002: 16; Houston and Inomata 2009: 127). The increase in alliance building potentially created an increase in trade and exchange within networks, consequently creating a decrease in trade with centres outside of the network, while simultaneously creating and increasing regional ceramic styles and types (Masson 2002: 16-17)

The Late Classic was considered the "high point" in Maya culture with a rapid increase in population throughout the lowlands, a tiered urban hierarchy of major and minor centres, and an increase in carved stelae, monumental architecture, writing, calendars, ceramics, and prominent divine leadership and extravagance (McLellan 2019: 34; Houston and Inomata 2009: 127;

Sullivan 2002: 201-202). The larger populations of the Classic period required increased agricultural activities, land modifications, and rural communities which popped up in the areas surrounding larger centres (Sullivan 2002: 201).

Divine kingship was a major characteristic of the Maya, and the changing political dynamics of the Classic period resulted in changing rulers and attempts at maintaining stability. King, or *ajaw*, held connections to deities and symbolized their holiness or divinity through the use of "theonyms" that associated them with specific deities (Houston and Inomata 2009: 133). Staples of the Classic period were large, carved stelae, monuments, lintels, and panels which depicted kings and their associated deities, or myths, along with hieroglyphic writing (Houston and Inomata 2009: 118-119).

Environment

The environment of the Maya lowlands is very diverse which required a range of agricultural practices to accommodate the differences in soil type and agricultural potential. Despite potential difficulties for effective production, the Classic period did see an intensification of agriculture as a result of these various practices including terracing to prevent soil erosion, and the use of wetland and water management for areas featuring marshland or *bajos* (Houston and Inomata 2009: 10). The Maya lowlands had very little in terms of mineral resources, which created a focus on the use of clay for ceramics and limestone for building and the production of lime plaster (Houston and Inomata 2009: 10).

Ka'kabish

Ka'kabish is a small site located 10km from Lamanai in north-central Belize on a limestone ridge, with occupation from the Late Formative period to the Late Classic period (Haines 2008). A series of almost continuous house mounds between the two sites points to a connection between Lamanai and Ka'kabish, the extent of which is still under investigation (Haines 2008). Initial survey of the site pointed to Ka'kabish being a minor administrative centre (Guderjan 1996), however, later field seasons revealed Ka'kabish to be much larger and had multiple indicators of an elite presence including specific tomb types, ballcourts, and larger temples (Haines 2008). Four possibilities for the socio-political organization of Ka'kabish have been identified including:

> (1) it was the centre for a mobile royal court from Lamanai; (2) it was the ideological or political seat for a heterarchically arranged polity with the economic seat being Lamanai (cf. Haines 2008a); (3) it was a suburban settlement for elites who may have 'worked' at Lamanai (cf. Haines and Patterson 2008); (4) it was an autonomous polity centre (Haines 2011: 146).

The settlement history of Ka'kabish is similar to that of other regions in Belize throughout the Classic period, with periods of expansion, remodelling, and growth, along with periods of hiatus (McLellan and Haines 2013).

There are a variety of challenges that limit our understanding of Ka'kabish and its settlement zone, specifically concerning its agriculture and agroforestry. The settlement zone between Ka'kabish and Lamanai has faced intensive land clearance, such as ploughing and deforestation, for maize agriculture and eventual cattle grazing (McLellan 2019). Communities such as Indian Creek and Shipyard, home to growing Mennonite populations, are encroaching onto the land surrounding Ka'kabish, making it difficult to investigate the area (McLellan 2019: 112). The intensive agricultural practices of Mennonite communities create difficulties in identifying the plant resources of the ancient Maya from Ka'kabish for a variety of reasons including limited access and cooperation with archaeologists, and the many years of monocropping and agriculture in general can potentially change the soil composition of the land making it difficult to get accurate soil samples. The inability to research in close proximity to the site of Ka'kabish requires investigation further afield.

Research in North-Central Belize

North-central Belize has had a multitude of research done over the last few decades, allowing for a surplus of data to pull from for comparison with Ka'kabish. Norman Hammond conducted research in northern Belize in the 1970s and 1980s with a specific focus on Cuello (Hammond 1991; Hammond and Miksicek 1981). Lamanai to the east has been a focus of multiple investigations with notable work initially done by David Pendergast in the late 1970s and later environmentally focused work by Elizabeth Rushton (2013, 2020) and David Lentz (2016). To the west of Ka'kabish, the variety of sites within the wetland environment have been the focus of environmental and agricultural research projects with notable work by Thomas Guderjan at Blue Creek (2004), and Sheryl Luzzadder-Beach and Tim Beach in the Birds of Paradise region (2002, 2013, 2015, 2019).

CHAPTER 3: THE MAYA AND PLANTS

Plants remain an integral part of most cultures, providing nutrition, medicine, and religious significance. The Maya have a variety of plants that were used for various purposes and held important value. Plants of importance are often depicted on ceramics, monuments, stelae, and other cultural artifacts, as either a picture or in the form of a glyph that writes the plant out. The depiction of specific plants can provide insight into what held value to the ancient Maya.

Iconography

There are numerous plant images on the walls of palaces and ceramics both for daily activities and ritual purposes (Morell-Hart 2020). The presence of specific plants on palace walls would imply that the plant holds high status within Maya culture and may have been used for ceremony or perhaps trade. For example, the seventh-century tomb of the Maya king of Palenque, Pakal, has multiple images of ancestral fruit trees including avocado, nance, mamey, guayaba, and cacao, all of which are plants that also appear within the ethnographic record of current Maya cultivation as important species (Ford and Nigh 2015: 52).

Ceramics

Ceramics are one of the most common artifacts to come from Maya excavations due to their use in daily tasks and ceremonies. Plants were often painted or sculpted into Maya ceramics as they had ritual, economic, and ecological importance (Zidar and Elisens 2009: 119; Morell-Hart 2020). Some plant species are easy to identify on ceramics and other artifacts through unique morphological features. For example, the *Malvaceae* subfamily *Bombacoideae,* has palmately compound leaves, trunk spines, five-parted flowers with recurved petals, and numerous stamens, which can be identified on ceramics down to the specific type (Zidar and Elisens 2009: 119, 125). This species is either painted or sculpted onto artifacts and has inferred importance to the Maya based on its known importance to current Maya populations for ceremonies (Zidar and Elisens 2009: 119, 125). Specific examples of subspecies identified on artifacts include *Ceiba pentandra* (Silk Cotton or Kopok tree), which is considered to be the "World Tree", representing the various levels of the underworld along with connections to death (Zidar and Elisens 2009: 126). This tree is often found on the walls of palaces, stelae, and sarcophagus lids, as it holds ritual importance and is still considered important to the Maya today, as it is often left unharmed during clearing, and used in ceremony (Zidar and Elisens 2009: 126). Other species include *Pseudobombax ellipticum* (Amapolla or Shaving Brush Tree), and *Pachira aquatica* (Provision Tree), along with individual parts of the plant such as the leaves or flowers (Zidar and Elisens 2009: 126-127). Drinking vessels and other ceramics often have glyphs on them that symbolize various messages of what they may have contained and often the glyphs for maize and cacao are carved or painted onto them (Beliaev et al. 2010; Stuart 2006). Images of *Theobroma cacao* (cacao) specifically are often found on small drinking-sized vessels but based on the lack of cacao residue on the cups, they are most likely not for drinking a chocolate beverage (Loughmiller-Cardinal 2019: 18).

Diet and Agriculture

Paleoethnobotanical Analysis

Archaeological remains collected at virtually every site that has had a systematic study of paleoethnobotany have produced the Mesoamerican Food Triad, commonly called the Three Sisters. which consists of *Zea mays* (maize), found at most sites, *Phaseolus vulgaris* L. (common bean), which is not as common at Maya sites due to poor preservation but is often grown in conjunction with maize due to the nutritional balance provided, and finally *Curcurbita* (squash) (Lentz 1999: 4-5, 10). *Capsicum annuum* L (cultivated chili peppers) are occasionally found in the record, along with *Gossypium hirsutum* L. (cotton) for clothing fibres and seed oil (Lentz 1999: 10-11). Agroforestry and tree cropping also appear in the paleoethnobotany record in remains of branches, leaves, and fruit from species such as *Persea americana* Mill. (avocado), *Theobroma cacao* L. (cacao), and *Anacardium occidentale* L. (cashew) (Lentz 1999: 12). Additionally, there was wide use of indigenous palms for their high fat count, and were often grown together, such as *Acrocomia aculeata* (Coyol), and *Attalea cohune* (Cohune) (Lentz 1999: 12).

Isotopic Evidence

At the site of Altun Ha, to the east of Ka'kabish, isotopic analysis was conducted on bone collagen to determine the diet of the population. Plants are examined through varying ^{13}C amounts acquired through photosynthesis, as "stable carbon and nitrogen isotope ratios are measurable in all foods and can be used to separate them into isotopically distinct groups" (White et al. 2001: 372). C3 plants are the most common, but C4 plants, such as maize have a different ratio which can be seen in the analysis allowing for the identification of maize consumption (see White et al. 2001: 372-372 for a thorough explanation of isotopic analysis). It was determined that C4 plants such as maize formed the majority of the carbohydrates for the site, pointing to maize being a large portion of their diet (White et al. 2002: 381-382). A similar, albeit smaller, study conducted on Post-Classic human remains from Ka'kabish suggested the same reliance on C4 plants for the majority of the individuals studied (Smith 2020). However, not all of the individuals in Smith's study showed a reliance on C4 plants (Smith 2020). The variability in the plant diet makes research into the possible flora of the area important for understanding the other potential plant food sources.

Agricultural Types

There are a variety of Maya agricultural practices and farming techniques including terracing, raised fields, check dams, drained fields, and various water management techniques (Lentz 1999: 10; Gómez-Pompa 1987: 7). Shifting, Milpa, cultivation was common as it allowed for multiple crops to be grown and promoted the protection of certain trees, especially those with religious importance such as the Ceiba tree (Gómez-Pompa 1987: 7). Additionally, household courtyards near the residences contained orchards for easy access to resources (Lentz 1999: 12). Currently, it is unclear what types of agricultural practices were employed at Ka'kabish or in the KKB-LAM corridor. However, by identifying the plants that possibly existed in the area we may gain a better understanding of the types of agricultural practices that might have been used in the area.

Ethnographic Knowledge

Ethnographic knowledge gathered from current Maya populations provides cultural knowledge and traditions that have been passed down from generations. Additionally, remnant forest ecosystems can provide valuable information about how past populations may have influenced the landscape and ecosystem. Remnant forest systems appear as "natural" ecosystems, however, there are clusters of useful trees surrounding Maya sites that are disproportionately larger than clusters in areas away from settlements (Gómez-Pompa 1987: 4-5). A potential remnant forest system takes form in clusters of Ramon trees (*Brosimum alicastrum*) near Maya sites. These clusters point to the possible cultivation of Ramon by the ancient Maya as there are more productive and resistant trees near the sites compared to clusters of Ramon not near sites (Peters 1983).

Milpa cultivation, the practice of shifting cultivation in different periods of growth and fallow, is still practiced by Maya peoples today and it is considered an efficient and enrichening process that improves the ecosystem and cultivates useful plants, pointing to its use as an effective traditional agricultural practice (Ford and Nigh 2015: 44). Multiple species are associated with the milpa both in the archaeological record and ethnographically, including Ramon (*Brosimum alicastrum)*, Ceiba (*Ceiba petandra)*, Coyol (*Acromia aculeata),* avocado (*Persea americana),* cacao (*Theobroma cacao),* cotton (*Gossypium hirsutum),* and Mamey (*Pouteria sapota)* (Ford and Nigh 2015: 52). Another practice seen both in the archaeological record and ethnographically is the use of kitchen gardens/dooryard gardens, which were planted with trees and a variety of species between them such as cacao, corn, beans, chili, and coffee (Gómez-Pompa 1987: 9).

Another species found in both the archaeological and ethnographic records is Pine. *Pinus* spp. (Pine) archaeobotanical remains, mostly in the form of charcoal or pine splits have been found in multiple caves throughout the Belize River Valley and the Maya Mountains of Belize (Morehart et al. 2005: 262). Pine is documented to have been used as a construction material, for fuel, and in limited contexts of ceremonial use for the ancient Maya but is also utilized by current Maya groups for timber, home construction, fuel, and ceremonies in the form of shrines or incense (Morehart et al. 2005: 264-265).

CHAPTER 4: DATA

Data for this thesis was collected through a literature review of the surrounding regions of Ka'kabish. Sites were selected based on proximity to the main study region, with the majority of sites either within 25km of Ka'kabish or within 25-50km to increase the chances of similar environments and thus resources. Alec McLellan's work on the inter-settlement zone of Ka'kabish and Lamanai provided a foundation for site selection (2019: 236-261). Research on plant remains from specific case studies were examined and the main plant species were recorded. A chart highlighting all potential resources can be found in Appendix A.

Lines of Evidence

Organic Remains

Organic remains, in the form of phytoliths and macrobotanical remains, make up the majority of plant and vegetation findings for the Maya region. Along with carbon analysis and cultural iconography, organic remains will form the basis for understanding what was growing in the Ka'kabish-Lamanai (KKB-LAM) corridor through the comparison of finds from surrounding regions. Exploring sites to the West, North, and East of Ka'kabish, plant types will be gathered from various case studies to formulate a master list of possible plant resources. No analysis of plant resources to the South were explored due to the lack of excavation and documentation of the region. Investigation into the southern region should be done when adequate resources exist.

Phytoliths

Phytoliths are micro-botanical remains that can be observed in sediment samples. Phytoliths are formed by plants through the absorption of water containing silica (Bozarth and Guderjan 2004). Silica bodies of the plant cells have unique shapes and sizing that can be compared to reference collections for the identification of specific plant taxon. Phytoliths are often well preserved in the archaeological record as they are resistant to weathering and can survive in most soil types for long periods of time Three prominent food crops for the Maya, maize, squash, and beans, along with palms have distinct phytolith shapes for identification (Lentz et al. 2016). Maize produces cross-shaped phytoliths with variants to help identify the type of corn and section of the plant preserved (cob, husk, etc.) (Bozarth and Guderjan 2004: 208). Squash produces a scalloped shaped phytolith with some domesticated species showing clear distinctions from their wild counterparts, while beans have a hooked-shaped phytoliths (Bozarth and Guderjan 2004: 208-209). Two distinct shapes are found for palm phytoliths including "hat-shaped" and spinulose spheres (Bozarth and Guderjan 2004: 209).

Macrobotanical

Macrobotanical remains consist of "seeds, wood, and other plant parts identifiable at low magnifications typically ranging from 5x to 30x", or commonly can be seen with the naked eye (White and Shelton 2014: 95). Macrobotanical remains are preserved through charring, desiccation, and waterlogging, which allows them to be found in archaeological sites such as hearths and caches, and through the sifting of excavated material (White and Shelton 2014).

Pollen

Pollen is a micro-botanical remain that is observed in the archaeological record through extraction from sediment samples, most commonly originating from peats and lake sediments (Traverse 2008: 464). Pollen samples are analyzed through precise counts and in conjunction with Carbon-14 dates, which can provide information on local vegetation types in different time periods (Traverse 2008: 464). Pollen evidence from ancient occupation sites has the potential to provide insight into the nearby plant resources which can be used to determined diet, and plant utilization.

C_4 and C_3 Plant Identification

The process of photosynthesis can vary within plants, labelling them as either C_3, C_4, or CAM plants. The large majority of plants are C_3 plants which "convert carbon dioxide from the air to a phosphoglycerate compound with three carbon atoms" (Van der Merwe 1982: 596-597). C_4 plants convert carbon dioxide into dicarboxylic acid, a four-carbon compound and also have bundle sheath cells, or Kranz leaf anatomy, in their leaves which are visible in a cross-section under a microscope (Van der Merwe 1982: 597). C_4 use the Hatch-Slack cycle for photosynthesis and have an average isotopic signature of -13% to -12%, while C_3 use the Calvin cycle and have a signature of -28% to -26% (Krause et al. 2019). C_4 are considered to be heartier and more efficiently grow in dry and hot environments, as well as in tropical climates. This growth pattern allows for larger yields and more reliable growing seasons. Crops such as maize, sorghum and sugarcane are all C_4 plants and are staple crops in many ancient societies (Wang 2012; Van der Merwe 1982). Through carbon isotope rations in sediment samples, researchers can identify the plant type that forms the majority of vegetation during specific time periods, allowing them to identify periods of agriculture or human interference.

Historical Survey

In 1959, D. H. Romney and his team published their findings of an extensive land survey done of Belize, formally known as the British Honduras. This survey, beginning in 1952 and finishing in 1954, provided specific details into the climate, soil, geography, and vegetation of the entire country and is the only survey which covers such an extensive and thorough investigation into the region (Romney 1959: 6-7). The original intent of the survey was to provide insight into the productivity capacity of the land and potential land use practices for the future (Romney 1959). This survey provides a complete overview of the region being investigated, thorough context to vegetation patterns, and lists the vegetation present in the Ka'kabish and broader study region, along with the soil composition of the regions (See Appendix A). This survey of historical documents will provide the foundational knowledge of the region, that will be used in conjunction with the archaeological remains in order to use multiple lines of evidence for the analysis of plant resources in the area. The survey produced two reference maps for vegetation areas and soil composition, which were used to determine the main plant species growing in the region of each site (See Appendix B).

Current Land Use

Reports of current land use are based on personal communication with Dr. Helen Haines who has worked in the Ka'kabish corridor for over 20 years. Using the soil map from the Romney land survey, Haines provided a description of vegetation currently growing at the Ka'kabish site based on her experience and knowledge from local workers. Future work is planned for the 2022 field season to augment this information with direct conversations and field surveys with local people familiar with the environment.

Belize Environments

Belize can be divided into multiple environmental zones with varying rainfall, temperatures, soil compositions, and vegetation. Zones created by Romney and colleagues provide distinct environments that are mostly based on precipitation levels (Romney 1959:28-29). The Ka'kabish corridor, in northwest Belize, falls into the Dry Tropical lowlands zone which extends from the coastline to the Guatemala border in the northern half of the country (See

Figure 1) (Romney 1959). The Dry Tropical lowlands have a mean annual rainfall of less than 80 inches and a mean temperature of more than 24 degrees Celsius (Romney 1959:28 insert). This environment is most likely to have a deciduous seasonal forest environment. Northwest Belize is primarily on Cretaceous through Tertiary limestone and faulting has created a horst and graben landscape with a fluviokarst system (Doyle et al. 2021). Horst and graben landscapes consist of alternating raised and lowered faults that form from crust movement, that create a series of valleys and ridges (National Park Service 2020). Fluviokarst systems are created from river cut valleys and often feature large underground drainage systems. The fluviokarst landscape in northwestern Belize creates escarpments and depressions with elevations of 100-300 metres above sea level in the western regions, gradually decreasing to 0-10 metres above sea level in the east across the Coastal Plain (Doyle et al. 2021).

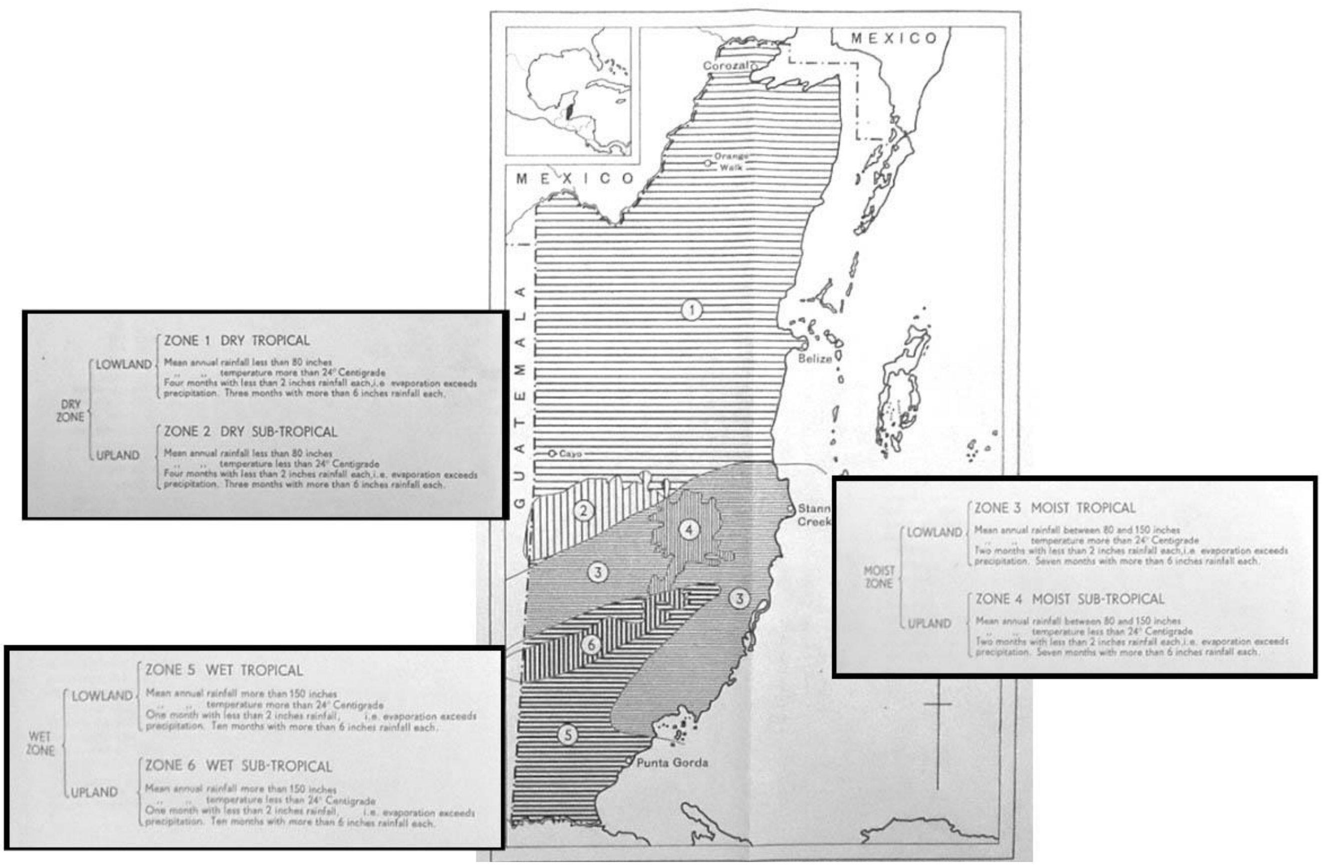

Figure 2. Environmental Zones (adapted from Romney et al. Land Survey 1959)

West

The region West of Ka'kabish has a similar vegetation and soil profile to the KKB-LAM corridor, however, it includes more swampy ecosystems. To create a comparative analysis of the plant resources, selected sites were about 25-35 kilometres west of the KKB-LAM corridor in the Birds of Paradise Region. Within the western area, sites examined for similar plant resources include Blue Creek and Akab Muclil. The Birds of Paradise region is located within the Three Rivers Region of Belize which is on the eastern margins of the Peten karst plateau (Dunning et al. 1999). The Peten karst plateau is a "hydrologically elevated limestone area characterized by rugged free-draining uplands and seasonally-inundated, clay filled depressions (bajos)" (Dunning et al. 1999:650). The Birds of Paradise region and nearby sites are situated both on and at the base of the Rio Bravo escarpment. Due to the placement of the Birds of Paradise region across the escarpment, the area features a variety of upland escarpments with depressions or *bajos* between ridges and has a tropical climate with intense dry and wet seasons (Krause et al. 2019). The Rio Bravo Escarpment separates the Coastal Belize Zone and the Eastern Peten Zone (Guderjan 2004). The valleys generally have very fertile soils but are prone to flooding and poor drainage (Dunning et al. 2019; Guderjan 2004). Blue Creek is placed on an elevated ridge and most likely made use of the fertile soils in the depression below, while Akab Muclil was on a slightly lower elevation on the Chan Cahal Escarpment (Krause et al. 2019). This area represents the furthest region to the west of the study region for the KKB-LAM corridor as any further west leads into a different vegetation zone that would not be useful for comparison.

Birds of Paradise

Archaeological Investigations

Beach and colleagues investigated the Rio Bravo watershed to report on Maya wetland field systems in northwestern Belize using LiDAR survey and a variety of proxy data to identify formation, cultivation, and chronology of the area (Beach et al. 2019). LiDAR imaging detected wetland field systems by identifying canals and fields through thick forest cover (Beach et al. 2019). Through excavation of the wetland field systems and the extraction of multi-sediment cores, the authors identified Classic to Postclassic maize pollen. Using carbon isotope ratios from the soil, the authors found that the area had an increase in C_4 plants, representative of "maize and weedy species associated with human disturbance", during the Late Classic period, with C_3 plants dominated before and after this period, indicating agricultural use (Beach et al. 2019:21473).

Historic Documentation

Using the reference maps from Romney and colleagues (see Appendix B), a list of the soil types and vegetation regions were created for the Birds of Paradise region. Of special interest are the various palms that grow in the Birds of Paradise region such as Thatch palms, as these were, and still are, an important component for home construction. The Birds of Paradise region covers a vast array of vegetation zones and historically has supported a wide variety of plant species. Some indigenous species that could be of economic value to the Maya include wild coffee, and figs. Finally, this region supports a Cohune Palm Forest, High Marsh Forest, and Deciduous Broadleaf Forest, represented by zones 34, 21/21a, and 1a. For a full list of the vegetation zones and soil composition see Table 1 and 2.

Data Correlation

There were no specific correlations between the historic survey and archaeological survey in the Birds of Paradise region.

Blue Creek

Archaeological Investigations

Blue Creek is situated on a limestone ridge and is on an "ecotone, a transitional area between two biomes that are biologically dense and diverse", allowing the centre to have an abundance of resources available (McLellan 2019: 245). Bozarth and Guderjan examined dedicatory caches at Blue Creek, a larger centre in the eastern region, dating from the 200-650CE (2004). Ten sediment samples were collected from nine vessels from caches and phytoliths were collected and categorized by taxa (Bozarth and Guderjan 2004). Within the caches there was phytolith evidence of palm fruit and leaves, agave, squash, and maize cobs. Cache 4A produced hat-shaped palm phytoliths, most likely from *B. gasipaes* (peach palm); Cache 6A had *Heliconia* (Lobster Claws), and *Agave* phytoliths; Cache 7 had *Agave* fibre phytoliths, and Cache 28 had *Cucurbita* (squash) phytoliths (Bozarth and Guderjan 2004: 211-212). The phytolith analysis found that these taxa were placed in the caches as food offerings, or the leaves were used to wrap various offerings (Bozarth and Guderjan 2004: 212).

Historic Documentation

Similarly to the Birds of Paradise, the soil composition of Blue Creek is compatible with the natural vegetation reported for the area, as the vegetation types identified correlate to what species most effectively grow in the soil type (see Table 3 and 4). Blue Creek also has a variety of palm species reported for the area and larger trees hardwood trees such as Mahogany which could have been beneficial to construction. For the full list of vegetation zones and soil composition see Table 3 and 4 in Appendix A.

Data Correlations

The only correlation between the archaeological and historical information was of palms. While the specific type of peach palm identified in the archaeological is not identified in the historic survey, the presence of palms in the archaeological record is a good indicator that a wide variety of palms may have existed in the region, including types not identified in the historical survey (Romney et al. 1959).

Chan Cahal

Archaeological Investigations

A cache from nearby Chan Cahal had three maize cob phytoliths, indicating that ears of corn were placed in the vessel (Bozarth and Guderjan 2004: 212). Chan Cahal also had phytolith and macrobotanical remains of *Cucurbita spp* (squash), *Zea mays* (maize cobs), *Phaseolus spp.*(beans), *Theobroma cacao* (cacao), and *Manilkara zapota* (sapodilla) fruit in a Late Classic structure (Beach et al. 2019:21473).

Historic Documentation

Due to the close proximity to Blue Creek, Chan Cahal has a similar soil composition and vegetation zones, including a variety of palms and the High Marsh Forest which includes plant species such as Sapodilla. For the full list of vegetation zones and soil composition see Table 5 and 6 in Appendix A.

Data Correlations

Sapodilla was the only match reported for the region in the land survey, which corresponds to the archaeological evidence found at the site by Beach and colleagues (2019).

Akab Muclil

Archaeological Investigations

The small village of Akab Muclil persisted from the Early Classic into the Terminal Classic and is located near the base of the Rio Bravo Escarpment, four kilometres south of Blue Creek. Krause and colleagues (2019) used a 2.6m sediment core from the area surrounding Akab Muclil to examine the ecological history of the wetland system used by the centre. The sediment core was divided into six zones with distinct ecological/sedimentological characteristics (Krause et al. 2019). Zone 2 provided excellent pollen preservation with indications of "abundant tropical forest taxa, [specifically] *Combretaceae* [white mangrove] and *Euphorbiaceae* [spurge family] (major regional flowering plant families)" and *Pinus* (pine) and *Zea mays* (maize) pollen (Krause et al. 2019). Zone 3 continues to have *Zea mays* (maize) pollen in the sediment sample, along with increase "in disturbance taxa such as *Poaceae* [wetland grasses] and *Asteraceae* [Aster family]" (Krause et al. 2019). Zone 6 includes an increase tropical forest taxa such as *Poaceae* (wetland grasses) and a decrease of *Pinus* (pine). The findings at Akab Muclil show similarities to other Birds of Paradise sites with an increase in C_4 plants during the Classic period, pointing to maize cultivation, with a later revert back to C_3 in the Post-Classic (Krause et al. 2019).

Historic Documentation

Akab Muclil had a smaller number of vegetation zones than other regions with the majority of their vegetation growing in marsh forest zones. Notable plant types found in the land survey from Romney and colleagues (1959) include Pucte, Mahogany, and a variety of palms. For the full vegetation zone list and soil composition, see Table 7 and 8 in Appendix A.

Data Correlations

Combretaceae, commonly known as the White Mangrove family, was found at the site in the archaeological record through pollen analysis (Krause et al. 2019). This same family is found in the historical record through the plant Pucte, indicating a potential alignment in the historical and archaeological record.

East

The region east of Ka'kabish is fragmented by the New River Lagoon and surrounding swampy vegetation. Lamanai is the closest site to Ka'kabish and shares a similar environment. Lamanai's current environmental layout and land use is divided into vegetation zones, including "Shoreline, Cohune Ridge, Pine Ridge, Bajo, and High Bush" (Lentz et al. 2016:287). To the northwest, closer to Ka'kabish, the Bajo is a seasonal swamp zone that drains in the dry season and has woody plants such as logwood, and thickets (Lentz et al. 2016). The landscape to the west of New River Lagoon and Lamanai transforms from reeds such as *Phragmites australis* (common reed) and *Cladium jamaicence* (saw-grass) into an area "dominated by logwood and then into tropical evergreen, seasonal broadleaved lowland forest" (Rushton et al. 2013). On the eastern side of New River Lagoon, the closest sites to the KKB-LAM corridor are Chau Hiix and Altun Ha. While Chau Hiix is geographically close to Ka'kabish, its environmental layout is too dissimilar to Ka'kabish for inclusion in this analysis as it features a more Pine Forest and Orchard Savanna environment (Romney et al. 1959). While there are vegetation deposits in the east that are similar to vegetation areas west of Ka'kabish, such as those on the Eastern side of New River Lagoon, the overall environment was not deemed similar enough to warrant comparison, making Lamanai the furthest site to the East that was used as comparison, stopping on the western shore of New River Lagoon.

Lamanai

Archaeological Investigations

Lentz and colleagues collected archaeological plant samples in the form of macrobotanicals and carbonized samples of plant pieces during excavation at the site of Lamanai and examined them for taxa identification (2016). A variety of charred wood remains were found, along with maize kernels and cobs, and burned palms. There were a large variety of charcoal wood samples found in caches at the site of Lamanai, whose wood of origin aided in construction, food, and medicine, such as *Annona sp.* (Soursop), which bears edible fruit, and *Casearia sp*., which is used in construction and medicine (Lentz et al. 2016). *Pinus caribaea* (pine) charcoal was found in all caches at Lamanai, pointing to its importance in ceremonial activities and trade (Lentz et al. 2016).

Through the analysis of a 3m core from New River Lagoon near Lamanai, Rushton and colleagues (2013) examined the charcoal and pollen samples from the sediment. The pollen samples were categorized by ecological types including seasonal forest, savanna, disturbance taxa, *Arecaceae sp.* (palms), and crop taxa (Rushton et al. 2013). Four zones were identified from the sediment samples, representing various time periods in the site's history. Zone Two, dated 900BCE -350CE, has two patterns of pollen assemblage beginning with a decline in arboreal signatures, followed by an increase in signatures, specifically species such as *Brosimum sp.* (breadnut), *Pinus sp.* (pine) and *B. simaruba* (gumbo-limbo/turpentine) (Rushton et al. 2013:489). In Zone Three, dated 350-1000CE, Rushton and colleagues (2013) identified a decline in seasonal rainforest cover starting in 590CE until 970CE (Rushton et al. 2013:489). *Z.*

mays (maize) is the only crop recorded for this zone and shows a decrease near the end of the period; however, it is present throughout the entire core and therefore was used throughout the occupation of Lamanai. The core shows periods of reduced pine pollen from 600-980CE, correlating to periods of construction in the area which exploited *P. caribaea* (pine) (Rushton et al. 2013).

In a follow up article, Rushton and colleagues (2020) expand on previous research of the vegetation history at Lamanai through further pollen and charcoal analysis from sediment cores. A 52cm core was extracted from New River Lagoon near the settlement of Indian Church, south of the original extraction site. The new core was divided into three zones for different chronological time periods beginning at 800CE and ending in 1680CE to present (Rushton et al. 2020:11). Pollen analysis from Zone One indicates that *Z. mays* (maize) "pollen is present almost continuously throughout the zone and other crop pollen types are present in less consistent amounts" (Rushton et al. 2020:11). The other crop types included *Capsicum* (red pepper/chili), *Cucurbita* (gourds), and *Ipomoea batatas* (sweet potato). Pollen analysis for Zone One shows that *Arecaceae* (palm) pollen values are highest in the Zone One, compared to Zones Two and Three, indicating that there may have been high levels of palm cultivation. The most abundant taxa found in Zone One of the 52cm core are from the *Urticaceae/Moraceae* (fig/mulberry) family, and more specifically *Brosimum* (Breadnut), *Metopium* (poisonwood), *Manilkara* (*Sapotaceae), Vitex* (chaste tree), and *Bursera simaruba* (gumbo-limbo/turpentine) (Rushton et al. 2020).

Historic Documentation

The Lamanai region has a large variety of vegetation zones, which correspond well to the soil composition for the area. There are numerous plant species present in the region, some of which may present economic value. The survey by Romney and colleagues (1959) indicates plants such as pine, breadnut, wild rubber, wild cacao, fig, various fruiting trees, sapodilla and palm varieties including thatch and give-and-take palm. For a complete list of the vegetation zones and soil compositions for Lamanai see Tables 9 and 10 in Appendix A.

Data Correlations

There are a variety of plant types present in both the archaeological record and the historical documentation. The most significant plants for the study are *Brosimum* (Breadnut), the *Manilkara* (*Sapotaceae)* family in the form of Sapodillo*,* the *Urticaceae/Moraceae* (fig/mulberry) family in the form of figs, *Arecaceae* (palm), and *Pinus caribaea* (pine).

North

The region north of Ka'kabish features many archaeological sites such as El Pozito, Cuello, Nohmul, and K'axob. The region has a similar vegetation pattern to the KKB-LAM corridor, however only the sites of El Pozito and Cuello were examined as the sites of Nohmul and K'axob are in a different vegetation region than the main study site. The site of Cuello, located near the town of Orange Walk is the furthest site north as past this area the vegetation pattern changes to include more marsh-forest land and begins to be dissimilar to the land around Ka'kabish. Additionally, there are fewer archaeological excavations that look specifically at vegetation and organic remains, limiting the available data that can be used for comparison.

El Pozito

Archaeological Investigations

El Pozito has limited archaeological research that focuses on the vegetation and plant resources used by its inhabitants. Research in the region during the 1970s and 1980s focused on lithics and chipped stone tools, specifically obsidian workshops, such as the work done by Mary

Neivens in 1976 (Robin 2020:8). Returning to the site to re-examine the excavations with a specific focus on identifying organic remains using new methods would provide vital information to the diet and plant use of the people of El Pozito.

Historic Documentation

According to the reference maps from Romney and colleagues (1959), El Pozito is a combination of Broadleaf Forest, High Marsh Forest, and Cohune Palm Forest, which are the same vegetation zones found at Ka'kabish. Notable plant types in this region include Sapodillo, various palms, wild rubber, wild cacao, cotton, pucte, and breadnut, all of which have been found in at least one other comparison site. The soil composition for El Pozito varies from Ka'kabish slightly as it is made of Yaxa clay varieties, Lazaro sandy clay, and Pixoy sandy loam. For the full list of vegetation zones and soil composition, see Tables 11 and 12 in Appendix A.

Data Correlations

Due to the lack of significant archaeological investigation it was impossible to draw any correlations between the data sources.

Cuello

Archaeological Investigation

Cuello is another site in the north that has limited research specifically focused on the vegetation types in the region, however, work done by Norman Hammond in the 1980s and 1990s provides some insight into the plant resources found at the site. Re-examination of the site and the organic remains using updated methods would be beneficial for creating a fuller picture of the plant use at the site.

Through the examination of carbonized plant macrobotanical remains at Cuello using flotation techniques, Hammond and Miksicek (1981) identified plant resources present at the site for different archaeological periods from the Early Formative to the Late Formative. During the Middle Formative (1300/1200-450BCE), Hammond and Miksicek (1981:267) identified a chili pepper seed, squash rind, and a pod from the *Bombacaceae* family (silk cotton tree). In the Late Formative (350-100BCE), maize was identified, along with *Gossypium hirsutum* (cultivated cotton) (Hammond and Miksicek 1981:268). In a sealed *chultun* "several complete carbonized cacao beans…" were found, along with maize kernels and cob fragments (Hammond and Miksicek 1981:268). The tree taxa found in the *chultun* include jauacte palm, Crabboe/Nance, hogplum, mamey, allspice and chili (Hammond and Miksicek 1981:268).

Jon G. Hather and Norman Hammond examined macrobotanical plant remains found in a soil sample at Cuello (1994). Using flotation techniques, more than 10 tonnes of soil were examined in excavations from 1975 to 1993, with "more than 1100 maize cupule and kernel fragments…recovered, together with carbonized fruits and/or wood from trees yielding edible crops such as avocados" (Hather and Hammond 1994: 2).

Historic Documentation

Cuello has a similar vegetation environment to El Pozito with Broadleaf Forests, High Marsh Forest, and Cohune Palm Forest. Based on the reference maps from Romney and colleagues' land survey (1959), notable plant types include cotton, breadnut, various palms, Botan, mamey varieties, and wild cacao. The soil composition includes Lazaro sandy clay, Pixoy sandy loam, and Lazaro dark grey sandy clay. For the full list of vegetation zones and soil composition, see Tables 13 and 14 in Appendix A.

Data Comparison

A variety of plant types were found both in archaeological record and in the historical documents including cotton, plants of the mamey variety, and wild cacao, increasing the possibility that these resources were grown/used in the area and possibly in Ka'kabish as well.

Central

The site of Ka'kabish forms the focus of this study. As such it forms the central point upon which all other sites were based.

Ka'kabish

Archaeological Investigations

Ka'kabish has not had archaeological excavations and tests specifically for organic remains to see what plant resources may have been used in the region. When resources allow, investigations of sediment samples and cores for pollen, phytolith, and macrobotanical remains should be made in order to get a clearer picture of what archaeological evidence exists for the plant resources used by the people of Ka'kabish.

Historic Documentation

The reference maps from Romney and colleagues' (1959) land survey shows that the area surrounding Ka'kabish is made up of three vegetation zones including broadleaf forest, high marsh forest, and Cohune Palm Forest (See Appendix B). These zones have plant types including Sapodillo, Breadnut, and Mahogany, which are all found in many of the surrounding regions. Additionally, the area has various palm varieties including Cohune Palm which is used as an indicator species for fertile soils (Romney et al. 1959). The soil for the Ka'kabish area is predominantly Yaxa and Chucum clay. For the full list of plant types of the vegetation zones and soil composition at Ka'kabish see Tables 15 and 16.

Current Environment

The Ka'kabish site is divided into three vegetation regions based on the Romney land survey. Haines identified the plant species growing in each vegetation area (See Table 19 in Appendix A). The presence of Cohune Palms is similar to almost every other site analysed, along with Give-and-take palms, Thatch palms, Chechum, and Mamey. These larger tree species are key indicators of soil quality and may present similar growing environments to the surrounding regions (Romney et al. 1959). Copal is also present at the site which was an important resource for the Maya (Haines, personal communication, 2022). While the vegetation currently growing at the site could be the result of decades of environmental changes and influences from nearby modern agricultural sites, as the long-term intensive management of the ecosystem by ancient Maya has left remnants of ancient resource use in the current forest make-up of Belize (Ross and Rangel 2011), it is likely that many of the plants at Ka'kabish also represent remnant ancient forests. In the future, ethnographic work with the local bushman should be done to obtain local and historical knowledge of what plant resources are in the area and what plant resources are economically useful.

Data Correlations

The main correlation between the historic survey and what is known about the current environment at Ka'kabish is the presence of a multiple palm varieties such as Cohune and Give-and-take, along with tree species such as Chechum and Mamey.

Data Limitations

There are a variety of limitations in researching vegetation from the Classic Period in Belize that make it difficult to assess resource use. Changing climates and landscape uses can drastically change the ecosystem of specific areas, leading to a very different vegetation composite seen now than in the past, making ethnographic or historical research difficult to include. An increase in industrial farming, particularly by Mennonite groups in northwestern Belize has resulted in mass deforestation in exchange for agriculture fields (Doyle et al. 2021; McLellan 2020). The deforestation of areas makes it difficult to see current vegetation its relationship to the past, and the planting of new crops creates changes within soil samples and can lead to inaccuracy in findings. Additionally, changes to the landscape can make it difficult to identify ancient sites. For example, deforestation can lead to the growth of dense pasture grasses, changing the accuracy of digital elevation models with LiDAR work (Beach et al. 2019). Industrial agriculture also limits the number of protected sites available for research.

Another limitation in vegetation classification is inaccuracies in evidence types. For example, while pollen can provide specific plant species, wind-pollinated taxa can disrupt core samples or provide an inaccurate picture of the local vegetation (Ford and Nigh 2009). Further, most pollen in core samples come from wind-pollinated species, which leaves about 98% of Belizean forest species that are pollinated through animals unpresented in the record (Ford and Nigh 2009).

Poorly preserved organic remains that cannot be identified or are absent in the record altogether create difficulties when examining the archaeological record (Harris 2006). Phytoliths, macrobotanical remains, and actual seeds, while somewhat resistant to decay are not also easily identifiable in the record, either through absence or potential human error in identification and collection.

Biases in representation of vegetation classification is another limitation in data collection. These may be the result of preservation and/or collection methods, but there could also be biases in the past for selective foods that held a higher status in the culture. For example, plant resources are often found in dedicatory caches or identified by their presence in art and iconography. These plants would be important to the culture and thus it is useful to identify them, however, staple items, famine foods, foods reserved for certain classes, or foods that held no ritual importance may be underrepresented in the archaeological record.

Summary

While there is little research done specifically on the plant resources utilized in the Ka'kabish-Lamanai (KKB-LAM) corridor, there is abundant research on the vegetation history of the surrounding regions. This information is often obtained in the form of sediment samples, pollen, and phytoliths. The case studies from the east, west, and north of the KKB-LAM corridor indicate a wide variety of vegetation due to the slightly varying environments and agricultural methods. The majority of this research does not indicate specifically the level of abundance each plant resource had, or precise uses, however, there are staple taxa that appear in almost every region and site, that was most likely used in the KKB-LAM corridor as well. For example, varieties of maize, squash, beans, and palms were often found in all environments. To see a summary of corresponding plant resources with economic value at each site see Appendix C. A discussion of the data will follow in the next chapter.

CHAPTER 5: ANALYSIS AND DISCUSSION

To establish what plant resources were the most likely to be used and cultivated by Ka'kabish, results from the data collected from the historic survey and archaeological records were cross-referenced and correlated with what was already known about Maya culture and habits. For the purposes of this thesis, Maya culture included diet, agricultural practices, and iconography on ceramics and in texts. Information about Maya culture was collected from ethnographic and archaeological sources (see subsection *The Maya and Plants* for details). Criteria for determining the plants most likely to have been used include the frequency in which a plant type appears within the data, the presence of a plant type on iconographic and cultural items, specifically those connected to ritual/religious symbols, and plant types that appear in remnant ecosystems and ethnographic research from current Maya peoples. While there is no guarantee that these plant types were used by Ka'kabish, if a plant type from the surrounding regions meets one or all of the listed criteria, there is a higher probability of it being present at Ka'kabish as well. The plant species will be placed in a tiered system of High, Medium, and Low probability of occurring at Ka'kabish based on the listed criteria.

Criteria

The three criteria, frequency, iconographic presence, and ethnographic presence are defined as follows:

Frequency

The frequency at which a plant species appears within the data is a good indicator of its presence at Ka'kabish as it means that the plant is more common within the region and likely to have been used at Ka'kabish due to availability. Frequency is based on the three data types: archaeological data, historic survey, and previous knowledge of Maya culture. All species identified in the archaeological record, the previous knowledge, and the historic survey was recorded separately (see Tables 20, 21, and 22). Due to the high volume of plant species listed in the survey, only the top five most present vegetation regions were analysed. This was determined based on how many sites had that specific vegetation region within their landscape (See Table 21 and Appendix B). This included region 21a *High Marsh Forest,* which was present at all archaeological case study sites, followed by 1a *Broadleaf Forest Rich in Lime-loving Species – Deciduous seasonal forest 50-70 high on limestone*, present at 6/8 sites, 34 *Cohune Palm Forest* at 5/8 sites, and a tie between 22 *High Marsh Forest* and 25 *Herbaceous Marsh and Swamp* both at 4/8 sites (See Table 21). From these five vegetation zones, the most frequent plant species were recorded for comparison and correlation with the other data types (See Table 22). With the archaeological, historic, and previous knowledge cross-referenced, the most frequent species were selected. Plants could either be present in all three data types, resulting in a high possibility of being used at Ka'kabish, being present for two data types to have a medium possibility of being used at Ka'kabish and finally, plant species only observed in one data type had a lower possibility of being used at Ka'kabish. In addition to frequency, however, the cultural significance of the plant type was noted, along with its physical presence in the archaeological record of surroundings sites.

Iconographic and Ritual

Many plant species held important value and significance to the Maya for various reasons, especially connections to rituals and authority. If a species is depicted on ceramics, stelae, monuments, or other artifacts, the species likely held value, potentially for ritual purposes, subsistence, or connections to deities and symbols of authority. Species were identified that correlated between data from previous research on iconographic images and the species identified at the sites surrounding Ka'kabish. This included painted and sculpted images on ceramics, walls, stelae, and monuments, along with drinking vessels.

Remnant Systems and Ethnographic Connections

Human modification of the land for agricultural and agroforestry purposes can leave imprints on the land generations later. In order to determine the potentiality for a presence at Ka'kabish, remnant species were considered as they are possibly a result of human cultivation and selection for a specific plant. Additionally, species that are still in use today by Maya populations may hold cultural or economic value that has been passed down. Species that have been continually cultivated for generations and are well known within the history of the Maya were recorded.

Results

The data produced a long list of potential plant resources; however, it is unlikely that all species would have been used and/or cultivated by Ka'kabish (See Appendix A).

Frequency

The species which had the highest frequency level included *Attalea cohune* (Cohune palm), *Brosimum sp.* (Breadnut/Ramon), *Pouteria sapota* (Mamey), *Theobroma cacao* (Cacao), and *Gossypium hirsutum* (Cotton), all of which were present in the historic survey, the archaeological record for the surrounding sites, and in the previous knowledge about Maya culture (See Table 20, 21, and 22). The group with the second highest frequency consisted of *Bucida buceras* (Pucte), *Pinus sp.* (Pine), *Manilkara zapota* (Sapodilla), *Hevea brasiliensis* (Wild Rubber), *Pimenta dioica* (Allspice), *Byrsonima crassifoli* (Crabboe/Nance), and *P. americana* (Avocado), which were all present in at least two of the data types (See Table 20, 21, and 22). Another group that was present in both previous knowledge and the archaeological record included *Zea Mays* (Maize), *Phaseolus spp.* (Common bean), *Cucurbita spp.* (Squash), *Capsicum* (Chili), and *Bombacaceae/Ceiba pentandra* (Ceiba/Silk Cotton Tree), all of which are common cultigens across the Maya landscape, at Ka'kabish and beyond.

Iconography

The main species depicted in the iconographic record were maize, cocoa, and the Ceiba Tree and other *Bombacaceae* subspecies. The presence of these species on ceramics and in the archaeological record for the surrounding sites, points to a higher probability of these resources being used at Ka'kabish since they were found at settlements and hold spiritual significance as demonstrated by their display on cultural artifacts.

Remnant Systems and Ethnographic Connections

The main species that is seen to have maintained a remnant forest system is *Brosimum sp.* (Ramon/Breadnut). Its inclusion as a remnant system at various Maya sites, and presence within the archaeological record through botanical remains leads to a high possibility that it would be utilized by Ka'kabish. In addition, breadnut has an abundance of nutritional fruit that would have been a useful crop and is seen in the ethnographic record being used by current Maya populations in their kitchen gardens and milpa systems.

Plant Significance

Many of the plants categorized from the regions surrounding held significance either as a ritual item, construction material, or simply by providing food sources. See Tables 20 and 22 for a brief note on the uses of all significant species identified. Below is a short introduction to the uses and significance of the main high probability species that most likely were cultivated at Ka'kabish.

***Theobroma cacao* (Cacao)**

Cacao held a place of high value within Maya society, being used a ceremonial drink for elite consumption and as a status marker, along with acting as a physical "cash crop" for trade (Martin 2006: 154). Cacao can be found both within the archaeological records at Chan Cahal, (see Table 20) but also in the iconographic evidence through its placement on ceramics as itself or representing through its associated glyph. Cacao is often depicted in conjunction with deities such as the Maize God, or in association with kings and nobles as a status symbol and a way to connect elite individuals with spiritual forces (Martin 2006: 154-166).

***Attalea cohune* (Cohune)**

The Cohune Palm has various uses and is still utilized by current Maya peoples for tasks such as providing thatch for roofs, or shade for cattle (Schlesinger 2001: 116, 118). Additionally, Cohune Palms signal good soil conditions for growing, helping to direct agricultural activities and land clearance initiatives (Schlesinger 2001: 118). The heart of the palm can also be eaten, or seed oil can be extracted for various uses.

***Brosimum sp.* (Breadnut/Ramon)**

Breadnut is an example of a remnant species that grows near Maya ruins, potentially a result of many years of cultivation by the ancient Maya (Schlesinger 2001: 132). Breadnut provides large quantities of fruit that is high in protein. Breadnut also has the potential to be stored for up to 13 months, making it a very sustainable food option (Schlesinger 2001: 133-134). Breadnut is still eaten by current Maya populations.

***Gossypium hirsutum* (Cotton)**

Cotton was cultivated for its fibre to create clothing, especially more extravagant designs for the elite and the seeds are sometimes used for making cooking oil (Houston and Inomata 2009: 221).

***Bombacaceae/Ceiba pentandra* (Silk Cotton Tree/Ceiba)**

The Ceiba tree is considered the World Tree or the First Tree and represents the upper, middle, and underworlds and hosts the gods (Schlesinger 2001: 111). The Ceiba tree is depicted on multiple ceramics and iconography including palace walls, stelae, and sarcophagus lids, cementing its position as an important religious symbol representing themes such as death (Zidar and Elisens 2009: 126). The Ceiba tree is still important to current Maya populations and I =s often avoided when clearing land and it is still used in ceremonies (Zidar and Elisens 2009: 126).

***Pimenta dioica* (Allspice)**

Allspice, apart from its current use as a seasoning, has multiple medicinal uses including encouraging blood circulation, and soothing aches and pains (Schlesinger 2001: 105). It is reported that the ancient Maya used allspice to flavour foods and the oil was used to embalm individuals after death (Schlesinger 2001: 105)

***Manilkara zapota* (Sapodilla)**

Sapodilla, also known as Zapote or Chicle is a coveted wood for multiple reasons. Ancient Maya would use its timber to build the carved lintels and doorways of temples as it has a long decay time (Schlesinger 2001: 145). Sapodilla also holds religious/spiritual importance in the form of its sap that was considered a “sacred secretion of life” (Schlesinger 2001: 146). The latex from the tree provided the ancient Maya with a quenching method when working, and this same tradition ahs continued into the current era in the form of gum, and more specifically *Chiclets* (Schlesinger 2001: 146).

***Zea Mays* (Maize)**

Maize is a well-known cultigen from across the Maya landscape and forms the majority of the diet in the form of carbohydrates at many Maya sites, making it a very significant crop and most likely was grown at or near Ka'kabish. Maize also holds a spiritual value as it is connected with multiple myths and stories from the Maya and is also associated with some deities (Houston and Inomata 2009: 218-219).

Looking at Ka'kabish

Excavation and research at Ka'kabish should focus on the high probability species such as cacao, cotton, breadnut, and cohune, along with the well-documented maize, beans, squash, and Ceiba. These species have the most potential to be found at Ka'kabish either through remnant forests in the case of breadnut, but also as both archaeobotanical remains and iconography. However, organic remains of corn, beans, and squash must be found within sealed contexts such as caches or in pottery, as these may be confused with current crops. Allspice and Copal are also found on site and could have a high possibility of being used in the past. When excavating care should be taken to look out for icons on ceramic pieces if found, but also paintings on the tomb walls at the site.

CHAPTER 6: CONCLUSION

The goal of this thesis was to provide a foundational predictive model of potential plant resources and agroforestry for the Maya site of Ka'kabish as there is no floral analysis currently done for the site. In order to accomplish this, information in the form of archaeological investigations and historic surveys, was gathered from surrounding sites to the North, East, and West of Ka'kabish in northern Belize. Another goal was to determine if the surrounding sites could provide insight into the agricultural resources of Ka'kabish. I believe that this thesis provides a foundational set of data on possible plant resources, along with suggestions for further research to confirm what plant resources were actually at Ka'kabish if given the option for further investigation.

The most important findings include the high frequency items as they not only showed up in multiple data records but also held a variety of purposes from ritual use to construction. The "Mesoamerican Triad" of maize, beans, and squash, which was identified in the archaeological data is most likely one of the main cultivars at Ka'kabish due to its high nutritional value and its prominence at many Maya sites across Belize. In addition to the triad, highlights of potential resources include Breadnut, cotton, sapodilla, Allspice, and cocoa.

Challenges and Limitations

There were a variety of challenges when researching the plant resources of Ka'kabish. Due to there being limited research on paleoethnobotany for Ka'kabish, looking further afield was needed to create a comparison, however, there was limited research done to the North of Ka'kabish and virtually no research done to the South of Ka'kabish within a close enough proximity to allow for comparison. This greatly limited the available data, however, sites to the East and West had the most similar environments to Ka'kabish, allowing for a more complete picture. If further research is conducted to the North and South, it is hoped that new data for those regions can be added to this analysis. Another challenge was finding archaeological research that specifically looked at the plant resources of a site. Most investigations either explored a site's environmental history more generally or were looking at other facets of a site such as burials or social organization. While both types of research provided some organic remains to use for data collection, it created a more tedious investigation into each site to reveal the relevant information. Sources that did provide specific plant types were based on more recent biological surveys, potentially providing information on changed or tainted environments. That being said, the combination of land surveys and archaeological excavations produced a list of potential plant resources for Ka'kabish and a base from which further research can be directed.

Next Steps and Future Avenues

Further research on the plant resources and agroforestry of Ka'kabish should be conducted to better understand the agricultural practices, diet, economics, and religion of the site and to determine how similar or dissimilar Ka'kabish is to its neighbours. The next steps should include excavation at Ka'kabish itself with a specific focus on paleoethnobotany to search for macro and micro-botanicals such as phytoliths and pollen. Additionally, soil samples and sediment cores should be taken from the land immediately surrounding Ka'kabish to create an environmental reconstruction and history of change at the site for comparison with surrounding regions and previous research done, such as that at Lamanai (Rushton 2013, 2020). Sediment core analysis would also provide further pollen analysis and potential plant species identification for local vegetation. Another avenue of research should be conducting interviews with local bushmen from the region including at San Felipe, Indian Church Village, and San Carlos. This ethnographic research would provide vital cultural history and knowledge of plant types and uses that can be correlated with and compared to the archaeological record. The focus of these interviews should be on which plants held cultural value to the current Maya, oral histories of important species, and the various medicinal and nutritional uses of plant types.

Beyond using this information to gain a better understanding of the agricultural and agroforestry practices of the ancient Maya at Ka'kabish, this research has the potential to contribute to community research with the Mennonite communities in the research. There has been interest expressed by local Mennonites in understanding the agricultural practices of the ancient Maya and how these same practices can be applied to current practices to make them more efficient and effective (Helen Haines, personal communication 2022). Willing members of the Mennonite Communities of Indian Creek and Shipyard, particularly those people engaged in the timber trade could also be interested to learn about the hardwood forests. Sharing this knowledge could help maintain and strengthen the relationship with the Mennonite communities which would aid with access to land for further excavation, and the preservation of archaeological sites on Mennonite property.

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APPENDIX A: Summary of Soil and Vegetation Composition for Each Site

Table 1. Soil Description for Birds of Paradise Region (Summarized from Romney 1959)

Map Number	Description of Reported Soil Type	Natural Vegetation in Soil Type
9/9d	Yaxa clay/ yaxa mottled clay	1a/2b and 21a
41	Sennis silt loam	11f
50	Haciapina sandy loam	15
53/53a/53c	Puletan loamy sand/ " shallow loamy sand and gravelly sand/ " sandy loam	19/19/19a
55	Pucte clay	22
56	Chucum clay	23
58c	Sibal peaty loam	25

Table 2. Vegetation Description for Birds of Paradise Region (Summarized from Romney 1959)

Map Number	Description of Reported Vegetation	Specific Vegetation in Region
11f	Transitional Broadleaf Forest Rich in Lime-loving Species: Semi-evergreen seasonal forest	-Negrito-Cockspur-Botan Palm Forest: - Grape - Pixoy - Black Maya - Cutting Grass
13a	Transitional Low Broadleaf Forest and Shrubland: Rich in Lime-loving Species	-Ensino-Pixoy Forest: - Grape - Cojeton - Tastab - Botan Palm - Cutting Grass
15	Transitional Low Broadleaf Forest and Shrubland: Poor in Lime-loving Species	-Black and White Maya: - Polewood - Wild Coffee - Carbon - Mylady - Pimento Palm
19/19a/19b	Pine Forest and Orchard Savanna: Without Lime-loving Species	19/19a: Grass/Sedges: - Pines - Crabboe/Nance - Yaha - Oak - Salt-water Pimento Palms - Calabush 19b: Palmetto Palm Clumps - Grasses and sedges - Oaks

		- Crabboe/Nance
21a/22	High Marsh Forest	21a: Botan-Chechem: - Pucte - Basket tie-tie - Sapodilla - Grape - Chechem - Botan 22: Pucte-Chechem Forest: - White Wattle - Knock-me-back - Logwood - Redwood - Palmetto - Basket tie-tie
23	Low Marsh Forest	-Chechum Logwood Palmetto - Stunted Pucte - Sapodilla - Madre de cacao
25	Herbaceous Marsh and Swamp	-Rush-Sedge Community - Calabash - Small Pucte - Palmetto - Knock-me-back
34	Cohune Palm Forest	- Wild Rubber - Trumpet - Mamey Apple - Copal - Fig - Pork and Doughboy Palm - Bookut - Tubroos - Wild Tamarind - Cherry - Cojeton - Thatch Palm - Give-and-Take Palm - Hone Palm - Bullhoof - Chicle Macho - Wild Coffee - Bitterwood - Nargusta - Ironwood - Mamey Ciruela

		- Cotton - Silion - Breadnut - Wild Cacao - Polak

Table 3. Soil Description for Blue Creek Site (Summarized from Romney 1959)

Map Number	Description of Reported Soil Type	Natural Vegetation in Soil Type
3	Hondo Clay	20
9/9d	Yaxa clay/ yaxa mottled clay	1a/2b and 21a
13/13a	Jolja clay/ Jolja gravelly clay	2b/2a
13H	Jolja gravelly clay loam, hill soil	2a
50	Haciapina sandy loam	15
55	Pucte clay	22
58c	Sibal peaty loam	25

Table 4. Vegetation Description for Blue Creek Site (Summarized from Romney 1959)

Map Number	Description of Reported Vegetation Area	Specific Vegetation in Region
1a	Broadleaf Forest Rich in Lime-loving Species – Deciduous seasonal forest 50-70 high on limestone	-Sapote-Mahogany Forest - Pixoy - Cockspur - Cabbage Bark - Turtlebone - Give-and-Take Palm - Thatch Palm -Taller trees (70-100ft) - Silion - Zapodillo - Mylady - Mahogany - Cedar - Santa Maria - Bullhoof - Chiquebul -Legume Trees - Turbroos - Barba Jolote - Quamwood - Jim Crow Wood -Shrubby Plants:

		- Piper - -Pyschotrea -Low Palms: - Monkeytail -Lianes: - Basket Tie-Tie - Vanilla Vines
2/2a	Broadleaf Forest Rich in Lime-loving Species – Deciduous seasonal forest 70-100 high on limestone	-Sapote-Silion Forest: - Bombacoideaeon - Mylady - Mahogany - Cedar - Give-and-take Palms - Spice
20/21a/22	High Marsh Forest	20: Bribri Provision Bark: - Coco plum - Pucte - Poknoboy - Cohune Palms 21a: Botan-Chechem: - Pucte - Basket tie-tie - Sapodilla - Grape - Chechem - Botan 22: Pucte-Chechem Forest: - White Wattle - Knock-me-back - Logwood - Redwood - Palmetto - Basket tie-tie
25	Herbaceous Marsh and Swamp	-Rush-Sedge Community - Calabash - Small Pucte - Palmetto - Knock-me-back

Table 5. Soil Description for Chan Cahal Site (Summarized from Romney 1959)

Map Number	**Description of Reported Soil Type**	**Natural Vegetation in Soil Type**
3	Hondo Clay	20
9/9d	Yaxa clay/ yaxa mottled clay	1a/2b and 21a

55	Pucte clay	22
58c	Sibal peaty loam	25

Table 6. Vegetation Description for Chan Cahal Site (Summarized from Romney 1959)

Map Number	**Description of Reported Vegetation Area**	**Specific Vegetation in Region**
1a	Broadleaf Forest Rich in Lime-loving Species – Deciduous seasonal forest 50-70 high on limestone	-Sapote-Mahogany Forest - Pixoy - Cockspur - Cabbage Bark - Turtlebone - Give-and-Take Palm - Thatch Palm -Taller trees (70-100ft) - Silion - Zapodillo - Mylady - Mahogany - Cedar - Santa Maria - Bullhoof - Chiquebul -Legume Trees - Turbroos - Barba Jolote - Quamwood - Jim Crow Wood -Shrubby Plants: - Piper - -Pyschotrea -Low Palms: - Monkeytail -Lianes: - Basket Tie-Tie - Vanilla Vines
15	Transitional Low Broadleaf Forest and Shrubland: Poor in Lime-loving Species	-Black and White Maya: - Polewood - Wild Coffee - Carbon - Mylady - Pimento Palm
19a/19b	Pine Forest and Orchard Savanna: Without Lime-loving Species	19a: Grass/Sedges: - Pines - Crabboe/Nance

		- Yaha - Oak - Salt-water Pimento Palms - Calabush 19b: Palmetto Palm Clumps - Grasses and sedges - Oaks - Crabboe/Nance
20/21a/22	High Marsh Forest	20: Bribri Provision Bark: - Coco plum - Pucte - Poknoboy - Cohune Palms 21a: Botan-Chechem: - Pucte - Basket tie-tie - Sapodilla - Grape - Chechem - Botan 22: Pucte-Chechem Forest: - White Wattle - Knock-me-back - Logwood - Redwood - Palmetto - Basket tie-tie
25	Herbaceous Marsh and Swamp	-Rush-Sedge Community - Calabash - Small Pucte - Palmetto - Knock-me-back

Table 7. Soil Description for Akab Muclil Site (Summarized from Romney 1959)

Map Number	**Description of Reported Soil Type**	**Natural Vegetation in Soil Type**
9d	Yaxa mottled clay	21a
13/13c	Jolja clay/ Jolja mottled clay	2b/21a
58c	Sibal peaty loam	25

Table 8.Vegetation Description for Akab Muclil Site (Summarized from Romney 1959)

Map Number	**Description of Reported Vegetation**	**Specific Vegetation in Region**
2/2a/2b	Broadleaf Forest Rich in Lime-loving Species – Deciduous seasonal forest 70-100 high on limestone	2/2a: Sapote-Silion Forest: - Ramon - Mylady - Mahogany - Cedar - Give-and-take Palms - Spice 2b: Sapote-Ramon-Spice Forest: - Mahogany - Turtlebone - Cabbage Bark - Give-and-take Palm - Thatch Palm
21a	High Marsh Forest	21a: Botan-Chechem: - Pucte - Basket tie-tie - Sapodilla - Grape - Chechem - Botan
23	Low Marsh Forest	-Chechum Logwood Palmetto - Stunted Pucte - Sapodilla - Madre de cacao
25	Herbaceous Marsh and Swamp	-Rush-Sedge Community - Calabash - Small Pucte - Palmetto - Knock-me-back

Table 9.Soil Description for Lamanai Site (Summarized from Romney 1959)

Map Number	**Description of Reported Soil Type**	**Natural Vegetation in Soil Type**
3	Hondo Clay	20
9/9a/9c/9d	Yaxa Clay/ " gravelly clay/ " dark grey clay / " mottled clay	(1a/2b)/(1a/2b)/34/21a
12	Lazaro sandy clay	1a
20	Pixoy sandy loam	1a
50	Haciapina sandy loam	15
53c	Puletan sandy loam	19a

56	Chucum clay	23
58	Sibal peaty sandy silt and loamy sand	24

Table 10.Vegetation Description for Lamanai Site (Summarized from Romney 1959)

Map Number	Description of Reported Vegetation	Specific Vegetation in Region
1a	Broadleaf Forest Rich in Lime-loving Species – Deciduous seasonal forest 50-70 high on limestone	-Sapote-Mahogany Forest - Pixoy - Cockspur - Cabbage Bark - Turtlebone - Give-and-Take Palm - Thatch Palm -Taller trees (70-100ft) - Silion - Zapodillo - Mylady - Mahogany - Cedar - Santa Maria - Bullhoof - Chiquebul -Legume Trees - Turbroos - Barba Jolote - Quamwood - Jim Crow Wood -Shrubby Plants: - Piper - -Pyschotrea -Low Palms: - Monkeytail -Lianes: - Basket Tie-Tie - Vanilla Vines
15	Transitional Low Broadleaf Forest and Shrubland: Poor in Lime-loving Species	-Black and White Maya: - Polewood - Wild Coffee - Carbon - Mylady - Pimento Palm
19a	Pine Forest and Orchard Savanna: Without Lime-loving Species	-Grass/Sedges: - Pines - Crabboe/Nance

		- Yaha - Oak
20/21a	High Marsh Forest	20: Bribri Provision Bark: - Coco plum - Pucte - Poknoboy - Cohune Palms 21a: Botan-Chechem: - Pucte - Basket tie-tie - Sapodilla - Grape - Chechem - Botan
24	Herbaceous Marsh and Swamp	-Rush Vegetation: - Sedges - Calabash - Palmetto
34	Cohune Palm Forest	- Wild Rubber - Trumpet - Mamey Apple - Copal - Fig - Pork and Doughboy Palm - Bookut - Tubroos - Wild Tamarind - Cherry - Cojeton - Thatch Palm - Give-and-Take Palm - Hone Palm - Bullhoof - Chicle Macho - Wild Coffee - Bitterwood - Nargusta - Ironwood - Mamey Ciruela - Cotton - Silion - Breadnut - Wild Cacao - Polak

Table 11. Soil Description for El Pozito Site (Summarized from Romney 1959)

Map Number	Description of Reported Soil Type	Natural Vegetation in Soil Type
9/9a/9c/9d	Yaxa Clay/ " gravelly clay/ " dark grey clay / " mottled clay	(1a/2b)/(1a/2b)/34/21a
12	Lazaro sandy clay	1a
20/20b	Pixoy sandy loam/Pixoy mottled sandy loam	1a/21

Table 12.Vegetation Description for El Pozito Site (Summarized from Romney 1959)

Map Number	Description of Reported Vegetation	Specific Vegetation in Region
1a	Broadleaf Forest Rich in Lime-loving Species – Deciduous seasonal forest 50-70 high on limestone	-Sapote-Mahogany Forest - Pixoy - Cockspur - Cabbage Bark - Turtlebone - Give-and-Take Palm - Thatch Palm -Taller trees (70-100ft) - Silion - Zapodillo - Mylady - Mahogany - Cedar - Santa Maria - Bullhoof - Chiquebul -Legume Trees - Turbroos - Barba Jolote - Quamwood - Jim Crow Wood -Shrubby Plants: - Piper - -Pyschotrea -Low Palms: - Monkeytail -Lianes: - Basket Tie-Tie - Vanilla Vines
21a	High Marsh Forest	21a: Botan-Chechem: - Pucte - Basket tie-tie

		- Sapodilla - Grape - Chechem - Botan
34	Cohune Palm Forest	- Wild Rubber - Trumpet - Mamey Apple - Copal - Fig - Pork and Doughboy Palm - Bookut - Tubroos - Wild Tamarind - Cherry - Cojeton - Thatch Palm - Give-and-Take Palm - Hone Palm - Bullhoof - Chicle Macho - Wild Coffee - Bitterwood - Nargusta - Ironwood - Mamey Ciruela - Cotton - Silion - Breadnut - Wild Cacao - Polak

Table 13.Soil Description for Cuello Site (Summarized from Romney 1959)

Map Number	Description of Reported Soil Type	Natural Vegetation in Soil Type
12	Lazaro sandy clay	1a
12a/12b	Lazaro dark grey sandy clay/Lazaro mottled sandy clay	3b/21b
20	Pixoy sandy loam	1a

Table 14.Soil Description for Cuello Site (Summarized from Romney 1959)

Map Number	Description of Reported Vegetation	Specific Vegetation in Region
1a	Broadleaf Forest Rich in Lime-loving Species – Deciduous seasonal forest 50-70 high on limestone	-Sapote-Mahogany Forest - Pixoy - Cockspur - Cabbage Bark - Turtlebone - Give-and-Take Palm - Thatch Palm -Taller trees (70-100ft) - Silion - Zapodillo - Mylady - Mahogany - Cedar - Santa Maria - Bullhoof - Chiquebul -Legume Trees - Turbroos - Barba Jolote - Quamwood - Jim Crow Wood -Shrubby Plants: - Piper - -Pyschotrea -Low Palms: - Monkeytail -Lianes: - Basket Tie-Tie - Vanilla Vines
21a/22	High Marsh Forest	21a: Botan-Chechem: - Pucte - Basket tie-tie - Sapodilla - Grape - Chechem - Botan 22: Pucte-Chechem Forest: - White Wattle - Knock-me-back - Logwood - Redwood - Palmetto - Basket tie-tie

34	Cohune Palm Forest	- Wild Rubber - Trumpet - Mamey Apple - Copal - Fig - Pork and Doughboy Palm - Bookut - Tubroos - Wild Tamarind - Cherry - Cojeton - Thatch Palm - Give-and-Take Palm - Hone Palm - Bullhoof - Chicle Macho - Wild Coffee - Bitterwood - Nargusta - Ironwood - Mamey Ciruela - Cotton - Silion - Breadnut - Wild Cacao - Polak

Table 15.Soil Description for Ka'kabish Site (Summarized from Romney 1959)

Map Number	Description of Reported Soil Type	Natural Vegetation in Soil Type
9/9a/9c/9d	Yaxa Clay/ " gravelly clay/ " dark grey clay / " mottled clay	(1a/2b)/(1a/2b)/34/21a
56	Chucum clay	23

Table 16.Vegetation Description for Ka'kabish Site (Summarized from Romney 1959)

Map Number	Description of Reported Vegetation	Specific Vegetation in Region
1a	Broadleaf Forest Rich in Lime-loving Species – Deciduous seasonal forest 50-70 high on limestone	-Sapote-Mahogany Forest - Pixoy - Cockspur - Cabbage Bark - Turtlebone - Give-and-Take Palm

		- Thatch Palm -Taller trees (70-100ft) - Silion - Zapodillo - Mylady - Mahogany - Cedar - Santa Maria - Bullhoof - Chiquebul -Legume Trees - Turbroos - Barba Jolote - Quamwood - Jim Crow Wood -Shrubby Plants: - Piper - -Pyschotrea -Low Palms: - Monkeytail -Lianes: - Basket Tie-Tie - Vanilla Vines
21a	High Marsh Forest	21a: Botan-Chechem: - Pucte - Basket tie-tie - Sapodilla - Grape - Chechem - Botan
34	Cohune Palm Forest	- Wild Rubber - Trumpet - Mamey Apple - Copal - Fig - Pork and Doughboy Palm - Bookut - Tubroos - Wild Tamarind - Cherry - Cojeton - Thatch Palm - Give-and-Take Palm - Hone Palm - Bullhoof

		- Chicle Macho - Wild Coffee - Bitterwood - Nargusta - Ironwood - Mamey Ciruela - Cotton - Silion - Breadnut - Wild Cacao - Polak

Table 17.Soil Description for KKB-LAM Corridor (Summarized from Romney 1959)

Map Number	Description of Reported Soil Type	Natural Vegetation in Soil Type
3	Hondo Clay	20
9/9c/9d	Yaxa Clay/ " dark grey clay / " mottled clay	(1a/2b)//34/21a
20/20a	Pixoy sandy loam/ " dark brown sandy loam	1a/34
23	Felipe loamy sand	13a
41	Sennis silt loam	11f
50	Haciapina sandy loam	15
53/53a	Puletan loamy sand/ " shallow loamy sand and gravelly sand	19/19
55	Pucte clay	22
56	Chucum clay	23
58c	Sibal peaty loam	25

Table 18.Vegetation Description for KKB-LAM Corridor (Summarized from Romney 1959)

Map Number	Description of Reported Vegetation	Specific Vegetation in Region
1a	Broadleaf Forest Rich in Lime-loving Species – Deciduous seasonal forest 50-70 high on limestone	-Sapote-Mahogany Forest - Pixoy - Cockspur - Cabbage Bark - Turtlebone - Give-and-Take Palm - Thatch Palm -Taller trees (70-100ft) - Silion - Zapodillo

		- Mylady - Mahogany - Cedar - Santa Maria - Bullhoof - Chiquebul -Legume Trees - Turbroos - Barba Jolote - Quamwood - Jim Crow Wood -Shrubby Plants: - Piper - -Pyschotrea -Low Palms: - Monkeytail -Lianes: - Basket Tie-Tie - Vanilla Vines
11f	Transitional Broadleaf Forest Rich in Lime-loving Species: Semi-evergreen seasonal forest	-Negrito-Cockspur-Botan Palm Forest: - Grape - Pixoy - Black Maya - Cutting Grass
13a	Transitional Low Broadleaf Forest and Shrubland: Rich in Lime-loving Species	
19/19a/19b	Pine Forest and Orchard Savanna: Without Lime-loving Species	19/19a: Grass/Sedges: - Pines - Crabboe/Nance - Yaha - Oak - Salt-water Pimento Palms - Calabush 19b: Palmetto Palm Clumps - Grasses and sedges - Oaks - Crabboe/Nance
21a/22	High Marsh Forest	21a: Botan-Chechem: - Pucte - Basket tie-tie - Sapodilla - Grape - Chechem - Botan

		22: Pucte-Chechem Forest: - White Wattle - Knock-me-back - Logwood - Redwood - Palmetto - Basket tie-tie
25	Herbaceous Marsh and Swamp	-Rush-Sedge Community - Calabash - Small Pucte - Palmetto - Knock-me-back
34	Cohune Palm Forest	- Wild Rubber - Trumpet - Mamey Apple - Copal - Fig - Pork and Doughboy Palm - Bookut - Tubroos - Wild Tamarind - Cherry - Cojeton - Thatch Palm - Give-and-Take Palm - Hone Palm - Bullhoof - Chicle Macho - Wild Coffee - Bitterwood - Nargusta - Ironwood - Mamey Ciruela - Cotton - Silion - Breadnut - Wild Cacao - Polak

Table 19.Vegetation Description of Current Environment Based on Vegetation Zones (Summarized from Helen Haines personal communication 2022)

Vegetation Area	Description of Reported Current Vegetation
1a	- Cohune - Mahogany - Sapote - Give-&-Take Palm - Thatch Palm - Zapodillo - All-spice (Pimento)
21a	- Chechum
34	Cohune Palm Forest - Mamey - Copal

Table 20.Summary of Plant Species identified in the Archaeological Record of Surrounding Sites

Plant Type	Common Name	Birds of Paradise	Blue Creek	Chan Cahal	Akab Muclil	Lamanai	El Pozito	Cuello	Known Use/Importance
Agavoideae	Agave		✓						fibre
Annona sp.	Soursop					✓			food
Arecaceae sp.	Palm					✓			construction, food
Asteraceae	Aster				✓				
Attalea cohune	Cohune	✓				✓			construction, food
B. gasipaes	Peach Palm		✓						food/construction
Bactris major	Jauacte Palm							✓	
Bombacaceae/Ceiba pentandra	Silk Cotton Tree/Ceiba							✓	ritual/fibre
Brosimum sp.	Breadnut/Ramon					✓			food
Bucida buceras	Pucte								construction/fuel
Bursera simaruba	Gumbo-limbo/Turpentine					✓			construction/food
Byrsonima crassifoli	Crabboe/Nance							✓	food
Capsicum	Chili					✓		✓	food
Casearia sp.	N/A					✓			
Combretaceae	White mangrove family				✓				
Cucurbita spp.	Squash		✓	✓		✓		✓	food
Euphorbiaceae	Spurge Family				✓				
Gossypium hirsutum	Cotton							✓	fibre
Heliconia	Lobster Claws		✓						
Hevea brasiliensis	Wild rubber					✓			
Ipomoea batatas	Sweet Potato					✓			food
Manilkara zapota	Sapodilla			✓		✓			construction
Metopium	Poisonwood					✓			
P. americana	Avocado							✓	food
Phaseolus spp.	Beans			✓					food
Pimenta dioica	Allspice							✓	food/medicine
Pinus sp.	Pine				✓	✓			construction/ritual
Poaceae	Wetland Grasses				✓				
Pouteria sapota	Mamey							✓	food
Spondias mombin	Hogplum,							✓	food
Theobroma cacao	Cacao			✓					food/ritual
Vitex	Chaste Tree					✓			medicine
Zea Mays	Maize/corn	✓	✓	✓	✓	✓		✓	food/ritual

Table 21.Summary of Matching Vegetation Regions based on Romney 1959 for Surrounding Sites

Vegetation Region from Romney Survey	Description	Birds of Paradise	Blue Creek	Chan Cahal	Akab Muclil	Lamanai	El Pozito	Cuello	Ka'kabish
1a	*Broadleaf Forest Rich in Lime-loving Species – Deciduous seasonal forest 50-70 high on limestone*		✓	✓		✓	✓	✓	✓
2	*Broadleaf Forest Rich in Lime-loving Species – Deciduous seasonal forest 70-100 high on limestone*		✓		✓				
2a	*Broadleaf Forest Rich in Lime-loving Species – Deciduous seasonal forest 70-100 high on limestone*		✓		✓				
2b	Broadleaf Forest Rich in Lime-loving Species – Deciduous seasonal forest 70-100 high on limestone				✓				
11f	Transitional Broadleaf Forest Rich in Lime-loving Species: Semi-evergreen seasonal forest	✓							
13a	Transitional Low Broadleaf Forest and Shrubland: Rich in Lime-loving Species	✓							
15	Transitional Low Broadleaf Forest and Shrubland: Poor in Lime-loving Species	✓		✓		✓			
19	Pine Forest and Orchard Savanna: Without Lime-loving Species	✓							
19a	Pine Forest and Orchard Savanna: Without Lime-loving Species	✓		✓		✓			
19b	Pine Forest and Orchard Savanna: Without Lime-loving Species	✓		✓					
20	High Marsh Forest		✓	✓		✓			
21a	*High Marsh Forest*	✓	✓	✓	✓	✓	✓	✓	✓
22	*High Marsh Forest*	✓	✓	✓				✓	
23	Low Marsh Forest	✓			✓				
24	Herbaceous Marsh and Swamp					✓			
25	Herbaceous Marsh and Swamp	✓	✓	✓	✓				
34	*Cohune Palm Forest*	✓				✓	✓	✓	✓

Table 22.Summary of Plant Species gathered from Previous Knowledge about Maya Culture based on Ethnographic, Archaeobotanical, and Iconographic Research

Plant Type	Common Name	Ethnographic	Iconographic	Archaeobotanical	Known Use/Importance
Acromia aculeata	Coyol	✓			Fermented Beverage
Anacardium occidentale L.	Cashew			✓	Food
Attalea cohune	Cohune			✓	Construction/food
Bombacoideae spp.			✓		Ritual
Brosimum sp.	Breadnut/Ramon	✓			Food
Byrsonima crassifoli	Crabboe/Nance		✓		Food
Capsicum	Chile			✓	Food
Ceiba petandra	Ceiba/Kopok Tree	✓	✓		Ritual
Cucurbita spp.	Squash			✓	Food
Gossypium hirsutum	Cotton	✓		✓	Textile
P. americana	Avocado	✓	✓	✓	Food
Pachira aquatica	Provision Tree		✓		Food
Phaseolus spp.	Beans			✓	Food
Pinus sp.	Pine	✓		✓	Construction/ritual
Pouteria sapota	Mamey	✓			Food
Pseudobombax ellipticum	Shaving Brush Tree		✓		Ritual
Psidium guajava	Guayaba/guava		✓		Food
Theobroma cacao	Cacao		✓	✓	Food/Ritual
Zea Mays	Maize/corn		✓	✓	Food/Ritual

APPENDIX B: Vegetation and Soil Reference Maps from Romney 1959

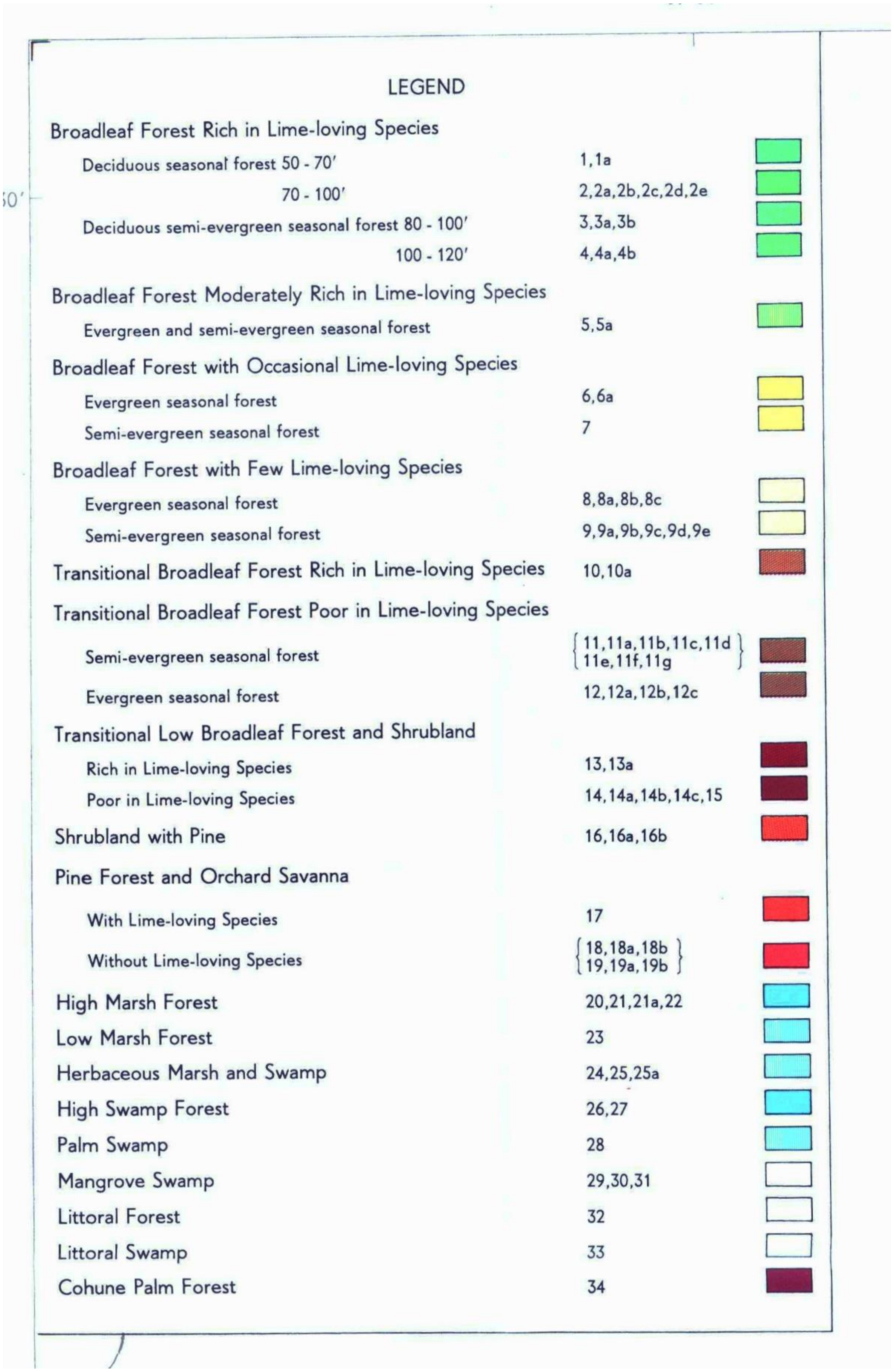

Figure B-1. Legend for Natural Vegetation Map from Romney et al. Land Survey 1959

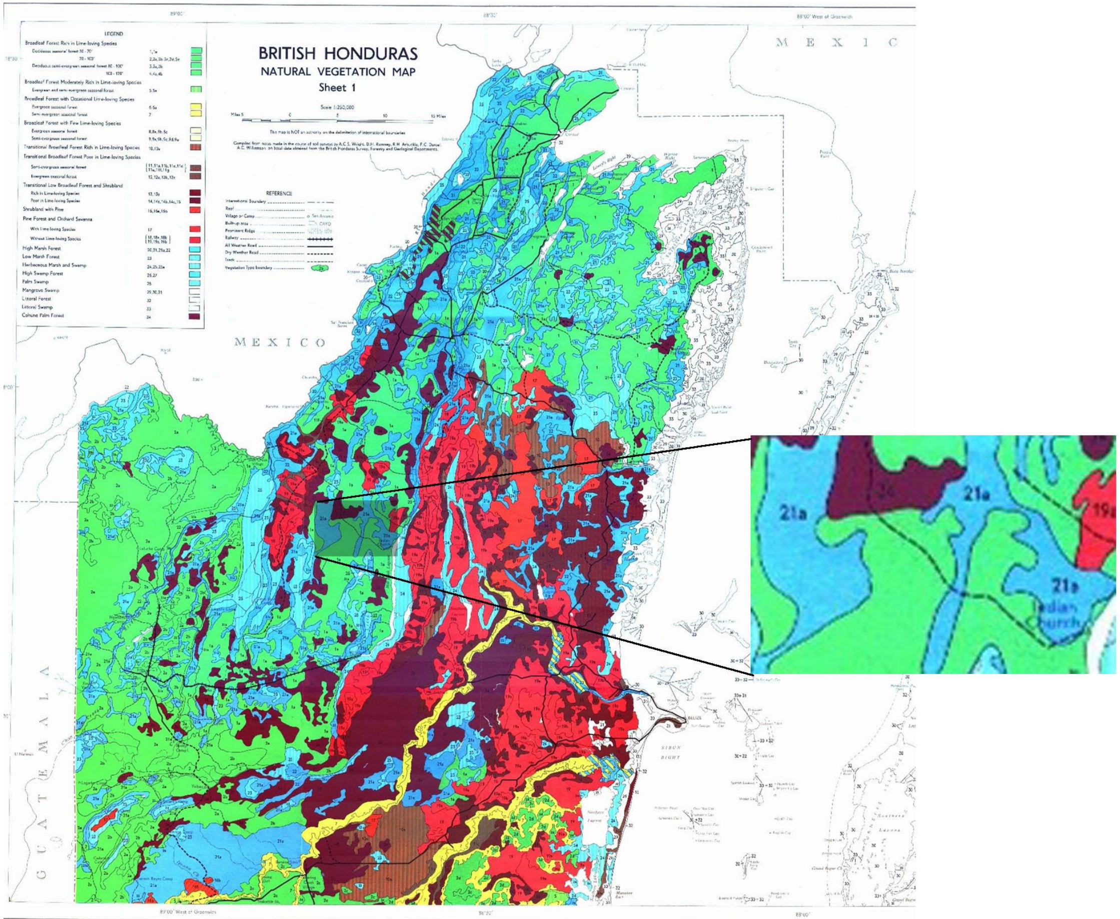

Figure B-2. Natural Vegetation Map from Romney et al. Land Survey 1959

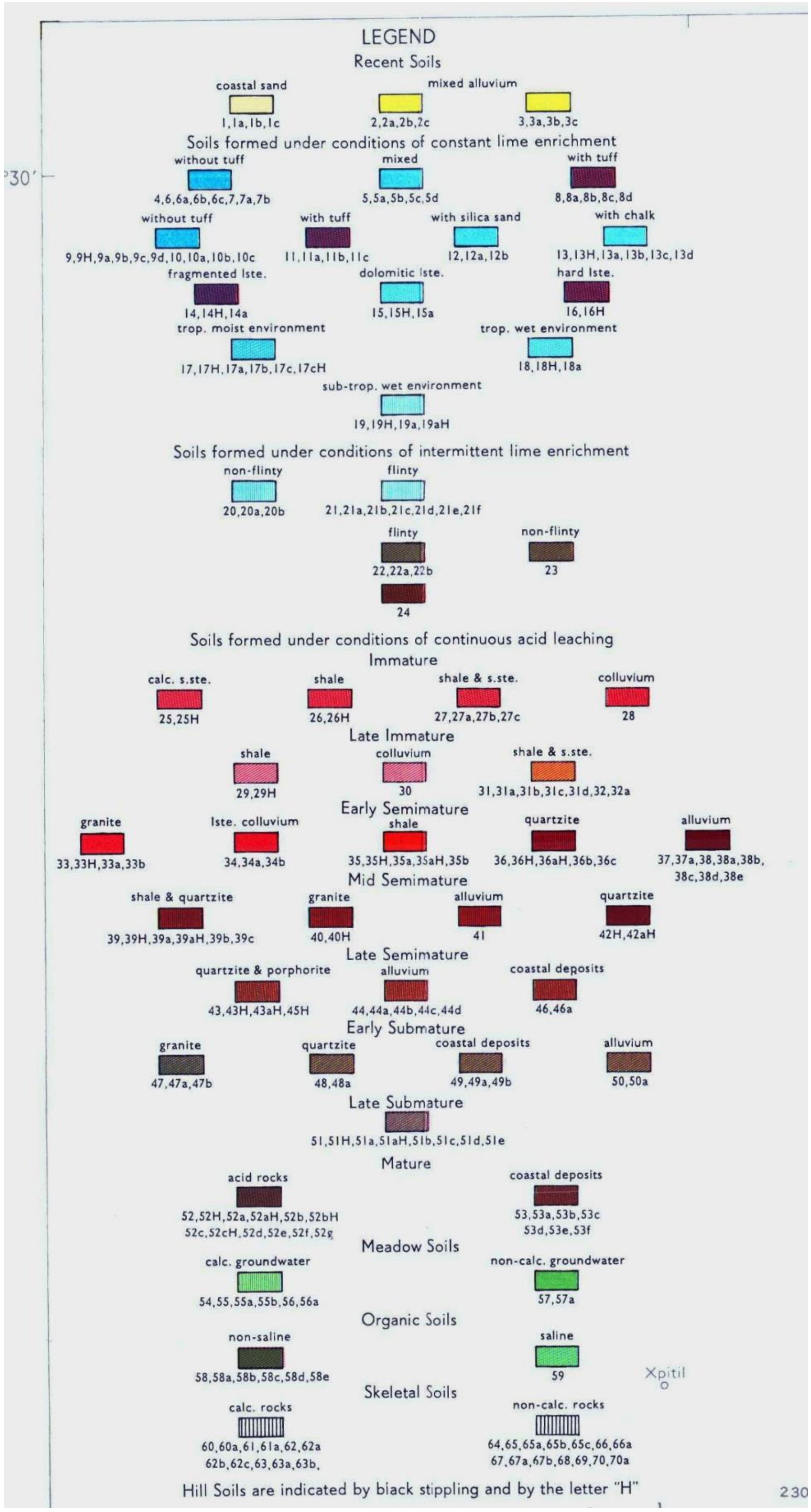

Figure B-3. Legend for Soil Composition Map from Romney et al. Land Survey 1959

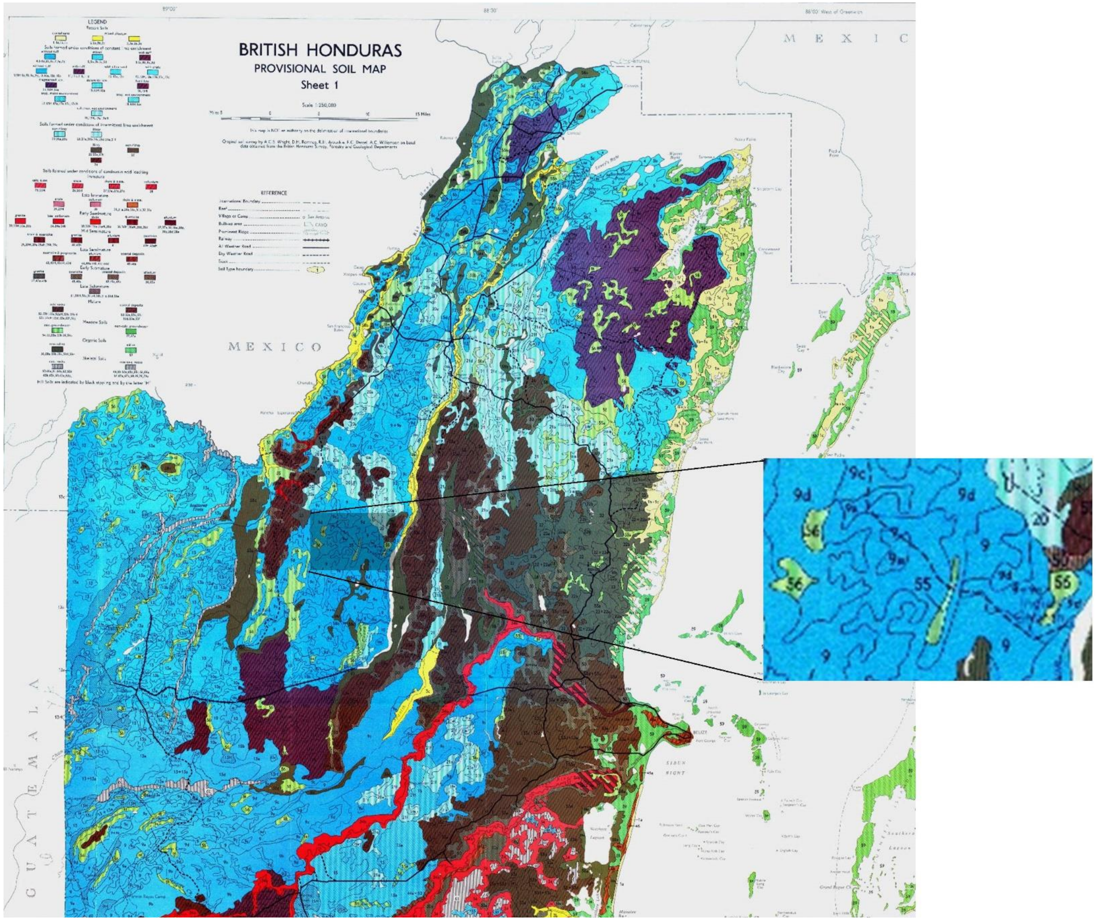

Figure B-4. Soil Composition Map from Romney et al. Land Survey 1959