THESIS

POPULATION AND EMPIRE: A NEW REGIONAL DEMOGRAPHIC MODEL FOR THE PURÉPECHA IMPERIAL HEARTLAND

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ABSTRACT

POPULATION AND EMPIRE: A NEW REGIONAL DEMOGRAPHIC MODEL FOR THE PURÉPECHA IMPERIAL HEARTLAND

This thesis investigates the demographic processes involved in Purépecha Imperial consolidation and administration in the Late Postclassic Period (1350-1520 CE) with respect to demographic scale and distribution. In doing so, I present a new regional demographic model for the Lake Pátzcuaro Basin (LPB), Michoacán, Mexico, which formed the heartland of the Purépecha Empire in the Late Postclassic period. This region was home to the imperial capital Tzintzuntzan, several other dense urban centers. In the last thirty years, researchers have discovered significant new settlements in this region, including the expansive urban zone of Angamuco, but published estimates for the size, distribution, and makeup of its population have not kept up with these discoveries. Key questions regarding state consolidation and administration in relation to demographic scale, distribution, and dynamics all rely on accurate information about population and therefore demand a new, systematic demographic study. This project synthesizes highly precise data on settlement size and density from recent LiDAR surveys of the LPB with ground survey and insights from settlement scaling theory to construct an up-to-date regional settlement demographic model for this understudied Mesoamerican region. The model shows that the LPB population existed on a much greater scale than previously imagined, clustered in a diverse array of highly developed urban settlements. This more accurate model of the scale and distribution of the Purépecha population provides insights into the conditions in which the empire arose, the political strategies employed by its rulers, and

the devastating effects of Spanish colonization. This project contributes not only to all future Purépecha scholarship, but also broadly to our knowledge of the diverse forms of social organization and the relationship between population and the state in prehispanic Mesoamerica.

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1. Introduction

In this thesis, I seek to understand the role of demographic processes in the consolidation and administration of the Purépecha Empire by investigating the demographic scale and spatial patterning of settlement in the Late Postclassic Lake Pátzcuaro Basin (LPB), Michoacán, Mexico. I present a new regional demographic model for the heartland of the Purépecha Empire and use it to explore the relationship between population dynamics and imperial institutions. I construct the model using material evidence from recent LiDAR and pedestrian survey data and settlement site data available through the INAH public archaeological registry informed by empirically observed patterns from settlement scaling theory. Through this model, I revise the previous model presented by Gorenstein and Pollard (1983) and challenge their primate city concept of the LPB and the sociopolitical implications thereof. I propose based on the new model presented here that the demographic scale of urban settlement was much more extensive than accounted for previously, and that demographic processes such as immigration and settlement expansion played a greater role in the processes of imperial consolidation, expansion, and administration than previously thought.

The LPB formed the heartland and "political core" of the Purépecha Empire in the Late Postclassic period (1350-1520 CE) (Pollard 1993:63). This state was the second largest empire in Mesoamerica, covering an area over 75,000 km^2 whose borders were roughly analogous to the modern state of Michoacán. Ruling from the capital city of Tzintzuntzan, the Purépecha empire exerted influence over the sociopolitical and economic realities of its realms and was a significant force in the broader Mesoamerican region. The Purépecha fought and won two wars with the Aztec Triple Alliance, and the Purépecha emperor was the only person acknowledged by the Aztec crown to have the same divine right to rulership (Pollard 2008). Understanding the

settlement system and demographic characteristics of this empire's heartland region will contextualize important aspects of its administrative and economic systems as well as the general scale of the society it contained, thus illuminating social, political, and economic realities for the people of the basin and beyond.

Shirley Gorenstein and Helen Perlstein Pollard produced the previous demographic model of the Postclassic LPB in their 1983 work *The Tarascan State: A Late Prehispanic Cultural System*. This model projects that the Late Postclassic LPB under the rule of the Purépecha Empire was home to 60,000-100,000 people and experienced a 32% drop in population between 1518 and 1550. Gorenstein and Pollard (1983) present an extreme primate city model, with the capital city Tzintzuntzan holding 25-35% of the basin's populace. They use this finding to argue that Tzintzuntzan was an absolute center of political, economic, and military power in the LPB. 40 years later, this model needs an update.

Archaeological evidence of the LPB settlement pattern was sparse at this time, and this model heavily relies on settlement descriptions from ethnohistoric sources and extrapolation based on 20th century census data. The result of this is that nearly half of the sites they describe are unverified projections (discussed further in Chapter 3). Despite this, the model has been repeatedly referenced without alteration or criticism in decades of subsequent publications (Pollard 1993, 2008, 2016) and used as a firm starting point for counting populations backward into the past (Fisher 2005; Fisher et al. 2003). New archaeological evidence provides the opportunity to revise this outdated model.

The LIDAR coverage of the extensive Angamuco urban zone call into question previous models of Purépecha prehistoric settlement demography (Fisher and Leisz 2013). The Angamuco urban zone is a 26km^2 *malpaís* on the eastern end of the basin discovered in 2009 almost entirely

covered with dense human habitation (Fisher et al. 2017; Fisher and Leisz 2011, 2013). Human settlement appeared the site of Angamuco around 250 CE, and it was continuously occupied until final abandonment near the end of the 16th century (Fisher 2014; Solinis-Casparius 2024). The extensive settlement observed at Angamuco indicates that the Purépecha population existed on a much larger scale than previously imagined.

New information about the Colonial Period demographic collapse in the Americas corroborates Angamuco's indication of a much greater settled population in the LPB. Recent research suggests that Gorenstein and Pollard's (1983) model underestimates the demographic collapse in the LPB after Spanish arrival (discussed in detail in Chapter 3). The LPB meets all the requirements for experiencing devastating demographic catastrophe after 1520, much like the Basin of Mexico, but this has not been fully considered in demographic reconstructions of the area. This has led to a gross underestimation of the demographic scale of the LPB before the arrival of the Spanish and thus likely misinterpretation of the social, political, economic, and ecological variables related to demographic scale (discussed further in Chapter 3).

Angamuco therefore presents an opportunity to develop a new regional demographic model for the LPB based on archaeological evidence. Angamuco exhibits exceptional preservation, enabling the identification and detailed mapping of individual house structures and neighborhoods (Fisher and Leisz 2011, 2013). This provides the necessary data for a settlement population estimate based on a house structure count, the first of its kind in the LPB. This, in turn, forms the foundation for a new regional demographic model.

Working from the Angamuco settlement data, I use observations from settlement scaling theory to derive population estimations for the basin's settlements based on their area. Modern settlement scaling theory arose from the work of researchers in the Santa Fe Institute, an

organization dedicated to scientific approaches to human complexity (Smith 2023:88). This perspective has enabled the observation of context-specific yet mathematically consistent patterns in the ways quantifiable urban characteristics scale with population (Bettencourt 2013; Bettencourt et al. 2007, 2010; Ortman et al. 2014; Pumain et al. 2006; West 2017). This body of research consistently observes a predictable sub-linear scaling relationship between population and settlement area, allowing for the estimation of one based on the other within a given settlement system (discussed further in Chapter 5) (Bettencourt 2013). Thus, settlement scaling theory provides an evidence-based framework for deriving more accurate and nuanced population estimates relative to settlement area than simply using area as a 1:1 proxy for population as is common (Drennan et al. 2015). This model, based on observed archaeology with minimal extrapolation, will then make a useful point of comparison with other means of population reconstruction based on historical materials (Borah and Cook 1960; Whitmore 1992).

More importantly, this new model will allow me to revise Gorenstein and Pollard's (1983) interpretations about Purépecha sociopolitical organization based on their regional demographic model. I challenge Gorenstein and Pollard's (1983) classic primate city model of the LPB's population, showing that urbanism was much further developed in the region than they imagined 40 years ago and that Tzintzuntzan was not as much of the total solar center of the basin as they claim. I do this at multiple scales as settlements of all sizes within an urban system can provide insight into social conditions and processes in that system. The spatial characteristics of population weigh heavily on social realities (Drennan et al. 2015: 3), and the demographic analysis presented here gives important insight into the scale, organization, and ecological impact of human settlement activity in this Mesoamerican core area. The results have

implications for how we understand the processes behind imperial consolidation and administration.

I rely on remote sensing data, especially LiDAR, in the acquisition and interpretation of the archaeological evidence presented in this thesis. Regional settlement archaeology has incorporated remote sensing from its inception, beginning with Willey's (1953) extensive use of aerial photographs in the Viru Valley, Peru. Fisher and Leisz (2013) state that LiDAR presents the opportunity for revolutionary new studies of ancient settlements. This project attempts to develop this potential further and apply LiDAR's notable capabilities to the study of archaeological settlement demography.

I will begin in Chapter 2 by overviewing Purépecha prehistory and early Colonial history as it relates to settlement and demography. I will then in Chapter 3 review previous settlement demographic work in the LPB and Mesoamerica at large and the importance of demography in archaeological theory. In Chapter 4, I analyze the pedestrian and LiDAR survey data of Angamuco to arrive at a precise population estimate for that city and its greater urban settlement zone. In Chapter 5, I construct a regional settlement demographic model for the LPB based on observed archaeological data from the Angamuco surveys, the INAH public archaeological site registry, and interpretation based on empirically verified settlement scaling patterns. This will allow for a new settlement demographic model based on archaeological analysis of the basin's principal population centers and informed by the observed power-law scaling relationship between population and area rather than predictions based on 20th century settlement patterns.

In this thesis I refer to the political entity ruling most of modern Michoacan from the capital Tzintzuntzan as the Purépecha Empire, rather than by the name 'Tarascan' Empire which has historically been more popular in published literature. I do this because 'Purépecha' is much

closer to how this ethnic group referred to themselves, unlike ‘Tarascan,’ which is a likely Nahua insult used by the Spanish at the time of conquest (Stone 2004).

2. Purépecha Prehistory

In this chapter, I will overview the cultural history of the LPB from the earliest evidence of human occupation to the Spanish conquest, with particular attention to the formation and expansion of the Purépecha imperial state. In doing so, I will contextualize the Late Postclassic Purépecha population within the deep history of human activity the LPB and provide context regarding the origins of the ethnohistoric sources used in this project.

2.1. LPB History Through the Epiclassic Period

Table 1: Local LPB and Mesoamerican chronological phases, adapted from Pollard (2008)

Mesoamerican Period	Local Phase	Date Range
Colonial	Colonial	After 1521 CE
Late Postclassic	Tariácuri	1350-1530 CE
Middle Postclassic	Late Urichu	1000/1100-1350 CE
Early Postclassic	Early Urichu	900-1000/1100 CE
Epiclassic	Lupe-La Joya	600/700-900 CE
Middle Classic	Jarácuaro	550-600/700 CE
Early Classic	Loma Alta 3	350-550 CE
Late Preclassic	Loma Alta 1-2	150 BCE-350 CE
Middle Preclassic	Chupícuaro	> 500-150 BCE

The earliest evidence of human activity in the Purepécha region comes from the Paleoindian period (14 – 4.5 kya). The evidence consists of stone tools including Clovis-like fluted projectile points associated with Pleistocene megafauna (Oliveros 1975; Schondube 1987). Archaeologists have found no sites from this period within the LPB, but their presence in the Lake Chapala basin strongly suggests that the mobile hunter-gatherer groups associated with this technology were present in the Zacapu and Patzcuaro lake basins as well (Pollard 1993: 6). Evidence from the subsequent Archaic Period is scant and the nature of human activity in Michoacan then is very poorly understood.

The Preclassic Period (2500 BCE-350 CE) saw the beginnings of agricultural sedentism in Western Mexico. Paleoethnobotanical analyses of pollen in the sediments of Lake Pátzcuaro show evidence of domesticated maize varieties in the LBP beginning around 1500 BCE (Hutchinson et al. 1956; Watts and Bradbury 1982). Researchers have identified three distinct archaeological cultures in the Purépecha region active during the Preclassic: The Balsas-Mezcala culture in the south, the Chumbícuaro in the southwest, and the Chupícuaro in the north and central portions of the region (Pollard 1993: 6). There is no culturally diagnostic evidence of these cultures within the boundaries of the LPB, but Pollard (1993: 6) has argued that Chupícuaro is the most likely to have inhabited or exploited resources there. Evidence indicates that Chupícuaro populations preferred riverine and lacustrine environments for settlement, interacted with their contemporaries with minimal conflict, and that they developed multiple levels of social stratification by the turn of the first millennium CE.

The earliest archaeological evidence of permanent settlements in the LPB dates to this time Late Preclassic and Early Classic periods, between 100 BCE – 500 CE both near the lakeshore (Fisher 2005) and at higher elevations, such as at the city of Angamuco (Fisher 2014). Between 400 and 900 CE, ceremonial centers begin to appear among the agricultural villages of the lake basins of Western Mexico (Pollard 1993: 9). Some of these centers, like many other contemporary places in Mesoamerica, bear the marks of Teotihuacan's influence, including talud-tablero architecture on pyramids and plazas. The LPB itself lacks direct evidence of Teotihuacan influence, talud-tablero architecture appears at Tingambato immediately to the west as well as various Teotihuacano ceramic styles and other artistic motifs,. Tingambato also had a Mesoamerican ball game court during this period, showing further evidence of interaction with the rest of Mesoamerica. This relationship included Purépecha emigration to Teotihuacan, as

shown by osteological isotopes (Spence et al. 2023) and ceramic types and burial forms (Gomez Chavez 1998) present in an apartment compound in the Oaxacan barrio of Teotihuacan.

These changes in the Middle Classic-Epiclassic accompanied a significant population increase. As trade and intensified agriculture expanded, polities such as Angamuco experienced steady demographic expansion(Fisher 2014; Fisher et al. 2017; Fisher and Leisz 2013) and new settlements sprang up around them (Pollard 1993: 11). As the populace grew, so did the power of local elites. These elites controlled polities with increasingly well-defined territorial boundaries and competed with one another for access to foreign trade. This trend toward increases in population and consolidation of local elite power set the stage for a major empire to emerge in Western Mexico.

2.2. The Postclassic and the Formation of the Purépecha State

The Early Postclassic (900-1100 CE) saw dramatic changes in population density and distribution in the LPB. The Medieval Warm Period brought a stark drop in the Lake Pátzcuaro's level, revealing new islands and fertile shore lands prime for settlement and agricultural intensification (Pollard 2008). The settlement patterns appear to change away from lakeshores in favor of higher elevation locations like the volcanic *malpaíses,* increasing the population size and density of polities like Angamuco (Cohen 2021; Michelet 2008; Migeon 2003). Inter-polity competition likely involved armed conflict at this time, as these higher elevation *malpaís* positions are naturally more defensible than lakeshore settlements and some developed defensive structures (Fisher 2005; Fisher et al. 2019).

One of these warring elites was Tariácuri, who, according to the official legendary history of the Purepécha Empire, established the final Purepécha ruling dynasty in the early 14th century

CE. He rose to prominence as the lord of the city of Pátzcuaro on the southern end of the lake and placed his nephew Hiripan as lord of Ihuatzio and his other nephew Tangaxoan as lord of Tzintzuntzan. This was part of a longer process of the center of elite power moving from Zacapu in the north towards the heart of the LPB (Evans 2013:446). This young dynasty, the *uacúsecha* (literally 'the eagles'), became the dominant center of an alliance of local elites that controlled the populations of the LPB. Tariácuri began a practice of military conquering raids with his nephews and other local allies, demonstrating his power in the area and growing in wealth through plunder (Pollard 1993: 88).

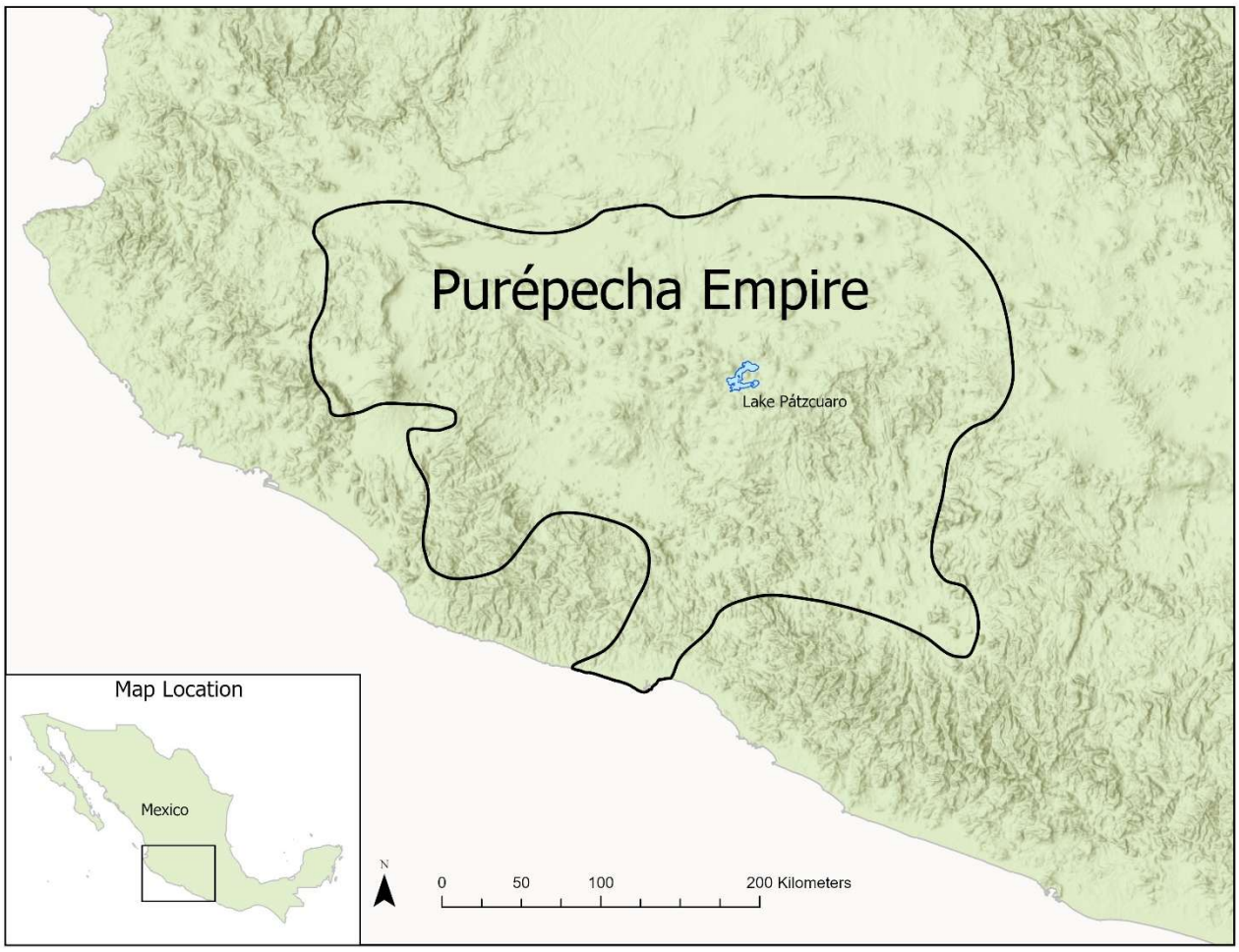

Figure 1: Maximum extent of the Purepecha imperial territory. Boundary provided by LORE-LPB. Surface imagery from ESRI, USGS, NASA.

His dynastic descendants continued and improved upon this practice after his death, leading to the creation of a vast, solidified tribute state. Hiripan continued to lead raids after the death of Tariácuri ca. 1400-1440 CE, and his brother Tangaxoan later succeeded him after his death (Pollard 1993:88). Around 1440 the brothers began to formalize this grouping of military and political allies into an empire. They organized the lordly lineages and their raiding bands into a formal military and administrative hierarchy, giving elite families formal military and administrative control of specific territories under the *Cazonci* (emperor). The empire continued to expand under Tariacuri's dynasty and unified the territories in an area covering approximately the modern Mexican state of Michoacan, including Angamuco, under this complex tribute hierarchy between approximately 1300 and 1450 CE (Cohen 2021). As Tangaxoan's capital, Tzintzuntzan became the center of this new tribute hierarchy. By the time of consolidation, it had risen to preeminence among the Purépecha cities and would remain the imperial capital until Spanish arrival.

The Cazonci's family was the absolute center of power according to the RM, and the Lake Patzcuaro Basin was the "political core" of the Purepecha state (Pollard 1993:63). The administrative system divided imperial territory into regions in which clusters of communities relied on a regional center controlled by an elite family which reported directly to the crown. Each position in the 5-tiered hierarchical system was patrilineally hereditary but the *Cazonci* could replace them at will (Pollard 1993: 124). This system allowed royal control to transmit out from the LPB core to the imperial frontiers and for tribute wealth to flow inward.

The tribute system under the direct control of the royal family became necessary to sustain the LPB population. The basin population's caloric needs were known to have greatly exceeded the productive potential of its lands even before the discovery of Angamuco (Pollard

1993: 112). The tribute system primarily brought maize, cotton cloth, and clothing into the basin to sustain the royal and elite households as well as priests and temple staff. It also brought in people as slaves and sacrificial victims, and as labor in the form of construction workers and military service members. Commoners in the LPB benefitted little from the incoming tribute and had to acquire necessary goods through markets.

This governmental system produced and maintained a robust, stable state that stood the test of time and of conflict with powerful neighbors. The Purépecha were the direct western neighbors of the Aztec Triple Alliance Empire. Despite Triple Alliance military efforts, the Purépecha state successfully defended themselves and remained independent from them (Evans 2013:444). Triple Alliance emperor Axayactl waged a campaign against the Purépecha in 1476-1477 CE in retaliation for Purépecha eastward expansion into Triple Alliance lands (Pollard 1993: 90). Axayactl cut deep into Purépecha territory, making it as far west as the city of Charo, but the Purépecha soon repelled him and reclaimed their territory. The Purépecha and Triple Alliance continued to skirmish on their border through the 1480s and 1490s leading to no significant gain for either side. The Purépecha fought a final great war against the Triple Alliance Empire under Moctezuma II in 1517-1518 CE, in which the Purépecha again successfully defended their territory from their perennial foe (Pollard 1993: 92). These conflicts created a firm, regulated border between the two powers that reflected not only Purépecha territorial distinctness, but their cultural distinctiveness as well.

While they shared many cultural features in common with their neighbors, Purépecha independence from the other great Mesoamerican powers was exemplified by certain key cultural distinctions. Purépecha religion was quite distinct from practice and belief elsewhere in Mesoamerica. Their deities did not appear in both male and female forms, and they had no

analogues of Tlaloc and Quetzalcoatl (Evans 2013:444). Their principal deity was *Curicaueri*, the god of fire and the sun, a character with no direct analogues in contemporary societies. They worshiped *Curicaueri* at *yacata* pyramids, also known as keyhole pyramids, an architectural form unique to the Purépecha region. The Purépecha language is also marked by distinctiveness from its neighbors, causing much debate among linguistic scholars as to its origin (Evans 2013:445). Purépecha people had contact with the written forms of some of their neighbors' languages but produced no writing of their own. Purépecha forms and styles in material culture terminate abruptly at the imperial frontiers, an observation Pollard (1993: 174) interprets as evidence of successful spread of Purépecha ethnic identity out from the LPB to the imperial periphery. The Purépecha retained their distinct language, religion, and forms of political and social organization up to the time of Spanish conquest when the final *Cazonci*, Tzintzicha Tangaxoan, submitted to the Spaniards in 1521 (Warren 1985).

2.2.1. LPB Postclassic Population Centers

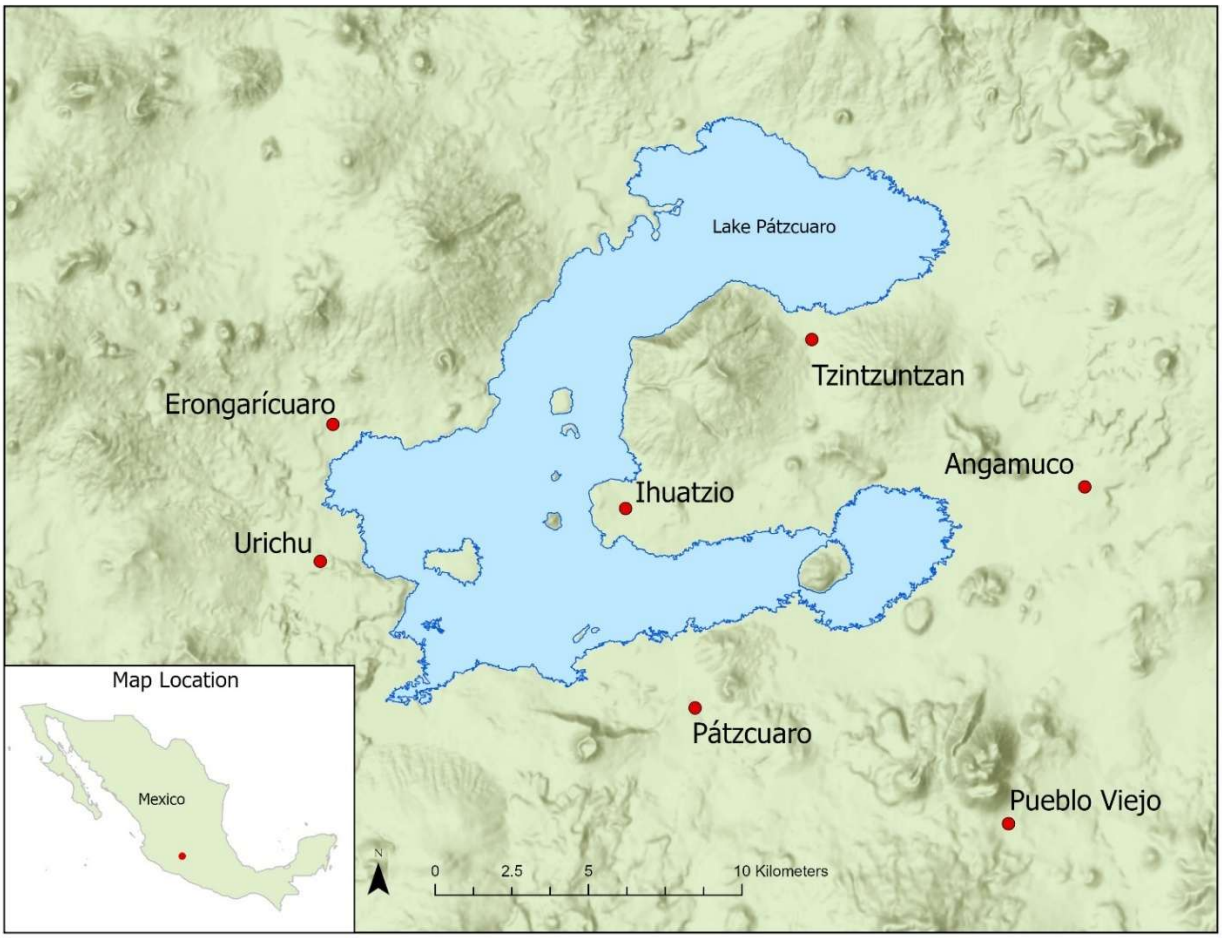

Figure 2: Archaeological sites of the major population centers of the Late Postclassic LPB. Lake level shown at 2043 masl according to Leisz' (2011) basin DEM. Ground surface imagery from Esri, NASA, NGA, USGS.

Tzitzuntzan was the imperial capital and the grandest of the Purépecha cities at the time of Spanish contact. The city stood in the south shore of the northern arm of Lake Patzcuaro and extends southward approximately 4 km to the south between the mountains Cerro Tariacuri to the west and Cerro Yaguarato to the east. The city covers an area of an estimated 6.74 km^2 (Pollard 1993:77), with surrounding agricultural features covering 10.75 km^2 (Punzo-Díaz 2023a). The earliest evidence shows that the community that would become the imperial capital was in place by at least 1000 CE (Pollard 1993: 29). Pollard estimates its maximum population to have been 25,000-35,000 people (the means of reaching this estimate are discussed further in the following chapter). Tzintzuntzan was the home of the Cazonci's residence, which likely stood

on the Santa Ana platform before the Spanish built their first Catholic chapel on that spot (Pollard 1993: 38). In addition to the royal residence, the focal point of the city is its main ceremonial complex. The platform, a 450m x 250m rubble-filled structure, supported 5 yacata pyramids built in a row facing northwest (Pollard 1993: 48). The city also hosted thousands of artisans and craft specialists who either served the Cazonci's household or worked in the city's manufacturing zones. Despite the importance of this center, there is no evidence of defensive structures or military fortifications of any kind at Tzintzuntzan (Pollard 1993: 52).

Ihuatzio stood on the eastern side of Lake Patzcuaro in the crook of the lake's curved shape. This city was characterized by its interior walled precinct divided within by yet more walls (Evans 2013:447). It was from here that rulers from Tariácuri's dynasty launched campaigns against the Cuitzeo region to the northeast. Ihuatzio's focal point is its impressive ceremonial center. This special district took up over 40% of the site's total area and contained multiple altars and temples (Pollard 1993: 152). It is oriented in alignment with the cardinal directions, and some of the temples it contains appear to be aligned with the sacred mountains in view of the city. This is the only example of intentional alignment of ritual structures in the LPB. The dominance of this district in the city suggests that the population's activities and interactions centered around its maintenance, functions, and regional draw as a sacred site. Today Ihuatzio is the site of a nucleated village of ethnic Purépechas (Pollard 1993: 33).

Pátzcuaro is a polity on the southernmost shore of Lake Pátzcuaro. This city, covering an area of at least 1 km^2, served as capital for Tariácuri as he established his dynasty (Pollard 1993: 86). Less is known about this important center because the modern city of Pátzcuaro stands atop it. However, excavations have uncovered evidence of its significance as a place of political administration and religious ceremony. INAH archaeologist Jose Luis Punzo Diaz recently

uncovered a large chacmool figure in the course of these ongoing excavations, the second ever discovered in the LPB (Milligan 2023). It has also been identified as the home of an *ocambecha* and one of the principal administrative hubs of the LPB (Gorenstein and Pollard 1983:70).

Angamuco stands on the eastern end of the LPB. Human settlement in some form occupied the site of Angamuco from 250-1530 CE, and it was fully abandoned by the end of the 16th century (Solinis-Casparius 2024). The first settlements may have been local hubs of early urban organization, placing the settlement's origin in the Preclassic, long before the formation of the Purépecha Empire (Cohen 2021). Evidence from the city's road network indicates that for most of its existence, the city developed organically and without significant influence from top-down organization (Solinis-Casparius 2022). The most significant period of expansion occurred in the Late Classic-Early Postclassic (600-1100 CE), reaching its full height before incorporation into the Purépecha Empire in about 1300 CE during a major period of empire formation (1300-1400) (Cohen 2021; Fisher et al. 2019). This period coincides with the fiery abandonment of Tingambato, the major Purépecha center west of the LPB (Pérez-Rodríguez et al. 2023), which may indicate a pattern of migration. Like other cities incorporated into the empire, Angamuco's populace was reorganized into a set of administrative districts and neighborhoods based on kinship groups and craft specializations (Fisher and Leisz 2013; Warren 1985). During and after this expansion period Angamuco was a major center of population as well as economic, subsistence, and ritual activity in the LPB.

Erongarícuaro was a major administrative center on the western side of the LPB directly subordinate to Tzintzuntzan and said to have many settlements under it in the tribute hierarchy, including the nearby polity of Urichu (Gorenstein and Pollard 1983; Warren 1985). It likely contained a large plaza with a yacata at its highest topographic point, but no clear architectural

forms have preserved (Haskell 2006). As the site of an elite-sponsored obsidian lapidary and brick factory, population accumulation here was likely related to economic factors as well as political. Like Tzintzuntzan, it is believed to have reached its largest population shortly before Spanish arrival.

Urichu was a major settlement on the Itzira *malpaís* on the southwestern end of the lake whose extensive settlement sprawl was much affected by rising lake levels in the Postclassic (Fisher 2005; Fisher et al. 2003; Pollard 2008). The lords of this polity were said to be members of Tariacuri's original alliance (Pollard 1993). Urichu was subject to Erongarícuaro in the tribute hierarchy but still named as one of the 10 administrative centers of the LPB (Warren 1985). The site boasts multiple civic-ceremonial centers and multiple regions of agricultural terracing (Pollard and Cahue 1999). Elite culture flourished in this polity, as shown by extensive excavation of its elite burials (Pollard and Cahue 1999). Settlements spread all across the Itzira *malpaís*, but they are more recently identified by LiDAR coverage and are not as well documented or understood as Urichu.

Pueblo Viejo, or *Cuanaho Viejo* is a little-known, under-studied large settlement site on the southeastern end of the LPB covering approximately 2 km^2. It is only known through Trejo's (1981) informe on basic field work delimiting the site extent and artifact scatter. It is a possible candidate for the polity of Corínguaro, described in the RM as a powerful polity in the Postclassic LPB, whose location has yet to be archaeologically confirmed. Despite its significant demographic size, it is not referred to as an administrative or market center in the RM.

2.3. Spanish Arrival and the Production of the Relación de Michoacán

The first Purépecha knowledge of the arrival of the Spaniards in Mexico came from a Triple Alliance emissary come to ask for the *Cazonci's* aid in opposing the new foreign enemy. Though historical accounts differ on the details and reasoning, it is known that the *Cazonci* withheld the requested military support (Warren 1985: 26-28). It did not take long after this for smallpox too arrive in Michoacan. This greatly reduced the Purépecha population before Spanish musket fire ever echoed in the mountains of Michoacan. In 1521, (accounts differ as to whether this occurred before or after the fall of Tenochtitlan) Cortez sent a soldier named Porrillas to Michoacan as an emissary, who brought two Purépecha representatives to whom Cortez made a show of military strength and an offer of alliance in exchange for Michoacan's fealty to the Spanish crown (Warren 1985: 31). In 1522, after a series of diplomatic exchanges of visits and gifts, Cortez sent a detachment of soldiers and Texcocan allies to Michoacán under the command of Cristobal de Olíd. The young *Cazonci* and his nobles prepared for war but were convinced to receive de Olíd in peace (Warren 1985: 45-53). Thus begun a strange political period in Michoacán, as the Purépecha Imperial administrative and tribute hierarchy continued to operate under the emperor even as Olíd and his men extracted gold and destroyed religious sites from what they perceived as a newly conquered vassal state (Gorenstein 1993:14). This uncertainty ended when an alliance between Nuño de Guzmán, the first governor of New Spain, and Cuinierangari, a double agent figure from the *Cazonci's* court known as Don Pedro to the Spaniards, led to the execution of the last *Cazonci.*

The *Relacion de Michoacán* was compiled between 1539 and 1541 by six Spanish Franciscan monks under the direction of Fray Jose de Acalá for the Viceroy Don Antionio de Mendoza (Craine and Reindorp 1970: vii). It is an attempt to record the history and lifeways of

the Purépecha people up to and including the Spanish conquest. The friars gathered information from elite Purépecha informants including the aforementioned Don Pedro and the high priest of Curicaueri. It is entirely, however, filtered through a Spanish Catholic lens. The compilers attempt to present the information in the informants' manner of expression, but this clouded and confused by the friars' implicit and explicit biases (Craine and Reindorp 1970: viii). It also is biased in favor of the elite class's view of Purépecha society and history, as the majority of the friar's sources were members of the ruling class (Pollard 1993: 175). Despite this bias, it is the most comprehensive and detailed picture of Purépecha political and social ways, as well as recent history, that modern researchers have access too. Thus, it has served as a useful point of entry for several important studies of the history and prehistory of Michoacán (e.g. Gorenstein and Pollard 1983; Warren 1985; Pollard 1993). The version I use in this study is the 1970 Craine and Reindorp English translation based on the Morelia manuscript.

3. Historical and Archaeological Demography

In this chapter I will discuss my settlement pattern approach to the archaeological demography of the Late Postclassic LPB within the context of the ongoing debates around precolonial population reconstruction in this region and Latin America more broadly. I pay special attention to the theoretical and methodological developments which occurred in Latin America and explore archaeological demography's continued relevance to modern archaeological inquiry.

3.1: Aims and Origins of Historical Demography

Demography is the study of the contours and content of human populations, and the ways those features change over time. Demographers quantify populations by seven key characteristics: size, structure, dynamics, density, fertility, mortality, and migration (Daugherty and Kammeyer 1995). The aim of archaeological demography is to reconstruct these aspects of a past population through its material remains and thus better understand past forms of social organization and relationships to the environment (Chamberlain 2006; Drennan et al. 2015; Eversley 1965). Regional settlement demography focuses on the spatial characteristics of two of those seven factors: population size and density.

Historical demography as a discipline began with Enlightenment thinkers' concern with whether humanity's trajectory was one of progress or decay (Glass 1965:2). This question, fundamental to Enlightenment thought, required answers as to how current population characteristics compare to those of past populations. John Graunt's *Natural and Political Observations Made upon the Bills of Mortality* (1661) as the first work of modern historical demography. In this work, Graunt was the first to make observations about the behavior of a population over time according to the variables of age and sex and the rates of births, deaths, and marriages. Graunt's approach set a template for future demographers regarding research

priorities, methodological foundations, and principles of population dynamics (Glass 1965:2; Smith 2023:65).

18th century historical demography was characterized by further controversy over the progress or decay of the human condition. Those in favor of the image of decay, led by thinkers like Brackenridge (1755) Wallace (1753, 1761), and Price (1780) believed that the population of the world, including great European cities and countries, was in decline when compared to Biblical and Classical times due to moral decay and loss of knowledge (Glass 1952, 1965). Those in favor of the more progressive view, exemplified by Forster (, personal communication 1757) and Chalmers (1786), population was most likely stable or increasing, and the methods of those in the former camp were unsatisfactory. For these researchers, the question was not only scientific but moral and theological. However, these debates led to the rise of hypotheses and data collection methods more conducive to scientific testing, as exemplified by Süssmilch's (1761) work on the history of the sex ratio at birth (Glass 1952, 1965:2)

The field and its methods developed from its Enlightenment roots and grew in importance following the industrial revolution of the 19th century and the devastating wars of the 20th (Glass 1965:3). These events further showed the importance of population in the study of the past. In the 19th century, these developments involved improved methods of data collection, management, and manipulation as well as causative factors like disease and famine (Guy 1882; Mallet 1837). By the 1960s, the focus of historical demography settled on scientific investigation of the underlying mechanisms of population change through the search for correlated variables (Eversley 1965:25; Glass 1965:7). However, disagreement and debate still rages regarding the nature of past populations and the best ways to appropriately reconstruct them.

Archaeological demography was developing as a methodology in the early-mid 20th century as well, and it too had to grapple with the difficulties and uncertainties of reconstructing the character of past populations alongside historians (discussed further in sections 3.2-3.3). Most work in historical and archaeological demography in the Americas centers on the issue of demographic collapse after the arrival of European colonists. This is especially clear in the debates over reconstructing the precolonial populations of Central Mexico, of which this thesis is a part.

3.2: Archaeological Demography in Mesoamerica and the LPB

This project aims to critique and update the protohistoric LPB demographic model proposed by Gorenstein and Pollard (1983) and repeated in Pollard (1993). This model and the one I will propose are part of a discourse on the pre-colonial population of Central Mexico and the Western Hemisphere in general characterized by deep disagreement and spirited debate. All agree that the arrival of Europeans caused a marked reduction in the Indigenous population, but consensus on the precise degree of this reduction has been elusive. Throughout the 20th century, archaeologists and historians separated into camps preferring models of high pre-colonial population and a high rate of decline or a low precolonial population and lower rates of decline respectively. While Gorenstein and Pollard's model presents a highly conservative estimate of decline, partially due to the limited available evidence in the 1970s, current evidence suggests a much more extreme reduction.

In Central Mexico, a region covering roughly the same extent as the Spanish colonial division of New Spain, Cook and Simpson (1948) estimated a precolonial population of 11 million and a 1600 population of about 2 million based on early colonial period censuses and tribute records, indicating a steep decline. Later, Borah and Cook (1963) revised these estimates

to 25.2 million in 1518 and 1 million in 1600. Cook and Borah (1960:40) provide an estimation of 210,000 people for the protohistoric LPB by application of an average reduction rate in Mesoamerica between 1520 and 1565, for which population data is better known. These estimates depended on interpretation of early Hispanic census and taxation data as well as Aztec tribute records. Dobyns (1966) incorporated this data in his reconstruction of the 1492 population of the Western Hemisphere, estimating 90-112 million people, agreeing with Simpson, Cook, and Borah's assertions of a 90-95% decline by the early-mid 17th century.

Others would take issue with such estimates, seeing them as generally too high to be reasonable. Sanders (1976) sharply criticized the higher precolonial rate proposed by Cook and Simpson (1948) and Borah and Cook (1963) claiming sloppy handling of early Spanish censuses in their estimation of the 1548 Central Mexican population. Zambardino (1980) agreed, arguing that their estimation of ~6.3 million in 1548 should be nearly halved to ~3.6 million. These more conservative studies suggest a precolonial Central Mexico population of around 5-10 million (Brooks 1993; Sanders 1976; Zambardino 1980). For the LPB specifically, Sanders (1970) critiqued Borah and Cook's coefficients, arriving at an estimated 95,000-106,000 people in the basin before Spanish contact. Because the figures for the colonial population low-point are generally agreed upon, this lower precolonial estimate indicates a much lower rate of decline. The disagreement is not just over the treatment of historical sources but over the severity of the mechanisms of decline such as disease, warfare, and enslavement.

Gorenstein and Pollard's (1983) demographic estimations borrow methodologically from the Basin of Mexico Project, including the Teotihuacan Valley Project (Sanders 1970), which favored more conservative population estimates (Sanders, Parsons, and Stantley 1979). Sanders et al. conducted extensive pedestrian and aerial surveys of the Basin of Mexico, attempting to

identify and map all possible archaeological settlements. They used counts of house structures multiplied by an average household size to estimate settlement populations. In the absence of house structures, they used density of sherds, which correlates with number of houses, as a proxy for the house count. They compared these estimated values to those in the available historical reconstructions, noting an acceptable degree of agreement (Sanders et al. 1979). Gorenstein and Pollard (1983) make their reconstructions with a similar attention to the spatial patterning and population size of settlements, but rely heavily on documentary sources with little balancing from the material record.

Gorenstein and Pollard's (1983) estimate of Purépecha precolonial population and colonial decline falls well into the conservative end of the debate. They make demographic estimates of the LPB in the protohistoric period based on early Hispanic period and 20th century census records with minimal input from direct archaeological observation. Of the LPB 86 settlements named in the historical sources, Gorenstein and Pollard (1983) were able to geolocate 50 early Hispanic period sites mostly through locational information in ethnohistoric sources (only 7 of these are specifically mentioned as being corroborated by observation of archaeological remains). They then analyzed settlement patterns from 1940s and 1970s censuses to arrive at a projected 92 total likely early historic settlements, leaving 42 unlocated settlements which they placed in likely locations based on the 20th century settlement pattern (Gorenstein and Pollard 1983). Gorenstein and Pollard (1983) first estimated the population sizes of the 92 proposed settlements in 1550 based on data from the 1547-1550 *Suma de Visitas de Pueblos* censuses and categorizing these settlements by size into ranks 1-5, each with an assigned estimated population range. This led to a 1550 population estimate of about 40,000-75,000 with a mean of 56,130 people. They then applied the same size-rank scheme to LPB settlement data

from 1940s and 1970s censuses respectively and averaged the 1550 values with the 1940s and 1970s values for each rank size category to arrive at an estimated population size for each settlement category in the protohistoric period. They then placed the 91 proposed protohistoric LPB settlements into these categories and summed up their values to reach their protohistoric population estimate. The only settlements with archaeologically derived estimates are the three in category 2, Pátzcuaro, Ihuatzio, and Erogaricuaro, and the one in category 1, the imperial capital Tzintzuntzan, for which the general settlement area was known (Gorenstein and Pollard 1983: 60). Gorenstein and Pollard (1983: 62-63; Pollard 1993:77-79) estimated the peak population of the LPB at 60,750-100,050 people in the protohistoric period, reported in later publications as a mean of 80,000 (Pollard 2008), indicating a decline of only about 32% between 1519 and 1550. This estimate is notably much more similar to that of Sanders (1970), emblematic of the more conservative camp, than to those of Borah and Cook.

Table 2: Summary of the size categories used in Gorenstein and Pollard's (1983) demographic model

Size Category	Estimated Population	Number in Basin
1 (capital)	25,000-35,000	1
2 (center)	3,000-5,000	3
3 (town)	1,000-1,500	22
4 (village)	100-500	40
5 (hamlet)	30-80	25

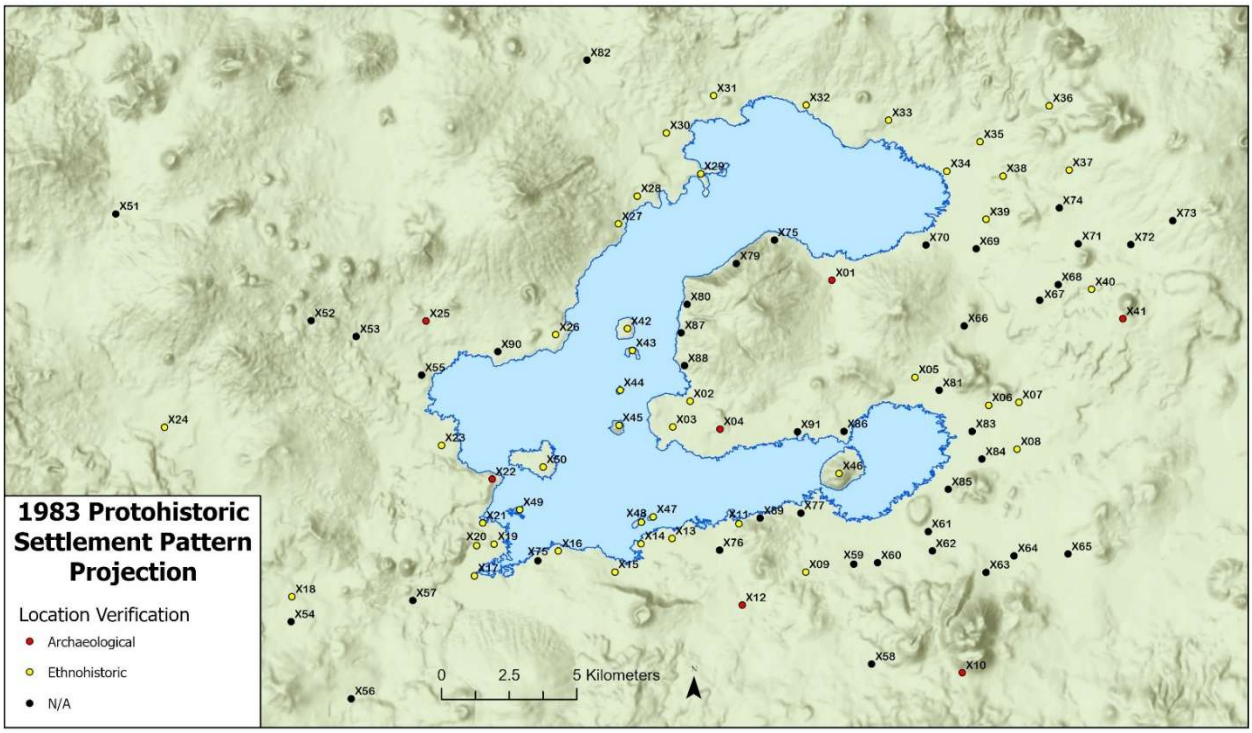

Figure 3: LPB settlement pattern as proposed by Gorenstein and Pollard (1983) digitally recreated from the hand-drawn original. The lake surface is shown at 2043masl based on Leisz's (2011) basin DEM. See Appendix A for the full list of site names and numbers. Ground surface data from ESRI, USGS, and NASA.

However, more recent historical and archaeological evidence shows that the demographic collapse following Spanish arrival in Mexico and Latin America occurred on a much greater scale than Gorenstein and Pollard's (1983) model accounts for. Scholarly consensus is that the decline was catastrophic, though exact quantified estimations of degree still differ (Livi-Bacci 2006; McCaa 1995). There continued to be detractors to claims of such high decline rates, arguing that smallpox and war could not possibly create so steep a decline (Brooks 1993) and reasserting the thesis of a much lower precolonial population in the Americas (Ubelaker 2006). However, such criticisms do not directly engage with testable models like Whitmore's and rather rely on claims of mistreatment of historical sources, little different from Sanders (1976). They dismiss reconstructions that indicate catastrophe as an "anti-Columbus polemic," attacking

assumed political opinions rather than the strength of the statistical science (Brooks 1993). As the 20th century turned toward the 21st, such positions increasingly became a minority.

In the Basin of Mexico, Whitmore's (1992: 202) epidemic simulation study showed that the population reduced by about ~90%, from 1.6 million to 180,000, between 1519 and 1607. Between 1519 and 1550, he identifies a Crude Mortality Rate (CMR) of 70%, more than double the rate proposed by Gorenstein and Pollard (1983) in a similar period and apparently agreeing with earlier projections of a large population and catastrophic decline. Whitmore's model goes beyond historical interpretation to account for the biological mechanisms of disease as a causal factor, something that has proven necessary in further disease-based population reconstructions (Ramenofsky et al. 2003). Whitmore argues that this model has implications greater colonial Latin America.

Similarly dramatic decline rates have been observed in Latin American regions associated with Spanish contact based on historical and archaeological information. Evidence from Puerto Rico shows that the island's population decreased from 30,000-70,000 individuals before contact to just 1,543 people in 1530, a reduction of at least 95% (Anderson-Cordova 2005), a pattern observed elsewhere in the Caribbean as well (Anderson-Cordova 2017; Livi-Bacci 2006; Tinker and Freeland 2008). In colonial California demographic collapse after contact due to disease has been shown to be so rapid and devastating that missions found it impossible to keep up their indigenous populations without constant recruitment (Jackson 1992; Jones et al. 2021). Stojanowski (2004) notes similar population decline at Spanish missions in La Florida. Sharp population decline directly related to proximity to Spanish colonial authorities has also been noted in the Andes (Covey et al. 2011). Hemispheric and continental perspectives also observe catastrophic decline across the colonial Americas (Cook 1998; Livi-Bacci 2006). This decline did

not occur uniformly across the hemisphere after 1492 but followed contact with colonizers location to location (Jones 2014; Jones et al. 2021; Milner and Chaplin 2010; Van Buren 2010). Overall, to borrow Sanders' words, "the implication is of a much steeper decline" (Sanders 1976: 88).

Historians in recent decades also emphasize that disease worked in tandem with other drivers of decline, as observed in ethnohistoric accounts of the Indigenous experience of demographic collapse. McCaa (1995) affirms in his analysis of all available historical data that both Spanish and Nahuatl accounts attest to the horrifying experience of smallpox and its devastating impact on the nonimmune Indigenous population in Central Mexico, but historians also note that disease was not the only cause of demographic catastrophe. Historical accounts also attest to decline related to enslavement, forced migration, unreasonable demand for tribute goods and labor, dietary changes, and ecological degradation brought on by the Spanish (Isaac 2015; McCaa 1995). Paláez (2020) notes also the importance of sexual violence against Indigenous women related to the encomienda system as a driver of declining birth rates in the Indigenous populations forced into that system. The Indigenous people of Central Mexico, including Michoacán, understood the lethal comorbidity of disease and forced labor regimes like the encomienda, citing them together often as a source of the devastating decline in population and lifespan in their communities (Isaac 2015). This evidence indicates that arguments against the idea of more rapid depopulation, which mostly dispute assumptions about disease mechanisms (e.g. Brooks 1993) are futile.

This is also supported by recent genetic studies of Indigenous populations and the remains of their ancestors. These studies have revealed a great number of extinct Indigenous genetic lineages and a marked reduction in genetic diversity, indicating dramatic bottlenecks of

varying degrees of severity across the Americas (Bolnick et al. 2016; Bolnick and Smith 2003; Gravel et al. 2013; Lindo et al. 2016; Nores et al. 2022; O'Fallon and Fehren-Schmitz 2011; Raff et al. 2011; Wang et al. 2004), including the Andes (Llamas et al. 2016), the Caribbean (Forbes-Pateman et al. 2022; Nieves-Colon 2022; Nieves-Colon et al. 2019), and Central Mexico including Michoacán (Villa-Islas et al. 2023) after Spanish contact. These studies do not offer specific quantifications of population decline based on genetics due to the yet incomplete size of the archaeological genetic sample population, but the extreme bottlenecks they note still support the idea of a sharp decline. These studies help to defend historical and archaeological interpretations that claim a higher precolonial population from detractors criticizing too-liberal use of historical sources.

The Purépecha certainly experienced this greater demographic collapse as well. They had contact with the Spanish through the exchange of diplomatic emissaries in 1521 and with the exposed Aztecs in the form of messengers come to ask for military aid against the Spanish in the same year (Warren 1985: 31). Cristobal de Olíd's 1522 arrival at Tzintzuntzan with a detachment of soldiers meant that the Purépecha experienced the potential for exposure to European diseases only marginally later than the people of the Basin of Mexico (Warren 1985: 45). They had immediate, close, and constant contact with the Spanish colonial machine, the trigger for steep population decline noted in the studies cited above.

However, disease was not the only factor at work on the Purépecha population. The Spanish implemented this same violent encomienda system in Michoacán described by Peláez (2020) as quickly as they could after conquest (Gorenstein and Pollard 1983). Some of the decline in West Mexico was also likely caused by forced migration into the Basin of Mexico to bolster that region's plummeting population (Ragsdale et al. 2019). The Purépecha never fought

a war with the Spanish like Tenochtitlán did, but violence still played a significant role in the conquest. The Spanish instituted a systematic culling of the Purépecha elite class to secure their rule (Gorenstein and Pollard 1983, Warren 1985). Thus, with these other factors at work, disease was not the only force driving the population down.

Gorenstein and Pollard's (1983) estimations certainly underestimate the prehispanic LPB population by a wide margin. Compared to their estimates for 1550, the protohistoric estimate for the basin only shows a mean population decline of 32% between 1519 and 1550. This rate is far too low to be realistic and shows that the method of averaging with 20th century data is likely inappropriate. It is also known now that their settlement pattern model of the LPB lacked numerous settlements including the Angamuco urban zone (Fisher and Leisz 2013), limiting their ability to reconstruct the precolonial population and leading to inappropriate application of the primate city model in their description of Purépecha political organization. This regional settlement project is a step toward creating a more accurate picture of the dense, urbanized population of the LPB before colonization.

The LPB is a similarly significant region to the Basin of Mexico as a highly populated imperial core and the effects of disease and famine were likely felt in similar ways, suggesting a likely similar experience of demographic decline between these two regions. It has been noted that smallpox has a greater proportional effect in smaller scale societies, so its effects in the LPB may have been in fact more severe than in the Basin of Mexico (Brooks 1993). Archaeological and historical demographers of Mexico warn against extrapolating local decline rates broadly or applying them interregionally, but the proximity and sociopolitical similarities between the LPB and the Basin of Mexico and similar exposure to Spaniards allow for a tentative extrapolation.

With Whitmore's modelled rate applied, the 1519 total predicted population of the basin would be 133,000-250,000 with a mean of 187,000 people.

Since Pollard's study, demographic projects in the LPB have been localized to single polities or micro-regions within the basin. Fisher (2005) evaluated demographic growth and decline through time in relationship to changing lake levels in the Urichu area on Lake Patzcuaro's southwest shore. Cohen (2021) identified episodes of demographic expansion at Angamuco using spatial analysis of radiocarbon dates. Solinis-Casparius' (2022) study of the city's road network shed light on the organic nature of population growth at Angamuco as well as the distribution of its population within its bounds. These works have shed light on relative population size and density changes through time but have not provided estimates of absolute numbers beyond preliminary guesses. These studies and the extensive and detailed LORE LPB surveys they build on provide the basis for a new basin-scale analysis. Region-scale demographic studies are most often made up of information from smaller studies of specific locales (Drennan et al. 2015:6). In the following chapters I will build a new demographic model from previous and new information about the patterning of individual settlements in the LPB.

There have also been significant developments in regional settlement pattern studies since the construction of Gorenstein and Pollard's (1983) model. Latin America, especially Mesoamerica, has served as home to many significant developments in settlement pattern archaeology and therefore the study of regional archaeological demography (Kowalewski 2008). As discussed above, Gorenstein and Pollard drew from pioneering works like Willey's (1953) landmark study, Prehistoric Settlement Patterns in the Viru Valley, Peru, Sanders' et al. (1979) expansive settlement pattern study of the Basin of Mexico, and others in the Lowland Maya region (see chapters in Ashmore 1981) and the Valley of Oaxaca (Feinman and Nichols 1990).

These studies laid the groundwork for subsequent studies of regional settlement patterns and regional settlement demography around the world. Since then, regional archaeologists have further improved regional methodological approaches (Drennan et al. 2015). More recently, Robert Drennan completed ground-breaking work in archaeological settlement demography at the Valley of La Plata (Drennan 2006a, 2006b). Balkansky's (2006) macro-regional approach laid the groundwork for large-scale, synthetic demographic studies that this work hopes to contribute to. The list presented here is by no means exhaustive but contains important highlights in the methodological lineage that this work descends from.

3.3: Demography and Settlement Scaling in Archaeological Theory

The debates described above have raged for decades and will continue to do so because demographic issues are at the heart of foundational questions of archaeological theory (Ortman 2016). For instance, the relationship between cultural change and population dynamics that archaeologists have debated for decades is fundamentally a demographic one. Archaeologists and historians note dramatic population increases associated with significant technological changes, such as the agricultural (Hassan 1973a) and industrial (McKeown 1976) revolutions. The nature of the cause-and-effect relationship between these events has been debated by archaeologists for decades manifesting most recently as advancements in settlement scaling theory (Bettencourt et al. 2007; Lobo et al. 2020; Pumain et al. 2006; West 2017) and new concepts of the relationship between demographic factors and the formation of complex hierarchical states like the Purépecha Empire (DeMarrais and Earle 2017; Furholt et al. 2020).

The earliest of the culture historians understood cultural and technological change as the result of migration, a key demographic variable. They interpreted stylistic changes in material culture as the result of contact with another group, as they believed internal innovation to be

quite rare in human societies (Trigger 1989:150). This creates a concept of history dependent upon the spatial aspects of population dynamics, with migration of populations into new regions being the root of social, technological, and artistic change. This perspective on the relationship between demography and social change has been debunked, but it was the first in a long process of theoretical development.

V. Gordon Childe (1936) offered a new interpretation of the relationship between population change and social change. Drawing from the works of Malthus, Childe proposed that societies generally grow steadily in size until reaching a carrying capacity determined by resource abundance and availability. Major changes in technology, land use, modes of exchange, and social organization like those mentioned above drastically alter carrying capacity by increasing a society's ability to produce and access resources (Chamberlain 2006:5). Thus, innovative changes precipitate episodes of population growth by raising the size ceiling set by resource limitations. This cycle repeats as societies continue to periodically free themselves to grow by developing culturally and innovating technologically. Childe (1950) further developed this causative concept in his theory of urbanism, arguing that the "urban revolution" was an event of dramatically increased population size and density thanks to changes in production and economy leading to a surplus. Childe (1950) placed this demographic phenomenon at the center of his theory of civilization, naming it the first of his ten features of a true civilization. Thompsen's Three Age system of describing human prehistory exemplifies the culture historians' concept of the determinant role of technological changes, as the eras of the human past turn upon technological innovations. Childe's contemporaries and economic historians and prehistorians of following generations embraced this causative theory.

Later in the 20th century, the Processualists adopted a theory that saw cultural change as a consequence of population growth rather than a catalyst. Boserup (1965) and Drummond (1965) independently articulated versions of this theory in the same year. Boserup (1965:118) argues that cultural change is best understood as an adaptation to changing population size and density. This, she claims, better explains subsistence techniques and social structures in human societies than the Malthusian model. Drummond (1965), taking a more moderate approach, argued that understanding population size as either a dependent or independent variable is too simplistic. In his conception, increasing population is a material pressure that drives societies toward improved subsistence technologies and more stable forms of social organization (i.e. sedentism and centralization of authority), which then facilitate continued population growth. Thus, the relationship between population growth and cultural change is best described as reciprocal. Binford (1968) and subsequent proponents of New Archaeology soon took up this adaptive concept of the relationship between population pressure and social change thanks to its ecological applicability. Among these were Sanders and his collaborators in their work in regional settlement studies of the Basin of Mexico, work that has proven foundational to all settlement and demographic research in Mesoamerica, including this project, since (Drennan et al. 2015:2). Others of the Processualist movement preferred a more nuanced concept of the relationship between population and social change, understanding it as an important factor but by no means a determinant or prime mover capable of explaining all or even most cultural evolution (Flannery 1973).

Demography continues to be relevant to archaeological inquiry. Though some may scoff at archaeological demography as imprecise and therefore useless, it provides vitally important information despite the necessity of approximation (Ortman 2016). This dismissive attitude

accompanies a contemporary trend moving focus away from quantitative demographic analysis in archaeological theory (Smith 2023:3). However, archaeological demography is no more or less approximate than other avenues of archaeological reconstruction or interpretation (Smith 2023: 23). Studies in archaeological demography, continue to shed light on how and why populations distribute themselves on the landscape in relation to resources and neighbors, as well as the influence of demographic processes on social realities.

Demographic factors strongly influence the process of the formation of complex stratified social forms like the Purépecha Empire. Specifically, recent perspectives from collective action theory in archaeology have begun to highlight the importance of population migration and concentration in this process. Collective action theory understands the relational and institutional networks that constitute social and political complexity as the result of cooperation and conflict among agents (Blanton and Fargher 2008; DeMarrais and Earle 2017; Fargher et al. 2020; Furholt et al. 2020; Levi 1981). In this framework, ancient elites had to form coalitions and bargain with those they wished to rule due to their dependence on the masses for their position and subsistence (DeMarrais and Earle 2017). The ability of populations to relocate, therefore, was a significant check on elite power. Fissioning migration patterns allowed people to protest overly hierarchical, controlling political arrangements by 'voting with their feet' (Furholt et al 2020). The inverse is therefore also true: conditions that prevent movement and facilitate population concentration and crowding in settlements can enable permanent complex hierarchies to consolidate. Thus, while demographic factors like migration and settlement concentration are never the sole determinant of social change, they weigh heavily on social realities.

Daily social interactions form the foundation of such communities and the sociopolitical changes they experience, and archaeological settlement demography illuminates the nature of the

social interactions that constitute these communities by providing an important, contextualizing measurement of scale and intensity. Settlement scaling theory contends based on extensive empirical observation that quantifiable urban characteristics like density, economic output, crime etc., scale with population based on interaction potential (Bettencourt et al. 2007, 2010; Pumain et al. 2006; West 2017). Cognitive evidence shows that human capacity for creativity and reasoning increase greatly in face-to-face interaction compared to solitary thought (Graeber and Wengrow 2021:94), and the effects of this exponentiate as population size and density increases lead to more opportunities for interaction between more individuals (Smith 2023: 37). These multiplicative effects have been observed in crowding at all scales, from permanent cities (Bettencourt 2013; Bettencourt et al. 2007; Ortman et al. 2015) to periodic gatherings among Upper Paleolithic hunter-gatherers (Powell et al. 2009). Increased population size and density also generate additional stresses in the experience of daily life. Disease and poverty, among other negative factors, are known to scale positively with population size and density (Smith 2023:55). This leads to the conclusion that social realities are necessarily different in small towns and large cities respectively because population size and density are key factors in both limiting and enabling human actions and interactions, and population data can thus begin to elucidate key aspects of the experience of daily life in ancient settlements. (Drennan et al. 2015:2; Schläpfer et al. 2014).

Interaction in complex societies like the Purépecha Empire is multiscalar by its nature, occurring embedded in broad inter-settlement networks. Settlement scaling theory understands settlements as “containers” of interaction embedded spatially in networks of interaction at the regional scale (Ortman et al. 2014). Interactions are constitutive of all social processes and institutions, large and small, and thus have consequences at multiple scales. Archaeological

regional settlement scaling demography aids in defining the shape, size, and character of these multiple levels of scale—intra-site, regional, and beyond—by quantifying size, density, and spatial distribution in a way that is comparable, tangible and workable (Drennan et al. 2015:5).

Regional settlement demography thus also provides a valuable insight into sociopolitical organization beyond processes of complexity formation. Regional demography is an essential part of understanding the relationship between space and social order, as spatial distribution of individuals on the landscape reflects the concepts of place and structure of societal organization (Knapp and Ashmore 1999:16). For example, the Zipfian (Zipf 1949) and Primate City models (Jefferson 1939) of settlement population distribution describe respective regional demographic patterns with significant socio-political and economic implications (Smith 2023: 87-88). This is especially relevant for state-level societies like the Purépecha Empire with complex administrative networks tied to key settlements. Concentrations of population reflect concentrations of power, production, and trade, and can illuminate competition between polities within a region in these spheres. Distribution of the population also illuminates more formalized aspects of social organization like government administration. Pollard (1993: 82) observes a connection between population dynamics and the morphology of the Purépecha administrative system, positing that it conforms to patterns of population distribution rather than dictating them. Systems of political organization are inseparable from economic systems, and population size and density are key variables in any study of economic factors like division and allocation of labor and modes of exchange (Smith 2023: 144). Economic complexity is known to scale positively with settlement size and density (Smith 2023: 155). The distribution of the LPB's population will surely shed light on the system of imperial administration, the tribute hierarchy, and market exchange (as seen in Chapter 5).

Studies in regional settlement demography in archaeology are also useful for comparative approaches. Working with quantity and distribution of individuals creates a standardized language with which to make appropriate comparisons across regions (Drennan et al. 2015:17; Smith 2023:92). Additionally, population factors tend to function similarly around the world, making the comparison of the differences that do arise a point of meaningful analysis (Smith 2023: 61). This has potential to prove especially useful with the LPB. The Purépecha region, a Mesoamerican core area, is often left out of broad comparative analyses even within Mesoamerica. Advancing research that is well-suited for comparison in this region will help advance its contributions to comparative analyses. The LPB is similar to the Basin of Mexico in terms of elevation, vegetation, geology, and climate (Chacon 1993). Given these similarities, comparison of detailed demographic models for these two core regions could reveal a great deal about the forms of social organization, landscape modification, and resource exploitation present in them. This is also true for locations beyond Mesoamerica. Paleoenvironmental studies from the LPB, such as that of O'Hara et al. (1993) have been widely cited in overviews of the nature of past human-environment interactions (Fisher 2005; Fisher et al. 2003). Demography is central to inquiries into past human-environment relationships and thus this study similarly has the potential to contribute to comparative conversations on a larger scale.

Demography is also of particular importance in the archaeology of the indigenous Americas beyond issues related to demographic collapse. As discussed in the previous section, the more we discover about the size and distribution of indigenous populations, the clearer it becomes that indigenous populations exited at massive scales, in extensive networks, and in complex relationship to landscape. As we explore precontact Indigenous demography we deconstruct the myth of the empty land. This *terra nullius* lie used to justify imperial subjugation

of land and people cannot stand in light of the ongoing work in American archaeological demography. This work also provides context to the archaeology of European colonialism by shedding light on the impact of the war and disease that came with European conquest which led to catastrophic demographic collapse.

Archaeological estimates of demographic values are just that: estimates. Due to the nature of archaeological evidence is impossible to produce precise numbers like '7,201 people' with any degree of confidence or honesty. Estimated ranges of archaeological regional populations often span tens of thousands of people and sometimes cross the boundary between orders of magnitude. They rely on estimated quantifications of units like household size or average density of occupation whose margins of error scale with the size of the society under study (Smith 2023: 62). However, the LiDAR and ground surveys of the cities, towns, and hamlets of the LPB provide an excellent opportunity for calculating a population estimate with as little error as possible. These methods combined provide highly accurate measurements of site area and density of households, reducing potential error. Habitation area and density combine to create a robust means of reaching a population estimate that is as precise as possible.

4. Demography of Angamuco

4.1: Introduction

This chapter offers a population estimate for the ancient city of Angamuco (also known as Sacapu or Sacapu-Angamuco) and the greater Angamuco urban zone. Angamuco was first documented by a regional survey in 2009 conducted by *Legados de la Resiliencia: La cuenca del lago de Pátzcuaro Proyecto Arqueológico* (Legacies of Resistance: The Lake Patzcuaro Basin Archaeological Project, or LORE-LPB). Continued ground surveys and excavations from 2009-2014 and extensive LiDAR scans in 2011 provide a comprehensive and detailed picture of the site's extent and contents (Fisher and Leisz 2011, 2013). The surveys showed that Angamuco urban zone covers a vast *malpaís* on the eastern side of the basin. A *malpais*, literally translating as 'bad land,' is a lava flow covering a large area, rendering it useless for agriculture (Bates and Jackson 1984). The surveys showed that settlement is roughly contiguous between the north end of the *malpaís* to the southern urban core that I focus on first (see Chapter 5 for population estimates of the greater urban zone) (Urquhart 2023). Population estimates since the ground-based and LiDAR mapping of the southern urban core remain rough, preliminary estimations averaging at about 30,000 (Solinis-Casparius 2022, 2024). However, the information that these studies provide offers an opportunity to derive a rigorous estimation of this major Mesoamerican polity's population at its height in the Middle-Late Postclassic Period (1350-1530 CE). I will use these surveys to reach an estimated census of households within the city and inform this with ethnohistoric information about the makeup of Purepecha households to estimate the size of the city's populace. I will compare this to values reached by alternative methods, such as ethnographically derived settlement density estimates and extrapolation from district-based military units, used in Pollard's (1993) population estimate for Tzintzuntzan and others. Then, I

will compare Angamuco's spatial-demographic measurements with models of settlement scaling with area and density to draw conclusions about urbanism at Angamuco.

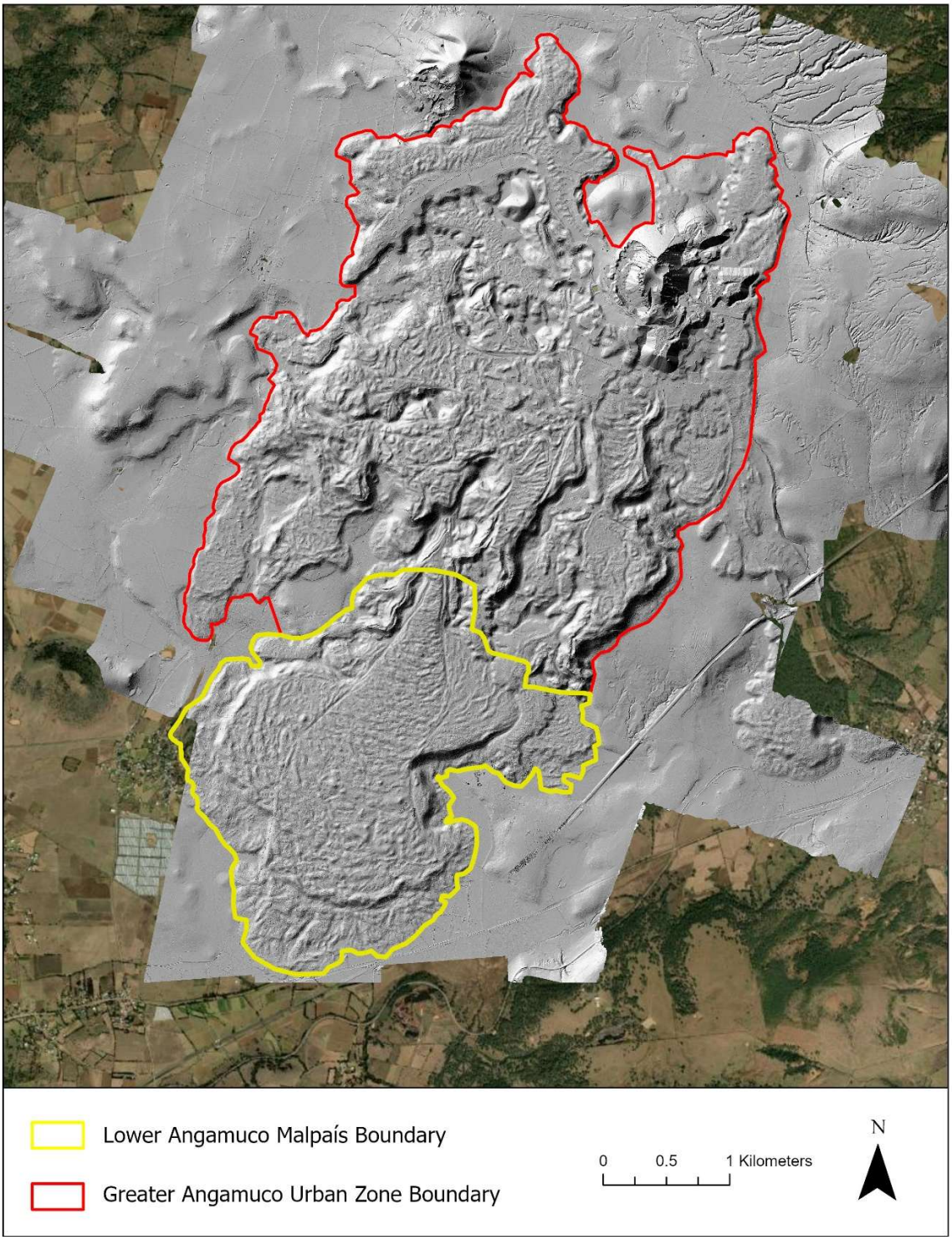

Figure 4: Boundary of the Greater Angamuco Urban Zone overlaid on the LiDAR hillshade model created by LORE-LPB (Fisher et al. 2012, Fisher and Leisz 2011). Base layer imagery from Maxar (2014).

The taphonomic issues that so often hinder studies in archaeological demography are minimized at Angamuco, making way for a robust demographic project with minimal sources of error. Angamuco was built on a volcanic *malpais* on the eastern end of the LPB. The uneven, craggy igneous rock of the Angamuco *malpais* surface is covered with shallow soils that support forest growth, but this surface has proven undesirable to farmers since Spanish colonization. This has led to better preservation of archaeological features here than in the surrounding area of the lake basin (Fisher and Leisz 2013). The remarkable preservation of Angamuco has allowed for highly detailed mapping of its features, providing new insights into Purépecha settlement.

LORE-LPB archaeologists conducted ground survey from 2009-2011 and LiDAR scanning in 2010 and 2013-2014 to identify the extent and contents of the site. The pedestrian surveys used high-precision handheld GPS devices to identify and record over 2500 of Angamuco's landscape and architectural features in a 2 km^2 area in the southern and western portions of the site. The LiDAR covered the rest of the 6 km^2 of the city at 50 cm resolution (Fisher and Leisz 2013). The resolution of the LiDAR-derived DEM is so high that one can identify objects as small as a cinder block (Solinis-Casparius 2022). This has allowed archaeologists to identify thousands of individual features, including approximately 40,000 architectural features such as roads, walls, houses, storage buildings, terraces, plazas, pyramids and palaces, as well as macro-features like the boundaries of neighborhoods (Fisher et al. 2019). The LORE-LPB conducted its surveys in a systematic, comprehensive way intended to be useful for future paleodemographic analyses (Fisher 2012), which is an indispensable first step for a project intending to draw demographic conclusions of any reliability or usefulness(Drennan et al. 2015). The overlaid LiDAR and pedestrian survey data constitutes a robust geodatabase for spatial analysis of aspects of ancient urbanism like demography.

4.2: Research Design

To answer the question of Angamuco's population, I employ a modified form of the methodology that Sanders et al. (1979) used in Basin of Mexico settlements and that Pollard (1993) used in her estimation of the imperial capital Tzintzuntzan's population. Sanders et al. (1979) used house counts multiplied by average household size to estimate settlement population. Pollard zoned Tzintzuntzan into public and residential spaces and multiplied the area of the residential zones with a habitation density coefficient derived from 20th century ethnographic data from the area. I merge house counts with residential area zoning by combining the area devoted to habitation with an estimate of density of homes in that area to arrive at an estimated number of homes in the city.

I then multiply this number by an average number of persons per household derived from ethnohistoric writings to arrive at an estimated population range for the city. Thus, rather than relying on this ethnographic analogy of dubious usefulness, I focus on material evidence gathered by the LiDAR and pedestrian surveys informed by historical accounts of household composition. I discuss how I use LiDAR and survey data to arrive at area and density values below, as well as my interpretation of ethnohistoric materials.

Figure 5: Lower Angamuco urban core archaeological site, ground surface imagery from Maxar (2014)

4.2.1 Area

The southern *malpaís* settlement core of Angamuco comprises a dense sprawl of urban features separated from the continued settlement to the north by a marked decrease in feature density and increase in area without evidence of occupation. This concentrated area is divided into 715 *complejos*, or clusters of buildings somewhat akin to modern city blocks without any standardized size or shape, separated by roads, walls, or some form of public space (Map 5) (Solinis-Casparius 2022). *Complejos* cluster into larger mulitfunctional units called neighborhoods and are likely analogous to plaza groups found elsewhere in Mesoamerica (Ashmore and Willey 1981; Fisher and Leisz 2013). They are composed of residential groups

likely related by kinship, socioeconomic status, and occupation clustered into "functional units," the primary loci of daily activity. (Fisher and Leisz 2013). They are not just functionally but socially significant "spatial clusters of interaction" generated in relation to the built environment (Smith 2023: 74). Residential units in *complejos* distribute themselves on residential terraces built into the undulating surface of the *malpaís* as well as around and among public plazas and agricultural terraces for household subsistence agriculture. Therefore, each *complejo* contains portions of residential space and non-residential space.

In order to reach the most accurate measurement of residential area possible, I examined each *complejo*, with both hillshade and slope-raster renderings with the aim of identifying non-residential spaces. I digitized polygons representing the area these spaces cover within each *complejo* so that their area could be subtracted from the total *complejo* area to reach a value representing residential space. This process is necessary for multiple reasons. First, performing this analysis at the scale of larger urban units like neighborhoods or districts would involve redundant labor as the complejo boundaries already exclude much of the city's non-residential space. Doing so would also decrease the precision of the resulting estimates. Second, Angamuco is not a planned, zoned city like Teotihuacan or Tenochtitlan (both of which Angamuco's lifespan overlaps) (Leadbetter 2021; Morton et al. 2012). Angamuco developed organically over 1000 years before the imperial takeover and lacks the central, singular ceremonial districts and large public spaces seen in other Mesoamerican polities (Solinis-Casparius 2022; Fisher et al. 2019; Fisher and Leisz 2013). Public and domestic spaces intermeshed at Angamuco, and houses intermingle with plazas, altars, pyramids, and subsistence agriculture infrastructure (Fisher et al. 2019). Therefore, a broad zonal approach similar to that employed by Pollard (1993) at the imperial capital of Tzintzuntzan is impossible. Angamuco's organic layout requires this

complejo-by-complejo approach. I discuss the types of non-residential spaces and criteria for identifying them below.

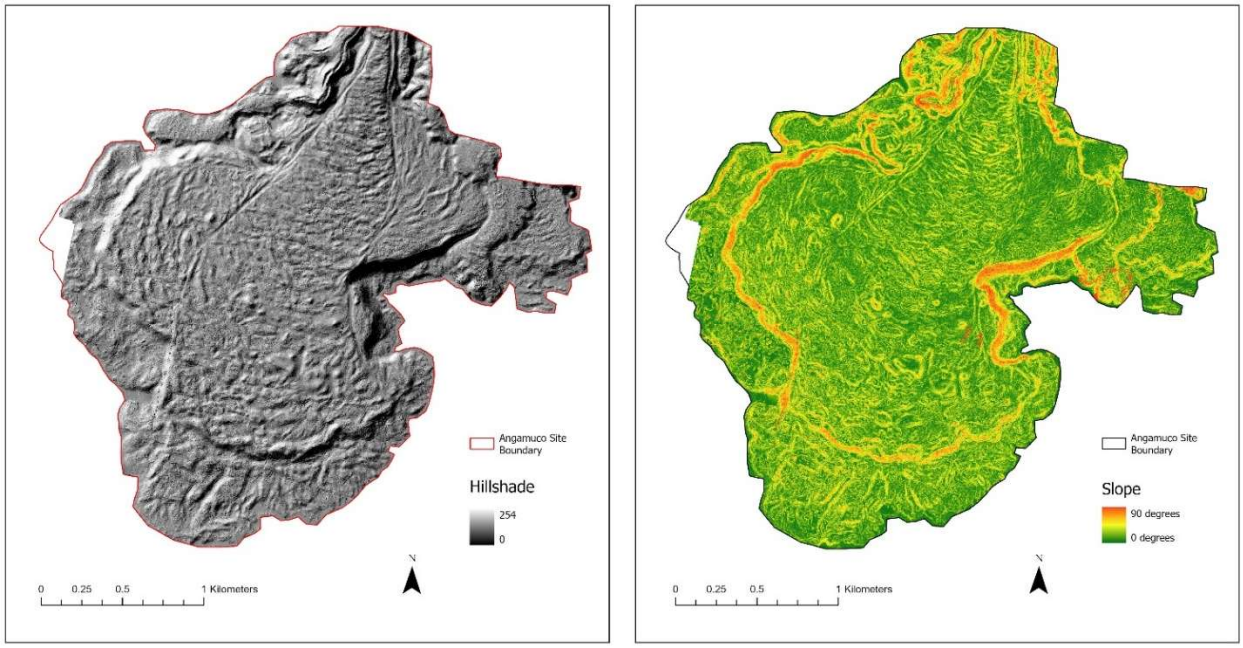

Figure 6: Hillshade (left) and slope (right) renderings of the Angamuco DEM used for visual interpretation based on data from LORE-LPB

Plazas are cleared and leveled public open spaces greater than 10m^2 in area (Fisher et al. 2019). They can be surrounded by walls or buildings and often contain small rectilinear pyramids or altars. One subtype, sunken plazas, are sunken down below the surrounding ground-level and are rectilinear or kidney-bean shaped. These are usually larger, measuring 250-1000m2, and are associated with larger residential groups comprising extended households. Another significant subtype is the I-shaped ball court, a specialized type of plaza built in the shape of a blocky capital letter "I" for playing a version of the Mesoamerican ball game (Fisher et al. 2019).

Agricultural Terraces are terraces built for practicing subsistence agriculture within the city. These terraces are less than 3 meters wide (Fisher et al. 2019). Terraces larger than 3 meters wide are considered habitation terraces, and thus count as residential space.

Sloped Areas are contiguous regions of 10 m2 or more that are within complejo

boundaries but are too steep for building houses on.

Monumental Architecture includes elite palaces, altars and pyramids covering an area greater than 10m2. Yacata Pyramids, sometimes called 'keyhole pyramids,' are large ceremonial structures consisting of a circular structure and a wide rectilinear structure conjoined by a short linear platform running from the circular portion to the middle of the rectilinear (Fisher et al. 2019). This distinctive monument was the site of rituals honoring the Purepecha sun god Curiacueri (Pollard 1993). Structures in this category are large and distinctive enough to merit designation as non-residential space. Elite palaces are technically a form of residence, but they do not fit into the average size distribution of commoner households. I will deal with them separately.

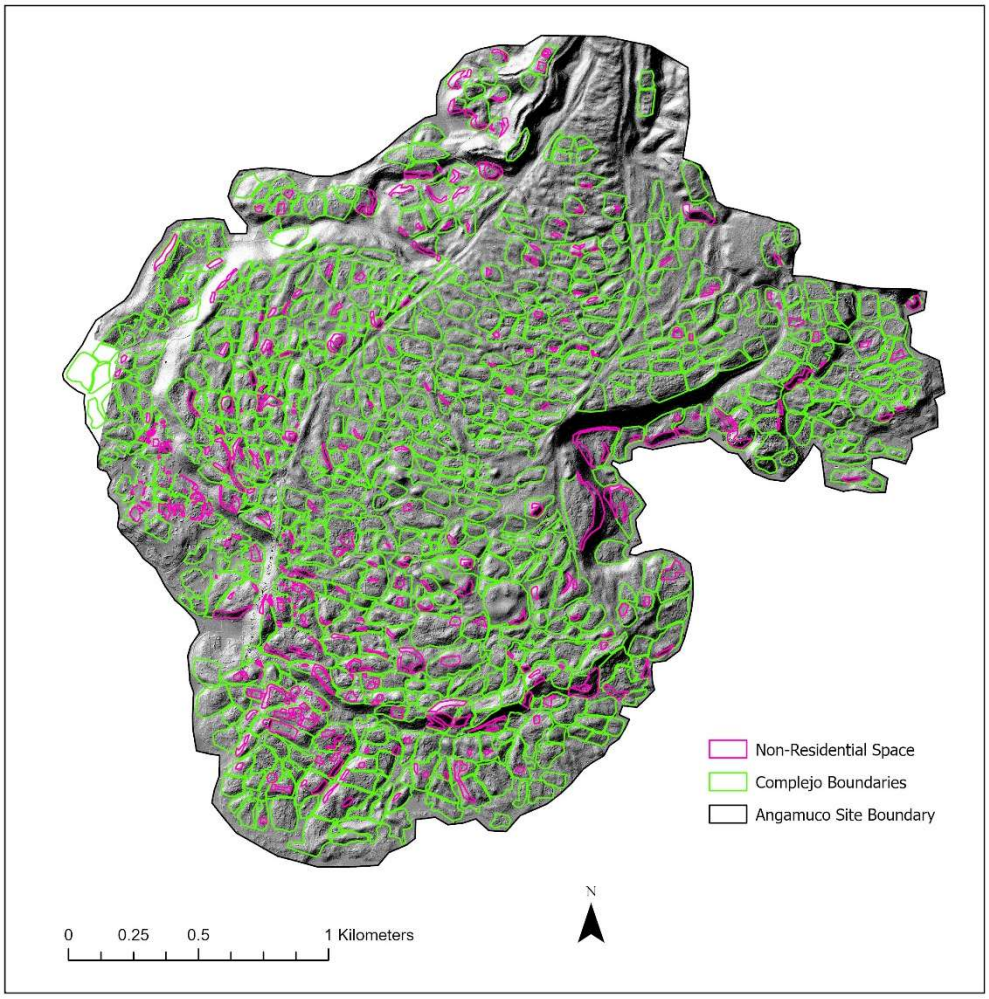

Figure 7: Angamuco complejo boundaries with non-residential space

4.2.2 Density

Area is most useful as a population proxy when supplemented with a value for density of occupation (Drennan et al. 2015). I derived an estimate of density based on data from the 2010 and 2011 seasons of LORE-LPB ground surface survey (Map). This survey identified architectural features in the southern and eastern portions of the city using a systematic architectural typology as described in Fisher et al. (2019) to categorize the structures they identified. Structures belonging to the *edificios* category and its subtypes (A, B, C, and Cuarto) are most likely to function as houses. Buildings in the *edificios* category are consistent with architectural morphology associated with single nuclear family homes (Flannery 2002). These are rectilinear buildings with either 3 walls and an open side (type A) or four walls with an

entrance opening in one (types B and C). These can be single family residences or quarters for priests and their servants. Survey is most likely to err by omission, so this density estimate is likely to err by under-estimation. This means that the population this project will derive can be thought of as a minimal, "at least" estimate.

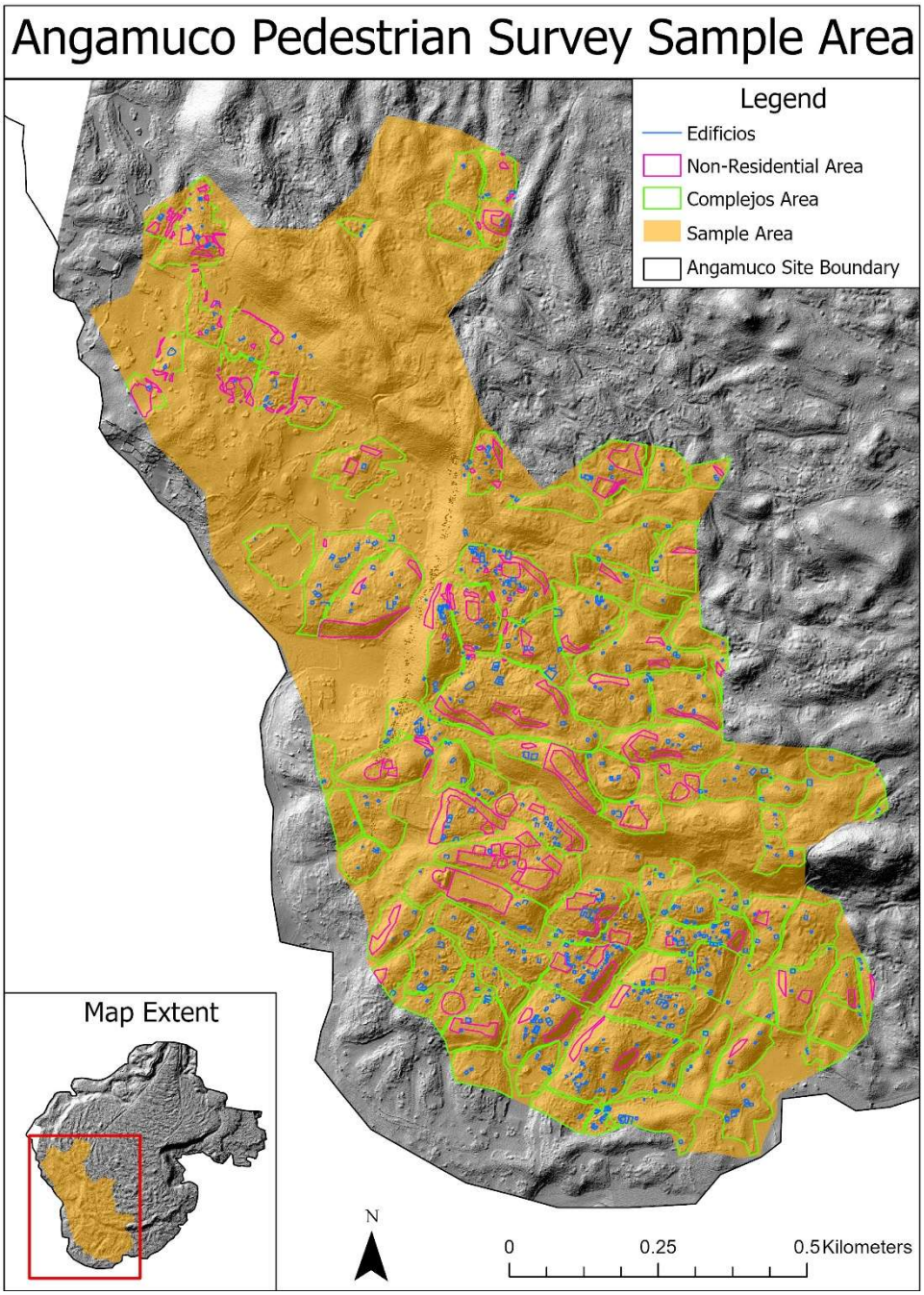

Figure 8: Surveyed sample area of Angamuco

I used this surveyed area as a sample for determining Angamuco's parcel density, or density of house structures in residential areas of *complejos*. I performed the operation described above of subtracting the non-residential space from the total *complejo* area within the sample zone to calculate the sample residential area. I removed any *complejos* in the sample area that contained no surveyed *edificios.* These *complejos* have relatively poor preservation of architectural features, as they show evidence of former structures but contain none preserved well enough to plot. Including these would skew the density estimate down to a point of non-usefulness, so I excluded them to limit the study to better-preserved and therefore better representative *complejos*. I divided the number of house structures by the sample residential area to arrive at an estimated density of houses in residential areas of Angamuco. This method gives an average density to apply uniformly across the site. This precludes analysis of differential density clusters within the city. However, comparative studies of various measures of density conclude that total population density for a site is the most useful in urban studies (Angel et al. 2020, 2021). Measures of differential density clusters will only be possible with more extensive ground surveys.

4.2.3 Households

Demographers define a household as a person or group of persons who share and participate in a common domestic economy (Pressat 1985). This is distinct from a family or conjugal unit, consisting of a mated pair and their offspring (Chamberlain 2006). Here, "family" is a biological, reproductive term while a "household" is a material and cultural construct. The household can include the conjugal unit as well as extended family members, live-in servants or slaves, or other persons living in proximity and sharing provisions for shelter, food, and other essentials.

Households are handy as a unit of measurement and as an analytical scale for archaeological demographers. Anthropologists often look to the household as a fundamental unit of human social structures and subsistence systems and as a meaningful locus of social processes. Historic records like censuses and tax assessments often use them as the basic unit of analysis (Chamberlain 2006: 52). The Spaniards chronicles of the Purépecha history and lifeways are no different—their attention to household composition and behavior is another testament to their usefulness across time. They also leave clearer, more discreet remains in the archaeological record than do individual humans, especially in urban settings.

Archaeologists have long held that the household is the basic unit in the organizational hierarchies of complex Mesoamerican societies, and the LPB is no different (Solinis-Casparius 2022). Households have therefore been the chosen unit of analysis for demographic studies of other Mesoamerican regions and polities, as exemplified in the Basin of Mexico Project (Sanders 1976; Sanders et al. 1979). At Teotihuacan, a significant site within the Basin of Mexico Project, population estimates have long relied on counting household compounds and using this number as a coefficient with average household size (Cowgill 2015:143; Millon 1973:44; Sanders 1970). Spanish colonial records are part of what makes this approach so useful, especially when investigating the centuries before colonization. The Spaniards recorded much about the makeup and activities of Purépecha households in their chronicles, data that will inform the count of houses that this project will produce.

The RM records a great deal of detail about Purépecha marriage practices, which indicates that households and the neighborhoods they made up were relatively stable units and therefore a useful point of analysis for archaeological demography. Purépecha households consisted of a man and one or more wives, their children, and sometimes slaves and extended

family (Pollard 1993: 55-56). Elites, and to a lesser degree, commoners, preferred mates from within their own family lineage and residential districts (Craine and Reindorp 1970: 38, 40). Elite and commoner families practiced a patrilocal system of marriage in which women left their family home to live with their husband and form a new household, but preferences for intra-group marriages indicate that this was not a driver of long migrations for women. This usually required consensus and approval from both families, another factor encouraging marriage within one's neighborhood. According to the *Relacion*, Purépecha families took adultery very seriously—the document mentions both death and marking mutilation of the ear as punishments for adulterers (Craine and Reindorp 1970: 39, 101). Divorce was an option for husbands in cases of the wife's infidelity or failure to perform customary household work (41). The *Relacion* records no options for divorce initiated by a wife. Like marriage, divorce required no legal action and involved only the woman returning to her father's house to wait for remarriage.

Accounting for the family of the household, however, is not enough to capture the population of a Purépecha city. Elite Purépecha households and certain commoner households also contained slaves in addition to the family, as the RM mentions on multiple occasions. Elites certainly had slaves, but it is unclear how common slave ownership was among the commoner classes. Most commoners who made up Angamuco's neighborhood communities had lands of their own (Urquhart 2023). Slaves were almost always acquired as war captives (Pollard 2016) and members of all social classes served in neighborhood-based military units as a form of tribute to the crown (Pollard 1993:34). Given that commoners participated in war and had lands that needed working, it is very possible that commoner households owned slaves as well. Slaves were also bought and sold at public markets in exchange for blankets, a practice most commoners likely had access to (Pollard 1993:114). Therefore, any household-based census

needs to take slaves into account at the household level. There are also references in the RM to an unhoused, poor population in Purépecha cities (Craine and Reindorp 1970:42), which is a well-explored negative product of increased urbanization across global contexts (Smith 2023:38). Previous demographic analyses have struggled to reliably quantify the presence of this part of the population.

I estimate the average commoner household size at 5-7 persons. This is an increase from Pollard's (1993) estimate of 4-6 people per household, which she arrived at by expanding Cook and Borah's (1972) estimate of 5-6 people in protohistoric Purépecha families to better match 20th century ethnographic data and account for greater variation. This estimation is almost certainly too low. Partially, this is because the estimated size is for stated to be for families, not total households. Though rare (*n*=2), ceramic depictions of households from Prehispanic Western Mexico, both dating to the Late Classic, depict 8-10 individuals seated together under one roof (Bernal et al. 1968). The *Suma de Visitas de Pueblos* (1547-1550) indicates a ratio of 8.85 individuals per house in the Purépecha region in the decades after colonization, but this figure reduces to 5.4 person per house when the large multi-family dwellings found along Michoacán's northern border are removed from the sample (Cook and Borah 1971:124-128). However, multi-family households remain distinct possibility in the LPB (Cook and Borah 1971:126). Given these indications and the evidence of likely landed commoner access to slaveholding, I add an additional average 1 person per household, landing on an average household size of 5-7 individuals. Following Pollard (1993), I will account for the additional persons contributed by larger polygamous elite households, their sponsored priests greater numbers of slaves, and the unhoused population by adding a flat number. As all evidence points to Angamuco being of similar size to Tzintzuntzan, so I will borrow Pollard's conservative estimated modifier of 5000

to account for elite individuals, their slaves, and their sponsored priests. Excavations at Tzintzuntzan in 1977-78 indicate that priests' quarters may have been occupied more densely than the average commoner dwelling (Cabrera Castro 1987) but the available evidence is not firm or extensive enough to merit counting likely priest's residences differently in this study.

4.3: Results

Angamuco contains a total of 3.126 km^2 of residential space. The density of houses in that space is 1190 houses per km^2, leading to an estimated 3721 households in the city. The household size estimate of 5-7 is the same as (6 ± 1), so I use this expression as the household size coefficient. Plugging this into the population formula printed below provides a population estimate of 23,600-31,000 people in the southern urban zone of the Angamuco *malpaís* at its height with a mean of 27,330 people.

4.3.1 Calculations

$$(a_r) = 3.126 \text{ km}^2$$

$$(d) = 1190 \text{ houses / km}^2$$

$$(h) = (3.126 \text{ km}^2) \times (1190 \text{ houses / km}^2) = 3721 \text{ houses}$$

$$\text{Population} = 5000 + (6(3721) \pm 3721) = \underline{23{,}600 - 31{,}000 \text{ people}}$$

4.4: Comparison to Other Estimation Methods

One alternate means for estimating city populations that Pollard (1993:33) uses involves descriptions of Tzintzuntzan's military units in the Relacion to extrapolate its population, but this means of comparison is not possible at Angamuco. Purepecha cities divided their military units by *ocambecha*, a kind of administrative ward consisting of 25 households, so Pollard uses the 200 military units that the Relaccion reports coming from Tzintzuntzan to arrive at an estimate of

25,000-35,000 which she takes as complementary to the previous one (See chapter 3). This method is not available for comparison with Angamuco as the Relacion records no specific mention of military units from Angamuco and the ocambecha has never been identified archaeologically (Pollard 1993: 60).

Pollard (1993: 33) applies an estimate of Purepecha urban settlement density from Van Zantwijk (1967) observations at 20th century Ihuatzio of approximately 6,600 people per square kilometer to the residential area of Tzintzuntzan (~4 sq km) to arrive at an estimated 26,400 people. She adds 8000 people to this (5000 upper class members and 3000 artisans of the royal household) to reach approximately 35,000 people. Applied to the total *complejo* area of Angamuco's lower malpais settlement, Van Zantwijk's density value produces an estimated population of 22,275 for Angamuco. When the 5,000 is added, the final estimate with this method is 27,275. This matches remarkably well with my estimate, landing almost exactly in the middle of my reported range. Correspondingly, Pollard's (1993: 33) average population density of 4,452 people per sqkm at Tzintzuntzan also falls in the center of Angamuco's population density range: 3,933 to 5,167 people per sqkm.

The *Suma de Visitas* (1547-1550) provides another means of estimating population at Angamuco based on house count. The data that the Suma provides indicaates an average ration of 8.85 people per 1 house in Purépecha settlements, including the multi-family dwellings in the north (Cook and Borah 1971:124). It is possible that this high ratio indicates further that the household size and habitation values provided by Pollard (1993) and Van Zantwijk (1967) underestimate the total size of Purépecha households, including slaves and extended family members. Applying this ratio to Angamuco reaches a value of around 32,930 people with an unknown margin of error. This is above the high end of the previously provided estimations.

However, the difference of 6.2% from the high end of my estimation and 17.0% from the mean center of my estimation is within the range considered to be acceptable agreement in regional settlement demographic studies (Sanders et al. 1979, Drennan et al. 2015).

This agreement has a few implications. First, its agreement with the center of my estimate based on density of household remains confirms that this can be treated as an 'at least' estimate for Angamuco at its height. Van Zantwijk's data is based on a modern nucleated village on top of ancient Ihuatzio. The area of this settlement is much smaller than that of Angamuco or Tzintzuntzan. Population density tends to increase with settlement area (Smith 2023:88), and the added 5000 individuals may or may not be enough to account for this density-area scaling. The fact that it matches an estimate based on observed well but not perfectly preserved surface remains suggests that it may not be enough. Thus, the true peak population density and size of Angamuco may be higher than what these estimates represent. This extends to Pollard's estimates based on this data. The fact that Van Zantwijk's estimated urban settlement density aligns reasonably well with well-preserved archaeological household density evidence from Angamuco implies that Pollard's estimate for Tzintzuntzan is similarly reasonably accurate as an 'at least'.

Table 3: Summary of results of population estimation methods

Estimation Method	Population
This Project	23,600-31,000
Pollard (1993)	27,275
Suma de Visitas (1547-1550)	37,210

4.5 Conclusion

This chapter has presented the first analysis of Purépecha urban settlement density based on empirical documentation of material domestic structure remains. Based on pedestrian and LiDAR survey identification of house density, I have derived an estimate for the city of Angamuco that exhibits a high degree of agreement with other estimation methods. In the next

chapter, I will use this information to construct a settlement scaling model to estimate the total population of the basin in comparison to other methods.

5. Regional Settlement Demography of the Greater LPB

5.1 Introduction: The Previous Model

In this chapter, I will use my population estimate of Angamuco to construct a settlement scaling model of Late Postclassic Purépecha settlement demography in the LPB. I will apply this model to the known urban centers as well as the smaller sites listed in the INAH archaeological database to develop total population estimate of the LPB as well as a spatial model of this population's distribution based on material remains. I will then compare this estimate based on material remains and evidence-based models to demographic reconstructions using documentary sources (Gorenstein and Pollard 1983) and epidemiological modeling (Whitmore 1992) in order to reanalyze and reinterpret previous demographically derived hypotheses about Purépecha social, political, and economic organization.

The previous settlement demographic model, presented in Gorenstein and Pollard (1983) and referenced without alteration in subsequent publications (Pollard 1993, 2008, 2016), relies heavily on ethnohistoric description and projection based on 20th century census data. By consulting settlement descriptions the *Relación de Michoacán* (1541), the *Suma de Visitas* (1547-1550), and the writings of Juan Infante, the area's first encomendero, they identified and located 50 named settlements in the historic period. Some of these were confirmed through interpretation of aerial photos and interviews with locals, but only 7 are described as identified through direct observation of architectural remains. There remain 36 named but not locatable settlements, but Gorenstein and Pollard (1983) consult census data from the 1940s and 1970s and conclude that there are actually likely 41 more settlements that haven't been identified, bringing the expected

total to 91. They divide the settlements into 5 discreet size categories and predict the protohistoric sizes of these categories by averaging them with their respective values from the 1940s and 1970s data. They then distribute the 41 predicted settlements on a map based on where settlements not associated with known archaeological sites occur in the 20th century but make no distinction between the predicted settlements and those identified through ethnohistoric or archaeological interpretation. Gorenstein and Pollard (1983: 62-63, Pollard 1993:77-79) thus estimate the peak population of the LPB at 60,750-100,050 people in the protohistoric period, reported in later publications as a mean of 80,000 (Pollard 2008). As discussed in Chapter 3, this results in a model mostly based on conjecture that vastly underestimates the prehispanic population of the Basin.

This previous model describes an extreme primate city pattern in the LPB. This term refers to a settlement pattern in which the largest settlement is more than twice as large as the second largest, representing a deviation from Zipf's Law (Zipf 1949) in which political forces supersede those of economics in the arrangement of settlements (Jefferson 1939). In the model presented for the Late Postclassic LPB, the largest settlement, Tzintzuntzan, is estimated to be around 6 to 10 times as large as the second largest and to have contained 25-35% of the basin's total population, making it an exceptionally extreme example of a primate city (Gorenstein and Pollard 1983:93; Pollard 1993:79). Despite noting a preference for residence in relatively dense clusters, Pollard (1993:182) describes Purépecha urbanism as "weakly developed" outside of the supposed primate city. Based on their model they posit that the primate city pattern was stable and constant for 5 centuries from the Late Classic through the arrival of the Spanish, suggesting that settlements grew proportionally on linear trajectories as population increased (Gorenstein and Pollard 1983:90). This leaves no room for dynamic changes in settlement patterns or

potential rises, falls, and shifts in the relative populations of the large centers. From this, they argue that Tzintzuntzan was an absolute regional and supra-regional center of gravity in the Postclassic basin and the imperial territory at large in "administrative, economic, religious, social, and transport" matters with no rivals (Gorenstein and Pollard 1983:94).

They note that this pattern is unusual given settlement arrangements in other regions with similar agrarian modes of production (Gorenstein and Pollard 1983:93). They do not attribute this to any potential problems with their methods of settlement pattern projection or assumptions of their model. They rather attribute this to the exceptional nature of Tzintzuntzan as a central place. But the choice to project the remaining 41 assumed settlements only in size categories 3-5 precludes the possibility of any other large settlements and serves to support the *a priori* assumption of this extreme primate city pattern.

Part of this misinterpretation arises from an over-reliance on the 1541 *Relación de Michoacán* (RM) in the archaeology of the LPB. As discussed in Chapter 2, it is also biased in favor of the elite class's view of Purépecha society and history, as the majority of the friar's sources were members of the royal household (Pollard 1993: 175). It is also entirely filtered through a Spanish Catholic lens. The friars attempt to present the information in the informants' manner of expression, but this is clouded and confused by their implicit and explicit biases (Craine and Reindorp 1970: viii). It is thus best thought of as an official, propagandistic history composed by and for elites. The RM and its perspective have contributed, along with long-standing biases in archaeological theory, to an over-focus on the elite, especially royal, concept of society. This then potentially calls into question the extreme primate city model presented by Gorenstein and Pollard (1983), as such a description of the royal city is to be expected in a

propagandistic telling of Purépecha history and lifeways. In the following analysis I will rely on archaeological data as much as possible and draw from the RM cautiously and critically.

The Late Postclassic (1350-1520) was a time of dynamic population movement in the LPB. This includes the increase of population in the capital of Tzintzuntzan (Pollard 1993), a contraction of population at Angamuco (Cohen 2021; Fisher et al. 2019), and a general trend of immigration from locales outside the basin, all associated with imperial integration. Given the available evidence, it is not possible to capture these complex movements over the two centuries that make up this period. Thus, the following model must be understood as an average estimation for the entire Late Postclassic.

5.2 Settlement Scaling Theory

I will use settlement scaling theory to estimate the population sizes of the sites in this sample. Researchers have long observed that certain quantifiable aspects of urbanism, such as settlement size or economic output, scale with population in regular, identifiable patterns (Ades and Glaeser 1995; Berrey and Garrison 1958; Christaller 1933; Ettinger 1981; Jefferson 1939; de Long and Shleifer 1993; Nordbeck 1971; Rashevsky 1947; Simon 1955; Zipf 1949). Modern settlement scaling theory arose from the work of researchers in the Santa Fe Institute, an organization dedicated to scientific approaches to human complexity, building from such observations (Smith 2023:88). Settlement scaling theory rejects most schemes of discreet size categories like that employed by Gorenstein and Pollard (1983) because labels like ‘city,’ ‘town,’ or ‘hamlet’ are arbitrarily defined and reflect distinctions that are mostly semantic (Smith 2023:5). Rather, complementary to Smith’s (2023, 2019) concept of ‘energized crowding,’ they see settlement as a continuous phenomenon in which characteristics of urbanism scale with changes in population size and density. Urbanism is therefore something that occurs wherever

humans settle permanently together, rather than something that begins at an arbitrary numerical boundary.

This perspective has enabled the observation of context-specific but mathematically consistent patterns in the ways quantifiable urban characteristics scale with population (Bettencourt et al. 2007, 2010; Ortman et al. 2014; Pumain et al. 2006; West 2017). These researchers studied settlement systems across historical, geographic, and cultural contexts and observed strikingly regular patterns among certain quantifiable settlement variables like settlement area and density. Particularly, they observed that area scales at a consistently sublinear rate to population such that density increases with population size across contexts (Bettencourt 2013; Bettencourt et al. 2007; Cesaretti 2016; Hanson and Ortman 2017; Lobo et al. 2020). This phenomenon is represented in the equation $A(N) = aN^{\alpha}$ such that A = area, N = population and a and α are constants. In the case of the relationship between population and area, a is a normalization constant that is unique to a given settlement system representing the cost-benefit ratio between movement costs and interaction benefits (Ortman et al. 2014). The power law α represents the scaling dynamic of settlement area with population (N) (Bettencourt 2013; Bettencourt et al. 2007). Across modern and archaeological settlement systems, α has an observed average value of 2/3, or 0.67 (the mean center of an observed range of 0.56-1.04) (Bettencourt 2013; Nordbeck 1971; Ortman et al. 2014). This means that settlements larger in area are consistently more dense than settlements with smaller area across time and space (Smith 2023:90). The underlying causes of such patterns are unknown, but their regularity is undeniable (Bettencourt 2021; Gonzalez-Val et al. 2014).

This pattern has been shown to apply strikingly well in urbanized prehispanic Latin America as well as in modern settings, including in the Late Postclassic Aztec settlement system

in the Basin of Mexico (Ortman et al. 2014, 2015), the Classic Lowland Maya Region's low-density urbanism (Smith et al. 2021) and the settlements of the Incan Central Andes (Ortman et al. 2016). This suggests that it will prove just as useful to describe Purépecha settlement demographic patterns in the LPB. Given the reliable population size, density, and settlement area estimates now available for Angamuco and Tzintzuntzan, such a model can be applied to smaller settlements for which only area is known to derive population estimates.

5.2 Methods

I cannot simply add the newly documented sites to the previous model. As discussed above, half of the 91 proposed sites are unverified projections and only 7 are explicitly stated to be verified through identification of archaeological architectural remains. Since the publication of this model, two major population centers, Urichu and Itziparamucu, have been shown to be misplotted. These are two sites that were claimed to be archaeologically identified in the previous model. This, combined with the recent discovery of the urban sprawl of Angamuco and its surrounding settlements reveal the need for a total re-evaluation of the Late Postclassic settlement pattern in the LPB.

I limit this study roughly to the boundaries of the Lake Pátzcuaro *cuenca*, or drainage basin system. Delimiting a region combines observation of natural and social/historical phenomena, and one's chosen region should make sense from environmental and cultural perspectives and be of a reasonable size for an archaeological undertaking (Drennan et al. 2015: 135). The LPB has long been used as a boundary for region-scale analyses of political, social, and demographic phenomena. Like the Basin of Mexico, the LPB is a bounded watershed region that was also a culturally meaningful region in its role as political core region for an imperial state. This region also represents a bounded hydrological system that influenced practices of

agriculture and urbanism. Gorenstein and Pollard's (1983) model includes settlements extending a short distance outside of this basin due to RM descriptions of administrative zones extending beyond the natural basin boundaries. This continues to be necessary in this project, as certain features like the Angamuco *malpaís* extends beyond the basin boundary, and the municipality-based site data I use also does not conform to the hydrological limits of the basin (discussed further below) Given this precedent in the local and wider cultural regions, and the data restraints, I roughly confine this demographic study to the boundaries of the Lake Pátzcuaro drainage system.

A project of this scale requires a comprehensive accounting of known settlement sites in the basin. For the larger known settlements beyond Tzintzuntzan and Angamuco, such as Pátzcuaro, Urichu, Ihuatzio, Pueblo Viejo and Erongarícuaro, I surveyed all available published literature to arrive at up-to-date measurements of settlement extent. For the settlements of the Greater Angamuco Urban Zone, I consult LORE-LPB LiDAR survey of the *malpaís*. For the many sites beyond these urban centers, I consult the INAH *Sistema Único de Registro Público de Monumentos y Zonas Arqueológicos e Históricos* (Single Public Registry System of Monuments and Archaeological and Historical Zones), a public database of all registered archaeological sites across Mexico. This database is constantly updated with new sites, assuring up-to-date information (INAH N.D.). I queried the database for archaeological sites in Michoacán dating to the Middle-Late Postclassic (1200-1521 CE), associated with the 'Tarasco' cultural category, and fitting the material profile of a settlement: sites containing structural remains and designated in the registry as either habitational, administrative, civic, or some combination of those three. Limiting the search to sites with structural remains may leave some less well-preserved settlement sites out of the population, but given the limited information available on the INAH

database, I leave out sites with only artifact concentrations to avoid over-counting. I then eliminated all sites not located in one of the municipalities in the LPB: Pátzcuaro, Erongarícuaro, Tzintzuntzan, Quiroga, Huiramba, and Tingambato. The database provides very little regarding site location beyond municipality, but I then eliminated any sites that could be confirmed as outside the boundaries of the LPB, such as the Tingambato ceremonial center, which is in a part of the Tingambato municipality outside of the LPB cultural system. I then record the estimated site area given in the registry for each site. This will allow for a new settlement model based on archaeological analysis of the basin's principal population centers and extrapolation regarding the smaller size categories based on a large archaeological sample rather than predictions based on 20th century settlement patterns. I will keep extrapolation and prediction based on observed settlements minimal.

I use settlement scaling theory's equations representing the relationship between population dynamics and settlement area to estimate site populations. I use the above-described equation $A = aN^{\alpha}$ where A = area, N= population and a and α are constants. The value of the power-law variable α representing the scaling dynamic of settlement area with population is known: 2/3, or 0.67. It has been proposed that the value of the α value may range between 2/3 and 5/6 (0.67-0.83) depending on intra-settlement movement network qualities (Ortman et al. 2014), but for the purposes of this predictive model I will use the 2/3 coefficient that has proven more generically applicable due to the small sample size of well-studied intra-settlement movement infrastructure networks (n = 1) (Solinis-Casparius 2022). The estimated area and population values for Angamuco and Tzintzuntzan will allow us to solve for an estimated a value for the Purépecha settlement system. This will result in a complete predictive equation that can be applied to settlements with smaller area values to estimate population from area. This will

result in estimations with greater precision than that achieved by simply applying a single density value to all settlements. The application of such a model, as with all models, presents the opportunity for error. Chiefly, however robust and powerful the model, it cannot predict deviations from itself. Thus, the following estimates should be taken as what they are: predictions based on a reliable, empirically derived model, but still prone to error.

When this equation is applied to Angamuco with my mean population estimate and Tzintzuntzan with Pollard's (1993) mean estimate, it produces a values of 0.0066 and 0.0067 respectively. This is a difference of only 0.0001, showing remarkable agreement. Their minima are similarly close in agreement and their maxima are identical (Table 4). This close agreement means that these population estimates scale with area almost exactly as the settlement scaling theory model predicts, and each settlement's a values very closely predict the estimated population of the other. I will apply their average of the values derived from the mean populations, 0.00665, as well as the averages of the values derived from the minima and maxima to the other settlements observed in this study to arrive at a best-fit function for the mean and error ranges for these settlements. I will round the results to the nearest ten in their final presentation.

Table 4: Calculated (a) values for the minimum, mean, and maximum population estimates for Tzintzuntzan and Angamuco and their averages (based on area measurements in km^2).

Settlement	Estimated (a) Coefficient Values		
	Minimum density	Mean Density	Max Density
Tzintzuntzan	0.0076	0.0067	0.0061
Angamuco	0.0073	0.0066	0.0061
Average	0.00745	0.00665	0.0061

Thus, the final settlement population estimation for a given area in km^2 equations are as follows:

Table 5: Min, Mean, and Max population estimation formulae.

Minimum	Mean	Maximum
$A = 0.00745N^{0.67}$	$A = 0.00665N^{0.67}$	$A = 0.0061N^{0.67}$

I will not apply any further modifiers to the results of these. Some regional settlement studies, including the Basin of Mexico project, add percentage-based modifiers to their estimations to make them better match estimations derived from historical material (Sanders et al. 1979). I rather follow Feinman and Nichols (1990) in leaving the archaeological estimates as they are, as the error of underestimation is more manageable than the error induced by somewhat arbitrary correction or extrapolation. This allows me to find comparisons to other available models of reconstruction, such as Whitmore's (1992), sources for meaningful comparison rather than unnecessary correction. Where true settlement area is not yet known, as in the case of the settlement sprawl in the Angamuco urban zone, I will extrapolate using appropriate density estimations.

5.2.1: A Note on Osteology

Despite the often-prominent role of osteological remains in archaeological demographics, I abstain from using them in this project. Extensive osteological data is available from throughout the basin (Fisher 2014; Pollard and Cahue 1999), and more is forthcoming from the Angamuco civic-ceremonial center (Fisher, personal communication). Osteological analysis on the makeup of the LPB population is beyond the scope of this project. Rather, it presents a promising opportunity for future research to better understand the people I attempt to count in this project.

5.3 Results: The New Model

5.3.1 Known Principal Population Centers

Area values are known or able to be accurately estimated for many of the basin's principal population centers. Below, I give context on field work at these sites, including previous area estimates, and describe how I determined the area values for these sites other than

Tzintzuntzan and Angamuco as well as the population estimates derived from the area value. Results are summarized in Table.

Ihuatzio was originally estimated by Pollard (1980) to cover 1.25 km^2 based on then-known extent of archaeological material. It is currently listed in the INAH database as covering 2.8 km^2 (see Appendix B). Punzo-Diaz and Sandoval's (2022) LiDAR survey identified continuous evidence of settlement over an area of 3 km^2. These estimations are in close agreement, and for this analysis, I use the slightly larger and more recent LiDAR estimation.

Pátzcuaro was originally estimated by Pollard (1980) to cover approximately 1 km^2 based on historical descriptions and the spatial extent of identified archaeological landmarks. Identification of the full extent of this site is difficult because it lies under the modern city of Pátzcuaro, but more recent finds allow for the expansion of this estimate. There are three Late Postclassic sites within the modern city of Pátzcuaro listed in the INAH database: Zitunaro (Folio No. 2ASA00017097), Puke (Folio No. 2ASA00055185), and Las Palmas y El Tumín (Folio No. 2ASA00017100). These sites all include scatters of lithic and ceramic artifacts and at least 1 mound feature. All three lie near the edges of the modern urbanized area. There is an additional Late Postclassic find in Pátzcuaro, a Chacmool uncovered in the Mercado Municipal in the city center in 2023. This indicates that the modern city center lies atop the prehispanic civic-ceremonial center. The coincidence of the ancient and present city centers, combined with the presence of Late Postclassic urbanism evidence around the modern city's edges, suggest that the area of the Late Postclassic city of Pátzcuaro is roughly analogous to that of the modern city. To estimate the size of the city in the Late Postclassic, I placed a circle whose circumference intersects with the three INAH sites and has the Chacmool site near its center. This circle corresponds to the modern city center and its surrounding neighborhoods, and area of 4.5km^2.

Erongarícuaro was originally tentatively estimated by Pollard (1980) to be about 2.5-3 km2 based on preliminary observations of the modern town of the same name. A more recent pedestrian survey project observed architectural remains extending over an area of approximately 2.3 km2 (Haskell 2006). This survey underestimates the maximum extent of the site due to loss from erosion and disturbance from the modern city of Erongarícuaro. This settlement, which played a major administrative roll in the Late Postclassic, was likely similar in size to Ihuatzio and Pátzcuaro. For this analysis I use Pollard's estimated 3km2 but leave open the likelihood that future work will extend the site boundary.

Urichu and the Itzira Malpaís Urban Area is a settled *malpaís* on the southwestern side of the basin similar to Angamuco. The settlement of Urichu on the northern margin of the *malpaís* was originally estimated Pollard (1993:77) to cover an area of approximately 0.2-0.5 km^2 based on its rank in her size-rank category scheme. After several seasons of fieldwork, this was updated to an estimate of at least 0.9 km^2 (Pollard and Cahue 1999). One of its potential component sites, Huintzio, is today listed on the INAH database as 1.8 km^2. However, recent LiDAR and pedestrian coverage of the Itzira *malpaís* that Urichu occupies shows an occupied area similar to that of lower Angamuco, approximately 6km^2. This is the area estimate I use for this project, pending future research to refine the occupation area and date range of greater Urichu. This settlement is listed as "Urichu and Itzira" in Table 6 which summarizes my population estimates.

Pueblo Viejo, or *Cuynajo Viejo*, is a sizeable settlement in the Patzcuaro municipality only described in an INAH *informe* (Trejo 1981). It is located approximately where Gorenstein and Pollard (1983:24) propose the location of the frontier settlement of Cuynaho (also Cuanaho) as described in the RM. It has since been offered as a possible candidate for the polity of

Corínguaro mentioned in the RM and other sources thanks to its size and location (Espejel Carbajal 2007; Urquhart 2023). I use the estimated size of 2 km^2 listed in the *informe*.

For the island settlements (*Pacandan, Yenuan, Ticuinun, Jaracuaro, Xanecho, Uranden, Utuyo, Cuyameo,* and *Apupato*), I use the total area of the island given the Late Postclassic lake levels. Each island is documented to have archaeological remains related to the Purépecha imperial occupation of the site (Chávez et al. 2005). Each island was considered its own settlement-polity and no island supported multiple settlements. I determined their area by creating a model of the lake surface at 2043 masl, its Late Postclassic height, using a 2.5m ground resolution, ground-truthed DEM of the basin made by Stephen J. Leisz in 2011 using ALOS data. It is possible that single island settlements behave differently than settlement scaling theory anticipates, so this is a potential source of unknown error.

Table 6: Population estimates for principal settlement sites with known locations, including the lake islands

Name	Area (km2)	Pop Min	Pop Mean	Pop Max
Tzintzuntzan	6.7	25000	30000	35000
Angamuco	6.2	23600	27300	31000
Ihuatzio	3	7727	9155	10414
Erongaricuaro	3	7727	9155	10414
Pueblo Viejo	2	4219	4998	5686
Patzcuaro	4.5	14152	16767	19073
Urichu and Itzira	6	21742	25760	29302
Jaracuaro (Xaracuaro)	1.4	2477	2935	3339
Pacandan	0.45	455	540	614
Yenuan	0.12	63	77	85
Ticuinun	0.05	17	20	23
Xanecho	0.2	134	161	183
Apupato	1.7	3310	3922	4461
Uranden	0.09	41	49	56
Utuyo	0.03	8	9	11
Cuyameo	0.08	35	41	47

Angamuco Chico is a small 0.71 km^2 settled *malpaís* adjacent to the greater Angamuco *malpaís*. Archaeologists have observed that despite its spatial separation, its habitation density appears similar to that of lower Angamuco and thus may be a continuation of the same settlement unit separated by landform morphology (Fisher, personal communication). The habitation density of Angamuco Chico and its relationship to the settlements on the larger malpaís requires further research, but the model presented in this project allows for tentative prediction of its population. On the high end, supposing that it has the same population density as lower Angamuco, its population is 2792-3669 people, with a mean of 3130 people. On the low end, supposing its population is proportional to its area according to my formula, its population is estimated to be 899-1212 people with a mean of 1065. These results are summarized in the tables below.

Table 7: Summary and comparison of high and low-end population estimates for the site Angamuco Chico. The high end summary assumes this site has the same population density as the lower Angamuco malpais, as preliminary LiDAR inspection indicates. The low-end estimate is a function of its approximate area according to the SST formula.

Angamuco Chico	Pop Min	Pop Mean	Pop Max
Low-end estimate	899	1065	1212
High-end estimate	2792	3130	3669

5.3.2: The Greater Angamuco Urban Zone

The Greater Angamuco Urban Zone is a region of relatively continuous settlement covering the Angamuco *malpaís* north of and including Angamuco as revealed by LiDAR scanning. The entire ~26 km^2 area is covered with urban features such as roads, houses, and complejos indicating settlement at varying degrees of density (Fisher et al. 2017). Given the general settlement pattern observed in the LPB relative to other *malpaís* formations, it is likely that settlement here predated the empire, gradually expanding through the Late Classic and Early Postclassic and still present in the Late Postclassic (Cohen 2021; Fisher 2005; Fisher et al. 2017). The settlements of the northern *malpaís* lack the consistent settlement density of the southern

Angamuco section. These settlements do not represent a single urban entity but rather several interconnected settlements that steadily expanded into the semblance of semi-continual settlement, fitting the profile of a multi-nucleated settlement area (Fisher et al. 2017; Harris and Ullman 1945; O'Connor 1977; Urquhart 2023). This multi-nucleated pattern is heretofore unique in the LPB and possibly in Mesoamerica at large (Fisher et al. 2017). One of the nucleated settlements on the *malpaís* is the administrative center of Itziparamucu, though which one exactly is unknown.

Itziparamucu was estimated by Pollard (1993:77) to cover an area of approximately 0.2-0.5 km^2 based on its rank in her size-rank category scheme just south of the cinder cone on the northern part of the Angamuco *malpaís* based on a vague description in the RM of its location on the *malpaís*. This location has been revised by Espejel Carbajal (2007) to the northwestern portion of the *malpaís,* which was corroborated by Pollard (2008) and by Urquhart's (2023) analysis of the LORE-LPB total coverage LiDAR scan of the *malpaís*. However, the location of Itziparamucu has never been confirmed by archaeological or historical evidence. As settlement is nearly continuous across the northern section of the *malpaís*, any attempt or define Itziparamucu's location on the *malpaís* based on the LiDAR without ground-truthing would be speculation. As stated before, the population estimate presented here is meant to be based on archaeologically verified evidence. I will thus not include an estimate for Itziparamucu in my model, and will instead present a general estimate for the northern *malpaís.*

Estimating the population of the northern *malpaís* presents difficulties. Due to the multi-nucleated nature of settlement on the *malpaís*, it would be inappropriate to apply the settlement density values for Angamuco or Tzintzuntzan to the other 19.8 km^2, as settlement density has been observed to likely be lower overall here than in those two large polities (Fisher et al. 2017).

Also, given the area-dependent nature of the settlement scaling model, simply plugging in the total northern *malpaís* area value would produce results highly prone to gross over-estimation error. Given the sizes reported above for other settlements serving as administrative centers, Itziparamucu was likely between 1-2.5 km^2 in area. The arm of the *malpaís* that it is proposed to be on covers an area of approximately 2 km^2, though this placement is still tentative. The INAH site data show evidence of settlements ranging much smaller than this in size, but these are certainly prone to underestimation of total settlement area (See Appendix B). Also, the unique nature of the multi-nucleated settlement pattern may present a disruption in the settlement-scaling pattern. These settlements may reach densities higher than that which the model predicts for their area. Given these uncertainties, I tentatively apply the density range of a 1 km^2 to the northern *malpaís* in an attempt to estimate its average settlement density. This yields and estimated 25,850-35,430 people with a mean of 30,690. This brings the estimated population total for the entire Angamuco *malpaís* to approximately 49,450-66,430 people with a mean of approximately 58,000 people. This confirms Fisher et al.'s (2017) assessment that the population of the *malpaís* likely exceeded 40,000 people. This estimate also leads to an overall average settlement density of approximately 2760 people per km^2, just over half of Pollard's (1993) estimate of density for Tzintzuntzan, again confirming Fisher et al.'s (2017) prediction that settlement here was less dense than in the capital.

Alternatively, there is a possibility that the Greater Angamuco Urban Zone had a similar population density as the lower *malpaís*. When this density is applied to the remaining 19.8km^2, the result is an estimated population between 77,873-102,307 people, with a mean of 87, 280. This is similar to Gorenstein and Pollard's (1983) estimation for the population of the entire basin.

Table 8: Summary and comparison of high and low-end population estimates for the Greater Angamuco Urban Zone. The high end estimation is derived by applying the population density of the lower malpais to the larger northern malpais. The low-end estimation comes from assuming an average settlement size of 1 km^2 across the malpais.

Greater Angamuco Urban Zone	Pop Min	Pop Mean	Pop Max
Low-end estimate	22635	26818	30517
High-end estimate	77873	87280	102307

5.3.3 INAH Sites Smaller Than 1 km^2

The INAH database search returned 26 non-island sites smaller than 1 km^2 meeting the requirements to be considered a settlement. The municipalities of Nahuatzen, Lagunillas, Coeneo, and Tingambato, all of which intersect the border of the basin, contained no sites fitting the criteria. The table listing the names, Folio Real numbers, municipalities, and material components of these sites can be found in Appendix B. Their size ranges from 0.01-0.32 km^2 with a mean of approximately 0.1 km^2. This range overlaps with the low end of Gorenstein and Pollard's (1985) lowest size-rank categories: 3 (0.2-0.5 km^2), 4 (0.1-0.2 km^2), and 5 (0.1-0.01 km^2). Their populations range from those of a small hamlet or village, 250-350, to the size of a single *complejo*, $N \geq 100$. The smallest among these, those of 0.01-0.04 km^2, almost certainly underestimate the size of the settlement they represent in Late Postclassic due to preservation issues. As stated previously, I will not apply any modifications to this but stick to the material evidence and keep this likely source of error in mind. The model estimates that the number of people represented by these sites is 1643-2492 with a mean of 1952 people.

Table 9: INAH sites and population estimates

Folio Real	Nombre del sitio	Nombre del Municipio	Area (km^2)	Pop Min	Pop Mean	Pop Max	Located
2ASA00003884	BOSQUE DE SANTA MARÍA	PÁTZCUARO	0.04	12	15	17	N
2ASA00003885	CAMINO DE SAN BARTOLO	PÁTZCUARO	0.11	56	66	75	N
2ASA00003886	PZ97 LAS PALMAS	QUIROGA	0.05	17	20	23	N
2ASA00016785	LA LADRILLERA	ERONGARÍCUARO	0.02	4	5	6	N
2ASA00016780	ERONGARICUARO II	ERONGARÍCUARO	0.04	12	15	17	N

2ASA00016853	TOCUARO	ERONGARÍCUARO	0.1	48	57	65	Y
2ASA00016861	EL RANCHITO	PÁTZCUARO	0.23	167	198	225	N
2ASA00016865	HUERTA DE BORJAS	PÁTZCUARO	0.02	4	5	6	N
2ASA00016867	SN. BARTOLO PAREO	PÁTZCUARO	0.06	23	27	30	Y
2ASA00016936	SITIO 57	ERONGARÍCUARO	0.07	28	34	38	N
2ASA00016937	SITIO 58	ERONGARÍCUARO	0.07	28	34	38	N
2ASA00016943	BANCO DE EROCUTIN II	ERONGARÍCUARO	0.12	63	75	85	N
2ASA00016958	SITIO 60	ERONGARÍCUARO	0.18	116	137	156	N
2ASA00016959	CERRO CHENDANAS	PÁTZCUARO	0.045	15	17	20	Y
2ASA00016960	LA CARCACHA	PÁTZCUARO	0.04	12	15	17	N
2ASA00016964	MINAS DE NOCUTZERO	ERONGARÍCUARO	0.02	4	5	6	N
2ASA00017096	LOS ECUAROS	PÁTZCUARO	0.02	4	5	6	N
2ASA00017157	EL MANZANILLAL	PÁTZCUARO	0.1	48	57	65	Y
2ASA00018180	PZ 54 LAS CUEVAS	TZINTZUNTZAN	0.1	48	57	65	Y
2ASA00018184	PZ 45 CHAPULTEPEC	PÁTZCUARO	0.02	4	5	6	Y
2ASA00018215	SITIO 11	QUIROGA	0.32	274	324	369	N
2ASA00019736	SITIO 17 A	QUIROGA	0.1	48	57	65	N
2ASA00019760	SITIO 43	QUIROGA	0.04	12	15	17	N
2ASA00021299	CPUZ5 LAS PIPAS	PÁTZCUARO	0.02	4	5	6	N
2ASA00026360	CERRO BUENAVENTURA	PÁTZCUARO	0.28	224	266	302	N
2ASA00026359	CERRO CHAPULTEPEC	PÁTZCUARO	0.39	368	436	496	Y
2ASA00003887	EL PEDREGAL	HUIRAMBA	0.26	201	237	271	Y

5.3.4 Additional Settlements

This model must also account for settlements not yet documented in published literature or government records. Gorenstein and Pollard's (1983) model predicts 91 settlements in the LPB in the Late Postclassic. The present project, sticking to published data, contains less than half of that number of sites. Gorenstein and Pollard (1983) fill out their model by assigning settlement site locations to modern settlements with the same names as prehispanic settlements mentioned in the RM. As this has been shown to produce erroneous outcomes (see the above discussion on Urichu), I take a different approach.

I use the Angamuco LiDAR data to estimate the population value of yet undocumented settlements in the LPB. The LiDAR survey of Angamuco and its surroundings revealed 61 previously undocumented settlement sites likely dating to the Late Postclassic period (Fisher, personal communication). I compare the total area of these small settlements to the total area of the LiDAR survey minus the area of Greater Angamuco, Angamuco Chico, creating a ratio of undocumented settlement area to basin area outside of known settlements. I then apply this to the area of the entire lake basin minus the area of known sites to estimate the total area of the basin likely occupied by undocumented settlements. I populate this estimated area by averaging the area values of the LiDAR-identified settlements and plug the average area value into the population formula to derive an average population density and multiplying that density by the total estimated undocumented settlement area.

The 61 settlements' total combined area is 1.65km^2. When compared to the 27.5km^2 of LiDAR survey area not covered by known Late Postclassic settlement, this indicates a ratio of 0.06 km^2 of settlement area per 1 km^2 of land outside of known settlements. The total area of the LPB is approximately 935 km^2. When the area of known sites and the lake are subtracted, we are left with 740 km^2 of land that potentially contains undocumented settlements. Multiplied by the 0.06 km^2 estimated occupation ratio, this leads to a predicted 44.43 km^2 of predicted undiscovered settlement area in the LPB.

The average size of the 61 LiDAR-identified settlements is 0.03 km^2. When applied to the settlement scaling formula, this produces a mean estimated population density of 300 people per 1 km^2, with a minimum of 267 people per km^2 and a maximum of 367 people per 1 km^2. When these density estimates combine with the predicted area value described above, they

produce an estimated background population of 11,863-16,305 people in yet undocumented settlements, with a mean of 13, 329 people.

5.3.5 Final Totals

Given the sums of all the documented settlements evaluated in this analysis, I estimate a population for the Late Postclassic LPB of 147,747-200,234 people, with a mean of 174,503. This represents about a 117% increase from Gorenstein and Pollard's (1983) model. 91% of people accounted for in this estimate live in urbanized settlements of over 1000 people, higher than the 80% estimated by Gorenstein and Pollard (1983). This is possibly skewed in favor of large settlements due to taphonomic issues and the narrow criteria set for sites to be considered a settlement in this estimate. However, the inclusion of the LiDAR-based background estimation presented in section 5.3.4 is intended to offset this bias. These results still indicate a likely pattern of well-developed urbanism.

These totals use the low-end estimates for Angamuco Chico and the Greater Angamuco Urban Zone. Using the high-end estimates for these sites, the estimated total would be 204,878-274,481 people, with a mean of 236,580. This result represents the extreme high end of possible human occupation in the LPB. It is unclear whether the basin could have supported such a population concurrently cohabitating in the region. However, the archaeological data presented here indicate that it is within the realm of possibility, albeit at its upper limits. In the following analysis, I use the lower, more conservative total.

5.4 Discussion: Settlement Pattern Visualization

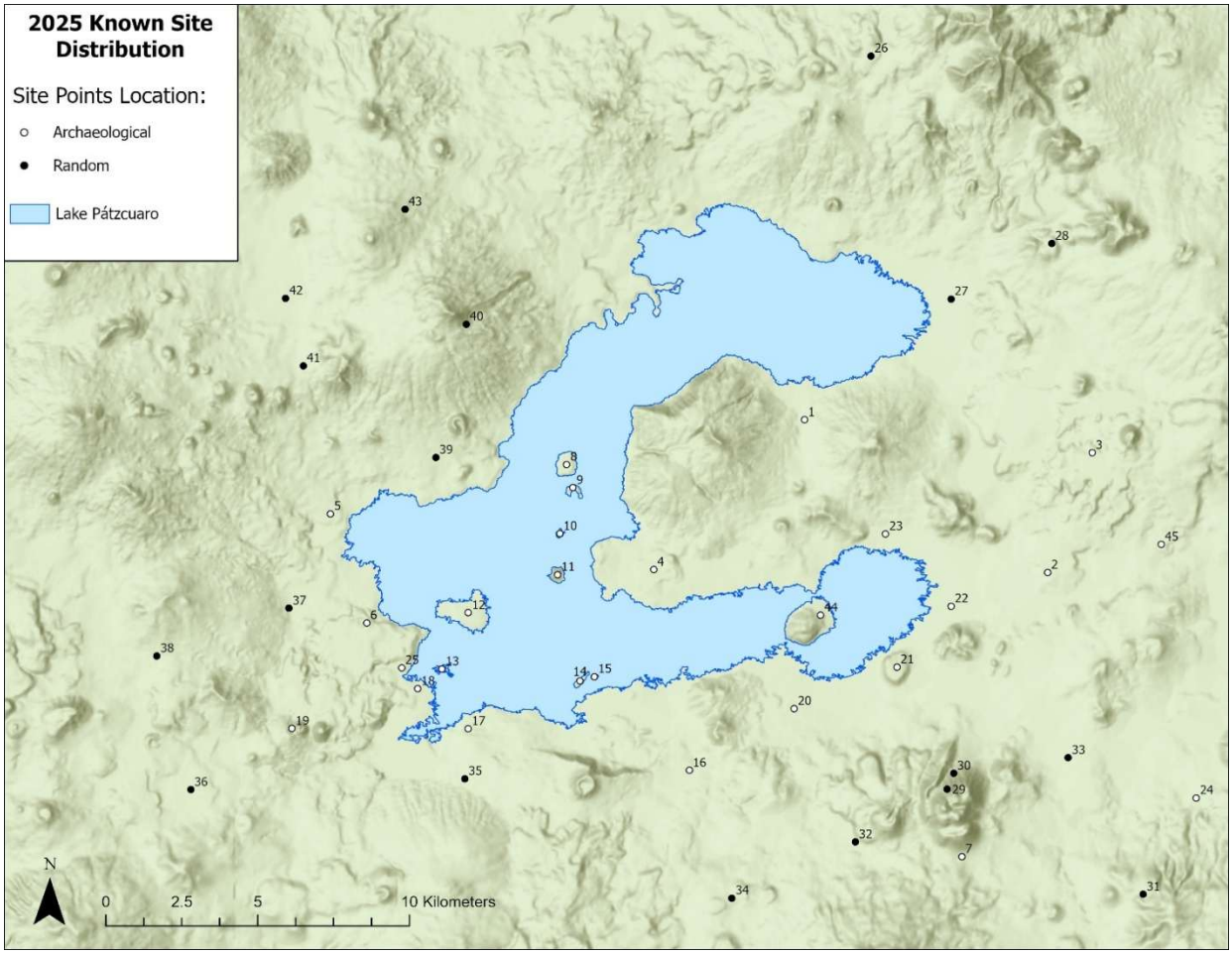

Figure 9: Map showing known and random Late Postclassic settlement site locations. Lake Patzcuaro shown at 2043 masl according to Leisz' (2011) DEM. See Appendix B for the site names that correspond with the numeric point labels. Ground surface imagery from Esri, USGS, NASA.

Settlement extended beyond the principal centers. Out of the 45 sites accounted for in this analysis (See Appendix B for a complete summary table of sites and site numbers), I was able to plot locations for 25, or 55% (Figure 9). This figure does not include the predicted sites that make up the estimated background population. The plotted sites, however, contain all of the principal population centers as well as several of the smaller sites provided by the INAH database, so that the located sites represent 92% of the estimated population. The remaining 22 sites were all from the INAH database, which only provides the municipality. I distributed the remaining 22 sites randomly within their municipalities using ArcGIS Pro, so despite their random location, they are within their correct quadrant of the basin (see Figure 9). The estimated

background sites could also not be confidently plotted, as spatial modeling of their locations is beyond the scope of this project. Given that these randomly distributed or unplotted sites only represent 8% of the estimated population and are constrained to their correct municipality, the error this introduces into the spatial distribution of the model is minimal.

Below, I present spatial analyses of their model in comparison to mine, using Spline (Figure 10), Kriging (Figure 11), and Inverse Distance Weighting (IDW)(Figure 12). Each of these analyses was completed in ArcGIS Pro. For the Kriging and IDW, I used a 'smooth' neighborhood type. These interpolations each showcase important contributions of my model to our understanding of the Purépecha settlement pattern in the Late Postclassic LPB.

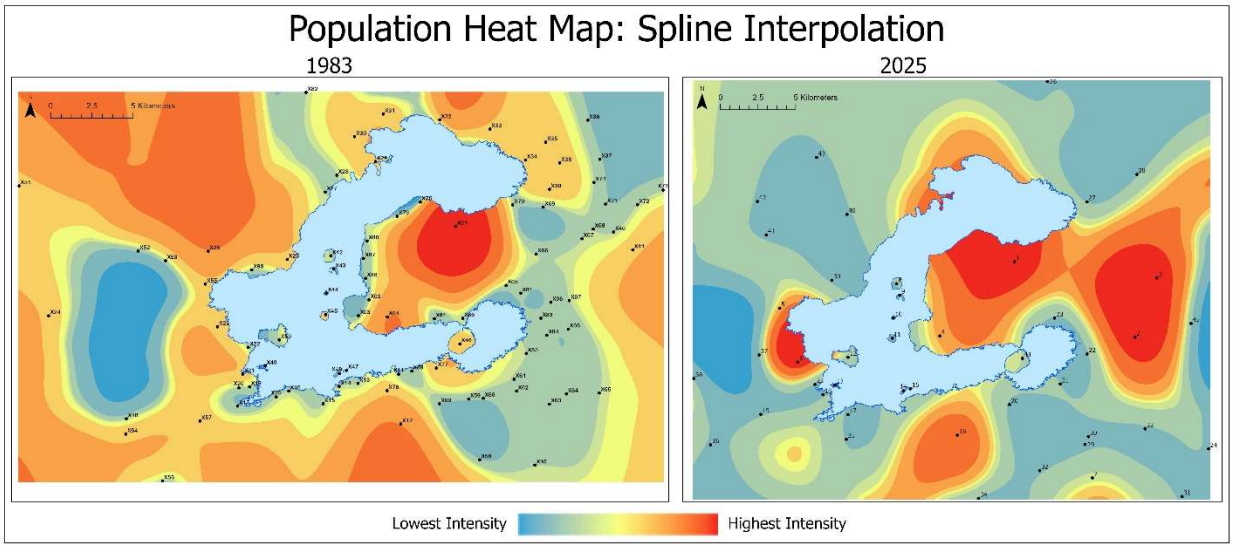

Figure 10: Comparison of Spline Interpolation heat maps for the 1983 and 2025 demographic models for the LPB. The 1983 data is digitized from the print source (Gorenstein and Pollard 1983) and the 2025 model is my data presented in this project. Lake Patzcuaro is shown at 2043 masl based on the DEM by Leisz (2011).

The Spline interpolation (Figure 10) shows the shift in population weight toward the eastern side of the basin. The 1983 model shows the most intensity at Tzintzuntzan and on the southern and western sides of the basin. In comparison, the 2025 model shows how significant of a concentration point that the Angamuco malpaís is in the LPB settlement pattern. This interpolation also highlights the importance of *malpaís* settlements generally. It shows clear

concentrations on the Angamuco and Itzira *malpaíses*. Whereas the distribution shown in 1983 model reflects Pollard's (1993) claim of poorly developed urbanism in, my 2025 model shows how important urbanized settlements are in this settlement system.

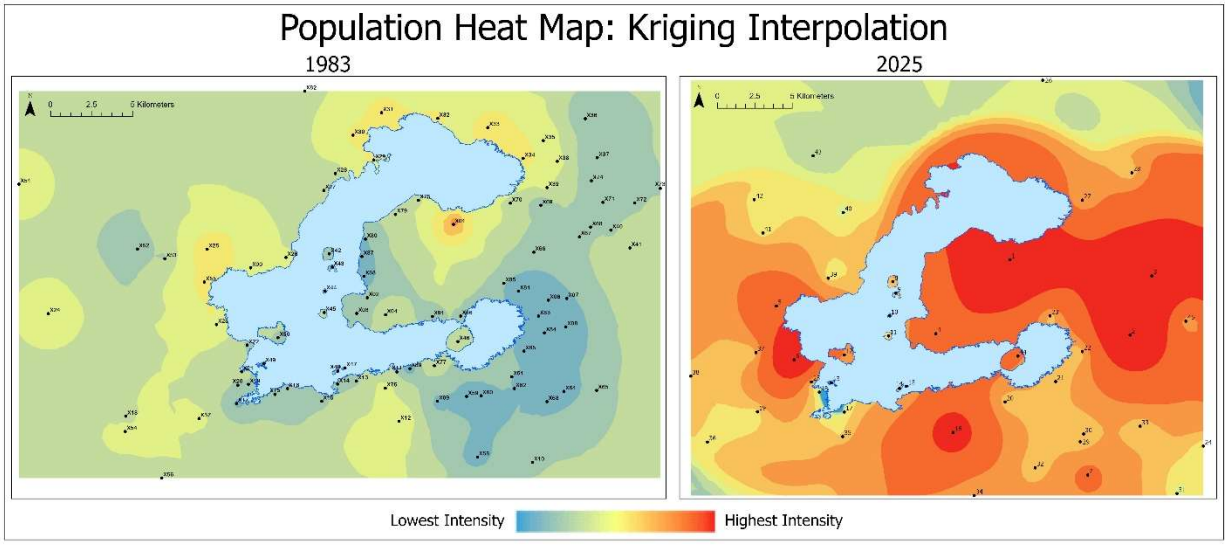

Figure 11: Comparison of Kriging Interpolation heat maps for the 1983 and 2025 demographic models for the LPB. The 1983 data is digitized from the print source (Gorenstein and Pollard 1983) and the 2025 model is my data presented in this project. Lake Patzcuaro is shown at 2043 masl based on the DEM by Leisz (2011).

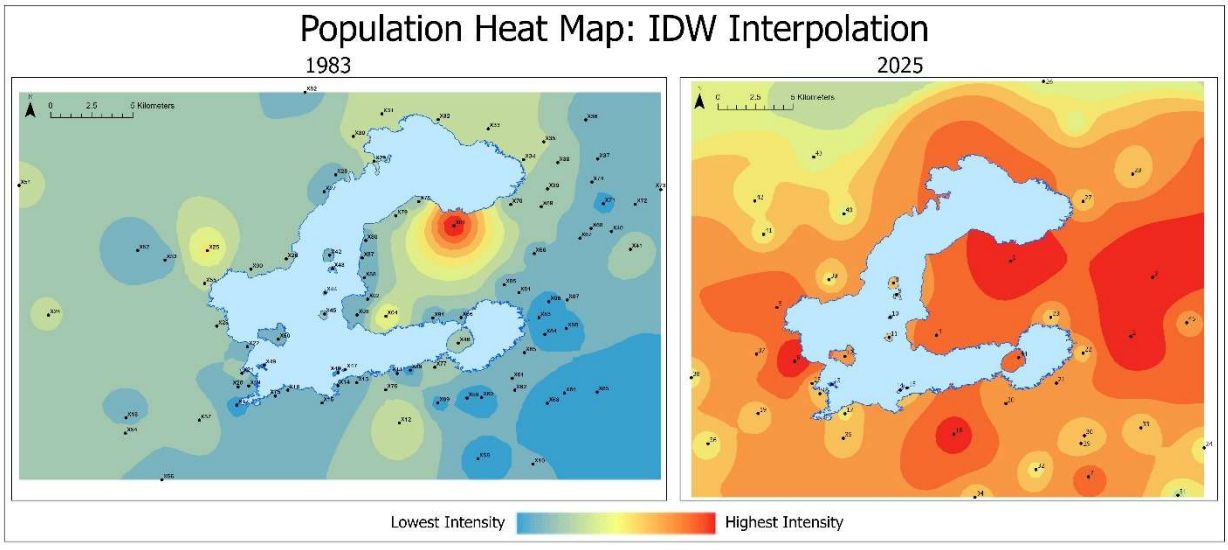

Figure 12: Comparison of IDW Interpolation heat maps for the 1983 and 2025 demographic models for the LPB. The 1983 data is digitized from the print source (Gorenstein and Pollard 1983) and the 2025 model is my data presented in this project. Lake Patzcuaro is shown at 2043 masl based on the DEM by Leisz (2011).

The Kriging (Figure 11) and IDW (Figure 12) interpolation heat maps display the general increase in the spread of settlement that my model shows in comparison to the previous model.

In both interpolations, the 1983 model is most heavily concentrated on Tzintzuntzan with small pips of population intensity at Erongaŕcuaro, Ihuatzio, and Pátzcuaro. Beyond this, the population is spread among scattered, low-intensity settlements. The 2025 model shows the generally greater population intensity of the LPB and the impact of multiple large urban centers beyond Tzintzuntzan. Similarly to the Spline heat map, these interpolations show that much of the growth is driven by *malpaís* settlements at Angamuco and Itzira as well as more well-developed urbanism in general.

Each of these spatial analyses shows that the previous model was in great need of updating. They show that the population of the LPB in the Late Postclassic was much greater and distributed drastically differently than previously thought. Most significantly, they show that Tzintzuntzan was not a primate city as has been the prevailing theory since it was proposed by Gorenstein and Pollard (1983) (discussed further in Chapter 6).

5.5 Discussion: Evaluation of the Model

As stated above, one of the limitations of applying this model is that it cannot predict deviations from itself. It is possible that some of these settlements deviate from the expected relationship between population and area based on special functions. For example, Patzcuaro, the smallest of the principal centers, was said to hold special privilege in the imperial administrative and religious networks despite its size due to its history as the legendary Tariacuri's original power center (Gorenstein and Pollard 1983). Thanks to this special status it may have been more densely populated than this model accounts for, leading to a possible underestimation of its population.

The islands may also present an issue for the settlement scaling model. Given the natural limitations of settlement expansion, population and density may have a different relationship on

islands. Settlement scaling theory has yet to thoroughly address the issue of settlement systems that include islands, presenting a potential avenue of future research. The smallest settlement sites in this study also show evidence of a possible shortcoming in the model. The smallest sites, measuring less than 0.01-0.02 km^2, return population values on the low end of a single household size. Settlements in this size range are included in Gorenstein and Pollard's (1983) and Pollard's (1993) descriptions of LPB settlement with a minimum estimate of 10 individuals based on 20th century census data. This may indicate the need for employing a density minimum in future analyses, or slightly adjusting the α coefficient between larger, networked settlements and smaller, unnetworked settlements as suggested by Ortman et al. (2014). Apupato may present a different challenge than the other islands in that its steep slopes may render much of the surface area counted in this model not actually fit for settlement and therefore introducing an instance of error by overestimation. Apupato is, however, described in the RM as an island where the *Cazonci* safely stored wealth goods like gold items and quetzal feathers (Gorenstein and Pollard 1983:27), and this special elite function may indicate greater demographic concentration than expected.

The three major sites missing from this analysis are the administrative centers of Uayameo and Pechataro and the market center of Asajo, all known through mentions of their importance in the RM. These sites have been potentially identified with modern settlements with colonial names (Gorenstein and Pollard 1983), but as shown in the cases of Urichu and Itziparamucu, this ethnohistoric method of location cannot always be relied upon. The INAH database information presented above likely contains information relevant to these settlements, but the site names and descriptions from their municipalities do not give enough context to approximate the location of the Late Postclassic settlements.

My model's remarkable agreement with the Prehispanic population that Whitmore's (1992) model predicted is a point in my model's favor. Based on an estimated 1550 population of about 40,000-75,000 people, the 70% crude mortality rate determined by Whitmore's epidemiological model for the Basin of Mexico in the same time period predicted a prehispanic population of 133,000-250,000 with a mean of 187,000 people for the LPB. The mean of my model indicates an average of 68% reduction in population by 1550, aligning much more closely with between the 70% predicted by Whitmore (1992) than the 32% indicated by Gorenstein and Pollard (1985). The entire range of my estimate (147,747-200,234) falls entirely within the range predicted by Whitmore's mortality rate (133,000-250,000) (see Table 10). The top end of my archaeological estimate falls near Borah and Cook's (1962) estimate of 210,000 people. This is a remarkable level of agreement not usually seen between population reconstructions based on archaeological, epidemiological, and historical methods respectively (Feinman and Nichols 1990; Sanders et al. 1979). This indicates that these higher population reconstructions, including the one I present in this thesis, are on target. The excellent fit of the model for Angamuco and Tzintzuntzan and the final outcome's convergence with Whitmore's coefficient indicates that the settlement scaling theory model is highly applicable in the Late Postclassic LPB.

Table 10: Summary and comparison of population estimates for the Late Postclassic LPB

Method	Estimated Population
This Project	147,800-200,200
Gorenstein and Pollard (1985)	60,750-100,050
Whitmore's (1992) Model	133,000-250,000
Borah and Cook (1960)	210,000

One of this model's limitations is its generality. As described previously, the Postclassic was a time of marked population increase in the LPB leading up to the Colonial Period collapse. This model is a static average of that time. This kind of generality is a necessary evil of region-scale demographic studies like this one, but the implications of this limitation must be taken into

account in the interpretation of the results (Drennan et al. 2015). While this model allows for comparison to other periods, it does not capture the nuances of population change that occurred within the Late Postclassic. The area and density determinations that this model relies on certainly changed throughout the roughly two centuries encompassed by the Late Postclassic Period.

The accuracy of this model will improve with more extensive survey coverage of the basin area and future excavations providing more precise chronology of the major settlement sites. As exemplified by Ortman et al.'s (2014) analysis of Basin of Mexico settlements, comprehensive survey allows for better fitting the model's coefficients to the specific context at hand. Such a survey will also fill in spatial gaps in this model, reducing the need for generalization within the broad, unwieldy spatial units of the municipalities and therefore reducing potential error. When detailed intra-settlement network analyses, like that completed by Solinis-Casparius (2022) have been done at more LPB settlements, the accuracy of the estimated *a* values may be improved. Additionally, future excavations will improve our understanding of how these settlements changed over time. As more of the smaller settlement sites in the basin are documented, the relationship between the different reconstruction methods will also become clearer. the epidemiological mean. This improved insight can be incorporated into this model to better reflect the changes that occurred within the Late Postclassic.

6. Discussion: Demography and Empire

This reassessment of the scale and distribution of urbanized settlement in the Late Postclassic LPB is a major departure from Gorenstein and Pollard's (1983) model and has significant implications for how we understand imperial origins, administration, and collapse. Urbanism in the LPB was much more extensive and well-developed than imagined in the previous model. This analysis does not support the extreme primate city model proposed before but paints a much more complex picture. The basin had multiple large settlements, boasting major urban centers of 5,000 people or more across the basin including Tzintzuntzan, Angamuco, Pátzcuaro, Erongarícuaro, Ihuatzio, Pueblo Viejo, and the Itzira *malpaís*. It also contained a unique zone of continuous, multi-nucleated settlement spanning an area of approximately 26 km^2 on the Angamuco *malpaís*. This validates Fisher et al.'s (2017) contention that Purépecha urbanism was well developed before the foundation of the empire, consisting of a highly concentrated population atop and between the *malpaíses*. This demographic landscape provides context for the conditions of imperial consolidation, expansion, and collapse.

6.1 Demography and Imperial Consolidation

This model completely alters the picture of population scale and distribution around Lake Pátzcuaro, with heavy implications for how we understand the early formation of the Purépecha Empire. Gorenstein and Pollard's (1983) model shows, as described previously, an extreme primate city model centered on Tzintzuntzan with a heavy population weight on the western and southern sides of the basin associated with the Erongarícuaro, Urichu, and Pátzcuaro polities. They use this to argue that the archaeology more or less supports the story told in the RM that these polities banded together under Tariácuri in an alliance that later became and empire. My model adds context and complexity to this story.

My model shows a tremendous shift in the population weight to the eastern side of the basin driven by Angamuco and the multinucleated settlements of the Greater Angamuco Urban Zone. This shift in concentration does not involve a significant decrease in the estimation of the population of the western polities—in fact, this model shows that the west side of the basin was much more heavily populated than projected in the previous model. Rather, the prime driver of this major increase in scale is the inclusion of the urbanized settlements of the Angamuco *malpaís*.

As stated previously, the Postclassic was a time of dynamic population change in the LPB. The Early-Middle Postlcassic saw settlement expansion and population increase, as seen in the settlements of the southwest portion of the basin around Urichu and in the rapid urban expansion of the Angamuco *malpaís* (Cohen 2021; Fisher 2005; Fisher et al. 2003, 2017; Pollard 2003; Solinis-Casparius 2024). This project estimates that Angamuco *malpaís* housed approximately 58,000 people, a major portion of the LPB's population. If most of this population arrived during the Postclassic as has been hypothesized, this multiplies the demographic expansion observed by the Urichu project a great deal. Although it is possible that internal factors like birth and death rates contributed to this increase, there are several indications that the LPB experienced rapid immigration at this time. The northern border of the Mesoamerican farmable zone shrunk southward in the Early-Middle Postclassic, forcing populations southward and possibly into the LPB (Haskell and Stawski 2017). It is also likely that there was immigration from the Basin of Mexico fueling this expansion, though the significance of this source is unknown (Ramírez-Uribe et al. 2021; Solinis-Casparius 2024; Terán Guerrero 2017). The nearby polity of Tingambato just to the west of the LPB experienced volcanic disruptions in the Epiclassic-Early Postclassic, leading to its abandonment (Pérez-Rodríguez et al. 2023). Given

its immediate proximity and clear temporal link to observed demographic expansion in the LPB, it is likely that those affected by the eruption relocated to the LPB. Thus, the Postclassic was a time of tremendous population concentration in the LPB, manifesting as both the spread of settlement area and the increase of density in established polities. This occurred even as the lake's level rose toward its highest point and covered land previously available for settlement and farming.

The Purépecha Empire formed in a time of intense demographic concentration within the basin. This is no coincidence—increasing population size and density is associated with the emergence of more complex sociopolitical forms like states and empires (Bettencourt 2013; Ortman et al. 2014; Powell et al. 2009; Smith 2023:27). The Classic and Preclassic inhabitants of the LPB engaged in a fissioning settlement pattern (Pollard 2008; Stone 2004:144), exercising a freedom of movement facilitated by lower populations that may have kept elite power in check (Furholt et al. 2020). In the Postclassic, population concentration in urbanized settlements limited this freedom of movement gave elites a greater sedentary resource extraction base to draw from. This population concentration occurred as key productive resources became scarcer due to lake level rise. This spurred increasing elite-led armed conflict through the Epiclassic and Postclassic, allowing elites to further consolidate power (Cohen 2021; Fisher et al. 2019; Pollard 2008). This combination of an increasingly concentrated, less mobile population under the power of competitive elites has been cited widely as a catalyst for hierarchical political forms such as an imperial state (DeMarrais and Earle 2017; Furholt et al. 2020). Thus, while demographic processes do not constitute a prime mover, they likely played a role in the process of the formation of a new, complex, hierarchical form of social organization in the region.

This new demographic model provides further context to events described in the RM during the time of imperial consolidation. As discussed in Chapter 2, the earliest form of what would become the Purépecha Empire consisted of an alliance of LPB polities under the legendary Tariácuri and his family. The expansive, densely settled polities of the Angamuco *malpaís* likely presented a challenge for the young empire, whose early days are described in the RM as occupied with raids and battles (Urquhart 2023). No member community in the extensive Angamuco settlement complex is listed as a member of the *Uacusecha's* early alliance, meaning that they likely had to be conquered in the process of early imperial expansion and consolidation. Even when accounting for the larger population estimates in all LPB polities offered in this project, the settlements of the Angamuco *malpaís* were potentially twice as large in population than any of the lakeside polities said to have made up Tariácuri's original alliance. As such, they represented a potential threat. Urquhart (2023) has argued that the southern *malpaís* urban core is the most likely candidate for Corínguaro, a city that plays a directly antagonistic role to Tariacuri's ambitions in the RM. Urquhart's argument is tentative and is unable to eliminate the other possibilities, but it does convincingly present the likelihood of conflict in the eastern *malpaís* settlements during early imperial expansion. My analysis shows the scale of that potential conflict; Angamuco reached its height right around the time Tariácuri's alliance became an empire, making it a major player in the demographic, economic, and military landscape of the pre-imperial LPB (Cohen 2021; Fisher et al. 2017, 2019). Perhaps opposition to this great *malpaís* population helped spur the alliance into being—alliance being the only chance at victory in this time of increased crowding and competition. I posit that this would have been enough to spur a system of independent competing centers to ally together and form into an imperial state.

6.2 Demography and Imperial Administration

The increased scale and altered distribution of the LPB's settled population that this project indicates changes the way we understand the strategies the empire used to maintain its power. Specifically, this model has implications for the political geography, political economy, and political ecology of the basin relative to the workings of the imperial administrative and tribute systems.

The new demographic model presented here shows that imperial administration and the maintenance of power in the LPB was not a simple task. As I have argued previously, Tzintzuntzan was not a primate city. The capital was one large settlement among several and could not rely on its size to keep itself at the center of power as proposed by Gorenstein and Pollard (1983). The demographic and political landscapes were more complex with that, with a large population (118% larger than proposed in the previous model) settled in powerful polities both allied and antagonistic. With these conditions in place, the Cazonci and the other elites had to employ political and economic strategies to maintain control of the LPB population. Urquhart (2023) has explored how elites controlled the redistribution of tribute goods as a means of maintaining control, and Cohen (2021) has explored the installation of imperial architecture in LPB settlements as a means to the same end. My model highlights other strategies that may have been at play.

One of these strategies may have been intentional population concentration at Tzintzuntzan. As the Late Postclassic period continued and the empire grew in size and strength, it has been proposed that the settlement of the lower Angamuco *malpaís* contracted (Cohen 2021; Fisher et al. 2017, 2019) while Tzintzuntzan's population continually expanded until the arrival of the Spanish (Pollard 1993). This may indicate a pattern of intentional population centralization

by the emperor. The demographic distribution in my model shows why this would have been an appealing strategy: members of a large population outside of the capital that represent potential conflict are brought into the fold to become better imperial subjects and to balance the population distribution more favorably for the capital. The emperor may have accomplished this through means of positive reinforcement like economic or diplomatic incentives, or perhaps more coercive means like the forced resettlement of elite families in the capital. Thus, while Gorenstein and Pollard's (1983) primate city model may not apply to the population distribution presented here, Tzintzuntzan may have enacted strategies and policies to make itself a primate city. This indicates the Cazonci's use of an ingenious political strategy of keeping one's enemy close to minimize internal political conflict in a densely populated region.

This model also supports the hypothesis that the empire strategically placed administrative centers to manage large polities in the LPB. The RM describes an administrative center at Itziparamucu in the eastern part of the LPB (Figure 13) (Gorenstein and Pollard 1983). This settlement's location is unknown, but it has been proposed to be within the Greater Angamuco Urban Zone high on the upper *malpaís* (Gorenstein and Pollard 1983; Pollard1993; Urquhart 2023). Descriptions of its size suggest that it may fit the category of satellite settlement better than central place for an administrative center. However, if Urquhart's (2023) contention that Angamuco is the source of internal conflict in the eastern basin as described in the RM is true, then it follows that the empire would prefer to put its administrative center at a settlement with a strategic flanking, high-ground advantage against it. The sheer size of the Angamuco population that my model offers lends credence to this idea, as the emperor would certainly want to keep such a large population in geopolitical checkmate if he anticipated conflict. More investigation is required to confirm whether or not Angamuco's southern urban core is indeed the

mysterious Curínguaro (Urquhart 2023) and where exactly Itziparamucu lies. However, my demographic model bolsters the hypothesis that the Purépecha emperor placed administrative centers strategically to better manage a large population and prevent internal conflict.

Attempting to redraw the limits of the basin's administrative zones is beyond the scope of this project (see Figure 13). Due to the limits of my means of data collection, this model cannot account for the precise positions of many of the subordinate sites to the major centers of the LPB. Erongarícuaro, particularly, is said to have commanded tribute from a great many small settlements in a territory expanding northwest out of the basin (Haskell 2006). This will improve with continued archaeological work in the area and the identification of sites for Uayameo and Pechataro. However, for now, my model shows the tremendous demographic scale managed by the Purépecha Empire that was not previously accounted for, and the possible creative strategies that imperial elites employed to manage this population.

Figure 13: LPB administrative zones as proposed by Gorenstein and Pollard (1983) based on their settlement projection and a description of administrative centers in the RM. Lake level shown at 2043 masl. according to Leisz' (2011) DEM. See Appendix A for site names.

6.3 Imperial and Demographic Collapse

The model presented here also indicates a much greater level of population devastation after Spanish arrival than previously accounted for. Throughout the Americas, the collapse of empires and other forms of social organization was directly correlated with Colonial Period demographic collapse. This decline was due not just to smallpox, but to its deadly comorbidities like the encomienda system and forced emigration (Matallana Palaez 2020; Ragsdale et al. 2019). This model shows that the population of the LPB was no different from elsewhere in the Americas in their experience of demographic catastrophe.

This project indicates a population reduction of approximately 68% between 1519 and 1550, a sharp increase from the 32% predicted by Gorenstein and Pollard (1983). The model presented here aligns closely with the estimated 70% reduction derived from Whitmore's (1992)

epidemiological model and the 73% reduction proposed by Borah and Cook (1960) for the same time span (See Table 10 and Figure 14).

The reduction rates described above show remarkable agreement with each other. The clustering of these three estimation methods around 70% indicates that this is likely near the true reduction rate for the first 30 years of colonization. Due to the tendency toward underestimation in my model, the value of 68% from my model should be taken as an approximate minimum. Gorenstein and Pollard's (1983) model, therefore, should now be understood as an outlier that grossly underestimates the rate of population reduction. Population decline did not stop in 1550, as historical evidence shows that Indigenous populations continued to fall well into the 17th century (Borah and Cook 1960; Gorenstein and Pollard 1983; Whitmore 1992). By the early 17th century, this model indicates that the population likely fell by around 90%.

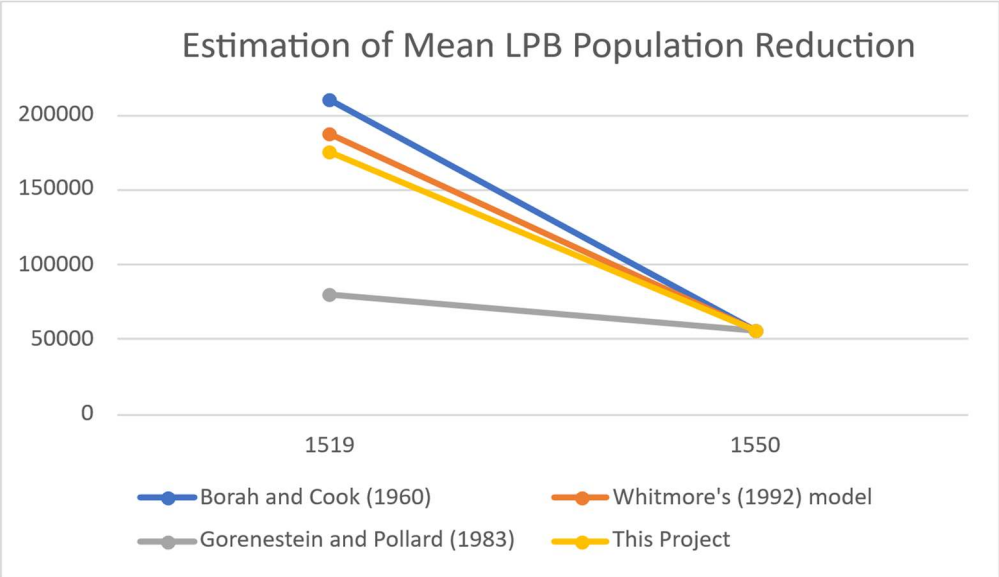

Figure 14: Graph comparing the projected population reduction rates of different reconstruction methods.

This new estimate brings the rate for the LPB more in line with current consensus of a sharp, devastating decline in indigenous populations after the arrival of European colonists. Archaeological and historical evidence from throughout the Western Hemisphere generally

(Cook 1998; Livi-Bacci 2006; Jones 2014; Jones et al. 2021; Milner and Chaplin 2010; Van Buren 2010) and Spanish Colonial America specifically, including the Caribbean (Anderson-Cordova 2017; Livi-Bacci 2006; Tinker and Freeland 2008), California (Jackson 1992; Jones et al. 2021), Florida (Stojanowski 2004), the Andes (Covey et al. 2011), and Central Mexico (Paláez 2020; Isaac 2015; McCaa 1995) all agree that the indigenous population was drastically reduced after European arrival. This agrees with emerging genetic evidence which shows an extreme bottleneck in Indigenous populations in the Colonial Period (Bolnick et al. 2016; Bolnick and Smith 2003; Gravel et al. 2013; Pateman et al. 2022; Llamas et al. 2016; Lindo et al. 2016; Nieves-Colon 2022; Nieves-Colon et al. 2019; Nores et al. 2022; O'Fallon and Fehren-Schmitz 2011; Raff et al. 2011; Wang et al. 2004), including Central Mexico, of which the Purépecha were a part (Villa-Islas et al. 2023). This model shows that the population in the Lake Pátzcuaro Basin's experience of the effects of colonialism was in line with all other regions of the Americas. The LPB's dense population and early contact with Spaniards made conditions right for rapid spread of disease. Demographic collapse here was swift and devastating.

This demographic catastrophe was the driving factor in the collapse of the Purépecha Empire. Demographic collapse, exacerbated by political and environmental factors, has been associated with the collapses of other pre-colonial Indigenous civilizations in the Americas (Chase et al. 2023; Douglas et al. 2016; Marsh et al. 2023). The workings of the Purépecha imperial administrative system continued to function in the early days of contact with the Spanish, which the Purépecha considered the beginning of an alliance and Spain considered an easy conquest (Warren 1985:30). In the 30 years after first contact, the inevitable demographic catastrophe led to the total collapse of the imperial systems, helped along by intentional Spanish culling of the elite class and the immediate institution of the destructive encomienda system

(Paláez 2020; Warren 1985; Gorenstein and Pollard 1983:43). With a reduced population, the government and economic systems of a social entity as large as the Purépecha Empire could not continue to function, and resistance to the conquering army became nearly impossible. The Purépecha Empire died with the majority of its people.

The Purépecha ethnic identity, however, survived and continues to thrive in the LPB and central Michoacán to this day (Amerlinck 1995; Pollard 1993; Van Zantwijk 1967). In the centuries since Spanish arrival, the Purépecha people of the LPB have persevered and steadily recovered in number. In the modern day, Purépechas continue to practice traditional methods of community building, self-governance, and resistance to outside authority (Campbell 2020).

7. Conclusion

7.1 Summary of Results and Implications

In this thesis, I have presented a new regional demographic model for the Late Postclassic Lake Pátzcuaro Basin based on identification of archaeological remains through pedestrian and LiDAR survey and principles from Settlement Scaling Theory. The LPB formed the heartland and "political core" of the Purépecha Empire in the Late Postclassic period (1350-1520 CE) (Pollard 1993:63). This state was the second largest empire in Mesoamerica at the time, covering an area over 75,000 km2 with borders roughly analogous to the modern state of Michoacán. Ruling from the capital city of Tzintzuntzan, the Purépecha empire exerted influence over the sociopolitical and economic conditions of its realms and was a significant geopolitical and military force in the broader Mesoamerican region. Based on available archaeological evidence of Late Postclassic settlement, I estimate that the basin heartland contained between 147,800-200,200 people, with a mean of 174,500.

This model shows that Purépecha urban settlement existed on a much greater scale and with an entirely different spatial distribution than previously understood. The previous model constructed by Gorenstein and Pollard (1983) proposed an LPB population of 60,000-100,000 people at its peak in the Late Postclassic, 54% smaller than the population proposed in my model. They argue that the distribution of this population followed an extreme primate city model, with 25-35% of the basin's residents concentrated in Tzintzuntzan. From this, they argue that Tzintzuntzan was an absolute regional and supra-regional center of gravity in the Postclassic basin and the imperial territory at large in "administrative, economic, religious, social, and transport" matters with no rivals (Gorenstein and Pollard 1983:94). The model presented in this thesis shows that Tzintzuntzan was no primate city; the population was concentrated in several large urban centers throughout the basin, including those on the Angamuco *malpaìs*. This new

population model paints a much more complex picture of the basin's sociopolitical landscape and has major implications for how we understand the consolidation and administration of the Purépecha Empire in the Late Postclassic.

The model presented in this project reveals the role demographic factors played in the emergence of the Purépecha Empire. The Postclassic was a time of rapid population concentration in the basin, creating both opportunities and challenges for the *uacusecha* elites with imperial aspirations. In the Epiclassic- Postclassic LPB, population size increased due to immigration and improved agricultural productivity, resulting in both the spread of settlement area and the increase of density in established polities controlled by elite families. This occurred as the lake's level rose toward its highest point and covered land previously available for settlement and farming. This created an environment in which a large, sedentary, urbanized population was mostly under the control of competing elites in a time of growing resource scarcity. These conditions are known to be fertile ground for the emergence of new hierarchical political forms such as an imperial state (DeMarrais and Earle 2017; Furholt et al. 2020). Thus, while demographic likely played a role in the process of the formation of the Purépecha Empire, the region's first imperial state.

This model also provides context for the history of the foundation of the empire as described in the RM. Elites of the early empire had greater resource extraction bases to draw upon but also faced greater blocks of potential opposition, and the most significant source of opposition was likely the settlements of the Angamuco *malpaís*. No member community in the extensive Angamuco settlement complex is listed as a member of the *Uacusecha's* early alliance, meaning that they likely had to be conquered in some way in the process of early imperial expansion and consolidation. Even when accounting for the larger population estimates in all

LPB polities offered in this project, my model shows that the settlements of the Angamuco *malpaís* were potentially twice as large in population than any of the lakeside polities said to have made up Tariácuri's original alliance. It is likely that opposition to this great *malpaís* population helped spur the alliance into being—alliance being the only chance at victory in this time of increased crowding and competition. Thus, my model suggests that the formation of the Purèpecha Empire under the mytho-historical Tariácuri may have been set in motion in part by demographic factors.

The new model also shed light on possible strategies that the empire employed to maintain control of this large population. The demographic and political landscapes were complex, with a large population settled in several powerful polities both allied and antagonistic. In the context of information from the RM and previous archaeological work, this model indicates that the empire likely intentionally gathered people from other large polities to its capital and placed administrative centers in strategically advantageous places rather than in the largest settlements as means of keeping this large population in check. These strategies, in addition to others, made for an effective suite of social controls that maintained imperial power in the LPB and beyond until the arrival of the Spanish.

Finally, this model indicates a greater, more devastating population reduction after Spanish arrival, with an estimated crude mortality rate from smallpox and its various comorbidities between 68% and 73% in the first 30 years after contact. This new estimate brings the rate for the LPB more in line with current consensus of a sharp, devastating decline in indigenous populations after the arrival of European colonists. This demographic catastrophe was the driving factor in the collapse of the Purépecha Empire. In the 30 years after first contact, the inevitable demographic catastrophe led to the total collapse of the imperial systems, helped

along by intentional Spanish culling of the elite class and the immediate institution of the destructive encomienda system (Paláez 2020; Warren 1985; Gorenstein and Pollard 1983:43). With a reduced population, the government and economic systems of a social entity as large as the Purépecha Empire could not continue to function, and resistance to the conquering army became nearly impossible.

7.2 The Path Forward

This model will contribute to current and future archaeological research in the LPB. Many questions in archaeology relating to past landscapes, labor, power structures, ecologies, settlement scaling, and more all relate to demography. These contributions will improve as further research also improves the model.

Demography is at the heart of the study of archaeological landscapes. Much recent work in the LPB has focused on human relationships to landscape (Fisher 2005; Fisher et al. 2003; Haskell and Stawski 2017; Ramírez-Uribe et al. 2021). Studies in archaeological demography shed light on how and why populations distribute themselves on the landscape in relation to resources and neighbors, and one cannot effectively explore archaeological landscapes without first knowing who is doing what where, the basic question of regional settlement demography in archaeology (Drennan et al. 2015). While demography has been a more prominent feature of earlier, settlement-oriented studies that saw the landscape as a passive backdrop on which to find evidence of human activity (Sanders et al. 1979; Willey 1953), it continues to be relevant to contemporary approaches that understand archaeological landscapes as constructed, conceptualized, and ideational (Knapp and Ashmore 1999:8). The knowledge of settlement scale and distribution that this project offers will inform future work in this area.

This new evaluation of the basin's population will also provide the basis for a re-evaluation of the relationship between population size and the agricultural productive potential of the basin, as first attempted by Gorenstein and Pollard (1983). Emerging evidence from Angamuco indicates that Purépecha imperial elites controlled the redistribution of tribute foodstuffs to the common inhabitants of the LPB, using this resource bottleneck as a means of social control (Urquhart 2023). In the context of this new demographic model, a revised study of the agricultural productive potential of the LPB may shed light on just how effective a means of social control the redistributive system was and provide context into the relationship between labor and power.

This model also provides a new opportunity for testing the principles of Settlement Scaling Theory. This project is the first to use Settlement Scaling Theory in a predictive rather than descriptive capacity. As more information emerges regarding the settlements described in this project, independent population estimates like the one I present for Angamuco become possible. Researchers will then be able to compare them to this model to test the effectiveness of Settlement Scaling Theory as a predictive tool. This will be especially enlightening for settlements where area is a limited, like on the islands or *malpaíses* of the LPB. This will lead to improvements in Settlement Scaling Theory's ability to model human settlement behavior in diverse environments

Further refinement of my results will involve increasing the detail of what we know of the makeup of this population. This will require more extensive analyses of skeletal material from the LPB to better understand the gender and age breakdown as well as rates of mortality. Many archaeological methods of demographic reconstruction rely on statistical analysis of skeletal remains, but the Purépecha population preferred cremation over burial for their dead

(with the exception of sacrificial victims and the highest elites), resulting in a heavily biased skeletal record (Pollard 1993: 155). Very few published studies exist, reflecting the small sample size to work with (Pollard and Cahue 1999). Fisher (2012) also reports several excavated burials from Angamuco, but even with these the sample remains too small and spread temporally thin. Continued research on the skeletal remains in Angamuco's cemetery is set to begin in 2025, which will provide greater insights into the makeup of Angamuco's population and thus the LPB population generally. This will help to better understand who the people counted in this project were and how they lived.

This model's precision will also improve with the ongoing LiDAR studies of the region. More detailed study of the LiDAR coverage of the Itzira *malpaís* that includes Urichu on the southwestern side of the LPB will undoubtedly provide deeper insight into the demography of *malpaís* settlements. Archaeologists have recently completed LiDAR scans of Tzintzuntzan (Punzo-Díaz and Sandoval 2022), Ihuatzio (Punzo-Díaz 2023a), and the nearby Purépecha center of Tingambato (Punzo-Díaz 2023b). As I have shown with Angamuco, LiDAR models of large settlements offer unprecedented precision and breadth of coverage, creating the opportunity for better regional demographic models. Once published analyses on these data sets become available to the wider research community (as well as the data sets themselves), they will be an important part of improving the demographic model presented in this project.

The conclusions of this model show the need also for extensive, systematic, full-coverage archaeological survey of the LPB as seen in the Basin of Mexico (Sanders et al. 1979) and the Valley of Oaxaca (Feinman and Nichols 1990). Given the promising conclusions from Angamuco, this should combine LiDAR and pedestrian survey whenever possible for the highest quality of settlement data possible. This data will make a much better understanding of

Purépecha demographic history possible, providing insight into the immigration events of the Postclassic and fluctuations relative to the lake level throughout the classic. As this project has done with the Late Postclassic, such information will provide insights into the relationship between demography and social change through the Preclassic and Classic periods.

This model will also aid in the study of modern Purépecha heritage. This project provides a more accurate picture of the large, complex population from which the modern Purépecha population descends. The magnitude of the population collapse that the Purépecha experienced provides meaningful context to their story of perseverance, resilience, and regrowth. Population research like this shows that the Purépecha population and the Indigenous population of the Americas in general was expansive and dense, making belief in the *terra nullius* lie impossible. I do not claim to give indigenous people any great gift with this project, but only to emphasize the importance of research like this in affirming Indigenous heritage and dispelling myths of small populations and empty lands.

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Appendix A: 1983 Settlement Population Estimates

Number	Name	Size Rank	Mean Population	Location Verification
X01	Tzintzuntzan	1	30000	Archaeological
X02	Cucuchuchu	4	300	Ethnohistoric
X03	Sipixo	5	55	Ethnohistoric
X04	Ihuatzio	2	4000	Archaeological
X05	Vemaquaro	4	300	Ethnohistoric
X06	Hiripo	5	55	Ethnohistoric
X07	Sacapo	4	300	Ethnohistoric
X08	Ychuen	5	55	Ethnohistoric
X09	Humilladero	5	55	Ethnohistoric
X10	Cuynaho	4	300	Archaeological
X11	Ahterio	4	300	Ethnohistoric
X12	Patzcuaro	2	4000	Archaeological
X13	Huecorio	4	300	Ethnohistoric
X14	Tzontzequaro	4	300	Ethnohistoric
X15	Chapitaro	4	300	Ethnohistoric
X16	Pareo	4	300	Ethnohistoric
X17	Charauen	5	55	Ethnohistoric
X18	Huyramangaro	4	300	Ethnohistoric
X19	Haramutaro	4	300	Ethnohistoric
X20	Nucutzepo	4	300	Ethnohistoric
X21	Toquaro	3	1250	Ethnohistoric
X22	Harocutin	4	300	Archaeological
X23	Urichu	3	1250	Ethnohistoric
X24	Pechataro	3	1250	Ethnohistoric
X25	Erongaricuaro	2	4000	Archaeological
X26	Puacuaro	3	1250	Ethnohistoric
X27	Opongio	4	300	Ethnohistoric
X28	Itzicuaro	4	300	Ethnohistoric
X29	Hazcuaro	3	1250	Ethnohistoric
X30	Tzirondaro	3	1250	Ethnohistoric
X31	Purenchequaro	3	1250	Ethnohistoric
X32	Chupicuaro	3	1250	Ethnohistoric
X33	Uayameo	3	1250	Ethnohistoric
X34	Yrapo	3	1250	Ethnohistoric
X35	Cutzaro	3	1250	Ethnohistoric
X36	Tirimicua	5	55	Ethnohistoric
X37	Caringaro	5	55	Ethnohistoric
X38	Cucupao	3	1250	Ethnohistoric
X39	Serandangacho	3	1250	Ethnohistoric

X40	Guanimao	4	300	Ethnohistoric
X41	Itziparamucu	3	1250	Archaeological
X42	Pacandan	4	300	Ethnohistoric
X43	Yenuan	4	300	Ethnohistoric
X44	Ticuinun	5	55	Ethnohistoric
X45	Xanecho	3	1250	Ethnohistoric
X46	Apupato	3	1250	Ethnohistoric
X47	Utuyo	4	300	Ethnohistoric
X48	Uranden	5	55	Ethnohistoric
X49	Cuyameo	5	55	Ethnohistoric
X50	Xaraquaro	4	300	Ethnohistoric
X51	N/A	3	1250	N/A
X52	N/A	5	55	N/A
X53	N/A	4	300	N/A
X54	N/A	3	1250	N/A
X55	N/A	3	1250	N/A
X56	N/A	4	300	N/A
X57	N/A	3	1250	N/A
X58	N/A	5	55	N/A
X59	N/A	5	55	N/A
X60	N/A	5	55	N/A
X61	N/A	4	300	N/A
X62	N/A	4	300	N/A
X63	N/A	5	55	N/A
X64	N/A	5	55	N/A
X65	N/A	4	300	N/A
X66	N/A	4	300	N/A
X67	N/A	4	300	N/A
X68	N/A	4	300	N/A
X69	N/A	5	55	N/A
X70	N/A	4	300	N/A
X71	N/A	5	55	N/A
X72	N/A	4	300	N/A
X73	N/A	4	300	N/A
X74	N/A	4	300	N/A
X75	N/A	4	300	N/A
X75	N/A	4	300	N/A
X76	N/A	3	1250	N/A
X77	N/A	3	1250	N/A
X79	N/A	4	300	N/A
X80	N/A	4	300	N/A
X81	N/A	5	55	N/A
X82	N/A	4	300	N/A

X83	N/A	5	55	N/A
X84	N/A	5	55	N/A
X85	N/A	4	300	N/A
X86	N/A	4	300	N/A
X87	N/A	5	55	N/A
X88	N/A	5	55	N/A
X89	N/A	5	55	N/A
X90	N/A	4	300	N/A
X91	N/A	5	55	N/A

Appendix B: 2025 Site Numbers Map Key

This table corresponds to the maps in Chapters 5 and 6 which show the 45 known sites accounted for in this model.

Name	Number
Tzintzuntzan	1
Angamuco	2
Greater Angamuco Urban Zone	3
Ihuatzio	4
Erongaricuaro	5
Urichu	6
Pueblo Viejo	7
Pacandan	8
Yenuan	9
Ticuinun	10
Xanecho	11
Jaracuaro	12
Cuyameo	13
Uranden	14
Utuyo	15
Patzcuaro	16
San Bartolo Pareo	17
Tocuaro	18
Cerro Chendanas	19
El Manzanillal	20
Cerro Chapultepec	21
PZ45 Chapultepec	22
PZ54 Las Cuevas	23
Banco de Erocutin II	24
El Pedregal	25
Sitio 17A	26
Sitio 11	27
Sitio 43	28
Huerta de Borjas	29
La Carcacha	30
Los Ecuaros	31
Las Palmas Y El Tumin	32
Las Pipas	33
El Ranchito	34
Cerro Buenaventura	35
Bosque de Santa Maria	36
Erongaricuaro II	37
Camino de San Bartolo	38
La Ladrillera	39
Site 57	40
Minas de Nocutzero	41
Sitio 60	42
Site 58	43
Apupato	44
Angamuco Chico	45

Appendix C: Complete INAH Site Table

INAH database LPB Sites Smaller than 1km^2:

Folio Real	Nombre del sitio	Nombre del Municipio	Elementos que definen al sitio	Cronología	Area (km^2)
2ASA00003884	BOSQUE DE SANTA MARÍA	PÁTZCUARO	Estructuras, Otros elementos relevantes del sitio, Concentración de materiales	1200 - 1521 d.n.e., Posterior 1521 d.n.e.	0.04
2ASA00003885	CAMINO DE SAN BARTOLO	PÁTZCUARO	Estructuras, Concentración de materiales, Otros elementos relevantes del sitio	1200 - 1521 d.n.e., Posterior 1521 d.n.e.	0.11
2ASA00003886	PZ97 LAS PALMAS	QUIROGA	Estructuras, Concentración de materiales	1200 - 1521 d.n.e.	0.05
2ASA00003887	EL PEDREGAL	HUIRAMBA	Otros elementos relevantes del sitio, Estructuras, Concentración de materiales	1200 - 1521 d.n.e., Posterior 1521 d.n.e.	0.26
2ASA00016780	ERONGARICUARO II	ERONGARÍCUARO	Estructuras, Concentración de materiales, Otros elementos relevantes del sitio	900 - 1200 d.n.e., 1200 - 1521 d.n.e.	0.04
2ASA00016853	TOCUARO	ERONGARÍCUARO	Concentración de materiales, Otros elementos relevantes del sitio, Estructuras	200 - 650 d.n.e., 650 - 900 d.n.e., 900 - 1200 d.n.e., 1200 - 1521 d.n.e	0.1
2ASA00016861	EL RANCHITO	PÁTZCUARO	Otros elementos relevantes del sitio, Estructuras, Concentración de materiales	1200 - 1521 d.n.e.	0.23
2ASA00016865	HUERTA DE BORJAS	PÁTZCUARO	Estructuras, Concentración de materiales	1200 - 1521 d.n.e.	0.02
2ASA00016867	SN. BARTOLO PAREO	PÁTZCUARO	Yacimiento de materias primas, Otros elementos relevantes del sitio, Estructuras	1200 - 1521 d.n.e.	0.06
2ASA00016936	SITIO 57	ERONGARÍCUARO	Otros elementos relevantes del sitio, Estructuras	200 - 650 d.n.e., 650 - 900 d.n.e., 1200 - 1521 d.n.e.	0.07
2ASA00016937	SITIO 58	ERONGARÍCUARO	Estructuras	1200 - 1521 d.n.e.	0.07
2ASA00016943	BANCO DE EROCUTIN II	ERONGARÍCUARO	Estructuras	900 - 1200 d.n.e., 1200 - 1521 d.n.e.	0.12
2ASA00016944	AROCUTÍN	ERONGARÍCUARO	Estructuras	1200 - 1521 d.n.e.	0.01
2ASA00016958	SITIO 60	ERONGARÍCUARO	Estructuras, Concentración de materiales, Otros elementos relevantes del sitio	200 - 650 d.n.e., 650 - 900 d.n.e., 900 - 1200 d.n.e., 1200 - 1521 d.n.e	0.18
2ASA00016959	CERRO CHENDANAS	PÁTZCUARO	Estructuras, Concentración de materiales, Otros elementos relevantes del sitio	200 - 650 d.n.e., 650 - 900 d.n.e., 1200 - 1521 d.n.e.	0.045
2ASA00016960	LA CARCACHA	PÁTZCUARO	Concentración de materiales, Estructuras, Otros elementos relevantes del sitio	201 - 650 d.n.e., 650 - 900 d.n.e., 1200 - 1521 d.n.e.	0.04
2ASA00016964	MINAS DE NOCUTZERO	ERONGARÍCUARO	Estructuras, Concentración de materiales, Otros elementos relevantes del sitio	1200 - 1521 d.n.e.	0.02
2ASA00017093	CORRALES	TZINTZUNTZAN	Estructuras, Concentración de materiales, Otros elementos relevantes del sitio	1200 - 1521 d.n.e.	0.05
2ASA00017094	CORRALES	TZINTZUNTZAN	Estructuras, Concentración de materiales, Otros elementos relevantes del sitio	1200 - 1521 d.n.e.	0.04
2ASA00017096	LOS ECUAROS	PÁTZCUARO	Otros elementos relevantes del sitio, Estructuras	1200 - 1521 d.n.e.	0.02
2ASA00017097	ZITUNARO	PÁTZCUARO	Estructuras, Concentración de materiales	1200 - 1521 d.n.e.	0.1

2ASA00017100	LAS PALMAS Y EL TUMIN	PÁTZCUARO	Estructuras, Concentración de materiales, Otros elementos relevantes del sitio	1200 - 1521 d.n.e.	0.12
2ASA00017157	EL MANZANILLAL	PÁTZCUARO	Concentración de materiales, Otros elementos relevantes del sitio, Estructuras	1200 - 1521 d.n.e.	0.1
2ASA00018180	PZ 54 LAS CUEVAS	TZINTZUNTZAN	Otros elementos relevantes del sitio, Estructuras, Concentración de materiales	1200 - 1521 d.n.e.	0.1
2ASA00018184	PZ 45 CHAPULTEPEC	PÁTZCUARO	Estructuras, Concentración de materiales	1200 - 1521 d.n.e.	0.02
2ASA00018215	SITIO 11	QUIROGA	Estructuras, Manifestaciones gráfico-rupestres, Otros elementos relevantes del sitio	1200 - 1521 d.n.e.	0.32
2ASA00019736	SITIO 17 A	QUIROGA	Estructuras, Concentración de materiales, Otros elementos relevantes del sitio	1200 - 1521 d.n.e.	0.1
2ASA00019760	SITIO 43	QUIROGA	Estructuras, Otros elementos relevantes del sitio	1200 - 1521 d.n.e.	0.04
2ASA00021299	CPUZ5 LAS PIPAS	PÁTZCUARO	Concentración de materiales, Estructuras	1200 - 1521 d.n.e.	0.02
2ASA00026360	CERRO BUENAVENTURA	PÁTZCUARO	Concentración de materiales, Estructuras	650 - 900 d.n.e., 900 - 1200 d.n.e., 1200 - 1521 d.n.e.	0.281627