# SETTLEMENT SYSTEMS, LANDSCAPES AND THE RISE OF THE TARASCAN EMPIRE: A SETTLEMENT ANALYSIS IN THE LAKE PÁTZCUARO BASIN, MICHOACÁN, MEXICO

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ABSTRACT

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This dissertation investigates the settlement, landscape, and adaptation of the Prehispanic populations in the Lake Pátzcuaro Basin, Michoacán, Mexico. Located in the highlands of Mexico, the Lake Pátzcuaro Basin (LPB) was the center of the Tarascan Empire, a Late Postclassic state that would become a major geopolitical core within Mesoamerica civilization.

This dissertation proposes a spatially and temporally dynamic study of the Tarascan (or Purépecha) settlement system that ranges from the Late Preclassic, circa 100 B.C., to the Spanish conquest in A.D. 1525. The data derives from full-coverage, intensive surveys that cover the southwest portion of the lake basin, the southeastern portion of the lake basin, and the immediate area around the capital of Tzintzuntzan. Through a landscape reconstruction of the Prehispanic lake basin, a reconstruction and demographic analysis of the past communities, and intensive spatial modeling and analyses in a Geographic Information System, this research provides the overall trajectory of human settlement within the basin, ending at the Spanish Conquest. This includes identifying the major variables that influenced settlement location in the lake basin, including both economic, political and social variables. This dissertation provides new commentary on human-environment interaction in the LPB, community formation and settlement, and the emergence of the state. Ultimately, a testable model of settlement is introduced, a model which can be applied to future research in the highlands of Mexico, thus advancing research in this core area of Mesoamerican Prehistory.

# ACKNOWLEDGMENTS

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Thank you to my wife, Becca, who everyday believed in me and helped me to reach my goals.  I truly couldn't have done this without you.

Finally, I dedicate this dissertation to my Grandfather, Leon.

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# CHAPTER 1: INTRODUCING THE SETTLEMENT SYSTEMS OF THE LAKE PÁTZCUARO BASIN

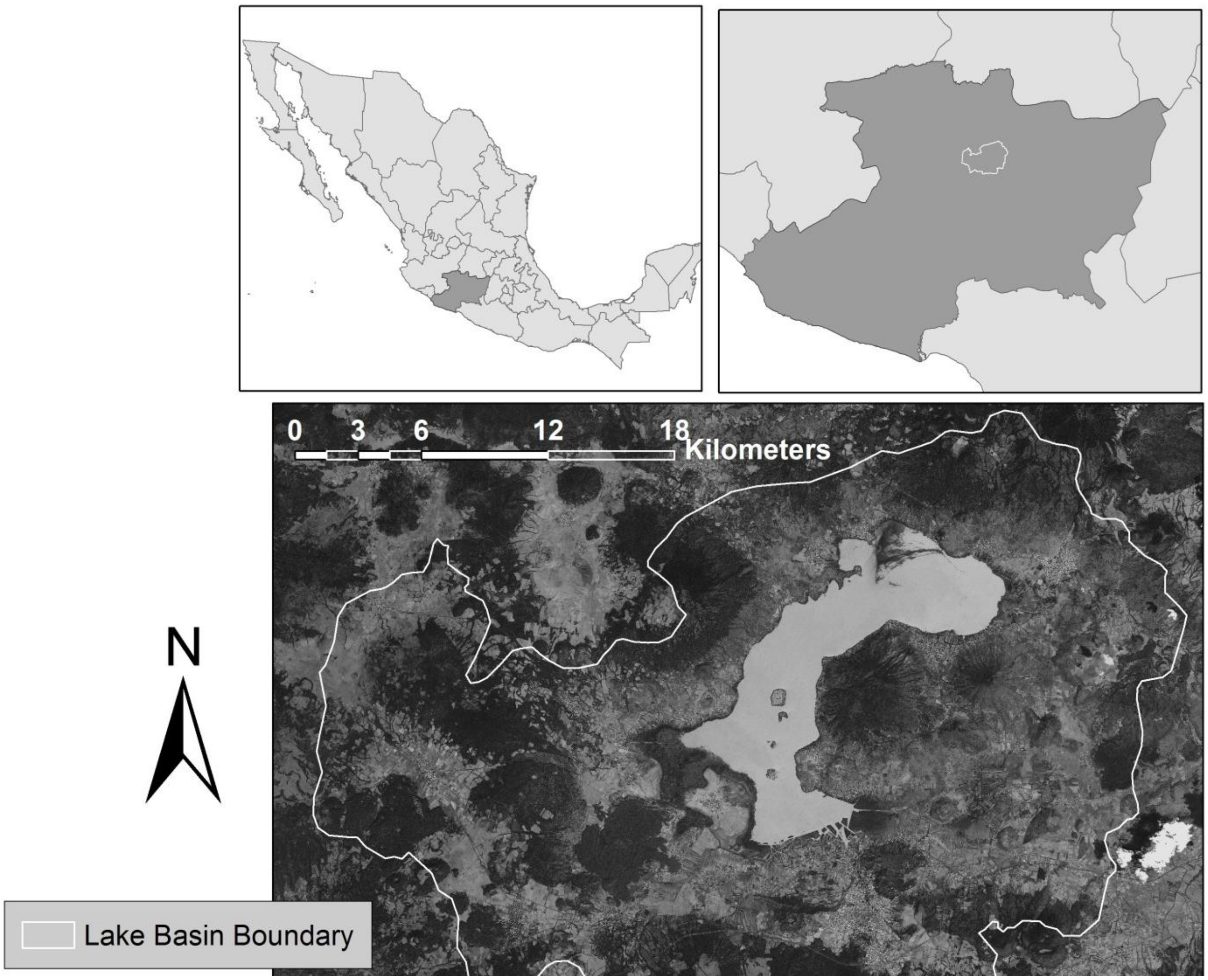
This chapter outlines an archaeological project that will provide a settlement system analysis of the Lake Pátzcuaro Basin, Michoacán Mexico (Figure 1). The scope of the settlement system analysis will cover the core area of the Tarascan Empire, an area of 803 square kilometers[1] and will range in time from the Late Preclassic (100 B.C.) until Spanish conquest (circa A.D. 1525) (see table 1for a list of periods/phases). The dissertation will systematically analyze the communities in the lake basin through time, the shifting economic and ecological resources, and will analyze the prehistoric landscape in terms of resource management and settlement. This will be done through the testing of a model, derived from Pollard's (2008) comprehensive archaeological work on the rise of the Tarascan state.

After many decades of neglect, West Mexico has become the subject of significant archaeological research over the past 40 years. According to Balkansky, one outcome of this work is the understanding that this area constituted another Mesoamerican core and was not simply the product of central Mexican influences (2006:72). With this realization comes a need for a continuation of research that moves beyond the "patch work" and site focused research that has been accomplished to date and toward research on a regional and macro-regional scale. This proposed research will in fact, help to bridge this regional gap through the advancement of a testable framework of settlement that can be applied elsewhere in West Mexico. This will ultimately allow researchers from different "regions" within West Mexico to collaborate and provide multi-disciplinary based projects that will aid in our understanding of the archaeology, anthropology and ecology of Mesoamerica. The regional and macroregional research on

[1] This figure was created by the author by utilizing ArcGIS to create a georeferenced image of the extent of the lake basin, overlaying it on a current, rectified satellite image, and calculating the area of the basin's extent. This number is lower than those previously published by Pollard (1983), and Toledo (1991, 1993), which were in the 920-930 km square range.

settlement and state emergence allow for this region to then be compared to other regions of early state development, such as the Andes, thus providing a larger comparative framework for this research to be analyzed and peer reviewed.

*Figure 1 – The Mexican State of Michoacán and the Pátzcuaro Lake Basin*




Furthermore, in keeping with the multi-disciplinary and collaborative nature of Mesoamerican archaeology, the archival data that will be used for this research will be placed into a database and digitally made available to other colleagues that work in the region. This region is a core area of research for American, French, British and Mexican scholars. By providing this data, we may bridge gaps and begin the collaboration process across many research projects.

**Previous Research and Data Sources**

The primary data that will be used to develop the settlement system model comes from archaeological surveys conducted from 1970-2005 within the Pátzcuaro Lake Basin (see Figures 2 and 3, and Table 2). The first zone surveyed included the Imperial Tarascan capital of Tzintzuntzan by Pollard in 1970. Pollard collected artifacts from areas of surface scatter across the survey area, an area that was defined by both artifact density as well as local geomorphology of soils. These dense concentrations of artifacts were noted and located on the survey maps by Pollard, and those that were "spatially isolable were given numbers and considered sites" (Pollard 1972:28). These n=120 sites comprise the primary units of analysis for both Pollard's survey (1972).

*Table 1 – Mesoamerican Temporal Phases and Pátzcuaro Lake Basin Phases*

| ***Period*** | ***Local Phases*** | ***Time Range*** |
|---|---|---|
| Late Postclassic | Tariacuri | A.D. 1350- 1525 |
| Middle Postclassic | Late Urichu | A.D. 1000/1100 - 1350 |
| Early Postclassic | Early Urichu | A.D. 900-1000/11000 |
| Epiclassic | Lupe-La Joya | A.D. 600/700 - 900 |
| Middle Classic | Jaracuaro | A.D. 500 - 600/700 |
| Early Classic | Loma Alta 3 | A.D. 350 - 500 |
| Late/Terminal Preclassic | Loma Alta 2 | 100 B.C. - A.D. 350 |

Following this survey, Pollard also surveyed what the ethnohistoric documents refer to as the land of the pre-state polities of Urichu, Jaracuaro, and Pareo (1990-1996) (Pollard 2000). The final portion, surveyed in 2001, was the town of Erongarícuaro[2] and its surrounding areas (see Table 1 for a review of the survey areas). All surveys were intensive and were supplemented by

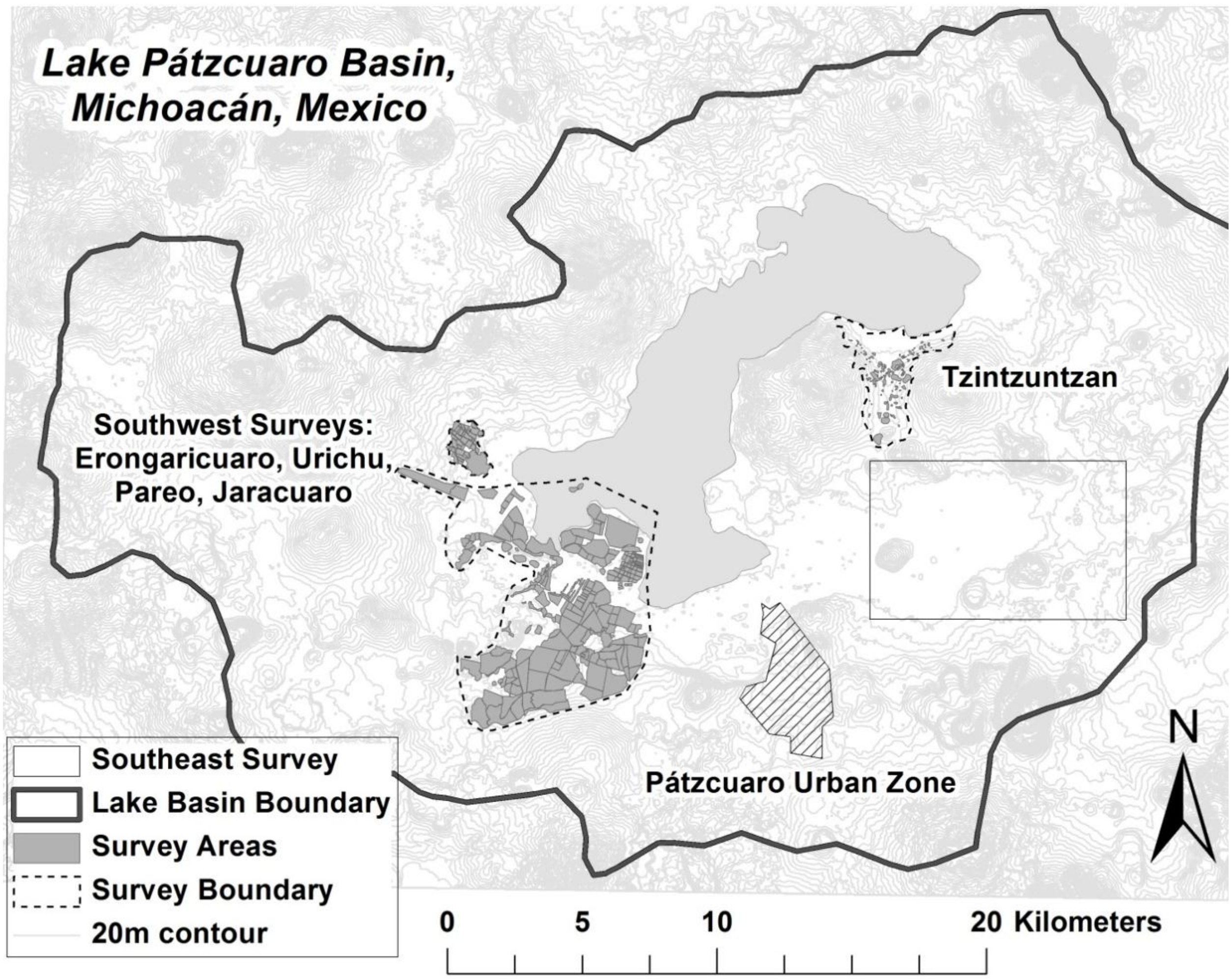
[2] The modern town names will be used in this dissertation, in the place of the 16$^{th}$ century names derived from the ethnohistoric documents. For example, Jaracuaro instead of Xaracuaro.

archaeological excavations. The goal of these surveys in the southwest of the basin was to provide a settlement pattern through time periods by locating major settlements and elite administration centers, which had been described in the ethnohistoric document the *Relación de Michoacán* (Pollard and Cahue 1999). The surveys included geoarchaeological research to test for lake and climate fluctuations, and test for evidence of intensive agriculture and land degradation through careful off-site placement of trenches and augers (Figure 4) (Fisher et al. 2003). The combined data sets confirmed sequences of both Prehispanic and post-contact settlement and land degradation, and extend our knowledge about Tarascan views of landscape and the primary role of an adaptation to a highland lacustrine ecosystem (Pollard 2008).

*Table 2 – Survey Areas of the Lake Pátzcuaro Basin*

| **Archaeological Surveys** | **# Survey Sites** | **Area (hectares)** | **Ceramic** | **Lithic** (Obsidian, Basalt) | **Other** (Figurines, Recortados, Pipes) |
|---|---|---|---|---|---|
| Tzintzuntzan | 120 | 901 | 2172 | 1041 | 327 |
| Southwest (Urichu/Pareo/Jaracuaro) | 248 | 5401 | 173229 | 27511 | 472 |
| Erongarícuaro | 41 | 228 | 4393 | 5447 | 33 |

*Figure 2 – The Pátzcuaro Lake Basin and Previous Archaeological Surveys*

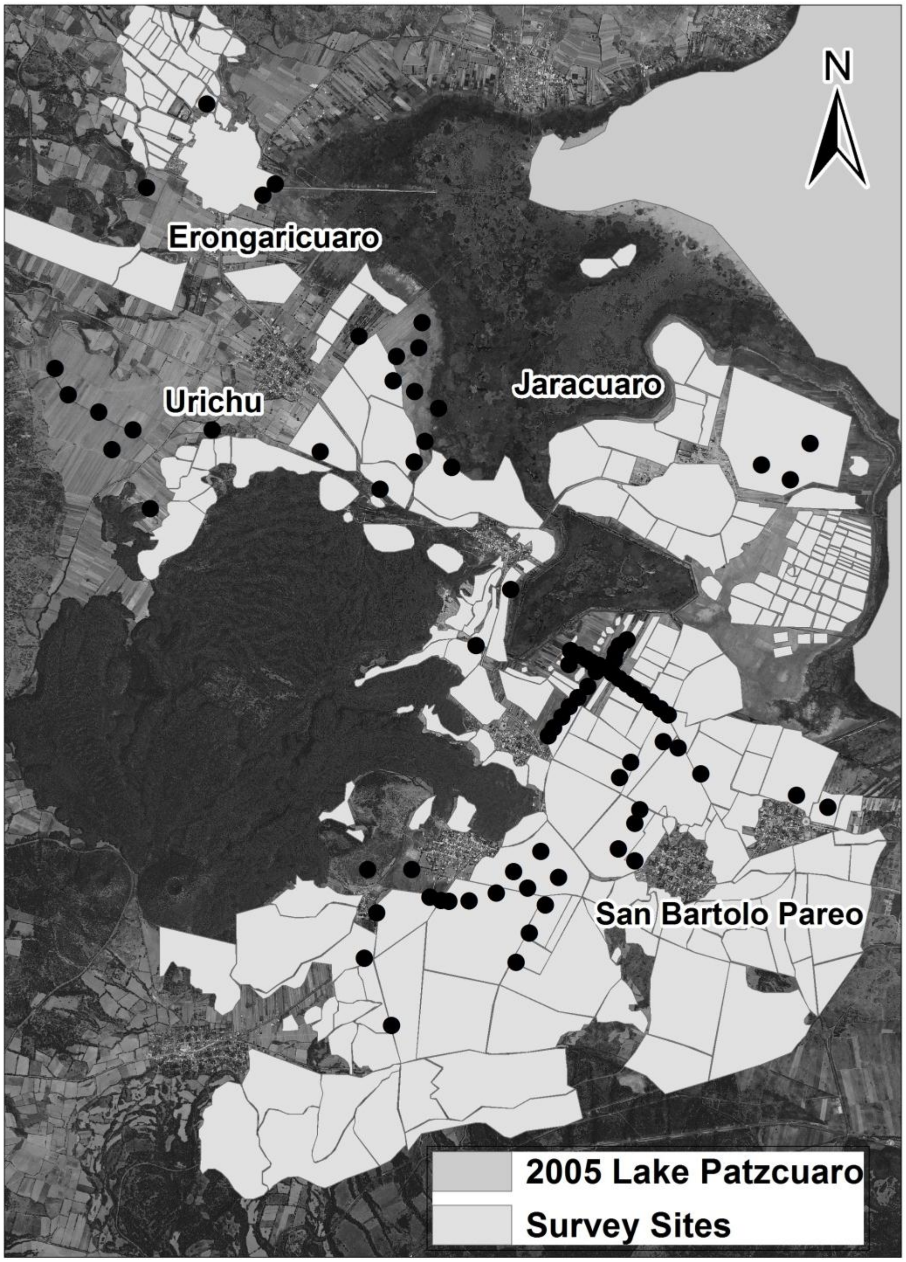



The ethnohistoric documents from the region are a great asset when trying to reconstruct the final stages of Tarascan civilization in the lake basin. One of the most important of these primary sources is the *Relación de Michoacán* (RM). The RM is a historic document, recorded in 1538-1539 in the Tarascan capital of Tzintzuntzan, and was given to the Spanish Viceroy in 1540 (Pollard 1993:17). It documents many aspects of Tarascan life before and during the Spanish conquest, and provides valuable data about to the locations of Prehispanic administration centers and settlements in the lake basin at the time of Spanish conquest. A second and equally important document is the *Carvajal Visitas* (Warren 1985), which is an account of the first inspections of

Antonio de Carvajal, which listed and cataloged the major settlements and their subject settlements within the Tarascan Empire prior to the Spanish *encomienda* system (Gorenstein and Pollard 1983:30). Other primary sources that will be used to reconstruct settlement and demography at the time of contact will be the *Suma de Visitas de Pueblos* of 1547-1550, the series of *Relaciones Geográficas* from 1579-1581, the Infante documents of 1528, and the Beaumont (1932) and Seler (1908) maps which are reproductions of the cartographic *pinturas* drawn in the decade following 1538 (Gorenstein and Pollard 1983:13). These ethnohistoric documents have been reproduced and interpreted by Gorenstein and Pollard (1983), Gerhard (1972), Warren (1985), and Espejel (2007).

A synthesis of the geoarchaeological work, and geographic work from a variety of sources, will aid in the reconstruction of the history of climate, lake and landscape of the Prehispanic lake basin. The geoarchaeological work from the southwest basin projects will be utilized in the modeling of the lacustrine ecosystem, intensive agriculture, and resource management on a basin-wide scale (Fisher 2003, 2005). Data from lake sediment cores (Watts and Bradbury 1982; O'Hara 1993b), from ethnoecology (Toledo 1991, 1993), and from historical records (O'Hara 1993a; Metcalfe and Davies 2007; Metcalfe et. al. 2007) will supplement the geoarchaeological research.

*Figure 3 – The Southwest Survey with the Geoarchaeological Sites*




The final source of archaeological data for this research comes from the nearby Zacapu Basin, located to the immediate northwest of the Pátzcuaro Lake Basin (Figure 5). The work from Zacapu represents a region incorporated into the Tarascan State early in its history and with a similar cultural tradition. It is the only region in the heartland of the Tarascan Empire where comparable full-coverage archaeological survey has taken place (Michelet 2008). The research derives from the CEMCA Zacapu project, which has been a French-led archaeological project begun in the early 1980s, focused on creating a full record of the history of settlement from initial occupation up to the Spanish conquest. This data derives from Michelet (1988, 1998, 2008), Migeon (2003), Arnauld (1998), Carot (2005), Faugere-Kalfon (1998), and Puaux (1989).

*Figure 4 – The Zacapu Basin in Relation to the Pátzcuaro Lake Basin, and the Research Area of Tzintzuntzan*


**Geographic Information Systems**

The last aspect of the analysis that will aid in the modeling and mapping of the variables in the settlement system model is the use of a Geographic Information System, or GIS. A GIS will be used to create and manage the database that will contain all the necessary data (i.e. artifact, geoarchaeological, demographic). A GIS is most useful because of its dual functionality as an analytical tool as well as a display tool. All maps will be made in a GIS program (ESRI ArcMap), and all data will be stored in the database and analyzed through the use of ArcToolbox, which contains a suite of spatial statistic tools.

For this specific settlement model, a 3D DEM will be used to create a digital terrain model, which will be used for a cost-distance analysis. This 3D modeling will take into account the terrain when assessing travel and interaction ease, efficiency, and rates within the lake basin. Ultimately, the most important types of distance that will be measured are economic distance and time, measured in energy expenditure in kilocalories and walking velocity, as well as canoe/boating velocity. Both variables will be factored into the gravity model to better estimate interaction, both political and economic, when discussing settlement location.

**Research Questions and Hypotheses**

The primary goal of this research is to determine the structure of the settlement system over a period of approximately 1,625 years leading up to the Spanish conquest. Ancillary to the primary goal is the goal of explaining the role of state formation and the state's political economy in the latter years of settlement in the Basin. A tertiary goal is the identification of a macroregional settlement of Tarascan society when analyzing the Zacapu and Pátzcuaro Basins.

In order to further develop theory about the settlement, formation and development of the state in West Mexico, a settlement system analysis must be completed. This differs from a settlement pattern analysis, in that settlement patterns are the arrays produced by sets of interacting, interdependent local groups of people, whereas settlement systems are the processes behind the patterns (Kowalewski 2008: 226). This research will focus on the patterns behind the settlement of the lake basin, and will do so by analyzing shifts in settlements both spatially and temporally, thus mapping the trajectory of development of civilization in the lake basin, from small and intermediate scale societies to the emergence of the state, from the Late Preclassic (100 B.C.) to the Spanish Conquest (circa A.D. 1525).

The main research questions that will be addressed are as follows:

1) Using the data from the Pátzcuaro Lake Basin surveys, what is the overall trajectory (the endpoint being that of the state at the time of Spanish contact) behind the regional settlement of the lake basin?

2) Which variables, whether internal or external, best explain the system and patterning behind the settlement of the lake basin?

3) What effect does the emergence of the state have on settlement within the lake basin? What does this reveal about the resource management and the conception of landscape?

4) When compared to the model developed for the Zacapu Basin (Michelet 1998, 2008; Migeon 2003), what are the characteristics of a Tarascan macroregional settlement system?

The central hypothesis for this research is based on an emergence of the state and settlement model for the Pátzcuaro Lake Basin (Pollard 2008). The theoretical frameworks for the model combine a political economy and settlement ecology approach. Therefore, a central hypothesis is that the primary variable that determined settlement within the lake basin was the proximity to the lakeshore of Lake Pátzcuaro and its lacustrine zones of resources. This derives from the lacustrine-based system model that was the dominating system of subsistence, both prehispanically, historically and into the modern era. This variable remained the primary settlement determinant until the emergence of the state in A.D. 1350, when the dominance of the capital, Tzintzuntzan, altered the foundations of the political economy of the lake basin. During this period, the primary factor changed, and settlement was now predicated upon proximity to the capital and other major state-run centers of administration, religion, and economy. The lake remained a secondary factor in settlement, primarily affecting peripheral settlement in the basin. Tertiary to all periods of settlement is the variable of proximity to arable land both inland and upland, followed by a fourth variable, proximity to travel/trade routes in and out of the basin.

An alternative hypothesis is that the lake is only a primary variable until the Middle Postclassic (A.D. 1000 – 1350), when political instability becomes the primary motivator for settlement in upland, defensible positions. Following this period, the emergence of the state and the proximity to the capital of Tzintzuntzan assumes the primary motivator for settlement location until Spanish conquest.

*Table 3 – Proposed Settlement Variables in the Lake Pátzcuaro Basin: 100 B.C.-A.D. 1525*

| ***Period*** | ***Phase*** | ***Primary Variable*** | ***Secondary Variable*** | ***Tertiary Variable*** |
|---|---|---|---|---|
| Late Preclassic | Loma Alta 2 | lake/lacustrine | other communities | travel/trade routes |
| Early Classic | Loma Alta 3 | lake/lacustrine | other communities | travel/trade routes |
| Middle Classic | Jaracuaro | lake/lacustrine | other communities | travel/trade routes |
| Epiclassic | Lupe-La Joya | lake/lacustrine | arable land | travel/trade routes |
| Early Postclassic | Early Urichu | lake/lacustrine | arable land | travel/trade routes |
| Middle Postclassic | Late Urichu | lake/lacustrine | defensible positions | arable land |
| Late Postclassic | Tariacuri | capital/admin. centers | lake/lacustrine | arable land |

**Defining the Region**

This research will operate on a regional scale of analysis. This research analyzes the Lake Pátzcuaro Basin as a region in the physiographic sense, defined by its hydrographic limits. The research by Pollard in the Pátzcuaro Lake Basin (see Figure 2), has been explicitly full- coverage (on the individual, not regional scale), intensive, and has treated the survey site (i.e. collection unit) as the smallest unit while keeping a larger regional framework in mind. Due to funding and permit limitations over the last decades, the survey of the lake basin has had to be completed in a piecemeal fashion, with areas still not surveyed today (Pollard 2010: in press). Therefore, the structure of the survey data to be used is one that lacks continuity both spatially and temporally. This challenges the rationale behind the regional scale analysis that will be attempted in this research, and therefore needs to be examined. Examining in more detail the lake basin and the actual area covered by the surveys, although non-contiguous the surveys show a level of coverage that, I argue, allows for a regional scale analysis to be done. Gorenstein and Pollard (1983) estimated that of the n=92 Early Hispanic settlements (A.D. 1520-1550), n=84 settlements occupied the lakeshore and lower sierra slope ecological zones, or lower than 2300 meters in elevation (1983: 149). Ethnography has shown that historically human populations occupied the environmental zones occurring below 2,300 meters in elevation, with these settlements continuing into the 20$^{th}$ century, thus creating a 500 year period trend (Gorenstein and Pollard 1983) (Pollard 1983) (Mexican National Census 1943, 1973). Therefore, I will assume that Prehispanically the same approximate land classes were occupied, and thus the probable settlement area of the lake basin (and area that could be surveyed) is reduced by 48%. My estimates of the area of the lake basin, as taken from Toledo et. al. (1993), place the area at 80301 hectares, or 803 square kilometers[3]. By applying Gorenstein and Pollard's estimates of percentage of land under 2300 meters in altitude, this leaves 41757 hectares of possible survey area. From this, if we subtract the area of the lake, open water and marsh zones (7777 hectares), the unsurveyable urban zones of Pátzcuaro (1109 hectares) and Quiroga (309 hectares), that leaves 32562 hectares of possible survey area. Of this 32562 hectares, the surveys of Tzintzuntzan, Erongarícuaro, the southwest

[3] Gorenstein and Pollard estimated the lake basin at 98,890 hectares, but with the use of rectified aerial coverage, the same lake basin area was calculated as smaller (Gorenstein and Pollard 1983: 149).

survey (including Urichu, Pareo and Xaracuaro), the *malpaís* of Urichu, the archaeological zone of Ihuatzio, and the southeast survey area currently being surveyed[4] add up to 13820 hectares, or approximately 42% of the possible survey area in the lake basin below 2300 meters in elevation (see figure 2). With this in mind, I believe this to be an acceptable percentage of the lake basin that has or will be surveyed to perform a systematic regional settlement analysis.

**Theoretical Discussion**

In order to test the settlement system model in the Lake Pátzcuaro Basin, a methodology must be laid out that is explicit and allows for analysis of multiple lines of evidence. The methodology requires a very clear-cut theoretical stance, one that fuses a political economy model and the resource and subsistence models of a landscape approach. The basic tenets of each theoretical approach will be discussed in terms of their use in this research, and will lead to a discussion of the testable model of settlement of this research

An approach employing political economy will be most useful when explaining the settlement systems in terms of access to resources, and the emergence of a state-level social and political structure. A political economy model assumes an economic structure, or base, for human interaction and decision-making and the critical role of social and political elites in allocation of those resources. The variables that will be assessed in the settlement model, and discussed further in the methodology section directly correlate with the economic and resource utilization of the lake basin. These are variables that are thought to have played a major role in the structuring of regional settlement and individual site/settlement function in the basin.

A landscape approach will also be utilized in the creation, analysis and interpretation of the

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[4] The LORE project (PI-C. Fisher and Senior Investigator H. Pollard) was initiated in 2009 to survey and conduct geoarchaeological research in the SE zone of the Pátzcuaro Lake Basin.

settlement system model. Described by both Kantner (2008) and Kowalewski (2008), landscape archaeology and historical ecology were "inspired by the traditional processual approach to regional data, either tracing their epistemological and interpretive history directly to processual archaeology, or reflecting the more humanistic postmodern approach"; the latter as a critique of the former (Kantner 2008:56). Within the realm of landscape approaches, the approach most aligned with the goals and variables set forth in this research is described by Anschuetz (2001) as settlement ecology. This approach is closely aligned with settlement pattern and system approaches, and addresses issues of archaeologically observed patterns of land use, occupation, and transformation over time (2001:177). It acknowledges the human- environment interactions that create landscapes, and emphasizes natural environmental variables, "including essential subsistence resources, other raw materials needed for physical comfort and health, and items for trade or exchange" (Anschuetz 2001: 177).

**Settlement Model**

The model for the settlement system is derived from the research by Helen Pollard in her work on the emergence of the Tarascan state (2008). This study will employ Pollard's model of the emergence of the Tarascan state (2008), and will emphasize the settlement patterns derived from her archaeological, ethnohistoric and ecological research (see Table 2 for a summary of the model). Keep in mind that this model is limited geographically to the Pátzcuaro Lake Basin, yet the sequence of events is in fact a product of a vast "open system" of interaction and communication within Mesoamerica; Tarascans didn't live in isolation.

The initial or starting point for the temporal sequence of settlement is in the Late Preclassic (100 B.C.). Population within the lake basin was relatively low (5,000 – 8,000), and all cases of settlement displayed the existence of small-scale, socially ranked agrarian societies (Pollard

2008:220). Furthermore, these ranked societies consisted of a hierarchy that would remain relatively unchanged until the emergence the state. Settlement was located on or very near the shorelines of Lake Pátzcuaro with the primary means of subsistence being lacustrine and wetland based. The shorelines of the lake fluctuated minimally, marking the only movement of settlements. Furthermore, settlements were not yet centralized spatially, but were situated primarily on or near the key resources of the lake.

The Early Classic (A.D. 600) to Middle Classic (A.D. 700) was marked by a stable population, between 6,000 and 7,000 (Pollard 2008:221). The settlements remained on or very near the lakeshore, continuing lacustrine and wetland agricultural practices. Ceramic production remained localized, yet preciosities found their way into the basin and were part of the way elite status was derived and marked. The goods, however, were finished goods, meaning that local level economic specialization had yet to permeate the economic structure in the basin. Each settlement had variation in its social hierarchy as well as its spatial composition, with varying types of architecture and no singular style dominating. This suggests the continuation of a local elite-dominated settlement with a highly agrarian component.

During the Epiclassic (A.D. 700-900) the region of West Mexico began to see political restructuring and climatic changes (Beekman 2009). The end of this period (A.D. 900) marked a climatic shift towards more arid conditions, with a synchronous drop in the lake level. The number of sites increased and the population rose to 12,000 at this time (Pollard 2008:224). These climate shifts and slight rise in population coincided with the beginning of the Early Postclassic (A.D. 900-1100). Lacustrine settlements, still the primary type of settlement in the basin, moved to these new lake margins as the lake dropped to its lowest elevation in the past two millennia (Pollard 2008:223).

With new arable land and a continued reliance on the lacustrine resources, the small-scale socially ranked societies shifted to larger-scale chiefdom-like societies, a shift that began in the Middle Classic periods. It is believed that with the rise in population, settlements began to centralize at various distances inland from the lake while continuing to utilize its resources. During the Middle Postclassic (A.D. 1000-1350), a large population increase occurred as it rose to 48,000, along with the doubling of the area of occupation due to the low lake levels. Near the end of this phase (~A.D. 1300), lake levels rose again, thus forcing settlements away from the low-lying areas around the lake to concentrate around the marsh production zones (Pollard 2008:224). Pollard asserts that due to these expanding, diminishing and shifting resources, competition must have been fierce, leading large-scale chiefdoms into inter-basin warfare. Settlement then shifted primarily due to the larger populations within the basin. Settlements continued to be located near the lake and slightly inland from it, but also moved upland into defensible locations, such as in the malpaís at Urichu (Pollard 2008:224).

The Late Postclassic period marked the emergence of the Tarascan state in A.D. 1350. The continued rise in lake levels forced settlements out of low-lying to new lakeshore and inland areas of high agricultural fertility. The added pressure from climate change and population size drove settlements to develop new economic mechanisms, thus diversifying communities with a heavier reliance on markets and state-run institutions. With the emergence of the state, settlement is now dictated by the royal dynasty at the capital of Tzintzuntzan. Pollard proposes a power shift towards the northern end of the basin, thus altering the spatial orientation of settlement. Resources were managed by the state, and the social model that dominated the basin since 100 B.C. was replaced by the state's rigid social hierarchy system, where a three class system was put into place; an upper elite class (containing the royal family), lower elite class, and a commoner class.

This model, as proposed by Pollard (2008), presents a testable framework upon which this research may now build a method with which to analyze which of several variables are primary to the structure of the settlement systems within the Pátzcuaro Lake Basin. The next step is to explain how the data are to be used, and to provide archaeological correlates to the behavior that has been discussed in the models.

**Method**

In order to test the hypothesis and settlement system model, a multi-step research strategy will be implemented. Each of the survey areas will be analyzed on an individual basis, separate from each other. From there, the survey areas can be analyzed on a multi-scalar basis dependent upon the research question being addressed. In their research on the archaeology of regions, Drennan and Peterson argue that in order to understand the settlement system of a region, one must first understand what constitutes a site, how these units form a community, and how the communities interact to form a regional pattern of social interaction and behavior (2005:6). In this research and analysis, a site is defined as a non-random, dense clustering of architecture, ecofacts, and/or artifacts that represents a form of human activity (Parsons 1972; Kowalewski 2008). The southwest surveys in the Lake Pátzcuaro Basin were collected by agricultural fields, whereas portions of the southeastern survey collected by clusters of structures (i.e. plaza groups), and agricultural fields. When mapped, these collection units can be combined to display these areas of human activity. From there, with help from the ethnographic data and archaeological excavations, major urban or administrative centers can be mapped, with the surrounding areas forming a community, which will be the main unit of analysis for the model in this research. Later in the process of analyses they will be combined to provide a basin-wide settlement system analysis using quantitative methods. So, for each survey area, the following will be done:

-1.) The survey units (i.e. survey sites or collection units) will be clustered, hopefully creating meaningful units of analysis for a demographic reconstruction. This will be done phase by phase so as to create a chronological series of occupations.

-2.) Based on these new clustered units (i.e. communities) the population will be reconstructed for each phase by using the artifact densities from the surveys, architectural remains, and the ethnohistoric documents.

-3.) Following the demographic reconstruction, the artifacts and ethnohistoric data will again be utilized to designate any functional categorization of the communities (i.e. manufacturing, administrative, agricultural, and ritual).

-4.) A reconstruction of the Prehispanic landscape will be completed by phase using the geoarchaeological evidence, survey data, and the ethnohistoric documents. This will include the lakeshore estimates by phase, estimating arable land used for agriculture, the basic topography, and major travel and trade routes.

-5.) Finally, the communities will be mapped by phase, as identified in the ethnohistoric documents. This will be attempted on a phase by phase basis, but may be limited due to the temporal constraints of the documents.

**Quantitative Analyses**

Once the individual survey areas are modeled in terms of demography, landscape and settlement, a basin-wide analysis will be undertaken in order to complete a regional model of settlement. The major measurement becomes the distance of known settlements through time (derived from the mapping of artifacts from the surveys listed above) to each of these variables; lake and lake resources, arable land, major centers and/or capital, trade/travel routes, and other communities).

When considering statistical tests to employ in a settlement systems model, the focus must fall on the data and scale of the research. As discussed previously, the scale is at the regional level, with the smallest unit being the collection unit and the main unit of analysis being the settlement. In his research on regional analysis, Johnson (1977) analyzed interaction models such as gravity models and modeling based on central place theory, and explored the quantification and testing of behavior and human-decision making in settlement studies (1977:479). This research will employ a gravity model in order to analyze economic interaction in the Pátzcuaro Lake Basin in order to weigh the variables and assess their role in settlement. A gravity model is based on Newton's law of gravity, its basic assumption being that interaction between two locations is directly proportional to their respective size and inversely related to the distance between them (Kantner 2005:1203). There are assumptions that must be made explicit for a gravity model to operate. For example, the simple assumption of minimization of energy expended in movement explains the theoretical impetus behind the gravity model's premise that interaction decreases with the increase in the distance over which the interaction takes place (Johnson 1972:481). Therefore, for the purpose of this settlement system model, interaction is defined by the political economy framework, where it is assumed that settlement is predicated upon distance to resources, whether it is the market, travel/trade routes, lacustrine resources, or other communities, and the size of these variables, size being one of the multiple problem dependent variables including population, artifact, resource area, or architectural density. The gravity model will analyze and rank the variables based on the size and distance factors, and thus inferences can be made as to the primary factors for settlement in the lake basin. Research by Hare (2004) and Ohnersorgen and Varien (2008) are examples of analyses that have employed the gravity model to analyze interaction on the regional level.

Once the individual survey areas are reconstructed for each phase in terms of communities, each community will be analyzed with respect to other communities on a regional basis, with a gravity model measuring the variables associated with settlement for each. In this statistical analysis, each community will be measured on the basis of its population density to other variables within the basin, i.e. the lakeshore, arable land, other centers or communities, and travel and trade routes. The distance between the variables will be also measured using a cost- distance model. This model doesn't assume a linear distance, but instead factors in the topography and gives a real-time distance for energy expenditure and walking velocity (Hare 2004: 803). This will be essential when factoring in the lake as a major travel variable within the basin. The variables, based on size and distance between them, are then weighted and ranked, thus interpreted based on their level of impact on the settlement. This will, in essence, allow for interpretations to be made about which variables most influence settlement in the lake basin through time, both as a regional measure of the settlement system through time and as a means to analyze each area separately. Through the measures between the communities, a secondary outcome will be to ascribe boundaries for the various polities in the basin through time. This will aid in our reconstruction of the political economy of the settlements, and allow for interpretations on how the pre-state polities operated and the effect the emergence of the state had on their infrastructure.

**Analytic Expectations**

The goal of the research presented here is to create a testable model of the Prehispanic settlement systems within the lake basin. The crucial aspect of the model is to find variables that will test the patterns behind the settlement: effectively asking why and how. As discussed previously, the settlement system model to be tested relies on variables derived from a political economic framework. Concurrently, these variables will also be used in conjunction with a landscape approach in order to evaluate research questions concerning the Tarascan's perception of the landscape and its maintenance and/or alteration before, during and after the emergence of the state. Therefore, the data must be discussed in terms of how it explains behavior in the settlement system model, thus explicitly correlating archaeological, geological and ecological evidence to settlement behavior. The following are the expectations for how the settlement model may translate in the material record, and how the data will answer the research questions posed by the author.

With the primary data being archaeologically surveyed artifacts, and having a sound ceramic typology and chronology based on these ceramics, we are able to date clusters of artifacts, and can give reliable estimates of periods of occupations for sites. As explained in the methodology, the sites will be spatially clustered, with the larger units now being called communities. We know from the ethnohistoric records (i.e. RM) and from elsewhere in Mesoamerica that communities existed at the time of Spanish conquest, and therefore this analysis must assume that the social unit "community" can be retrodicted back through the settlement sequence. Here marks one of the more difficult aspects of this analysis, as the analysis will have to utilize spatial statistics to be able to isolate these "communities" from archaeological data. Researchers such as Drennan (2006), Peterson (2005), and Kowalewski (2003b) have grappled with the concept of "community" as it is known and described in archaeology. Kowalewski (2003b) has traced the variation and evolution of communities in Oaxaca, Mexico. His research explains how communities change through time in their social, political, and economic composition, but seem to remain spatially distinct units where dispersed, smaller groups located themselves on the landscape and shared experiences through face-to-face interaction (2003b:16). However, certain things such as political, ritual, and economic resources were not always shared, and were depended highly on the larger regional social and political framework where these communities were located. Thus, this research will not make the claim that the community is and always has been an autonomous social unit, but instead treats the unit as a spatially isolable unit of social organization whose composition and structure evolves over time.

Differential artifact frequencies can be used to attribute function to a site or a community

(Stawski 2008). By building bridging arguments through previous excavations and the ethnohistoric record, one can infer certain economic, social, political or ritual behavior to certain types or classes of artifacts. The artifacts can then be correlated with certain subsistence strategies, rituals, economic specialization, household production, or political functions that were carried out within the communities. This will be a valuable analytical tool as we may witness the economic transitions through time as populations grow and the political economy evolves, thus allowing interpretations of the role of communities and their variation in the lake basin.

If the demographic model proposed by Pollard (2008) is correct we would expect a relatively low frequency of artifacts from the Late Preclassic (100 B.C.) to the Epiclassic (~ A.D. 700). With most artifact clusters found near the lakeshore, portions of the surveys will fluctuate spatially in elevation with changes in the lakeshore. Likewise, the artifact assemblage, will primarily be associated with a lacustrine based subsistence, and will include items such as *recortados*, which are worked sherds used as net weights (Phillips 2002). As the Epiclassic arrives, population increases and therefore a higher frequency of artifacts will be present from this period. The dense concentrations from this time until the Late Postclassic should resemble more centralized and more populated centers, leading up to the emergence of the state. It is during the Late Postclassic that we expect to see more diverse artifact assemblages that will be more functionally isolable, meaning that material goods represent the hierarchical organization of social classes, such as the upper elite, the lower elite, and the commoner classes. As the state emerges, we will also see a change in the mode of production of such items. For example, certain types of obsidian was produced by specialists, and thus became standardized and in certain forms, such as the prismatic blade. Ceramics also display more variation, and are produced on the household level as well as through specialized production for the elite class.

It is expected that the emergence of the state created a pull within the basin both economically and politically, meaning the settlements located based on proximity to the capital at Tzintzuntzan and its major trade/travel routes. The major administrative centers in the basin legitimized their relationship with the capital, and thus the centers exhibited a material record that is indicative of religious and/or administrative centers such as the capital, only not on the same scale. Due to the higher populations in the lake basin, we expect to see more land that was intensively farmed, manifested as terraces in the archaeological record, around these centers, while the more peripheral settlements were still in close proximity to the lake as well as to arable land. With the emergence of the state came more foreign material goods in the archaeological record, as the markets and trade networks began to exhibit a larger regional and macroregional scale of operation.

## Chapter Synthesis

### CHAPTER 1- INTRODUCING THE SETTLEMENT SYSTEMS OF THE LAKE PÁTZCUARO BASIN

This chapter introduces the proposed dissertation. Included is a brief background of the research, including the archaeological, anthropological, geological and ecological that has focused on the Prehispanic and historic settlement of the Lake Pátzcuaro Basin (LPB). Also introduced are the major research questions, the working hypothesis, the proposed model for analysis and the theoretical framework of the research.

### CHAPTER 2- THE TARASCAN EMPIRE AND THE LAKE PÁTZCUARO BASIN

This chapter provides background information on first the archaeological research that has shaped the academic and scholarly environment of the LPB. This is done to properly couch this dissertation into the long line of research focusing on the LPB and the Tarascan Empire. Second, this chapter provides a background of the culture history of the LPB and Prehispanic Tarascan state, primarily informed by the archaeological research, and secondarily informed by the ecological, anthropological and ethnohistoric research.

## CHAPTER 3 - COMMUNITIES OF THE LAKE PÁTZCUARO BASIN

The primary spatial variable used in the dissertation is the community unit. In archaeology, the community may be defined several ways, and the first half of the chapter aids in providing theoretical and conceptual frameworks for communities in the LPB. The second half provides the method and analysis of communities, and reconstructs them for the 1,600-year period leading up to Spanish Conquest in the LPB. This reconstruction includes the demographic reconstruction, the functional categorization of communities, and the rank-size analysis of the communities through time.

## CHAPTER 4 - LANDSCAPES OF THE LAKE PÁTZCUARO BASIN

The second major component of the dissertation is the reconstruction of the LPB landscape. This chapter first discusses the many theoretical models, derived from archaeology, geography and ecology, for landscape approaches in the social sciences, while providing a framework that this dissertation utilizes. The second half of the chapter provides the method and reconstructs the landscape over a 1,600-year period for the LPB. This reconstruction includes the physical and social landscape, including the travel and trade networks, the lake and its resource zones, and the surrounding environmental zones.

## CHAPTER 5 - A SETTLEMENT SYSTEMS ANALYSIS

With the communities and landscape now reconstructed, this chapter will provide the major analyses for the dissertation. The primary mechanism for these analyses is a spatial statistical approach that combines innovative spatial approaches with a Geographic Information Systems platform. The result is an analysis that effectively models the dynamic settlement of Prehispanic peoples through time and space, and quantitatively measures the impetus behind locational settlement and subsistence practices over a 1,600 year time period. Included are spatial analyses such as gravity models, cost-surface modeling, and catchment modeling.

## CHAPTER 6 - MODELING THE LAKE PÁTZCUARO SETTLEMENT SYSTEM

This chapter will provide a discussion of the settlement of the LPB. The section will first look at the micro-regional settlement system of the southwest data, creating a testable model that can be applied elsewhere in the basin. This section looks to expand to a regional scale and utilizes recent archaeological findings in the southeast area of the basin for a comparative analysis.

## CHAPTER 7 - THE MACROREGIONAL SETTLEMENT SYSTEMS AND CONCLUSIONS

The first section will then provide a regional analysis, which will compare the settlement of the LPB to the nearby Zacapu Basin, two distinct geographical entities yet still part of the same Prehispanic Tarascan state.

This chapter will conclude the dissertation, and provide the final interpretations of the research. The research questions posed in the Introduction Chapter will be revisited, as will the hypothesis. Finally, this chapter will summarize the dissertation, its intent and the finished results, and the future direction that the author's research will take based on this study and the manner in which this dissertation will aid in future research and publications.

# CHAPTER 2: THE TARASCAN EMPIRE AND THE LAKE PÁTZCUARO BASIN

This chapter will provide a brief background of two important facets of this research; the Tarascan Empire, as currently understood from the archaeological and ethnohistoric data, and the Lake Pátzcuaro Basin, which includes the basins historic and current geographic, geologic, and ecological characteristics[5]. The goal is to contextualize the analysis found in future chapters, which are centered on communities within the 1,600 year period leading up to Spanish conquest, and the dynamic landscape also associated with this time period.

## Research in West Mexico

In order to understand the current research paradigms that revolve around the Tarascan state and its core area in the Lake Pátzcuaro Basin, a brief history of the research must be presented. The earliest research in West Mexico, including the Lake Pátzcuaro Basin, comes in the early 20th century from seminal anthropologists such as Seler, Lumholtz, Hrldlicka, and Gamio. The leading theories on the Prehispanic West Mexican cultures were plagued by the insistence on comparing them within the context of other Prehispanic cultures, such as the Teotihuacán and Olmec civilizations. The result were theories of origin and complexity based on diffusionist notions of cultural contact. It is within this context that the Mesa Redonda (1946) work is referred to in order to provide a context for the beginnings of archaeology in the Occidente. This collection of articles provides a variety of research in the region of West Mexico that helps to better understand the origin of the research questions that have fueled archaeology in the region over the past half-century.

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[5] There are much more extensive resources on the Tarascan State, its prehistory and the ecological, geographical and environmental details. Please refer to Pollard 1993, Pollard 2008, Gorenstein and Pollard 1983, Toldeo 1991, and Beekman 2009 for a more comprehensive background.

Included is a discussion from Noguera reporting on the initial findings from the northwest portion of Michoacán, including shaft tombs and a culture that shares Tarascan traits as well as traits from Teotihuacán. The vast majority of this work derives from an attempt to provide ceramic analysis in hopes of creating a chronology for West Mexico. By analyzing the ceramics, the authors propose theories that include interaction with the Mixtec, Puebla, and Teotihuacán cultures, and pinpointing the role of the Chupicuaro ceramic culture leading up to the Tarascan Empire. Ultimately, the articles rely heavily upon diffusion, thus trying to explain the complex civilizations of West Mexico through directional diffusion with the state-level society cores of the Aztec, Olmec, Toltec, and Teotihuacán. It is also in the 1940s that within the study of state emergence comes the neo-evolutionary theory, where states are viewed as evolving from chiefdoms due to a variety of environmentally deterministic variables (White 1943, Steward 1949).

It is not until 1960s and the onset of Processualism in Mesoamerican archaeology that researchers begin to abandon the diffusionist models and focus on the broader issues of settlement, subsistence and the emergence of states. This shift in research paradigms led to a shift in research scale, where now regions and macro-regions play an important role in developing settlement theory, and households and communities aid in reconstructing commoner life and economic practices. The state emergence research is still littered with theories based on deterministic models, such as Carniero (1970) and Fried (1960). Inherent in the research couched in neo-evolutionary theory is the stage model, where societies move "up the ladder" so to speak, from tribe, to chiefdom, to state. The unilinear view of social change was under fire from processual archaeology in the late 1970s and 1980s. It is from this processual theory that this dissertation finds its ancestral roots.

The primary research that is used in this dissertation comes from Helen Perlstein Pollard (1972, 1980, 1983, 1993, 2008), whose work in the Lake Pátzcuaro Basin was the first to present a testable ceramic chronology, and to apply multi-linear theory to the question of the emergence of the Tarascan state. Pollard was the first to do extensive archaeological survey in the lake basin, supplemented by excavation. Probably the most complete and extensive resource on the Tarascan Empire is Pollard's 1993 monograph, entitled *Tariacuri's Legacy*. Pollard details all aspects of Tarascan society in the lake basin, focusing on the emergence of the Tarascans and the eventual state-level society they developed. Pollard looks to demystify the Tarascan state by discussing aspects of the society ranging from the political and religious elite to the rural commoner class, all the while bridging the research to include the ethnohistoric and ethnographic data.

Pollard's research is in fact the most comprehensive in the sense that she has completed fieldwork in many sites throughout the Pátzcuaro Lake Basin, and has been the predominant figure in the archaeology of the basin and has published the most extensively on the subject. Included are her studies on the urban characteristics of the Tarascan Empire, which focus on the Tarascan capital of Tzintzuntzan (1972, 1980). Pollard also provides a detailed analysis of the economic and agricultural potential of the Pátzcuaro Lake Basin, and provides a detailed ecological reconstruction based on multiple lines of evidence (Gorenstein and Pollard 1983). Pollard has also research the mortuary patterns of the regional elite in the basin, and discusses the archaeological evidence in terms of the concept and visibility of social stratification and ritual that can be seen in the material culture (1999).

Perhaps the most extensively researched issue by Pollard is the discussion of the emergence of the Tarascan state and its conceptualization within the larger theoretical frameworks of state-level societies in Mesoamerica (1980, 1993, 2008), (Gorenstein and Pollard, 1983). Pollard analyzes the Tarascan state on several scales, within the Pátzcuaro Lake Basin (regional), within the larger framework of West Mexico (macroregional), and finally within the Mesoamerican system (Smith and Berdan 2003a, Smith and Berdan 2003b, Pollard 2005). Topics that Pollard includes in this type of research include the economic systems of the Tarascans, including the long-distance and elite exchange networks, the long-term human- environment interactions in the Pátzcuaro Lake Basin, and how power and political control is seen in the material culture and its pervasion in the social stratification of Tarascan society. Pollard frames her research questions within the concept of what Beekman describes as the dynamic network of linked economic, social, and political practices of West Mexico, and then discusses these trends in terms of their place in the Mesoamerican world system (Beekman 2008).

**The Tarascans**

The majority of archaeological research on the Tarascans has occurred over the last 40 years, flourishing in the florescence of the New Archaeology. However, research in the Lake Pátzcuaro Basin, the core of the Tarascan Empire, has been under-researched and underfunded, resulting in "patch-work" survey, or entirely site-focused research (Pollard 2011). Only until recently has the cultural chronological sequence been confirmed, and a sufficient amount of data been collected to create a model of the emergence of the Tarascan State (Pollard 2008) and attempt the type of research this dissertation hopes to complete. The result of these 40 years of archaeological research is a foundational understanding of the Tarascans, primarily during the Late Postclassic period (A.D. 1350-1625) and the time during and after the Spanish conquest. This research also focused on the elite of the Tarascan society who, during this period of florescence of the state, were the most visible, both in ethnohistoric documents and the archaeological record. The exception to this has been Pollard's surveys in the southwest of the basin (Pollard 2000, 2001), the goal of these having been focused on the settlement around an important ecological niche in the basin, and providing evidence of the power relations held by both elites and non-elites in the basin, including land tenure, resource management and allocation, and autonomy among the lower classes within the state. Pollard's work also ranges through the full occupation of these areas, providing a longitudinal view of settlement in this part of the basin. Combined with Pollard's research at the Tarascan capital of Tzintzuntzan, there is ample information to provide a holistic look at the Tarascan Empire during the last 500 years of its rule before conquest, thus providing a definite "endpoint to the modeled transformation of the basin" (Pollard 2008:217).

**The Prehispanic Lake Pátzcuaro Basin**

The area that would one day become the extent of the Tarascan Empire in West Central Mexico, was first settled by hunter-gatherers during the Paleo-Indian period, before 2500 B.C. (Pollard 1993:6). This period, as well as the archaic period sheds little light on the populations that settled in this area, as archaeological evidence is very limited, and what is known about this time period is scant. We do know from recent findings, however, that maize had begun to be domesticated during the Archaic, with the earliest evidence of maize pollen being found in the Pátzcuaro basin at 1500 B.C. (Beekman 2009). However, sites associated with agriculture didn't occur until the Early Preclassic period, when after 2000 B.C. we find evidence from the Balsas Basin and Lake Chapala of sedentary, agriculturally based villages, who were also the first ceramic producers of the region (Pollard 1993:6). The early and middle Preclassic (also known as the Early and Middle Formative) in Western Mexico was defined by the presence of shaft tombs, a type of burial practice that also included burial offerings, sometimes of imported goods (Beekman 2009). The middle and late Preclassic in the Bajio and Michoacan are marked by the florescence of the Chupicuaro culture, with its indicative circular-style, earthen mound architecture found at the type-sites for the period (Beekman 2009).

The Late Formative and early Classic period (300 B.C. – A.D 500), sees rapid population growth, and evidence for social inequalities among the societies throughout West Mexico (Beekman 2009). Beekman cites two new forms of architecture emerged during this period; the ballcourt and the *guachimonton*, or ceremonial centers (Beekman 2009). Pollard sees the ceremonial center as a major transformation for the West Mexican cultures, as it altered the layout of settlement. Ceremonial centers, primarily within the Bajio region and during the Epiclassic, showed evidence of Teotihuacan-style, talud-tablero architecture, and sites from this time show an increase in long-distance trade items such as obsidian (1993:9-11). Rapid population growth continued into the Epiclassic period (A.D. 500- 900), which had a dramatic effect on settlement patterns in West Mexico. In many places, settlements become nucleated and defensive, and some remain this way until the emergence of the Tarascan State (Pollard 1993:12).

Populations in the Lake Pátzcuaro basin began growing during the Epiclassic, and into the Early Postclassic (A.D. 900) the basin is controlled by multiple, competing small-scale chiefdoms. Population remains steadily rising, and specific regional cultures and traditions begin to emerge by the Middle and Late Postclassic (A.D. 1200). According to Pollard, "The current archaeological evidence suggests that during the Middle/Late/Postclassic, local elites competed for communities, marking their relative success with polychrome pottery, metal goods, and patron deities. The absence of regional authority and decision- making in the face of what appear to have been increasing populations led to the formation of highly nucleated populations in some areas" (Pollard 1993:13).

This was the state of the Lake Pátzcuaro Basin just before the emergence of the state in A.D. 1350. According to ethnohistoric documents, Tarascan history told of the warrior-leader *Tariacuri* who united several independent polities to form the unified Tarascan state in the Pátzcuaro basin (Pollard 1993:15). This state would flourish, even with the continued threat of warfare from the Aztec Empire to the east, until Spanish conquest in A.D. 1525. The Tarascan Empire, as it was leading up to the time of the Spanish conquest in the 16$^{th}$ century, was one of the largest empires in Mesoamerica. Second in size only to their rivals, the Aztecs, the Tarascans ruled an area that covers almost the entire current Mexican state of Michoacán, and extended to the north beyond the Lerma River, to the south beyond the Balsas River, and to the north west into the current Mexican state of Jalisco (Pollard 1993).

The core of this vast empire was located in the Lake Pátzcuaro Basin, with the urban center of Tzintzuntzan as its capital. Tzintzuntzan was established as the capital in A.D. 1350, thus becoming the religious, political, and economic center for the empire. Much of what researchers know about the capital and those who resided there has been inferred from the ethnohistoric documents, such as the Relación de Michoacán (RM). Data from these documents has caused variation in population estimates, however, but Pollard has concluded that the population of Tzintzuntzan had reached between 25,000 and 35,000 shortly before Spanish contact (1993:32). Documented as covering an area of approximately 901 hectares (Stawski 2008), at the capital of Tzintzuntzan is classified as having been a major urban center. Studies have combined the ethnohistoric data and archaeological data to investigate the social complexity and the urban characteristics of the capital (Pollard 1972, 1980, 1993; Stawski 2008, 2010). These studies have shown that the capital showed high levels of residential zoning, where zones were divided by social class such as lower elite, upper elite and commoner (Stawski 2008). Furthermore, we see a high level of overlap when discussing functions of the state, such as political and administrative, and economic, suggesting that there were no separate zones for these functions, but were all centralized to the king's residence (Stawski 2008). Only the main platform at Tzintzuntzan, which includes the *yacatas* (pyramids), was shown to have had a centralized function and control over the state's religious functions (Pollard 1993). The data from these studies displays the capital of the Tarascan state in an early stage of urban and social development, when compared to other Mesoamerican urban centers, such as Tenochtitlan, or Teotihuacan. Suffice to say, researchers have estimated that at the time of Spanish contact, the Tarascan state was just entering its florescence.

Research on Tzintzuntzan has been the most studied aspect of the Tarascans, primarily due to the monumental architecture, the ethnohistoric documents recorded there during the Early Historic period (RM, dictionaries) and the draw of studying the elite and royal lineage that once existed there. However, given the scope of this research, attention must be paid to the larger Tarascan population in the basin. To start, physical anthropological research of the current West Mexican populations defined a demotype B, which includes the central and western portion of the central plateau in West Mexico. This distinguishable population, called *Purepecha*, also speaks the language of the same name, which is "recognized as a distinguishable linguistic isolate within Mesoamerica…and for many basic features, it stands out from the patterns of other Mesoamerican languages" (Pollard 1993: 15).

As was stated previously, these populations, according to archaeological evidence, seemed to have established sedentary, lacustrine-based settlements during the Early Preclassic period (2500 B.C.). But what is primarily known of these populations comes from the Late Postclassic period (A.D. 1350 – 1525), with help from the ethnohistoric records. The population in the lake basin was located in various settlement forms, such as villages, hamlets and towns, with the capital being the only "city", although the term urban center is preferred. The lake basin, at the time of Spanish contact, was densely populated, and estimated to hold a total population of between 60,750 and 105,000 (Pollard 1993:79). It is estimated, from documentary sources from the protohistoric, that during that time there were n=91 settlements in the Lake Pátzcuaro Basin (Pollard 1993:77). Of these n=91, the areas and estimated population size of the largest four are known, which are Tzintzuntzan (see above), Ihuatzio, Pátzcuaro, and Erongarícuaro (Pollard 1993:77). When discussing the administrative characteristics of the Tarascan state, there was a hierarchy which had Tzintzuntzan as both the imperial capital as well as the regional administrative center. From there, n=8 centers held the role of the third hierarchical center, which meant that they "were governed by *achaecha*, or *senores*, who reported directly to the royal dynasty in Tzintzuntzan" (Pollard 1993:82). Each of these would have had an *ocambecha* to organize tribute, labor for public works, and collect census data (Pollard 1993:82). The remaining settlements fell under the 4th and 5th tier of hierarchical administration, and are thought to have been run by local elites, or *caciques*, which carried out the state's political functions and answered to the senores of the closest level 3 administrative center.

Regarding the economic network in place at the time of Spanish contact, the primary mechanism for exchange was through a system of three main markets in the basin; Tzintzuntzan, Pareo, and Asajo (Pollard 1993:80). This information comes from the ethnohistoric record, and as it stands, there is little to no archaeological evidence corroborating the placement or specific attributes of these markets. Pollard uses ethnographic data to infer the nature of the markets in connection to the local settlements in the basin. Based on the behavior of current populations, it is thought that of these three markets, the Tzintzuntzan market probably occurred daily. Furthermore, local markets would have serviced populations who couldn't have easily accessed these markets daily. Behavioral analyses during the 20th century "suggests that populations will generally utilize marketplaces closet to them and that those populations midway between markets will attend both" (Pollard 1993:80). This suggests a variety of economic networks in place to deal with any possible demands that the settlements may have had. The transportation networks in the basin were thought to have been closely associated with the economic network, for it was on the transportation routes that "individuals traveled, information was transmitted, and with tumpline carriers, goods were moved" (Pollard 1993:84). Transportation within the basin during the Protohistoric was limited to canoe and foot travel. The transportation network during this period is vital in understanding the connectedness of the settlements, and the characteristics of movement in the basin concerning settlement location.

**The Ethnohistory of Communities: The Early Historic Periods**

The protohistoric and early Hispanic periods, approximately A.D. 1450 to 1520 in Michoacán, offers a singularly unique opportunity for researchers to attempt to decipher the environment and life ways of the Tarascan people. Several ethnohistoric texts survive that provides excellent sources of data that aid in reconstructing the environmental, geographic, cultural, political and economic features of the Lake Pátzcuaro Basin. As noted in the introductory chapter, they include the *Relacion de Michoacán* (RM), the *Carvajal Visitas* (1524), the *Suma de Visitas de Pueblos of 1547-1550*, the *Relaciones Geograficas* from 1579- 1581, the Infante documents of 1528, the Beamont (1932) and Seler (1908) maps, and Purepecha-language documents recently translated (Roskamp 2010; Monzon, Roskamp, Warren 2009). Fortunately, all of these have been heavily researched, translated and analyzed to aid in our understanding of the historic case of the Tarascans. This section will present the data from these sources, as well as their subsequent analysis by scholars and researchers, in order to understand the communities of the lake basin.

The primary means of ethnohistorical data analysis comes from the research by Gorenstein and Pollard (1983). Their reconstruction of the population and environment of the Lake Pátzcuaro Basin and Tarascan Empire combined both ethnohistoric data and archaeological data in an attempt to redrodict what life was like in the basin pre-contact. For the purposes of this dissertation and concerning communities, what is of most importance is Gorenstein and Pollard's analysis of settlement location, demography, and political and economic networks. The following is a summary of their work, and is divided into two periods, the Protohistoric (A.D. 1450-1520) and the Early Hispanic (A.D. 1520-1540) periods.

**The Protohistoric (A.D. 1450-1540)**

The only ethnohistoric document that covers the protohistoric period in the Lake Pátzcuaro period is the *Relacion de Michoacán* (RM) (Gorenstein and Pollard 1983:55). According to Gorenstein and Pollard, the RM "provided information on settlement names, settlement locations, environmental features, and certain political, social, and economic data such as political alliances, social classes, and market and tribute connection" (1983:55). And although an excellent guide, the data from the RM in not entirely comprehensive, or reliable, and therefore, Gorenstein and Pollard's settlement data from this time period is a combination of the RM data, archaeological field identification of protohistoric sites, and on extrapolation from 20$^{th}$ century data and Early Hispanic data (Gorenstein and Pollard 1983:55). According to Gorenstein and Pollard, the RM describes two definite time periods; "after the Spaniards came" and the "time before the Conquest" (1983:55). It is assumed that "time before the Conquest" refers to the protohistoric, "unless there was a clear distinction in the Relación of earlier time" (Gorenstein and Pollard 1983:55).

Derived from the 1976 field season, which was a non-collecting, observational project made as part of the geographical and ethnographic surveys undertaken in 1976, Gorenstein and Pollard "noted the locations of settlements, including structures, and routes that were identified as Protohistoric by the presence of the surface artifacts that were…known to exist in the last period at Tzinztuntzan" (1983:55). From these field observations, they located n=47 settlements as protohistoric. Other settlements that were located and mapped were done so by matching Tarascan settlement names and locations on the Beaumont and Seler maps with descriptions in the RM and other 16$^{th}$ century documents. Therefore, according to Gorenstein and Pollard; "In summary, sixty-six Protohistoric settlements were located on a map. The ethnohistoric sources provided eighty-seven names of Protohistoric settlements. Forty-nine of the sixty-six located settlements could be assigned names from the eighty-seven present. Sixteen located settlements had no names and thirty-eight of the names could not be attached to located settlements."

The early Hispanic settlement data was then used to "extrapolate the number of Protohistoric settlements in the Lake Pátzcuaro Basin as well as the location of those Protohistoric settlements not able to be located by either archaeological or ethnohistorical methods" (Gorenstein and Pollard 1983:59). Gorenstein and Pollard assumed that given the thirty year time span between the Protohistoric and Early Hispanic, no major changes had taken place in the settlement pattern in the lake basin (1983:59). So, in summary with the aid of the Early Hispanic data, n=91 settlements were chosen for the Protohistoric period; with n=66 settlements known and n=25 settlements inferred (Figure 6).

Gorenstein and Pollard then estimated settlement classes, which presented a range of the population for each class. This was accomplished through the extrapolation of population size from the 1940-1945 census data, the 1970-1977 census data, and the Early Hispanic data (Gorenstein and Pollard 1983:62-63). From this, Gorenstein and Pollard reconstructed the protohistoric population as seen in Table 4.

*Figure 5 – The Protohistoric Settlements of the Lake Pátzcuaro Basin*

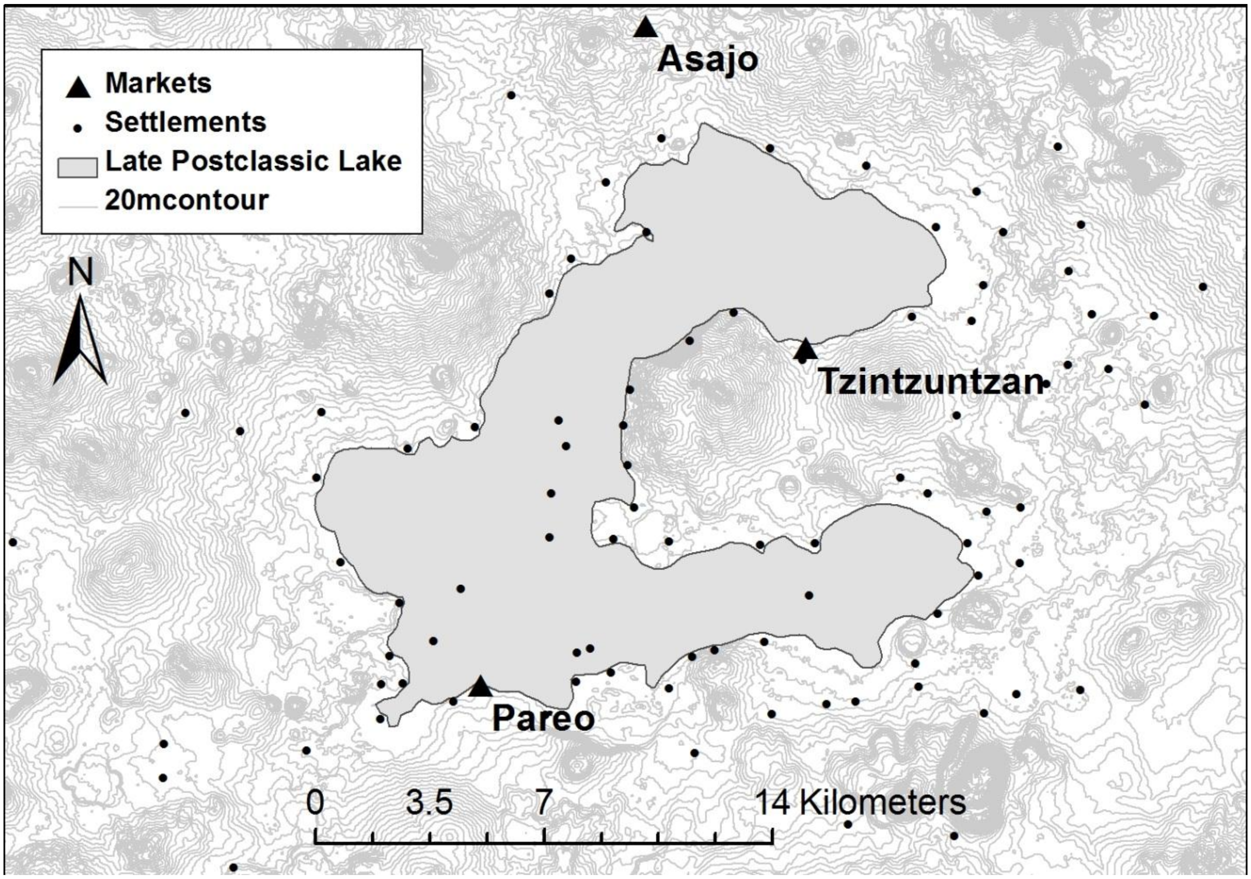



*Table 4 – Protohistoric Settlement Classes*

| Settlement Class | No. of Settlements | Mean Population | Range of Population |
|---|---|---|---|
| 1 | 1 | 30,000 | 25,000 to 35,000 |
| 2 | 3 | 4,000 | 3,000 to 5,000 |
| 3 | 22 | 1,250 | 1,000 to 1,500 |
| 4 | 40 | 300 | 100 to 500 |
| 5 | 25 | 55 | 30 to 80 |

The protohistoric settlement data serves as an excellent starting point in an attempt to reconstruct the 1,600 years leading up to Spanish Conquest. The retrodiction of communities back through the temporal phases will rely heavily on archaeological data, though the ethnohistoric data will aid in providing possible place names and locations. The ethnohistoric records reveals very much about the main four communities, Tzintzuntzan in particular, and very little regarding the smaller villages and hamlets. This is where one must rely heavily on archaeological data. What is known, however, from the ethnohistory is that more than ninety communities existed within two environmental zones within the basin; the lakeshore and the lower sierra slopes (Pollard 1993:84). Furthermore, according to Pollard, "69 percent of the settlements and 74 percent of the population was found in the lakeshore zone alone, including the capital city, Tzintzuntzan" (1993:84). This reliance on lakeshore resources was a key component to the communities, and thus they are regarded as having been a lacustrine-based society. This, though, is but a general fact in what was a very complex settlement system. The functional, demographic and subsistence data for each individual community must be analyzed in order to provide a more detailed look at Tarascan life in the basin, as well as to provide a holistic view of the emergence and statehood of the Tarascan Empire.

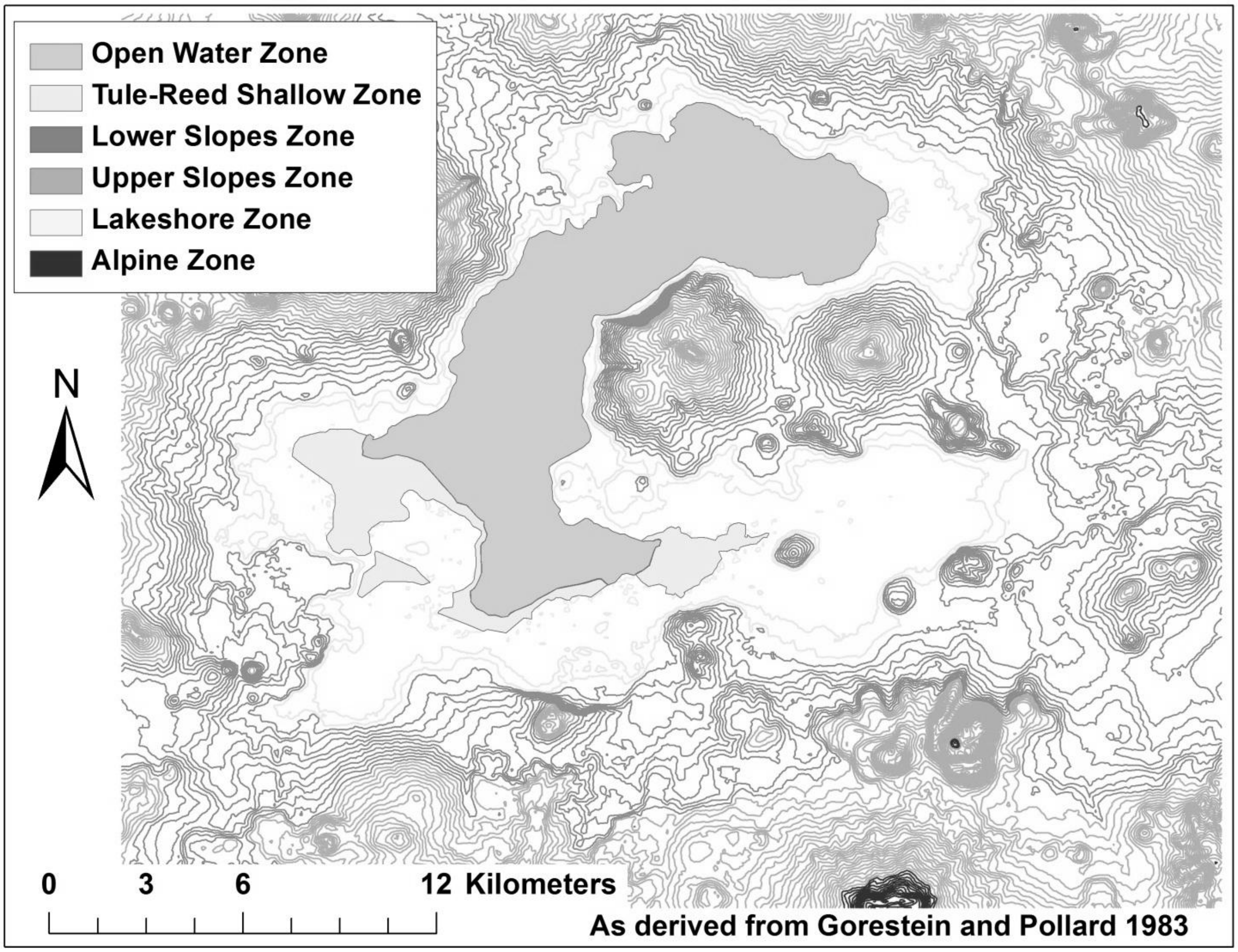
**The Lake Pátzcuaro Environment**

The physical environment is a vital aspect to this analysis, where the climate, geology, geography, geomorphology, and ecology all combine to describe the modern, historic and prehistoric landscape in order to bridge the gap between ecology and anthropology/archaeology. As discussed in the theoretical chapter of this dissertation, this historical ecology, or landscape approach, is what will aid in the selection of variables for analysis. This section will introduce the basic environmental, geographical and geological characteristics of the lake basin and the region, and then explore the region's ecology. Being one of the most heavily studied and researched lake basins in Mexico, data concerning the geoarchaeology, geology, and paleoecology of the Lake Pátzcuaro will aid in providing a comprehensive view of the current state of the lake basin environment and ecology, as well as attempts at reconstructing past environments. This data coupled with a landscape approach and the archaeological data will be used to reconstruct the Prehispanic landscape for the modeling and analysis of the Prehispanic settlement system.

The Lake Pátzcuaro Basin is a relatively small lake basin, and is defined by the extent of its hydrology. Past calculations have placed the area of the Lake Pátzcuaro basin at 929 $km^2$ (Pollard 1993, 2008), with Lake Pátzcuaro covering approximately 116 $km^2$, depending on the lake level at a given time (Metcalfe et. al. 2007:273). Recently, through the use of Geographic Information System (GIS) software, the extent of the basin was calculated through the georeferencing of a map of the basin's hydrology onto a rectified satellite image. The difference was somewhat drastic, and at 803 $km^2$, quite smaller an area when compared to earlier estimates.

The lake basin is located in the landscape of the Central Mexican Altiplano, and lies within the Michoacán-Guanajuato Volcanic field (Metcalfe et al. 2007: 273). Because of this volcanic landscape, the lake basin terrain is steeply sloped and ranges in elevation from 2,030 meters at lake level and to 3,200 meters in the alpine slopes. This elevation range covers six environmental zones (Figure 1), which range in elevation from the 1) open water (lowest elevation), 2) tule-reed marsh, 3) lakeshore, 4) lower sierra slopes, 5) upper sierra slopes, and the 6) alpine (Pollard 1993:66-67). It is because of this range in zones that, historically, the lake basin has had "considerable internal variation in altitude, topography, rainfall, frost, soils and vegetation" (Gorenstein and Pollard 1983:4). Also, due to the volcanic landscape, the soils are volcanic andosols, the primary one being charánda (which is the ethnosoil classification), or red earth (Gorenstein and Pollard 1983:136) (Toledo 1991). The charánda is red-brown clay, which occurs primarily below 2300 meters in elevation on the lower mountain slopes and the basin floor (Gorenstein and Pollard 1983:136).

*Figure 6 – The Resource Zones of the Lake Pátzcuaro Basin*




Climactically, the Lake Pátzcuaro Basin is located in a humid temperate area, as it is located in the central chain of highland Mexico. It is affected by seasonal precipitation, with a rainy season in the summer months and a dry season during the winter months. During the rainy season, the moisture generally comes from the Gulf of Mexico and Caribbean, but moisture from the Pacific also plays an important role given the western location of the lake (Metclafe et. al. 2007:273). The mean annual precipitation for the lake basin (taken between 1970 and 1986) is 901 mm, but has shown some decline since the 1921, when this recording started (Metcalfe et. al 2007:273). The average temperature varies between 12° and 16° Celsius, with the summer average being 17° C, and the winter temperatures in the range of 3° and 10° C, with frost common 35 to 50 days in the year (Gorenstein and Pollard 1983:133). It must be stated that this dissertation assumes similar climatic conditions, for both the modern period and prehispanically. New evidence from Stahl et al. (2011), shows climatic and drought changes for the region through dendrochnological dating, and these data have been taken into account when discussing the landscape and changes through time. It is felt that given the similarities in flora and fauna and lake fluctuations between the modern and prehistoric, it is appropriate to assume that, to an extent, conditions were similar.

At present, the environmental zones contain vegetation reminiscent of historic and prehistoric periods, although they have been greatly reduced as human populations fluctuated. The lowest vegetative zone in elevation, the tule-reed marsh, is "characterized by hydrophilous vegetation dominated by tule and reeds" (Gorenstein and Pollard 1983:138). Agriculture and secondary herbaceous plants and scrub dominate the lakeshore zone, and include grass shrubs, shrub oak, and cacti (Gorenstein and Pollard 1983: 138) (Metclafe et al. 2007:273). The higher elevations include deciduous stands of trees, and although mostly remnants of what existed, contain primarily pine and oak. The next zone up in elevation, described as the upper slopes in the basin between 2300 and 2800 meters, is dominated by pine and oak stands (Gorenstein and Pollard 1983:140) (Metcalfe et al. 2007:273). The highest zone, the alpine zone, occurs above 2800 meters in elevation and is dominated by fir forests (Gorenstein and Pollard 1983:140-141.)

As stated before, many regard Lake Pátzcuaro as the most comprehensively studied lake in Mexico, and perhaps even in Middle America (Bernal-Brooks, Rojas, Alcocer 2002:187). Yet, even with decades of research, there are still many unknowns surrounding Lake Pátzcuaro. Lake Pátzcuaro is a distinctive C-shape, currently containing eight islands and is a lake of interior drainage, having no outlets and no important water inlets; it is fed by springs and temporary streams during the rainy season (Torres et al. 1989:126). This fact has led to intense research concerning the geomorphological and limnological characteristics of the lake and the surrounding basin, most of which concern the relationship between the lake and climactic fluctuations as well as human-induced change during both prehistoric and historic time periods. Both issues are highlighted here, and play an exceedingly important role in how the environment and ecology of the lake basin is modeled in an attempt to discuss past human-environmental relations. For decades, limnological studies in Mexico have focused on Lake Pátzcuaro, in particular the cause and effect of the lake level fluctuations it has had throughout its history[6]. These fluctuations in the lake level has created a very interesting case study for researchers, and has led to much debate as to what is the root cause for the changes. The cause is typically discussed in reference to climactic fluctuation, human-induced factors, or geological and tectonic events, and a combination of these is cited as the causal variables for lake level change and/or changes in the lacustrine environment. Recent paleolimnological research has attempted to uncover the chronological sequence of lake level change for Lake Pátzcuaro, which includes providing exact levels through time in an attempt to model these fluctuations. As one would imagine, the chronology of these lake level changes is problematic, as gaps in the historical record, and larger gaps in the prehistoric record, leave large periods of time overlooked. As O'Hara explain "Even in those instances where there is good dating control, the time span between dates and the sampling strategy are such that small-scale and abrupt events are often overlooked" (1993:51).

Although this may be the case, several researchers have proposed their own lake level estimates through time, with some variation between. These studies can be broken into two general groups; those whose lake level estimates and environmental reconstruction of the past cite climactic and human induced variables as reason for fluctuations (O'Hara 1993, Metcalfe and Davies 1997, Endfield and O'Hara 1999, O'Hara et. al 1993, and Metclafe et. al. 2007), and those whose environmental and lake level reconstruction cites geologic processes, human induced

[6] For a comprehensive synopsis of limnological studies in Mexico, please refer to Alcocer and Bernal-Brooks 2010.

change and climactic fluctuation as the major variables (Fisher et. al 2003, Israde- Alcantara.et. al. 2005, Fisher 2005, 2007). The major theories proposed by these researchers use lake sediment cores and terrestrial sediments that have been dated and calibrated through the use of C14 dating as their primary source of data, as well as archaeological work, data from the ethnohistoric records, and current limnological and ecological studies.

Both sides of the debate utilize the core taken by Watts and Bradbury (1982), or the "Master Core", as a baseline for their own research. The Watts and Bradbury core was taken in 1973, and was 1520 cm in length and dates back to the Pleistocene, or approximately 44,000 years old at the base (1982:56) (Bradbury 2000). Since that initial core, others have been taken and reported on in various parts of the lake and adjacent area. Fisher (2000), Israde-Alcantara et.al. (2005) and Metcalfe and Davies (2007a, 2007b), and O'Hara (2007) all report on cores, trenches, agricultural wells, and exposed cross sections in an attempt to report on the sedimentation record, its chronology, and explanations for the deposition of certain sediments during certain time periods. O'Hara, Davies, and Metcalfe argue that during the late Holocene that increased sediments are a result of climactic change coupled with human impact in the basin, primarily in terms of catchment erosion both during Prehispanic and Hispanic time periods (2007:293). The work from Fisher, Pollard, Israde-Alcantra and Garduno-Monroy (2005) posit that this same sediment layer claimed to be erosional in nature by Metcalfe, Davies and O'Hara, is in fact a sediment layer that was caused by two specific geological events, the first being the collapse and associated landslide of the El Estribo Volcano, the second being a series of tectonic uplifting, which has distorted the sedimentation record (Israde-Alcantara et.al 2005:35). These arguments paint very different pictures of a Prehispanic landscape, making its reconstruction and the Prehispanic environment problematic.

Regardless of these debates, the two sides seem to be in agreement as to the approximate lake levels through time, although they don't necessarily always overlap in their periods of reconstruction. Chapter 4 which focuses on the Landscape Reconstruction, will synthesize the work from these researchers, and provide a more comprehensive view of their research, as well as provide a table that shows the lake levels through time. As one would imagine, the fluctuations of the lake levels are vital in reconstructing the environment and landscape of the past. Directly related to the lake level are also the resource zones that support local flora and fauna, and are the same resource zones that are accessed, utilized and controlled by human populations as the lake basin was settled and inhabited. As most causal relationships in nature, one can posit that as the lake level changes, so do the extent and existence of these resource zones, including the tule-reed marsh, the lakeshore, and land on the lower sierra slopes (Gorenstein and Pollard 1983). This shifting limnetic (free of vegetation) and shallow litoral (submersed vegetation) zones (Chavez et. al. 2002:172), affected, and continues to affect, the access to economic resources and subsistence catchment areas for the populations in the lake basin. From a more historical ecology stance, these shifts affected settlement location, trade and travel routes, property boundaries, agricultural land, and technological systems such as irrigation and terraces. Suffice to say, these lake level estimates through time will drastically affect the modeling of the past settlement systems.

**Summary**

This chapter introduced the Lake Pátzcuaro Basin, its culture history, its history of research, and its environmental and climatic characteristics. Informed mostly by archaeological research, the historical and Prehispanic contexts for the LPB provide the necessary backdrop for the future chapters, which work on a temporal scale of 1,600 years until the time of Spanish conquest. And although the immediate chapters following this look at a specific area of the lake basin, the southwest portion, future chapters will provide a regional and macroregional scale of analysis, where the information found in this chapter will be useful for reference.

Also provided were the basic information regarding the environments, climates, and physical characteristics of the lake basin and its landscape. Chapter 4 will look to expand on this, as it reconstructs the Prehispanic landscape and environment in order to systematically analyze the settlement in the basin. Of significance is the information surrounding the lake itself, such as being a lake of interior drainage, its dynamic nature, and how it affects the basin as a whole.

# CHAPTER 3: COMMUNITIES OF THE LAKE PÁTZCUARO BASIN

In order to perform a settlement systems analysis, two main variables must be discussed and analyzed that will be essential in spatial analysis that gives insight into the Prehispanic settlement. The first, which concerns this chapter, is the reconstruction of the Prehispanic communities of the southwest portion of the LPB, ranging in time from 100 B.C. to the Spanish Conquest, ~ A.D. 1525. This reconstruction is informed by archaeological, ecological, ethnohistoric and ethnographic data, and utilizes demographic analysis to provide population estimates for the communities. Therefore, this chapter covers both the theory and methodology concerning the communities of the Prehispanic Lake Pátzcuaro Basin. First, a theoretical discussion is undertaken that allows for a better understanding of variable selection while also being explicit and discussing scalar limitations, both spatial and temporal. Second, the methodology for the analysis of communities is undertaken, which involves the mapping, reconstruction, and functional and demographic analysis of these communities through the basin's 1,600 year time sequence.

## Theory

To understand a research methodology, the analysis, and the interpretations of a study, one must first understand its theoretical underpinnings. The theoretical framework from which research must manifest is crucial in shaping the methodology, the selection of the variables to be assessed, and dictates the manner in which the results of the analysis are interpreted.

Since the inception of processual research in anthropological archaeology, Mesoamerica has been a testing ground for social theory, primarily concerning the paradigms of state-emergence, both primary and secondary, and human adaptation. Processualism has allowed for a more scientific approach to archaeology, where hypotheses are tested and rigorous statistical tests are employed. Along with these additions to the archaeologist's toolkit came the full- coverage survey, a technique made famous in Mesoamerica by its use in the Basin of Mexico survey (Sanders, Parsons, Santley 1979) and the Oaxaca Valley surveys (Marcus and Flannery 1996). As discussed in the Introduction, the data used in this dissertation derives from full- coverage, intensive survey of the Lake Pátzcuaro Basin, which like the Basin of Mexico and Oaxaca Valley, is a highland area in Mexico that is ideally situated for testing social theory of state emergence and human-environment interaction.

Therefore, this section will outline and discuss the theoretical frameworks that this dissertation will employ in order to analyze the nearly 2,000 year history of human settlement and adaptation in the Lake Pátzcuaro Basin. First, the settlement system theory that this dissertation uses as the primary means for assessing human settlement and human adaptation in a highland, lacustrine ecosystem is discussed. Included is a discussion of the primary unit of analysis for the settlement system model, the community. From there, the discussion will shift to focusing on the larger scalar units of the region and the macroregion.

*Settlement Systems*

Typically, settlement studies can be discussed in the same vein as full coverage survey, but the two aren't mutually exclusive. Usually, full-coverage survey on the regional level leads to an analysis of the settlement of that region. Sometimes this may be a settlement pattern study; other times the more complex settlement systems study. The difference, as noted by Kowalewski, is that "settlement patterns are the arrays formed by sets of interacting, interdependent local groups of people," whereas settlement systems are the "processes behind the patterns" (Kowalewski 2008: 226). This is an important distinction to make, as this dissertation is an example of a settlement systems analysis. Furthermore, full-coverage surveys are also usually carried out and analyzed on a regional scale, although once again this isn't always the case. What is the case, though, is that scale is always an important factor when discussing full-coverage survey as well as settlement studies. The scale of the study defines the scope of the research questions, dictates the appropriate variables to be assessed, and heavily influences the methodology in which one analyzes the variables and performs quantitative tests. As was stated in the Introduction, this dissertation will be analyzing the Tarascan settlement system on a regional scale. Because the smallest unit of analysis is the survey site, one may analyze the data at different scales, and yet the main research questions and the analysis will exist at the regional scale. For example, within the survey site, one may be able to determine function of that site based on the artifact assemblage for a certain time period. Then, several survey sites that cluster together may constitute a larger unit, and the individual functions of each site can be projected onto the larger unit, which may be a community.

From there, the community is analyzed in comparison and in accordance with other communities, thus constituting a region. From the regional scale, one region may be compared and combined with a neighboring region in order to perform an analysis on the macroregional scale. This process is further explained by Drennan and Peterson (2005), who argue that in order to understand the settlement system of a region, one must first understand what constitutes a site, and how these units form a community, and finally how the communities interact to form a regional pattern of social interaction and behavior (2005:6). In order to legitimize the use of this scalar sequence, the following sections will discuss and define these units in order to better explain their role on the settlement system analysis. By making the underlying theoretical assumptions explicit, we will be able to move forward in bridging the archaeological record to these spatial units to define past human behavior. First, the unit "community" is visited, with a discussion of its use as a unit of analysis and how it is defined and used in this dissertation. The second is the region, which is the primary focus of this analysis and the research questions concerning the overall settlement within the basin. The third is the macroregion, another scalar paradigm that will affect the larger comparative framework of the analysis.

*Communities*

In the introductory chapter, the term "community" was defined and partially explained as to its use in the analysis. However, the term "community" can and is interchanged with the word "settlement", which is cause for confusion. This discussion looks to quell any assumptions in the term "community", and will define it as a meaningful unit of analysis. The following sections will do the following; differentiate between settlement and community; define the term "community"; examine the previous uses of community in anthropological and archaeological research; discuss the theoretical impetus behind this usage; and finally link the theory with the methodology and discuss how community will be used in this dissertation.

Gorenstein and Pollard (1983) were the first to provide a detailed study of the Tarascan Cultural system through a settlement analysis. As Pollard and Gorenstein point out, "The institutions of complex societies are expressed materially through the settlement system" (1983:3) and therefore a logical place to start was the location of settlements and estimation of population. Pollard and Gorenstein (1983) relied on the ethnohistoric data, field identification, and archaeological data to locate and describe the protohistoric settlements from which they derived settlement classes, which are "a classification of non-overlapping categories of population range" (1983:3). The settlement classes, ranging from smallest estimated population to largest, are as follows: class 5 – hamlet, class 4 – village, class 3 – town, class 2 – center, class 1 – capital (Pollard 1993: 78). It is expressed by Pollard and Gorenstein that these settlements were the larger units identified by the Spanish in the protohistoric and documented in the ethnohistoric data, and while these larger settlements could be placed into a specific class (i.e. hamlet, village, town), most of the smaller communities could not (1983:78). Pollard and Gorenstein seem to make a subtle distinction, but yet are not explicit about the terms "community" and "settlement". The difference is that a settlement is a spatial unit expresses through the materiality of the archaeological record, whereas a community is a behavioral unit of analysis. The following sources will aid in clarifying the term "community" and how it may be used in archaeological research.

Early studies and publications of "community" derived in sociology and anthropology from such seminal researchers as Hollingshead (1948) and Ahrensberg (1961). The definitions of "community" from these works are the basis for how the term was used in the New Archaeology in the 1960's, 1970's and 1980's (i.e. Flannery 1976). There are two fundamental definitions; "communities" as an ideal definition, where they exist as "a form of group solidarity, cohesion, and action around common and diverse interests", and also communities in the real, as "a geographic area with spatial limits" (Hollingshead 1948:145). Hollingshead also refers to a third definition, with community as "a socio-geographic structure" which combines the ideas in the first and second definitions (1948:145). It is within this third definition that archaeology and ethnography find relevance within anthropological research. Added to this definition was the concept of a community being composed of those who are in face-to-face association (Kolb and Snead 1997: 611). Drennan and Peterson (2005) follow up on this definition by using face-to-face interaction to define a community. However, these are very broad definitions, and it is no wonder why early uses of the term "community" in archaeological work lacked substantive middle-range theory. Kolb and Snead, who describe these weaknesses, expand on these definitions by identifying three "irreducible elements of human communities" (1997:611). They are, 1.) social reproduction, where the community is a node of social interaction, 2.) subsistence production is a central element to community life, and 3.) communities have the aspect of self- identification and social recognition by its members. These three elements, as well as the earlier definitions, give a better understanding of what a community is, but in order to understand its role in archaeological research, we must look closer at the underlying concepts behind the term "community" and its use.

The work from Kowalewski (2003), and Peterson and Drennan (2005) are good starting points for such a discussion. Kowalewski (2003) in particular provides a sound explanation with how anthropologists should use the term community. His work in Mesoamerica "traces change in local formations in Oaxaca, Mexico, over 3,500 years, from early sedentary villages through urbanism, centralized and decentralized states, Colonialism, and capitalist expansion" (2003:4). This "long view" of these social groupings, which he refers to as communities, is essential in order to create an explicit link between the model of a community from the ethnohistoric and ethnographic data and their material correlates in the archaeological record. In order to do this, Kowalewski explicitly states the basic characteristics of a community. First, local groupings, such as communities, were "always members of large-scale formations and changed in their composition and functions in response both to higher levels of integration (regional systems, states) and to pressure from households and other constituent units (Kowalewski 2003:4). *Thus, communities are not a fixed, basal unit of society, were never autonomous, and were not an early evolutionary stage* (Kowalewski 2003:4). This definition finds itself in opposition to the traditional way that community has been defined in settlement pattern studies. Yaeger and Canuto (2000) point out that in these studies, communities are "often conceived as settlement types that fulfill specific functions within a larger social system" (2000:4). In fact, this static view is one of the main hindrances in the analysis of community. Instead, we should view them as operating as dynamic, open systems, even when autonomous, and are a hub for interaction on a regional scale.

The question now becomes, how does one isolate communities archaeologically, and furthermore, how is variation and change in communal composition through time and space deciphered in the archaeological record? The literature emphasizes several key theoretical issues in order to deal with such an issue. First, as stated previously, we must view community as a behavioral unit that cannot be defined or arrived at through archaeological definitions. The problem with these archaeological-driven definitions is, according to Yaeger and Canuto, "because they are born of a keen awareness of the limits of the material record, they often represent methods for operational recognition rather than analytical theories" (2000:5). This means that the "community is not a spatial cluster of material remains to be observed, but rather a social process to be inferred" (Yaeger and Canuto 2000:9). In this case, it is the theoretical paradigm that best informs archaeologist how to proceed in the analyses of communities. Yaeger and Canuto have defined what they feel is the most useful definition of community, deriving from a modified interactionalist paradigm informed by practice theory; "it is an ever- emergent social institution that generates and is generated by supra-household interactions that are structured and synchronized by a set of places within a particular span of time" (2000:5).

The key term here, I believe, that makes the community an important, and accessible, unit for analysis is *interaction*. The work from Kowalewski (2003) points this out, as communities are described as open systems and hubs of interaction. Within the term *interaction* lays the central operating theory that makes community an applicable unit for archaeological research. Communities, as described by Peterson and Drennan are "constituted in the patterned interactions between households, which are central to everyday life", interactions which form a matrices that produce the forces for social change (2005:5). Yaeger and Canuto also see interactions as the vital component to identifying communities, but express it in terms of practice theory, where individual practice is the locus "for the production of the patterned processes that create and recreate society" (2000:3). Thus, interactions within and between communities are expected to reflect the broader patterns in spatial distributions of residences (Peterson and Drennan 2005:6). By defining community and the subsequent interactions that create, maintain and change them, one may now be able to see this unit expressed materially in the archaeological record. Furthermore, because of the behavioral definition of the term "community" (rather than the ideational definition), one can delineate and analyze the material traces of a community in terms of the open-system of interaction that reflects human behavior, and is contingent upon human agency for its creation and continued existence (Yaeger and Canuto 2000:5). Thus, by analyzing the communities in the Lake Pátzcuaro Basin through time and space, an assessment can be made as to the influencing factors for settlement within a larger system of regional interaction.

Having defined what a community is, its explicit assumptions, and the tenets for its use in archaeological research, we must now look to explain this unit of analysis in terms of scale. Peterson and Drennan (2005) offer an insight into what they believe is the appropriate scalar component to applying the unit of community. By defining community as a social unit where face-to-face interaction takes place, they are "entities within which variations in the nature of households and in household activities and interactions can be investigated" (2005:6). Therefore, household archaeology falls into this type of unit, where interactions between these residences can create a community. Yet Peterson and Drennan do not stop at this the smallest scale: "At the same time, small-scale communities become the units of analysis at a larger scale, where study can focus on variations in the nature of communities and the patterns of interactions between them. These patterns may permit the identification of yet larger social communities- entities to which we are accustomed to applying terms such as "district", "polity", and others, but which exist, in fact, like smaller communities, in the patterns of interaction between smaller units" (2005:6).

This patterned interaction can be witnessed up to the regional scale of settlement. What Peterson and Drennan look to accomplish by providing us with this lengthy scalar definition is to explain that there is no binding spatial scale that restricts the community, but instead communities are defined in their patterns of intensity across space (2005:6).

This patterned interaction, though, although seemingly well-conceived and essential in defining community, needs to be discussed further in order to be able to identify the material traces of community and attempt to define them spatially. We now move from the theoretical to the methodological. Peterson and Drennan once again (2005, 2010) define the way in which they proceed to treat communities in archaeological survey. By defining a "community" in the way they have, Peterson and Drennan (2005) make a logical assessment of how interactions define the spatial configuration of a community. Based on theory from household archaeology, the authors argue that based on economic practicality there is a push and pull of forces that aid in the settlement of households. These may be the locating near agricultural fields or other landscapes of subsistence, or near other households to ensure trade, economic cooperation and labor demands. The settlement, predicated upon economic needs, form a broad range of activities that represent social interaction (Peterson and Drennan 2005:7). Furthermore, a "local community is formed when this range of social interactions is intensely concentrated within single, well-defined groups of households that interact only much less intensely with households outside the group" (Peterson and Drennan 2005:7). Thus, interactions such as these encourage households to locate within close proximity to each other, thereby creating a recognizable spatial cluster of the material remains of the community. Therefore, the methodology that Peterson and Drennan (2005, 2010) use to locate and isolate communities is to treat clusters of artifacts from archaeological survey, not as sites, but as the unit themselves.

There are studies that go beyond this artifact delineated approach and attempt to define a broader scale for "communities". Kolb and Snead express their views on this, especially concerning sedentary agricultural communities. They state that these groups "create…physical "maps" reflecting social and economic relationships through direct modification of the physical landscape and the construction of architectural sites (houses, agricultural fields, burial mounds, etc.)" (1997:611). The result is a spatial expression of the community that not only includes artifacts, but also ecofacts (terraces, irrigation canals) expressed in the landscape. This creates a "sociogeographic" unit that reverts to Hollingshead's original definition of "community" (1948). This ability to define the community as part of the landscape is essential to this analysis, and fits well with the landscape approach that will be discussed later. It is this methodology that, when coupled with the evidence from the ethnohistoric data will be used to map and analyze communities in the Lake Pátzcuaro Basin.

*The Region*

The Introductory chapter discusses what this analysis defines as a region, and how a regional analysis is legitimized for the Pátzcuaro Lake Basin by using percentage of area covered by archaeological survey. However, now that this spatial area can be defined as a region, we must explore the underlying theoretical assumptions of performing a settlement system analysis at this level.

Like a community, a region can be conceptualized at many different scales. The broader definition of a region is an area or space where "meaningful relationships can be defined between past human behavior, the material signatures people left behind, and/or the varied and dynamic physical and social contexts in which human activity occurred" (Kantner 2009:41). This definition of a region is a behavioral one, and is defined, like a community, by the patterns of interactions and behavior that exist within it. Although I have defined the Lake Pátzcuaro Basin as a physiographic region, which is defined by the extent of the hydrography of the lake, the region may also be analyzed as a behavioral unit, which "contains multiple communities and one or more politically autonomous societies" (Kowalewski 2008:226). And although both physiographic and behavioral regions are assumed to be open systems with fuzzy boundaries, it is easier to use a physiographic definition when discussing the Lake Pátzcuaro Basin due the ease of setting the boundary.

However, this research does not assume that this geographic boundary is also the same type of criterion that people in the past would have used to define their landscape. This analysis acknowledges fluid and changing boundaries and relationships between humans as well as between humans and their environment in past societies (Kantner 2008:42).

With the region defined, the concept of regional analysis, or regional archaeology, must be addressed which will help frame the research questions and the methodology for this analysis. Regional archaeology, which encompasses “diverse spatial analytical methods available from a variety of disciplines as well as developed by archaeologists themselves”, is “concerned with spatial relationships among human entities and between them and the nonhuman physical world” (Kantner 2008: 43). Once again, this definition finds itself conflated with settlement pattern analysis, a distinction worth stating again. Kantner states that “Regional archaeology tends to be more interested in spatial relationships among a diversity of human and environmental phenomena, whereas settlement pattern analysis tends to concentrate more narrowly on quantifiable spatial relationships among material remains” (2008:43). This definition of regional analysis is important, because it correlates with the goals of a settlement systems analysis, and is well-situated to utilize landscape archaeology as a basis for analysis on such a scale.

*The Macroregion*

The scalar issues of this analysis, having dealt with the communities and the region, must now focus on the macroregion in order to apply the research from this regional analysis to a larger scale. The macroregional paradigm is one that pervades the settlement study literature and questions the empirical realities that have been constructed from years of regional survey data and analysis. A macroregion is defined as two or more contiguous regions, each of which is definable using conventional methods of regional analysis (Balkansky 2006:54). Further, it is argued that a macroregion is the minimal unit needed to study early civilizations and are measured in the thousands of square kilometers (Balkansky 2006: 54). There have been many models and theoretical frameworks that claimed to have as their goal that of explaining macroregional variation between civilizations, and unfortunately many have fallen short of this goal. Much of the research on this macroregional scale has derived from research in Mesoamerica, where the literature is thick in macroregional studies. This section will briefly trace the history of macroregional studies, in hopes that these studies will better define a macroregional analysis in archaeology and provide a framework for the analysis in this dissertation.

Balkansky (2006) provides a very comprehensive discussion of the intellectual lineage of macroregional studies in Mesoamerican archaeology. Therefore, only a few of these past studies will be referenced in order to better understand the applicability of a macroregional analysis on archaeology. Sanders' work on the "central Mexican symbiotic regions" is perhaps the first to look at a macroregional analysis in order to better understand change and variation cross- culturally (Sanders 1956). Symbiosis arose from diversity in the Mesoamerican physical environment, where this diversity created economic specialization at smaller spatial scales. Concerning cultural change, Sanders and Price argue, "the implication of the concept of economic symbiosis is that when areas were in constant historic contact, such contacts were a primary force in the enrichment of local cultural traditions" (Sanders and Price 1968:190). However, as Balkansky states, "the essential–and fatal- limitation of this analytical approach is demarcating the bounds of Mesoamerica's several symbiotic regions as closed systems" (2006:56). A second theory, regularly used on a macroregional scale is that of world systems theory. This theory has also fallen under harsh criticism in its use to explain macroregional variation cross-culturally. According to critics, the theory fails to explain all aspects of culture change, instead relying primarily on top-down processes of change as the core affects the periphery. Critics instead claim that, "the periphery has a much larger effect on structuring their exchange relations, and their economic organizations are more variable, than the world system allows" (Balkansky 2006:57). For the purposes of this dissertation, as well as other prehistoric analyses, it is not apparent whether the capitalist-based core-periphery exploitative relationships that structure the theory are applicable to prehistoric cases (Balkansky 2006).

This leaves the application of macroregional theory in archaeology at an impasse. Kowalewski (1990) describes the problem; "none of our current explanations of how complex societies evolved yet comprehends the prehistoric cases described by the regional archaeological surveys. Most such explanations are not equipped to reflect the behaviorally significant variation within a region at one time, between regions, or is one of the several regions over the long run" (1990:52). With this in mind, Balkansky discusses the theory of concordant change when explaining cultural change at the macroregional scale. Concordant change "is meant to describe an empirical reality in which settlement shifts over multiple regions occur simultaneously (and are linked historically) but with differing local outcomes" (2006:76). Therefore, studies looking to incorporate a macroregional scale of analysis to explain cultural change must understand the operating forces of change at all scalar levels of analysis (Balkansky 2006). This requires analysis and the understanding of the interactions that occur within and between regions, namely by analyzing interaction at the community scale. However, in order for this to happen, in order for the settlement system analysis to be carried out on multiple scales leading to the macroregional scale, the one theoretical factor that must be in place throughout the analysis is the analysis of these units as open systems. Once the site, community, and regions are viewed as open systems with fuzzy boundaries, the analysis can allow for interaction to be accessible to a settlement systems analysis on multiple scales.

Therefore, I believe that through the scalar unit and theoretical underpinnings of community change and interactions, this dissertation will be able to extrapolate patterned interaction and change of communities on the regional scale to those interactions and changes occurring in adjacent regions, thus allowing for a macroregional model to be developed and analyzed. It is the goal of this dissertation to use this framework to compare the Zacapu and Lake Pátzcuaro Basins, thus providing a macroregional analysis in the vein of concordant change. To be more explicit, the comparison between these two basins does not claim to be a complete macroregional analysis, but merely a settlement analysis between two regions that will hopefully aid in the construction of a larger, testable model for macroregional, concordant change.

*Discussion*

This dissertation looks to several excellent settlement studies done in order to construct the theoretical framework that will guide the methodology, analysis and interpretations of this dissertation. The work from Balkansky et al. (2000) in the Mixteca Alta region near the Oaxaca Valley, Mexico provides a regional analysis of a settlement system, spanning approximately 3,000 years (2000: 365). This survey, which was full-coverage and intensive in nature, sought to generate specific regional data sets, such as site size over time, surface architecture and site plans, artifact distributions, modern place names, trials and boundaries, ancient and modern agricultural features and physical environment data (Balkansky et al. 2000:368). From these data sets, the project attempted to establish a settlement pattern across phases, thus explaining phase transitions and creating a connection to the nearby Oaxaca Valley surveys (2000: 368). The survey and the subsequent data sets did pose limitations, as the survey was relatively small- scale and often non-contiguous, which according to Balkansky placed interpretive limitations on the results (2000:366). Furthermore, the survey battled soil erosion, which limited site preservation and site visibility, thus affecting artifact collection and site recording (2000:369). But because the study benefited from a carefully planned research strategy, the data set accommodated research questions and variables ranging from archaeological to ecological and from a regional to macroregional scale.

Like the research from Balkansky et al. (2000), this dissertation is dynamic in its research scope, and accommodates scales from the region to the macroregion. It is also similar in its goal of analyzing spatial units over several periods of time, thus creating a longitudinal view of settlement. And, like the Mixtec Alta survey, the surveys in the Lake Pátzcuaro Basin also had limitations in the field that will hinder the analysis and interpretations. In chapter one of this dissertation, the Lake Pátzcuaro Basin is defined as a region, and a case is made for why it can be analyzed as one. The surveys in the basin have been non-contiguous, and the erosion and site visibility a factor in every survey. Yet, like the Mixtec Alta surveys, because they were full- coverage and intensive in nature, the data from the Lake Pátzcuaro basin surveys have the ability to answer research questions on a regional and macroregional scale. Like the Mixtec Alta surveys abutting and being coupled with the Oaxaca Valley surveys, it is also the case that, with the right research design, the Lake Pátzcuaro surveys may be coupled with the Zacapu Research (Michelet 1988, Migeon 2003) to form a macroregional unit of analysis for a settlement system study. It is this factor, coupled with the ability to go beyond the collection of only archaeological data and to include ecological and anthropological data, which makes Balkansky et al.'s (2000) study a good template for this dissertation. The ability to look at the social and natural environment through the artifacts and ecofacts across time allows the researcher to accommodate variables that directly assess the history of interactions between the human component and the environment. By accommodating several types of data from multiple lines of evidence (i.e. ethnohistoric, ecological, and archaeological) the analysis and subsequent interpretation is able to comment on the nature of human adaptation in a region, in this case exemplified by the settlement system of a society.

**Method**

This section will deal with the identification and mapping of communities in the Lake Pátzcuaro Basin, which is an essential stage in the methods of this dissertation. The goal is to be able to isolate the communities in space and time, thus mapping them through the 1,600 year temporal scope of this analysis. Once the communities are spatially isolable for each phase of occupation, we can begin to analyze the material remains present within the community, which provides two significant pieces of data that are necessary for the settlement system analysis and testing of the settlement model presented in Chapter 1. The first is to be able to provide accurate population estimates for each phase based on community area and artifact density, and also informed by ethnohistoric sources and ethnographic research. Crucial aspects of demographic reconstruction are the rank-size graphs which were completed for each phase to better analyze the distribution of population among the communities for the survey area. Adopted from geography, the rank-size graph is used to characterize the "evenness or unevenness of population distribution across the settlements in a region" (Drennan and Peterson, 2004:533). The rank-size rule suggests "that we might expect the rank 2 settlement to be half as large as the rank 1 settlement; the rank 3 settlement to be one-third as large as the rank 1 settlement and so on", producing a straight-line pattern (Drennan and Peterson, 2004: 533). However, this comparison to what the previous sentence describes as a log-normal distribution isn't entirely useful for Prehispanic populations. Drennan and Petterson make the case that "direct comparison on observed rank-size curves to each other is of greater utility in identifying chronological change and inter-regional variation in settlement dynamics as reflected in rank-size patterns" (2004:533). Therefore, the rank-size graphs produced for each phase in this analysis are compared to one another to better understand the dynamic changes and characteristics of the population through time for the southwest survey area in the LPB.

A secondary goal to be used from this data is to attempt to provide a longitudinal view of the use of space through artifact function. Through the employment of these techniques, we may better understand the material correlates between a population, or community, and their economies. Furthermore, by understanding the use of space of a community and the economic functions of the different populations in the society, one can not only analyze change over time regarding the economy, but also social complexity and social class.

*Reconstructing Prehispanic Communities*

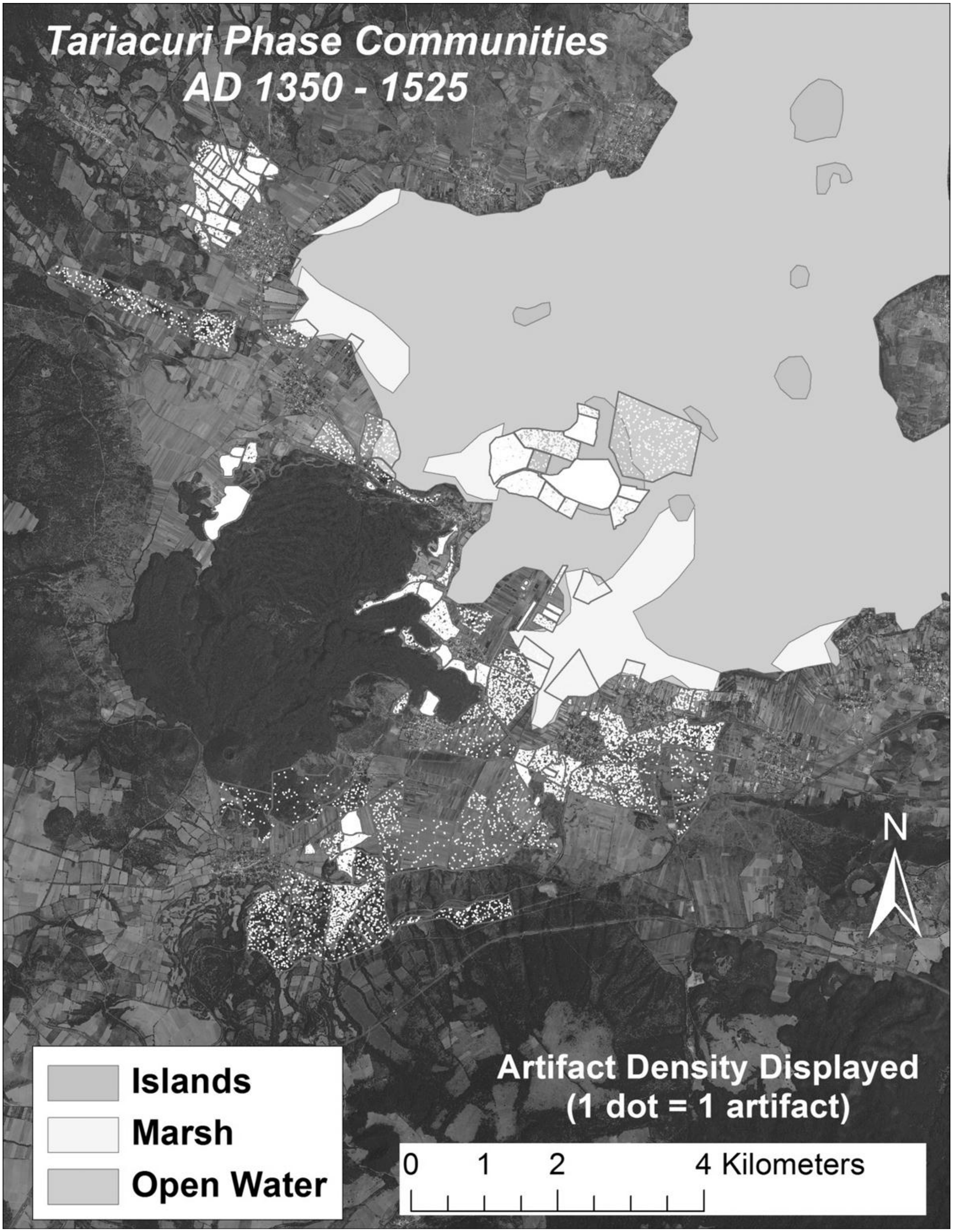
The essential variable of this analysis is the community, as it has been defined previously. This essential unit is the basis for the demographic and spatial analysis to follow. Therefore, all attempts are made to be explicit about the methods for identifying and delineating the community. The following section moves away from theory and into practice, utilizing new technologies and systems in order to best identify the communities of the southwest LPB. Once again, to reiterate, the data that is the source for this analysis derives from two combined field seasons, the Urichu, Pareo and Jaracuaro Projects from 1990 and 1996, and the Erongarícuaro Project from 2001. First, the identification of communities is discussed, followed by the delineation of communities, the analysis of the communities, and ultimately the demographic reconstruction of the communities.

*Identifying Communities*

The first step in reconstructing the communities of the southwest LPB was the creation of a geographic as well as relational database for the archaeology. Geographically, the survey data from Pollard's surveys (Tzintzuntzan, Urichu, Pareo, Jaracuaro, and Erongarícuaro) were all converted into digital form using the database program Filemaker. The product is a relational database that allows for dynamic searches and analysis to be performed on a large host of archaeological data. The second step was to digitize the survey maps and enter the survey data into a Geographic Information System. The program used to accomplish this task was ESRI's ArcInfo, with ArcMap being the most-used tool for analysis and database creation. The result was a dynamic mapping database, with each survey site located using real world geographic coordinates (UTM), and containing an attribute table that lists all artifacts and ecofacts found at that site. This geodatabase effectively allows for analysis by site, by phase, by artifact category (i.e. ceramic, lithic, obsidian, pipe, etc.), thus allowing for basic spatial patterning of archaeological data. Furthermore, the use of high resolution satellite imagery and digital elevation models allows for further analysis of the lake basin in conjunction with the archaeological data. It is through these combined sources, as well as the use of ethnohistoric, geographical and ethnographic data, that the communities were then analyzed.

The first step of the identification process was to view the survey site data by representing the artifacts in a dot density map. Each artifact type, as recorded in the Project Catalog, was used (ceramic, obsidian, basalt, figurine, pipe, recortado), and each single artifact was represented by a dot on the landscape. This effectively produced a dot density map of every artifact found in the survey area. Then, the map was further narrowed by phase, eliminating all artifacts except for those in the specific phase defined by the user. This was done through an exclusion tool in the symbology section for the survey sites in GIS. In order to be able to display the data by phase, each survey site was given qualitative data for the phases and periods they were occupied (i.e. Tariacuri, Loma Alta, Early Postclassic). Several sites, though, contained artifacts from multiple phases, and therefore querying these results for a single phase soon became difficult. To combat this, phases for the survey sites were then entered into the GIS using a binary system, where the presence/absence of a phase was entered in 1's and 0's, 1's being presence, 0's being absence. Thus, to view only sites that contained Late Urichu phase material, the exclusion would be in the form of the following if/then statement "exclude all sites where Late Urichu=0." Once this was done, the GIS then displays a dot density map of artifacts that represent only one phase. An example of this is Figure 8, which shows the Tariacuri Phase artifact densities.

*Figure 7 – Tariacuri Phase Artifact Densities and Clusters*

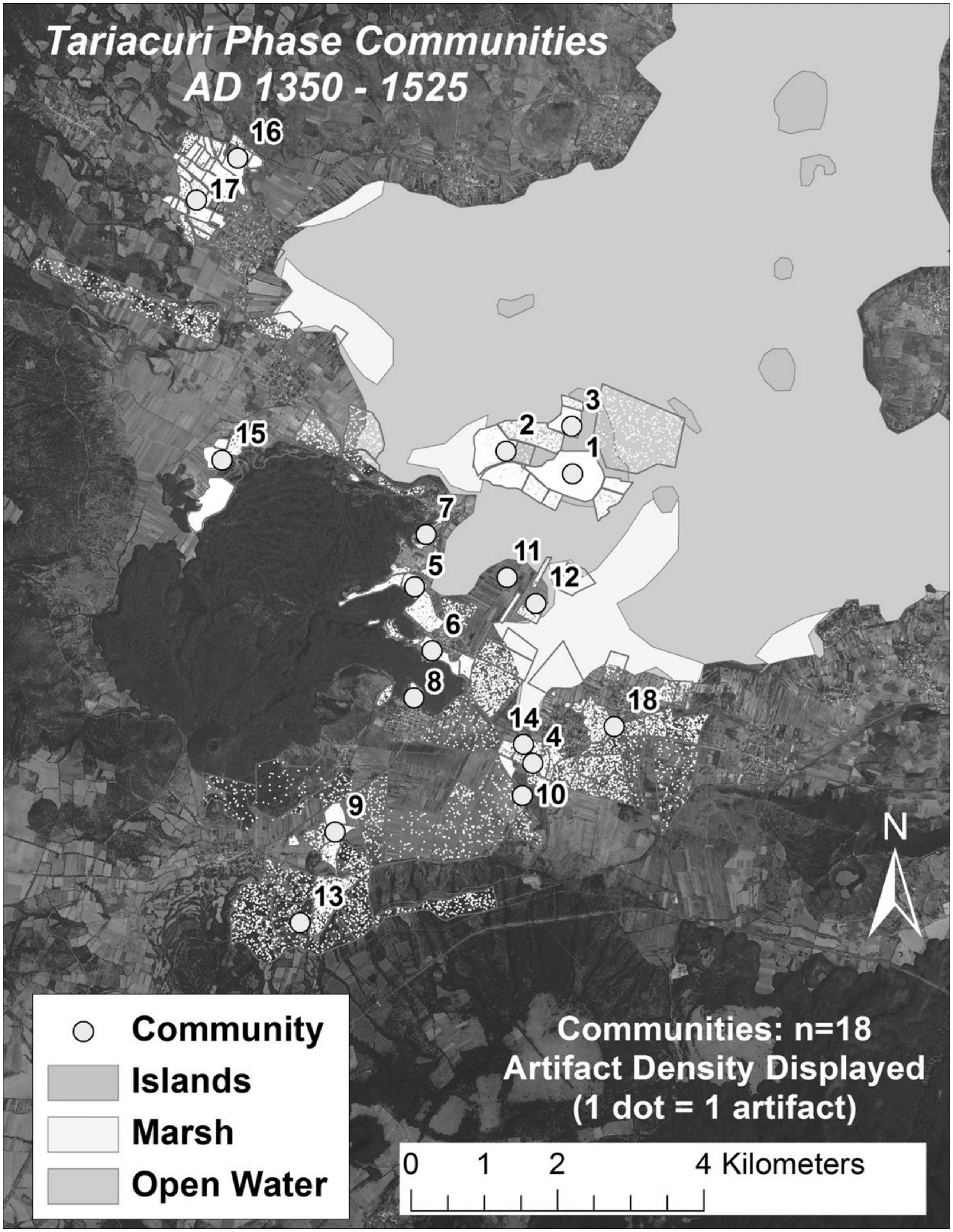


This method was carried out for each of the phases beginning with the earliest; Loma Alta, Jaracuaro, Lupe/La Joya, Early Urichu, Late Urichu, Tariacuri. The result was a map of artifact clusters on the landscape. The next step was to then identify each community by phase. In the literature, much of which has been discussed earlier, much is said about the subjective nature of identifying and delineating communities. And not to be overly repetitive, but some of this will be revisited in order to attempt to remain as explicit and objective in this process as possible. Some of the best and most scholarly work on the subject comes from Drennan and Petersen (2005, 2006, 2010) and their work in China, Mesoamerica and northern Peru. It is their position that identification of archaeological units varies at differential scales of analysis. For example, they posit that at a smaller scale, certain clusters of artifacts or collection units may best represent a "site", as we know it in archaeological terms. Yet this is a misleading unit, and when viewed at a larger scale, these "sites" may be clustered to then for a "community". And further, at an even larger scale, these communities may then be clustered to form larger, regional communities or community groups (2005:8). The analysis discussed here looks as far as the "microregion" as the scale of analysis. The identification of communities primarily took place at a scale of 1:20,000 in the GIS. This was to ensure that smaller units would be able to be identified without further grouping into larger units, so as to be able to locate possible hamlets or small villages. This scale also was useful for identifying the larger communities, those which may be administrative centers or possible towns.

Once the appropriate scale was chosen, a central point was created to locate the community in space on the landscape. This was not done lightly however. First, the clusters were analyzed by site to determine artifact densities, where heavy denotes areas with greater than 25 artifacts per square meter, medium heavy are areas between 15 and 25 artifacts per square meter, medium being between 10 and 15 artifacts per square meter, medium light being between 5 and 10 artifacts per square meter, and light being 1 to 5 artifacts per square meter. In some cases, a cluster comprised only one site, and the center point was put in the middle of that site. However, sometimes clusters contained several sites. In this case the central point was put in the area of highest artifact density, with the surrounding sites having lower densities. If all sites contained equal artifact densities, the central area was located and determined to be the center point.

The field notes for the survey seasons were often visited to note the field conditions of the survey site, and the notes were also used, as well as 10-meter contour lines in the GIS to note the topography of the area. In very few cases, sites were classified as erosional depositions, and I made sure not to include these as possible communities. Furthermore, the topography aided in locating the possible center of the community, or where community boundaries were hard to distinguish based on artifact clusters alone, the topography was used to further aid in the identification and delineation of communities. A map of the located communities is shown in Figure 9, for the Tariacuri Phase.

*Figure 8 – Community Locations for the Tariacuri Phase, LPB*



*Delineating Communities*

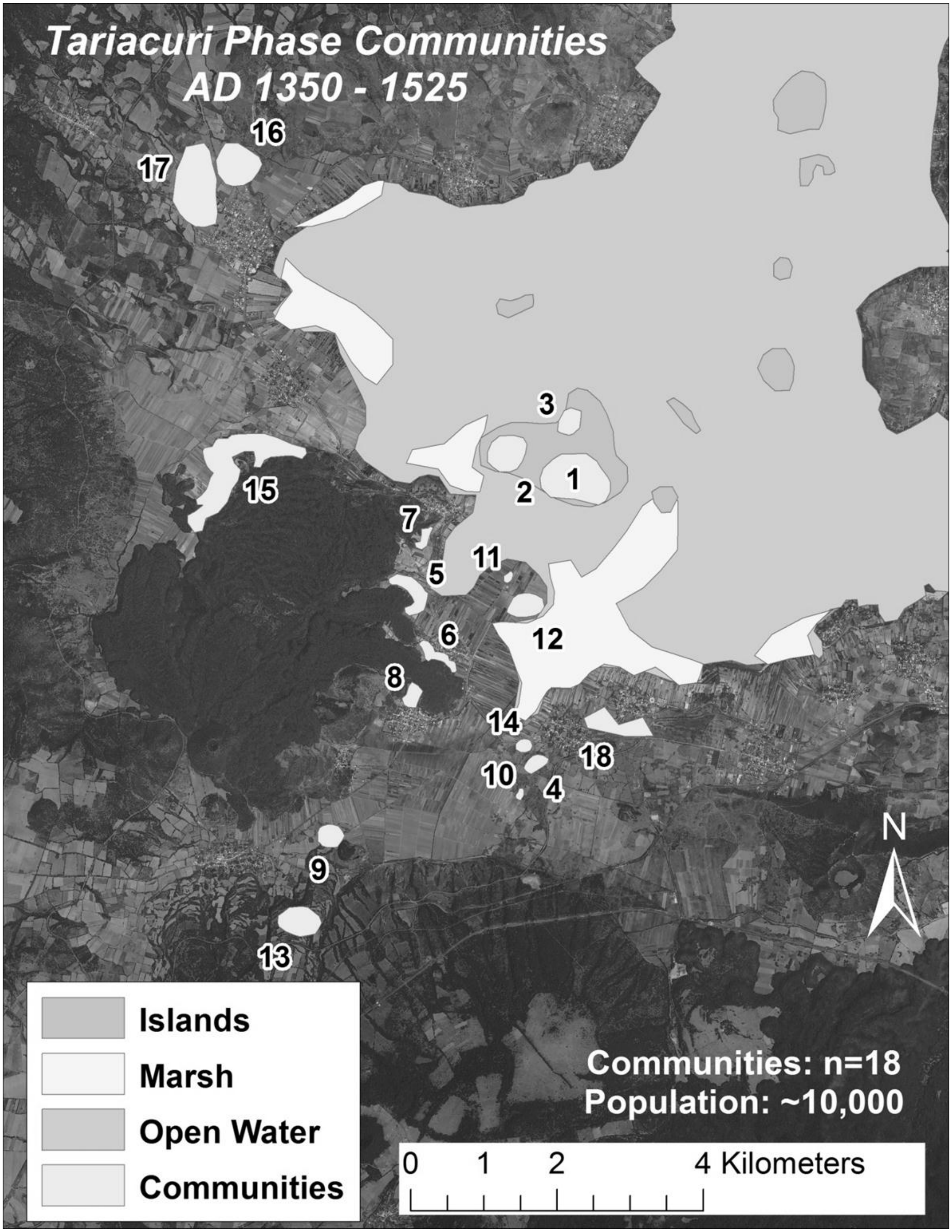
Several factors were taken into consideration for the delineation of communities. Once again, the issue of scale plays an important role, and once again the analysis was undertaken at the micro-regional level, at a scale of approximately 1:20,000. The vital variables taken into consideration were artifact density of the focal site, the artifact densities of surrounding sites (if applicable), the area of these sites, and the topography of the landscape. Once again, the field notes were visited to ensure that specifics on artifact concentrations and site topography were taken into consideration. This was done for each the communities by phase. The difficult part, as one would expect, was defining the outer edges of the communities. The delineation was done in such a manner to include the major areas of artifact concentration, with the border coming at the areas of drop-off of artifact densities. This isn't to say that outer areas weren't part of the communities, or even that there were no habitations in these areas. Simply put, it is impossible to fully reconstruct the exact boundaries of the social landscape of the past, and for this analysis the major determining factor was the artifact concentrations.

The result was a map of communities, with attributes of artifact densities, specific artifact counts, the survey sites included, and the area of the community in hectares. The results of both the identification and delineation of communities can be seen below in Table 5. Figure 10 shows the communities for the Tariacuri Phase. Final community maps for all phases are located in the appendices, including initial locations and the community areas arrived at from the delineation.

*Table 5 – The Mapping of Communities in the LPB*

| **Period** | **Phase** | **# Comm** | **Total Size of Comm** |
|---|---|---|---|
| Late Preclassic to Early Classic | Loma Alta | 6 | 46.61 hectares |
| Middle Classic - Epiclassic | Jaracuaro, Lupe/La Joya | 11 | 82.98 hectares |
| Early Postclassic | Early Urichu | 17 | 111.30 hectares |
| Middle Postclassic | Late Urichu | 35 | 276.39 hectares |
| Late Postclassic | Tariacuri | 18 | 318.61 hectares |

*Figure 9 – Tariacuri Phase Delineated Communities, LPB*



*Analysis and Demographic Reconstruction of Communities*

The method and process for demographic reconstruction of prehistoric populations has been a much debated and tenuous aspect of archaeological research. The roots of present-day demographic reconstruction in archaeology can be traced to the New Archaeology, and several seminal projects in Mesoamerica in the 1960s and 1970s, including those in the Basin of Mexico by Sanders and Parsons. Along with William Sanders, Parsons completed an archaeological survey in the Texcoco Region, which lies to the south of the Teotihuacan Valley. The survey built upon the earlier theory and method of archaeological settlement pattern analysis, and consisted of four major objectives: (1) a classification of the sites, which inferred site function, that was methodologically sound, (2) an estimation of relative populations for different time periods, (3) a chronological framework, (4) and some understanding of productive potential of the survey area for each period in question (Parsons 1972:142). By defining and meeting these objectives, the survey was considered methodologically sound and therefore the data derived from said survey could be safely used to determine settlement patterns and to estimate population size across time and space. Furthermore, larger research questions could be asked in relation to the surrounding archaeological landscapes, such as the dominant state-level society of Teotihuacan to the north.

The methods introduced field-by-field surface survey, where large aerial photographs were used to directly field plot archaeological features and detect ancient occupations. By doing this Sanders and Parsons were able to plot the distribution of sites for eight or nine temporal phases over large continuous tracts, with the confidence that all or most sites were accounted for (Parsons 1972:141). According to Parsons, "these distributional patterns served as the basis for inferences regarding changing patterns of land use, population expansion, sociopolitical evolution, and economic integration" (1972:141). Unfortunately, problems arose with the control of site function, and artifact density was estimated based solely on the visual appraisal in the field, and no objective, quantitatively derived index was made. This, according to Parsons, made it difficult for others to adequately analyze the survey data and arrive at an occupational density (1972:141). This last aspect is intrinsically tied to issues of artifact sampling in archaeological surveys.

This method developed by Sanders and applied in the Basin of Mexico was later applied to the Oaxaca Valley, a region to the south of the Basin of Mexico that was once home to the Zapotec Empire. Detailed by Feinman (1985), the basic strategy for the complete archaeological survey as well as estimating population density was taken from Sanders and Parsons, with minor changes made for their specific conditions. Both studies proceeded on the assumption of a general relationship between the areal extent of a settlement and the population of that locality (Feinman 1985: 336). Therefore it was possible to make a direct correlation with the settlement size and a population size. On a smaller scale, the extent of a site was defined as a cluster of cultural material separated by at least 100 meters from other such clusters (Feinman 1985). The basic methodology that linked the site with a population estimate was by defining the artifact density found for that site. Thus, the clustering of sites created the larger settlement, and by calculating population density for the site, Feinman could then extrapolate the estimate for the settlement.

The artifact density categories that were set up by Parsons and Sanders and utilized by Feinman created a methodology to qualify the quantity of artifacts found for each site. The categories, set up by Sanders, are explained as such: (1) trace to very light artifact densities correlate with what Sanders described as a compact low density village or scattered village. They are evidenced by a scatter of sherds separated by intervals of up to a meter, but most often several centimeters, in wide scatter distributions. (2) Light to moderate density areas correspond to Sanders' compact low-density village, and are evidenced by sites with intact architecture and denser concentrations of sherds distributed in an almost continuous layer with some areas of appreciable build-up. (3) Moderate heavy and heavy densities correspond to Sanders' high-density compact village, and are evidenced by the densest forms of artifact distributions (Sanders, Parsons, Santley 1979: 34-40, 52-60). After categorizing the sites based on the artifact densities, one may associate a population density estimate for each of the artifact density categories (Fisher 2000:95-96). For example, one may quantify a site with a moderate artifact density as having a population density of 25-35 persons per hectare. Therefore, if the site was five hectare in size, the population range for that site would be in the range of 125-175. Once the site densities have been calculated, the settlement size may also be calculated in terms of a range of population estimates. Feinman found that the sites in the Oaxaca Valley varied less in terms of artifact density than in the Basin of Mexico project. He concluded that the majority of the sites found in the Oaxaca Valley fell within the population density range of 10-25 people per hectare (Feinman 1985:336).

Feinman also analyzed occupied, residential terraces in terms of population size. These residential terraces were treated as "houselots", and could therefore be analyzed in terms of occupied households that inhabited each terraced area. This is another form of population estimates from archaeological data that is more specific than dealing with survey data. As Chamberlin (2006) explains, methods for estimating population size from the floor area of dwelling space is a more precise method than dealing with issues of surface scatter of artifacts for settlement sizes. Ethnoarchaeological studies have been done by Gorenstein and Pollard (1983), De Roche (1983) and Hassan (1981) to determine the estimates of space occupancy per person in instances where households and floor areas are present.  By studying present-day Mesoamerican peasants, Kolb and Snead's study found that the space occupancy in Mesoamerican agricultural households is 6.1 $m^2$ per person (1997).  Chamberlin explains that when applying these formulas it is important to distinguish between habitation space and storage and livestock space, and to "take into account the proportion of buildings or rooms that were occupied at any given time" (2006:126).  Also, Chamberlin stresses the use of stratigraphic evidence to determine the temporality of occupation (2006:127).

Specifically for the Lake Pátzcuaro Basin, Pollard's ethnoarchaeological study in the late 1970s led to two methods for estimating Prehispanic populations.  The first method looked at census data from the 1940s and 1970s taken by the Mexican government.  By mapping and analyzing the settlements in the 40s and 70s, Pollard referred to the $16^{th}$ and $17^{th}$ century ehnohistoric documents to try to correlate the modern settlements to those listed in the ethnohistoric records.  Doing such allowed for Pollard to create categories of settlement class based upon the current settlements and the ethnohistoric data.  She concluded that there were five distinct classes that existed Prehispanically: (1) the capital, which we know was Tzintzuntzan, whose population range is from 25,000 to 35,000, (2) the center, which ranges from 3,000 to 5,000, (3) the town, which ranges from 1,000 to 1,500, (4) the village, which ranges from 100 to 500, and (5) the hamlet, which ranges from 30 to 80 in population range (Pollard 1983:61).

The second ethnoarchaeological method tested the agrarian potential in the Pátzcuaro Lake Basin, thus allowing for an estimate to be made on the possible carrying capacity of the basin and the maximum population size it could hold.  This type of paleoecological reconstruction allowed Pollard to determine the extent and degree of land use and subsistence agriculture (1980:274).  These figures are based on potential maize crops and maize consumption patterns of modern populations. Ultimately, Pollard found that the Tarascan state at the time of Spanish contact was well above the local carrying capacity of the Lake Pátzcuaro Basin (1980:274, 1983).

A study based on Pollard's and that utilized her ethnoarchaeological census data was developed by De Roche. The goal was to use modern data on settlement area and population to retrodict population size of Prehispanic settlements in the lake basin for which "archaeological investigations have provided or might provide estimates of settlement area" (De Roche 1980:187). Pollard's original ethnohistoric research identified n=91 settlements that have been evidenced in the ethnohistoric data from the 16th century. From the recent data (1940's) and then modern data (1970s), n=97 settlements have been identified and their sizes calculated in order to predict populations. De Roche analyzed the populations at different scales, such as the residence, the settlement and the regional populations. She found that by basing her predictions on the residential units, where the average number of people per household was 5.972, a more accurate regional population estimate was arrived at for the 1970s census data.

The goal of the prediction of the 1970s population data was to correctly arrive at an estimate of persons per hectare, which would be a figure that could be applied to the Prehispanic Tarascans. De Roche argues that because a complex agrarian society has persisted in the lake basin through half a millennium with relatively little change, one may justify using the parallels of settlement and population data to retrodict population and settlement size. This led to the conclusion that an accurate range for persons per household falls between 5.71 and 6.11, which also matches Kolb's assessment (1983:191). De Roche also came to an average figure of thirty persons per hectare for estimating the basin's total population (1983:191).

A final attempt at population and settlement estimation for the Tarascans comes from Fisher. In his dissertation (2000), he utilizes the methods laid out by Parsons, Sanders and Santley (1979) to calculate population density based on artifact density (See Table 6). His focus is on the southwestern-most survey area which includes the lake basin centers of Jaracuaro, Pareo, and Urichu.

*Table 6 – Parson's, Santley, Sanders (1979) Artifact to Population Density Estimates*

| ***Artifact Density*** | ***Sanders' Descriptor*** | ***Population Density*** |
|---|---|---|
| trace to very light | Low Density Village / Scattered Village | 5 to 10 persons per hectare |
| light | Compact Low-Density Village | 10 to 25 persons per hectare |
| moderate | Compact Low-Density Village | 25 to 35 persons per hectare |
| moderate heavy / heavy | High-Density Compact Village | 35 to 50 persons per hectare |

Fisher calculated two measures of density based upon these ranges, occupation concentration and settlement density. Concentration is a "measure of the number of persons present at an occupied site for a given phase and is calculated by dividing the area of the site in hectares by the estimated archaeological population" (Fisher 2000:96). Settlement density is a "measure of the number of persons occupying the study area during a given phase and is calculated by dividing the estimated archaeological population by the size of the survey area in hectares" (Fisher 2000:96).

This analysis will utilize a combination of the three methods discussed above: 1.) Pollards' ecological and ethnohistoric study which relies heavily on the Spanish ethnohistoric documents from the 16$^{th}$ and 17$^{th}$ centuries, 2.) DeRoche's ethnographic study which retrodicts population per household and per hectare, and 3.) Fisher's approach to population using artifact density to achieve an estimated range of population for a given area.

*Table 7 – Past Estimates concerning prehispanic Populations*

| ***Author*** | ***Method*** | ***Population Estimates*** |
|---|---|---|
| Pollard (1980, 1983) | paleoecological reconstruction and carrying capacity analysis, ethnohistoric analysis | 60,750 - 105,000 (total lake basin, protohistoric) |
| De Roche (1983) | population prediction/retrodiction, settlement analysis | 5.972 persons per residence; 30 persons per hectare |
| Fisher (2000) | artifact density analysis, paleoecological reconstruction | see table 6 |

For each approach, the communities were categorized based on artifact density and size (hectares). The easiest populations to calculate were those using Fisher's and DeRoche's methods, where simple calculations based on the community size were performed and a final number, or range of numbers, were given for that communities population. Gorenstein and Pollard's method though, was more detailed. Pollard's method involved placing each community into settlement classes, as was done in the 1983 study. These settlement classes are a derivative of the ethnohistoric documents and the populations recorded by the Spanish at the time of contact and into the 17th century (described above). For this method, each community was given a rank, and therefore an associated population range. However, this method was derived primarily for the Protohistoric period in the lake basin. These population estimates, as well as the settlement classes, can be retrodicted into the Late Postclassic period, during the Tariacuri phase (A.D. 1350 – 1525). However to apply these population estimates to any phases earlier assumes a total lake basin population equal to a population during the height of the Tarascan state, which simply wasn't the case. To estimate population for earlier phases, Pollard has derived estimated populations for both the survey areas as well as the basin, based on her earlier work as well as Fisher's population estimates (Pollard 2008:223). In order to follow through with a consistent analysis, Gorenstein and Pollard's population ranges from the 1983 research will be used through all phases, and although primarily intended for use during the Protohistoric, they will allow comparative estimates for the other demographic calculations. In any case, the 2008 estimates will be used as checks on the method carried out for this analysis.

Each of the three methods was carried out through all phases of occupation for the survey area of this analysis. The first method, established by Pollard, produced a range of population based on the settlement rank given to the individual community. The second method also produced a range of population, and was based on artifact density, giving a population estimate per hectare. The third method, based on DeRoche's ethnographic, demographic retrodiction, produced a single population number based on her 30 people per hectare estimate. The population results for the reconstruction for all three methods are given below in Table 8. More detailed tables can be seen in the appendices, and display the population reconstruction data for each time phase, and include the individual communities for that phase, the community area, population for each method, and the survey site(s) that comprise it.

*Table 8 – Population Estimates by Phase for the Prehispanic Southwest LPB*

| Period | Phase | # Comm | Community Size (hectares) | Artifact Density (1979) | DeRoche | Ethnohistoric (Pollard) |
|---|---|---|---|---|---|---|
| Late Preclassic to Early Classic | Loma Alta | 6 | 46.61 | 422-1030 (726 mean) | 1398 | 390-1740 (1065 mean) |
| Middle Classic - Epiclassic | Jaracuaro, Lupe/La Joya | 11 | 82.98 | 702-1683 (1193 mean) | 2500 | 610-2560 (1585 mean) |
| Early Postclassic | Early Urichu | 17 | 111.30 | 863-1792 (1328 mean) | 3339 | 720-2620 (1670 mean) |
| Middle Postclassic | Late Urichu | 35 | 276.39 | 4175-8443 (6309) | 8292 | 3860-9980 (6920 mean) |
| Late Postclassic | Tariacuri | 18 | 338.41 | 7962-12708 (10335 mean) | 10151 | 6980-13530 (10255 mean) |

Several things are of note for the demographic reconstructions. The most accurate reconstruction of population was for the Late Postclassic period, Tariacuri phase. The research from Pollard (1980, 1983) and her work with the ethnohistoric documents provides this method with sound correlations and bridging arguments with the archaeological data, as well as the ethnographic data. The same can be said for DeRoche's method (1983), which relies heavily on ethnographic data to make correlations for the pre-Conquest period (DeRoche 1983:191). This does, however, provide a useful and sound starting point from which to retrodict the populations in earlier Prehispanic phases, while also relying heavily on the archaeological data to guide the demographic analysis. The following sections will describe the method and results for each phase, as well as provide a rank-size analysis for each phase to test against the population numbers arrived at above. The method for the rank-size analysis utilizes the population numbers arrived at by Fisher's method, and supported by Pollard's method. In all cases, both Fisher's method and Pollard's method produced similar population estimates. However, due to Fisher's method also taking into account community area, the estimates from this method will be the primary data used for rank-size graphs.

*Loma Alta/Jaracuaro Population Reconstruction*

The Loma Alta phase, by its nature, is the most difficult phase to reconstruct population for. It remains the phase from which there has been much less archaeological research done, given the scarcity of sites in the basin, and its depth of stratigraphy. The archaeological research from Pollard in the southwest portion of the basin yielded n=6 Loma Alta phase communities. Due to the difficulty of detecting material from this phase in walk-over survey, all of these communities, along with evidence in surveys, have been confirmed using excavation as well. The artifact density counts were derived by using a combination of both surveyed material as well as excavated material. The population reconstruction for this phase used categories, according to Fisher (2000), of only trace to light and light artifact densities, equating to compact low density villages or low density, scattered villages. According to Pollard's method (1983) these also equate to settlement ranks 4 and 5, which she describes as villages or hamlets. DeRoche's estimates are too high, at a 30 persons per hectare average, to accurately retrodict population at this time. Of the six communities, three were given higher ranks or categories of higher density due to the archaeological correlates. In the case of Erongarícuaro, architecture and burials, as well as long-distance exchange noted in the burials, mark this as a central community with higher ranked individuals existing there. Excavations at Urichu also displayed similar densities of artifacts, although no architecture was present. Still, these communities accurately represent what Pollard describes is also present elsewhere in the basin for the Loma Alta phase, as "they document the existence of small-scale, socially ranked agrarian societies." (2008:220).

In each method, the estimated population for the communities in the survey area is higher than Pollard's projection, which is between 400-600 people for the survey area, and 4,500 for the basin. However, Pollard's assessment is only for the last Loma Alta phase (Loma Alta 3) and the Jaracuaro phase. Pollard gives no estimate for the Loma Alta 2 phase. Communities 3, 4, 5, and 6 from Erongarícuaro are all Loma Alta 2 phase communities. The population reconstructions from these communities through Fisher's method give a population range of 167-393, with a mean of n=280. DeRoche's method produces a population of n=1266. Pollard's method produces a population range of 190-740, with a mean of n=465. If we throw DeRoche's estimates out, and combine the low and high ranges of Fisher and Pollard's estimates to produce an average range, the population range becomes 176-567, with a mean of n=372. When we take the Loma Alta 3 phase sites, and combine them with the Jaracuaro phase sites, we get much higher population estimates than Pollard's estimate of 400-600. Fisher's method produces a range of 662-1623, with a mean of n=1143, DeRoche's method a population of n=2157, and Pollard's method a range of 520-2320, with a mean of n=1420. Once again, relying on Fisher and Pollard's methods, we still have a much higher population for the Loma Alta 3/Jaracuaro period. However, the lower range does fall within Pollard's estimates, and I believe that an accurate assessment of the population lies somewhere in the lower range of the estimates arrived at by this analysis.

Rank size graphs were created for both Loma Alta 2 and Loma Alta 3 phases. In each case, they represent a primate curve. The primate curve for the Loma Alta 2 graph is due to the large population at one primate center, located at Community 3 at Erongarícuaro. The remaining communities represent small villages or hamlets. Another possible reason for the primate curve for Loma Alta 2 could be the lack of data and the small number of observations (n=4).  For the Loma Alta 3 phase, the number of observation increase, n=6, which is still a small number. Once again, the rank size graph displays a primate curve, determined primarily by two larger communities with higher populations and several smaller communities.

*Figure 10 – The Loma Alta 2 Rank-Size Graph*

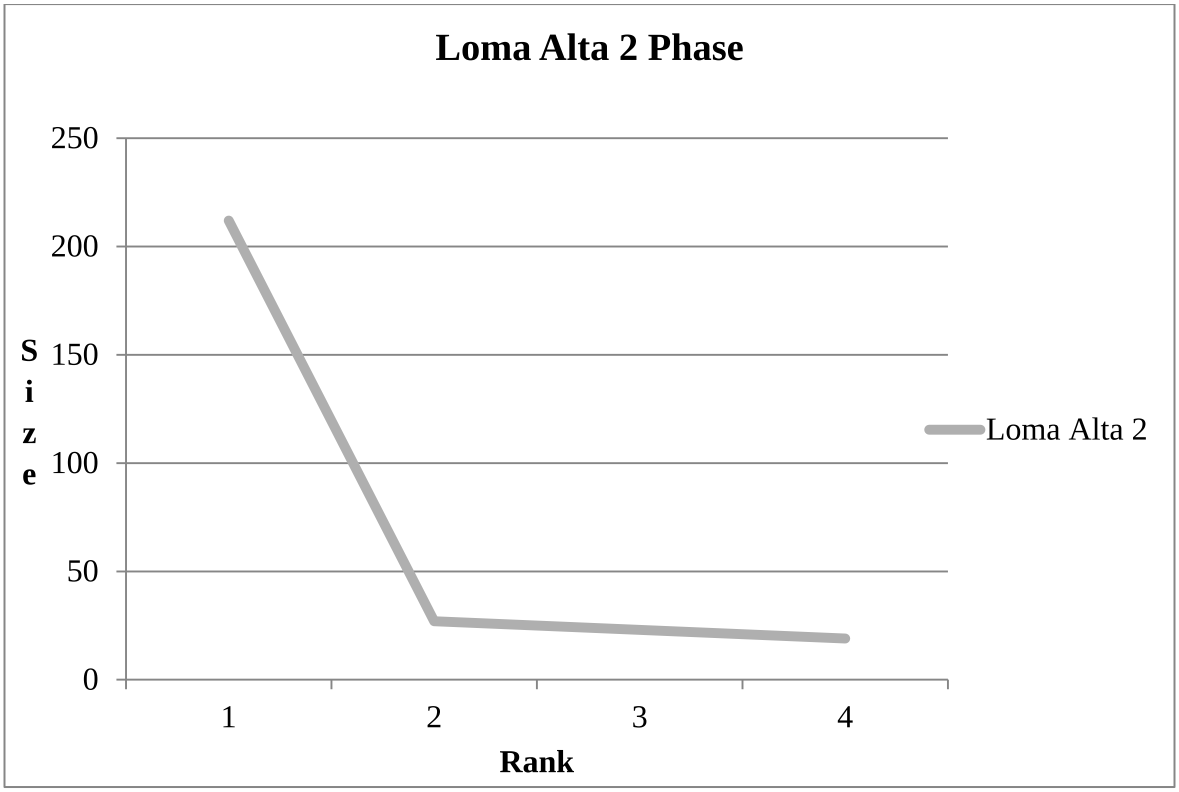
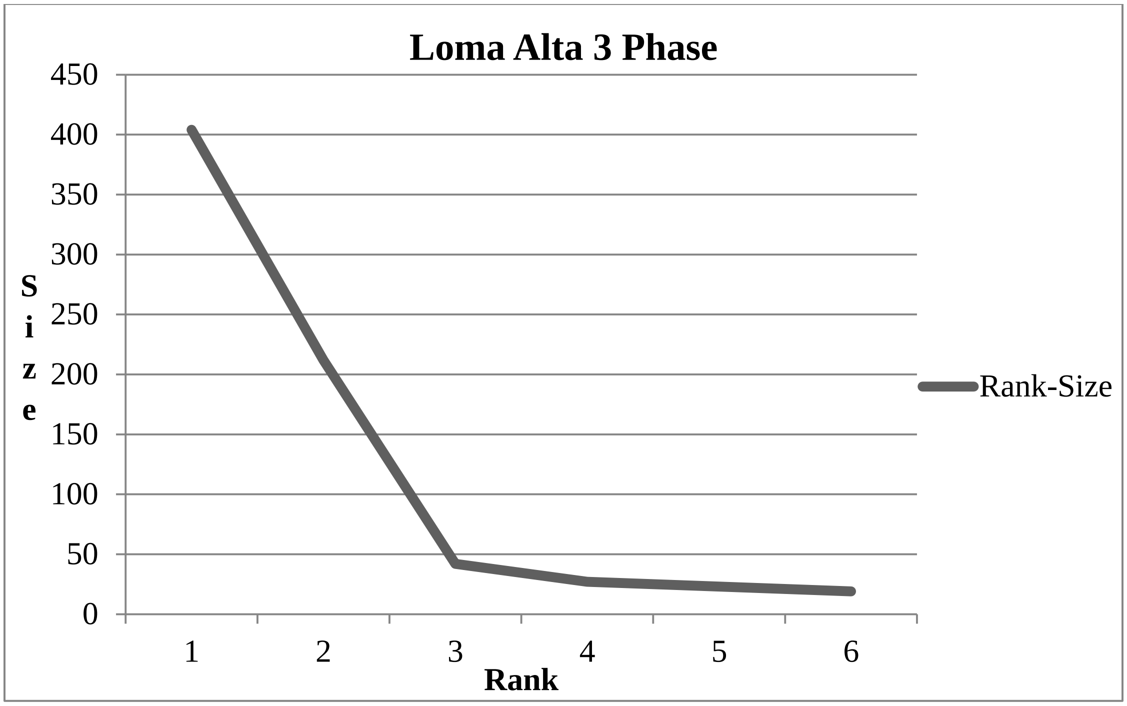


*Figure 11 - Loma Alta 3 Rank-Size Graphs*

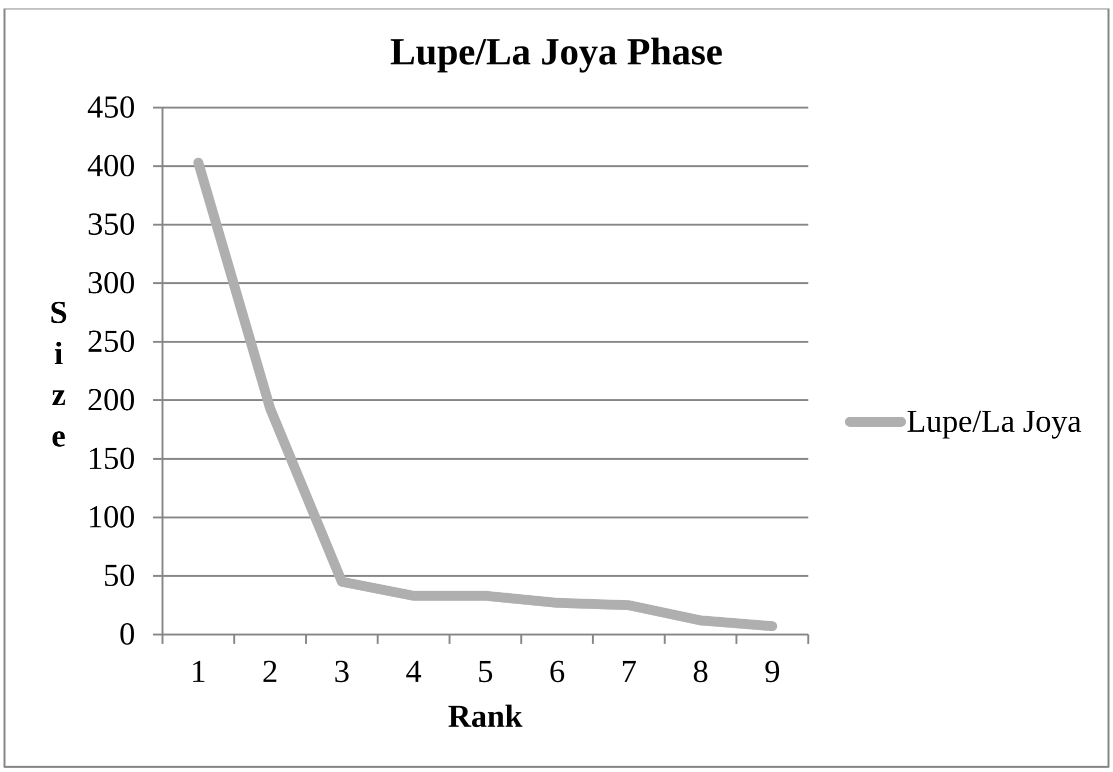



*Lupe/La Joya Phase Population Reconstruction*

The Lupe/ La Joya phases coincide with the Epiclassic period, ranging from A.D. 600 to A.D. 900. There were n=9 communities located for this phase, which is a slight increase from the earlier Loma Alta/Jaracuaro phases. The demographic reconstruction for this phase yielded population estimates as follows: The Fisher method yielded a population range of between 462 and 1090, with a mean of n=776; the DeRoche method produced a population of n=1741; the Pollard method yielded a range of between 480 and 1980, with a mean of n=1230. According to Pollard (2008), the population for the southwest survey area during this phase is estimated between 600 and 1,000, with a lake basin estimate of 6,000 and 7,000. The population number arrived at from Fisher seem to be the more conservative end of Pollard's 2008 estimate, while the Pollard method (1983) estimate seems to be on the higher end of that estimate. Once again, given the nature of the DeRoche method, this population estimate once again seems too high, given the archaeological evidence.

The rank-size graph of this period follows similarly to that of the earlier phases, displaying a primate curve.  The larger communities are those at Urichu, set back from the lakeshore.  There is then a drop off in community size, as smaller hamlets and villages dot the landscape closer to the estimated lakeshore and marsh zones.  This disparity between community sizes results once again in a primate curve.  However, we also must take note of the smaller sample size, which may conceivably lead to such a rank-size curve.

*Figure 12 - Lupe/La Joya Rank-Size Graph*



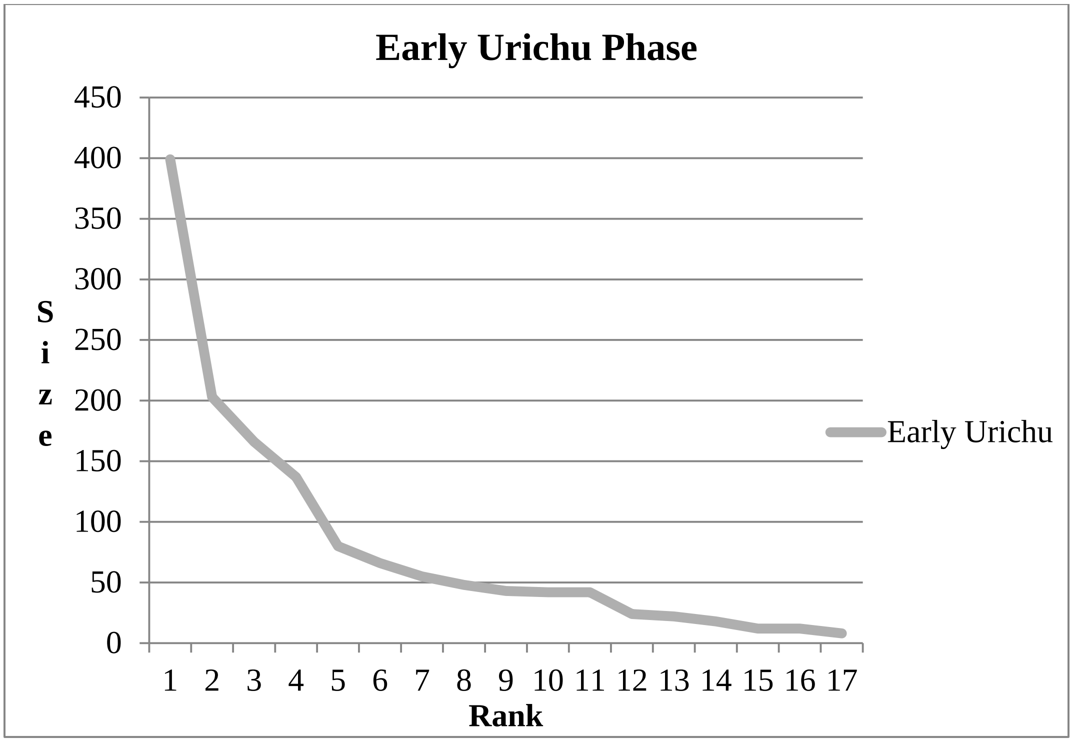

*Early Urichu Population Reconstruction*

The Early Urichu phase marks the beginning of the Postclassic, ranging in time from A.D. 900 to A.D. 1000/1100.  The location of communities during this phases shows a marked increase from the last phases, going from n=9 communities in the Lupe/La Joya phase to n=17 communities in the Early Urichu phase. However, the communities remain relatively smaller in size, mostly equating to hamlets and villages. The larger communities, at Urichu and Erongarícuaro, represent what are most likely the central villages, or even towns, where the population is the highest during this period. Pollard, in her 2008 synthetic article, estimates a population for this southwest survey area of between 1,000 and 2,000, and approximately 12,000 for the LPB. This represents a doubling in population from the last phase, both for the SW survey area and the basin. The population estimates arrived at for these analyses are as follows: the Fisher method produced a population range of between 863 and 1792; the DeRoche method a population of n=3339; and the Pollard method a population range of between 720 and 2620.

Once again, the estimate based on Fisher's method fits the estimates from Pollards' 2008 article the best, while still being on the conservative side. Pollard's method also fits her 2008 estimation, and is once again on the more liberal side. Finally, DeRoche's method is once again an outlier, and falls much higher than either method as well as Pollard's 2008 estimate.

The rank size graph for the Early Urichu phase once again shows a primate curve, although not as drastic and shows a slight move towards log-normal. This phase also had an increase in observations, thus making the confidence a little higher than the last two phases. According to Drennan and Peterson, primateness in the rank-size curve "is produced by a very few settlements in the topmost ranks, often depending almost entirely on the difference between the first and second ranked settlements" (2004:546). The curve is again due to the few more densely populated communities at Urichu and Erongarícuaro, and the higher frequency of low- population hamlets and villages. However, the move towards log-normal from the last few phases shows this dramatic increase in population for the basin, and the increase in communities and community size. And, according to the community ranks and sizes, the communities are growing slightly in area (hectares) which shows a light growth in community make-up and demography.

*Figure 13 - Early Urichu Rank-Size Graph*



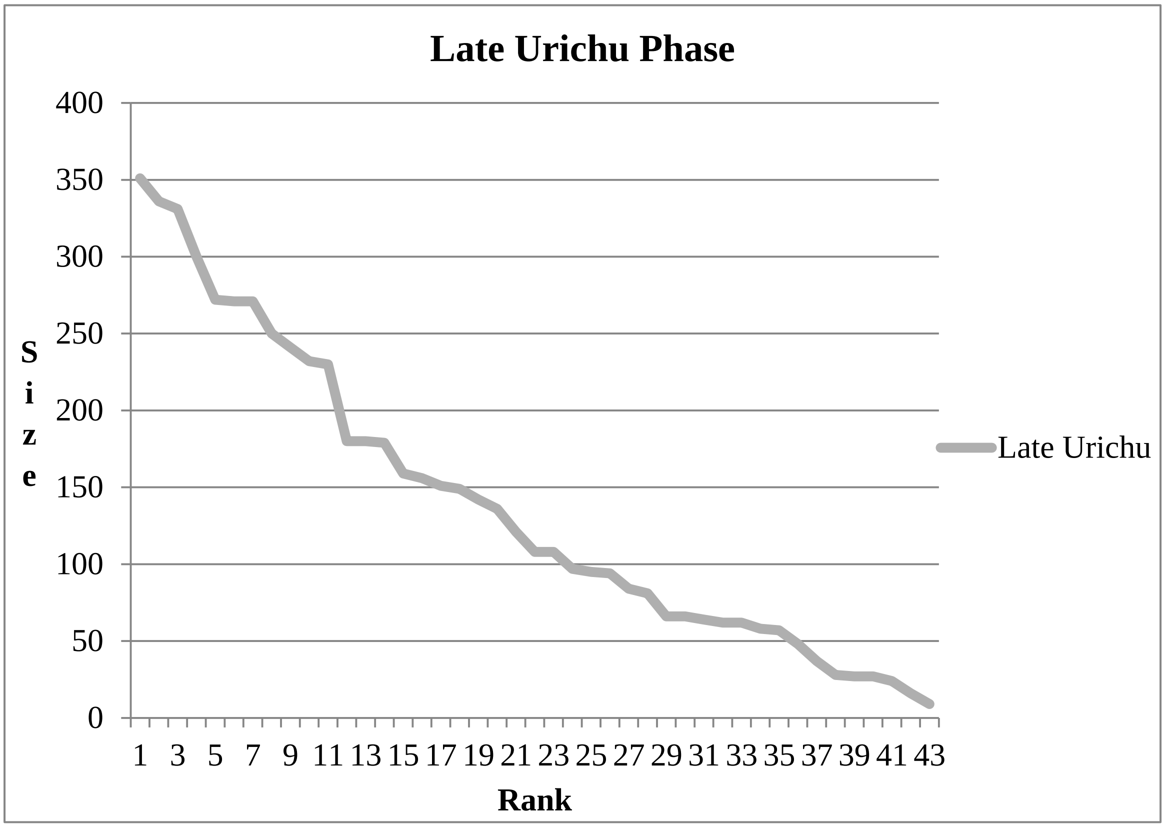

*Late Urichu Population Reconstruction*

The demographic reconstruction for the Late Urichu phase coincides with the Middle Postclassic, between A.D. 1100 and A.D. 1350. According to Pollard (2008), we see "the number of sites in the Pátzcuaro Basin increased, and the area of occupation again doubled" (2008:224). According to Pollard (2008) the population at this time for the survey area ranged between 4,000 and 7,800, with a basin population estimated at 48,000. The demographic reconstruction for this phase located n=43 settlements, a vast increase from the Early Urichu phase. However, the communities were smaller in area, with the majority representing small villages and hamlets, and only a few representing major central communities with denser populations. For the demographic reconstruction method, only a few communities were characterized as compact, high-density sites, or, according to Pollard, as rank 3 settlements.

Most fell within the low-density compact site category (Fisher 2000), or the rank 4 settlement (Pollard 1983). The reconstructed populations for each method are as follows: the Fisher method produced a population range of between 4175 and 8443, with a mean of n=6309; the DeRoche method a population of n=8292; and the Pollard method a population range of between 3860 and 9980, with a mean of n=6920. Once again, the Fisher and Pollard methods produced population ranges in accord with Pollard's 2008 estimates. The DeRoche estimate is once again high, although not as drastically in the earlier phases.

The rank-size graph for the Late Urichu phase shows a slight primate curve, nearing towards log-normal in its distribution. This means that with the increase in communities for the phase, we are also seeing more communities change in their nature, with a more diverse range of community types. The previous trends seemed to be that there were a few higher ranking communities with larger populations, and a high frequency of dispersed, lower density communities. However, the increase in basin population during the Late Urichu phase, for at least this portion of the basin, seems to have reversed that trend, with a growth in the middle range of community population.

*Figure 14 - Late Urichu Rank-Size Graph*

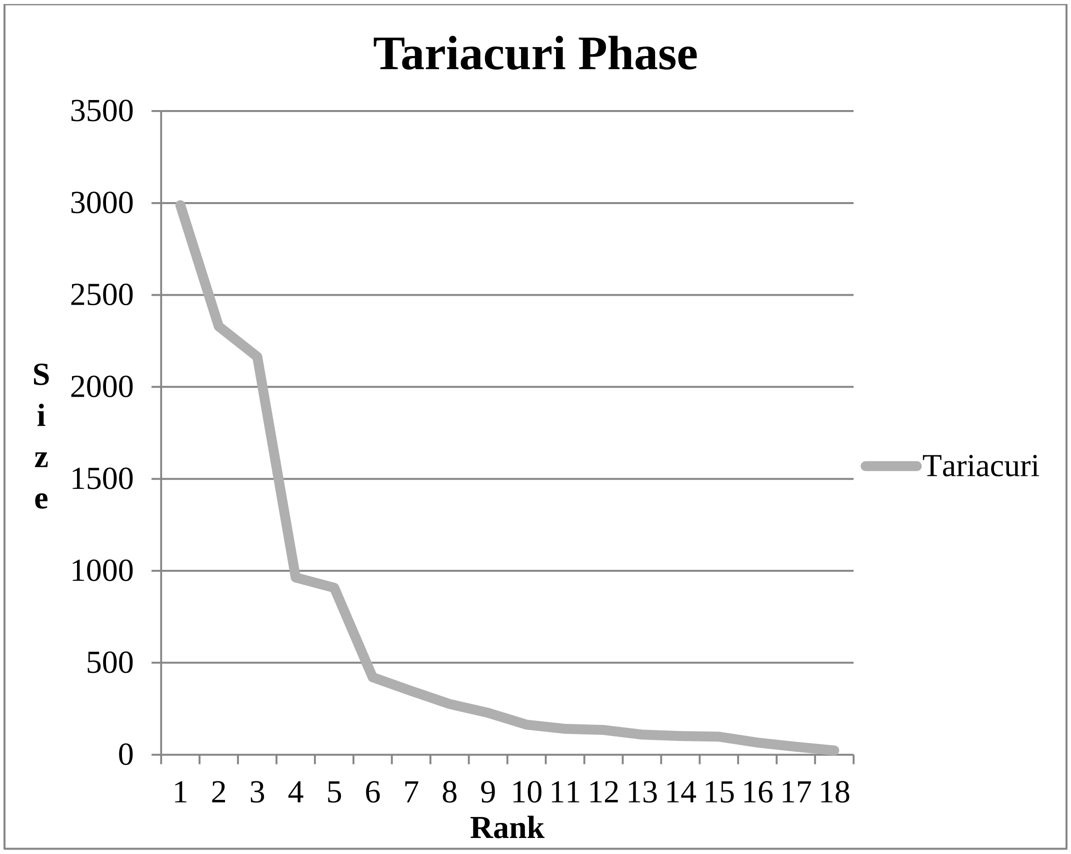



*Tariacuri Phase Population Reconstruction*

The final phase of the temporal sequence marks the emergence of the Tarascan Empire, and the unification of the LPB under this socio-political system of the state. According to Pollard's estimate for this phase, the population reached 80,000 for the basin, between 7,000 and 13,000, with a mean of n=10,000, for the survey area; population density is estimated to have been at 182-334 persons per hectare (Pollard 2008: 224). Due to the ethnohistoric data at the time of the Spanish Conquest, which is at the end of this phase, strong correlations can be made about communities, settlement, and the population, all of which were documented by the Spanish. This is also the phase that most closely aligns with the ethnographic research done by DeRoche in her demographic retrodiction analysis (1983). The number of communities dropped for this phase, to n=17, which is dramatic when compared to the Late Urichu phase. However, community area size increased dramatically for this phase. The following results were produced by the three population reconstruction methods: The Fisher method produced a population range of between 7962 and 12708, with a mean of n=10335; the Deroche method produced a population of n=10151; and the Pollard method produced a population range of between 6980 and 13530, with a mean of n=10255. Given, as stated previously, the level of confidence in the ethnographic, ethnohistoric, and archaeological data, all these estimates are very strong, and coincide closely with what Pollard estimates in her 2008 article. Of the communities, only one was given the settlement rank of two, which according to Pollard, was described in the ethnohistoric documents as a major administrative center during the Protohistoric period. This community also received the classification, according to Fisher's method, of a high-density, compact town. Rank 3 settlements, the next largest community type, can then be found on the outer area of Erongarícuaro, Urichu, Jaracuaro and Pareo. The remainder of communities received the rank 4 settlement classifications, equivalent to the low density, compact village.

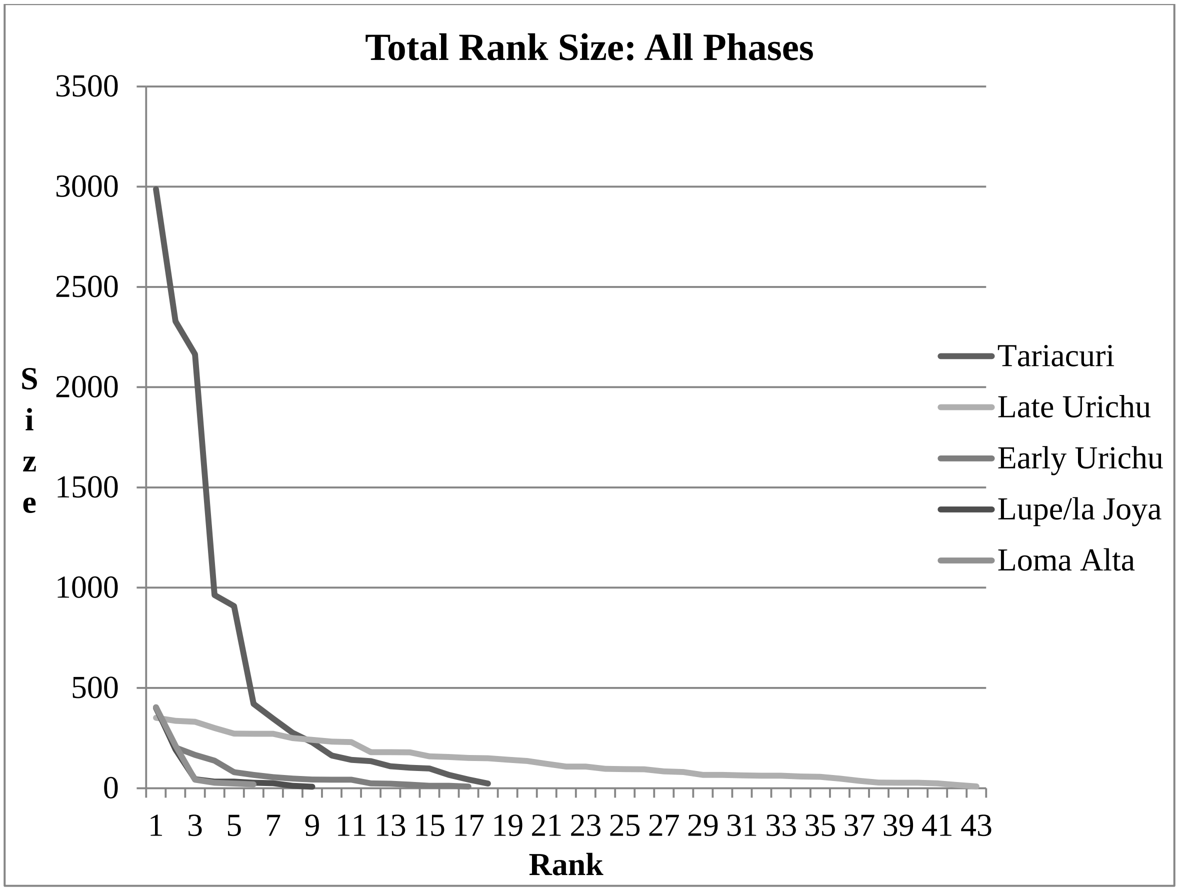
The rank-size graph for this phase reverts back to the dramatic primate curve trend that was witnessed in the earlier phases of the sequence. Once again, the curve seems to be determined by the few communities with high population densities, and the higher frequency of communities with lower population densities. Also, there are fewer observations for communities in this phase. However, due to the nature of the archaeological evidence, and the strong confidence in the survey results, it is unlikely that the primate curve is due to sampling error.

*Figure 15 - Tariacuri Phase Rank-Size Graph*




The final rank size table displays all the rank-size curves for all phases. This allows for a comparative view of the population through time, where it is easier to view the population shifts and trends. The graph, Table 16, shows clearly the major demographic hifts that occurred within the southwest region over the 1,600 year period, and the dynamic of settlement and community size through this time period.

*Figure 16 – The Comparative Rank-Size Graph: All Phases*




*Functional Analysis of Communities*

The final aspect of this analysis is an attempt to determine the function of the communities through the material record and known correlates to human behavior, social classes and class hierarchy, and human activities and economic practices. There are several types of archaeological material, and archaeological assemblages, that one may infer social and economic function from. Stawski, in his 2008 thesis, describes these material correlates through the use of historic, ethnographic, ethnohistoric and archaeological evidence, primarily for the Late Postclassic occupation in the LPB. His research looks primarily at ceramic form, frequency, function, decoration, ware and slip, and determined that certain ceramic variables for each represented areas of occupation for distinct social classes, such as commoner, lower elite and upper elite.

In the same manner, other material remains are also markers for economic and social functional zones. For example, sites where there are a high number of *recortados*, or reworked ceramic sherds used as fishing net weights, can be associated with fishing activities. Pipes have also been documented as a marker for both function and class. Stawski (2008) used the ethnohistoric documents, and excavations from Urichu and Tzintzuntzan, to determine that pipes, especially decorated pipes, are strong markers for areas related to ritual and ceremonial use, as well as those linked to the middle and upper elite classes (2008:44). Obsidian has also been used as a marker for both social and economic function in the archaeological record. In her research on obsidian production and consumption at the site of Erongarícuaro, Rebnegger identified areas of high obsidian consumption, with the obsidian accessed by local elites through a controlled market exchange system (2010:86). Furthermore she contends that although this area had a high frequency of obsidian material, it was not enough, comparatively, to be considered a workshop area. However, she does state that this was most likely an area where part-time craft specialization took place (2010:86).

In an attempt to establish functional areas for communities, the method will be fairly straightforward. Each survey site artifacts will be analyzed to determine what, if any, functional category may be attributed to said site. The categories, such as a specific activity (economic, subsistence) or social context (a commoner area, administrative zone), will be then attributed to the communities that have located and delineated. This method isn't intended to be a precise analysis for site functionality. It is understood that the primary data source is survey data, which poses taphonomic problems and is a difficult manner in which to interpolate an intensive categorical site analysis. Rather, this method and the results will be used post-settlement analysis in order to provide further insight into community organization across the landscape.

The following functional attributes are listed by phase. The survey sites were analyzed first, followed by an overlay of the communities to see which community could be attributed a functional category based on the site assemblages. Of note is that not every community will have a functional category given it. Only those sites that show a very high frequency of artifacts that represent possible functional markers will be used.

*Table 9 – Functional Attributes for Communities by Phase*

| **Phase** | **Comm** | **Artifacts/Assemblage** | **Functional Interpretation** |
|---|---|---|---|
| Loma Alta (2&3) | Comm 3 | High frequency ceramics, obsidian | administrative center, possible elite residence |
| Loma Alta (2&3) | Comm 2 | High frequency ceramics, obsidian | administrative center, possible elite residence |
| Loma Alta (2&3) | Comm 1 | High frequency ceramics, obsidian | administrative center, possible elite residence |
| Jaracuaro | Comm 1 | high frequency circles (recortados) | fishing/lakeshore subsistence zone |
| Lupe/La Joya | Comm 2 | high frequency circles (recortados) | fishing/lakeshore subsistence zone |
| Lupe/La Joya | Comm 5 | high frequency artifacts | elite residence (Pollard 2005) |
| Lupe/La Joya | Comm 7 | high frequency artifacts | administrative center |
| Early Urichu | Comm 1 | medium frequency of circles (recortados) | fishing/lakeshore subsistence zone |
| Early Urichu | Comm 3 | medium, medium light frequency of circles | fishing/lakeshore subsistence zone |
| Early Urichu | Comm 4 | medium, medium light frequency of circles | fishing/lakeshore subsistence zone |
| Early Urichu | Comm 11 | high frequency artifacts, high frequency circles | possible administrative center, fishing/lakeshore resource zone |
| Early Urichu | Comm 6 | high frequency artifacts | possible elite residence (Pollard 2005) |
| Early Urichu | Comm 11 | high frequency artifacts | administrative center |
| Late Urichu | Comm 12 | high frequency of circles | fishing/lakeshore subsistence zone |
| Late Urichu | Comm 10 | high frequency of circles | fishing/lakeshore subsistence zone |
| Late Urichu | Comm 9 | high frequency of circles | fishing/lakeshore subsistence |

*Table 9 (cont'd)*

| | | | |
|---|---|---|---|
| | | | zone |
| Late Urichu | Comm 25 | high frequency of circles | fishing/lakeshore subsistence zone |
| Late Urichu | Comm 24 | high frequency of cirlces | fishing/lakeshore subsistence zone |
| Late Urichu | Comm 21 | high frequency of cirlces | fishing/lakeshore subsistence zone |
| Late Urichu | Comm 20 | high frequency of circles | fishing/lakeshore subsistence zone |
| Late Urichu | Comm 2 | high frequency of circles | fishing/lakeshore subsistence zone |
| Late Urichu | Comm 30 | high frequency of artifacts, high frequency of obsidian | administrative center, possible craft specialization area |
| Late Urichu | Comm 28 | high frequency of artifacts | administrative center |
| Late Urichu | Comm 16 | high frequency of obsidian | possible craft specialization area |
| Late Urichu | Comm 11 | high frequency of obsidian | possible craft specialization area |
| Late Urichu | Comm 13 | high frequency of obsidian | possible craft specialization area |
| Late Urichu | Comm 35 | high frequency of obsidian | possible craft specialization area |
| Late Urichu | Comm 33 | high frequency of obsidian | possible craft specialization area |
| Tariacuri | Comm 1 | High frequency of pipes, circles, all artifact categories | administrative center, possible craft specialization area, fishing/lakeshore resource zone, ritual zone |
| Tariacuri | Comm 2 | high frequency of cirlces | fishing/lakeshore subsistence zone |
| Tariacuri | Comm 3 | high frequency of cirlces | fishing/lakeshore subsistence zone |
| Tariacuri | Comm 16 | medium frequency of pipes, high freqeuncy of circles, high frequency of obsidian & ceramics | regional administrative center, fishing/lakeshore subsistence zone, possible ritual area |
| Tariacuri | Comm 15 | High frequency all artifact categories, especially pipes, obsidian | Administrative center, ritual zone, elite zone |
| Tariacuri | Comm 11 | high frequency circles (recortados) | fishing/lakeshore subsistence zone |

The functional categories remain general, with certain assemblages and artifacts being used to direct the analysis. The main artifacts used were obsidian, pipes, and recortados, which have specific economic or social use correlated to them. Other categories, such as high frequencies of artifacts, aided in determining areas of intense use, which possibly represent administrative centers or residences. In the cases of the elite residences, Pollard's assessments, derived from the *informe* and field reports, aided in the categorization. Although not extremely detailed, those functional categories that have been assigned to communities will aid in further narrowing down causation for settlement through time. A comment must be made in concern to architecture at the survey sites. This analysis will forgo the use of architectural remains for the southwest survey area, in part due to an incomplete dataset. Future research, however, will most definitely take architectural data into account.

**Summary**

The focus of this chapter falls on the spatial and organizational unit of the community. The first section details the theory surrounding the community, its use in archaeological research, and its translation into fieldwork and research, especially concerning the archaeological survey. A significant theoretical point of this chapter is that community may be applied across scalar units, such as microregional, regional and macroregional. Ultimately, community is defined by the interaction that these spatial units have with other communities, the landscape, and the environment. Ultimately, these interactions that define the communities and create their boundaries also leave material traces, which can be seen in the archaeological record. Therefore, these clusters of artifacts that are witnessed and recorded as survey data can be interpreted as communities.

With this assumption in mind, the rest of the chapter turns to method, and located, delineated and defined communities for the southwest LPB surveys. This included a demographic reconstruction using three separate methods to reconstruct the population for the communities through time. The final aspect of this chapter used material-behavioral correlates to aid in defining the functional categories of the communities.

# CHAPTER 4: LANDSCAPES OF THE LAKE PÁTZCUARO BASIN

## Theory

### *Landscape Approaches in Settlement Studies*

In an analysis where the variables being assessed infer interactions between humans and their environments, a landscape approach allows for interpretation on the level of the human adaptation paradigm. Although the first chapter discusses the basic tenets behind a landscape approach, the discussion must go further in order to explain the role of this approach in this dissertation. The paradigmatic nature of a landscape approach is different from that of a metaphysical paradigm, or even an intermediate –level sociological paradigm. Landscape approaches are considered a construct paradigm, and "are methodological in that they are systems of tools for approaching particular kinds of scientific inquiry as well as interpreting what they do" (Anshuetz, Wilhusen, and Scheick 2001:160). Thus, a landscape approach is defined more by what is does than what it is. In order to explain what this approach will do for this dissertation, the term "a landscape" must be defined and given parameters for its usefulness. Deriving from the historical ecology literature, which is the approach most closely aligned with the aims of this dissertation, a landscape is a "multidimensional physical entity that has both spatial and temporal characteristics and has been modified by human activity such that human intentions and actions can be inferred, if not read as material culture, from it" (Balee and Erickson 2006:1). Furthermore, Crumley (1994) describes historical ecology as tracing the dialectical relationships between human acts and acts of nature, made manifest in the landscape, where the "landscape retains the physical evidence of these mental activities" (1994:9). With landscape defined, focus can now turn to what this approach will contribute to the analysis of a settlement study.

As explain, this dissertation will utilize the approach that is referred to as settlement ecology (similar to historical ecology) by Anschuetz (2001), where geological, geographic, ecological and archaeological data are combined to explain human relationships to their natural or social environments. This approach is closely aligned with historical ecology, and in fact sometimes are one in the same. The key point here is that "historical ecology and allied approaches generally trace their intellectual heritage to processual archaeology, and they typically concentrate on functional–economic relationships between humans and the regional landscapes in which they live" (Kantner 2008:57). This last point is critical for this dissertation, as the main tenets of this approach, as highlighted in the last sentence of the quote, fit well within the scale and scope of a settlement systems analysis.

The research from Fisher (2005) is an excellent example of the kinds of studies a historical ecology approach provides for a settlement analysis. Fisher's (2005) work in the Pátzcuaro Basin in Michoacán, Mexico is a long-term oriented project that utilizes regional settlement pattern research and geoarchaeology to identify the impact of thousands of years of intensive agriculture on the lake basin. Fisher's work is instrumental in this dissertation, as the geoarchaeological data aids in the reconstruction of the lake levels, the lacustrine resources, and the arable land in the basin. Therefore, several key variables may be used in the analysis of the settlement system that directly relate to settlement location with regard to economic resources. As mentioned previously, this dissertation defines human adaptation as the means with which humans locate themselves within an environment, their means for subsistence and economy, and the relationships that alter their social and natural landscapes. Therefore, by analyzing the settlement system that operated for 2,000 years in the Lake Pátzcuaro Basin, we can interpret the results through a settlement ecology framework in order to elicit information about the relationship the Tarascans had with their landscape. This includes the means by which populations utilized the resources in the lake basin, the resource management that occurred, the perception of landscape through cultural markers (i.e petroglyphs), ritual and place names, and the dynamic relationship between humans and the landscape as the climate and environment changed.

These interpretations become even more crucial to our understanding of human adaptation in the basin when placed within a study that is spatially and temporally dynamic. The issues of landscape that this approach raises can now be viewed across a 2,000 year period on a regional scale, thus making it possible to chart the relationship between humans and the environment in the basin. Also, because of the tight chronological control of the artifacts and ecofacts in the basin, it is now possible to distinguish these landscape issues before, during, and after the emergence of the Tarascan state. Therefore, interpretations may be made that include the state's impact on the landscape, and the effect of state policy that altered the communities' relationship with the landscape. The usefulness of such an approach gives us valuable information about the landscape, the communities and the state within a regional analytical scope.

*Political Economy and Settlement*

The basic operating mechanism that this analysis works within is that of a political economy theoretical framework. It is within this framework that the variables for the settlement analysis have been chosen, and within which lie the causal properties of social change. The settlement model to be tested in this dissertation is derived from the emergence of the state model proposed by Helen Pollard for the Tarascan Empire (2008). It is within this model that she states how important the economic base of resources is to social and political change: "Thus during the Middle Postclassic period a new political economy emerged dominated by a now socially stratified society." (Pollard 2008:227). In other words, the profound changes within the economic and political substructure, including the altering and shifting resources within and without the lake basin, created the ideal environment for the rise of a state-level society (Pollard 2008:227). It is the underlying mechanisms of economic change that fuel this analysis as well. I argue that in order to perform a settlement systems analysis of the lake basin, the theoretical impetus of the research must accommodate the forces of change that is argued by Pollard in a political economy framework.

To gain a better understanding of how the political economy theoretical framework is structured for this dissertation, several archaeological case studies will be analyzed to provide a means of structure and comparison. An important fact must be addressed, that brings to light the context in which the majority of these studies have been proposed. They all deal with the emergence of primary or secondary states, as well as confront the issues of "chiefdoms" and the dynamics that play into their structuring. This is an important fact because this dissertation provides an analysis that leads up to and includes the emergence of the Tarascan state, considered one of the great Late Postclassic secondary states to emerge in the highlands of Mexico. The following sections highlight several important issues that shed light on how a political economy framework aids the analysis for this dissertation.

The 1,600 year scope of this dissertation requires a theoretical paradigm that aids in facilitating the processes of settlement and societal change, with a secondary goal of analyzing the emergence of the state within the context of settlement. Through Marxist theory, several archaeologists look to explain these types of changes through structural relations. Brumfiel (1983) uses a structuralist approach in explaining the emergence of the Aztec state. Brumfiel explains change and development of states as "structural transformation over time in which the

trajectory of change is determined by the structural properties of the initial system" (1983:263). However, the leading theories from a structuralist approach explain state formation in terms of structurally induced social conflict (Brumfiel 1983:263). It is from this point that I refer to Zagarell's (1986) comments on structural relations in explaining the emergence of states and the processes behind these phenomenon. Zagarell, by attempting to look at structural relations rather than structural elements, states that "process and event (in context of social structure) are two separate, although related phenomena" (1986:155). In other words, Zagarell is hypothesizing
that one must understand the trajectory of pre-state societies prior to the emergence of the state in order to understand the climate and circumstance of the rise of such a "revolutionary" social phenomenon.

This dissertation looks to explain, not merely describe, the structural relations of the settlement system of the pre-state societies of the Lake Pátzcuaro Basin. That is what is so critical about a settlement systems analysis, it that it too looks to explain rather than describe. In order to hold true to Zagarell's theory behind structuralist change, we must forgo the final comparison between states that ultimately leads to a mere trait list comparison of elements. Instead, we must critically analyze the time leading up to state formation, and construct an analytical framework in which the underlying processes may be evoked. It is within these processes that variation may be found, thus allowing for a more holistic explanation for cultural change. With this in mind, researchers may move outside the realm of neo-evolutionary theory, which has marred the study of complex societies for too long.

It is through the analysis of this process that hopes to better explain the conditions and processes that resulted in the rise of the Tarascan state. The analysis for this dissertation is organized to try to explain these phenomena through economic variables; variables that I hypothesize structured the settlement, subsistence, and political and social organization, which ultimately led to the climate in which the Tarascan state emerged. The following chapters will take these theoretical stances and present a more tangible framework in terms of methodology and variables for the settlement systems analysis.

This chapter will provide a method for reconstructing the Prehispanic landscape of the Lake Pátzcuaro Basin in an attempt to qualify and locate the varying land classes during the temporal sequence, as well as quantify their size. This chapter will first discuss the method that will be used to reconstruct the landscape, explain the results in terms of environmental and lake fluctuations and what that means in terms of quantity of each environmental zones, and finally, apply the results to a model of the landscape for the basin that covers the temporal phases that spans the 1,600 year focus of this research.

**Method for Landscape Reconstruction**

The method that will be used to reconstruct the Prehispanic landscape of the Lake Pátzcuaro basin is comprised of two parts. The first part utilizes modern data, such as satellite imagery, modern climatic and geological data, to first pinpoint the elevation of Lake Pátzcuaro for a specific date and time, and then to locate the environmental zones (i.e. resource zones) that Gorenstein and Pollard (1983), Toledo (1993) and Barrera-Bassols et al. (2006) refer to, and estimate the size of these zones. The second part will look to the paleoecological, geoarchaeological and geological data to estimate the prehistoric lake levels, and thus aid in the reconstruction of the Prehispanic environmental zones. To reiterate, this dissertation works from the explicit understanding that there exist today six distinct environmental zones; 1.) open water 2.) tule-reed marsh 3.) lakeshore 4.) lower sierra slopes 5.) upper sierra slopes, and 6.) alpine

(Gorenstein and Pollard 1983: p.144). An assumption of this model, and an accepted fact among researchers and scholars, is that the same environmental zones that are present in the modern era, also existed during the Prehispanic time periods. However, it must be said that not all aspects of these zones exist in the same capacity. For example, it is understood that certain fish varieties that were abundant in the lake during Prehispanic and early historic periods have by now been all but extinguished from Lake Pátzcuaro, either through commercial fishing practices, introduction of alien species, pollution, or other human-induced factors (Alcocer and Bernal Brooks 2010). Therefore, the environmental zones may not have the same compositional quantity as they did during the prehistoric, historic or modern eras, but they are accepted as being the same qualitatively.

The analysis of the modern data will provide a direct correlation between the observed environmental zones (1940's to present) and the expected environmental zones (100 B.C – A.D. 1525). A series of remotely sensed aerial imagery, including imagery from IKONOS, Landsat, and SPOT satellites, will comprise the modern collection of data sets that the environmental zones will be estimated from. Given the large amount of limnological, ecological, biological and geological research that focuses on the Lake Pátzcuaro Basin, we have abundant and accurate data concerning the lake level and environmental zones during the modern period.

Through the use of the ArcGis suite of tools, we are able to accurately locate and measure the environmental zones in the lake basin from the aerial images. The specific method used for this derives from Hritz (2010) as well as Gomez-Tagle Chavez, Bernal-Brooks and Alcocer (2002), but locating both man made and environmental features on the earth's surface from remotely sensed images has for quite some time been a routine way to ground truth sites and landscape features, both in archaeology and the physical sciences. Because of the advanced technology available, we are able to distinguish these landscape features, such as environmental zones, much more accurately.

First, each aerial image has been georeferenced and rectified so that they are in UTM coordinates, and features within the image can be accurately measured with reference to size and location. Once the environmental zones have been located on the aerial images, a layer is created in ArcGis that accurately "traces" the features into a vector shapefile. For example, the lake levels are traced for each image, thus providing us with lake shapefiles that show the lake at varying levels through time. Once the shapefiles are drawn, each can be measured in size, thus creating a layer of data that can be analyzed in terms of what percentage of the total basin each environmental zone comprises. This will be repeated for each aerial image in the collection from 1940 to present. It should be noted that this method not only uses visual inspection to locate environmental zones, but also relies on certain wavelength signatures found in the color satellite images to locate certain environmental zones based on vegetation reflection, and also relies on the data that is produced in a digital elevation model (DEM) to locate zones based on elevation signatures. For each zone, the elevation is directly associated with the vegetation type that comprises each zone, and the climatic variables that define the zones.

With the satellite images now analyzed in terms of locating, mapping and quantifying the environmental zones, we can combine this data with the known lake level data at the time the aerial images were taken. What we now have is a set of data that can associate lake levels at specific dates with the size and locations of certain environmental zones.

*Reconstructing Lake Pátzcuaro*

This portion of the analysis first analyzes recent remotely sensed imagery, beginning with the 1940's and ending in 2010. Due to dramatic shifts in global climate and land use over the past century, Lake Pátzcuaro has undergone dramatic changes in its elevation, thus affecting it surrounding resources zones. This accelerated shift in lake levels and resource zones, specifically over the past 70 years as documented in the aerial imagery, is similar to lake fluctuations and climatic shifts witnessed in the archaeological and geological record for the Prehispanic scope of this analysis (100 B.C. – A.D. 1525). Therefore, the modern series of aerial imagery will be used as a direct link to reconstruct the Prehistoric landscape.

As described previously, the aerial imagery was closely examined and analyzed, and then edited to provide vector shapefiles that represent the lake, marsh zones, and islands. In each case, these edits were done using visual inspection to determine the lake boundaries, the lakeshore and the marsh zones. Due to the creation and editing in GIS, the areas of the shapefiles (i.e. marshes, lake, and islands) were calculated, first in square kilometers, and then converted to hectares. This was done for the sequence of aerial images including the years 1940, 1970, 1973, 1989, 2000, and 2010. The 1940 images were derived from U.S. Army Air Corps aerial reconnaissance, the 1970's, 1980's and 1990's derived from the Landsat 7 satellite imagery, and the 2000 and 2010 derived from the SPOT satellite. Each of the imagery differed in scale and resolution, but each was analyzed in the same manner in order to provide sound shapefiles for analysis.

The process for determining the modern lake levels derives from a variety of sources. Pollard and Gorenstein (1983) estimated lake levels for the years 1939, 1943, 1945-1948, 1961, 1963, and 1974 through the use of "some measurements, aerial photography, and ethnographic accounts" (143). Their measurements, however, were prior to the advent of GIS and georeferenced and rectified aerial imagery, the application of which have shown these initial measurements to be incorrect in the LPB. The key reference for estimating the historic lake levels for the LPB come from Bernal-Brooks, Rojas, and Alcocer (2002) who provide research that rearranges the historic data as they inspect the "historic records on water levels and climatic variables; check out the altitude of ground references, and analyze traces of runoff watercourses over the terrestrial basin by means of GIS" (187). Their method included re-measuring the water levels from the geodesic point established in downtown Pátzcuaro by CETENAL in 1974, with equipment that had a plus/minus 1mm accuracy. From there, the researchers calculated the watershed precipitation and recalibrated the lake levels for the unstable water-level conditions during the 1940's, and then again during the 1970's. The result was a chart that documents the fluctuating lake levels after the rearrangement and corrections to the historic data. This data, therefore, is what this analysis will use as the means for assessing lake levels for the historic aerial imagery. The resulting lake reconstructions are summarized in Table 10.

*Table 10 – The Historic/Modern Lake Pátzcuaro Reconstructions (Pollard 2008;O'Hare 1993; Alocer, Bernal-Brooks, Rojas 2002;Stahle et al 2011)*

| Imagery Year | Lake Level (masl) | Open Lake Area (hectares) | Marsh Area (hectares) | Island Area (hectares) | # Islands |
|---|---|---|---|---|---|
| 1940 | 2041 | 11439.02 | 400.1 | 264.28 | 7 |
| 1970 | 2038.5 | 10318.07 | 1509.3 | 281.43 | 6 |
| 1973 | 2039 | 10512.05 | 643.51 | 335.25 | 10 |
| 1989 | 2037 | 8388.93 | 1224.09 | 631.25 | 7 |
| 1999 | 2036 | 7517.75 | 1306.33 | 117.13 | 7 |
| 2000 | 2033 | 7377.81 | 1309.33 | 104.51 | 7 |
| 2010 | 2028 | 7374.69 | 1611.05 | 149.88 | 19 |

With the modern lake levels reconstructed and calculated, the analysis turns to reconstructing the Prehispanic lake levels. The primary data derives from a variety of sources, including paleoecological, geological, archaeological, and limnological. A summary of the current debates and themes of the reconstruction of the LPB prehispanically was discussed in

Chapter 2. Of the two perspectives on the matter of Prehispanic lake level fluctuations, this dissertation will utilize the work from Pollard (1983, 1999, 2008) and Fisher (2005). Their work incorporates geomorphological work as well as archaeological work, and they acknowledge geological processes in their view of lake and landscape change. It must be noted though, that between the two views (i.e. O'Hara, Davies, Metcalfe versus Pollard, Fisher) there exists only minor differences in lake level estimates, especially when considering the large spatial and temporal scale of this analysis.

The synthetic research from Pollard (2008) gives a summary of each Prehispanic period and the corresponding lake levels associated with the phases. Pollard's work, derived from her archaeological research and from Fisher's geomorphological research, begins in the Late Preclassic Period (100B.C.) and ends at Spanish Conquest (A.D. 1525). The following lake level descriptions for the LPB are by period and phase. The Loma Alta phase (the Late Preclassic to Early Classic period, 100 B.C. to A.D. 600) had lake levels fluctuate between 2033 and 2035 m.a.s.l. (meters above sea level). The Jaracuaro and Lupe/La Joya phases (spanning the Middle Classic to Epiclassic, A.D. 600 to A.D. 900) had lake levels remain steady at 2035 m.a.s.l. The Early Urichu Phase (Early Postclassic, A.D. 900 to A.D. 1100) had lake levels drop initially at A.D. 900 to 2033 m.a.s.l., and then go as low as 2028 m.a.s.l. at A.D. 1100. The Late Urichu Phase (Middle Postclassic) had levels that had risen to 2030 m.a.s.l. after A.D. 1100, and risen again to 2039 m.a.s.l. by the end of the phase at A.D. 1350. The Tariacuri Phase, (Late Post Classic, A.D. 1350 to A.D. 1525) had initial lake levels at 2039 m.a.s.l., which rose again to 2043 m.a.s.l. at the time of Spanish Contact at A.D. 1525. The maps of these reconstructed lake levels are depicted below, and can be correlated to each prehispanic phase in Table 11.

*Figure 17 – The 2033 m.a.s.l. Reconstructed Lake Level – Loma Alta Phase*

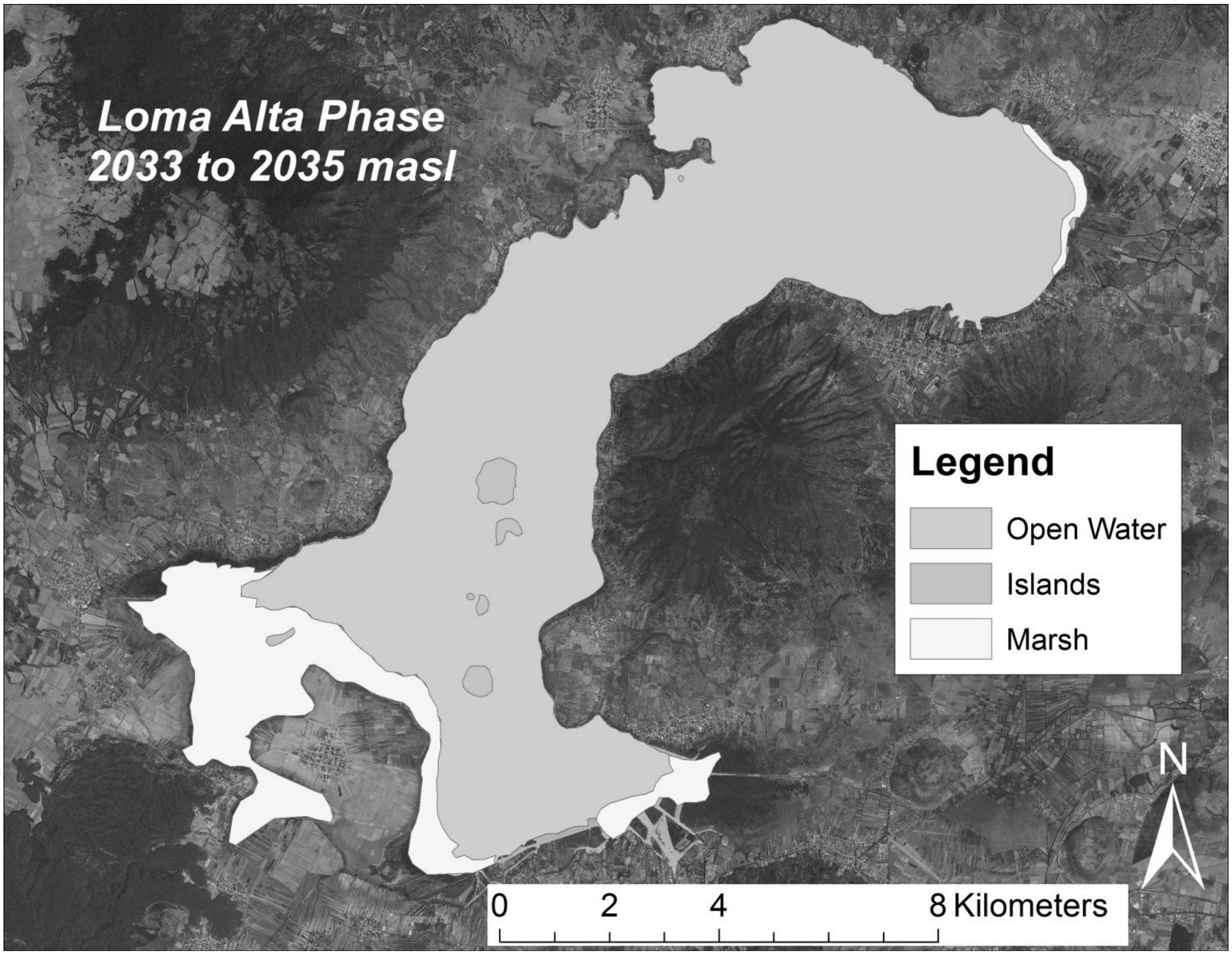


*Figure 18 – The 2035 m.a.s.l. Reconstructed Lake Level- Lupe/La Joya Phase*

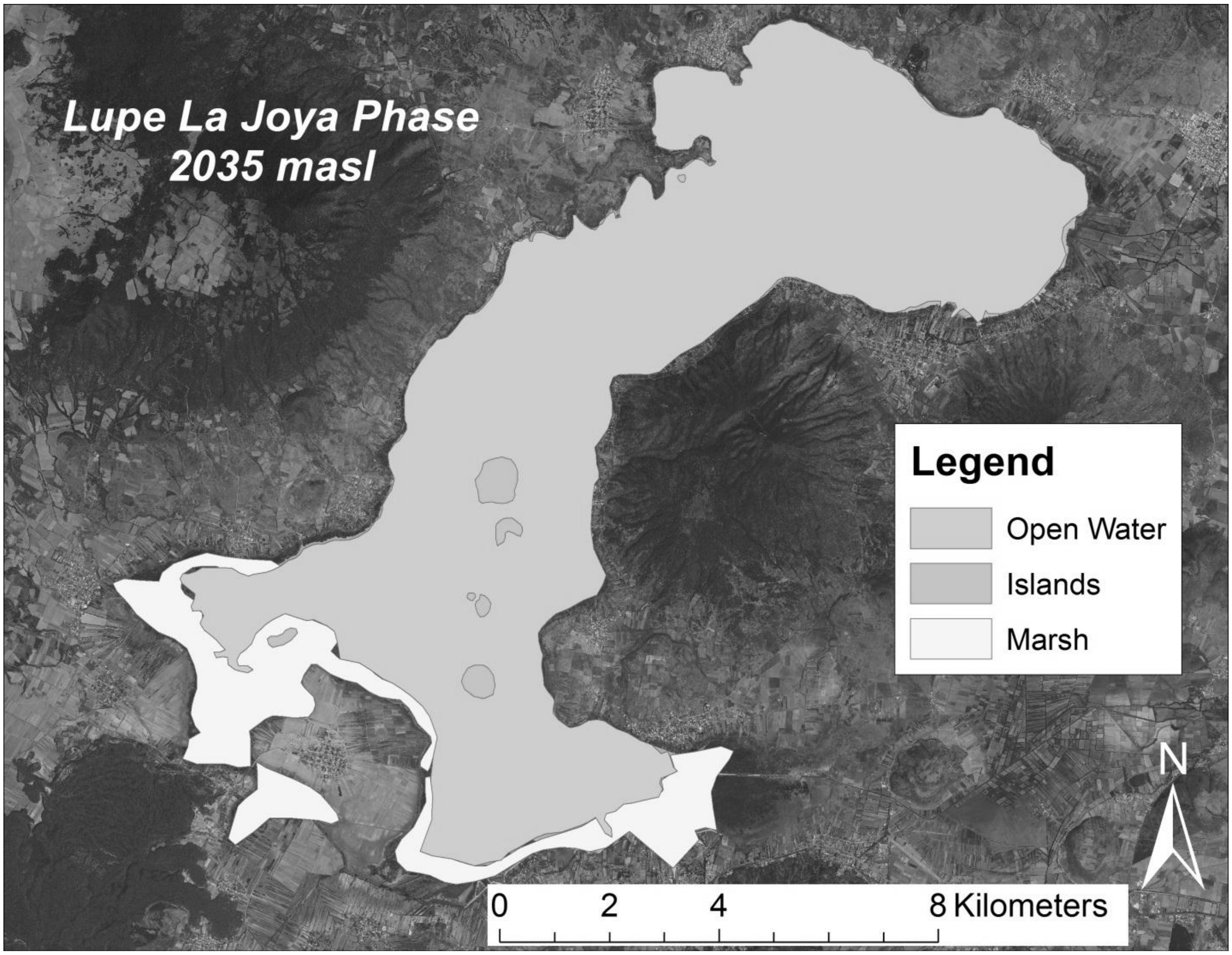


*Figure 19 – The 2028 m.a.s.l. Reconstructed Lake Level- Early Urichu Phase*

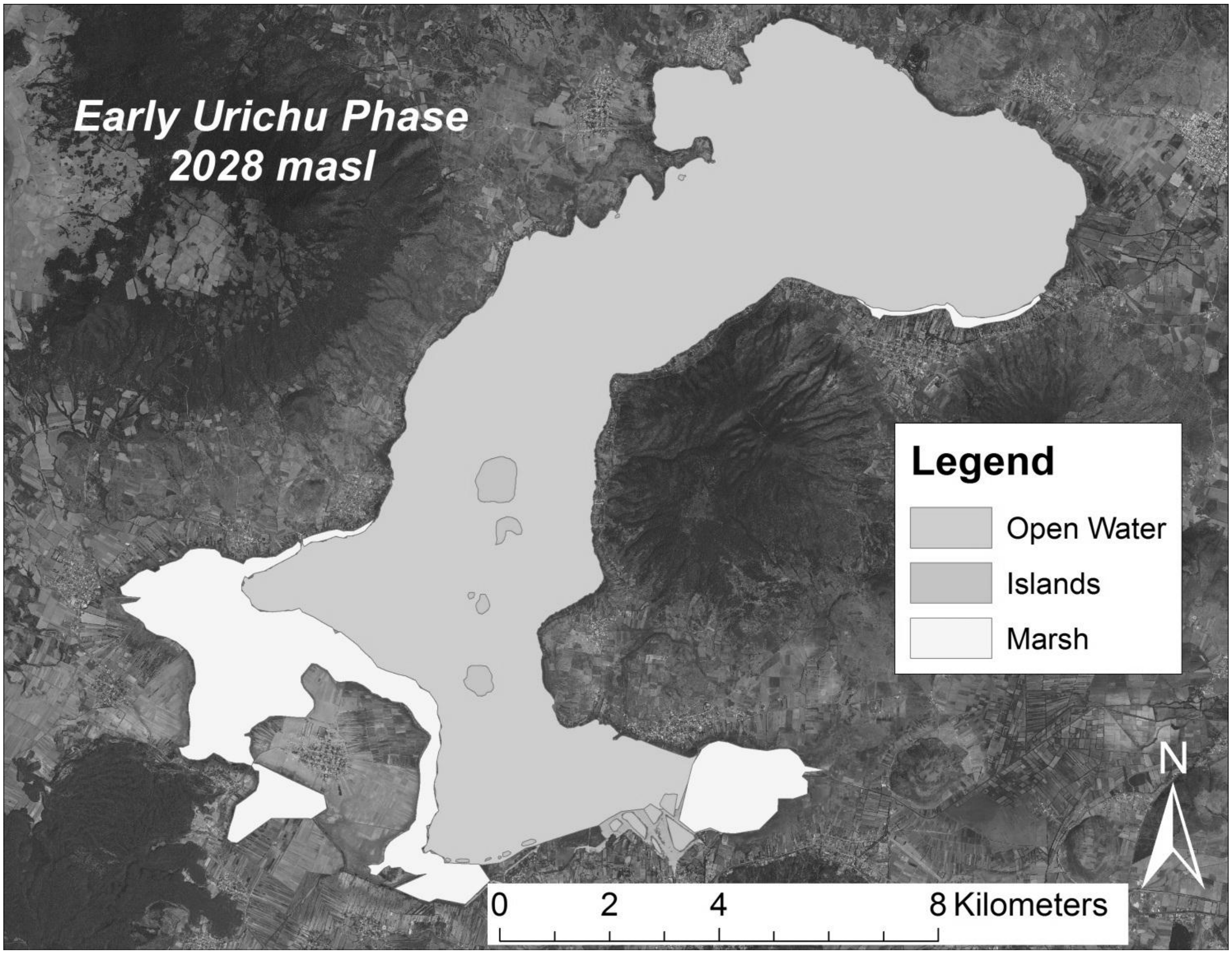


*Figure 20 – The 2030 m.a.s.l. Reconstructed Lake Level – Late Urichu Phase*

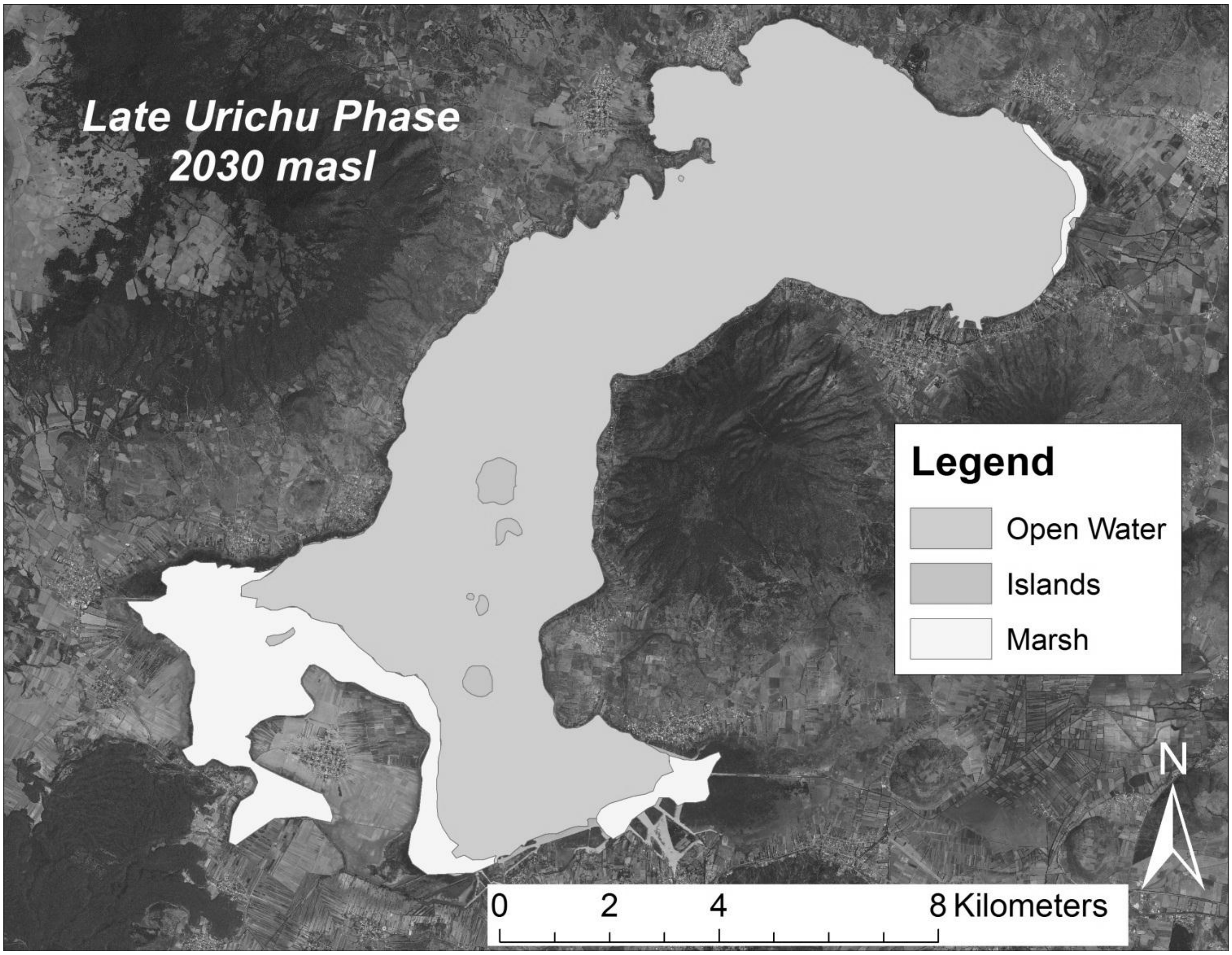


*Figure 21 – The 2040 m.a.s.l. Reconstructed Lake Level- Tariacuri Phase, AD 1520*

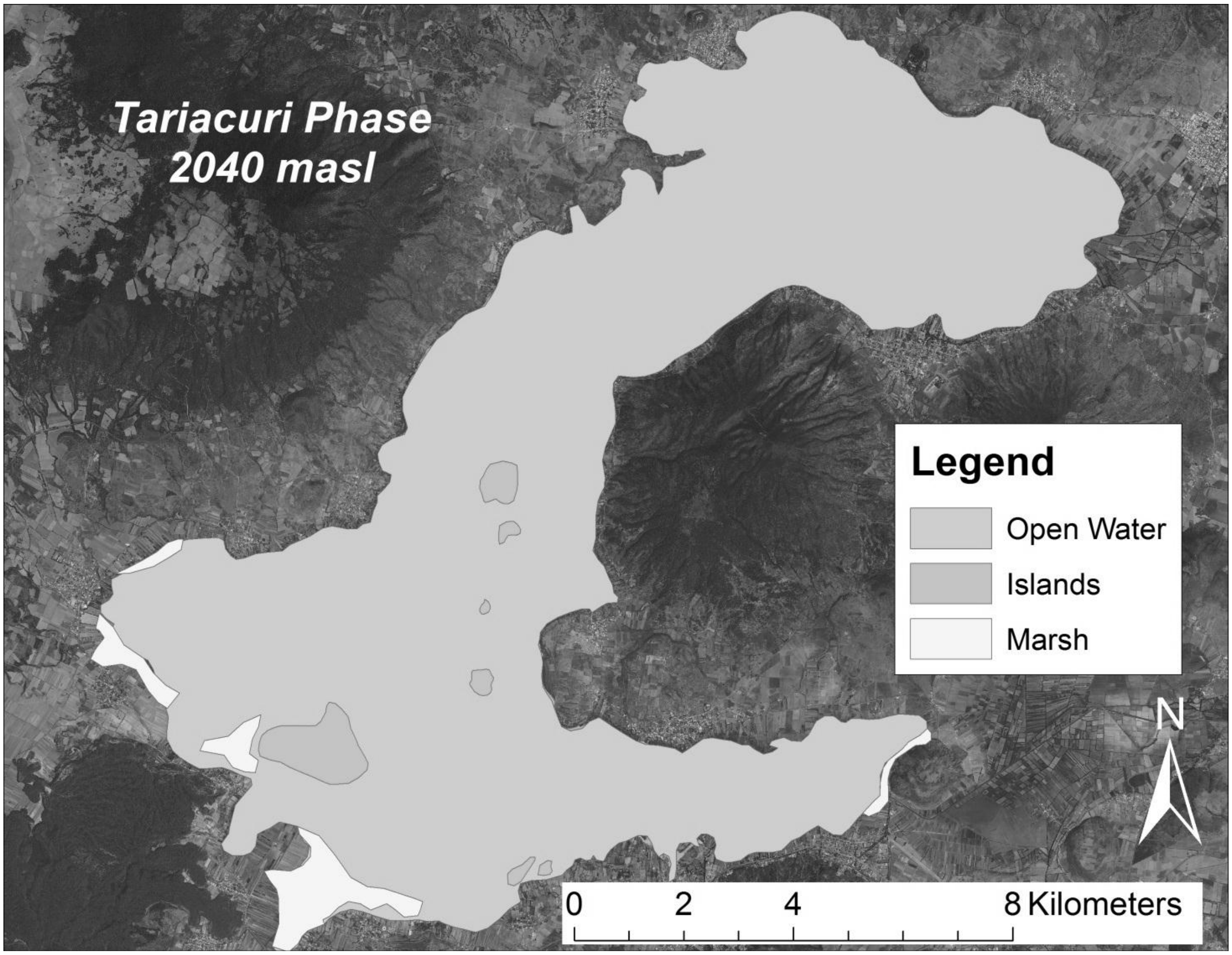
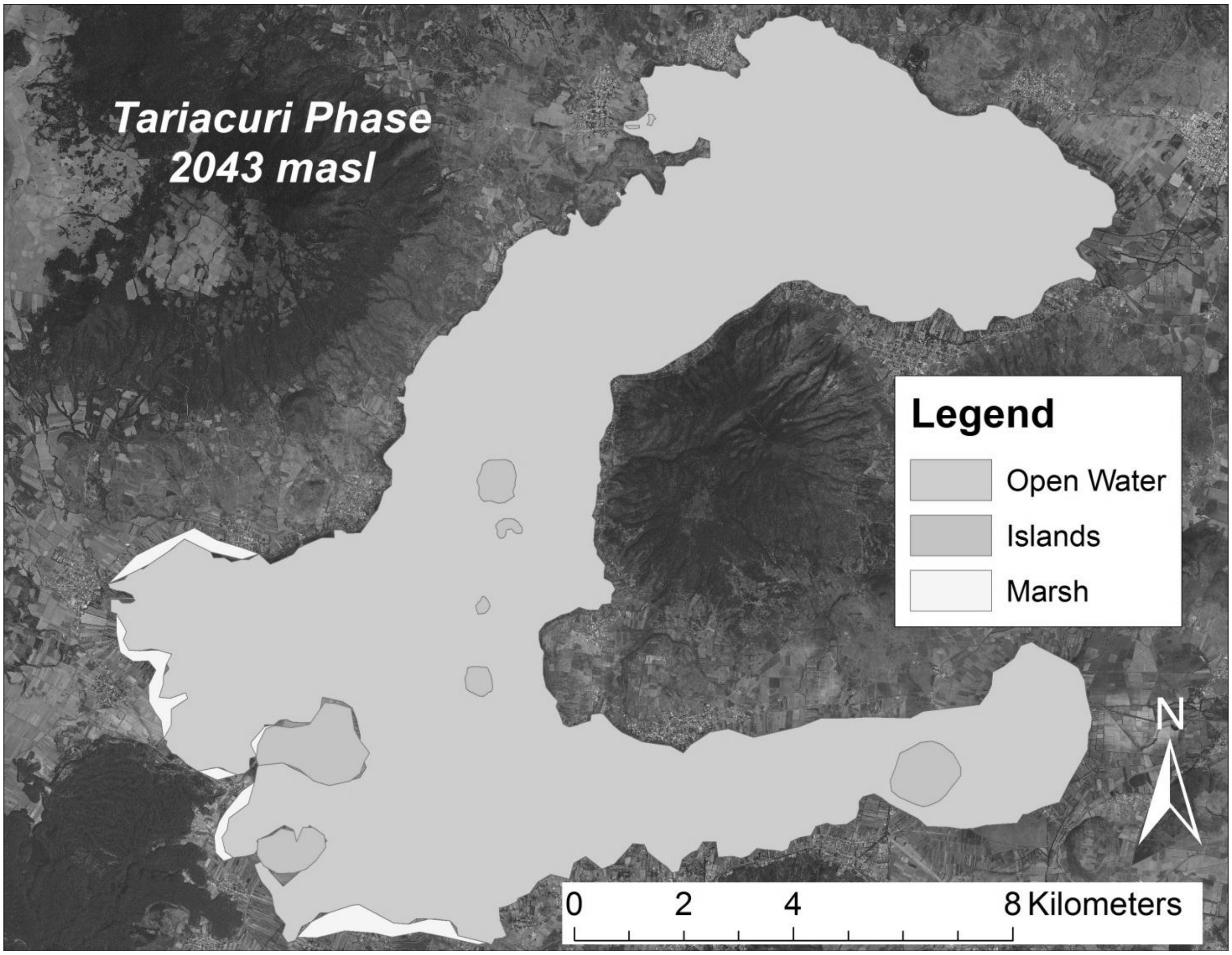


*Figure 22 - The 2043 m.a.s.l. Reconstructed Lake Level- Tariacuri Phase, AD 1525*




The process of lake reconstruction now turns to correlating the modern, GIS created lake levels to the Prehispanic levels noted above. As noted, the modern aerial imagery covers lake levels between 2028 m.a.s.l. and 2041 m.a.s.l. However, the extreme lake levels noted in the geomorphology and ethnohistoric records for the fluctuating Prehispanic levels have no modern counterpart. This includes the higher lake level of 2043 m.a.s.l. The method used to deal with this extreme level utilizes the digital elevation model (DEM) acquired by SPOT satellite to interpolate the highest lake level (2043 m.a.s.l.) and its resource zones through the use of contour and slope maps. For this upper limit of the lake level (2043 m.a.s.l.) a one meter contour map was created for the basin, and the 2043 meter contours were selected and then used to create the 2043 lake level. In the same manner, the islands were also created using the 2043 meter contours from the DEM. However, the issue of creating the marsh resources zones proves more difficult. The reconstruction of the marsh zone starts with the analysis of other constructed marsh zones. When viewing the relationship between open water area and marsh zone, in general the larger the lake elevation, the smaller the area of the marsh zone. The only anomaly for this rule is the 1970 areas, where the marsh zone is much larger in size than predicted. However, with such a high lake level, the 2043 lake reconstruction would most likely have a marsh zone area of approximately 200 – 400 hectares. Historically, the marsh zones occur around the island of Jaracuaro, along the southern shore near Pátzcuaro, and along the southwestern shore near Erongarícuaro. The marsh zones for the 2043 m.a.s.l. lake will be reconstructed in this manner.

*Table 11 – Historic/Modern Lake Level Correlates to Prehispanic Lake Levels*

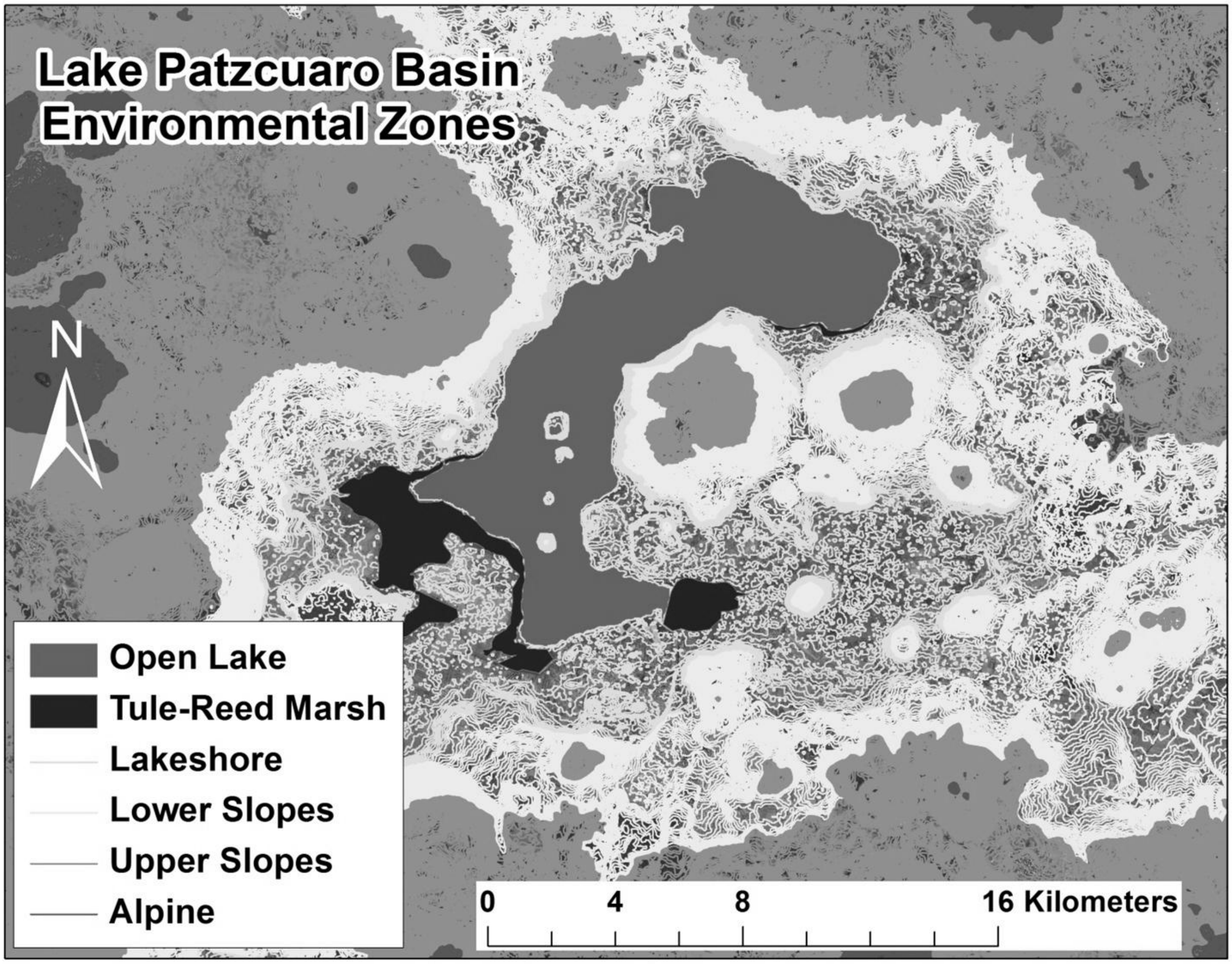
| Period | Phase | Year Range | Year (Modern/Historic Correlate) | Lake Level (masl) |
|---|---|---|---|---|
| Late Preclassic to Early Classic | Loma Alta | 100 B.C. - A.D. 600 | A.D. 2000, 1999 | 2033, 2035 |
| Middle Classic to Epiclassic | Jaracuaro, Lupe/La Joya | A.D. 600 - A.D. 900 | A.D. 2000 | 2035 |
| Early Postclassic | Early Urichu | A.D. 900 - A.D. 1100 | A.D. 2010 | 2028-2030 |
| Middle Postclassic | Late Urichu | A.D. 1100 - A.D. 1350 | A.D. 2010, 1973 | 2030, 2039 |
| Late Postclassic | Tariacuri | A.D. 1350 - A.D. 1525 | A.D. 1940, estimated 2043 level | 2041, 2043 |

*Reconstructing the Prehispanic Landscape*

This section utilizes a variety of resources, such as paleoecological, geomorphological, geological and archaeological data, to decipher what constituted the Prehispanic landscape of the LPB. The goal of this section is to provide as detailed information as possible so as to reconstruct the landscape of the lake basin in a GIS. This includes the use of data to construct a digital dataset in GIS that may be used to quantitatively measure the interaction between communities and landscape variables (i.e. lakeshore resource zones, open lake, agricultural land). Vital to this reconstruction will be the SPOT satellite imagery of the lake basin. The high resolution of this dataset will be a major factor when trying to detail the smaller scale at which the above variables may exist at. This method is similar to the one used for the lake and the lake resources zones. However, the difference is that although the lake has undergone drastic fluctuations during the temporal sequence of this analysis, certain aspects of the landscape have not. As a whole, the landscape is just as dynamic as the lake landscape, and yet certain aspects remain relatively stable. It is the view of Watts and Bradbury, whose main cores aided in reconstructing flora, climate, lake, and sediment changes for the basin since the Pleistocene, that "the character of the vegetation surrounding Lake Pátzcuaro has not changed drastically in the last 40,000 years" (1982:59). With this assumption leading the analysis, the reconstruction begins at the regional scale of analysis, and will move to as fine of a scale as possible in locating and delineating resources zones and landscape variables.

At the regional level, Pollard's assessment of the land classes and the environmental zones are the guiding data, which she collected from ethnographic, ethnohistoric, aerial and field reconnaissance (1983:133-151). The environmental zones of the basin, which are the broadest categories for the physical landscape, were introduced in Chapter 2. Again, there are six major environmental zones; 1.) the open water zone, which occurs at the lake level to the lake bottom; 2.) the tule-reed marsh, which occurs between the lake level and 3 meters below the lake; 3.) the lakeshore, which generally occurs between 2034 m.a.s.l. and 2100 m.a.s.l., although is dependent on the current lake level; 4.) the lower slopes of the sierra, which occur between 2100 m.a.s.l. and 2300 m.a.s.l.; 5.) the upper slopes of the sierra, occurring between 2300 m.a.s.l. and 2800 m.a.s.l.; and the 6.) alpine, which occurs between 2800 and 3200 m.a.s.l.. A map of these zones, which represent the modern era, can be seen below, in Figure 23.

*Figure 23 – The Environmental Zones of the LPB*

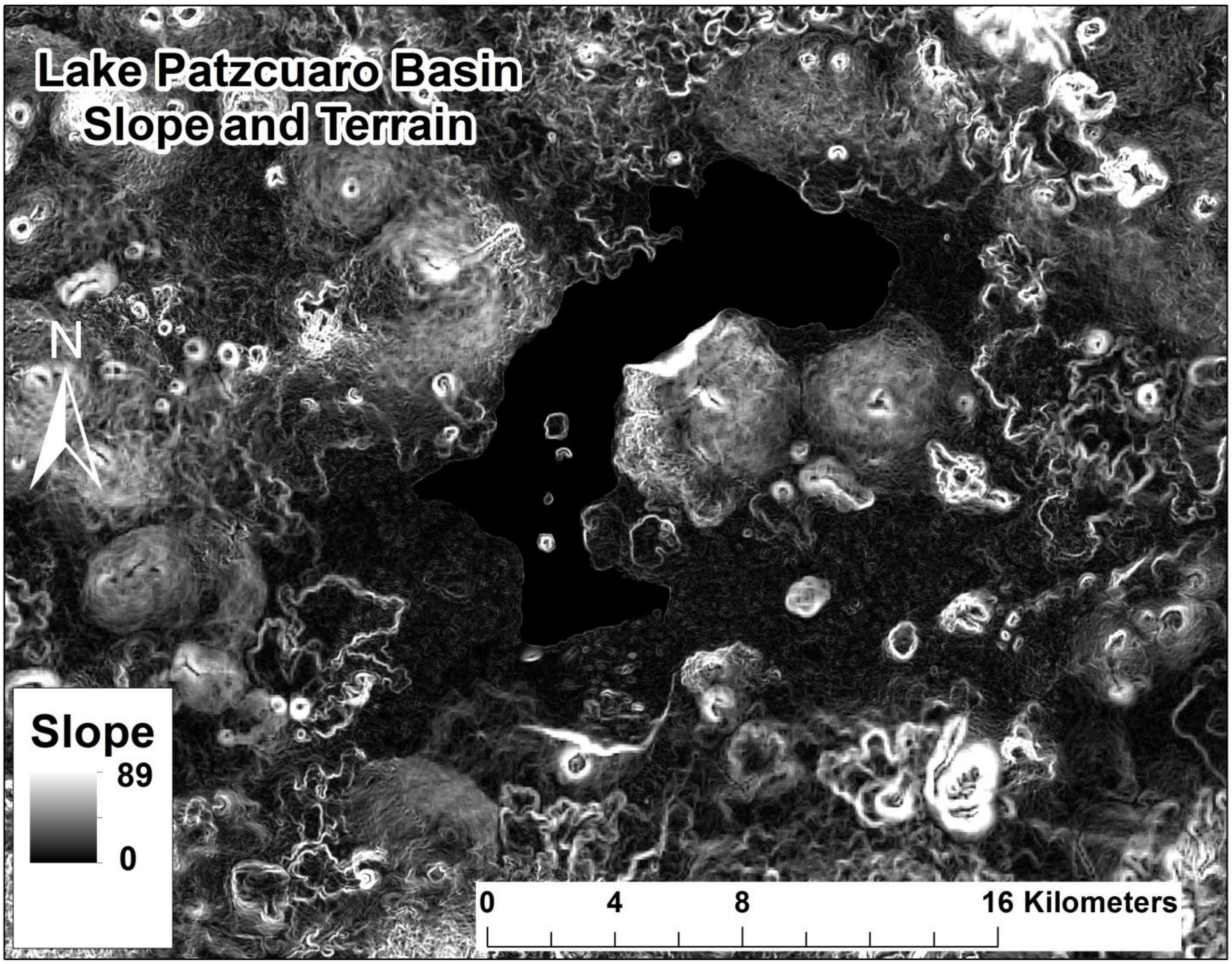



With the general environmental zones now established as the larger scale landscape variables with which one may measure basic resource zones, a smaller scale of analysis is now required. Gorenstein and Pollard also cites three different types of land classes, based primarily on their research on agricultural and resource productivity for estimates of carry capacity (1983:146-147). These land classes have been designated as such by Pollard from the extensive ethnographic data used to determine agricultural practices in the basin during the first half of the $20^{th}$ century. The Class I land consists of that land which is permanently watered, by "either canal or pot/ditch techniques", and seasonally watered, which the "land is under seasonal irrigation by flood water techniques" (Gorenstein and Pollard 1983:146). Class II land consists of "land in the flattish floor of the basin (Lakeshore environmental zone) and the alluvial basins of the Upper Slopes environmental zone", which is farmed by rainfall agriculture. Finally Class III land includes all the remaining agricultural land in the basin, including areas of the lower and upper slope environmental zones, forest, pasture, the tule-reed marsh and open water (Gorenstein and Pollard 1983:147). The issue with these land class assignments is that this is information based on data from farming and agriculture in the 20th century. And although some of the methods and techniques for farming were the same as those used prehispanically, we cannot assume the Prehispanic population put the same emphasis on these lands, which is also biased toward agricultural production. However, we can use these classes to help distinguish several important factors that will aid in reconstructing the landscape.

The first is that areas of lower slope, or flatter land, were desired for agricultural purposes. The lands were easier to maintain and irrigate. With the use of the SPOT digital elevation model, this variable is easily reconstructed using the DEM to create the contour lines and slope map for the basin. The contour lines created are at intervals of 5 meters, a resolution previously unattainable by other data sources for the basin. The use of these digital datasets will allow for analysis of differential types of landscapes based on slope and elevation classes. Ultimately, the slope and elevations will also be used to produce the cost-surface map, which will detail movement across a dynamic landscape and include energy expenditure as well. Figure 24 displays the slope map of the basin.

Of note is the assumption of this research that similar topographic conditions existed prehistorically as they do in the modern period. Although there have been some drastic changes to landscape due to seismic or volcanic activity, the majority of change and/or degradation is assumed to derive from human influence. However, research from Fisher shows that when erosion does occur, which is the main source of topography change, the erosion is limited to local areas, and isn't as widespread as to allow for major landscape change (Fisher 2000). It is with this understanding that a cost-surface model was created that was felt to have similar characteristics as the prehistoric landscape.

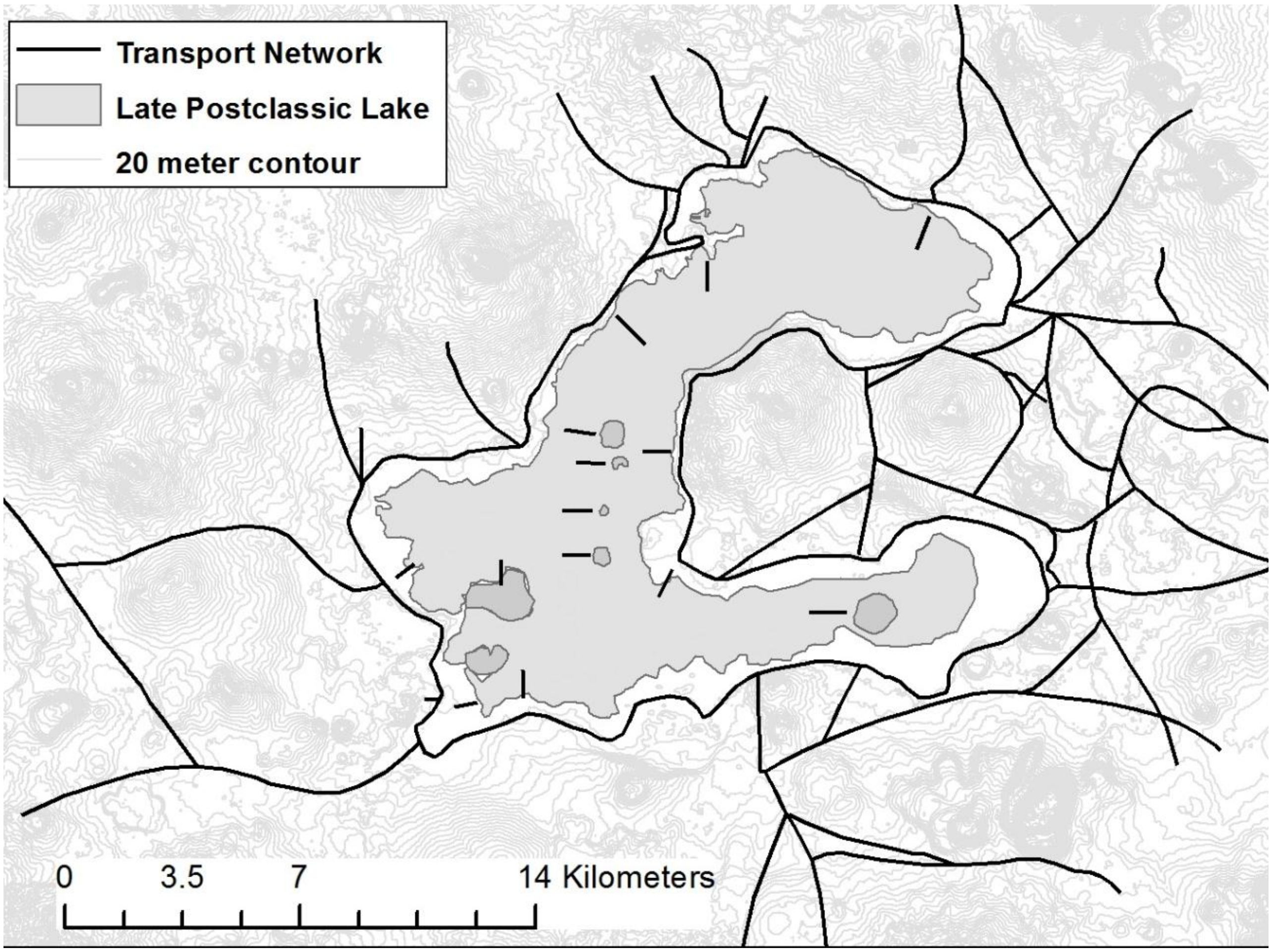
*Figure 24 – The Lake Pátzcuaro Basin Slope Map*




The second factor is the soil classes, which play a major role in agricultural productivity. Pollard cites West (1948), for the data for the soil categories, and others (Barrera-Bassols, Zinck, Ranst 2006; Toledo 1991) have made the correlations between indigenous *Purepecha* soil classifications and the technical soil terms that are used here. The lakeshore provides the most fertile soil, named lacustrine soil, a product of deposition when the lake was higher in elevation, and containing high amounts of organic material allowing for annual cropping (Pollard 1983:136). This is the most sought after agricultural land. The next soil, *charanda*, also called red earth, is the primary soil in the basin, located on the lower mountain slopes and the floor of the basin (Pollard 1983:136). This soil is a volcanic andisol, and is adequate for crops, although due to the high clay content, is more susceptible to erosion. The next most commonly occurring soil is *t'upuri*, or yellow earth, which occurs on the slopes of the volcanic hills surrounding the lake. This soil is "the most productive of the mountain soils with an extremely fine texture and moisture retentive quality" (Pollard 1983:135). Finally, the yellow-brown soil occurs in the highest margins of the basin, in the area of the fir-pine forests in the upper elevations (1983:135). These soil classes are those used presently, and are those that have been used historically and prehistorically. The fact that the words *charanda* and *t'upuri* are Purepecha words attest to this fact. For reconstruction purposes, the soils for the basin seem to correlate strongly with the land classes and environmental zones that Pollard has laid out. These, then, will be used in tandem with the environmental zone reconstructions. Ultimately, these reconstructions in GIS will be used as the areas of agricultural land variable that will aid in the analysis of the settlement system.

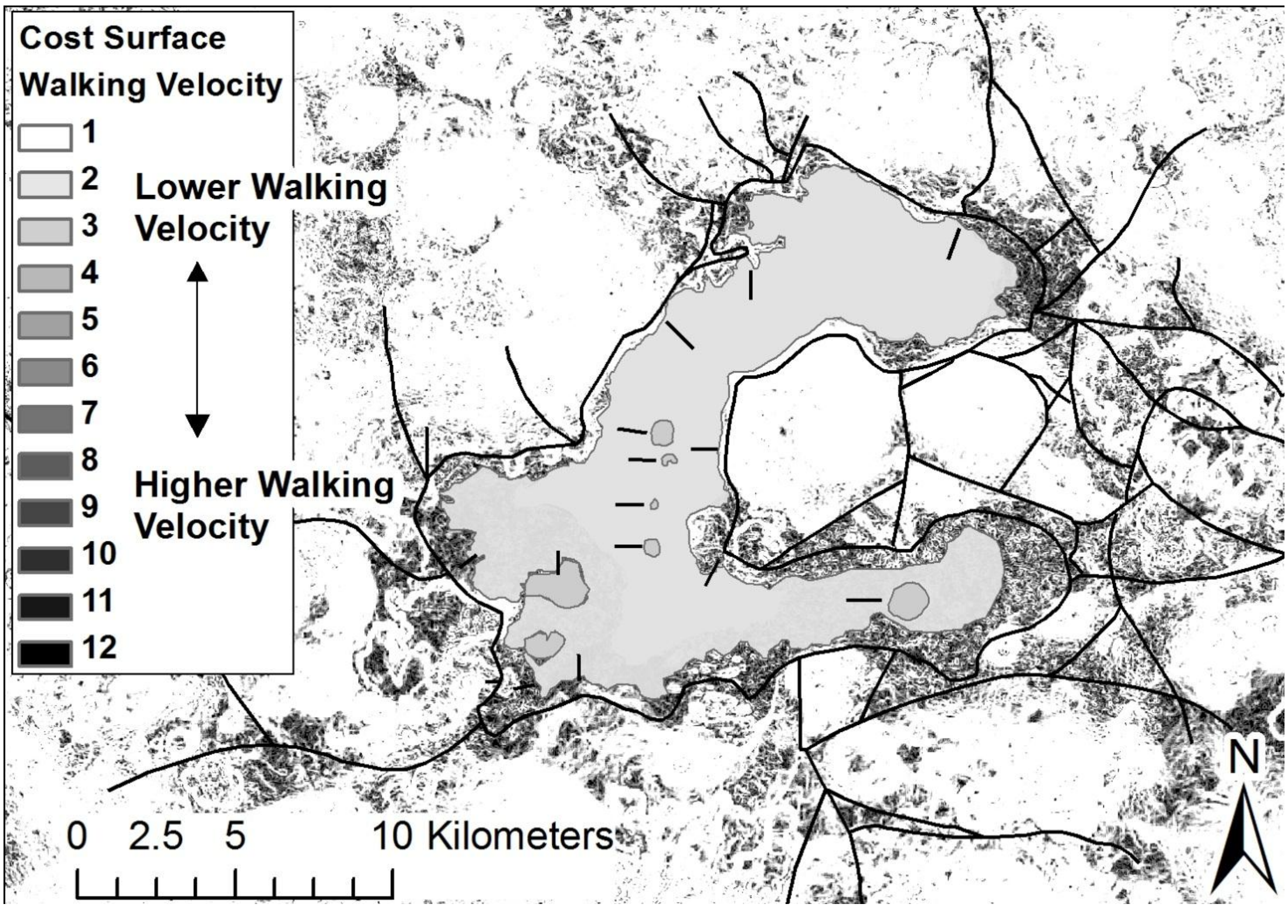
Travel and trade routes are a final variable that defines the landscape. Defined by human travel and interaction across the terrain, these routes are vital in reconstructing the social aspect of the landscape. Pollard's work on the Early Hispanic time period and analysis of ethnohistoric documents gives us a better understanding of travel and transport in the basin. In her analysis, Pollard ranks three types of travel routes based on "the fundamental transport property of magnitude of traffic flow" (Gorenstein and Pollard 1983:48), with rank 1 being external routes, rank 2 being water routes, and rank 3 being internal routes (see Figure 25). These routes, however, are based on ethnohistoric, archaeological, and ethnographic data, and are known to have existed in the Early Hispanic period. It is very plausible that these routes also existed in the Late Postclassic period, and we can retrodict them as such. However, given that these routes were created, altered and adjusted within the landscape in conjunction with changes in the socio- political and physical environment of the time, it is unlikely that these same routes existed in earlier phases. Therefore, it would be too presumptive to retrodict these routes any further back than the late Postclassic period (Espejel 1992).

*Figure 25 – The Early Hispanic Transport Network for the Lake Pátzcuaro Basin (Gorenstein and Pollard 1983)*




However, through the use of GIS modeling, we can create a map that, based on slope, predicts and models the cost of travel across the basin landscape. This is a cost-surface model, and is discussed in much more detail in Chapter 5. However, we can use it to make simple correlations and bridging arguments for its use to aid in reconstructing possible travel and trade networks throughout all phase of the Prehispanic sequence. As you can see in Figure 26, the cost-surface map is detailed, with Pollard's transportation network overlaid on top. Basic investigation shows that there exists a strong correlation between the areas of least-cost travel and the Early Hispanic travel network. Therefore, for earlier phases, the paths of least-cost will be used as potential travel and trade routes for those time periods, and can be used in the spatial analysis when determining variables that may have affected settlement.

*Figure 26 – The Early Hispanic Transportation Network and Cost Surface Map*




**Summary**

This chapter introduces the landscape approach as a major theoretical paradigm of this dissertation. This theory is crucial in understanding the human-environment relationships of the lake basin that, through a landscape approach, are defined as interactions that leave material traces in the archaeological and geological record. This interaction between the landscape and the human components translate well into a political economy approach, which is also discussed in this chapter.

With the theoretical underpinnings expressed, the chapter then moves to method, as the Prehispanic landscape is reconstructed. The major portion of this section included the reconstruction of the lake levels, the lakeshore and the lake resource zones. This involved using the geological, geomorphological and archaeological data to reconstruct the lake levels for the Prehispanic time periods. Once this was done, modern correlates of these lake levels were found, and the satellite imagery analyzed to produce GIS shapefiles of the lake levels. Following the lake reconstructions, the landscape and the environmental zones were reconstructed in a GIS, which allows for the quantification of the variables and statistical analyses.

# CHAPTER 5: A SETTLEMENT SYSTEMS ANALYSIS

The goal of this chapter is to use the combined data from the previous two chapters in order to analyze the communities of the Southwest portion of the lake basin, as well as the landscape of the basin. The statistical analyses presented in this chapter are divided into two separate methods, which are later integrated to provide a holistic assessment of the settlement systems throughout the sequence. The first method will assess the relationship among the individual communities within the lake basin through time. The second method will assess the relationship between the communities and the economic-resource variables (i.e. lakeshore resources, agricultural land, travel/ trade routes, forest resources). The primary means that will be used in these analyses are measures of distance and size (density). With each of these analyses, there is an explicit theory that will guide the method, and will be described in the next section. This will include a background and history of the concepts that shape the statistical analyses found in this chapter, including cost-surfaces, cost-distance, least-cost paths, and gravity modeling. A brief explanation of the algorithms used will also be presented, in order to understand the geographical theories that define the spatial statistics used. Finally, the methods will be introduced and performed, and the result will be an analysis that effectively tests the settlement systems of the southwest portion of the lake basin through time.

## Geographical Theory

The one common variable that underlies both the landscape and community analyses is interaction. The theoretical discussion in both chapters three and four, explain that this analysis uses a behavioral definition of community, where one can delineate and analyze the material traces of communities in terms of the open-system of interaction that reflects this human behavior. Furthermore, it is because of the landscape theory used in this analysis and described in chapter four, that we can identify a unique relationship between humans and the environment, and seen in this analysis as a relationship between communities and the surrounding landscape of the lake basin. This theory also emphasizes the essential role of interaction in this relationship; a relationship that is dialectical and where the landscape contains "spatial and temporal characteristics and has been modified by human activity such that human intentions and actions can be inferred, if not read as material culture from it," (Balee and Erickson 2006:1). It acknowledges the human-environment interactions that create landscapes, and emphasizes natural environmental variables, "including essential subsistence resources, other raw materials needed for physical comfort and health, and items for trade or exchange" (Anschuetz 2001:177). With interaction playing such an important role in both the relationship between communities as well as the relationship between communities and the landscape, a method and set of statistical analyses must be introduced that can help to quantify these relationships in order to better understand the role each variable (i.e. communities, lakeshore resources, agricultural land, travel/ trade routes, forest resources, lake/lacustrine) in determining settlement location and the larger systems behind settlement.

There are several factors that affect interaction. The theory behind communities and human-environment relationship in the lake basin, interaction is defined as face-to-face (Kolb and Snead 1997: Drennan and Petersen 2005). Prehispanically in the lake basin, the two primary methods of travel by which this interaction occurred were by foot or by canoe, each having their own limitations and advantages. With this in mind, factors such as distance and time, topography, and access are vital when quantifying these interactions. And for quite some time, geographical methods and theories have been grappling with these factors in an attempt to reconstruct human behavior. The following sections will first discuss the evidence there is for travel and interaction within the basin, both Prehispanically and historically, and then discuss the geographical approaches and spatial statistics that are used to reconstruct this interaction on a landscape.

## Travel, Trade and Interaction

There is good evidence concerning travel within the lake basin, both historically and prehispanically, from ethnohistoric and ethnographic sources. A large amount of information comes from multiple sources that document the extent of trade within Mesoamerica at the time of Spanish conquest. Research from Hirshman and Stawski (2011), Drennan (1984a, 1984b), Hassig (1986), Gorenflo and Gale (1990), and Pollard (1987), discusses the likely range of travel for a porter carrying goods across the landscape. Upon review of a range of sources, Hirshman and Stawski (2011) argued for 36 km as the maximal distance for a round trip to market; that is, two four-hour 18 km trips at an average walking speed of 4.5 km per hour, leaving a brief period of time within the destination market for transactions. Although this data is intended to describe the market exchange, ceramic production, and ceramic porting in the basin during the Late Postclassic, it does show that a vital aspect to interaction deals with the energetic cost of travel within the basin. In fact Hirshman and Stawski go on to argue for a maximum carrying load of 23 kg, based on principles of energy cost, time and distance to the market.

Canoe travel is also discussed by several sources, including Goreflo and Gale (1990) in their research in the Basin of Mexico, Gorenstein and Pollard (1983) and Pollard (1990, 2008) in research of the Lake Pátzcuaro Basin. Gorenflo and Gale, in their research focusing on the Late Formative to Late Toltec phases in the Basin of Mexico, looked to Spanish accounts and estimated canoe travel to be 1/3 slower than foot travel, approximately 3.33 km/h (Gorenflo and Gale 1990: 244). However, energy expended in canoe travel was less than porting items on ones back, and also more items could be carried by canoe than by porter. In terms of Lake Pátzcuaro, this is truer of the larger canoes that traversed the open water of the lake, and not the smaller fishing canoes that were more common in the Tule-reed marsh zones. Gorenstein and Pollard's work on the Early Hispanic time period and analysis of ethnohistoric documents gives us a better understanding of water transport in the basin. In the analysis, Gorenstein and Pollard rank three types of travel routes based on "the fundamental transport property of magnitude of traffic flow" (1983:48), with rank 1 being external routes, rank two being water routes, and rank 3 being internal routes. If this is the case, then according to Pollard and the ethnohistoric documents, water transport was a more desirable mode of transportation than the internal routes

These types of research tell us that interaction was costly, and that there was a very complex decision-making framework in place for both individuals and communities that structured their role in the political economy and their location on the landscape. To reiterate, this analysis looks at three distinct variables, distance, topography and access, and their roles in the decision-making process for travel, trade and interaction within the lake basin.

Distance is the most obvious of the three factors that can inhibit interactions within a landscape. Using Hirshman and Stawski's ceramic and market research, the estimate for travel during a four hour time period is 18 kilometers. That is an average walking speed of 4.5 kilometers per hour. This walking velocity fits into the expected range of travel speed that has been tested and observed in a variety of research scenarios (Tobler 1993; Gorenflo and Gale 1990; Aldenderfer 1998; Hare 2004). Therefore, using this estimate of walking velocity, the communities in the LPB were mapped, and distance buffers were then calculated in concentric rings of one-hour travel time from each other. The outcome is a basic map, based on Euclidean distance, which shows which communities fall into certain distance classes. No matter the case, though, it is shown that there is no community outside of this travel range from any other community.  If this is the case, then one can assume that distance may be less of a factor in the LPB than previously thought.  One may argue that the lake plays a pivotal role in inhibiting travel throughout the basin, and yet previous data shows that in most cases, canoe travel was the favored type of travel within the basin (Pollard 1983).  Therefore, we must explore other options that affect interaction within the basin, and play a role in the settlement decision-making process.

The second variable that affects travel is the topography of the landscape.  Although the cost of human travel is not thought to have a simple linear relationship with slope, the latter does have the most effect on the former when assessing variables.  The issue of topography compounds the already complex relationship that communities have with markets in the case of distance and time.  Once again, through the use of the ethnohistoric documents, Pollard has reconstructed the transport network for the lake basin or the Early Hispanic period.  For the purpose of reanalyzing these networks, the original maps have been taken, scanned and projected in ArcGis (see Figure 18).  A visual inspection of these maps as well as others from the Lake Pátzcuaro Basin shows topography indicative of the environments common in the Mexican Highlands.  This includes drastic elevation changes due to the volcanic activity of the region, detailed by lower fields made fertile by volcanic ash and higher slopes made steep by tectonic activity.  Pollard's retrodiction of the travel network shows that the majority of these transportation paths coincide with areas of relatively lower degrees of slope. And a great many of them focus around the lake, being the area of lowest elevation in the region.  Likewise, we may infer that travel throughout the basin was (and still is) greatly affected by the topography, more specifically the slope of the landscape.

The third variable, access, might be the most important of the three. We cannot assume that if a community was in close proximity to the lake, that the residents had access to either a canoe or a landing. Likewise, if a community was in close proximity to a "least cost" path, meaning one which allowed for increased walking velocity and optimized energy expenditure, we cannot assume they had access to this path and the lands it would cross. In this case, as stated by Kantner, the researcher must consider the numerous cultural and practical considerations that may cause people to alter their route, "making it unlikely that anyone in any landscape will follow an optimal route (2004:328). In order to further investigate the role access played in the basin, we once again turn to Pollard's ethnohistoric analysis of the Tarascans.

An important factor when considering access is the role of the Tarascan state in the lake basin. We can get an understanding of the role of the Tarascan state in terms of control of the markets, for example. In terms of the markets, Pollard states, "There is no indication that the markets were state controlled or regulated, despite an extensive description of the judicial systems in the Relacion de Michoacán" (1982:256-257). Furthermore, Pollard says that on only two occasions did the state forbid market activity; on the death of the king and the arrival of the Spanish. Of the three market locations, only Tzintzuntzan, the capital, was also an administrative center. This non-congruence of the markets and administrative centers further suggests a minimal politicization of the markets in the lake basin (Pollard 1982:257). Based on this data, it seems that there was little in the way of limited access to participation in the markets. However, we cannot assume the same level of control was also the case for broader travel and access within the basin. According to the ethnohistoric documents, there did exist a network that was state controlled and solely for state consumption. This included long-distance merchants, such as Nahua merchants (Monzon, Roskemp, Warren 2009) state agricultural lands, fisheries, state forest lands, and state mines (Pollard 1982:256, 2008:225). It is unclear if the state limited access across these lands, however, we do know that there was severe punishment for "neglecting the king's fields" as well as "damaging the maguey" (Pollard 1982:258). This steep cost alone may have been enough reason to avoid state controlled land, even if it was the optimal path to traverse. Along with state controlled land, it is known that the royal dynasty also officially allocated access to land, water, forests and mineral resources (Pollard 2008: 225). According to Pollard, "access to land was distributed within communities by traditional kinship ties, and land was acquired by kings for support of state administrators and state temples" (2008:225). Access to water resources is less clearly defined in the ethnohistoric documents, and whether access was traditionally held by communities or allowed access by the king. In any case though, it seemed that some regulatory entity had control of access to certain areas of lakeshore and lake resources, thus making access to lake travel much more limited.

**Cost-Surface and Cost-Distance Models**

Through a combination of spatial statistics and the use of Geographic Information Systems (GIS), this analysis uses a series of methods that take into account the aforementioned issues of interaction on a landscape. This section will explain the spatial analyses used, as well as the GIS technology that accommodates such spatial modeling. To begin, one must realize the implicit issues regarding modeling human behavior in space and time. In such a case, the only behavior that is assumed is that humans will take the least-cost path when traveling through a given landscape. That means that in the decision-making process, humans will attempt to travel a route that conserves time, money, or energy. And yet within each of these three options, there are assumptions again about human behavior. Compounding these issues, there is the matter of the level of detail the GIS software, the satellite imagery, and the algorithm employed to determine travel. In an attempt to limit error and assumption in the method, each of these factors will be explicitly discussed.

The first issue arises when deciding how to statistically approach modeling human behavior. The advent of GIS, and the increased processing speed and storage capacity of computers has allowed for vast amounts of data to now be stored, managed, analyzed and processed. In the case of human behavior, archaeologists have used such spatial techniques as viewshed and cost-surface analyses in order to investigate the past. Cost-surface, specifically, "has been used to enhance catchment analyses and the model prehistoric road networks" (Kantner 2004:323). A cost-surface in GIS is a "grid map where each cell contains the energetic cost of traveling" (Hare 2004:803). With each cell having a numeric output for the cost of travel, one can then analyze the landscape and determine the cost distance between features of a landscape, and the least-cost path that one could take to travel between features. The research from Hare also uses a cost-surface to partition territory into proximity zones around features in the landscape, thus creating social, political or economic boundaries (2004). However, the production of the cost-surface depends on the algorithm used, which can "represent the relative or absolute cost of travel over each unit of space, with cost measured either by units of time or energy" (Kantner 2004:325). The majority of these algorithms depend on slope to calculate the cost of movement through the "digital" landscape, with some algorithms being simple, such as "simulating a cost-path between two points by moving from one cell to another according to which neighboring cell represents the least amount of slope (Kantner 2004:325, e.g., Anderson and Gillam 2000:47). These "drainage" algorithms, as they are used commonly in hydrology analysis, contain merely a simple linear relationship with slope. However, the cost of human travel is known to be more complex than this simple linear relationship. In that case, several algorithms have been created to aid in better depicting human movements through a digital landscape.

Although many algorithms have been used to create cost-surfaces, not all algorithms articulate human movement realistically across the landscape. The cost of travel for a cost-surface can either be assumed to be “isotropic- the same no matter in which direction the space is crossed, or anisotropic” (Kantner 2004:326). As explained by Kantner in his summary on cost- surface algorithms: “The majority of analyses have implicitly or explicitly assumed that travel cost is isotropic, usually because most software packages do not readily accommodate anisotropic modeling. However, intuition suggests that the cost of traveling down a slope is less than trudging uphill, and a few attempts to develop anisotropic algorithms have been attempted.” (2004:326).

And yet, the algorithms that were first created to model anisotropic movement only arbitrarily assigned different uphill and downhill costs to movement, which weren’t based on empirical observations. The first successful use of empirical evidence derives from a report published in 1950 by Imhof that studied the marching of the Swiss military. This data was used to create Tobler’s “hiking function”, an anisotropic algorithm that suggests a more symmetrical relationship between movement uphill and downhill (Tobler 1993). The equation is as follows: $v = 6\, e^{-3.5 \ * \ \mathrm{abs}(s + .05)}$ where *v* is walking speed, *s* is the slope of the terrain, calculated as vertical change divided by horizontal change, and *e* is the base of natural logarithms. This means that on certain terrain, a traveler could spend as much energy braking against a downhill slope as they would spend walking up that same slope. For the Tobler equation, the function predicts a maximum velocity of six km/hour when going down a slope of five to seven degrees, with any steeper slopes forcing the traveler to slow down (Kantner 2004:327).

Tobler's "hiking function" is a realistic algorithm that is based on empirically observed data. But before a cost-surface can be created, there are still assumptions that must be discussed. The one assumption is travel through a digital landscape. In a GIS created layer, a surface is either represented through vector data or raster data, with vectors comprising lines, polygons and nodes, and raster consisting of square pixels that produce a grid. Satellite imagery, for example, is raster data. For the purpose of this analysis, the cost-surface map will also be a raster, and its smallest component will be a pixel, or cell, the size of which is determined by the resolution that the image was taken at. Thus, the larger the cell size, the more likely topographic details will be obscured. But no matter what the resolution, we must come to terms with how one theoretically "travels" across a square grid. Inherently, the cost-path algorithms are artificial, and calculate movement in an unrealistic, non-human manner. This movement, also called the "Queen's case", is frequently used to determine movement from cell to cell. The Queen's case provides only eight possible directions across cells, either diagonally or horizontally. However, this can be slightly remedied if the cell sizes are small, thus slightly masking the "jerky" movement across a grid.

Another question in creating a cost-surface is what exactly the measure of cost is. As explained by Kantner, "If the researcher wants to determine a path that someone might choose to walk from one point to another, the important question is whether humans choose the path that takes the least energy or the path that takes the least time" (2004:328). For instance, when looking at shorter distances, energetic cost may be the best measure, where time may be a better criterion for longer distances. Also the context for movement must be considered. For instance, if someone is transporting food, they must be aware of the energetic cost of travel relative to the amount of food they are gathering/transporting.

The final factor that affects the selection and use of an algorithm for a cost-surface are the cultural and practical considerations of human movement across a landscape. These factors, which in essence constitutes the landscape, may drastically alter human movement, and cause paths to be traveled that aren't optimal or the least-costly. Unfortunately, when dealing with prehistory and a temporal range of 1,600 years, it is impossible to recreate the landscape and all of its cultural, social and political attributes. However, for the Lake Pátzcuaro Basin, some of these factors have already been discussed in terms of access and travel throughout the basin. It is these variables that will be taken into account when determining the cost-surface for this analysis.

Therefore, with the assumptions of the creation of a cost-surface taken into account, this analysis will employ the use of Tobler's hiking function in the creation of a cost-surface. This anisotropic algorithm will be used to determine the energetic cost of traveling throughout the LPB. I have chosen this for several reasons. Given the smaller size of the LPB and the study area, and the exploratory analysis of Euclidean distance in the basin, it is seen that relatively shorter distances were traveled within the basin. Also, the context of travel is broader for this analysis, where "interaction" may be porters taking goods to market, farmers going to and from fields, people gathering firewood, or messengers traveling between communities. With such varying categories of interaction, it is felt that the majority would fall under the travel category of taking a least energetic cost path.

Once created, the cost-surface grid will represent differential velocities across the landscape that represents the real-time travel velocity. This will allow a least cost path analysis that allows for realistic modeling of distances between communities to other communities, and between communities and the landscape. The following sections will detail the analysis utilizing this cost surface; first through the analysis of community interaction, and second through the analysis of community-landscape interaction. The quantification of interaction and the spatial analysis used will directly aid in determining the major variables that affect the settlement system through the temporal phases.

**Community Interaction Analysis**

The community interaction analysis began with the application of the cost surface that was discussed previously. The cost surface realistically portrays the walking velocity across the landscape, a landscape that is by no means isotropic in its nature. The primary means that will measure the impact of the communities on each other will be a gravity model (discussed in Chapter 1). In short, the gravity model is a means in which to measure interaction, politically and economically, and states that "the level of interactions between two elements is proportional to the product of a measure of mass at each location and inversely proportional to a measure of distance between locations" (Hare 2004:802). Chapter 3 detailed the method in which communities were located, delineated and the population calculated for each. The population, in this case, will be the mass that is calculated. The distance variable is calculated using the cost surface, with the least cost path (LCP) measured between each pair of communities.

The GIS method used to obtain the distance variable that will be used in the gravity model equation is as follows. In order to realistically recreate the landscape for each phase, thereconstructed lake level and marsh zones were applied for each phase to the cost surface, the cost surface layer being a raster file in GIS. The cost surface was applied to the extent of the lake and marsh zones for each phase, therefore representing the navigable terrain that was present for each phase. This created a separate raster file that showed the velocity of traveling across the landscape. However, what this doesn't take into account is the lake and marsh zones, which, as we know from ethnohistoric and ethnographic data was and remains a major travel corridor. To accommodate this, the lake and resource zone was transformed into a cost surface whose velocity value was derived from research from the Basin of Mexico, at 3.33 km/h (Gorenflo and Gale 1990:244). Now we can model movement across terrain as well as the lake, with foot and canoe travel represented. That way the least-cost paths may best represent real world travel access, limitations, options and or constraints.

With an accurate cost surface now created for each phase, the communities were then added to the GIS workspace, and altered to produce the necessary raster files. In order for a least cost path to be created, each community was analyzed separately in relation to all other communities. The single community being analyzed was considered the source, with the other communities being the destination (Figure 27).

With the sources and destinations defined, a cost distance map and a backlink map were created for the source. Both of these maps were created using the cost surface, as seen in Figure 20. The cost distance file calculates the least accumulative cost distance for each cell to the nearest source over a cost surface (Figure 28). The back link file defines the neighbor that is the next cell on the least cost path to the nearest source (Figure 29). With these two defined, the next step is to create a cost path, using the remaining communities as the destination input. The result can be seen in Figure 30.

*Figure 27 – The Source and Destinations in a Cost Surface Model*

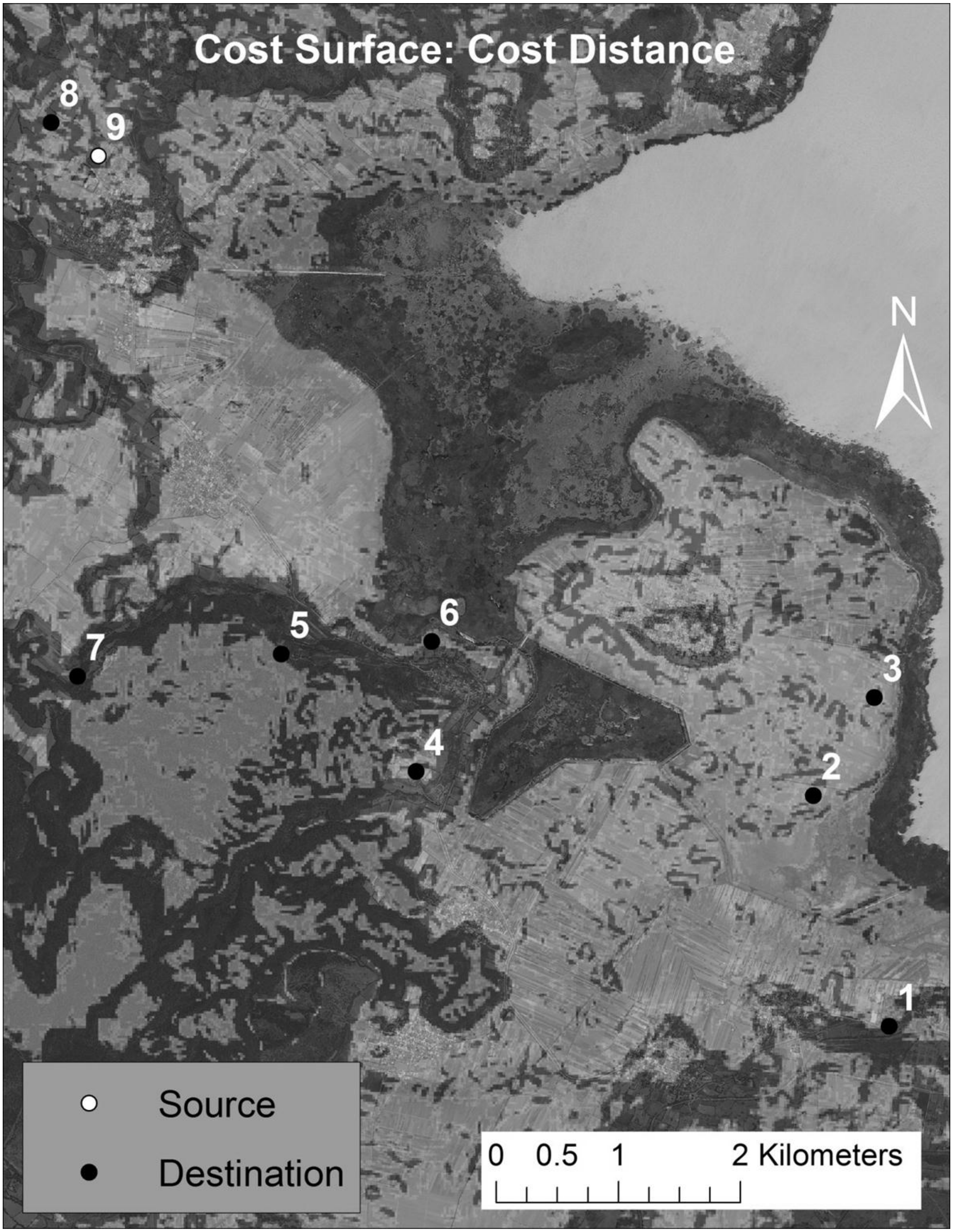


*Figure 28– The Cost Distance Map*

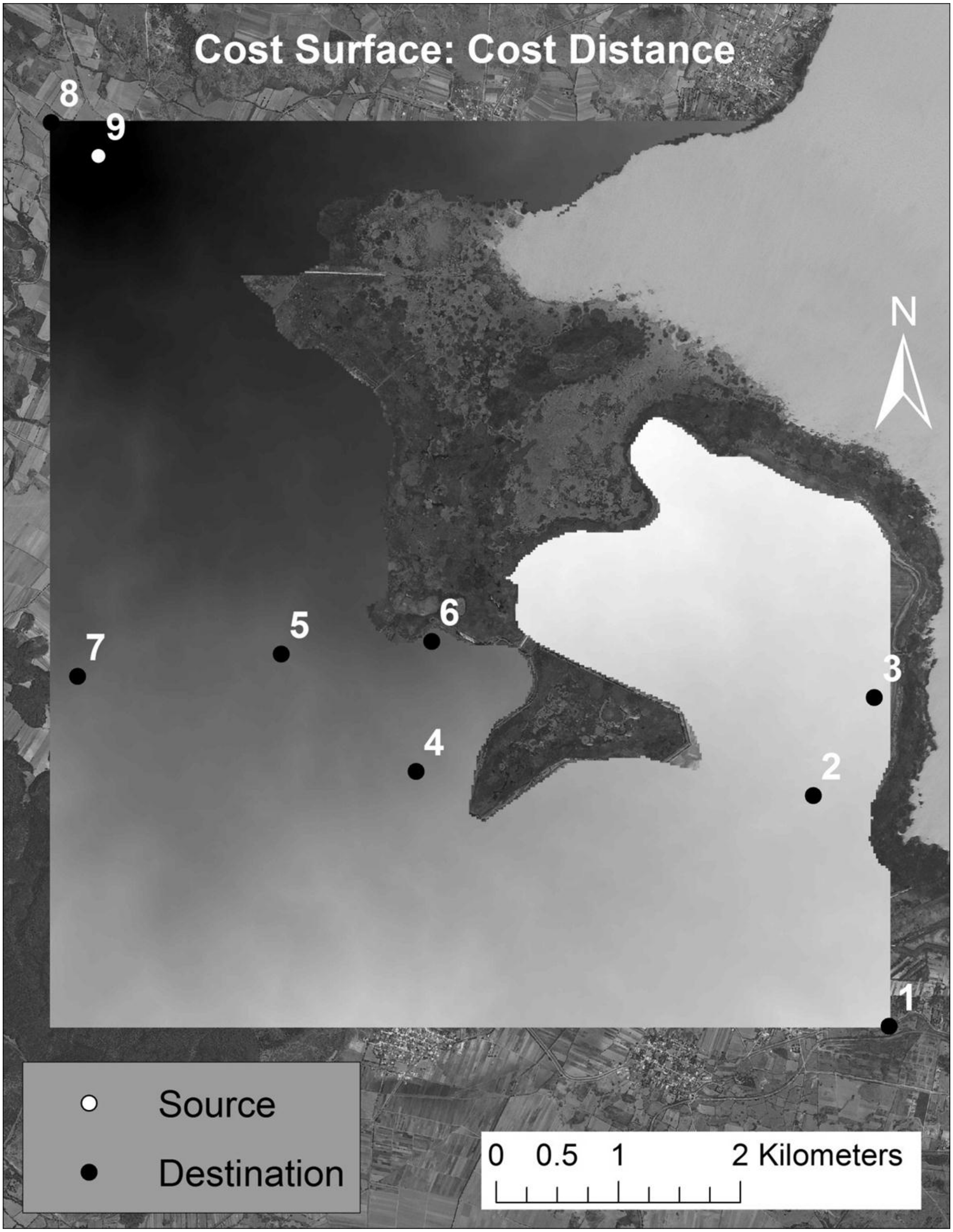
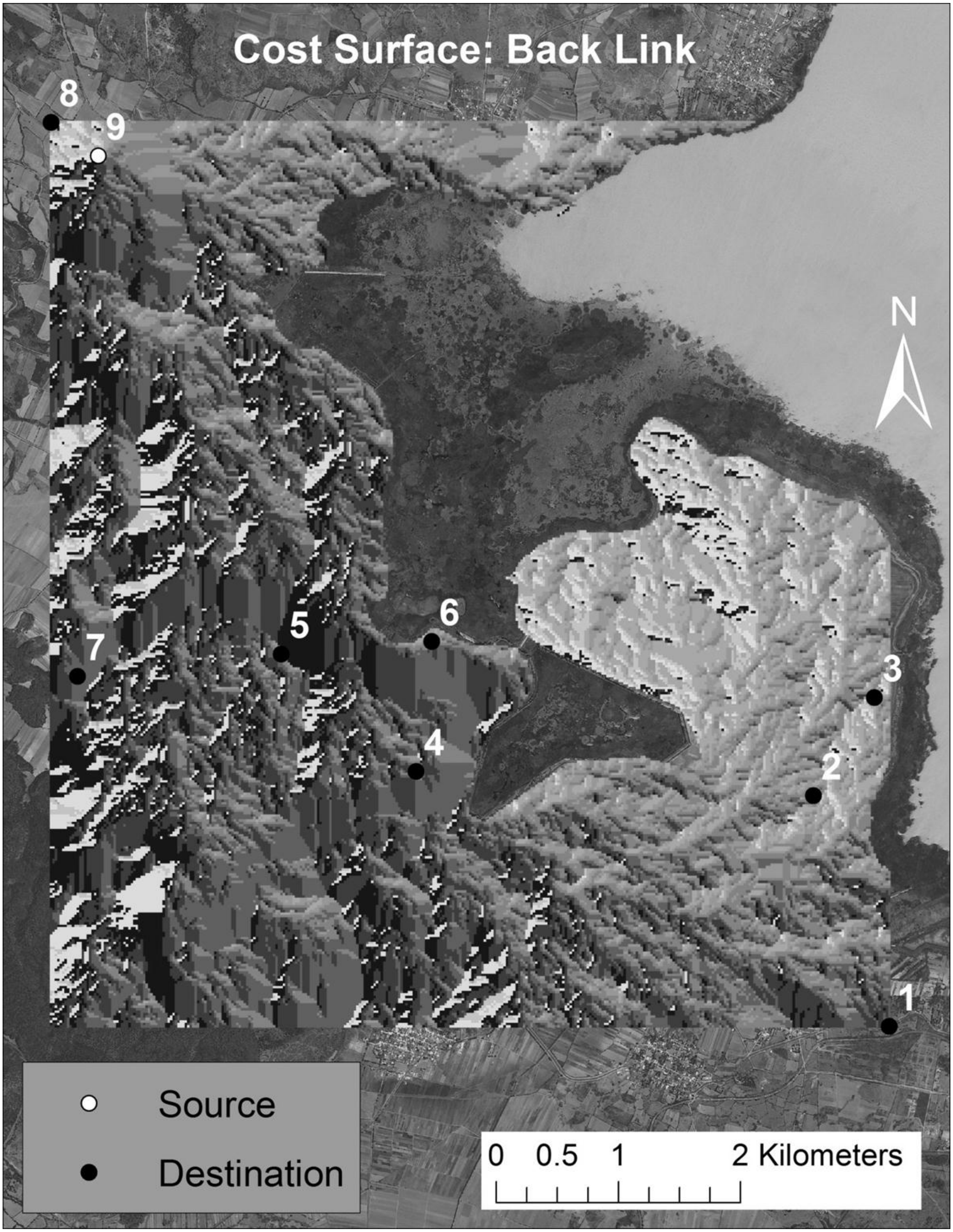
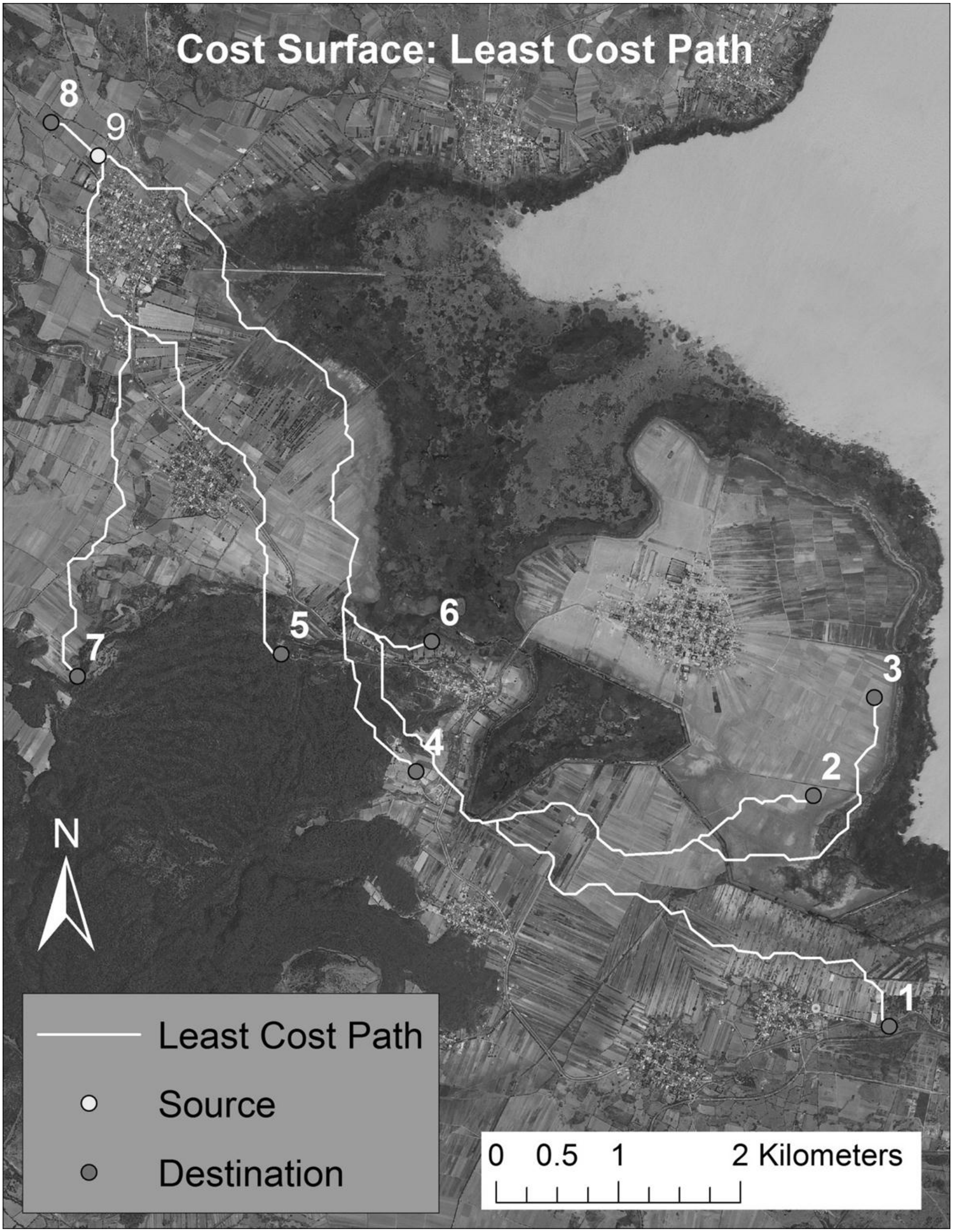


*Figure 29 - The Back Link Map*



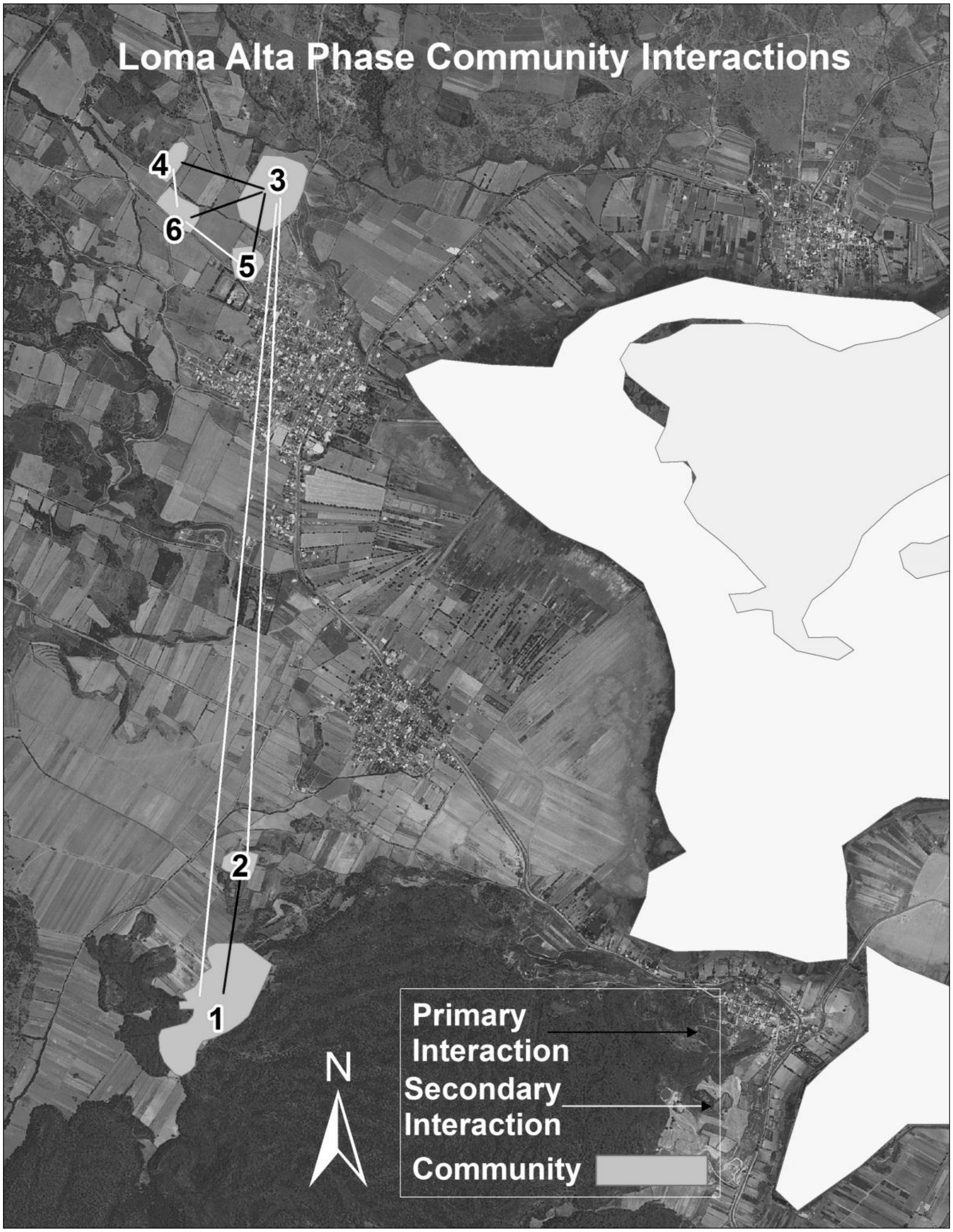
This was done for each community, to create an array of cost path maps that represent the least cost path between every combination of communities.  The paths were then measured individually between each community, giving an accurate geodesic distance measurement that is used in the gravity model to determine interaction values.  This was done for each community, for each phase.  Loma Alta had 6 communities, resulting in n=30 distance measurements; Lupe/La Joya had n=9 communities, resulting in n=72 distance measurements; Early Urichu had n=17 communities, resulting in n=272 distance measurements; Late Urichu had n=42 communities, resulting in 1806 distance measurements; and finally Tariacuri had n=17 communities, resulting in n=272 distance measurements.

*Figure 30 – The Final Least Cost Path*



With the least cost path distances measurements complete, an excel database was then created to calculate the interaction between communities through the application of the gravity model equation.  The equation is as follows: $I = Pi * Pj / dij^{1.9}$, where Pi is the population of community 1, $P_j$ is the population of community 2, $d_{ij}$ is the distance between the two communities, which is raised to 1.9, the constant that alters the distance of extension of influence, derived from Hare (2004: 802).  This equation was calculated for each combination of communities for each of the phases, thus creating an array of interaction values between communities for each phase.  The ultimate result of these interaction values is to determine which communities had the most interaction for each phase, what the overall characteristics of interaction of communities were, and to provide insight into which were the possible major communities, or centers, through each phase.  In order to do this, each community's interaction values were analyzed, and the highest interaction numbers were used to create a map of primary interactions between communities.  The interaction is shown using desire lines between the communities.  An example of these primary, and in this case, secondary interactions can be seen in Figure 31 for the Loma Alta period.  The tables for the community interactions can be found in the appendices.

*Figure 31 – Loma Alta Community Interactions*




*Statistical Analysis of Interaction Values*

In order to better understand the community interactions, an exploratory analysis of the interaction values is done by phase. Given that the gravity equation divides the population by the distance, one can assume that lower interaction values means that there exist a greater distance than population value. Likewise, higher interaction values must assume that larger population values. The "gravity aspect" of the equation involves the mass of the two communities, and the leading goal is to see whether it was distance or population that inhibited or prohibited interaction amongst the other communities. At the very basic level, these exploratory statistics will show the nature of the interaction values for each phase, which will be interpreted along with the interaction maps in the next chapter.

*Table 12 – Exploratory Interaction Statistics by Phase*

| **Phase** | **Year** | **Count** | **Max** | **Min** | **Mean** | **Median** | **St. Dev.** |
|---|---|---|---|---|---|---|---|
| Tariacuri | A.D. 1350-1525 | 272 | 1610.85 | 0.13 | 58.14 | 7.6 | 195.6 |
| Late Urichu | A.D. 1100-1350 | 1722 | 0.33 | 0 | 0.008 | 0.0012 | 0.03 |
| Early Urichu | A.D. 900-1100 | 272 | 0.07 | 0 | 0.003 | 0.0002 | 0.009 |
| Lupe/La Joya | A.D. 600-900 | 72 | 0.06 | 0 | 0.0024 | 0.0001 | 0.009 |
| Loma Alta (1 &2) | 150 B.C. - A.D 600 | 30 | 0.07 | 0.014 | 0.014 | 0.002 | 0.02 |

**Community- Landscape Interaction Analysis**

In the same manner in which the community to community interactions were analyzed and quantified, the community-landscape interactions will also utilize the cost surface model to interpolate interaction. However, given the difficulty in quantifying mass in terms of the landscape variables, such as lakeshore resources, with concern to the application of the gravity model, a different method will be used to determine interaction levels between the communities and the landscape variables. Instead of using the least cost path analysis, the cost surface will be used to create a cost allocation surface, which assigns territory to each polity center with the smaller cost distance (Hare 2004:805). In effect, this creates a site catchment for each community based on the cost surface. Johnson outlines two important factors that make this method relevant. First, "settlement location as well as sedentarization and settlement formation appears to be related to movement-minimizing behavior", with transport costs playing a central role in settlement location (1977:489). Second, based on these assumptions "catchment analysis normally defines the radius of that resource area as the distance beyond which energy expended in movement equals or exceeds the energy return of exploitation" (Johnson 1977:489). However, these Euclidean radii don't take into effect the terrain, which the cost allocation does.

Therefore, the cost allocation territory represents the area surrounding the community most easily and quickly accessed. For the sake of consistency, these output allocation polygons, which represent catchments, will be referred to as allocation catchments. The premise of the allocation catchments, also referred to as cost catchments, has its roots in site catchment analysis, where a specified area around a site is analyzed, and the resources within that boundary, or catchment, measures resources based on distance to the site. The catchment represents resource accessibility for the site. However, the major difference between cost and site catchments is that cost catchments "take into account the cost of moving through the landscape whereas the simple site catchments do not" (Surface-Evans 2012:128). The research from Surface-Evans uses a least cost-path analysis, and cost corridors between two points to ultimately create catchment areas for the sites, rather than rely on a simple 5km catchment buffer based on Euclidean distance (2012:142-143). Her research shows that although the cost catchments are smaller and model reduced accessibility than the site catchment counterpart, they appropriately fit the constraints that affect foot travel across the landscape (2012:146). In the same manner, the cost allocation function in GIS, when coupled with a cost surface, creates boundaries of allocation based on least cost from the point of origin, which in this case is the community.

The method that was followed to create these allocation catchments, as stated above, began with the cost surface grid, based on Tobler's hiking function, which includes the lake and marsh zone, with canoe travel velocity of 3.33km/h. Modeling water travel was important to the analysis because instead of the catchment stopping at the beginning of water features (as most land-based analysis do), it will compute the area of the lake that is most easily accessed by certain communities, which assumes canoe access and canoe travel. That way, we can compute the area of specific marsh or lake zones within the allocation catchments. However, one factor that complicates the resource and landscape catchment modeling is that when running the spatial analysis in a GIS, it bases the boundaries both on the cost surface model as well as the other communities around it. This is similar to how Theissen polygons are created. Whereas this creates useful boundaries for the interior communities, the outer communities are defined by the extent of the layer, which is an arbitrary outer edge. There really is no means by which an objective and meaningful outer boundary can be created, so in order to limit the extent of the allocation catchment, a two kilometer buffer was created around each community, which defines the overall extent of the allocation catchment. Figure 32 below shows the allocation catchment before the buffer was created, and also shows the allocation catchment after the buffer rings were applied and used to clip the extent of the layer.

*Figure 32 – The Cost Allocation Catchment: No Boundaries*

*Figure 33 - The Cost Allocation Catchment: Two Kilometer Buffer*

With the allocation catchments defined for each community, the method next involves quantifying the different resource and/or landscape variables within said catchments. In this case, four separate analyses will take place: 1.) the analysis of percentage of resource zones in each catchment (i.e. lakeshore, alpine, lower slopes, etc.); 2.) the analysis of the catchment's slope; 3.) the analysis of the satellite imagery to identify any major landscape features within the catchment; and 4.) the creation of hypothetical travel/trade networks for the Southwest portion of the basin. This was done for each phase and for each community in each phase.

The first method involved combining the resource zone layers in GIS (alpine, upper slopes, lower slopes, lakeshore, marsh, open water), and applying the above allocation catchment boundaries to each. For each cost catchment boundary, whatever resource zone was present in the catchment was clipped, and the area calculated. Therefore, each cost allocation for each community has the area of the resource zones located in it, and the percentage of the total area. This will ultimately aid in our understanding of the resources that the community was most likely accessing. An example of the results of this analysis can be found in Table 13, and a map depicting the analysis can be seen in figure 33.

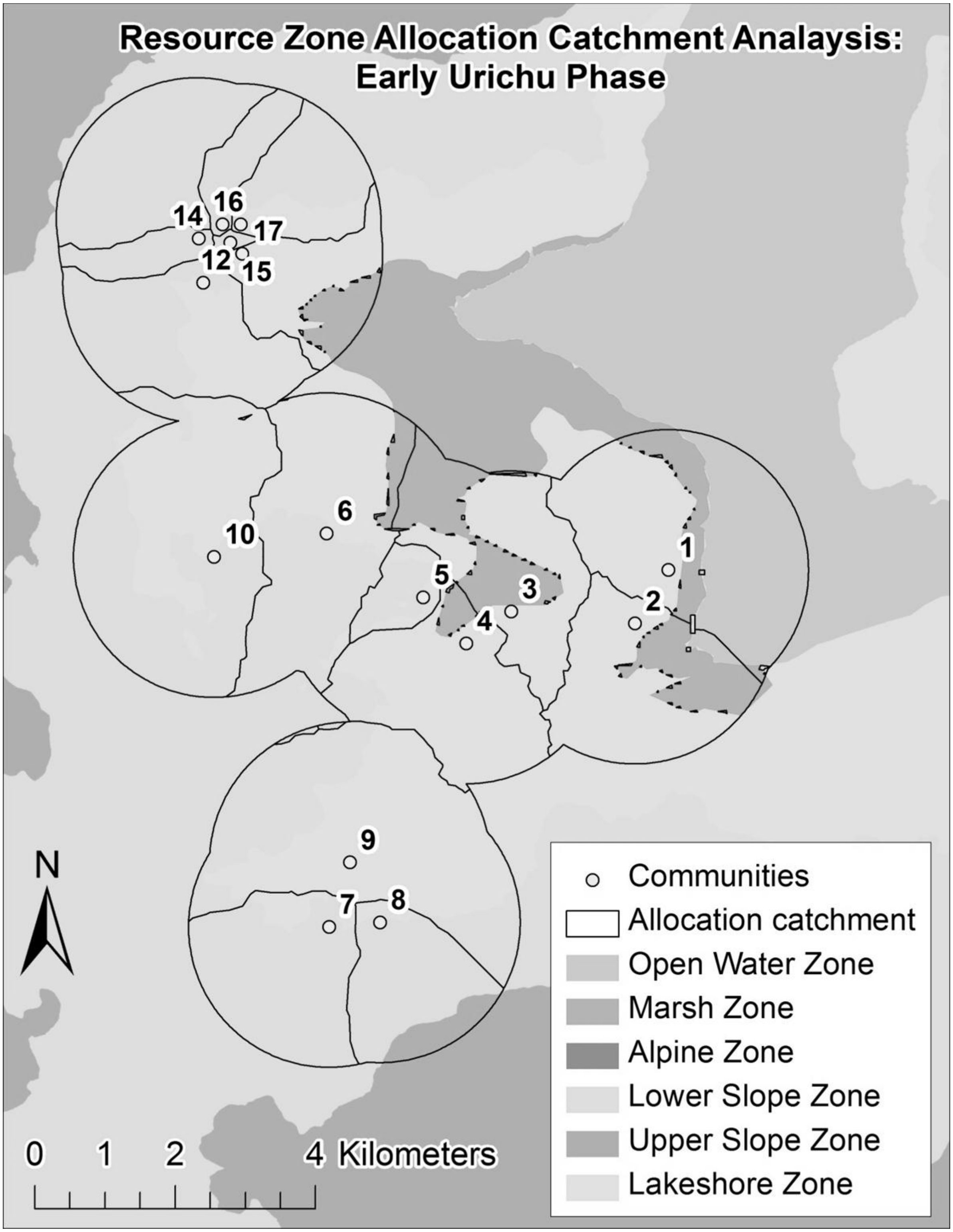
*Table 13a - Loma Alta Landscape Analysis*

| Community | Community Zone | Catchment Area ($m^2$) | Open Water ($m^2$) | % | Tule-Reed Marsh ($m^2$) | % |
|---|---|---|---|---|---|---|
| 1 | Lower Slopes/Lakeshore | 5695833 | NA | 0 | NA | 0 |
| 2 | Lakeshore | 10477548 | NA | 0 | NA | 0 |
| 3 | Lower Slopes/Lakeshore | 4367042 | NA | 0 | NA | 0 |
| 4 | Lower Slopes | 4939059 | NA | 0 | NA | 0 |
| 5 | Lower Slopes | 3996119 | NA | 0 | NA | 0 |
| 6 | Lower Slopes | 1638473 | NA | 0 | NA | 0 |

*Table 13b- Loma Alta Landscape Analysis*

| Lakeshore ($m^2$) | % | Lower Slopes ($m^2$) | % | Upper Slopes ($m^2$) | % |
|---|---|---|---|---|---|
| 695480.9 | 12.2 | 5000352 | 87.8 | NA | 0 |
| 7007452 | 66.9 | 3470095 | 33.1 | NA | 0 |
| 1798290 | 41.2 | 2568752 | 58.8 | NA | 0 |
| NA | 0.0 | 4939059 | 100.0 | NA | 0 |
| 2784231 | 69.7 | 1211889 | 30.3 | NA | 0 |
| NA | 0.0 | 1638473 | 100.0 | NA | 0 |

*Figure 34 – The Landscape Resource Zone Analysis*



The slope analysis was done in a similar fashion, where the slope map for the basin was clipped to each specific allocation catchment, and the statistics for that catchment's slope was calculated in GIS. The slope at the location of the community was recorded, as was the elevation. The remainder of the analysis looks at the specific catchment as a whole for each community, giving the maximum (max) value, minimum (min) value, mean and standard deviation of the slope frequency for that catchment. Examples of the slope analysis can be seen in Table 14. The remaining maps and tables for all phases, for both the resource and slope analysis, can be found in the appendices.

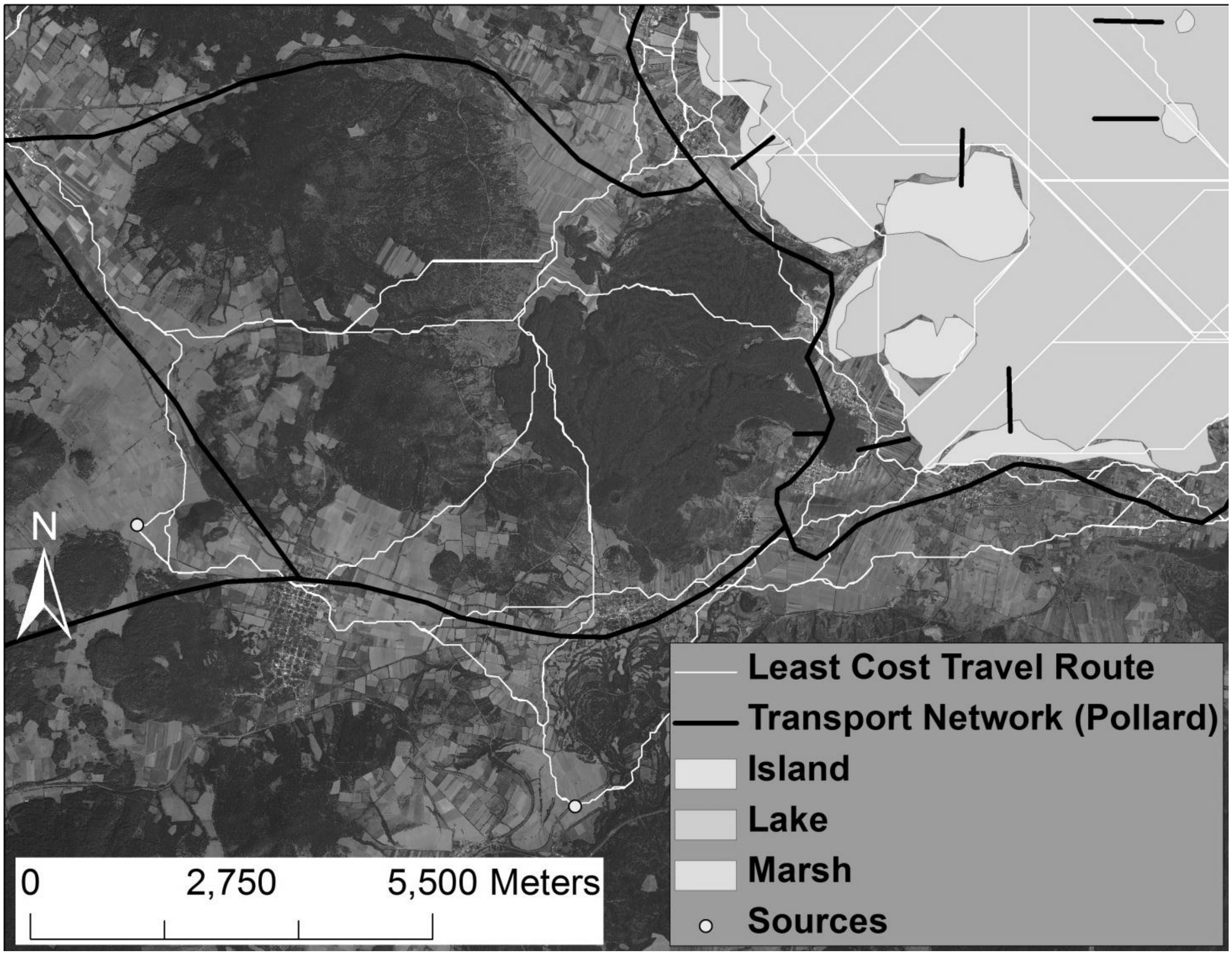
*Table 14 – Loma Alta Slope Analysis*

| Community | Comm Slope | Comm Elevation | Max | Min | Mean | St. Dev |
|---|---|---|---|---|---|---|
| 1 | 10.8 | 2098 masl | 25.2 | 0 | 4.9 | 4.2 |
| 2 | 4.1 | 2084 masl | 19.5 | 0 | 4.4 | 3.7 |
| 3 | 6.7 | 2108 masl | 24.1 | 0 | 4.9 | 3.3 |
| 4 | 5 | 2130 masl | 33.6 | 0 | 5.8 | 3.4 |
| 5 | 1.8 | 2103 masl | 21.3 | 0 | 4.6 | 3.4 |
| 6 | 2.6 | 2125 masl | 24.1 | 0 | 5.9 | 3.4 |

The final aspect of the analysis, the travel/transportation network analysis, included the same method for creating a least-cost path based on Tobler's hiking function as was done for the community interaction. This method worked from one major assumption. First, although it was stated earlier that it would be too presumptive to retrodict the Protohistoric transportation network that Pollard reconstructed back any further than the Late Postclassic, it was noted that there was a strong correlation between the cost-surface model, low slope, and the transport network, as analyzed in a GIS. Therefore, we can safely assume that major internal and major external roads would have these same characteristics of being in areas of flat terrain higher travel velocity. Therefore, to recreate the possible transportation network for the southwest portion of the basin, a cost path analysis was completed for each phase, taking into account the lake levels, foot and canoe travel, and resource zones. One variable that won't be taken into consideration are the communities themselves. Instead, the sources and destinations are locations outside of the communities, to represent potential origins/destinations of travel from outside this southwest zone. These sources, n=7, were selected from an array around the southwest area, and at least 2 kilometers away from the closest southwest zone community. The result was a "spider web" of least-cost paths that surrounded the communities, many of which intersected or overlapped. The result of the least cost path transportation network for the different phases for the southwest communities.

One note must be made about the creation of these routes in GIS. A brief analysis was done in order to test the feasibility of using travel routes created from the cost surface. In order to test its application, the cost surface travel routes created for the Tariacuri phase were compared to the transportation network presented by Pollard and Gorenstein (1983). In a GIS, the two layers were overlaid, and compared, noting any deviations in routes and proximity of routes to each other (see Figure 35). In the majority of cases, the major routes were very close in their location, with two exceptions. Given the higher amount of detail, on a sub-regional level, the least cost method predicted a route through to malpaís the link the southeastern portion with the northwestern portion. Pollard's network lacked these routes. Also, the routes running from the lake directly east out of the basin differed from each other. However, I believe that the similarity outweighs the differences, especially when considering scale of analysis, and therefore feel comfortable utilizing the least cost routes as a variable in modeling community-to-landscape interaction.

*Figure 35 – A Comparison of Least-Cost Travel routes versus Pollard's Transportation Network*



The method for quantifying the impact of the travel and transport network on the communities is simple enough. The same allocation catchments that were used to quantify accessible community resource zones were also used to estimate how many travel and trade routes were accessible to the communities. First, any routes existing inside a community's catchment were counted, and an average geodesic distance was calculated. Second, the access to water travel was assessed, and if access existed within the catchment, the water routes were counted. Once the data was retrieved, exploratory statistics were done to examine the community's relationship with the routes, as a whole, by looking at the basic frequency of routes and the average distances to the routes. Other notes were also made, such as if the communities were located on routes, near or on major intersections, or if water or other major topographic features blocked access. The results of the transport analysis can be seen in Table 15, with basic exploratory statistics for each phase found in Table 16. The data from all other phases can be found in the appendices.

*Table 15 – Transportation and Travel Analysis by Community: Tariacuri Phase*

| Community | Travel Routes (Land) | Average Distance to Routes (meters) | Water Access | Water Routes |
|---|---|---|---|---|
| 1 | 0 | NA | yes | 0 |
| 2 | 3 | 2394 | yes | 4 |
| 3 | 0 | NA | yes | 6 |
| 4 | 1 | 755 | no | NA |
| 5 | 2 | 50 | yes | 0 |
| 6 | 1 | 346 | no | NA |
| 7 | 1 | 359 | yes | 0 |
| 8 | 3 | 797 | no | NA |
| 9 | 3 | 133 | no | NA |
| 10 | 1 | 132 | no | NA |
| 11 | 0 | NA | yes | 2 |
| 12 | 2 | 1108 | yes | 2 |
| 13 | 2 | 970 | no | NA |
| 14 | 2 | 279 | yes | NA |
| 15 | 3 | 730 | no | NA |
| 16 | 2 | 219 | no | NA |
| 17 | 1 | 388 | no | NA |
| 18 | 2 | 50 | yes | 1 |

*Table 16 – Summary Statistics for Travel and Transport Analysis by Phase*

| Phase | Average # of Routes per catchment | Average distance to routes (meters) | Communities with water access |
|---|---|---|---|
| Loma Alta (1 & 2) | 2.2 | 663 | (n=0) |
| Lupe/ La Joya | 1.9 | 682 | (n=7) 77% |
| Early Urichu | 1.5 | 373 | (n=7) 41% |
| Late Urichu | 0.97 | 442 | (n= 22) 51% |
| Tariacuri | 1.6 | 586 | (n=9) 50% |

**Summary**

This chapter focused on the methods for analysis of the southwest portion of the Lake Pátzcuaro Basin, including all phases from the Loma Alta (150 B.C. to the Tariacuri Phase (A.D. 1350). This included first the community analysis, which utilized a cost surface and least cost path (LCP) analysis to determine the interaction values between communities for each phase. The equation used to measure this “interaction” was the gravity model, which uses population and distance, in this case geodesic, real word distance between communities.

The second aspect of the analysis utilized the reconstructed landscape of the Lake Pátzcuaro Basin to aid in quantifying the human-environment relationship that existed between communities and the resource zones and landscape of the basin. First, allocation catchments were created, using the cost surface for walking velocity that represented realistic resource catchments for each community by phase. The resource zones were measured within each community’s catchment, representing the potential resource allocation and accessibility for each individual community. Second, the slope was analyzed for each community’s allocation catchment, and exploratory statistics were run to measure the relationship between the community and the terrain on which they settled and that they potentially interacted with and accessed most regularly. Finally, potential travel and transportation routes were created once again using the cost surface model. These routes had origins and destinations outside of the southwest portion of the basin, representing a network of possible routes, based on least cost paths, coming in and out of the area. The community's allocation catchment was once again utilized to aid in defining which routes were most easily accessed by communities, with the distances measured between each community and route. Also calculated was the number of communities with water access and in relation to potential water travel routes. The following maps display the results from each of these analyses, by phase; the community interaction analysis, the allocation catchment resource analysis, and the travel-transport analysis.

*Figure 36 – The Loma Alta Phase Community Interaction Analysis*

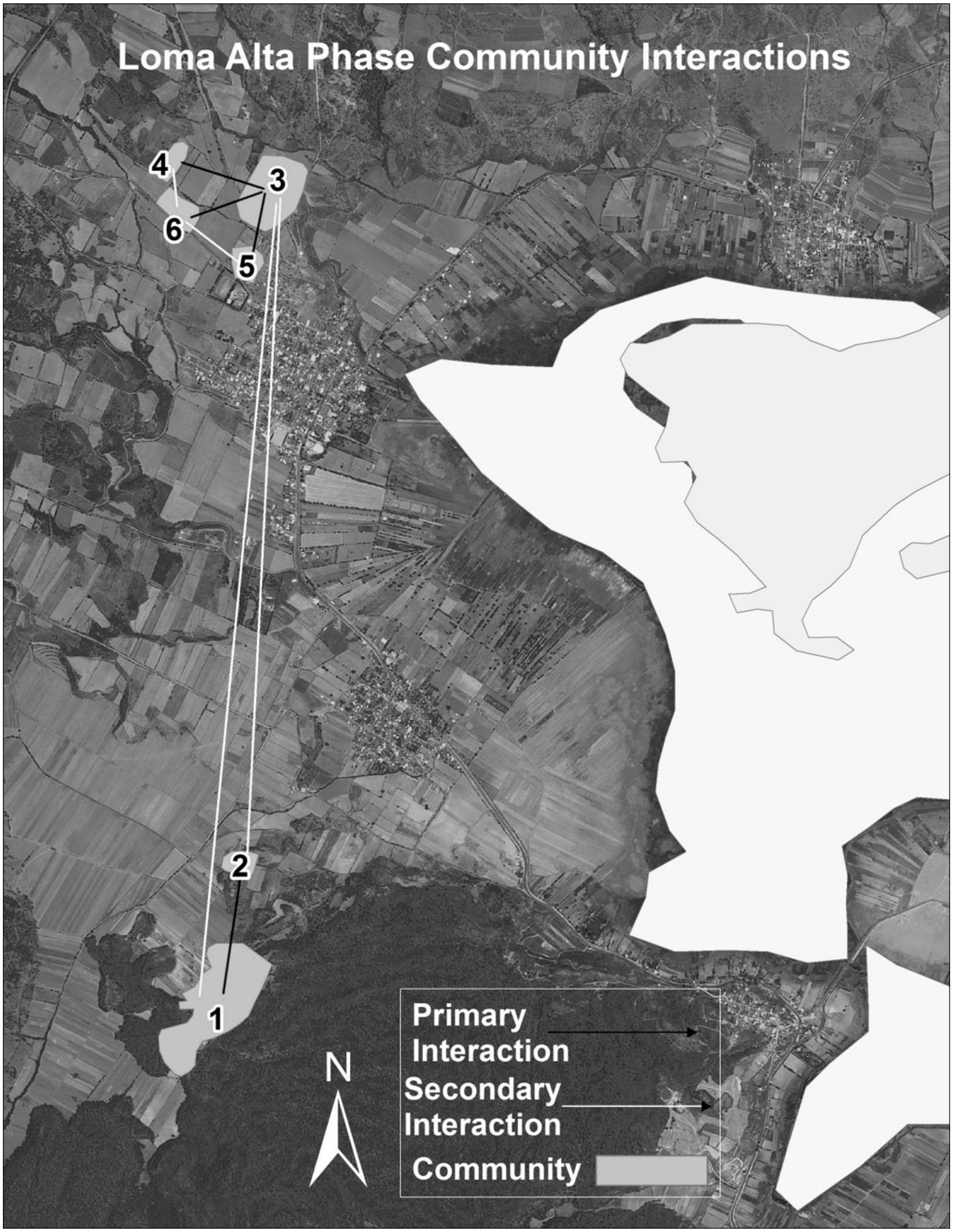


*Figure 37 – The Loma Alta Phase Allocation Catchment Analysis*

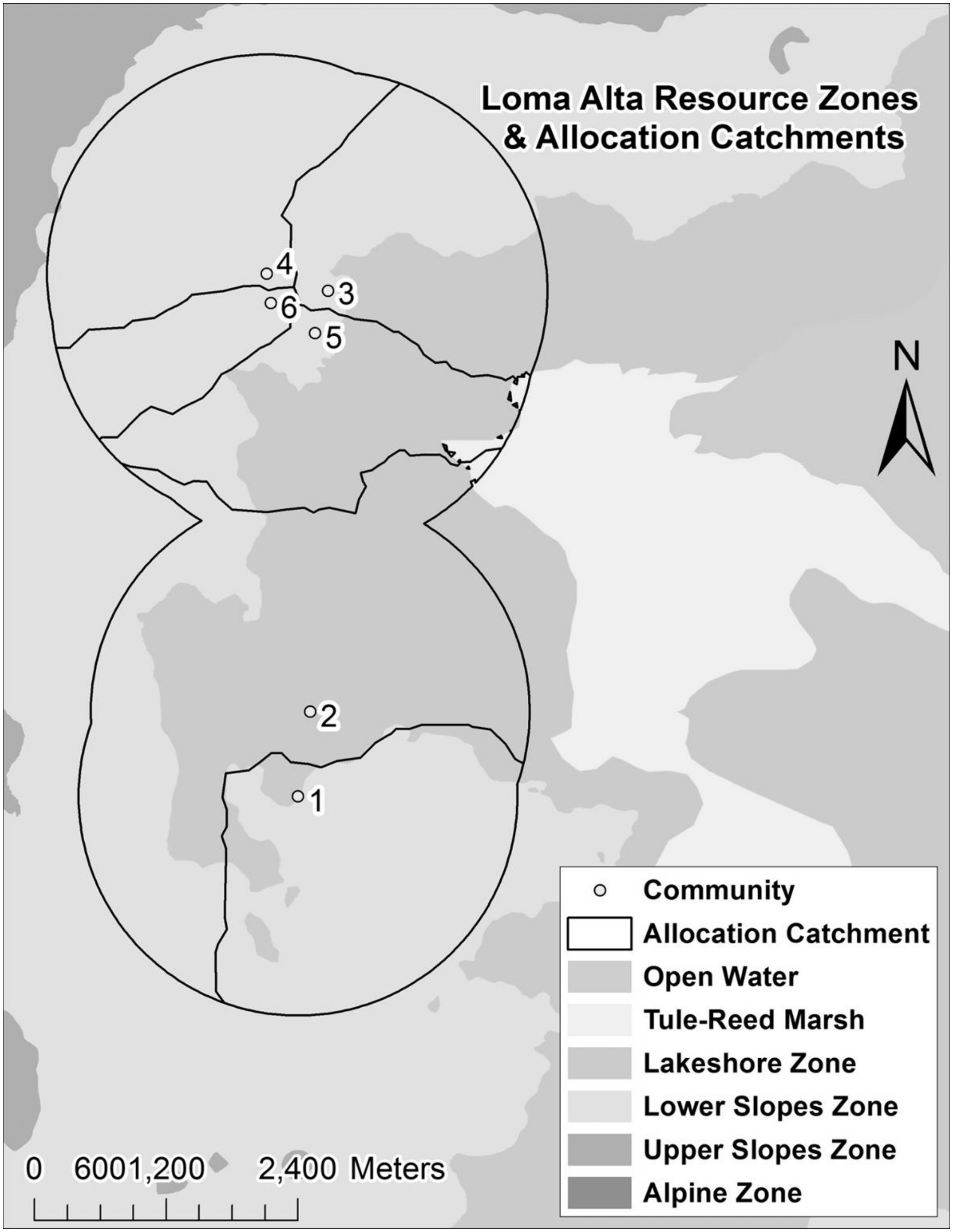


*Figure 38 – The Loma Alta Phase Travel/Transport Analysis*

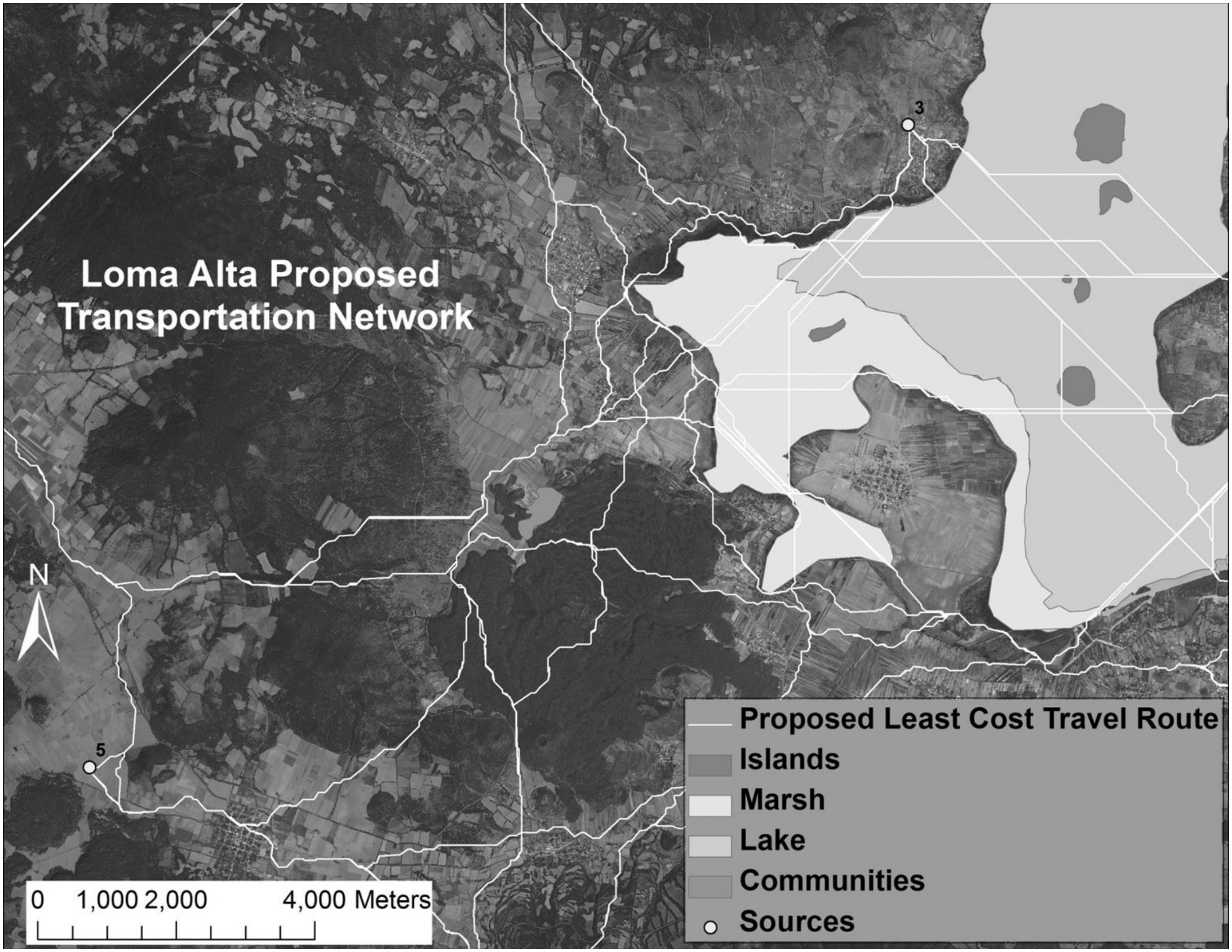


*Figure 39 – The Lupe/La Joya Phase Community Interaction Analysis*

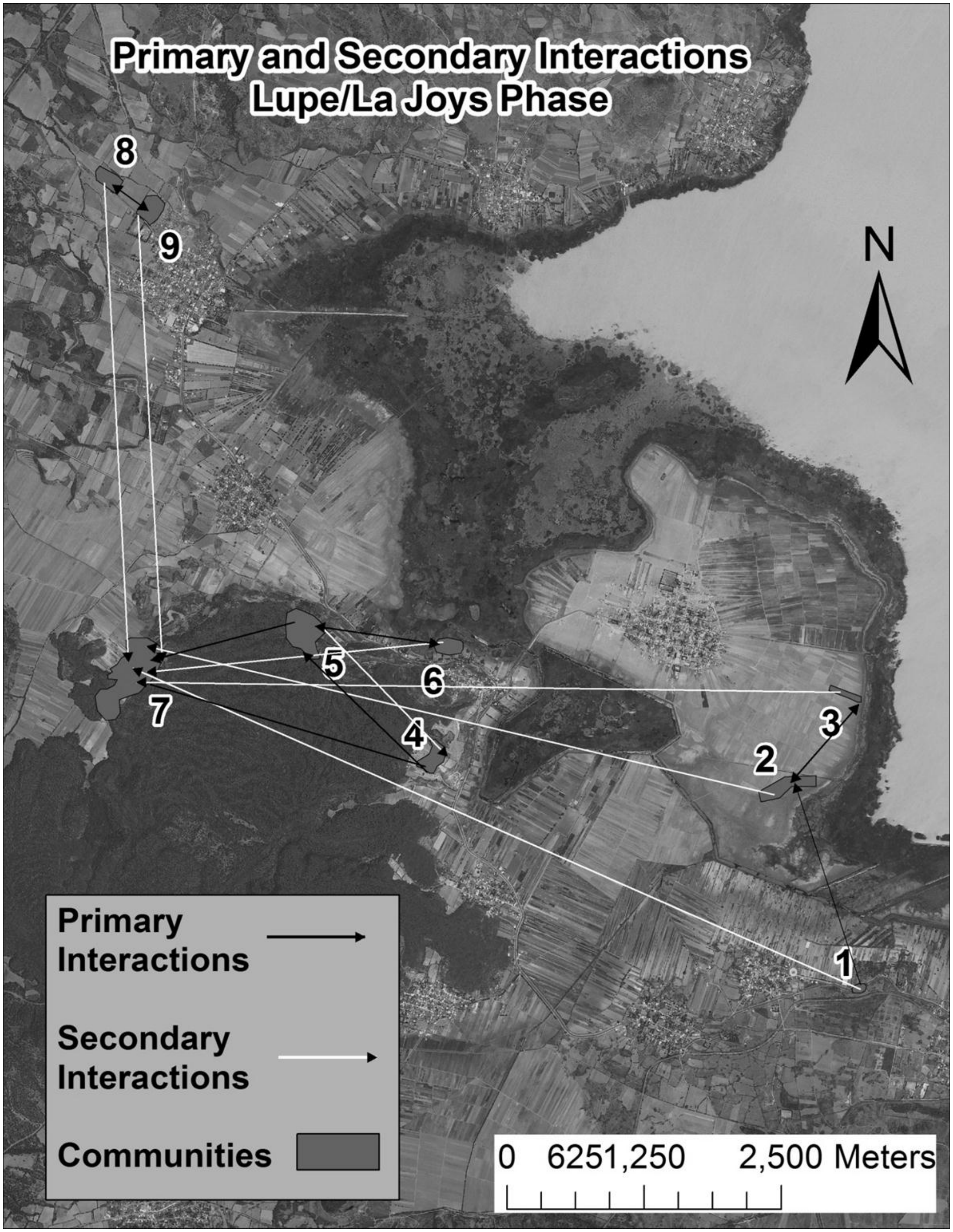


*Figure 40 – The Lupe/La Joya Phase Allocation Catchment Analysis*

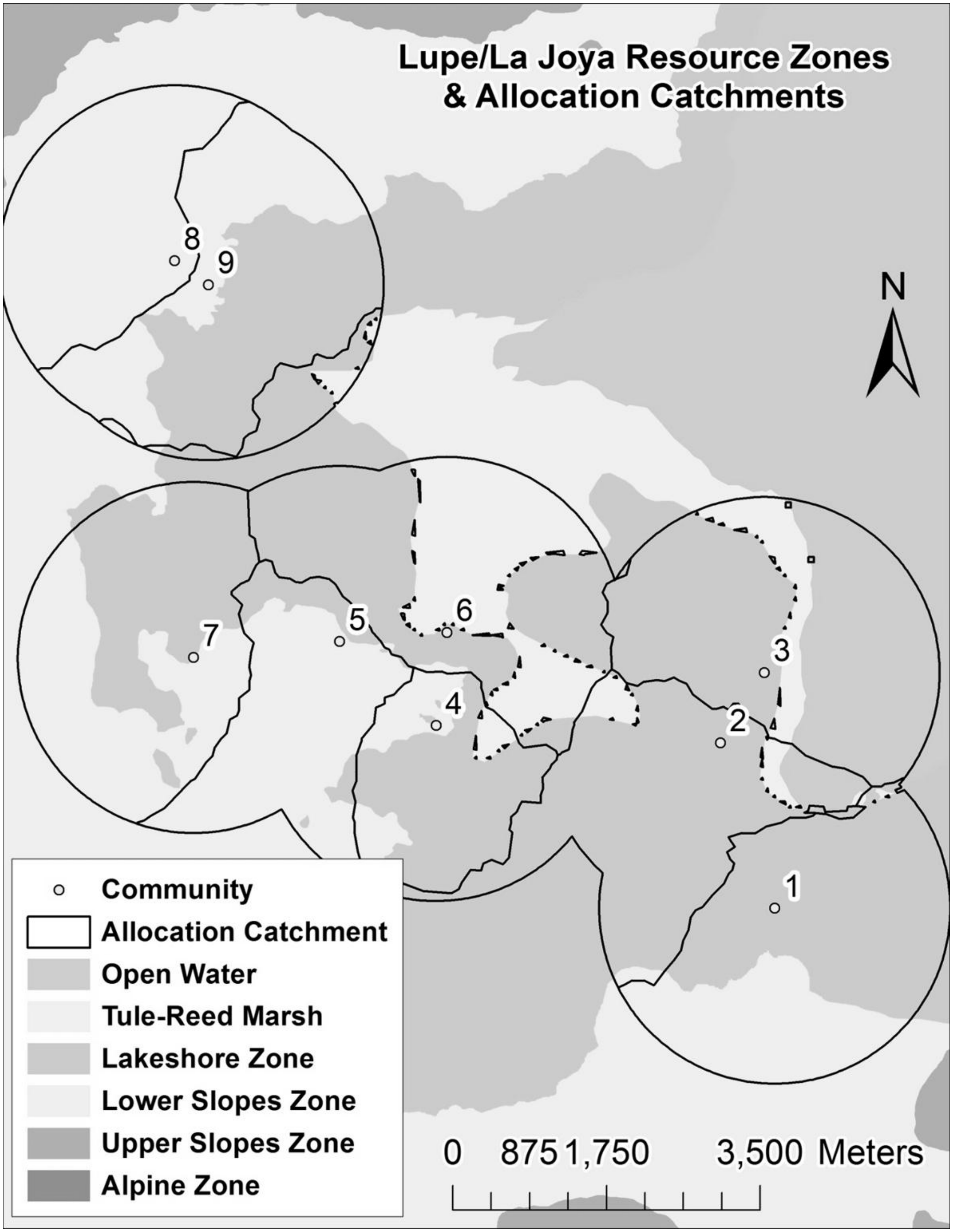


*Figure 41 – The Lupe/La Joya Phase Travel/Transport Analysis*

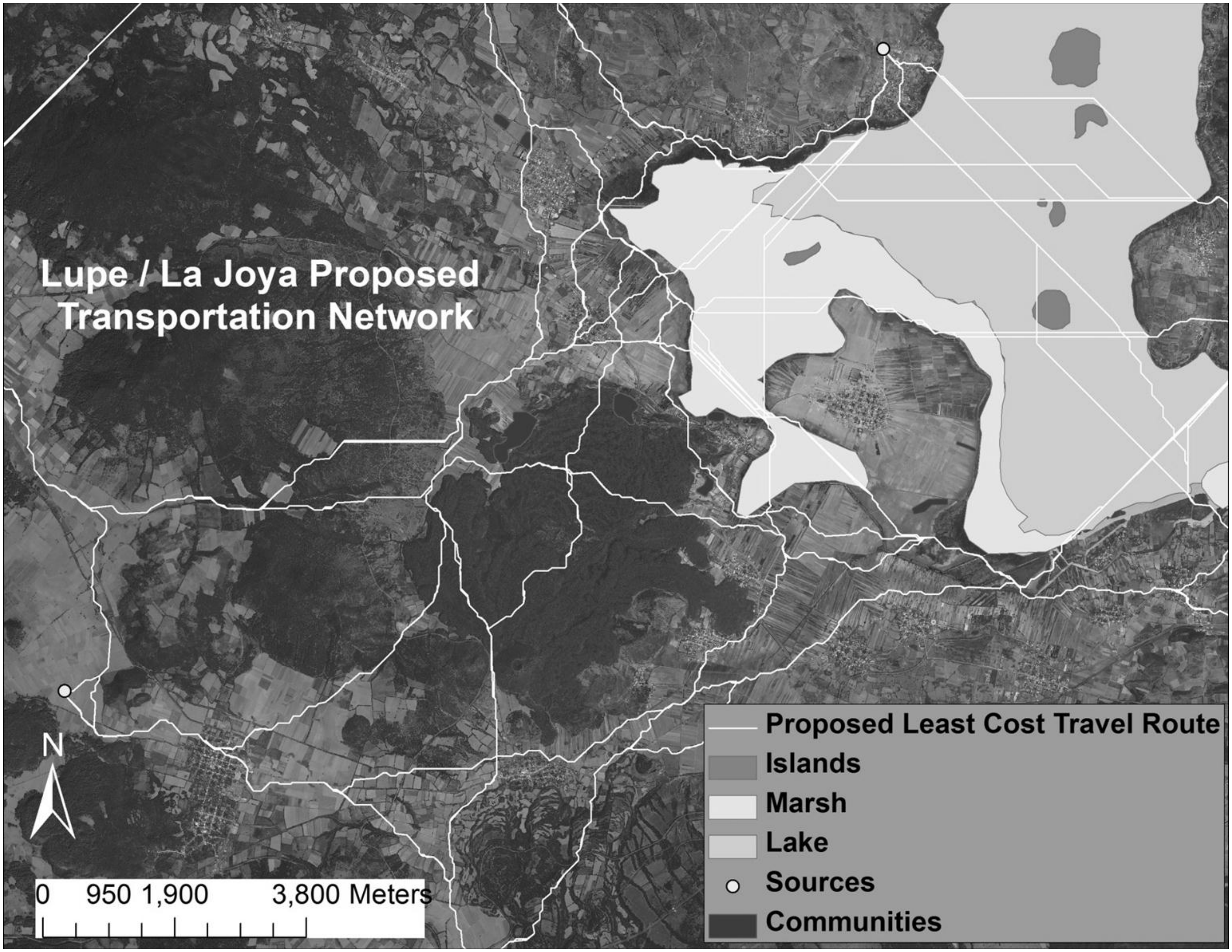


*Figure 42 – The Early Urichu Phase Community Interaction Analysis*

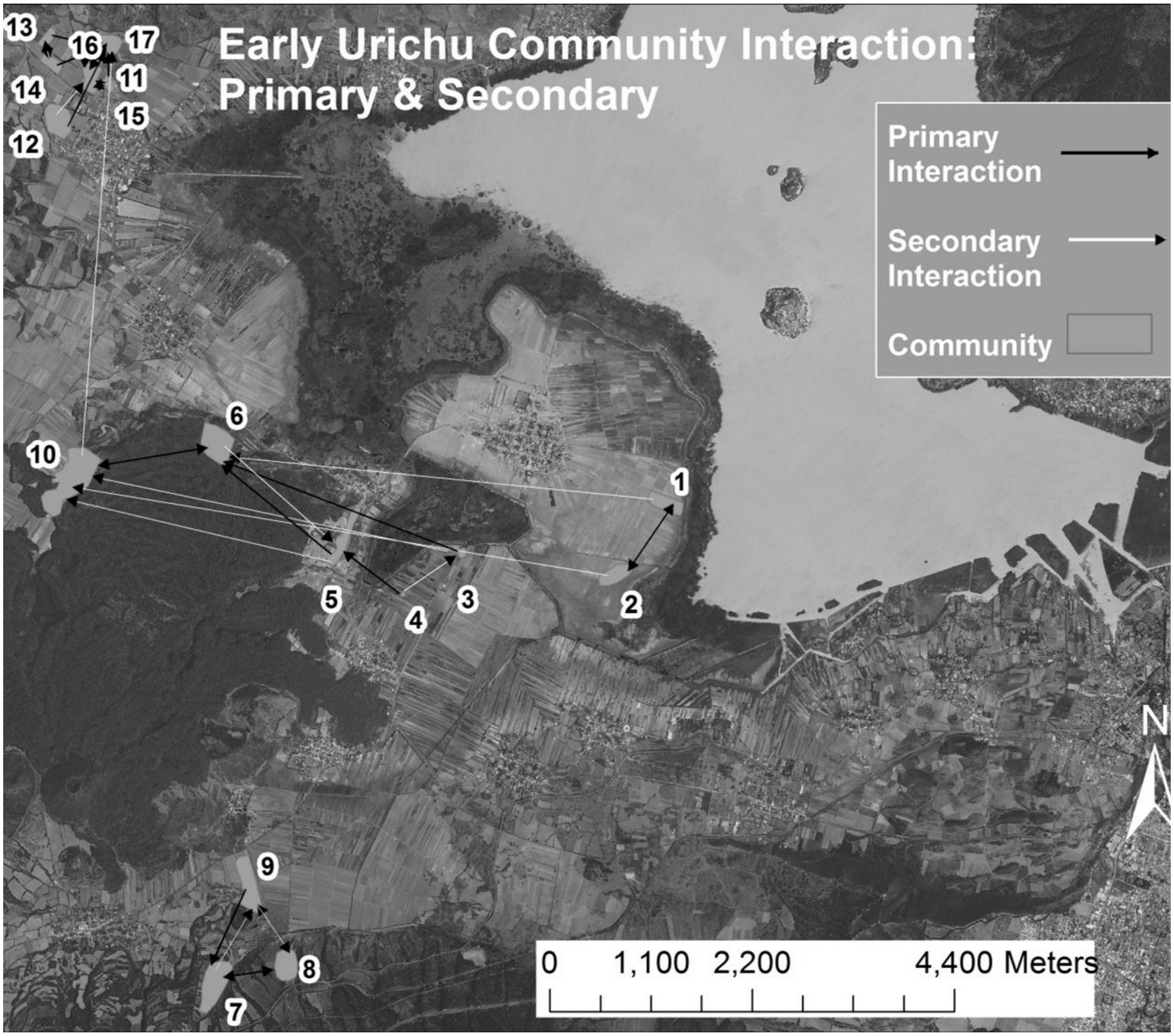


*Figure 43 – The Early Urichu Phase Allocation Catchment Analysis*

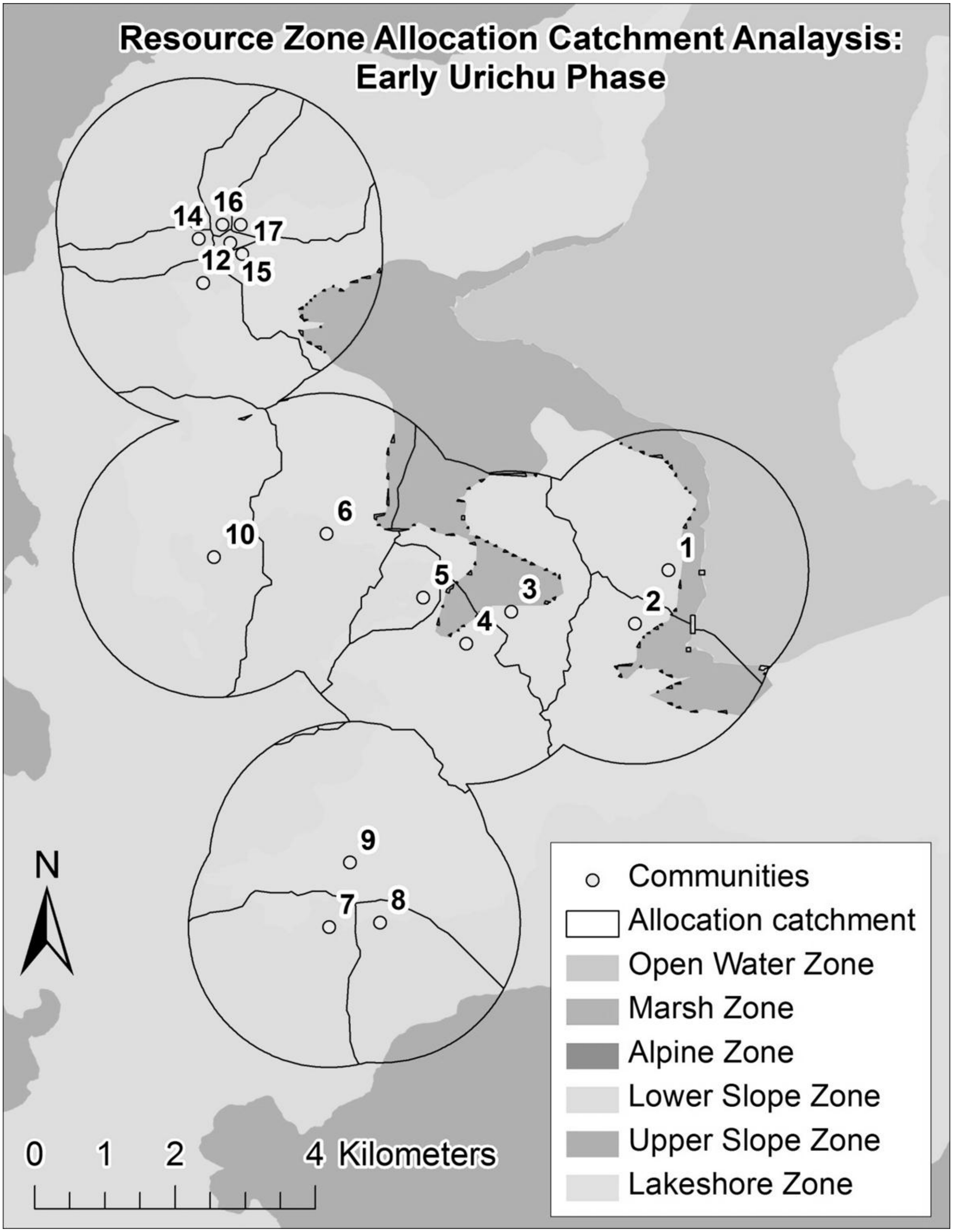


*Figure 44 – The Early Urichu Phase Travel/Transport Analysis*

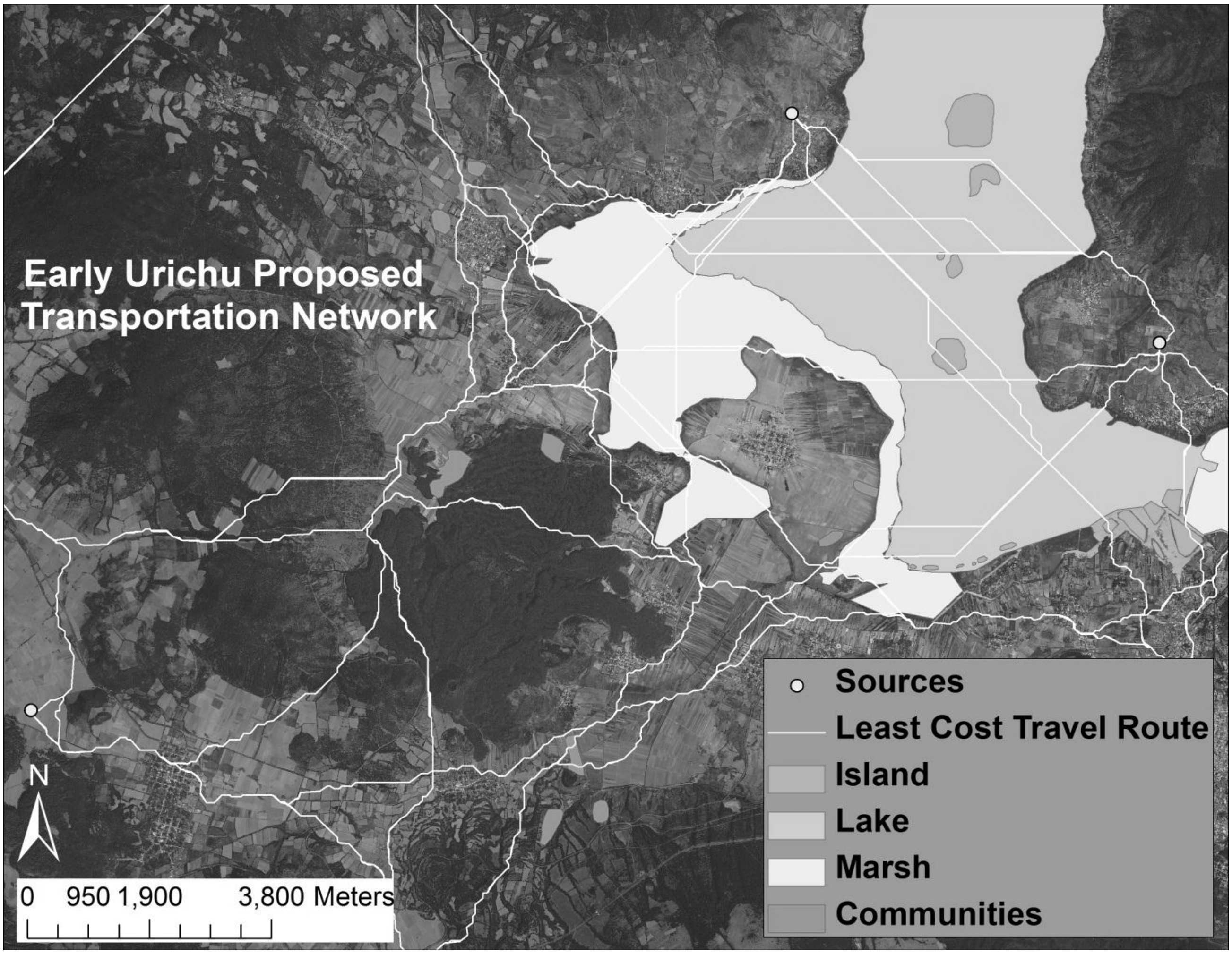


*Figure 45 – The Late Urichu Phase Community Interaction Analysis (Primary Interaction)*

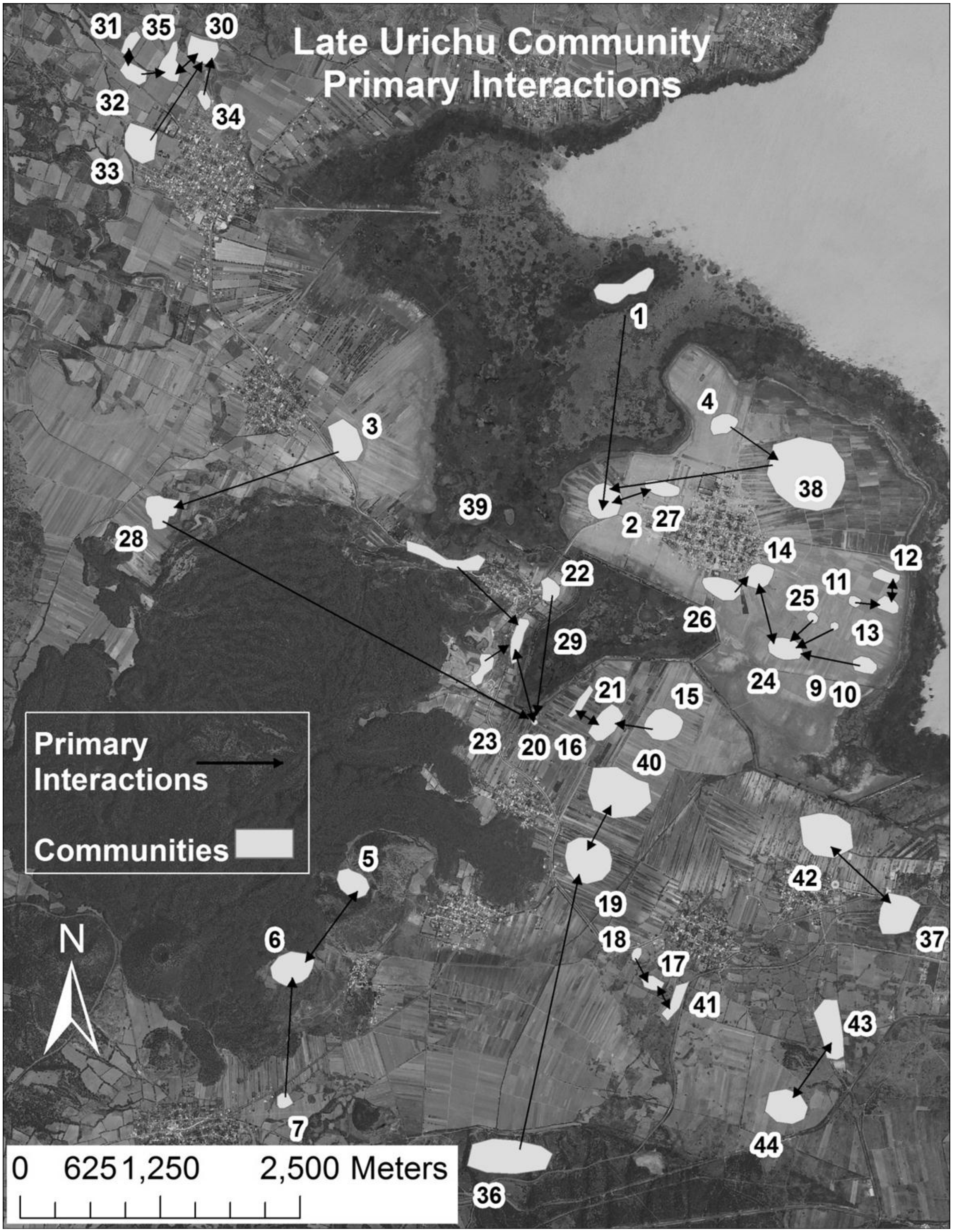


*Figure 46 – The Late Urichu Phase Community Interaction Analysis (Secondary Interaction)*

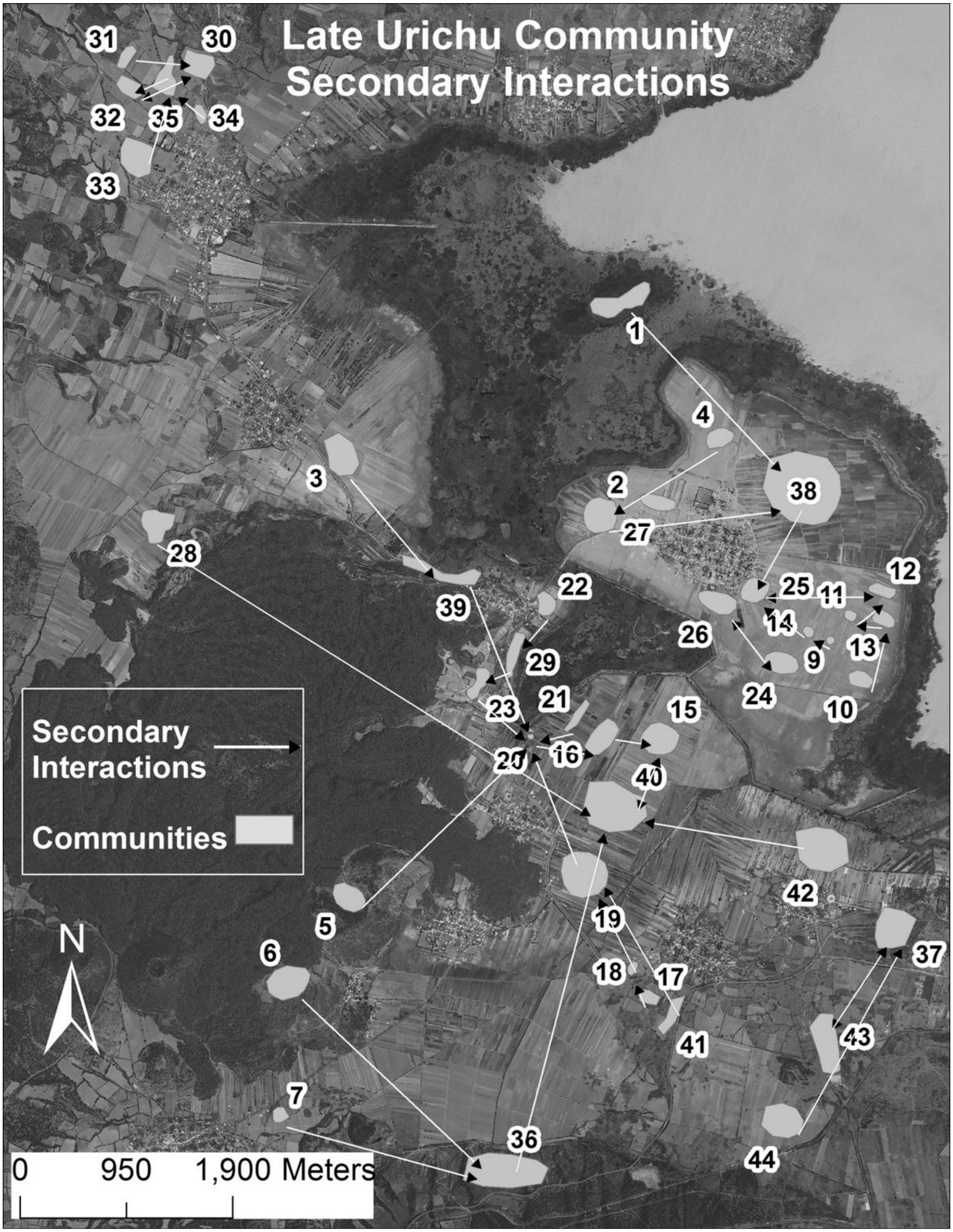


*Figure 47 – The Late Urichu Phase Allocation Catchment Analysis*

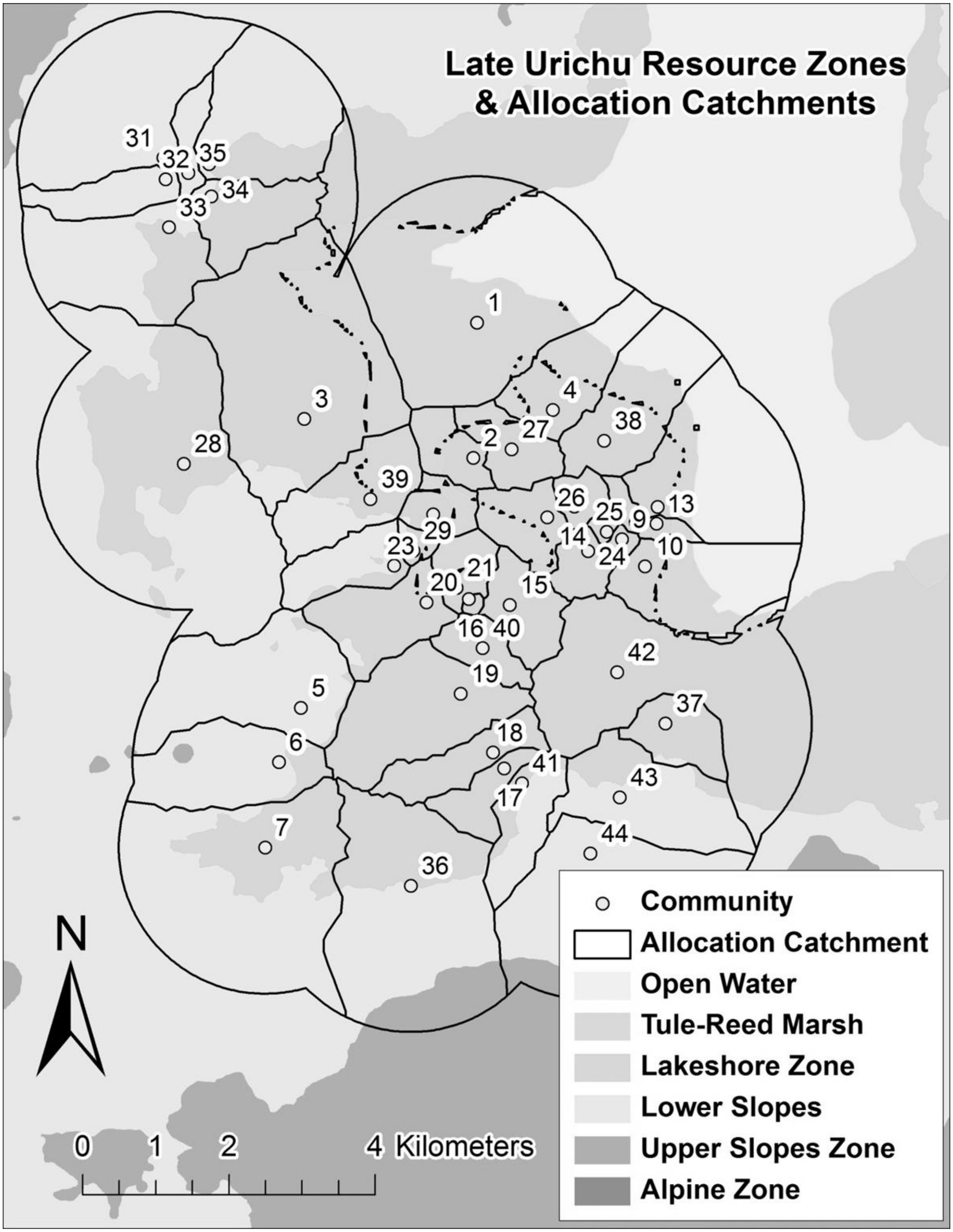


*Figure 48 – The Late Urichu Phase Travel/Transport Analysis*

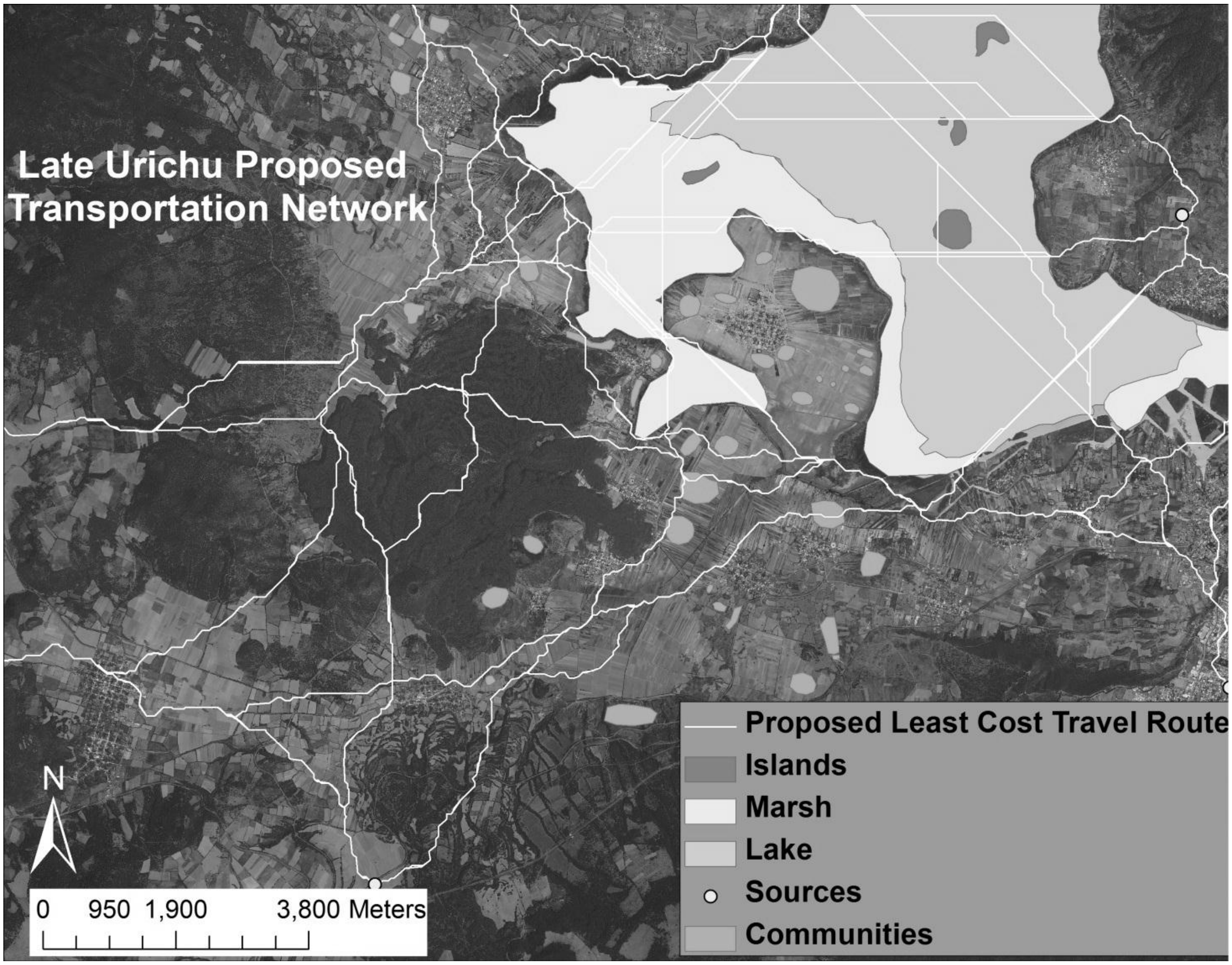


*Figure 49 – The Tariacuri Phase Community Interaction Analysis*

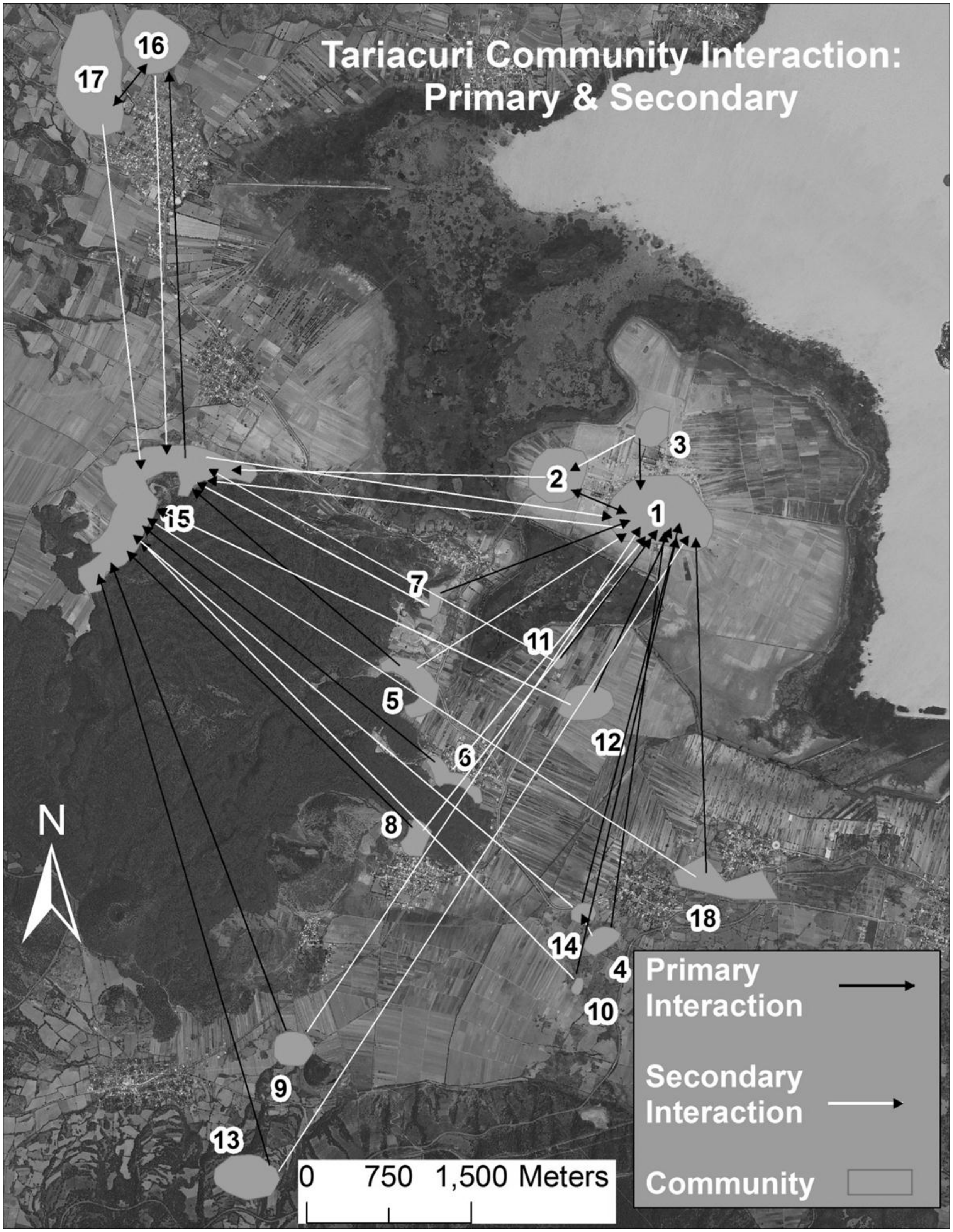


*Figure 50 – The Tariacuri Phase Allocation Catchment Analysis*

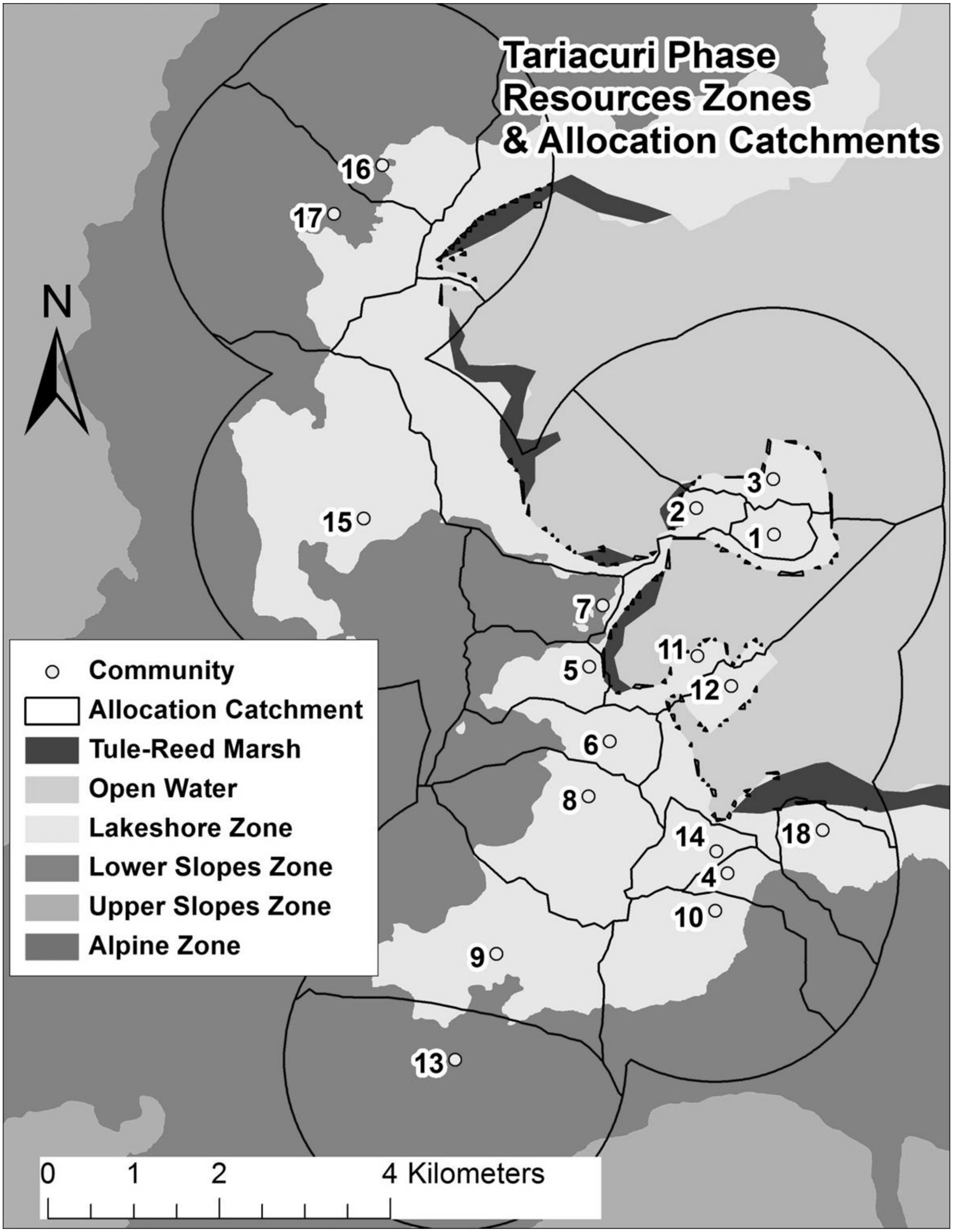
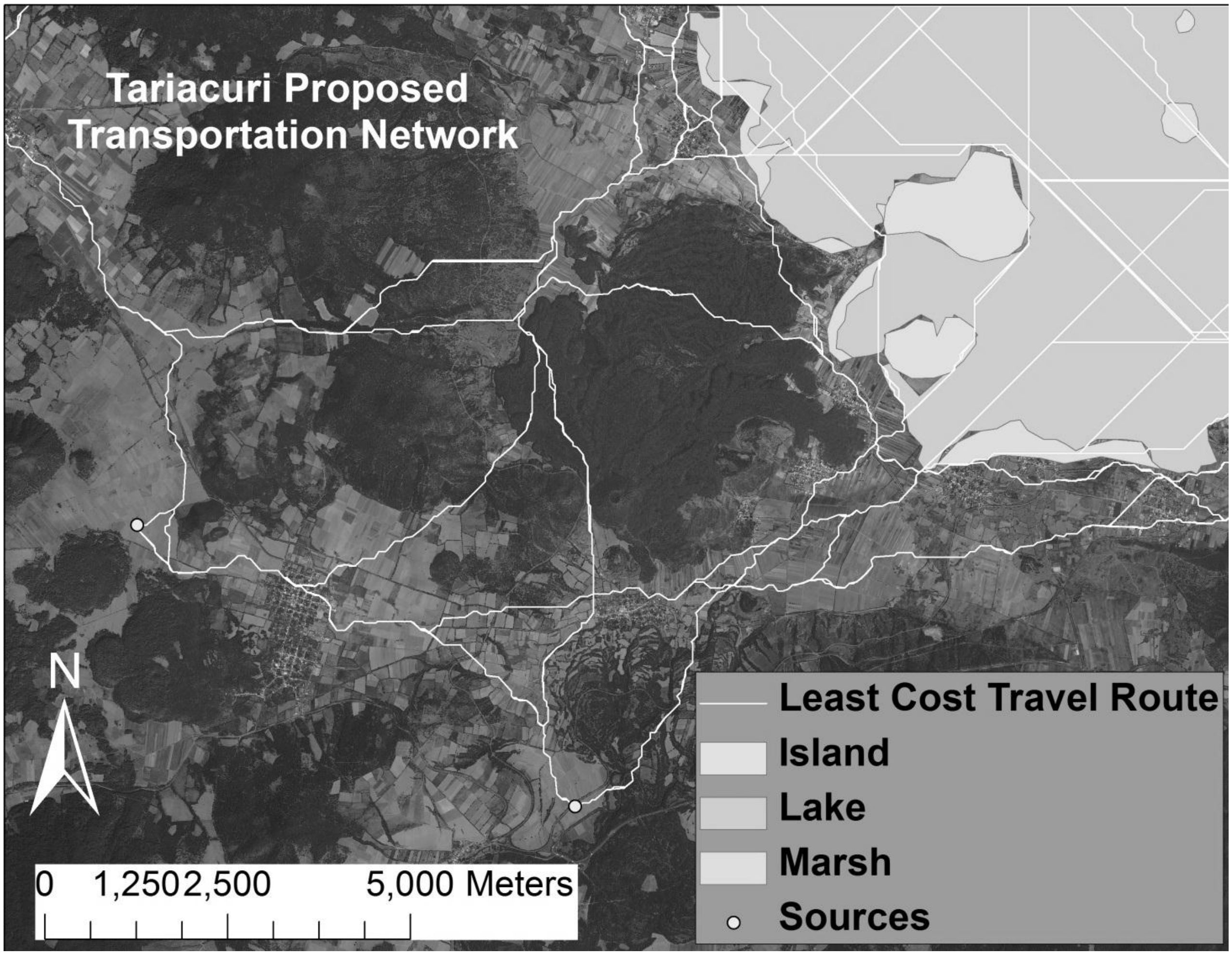


*Figure 51 – The Tariacuri Phase Travel/Transport Analysis*



# CHAPTER 6: MODELING THE LAKE PÁTZCUARO SETTLEMENT SYSTEM

The southwest survey area of the Lake Pátzcuaro basin provides a unique view of the settlement of the basin. Although many different factors were at play through the ~1,600 year scope of this analysis, the primary variables used to analyze the settlement system included the resource zones of the basin, the fluctuating lake levels, the surrounding communities, the terrain of the landscape, and the travel and transport network of the basin. Chapter Five described the analysis of these variables, attempting to quantify their impact on the communities and overall settlement for each phase, with the hopes that a longitudinal analysis of the settlement systems may be performed. This chapter summarizes and discusses the results of the aforementioned analysis, and provides a micro-regional settlement system model based on the analysis. The original settlement model that was tested, derived from Pollard (2008) is revisited, and a new model based on the findings from this research will be proposed for the lake basin as a whole. In order to then test this model, recent survey results from the southeast portion of the lake basin are used to compare and contrast to the southwest survey zone, thus providing us with a more complete *regional* settlement system model for the LPB.

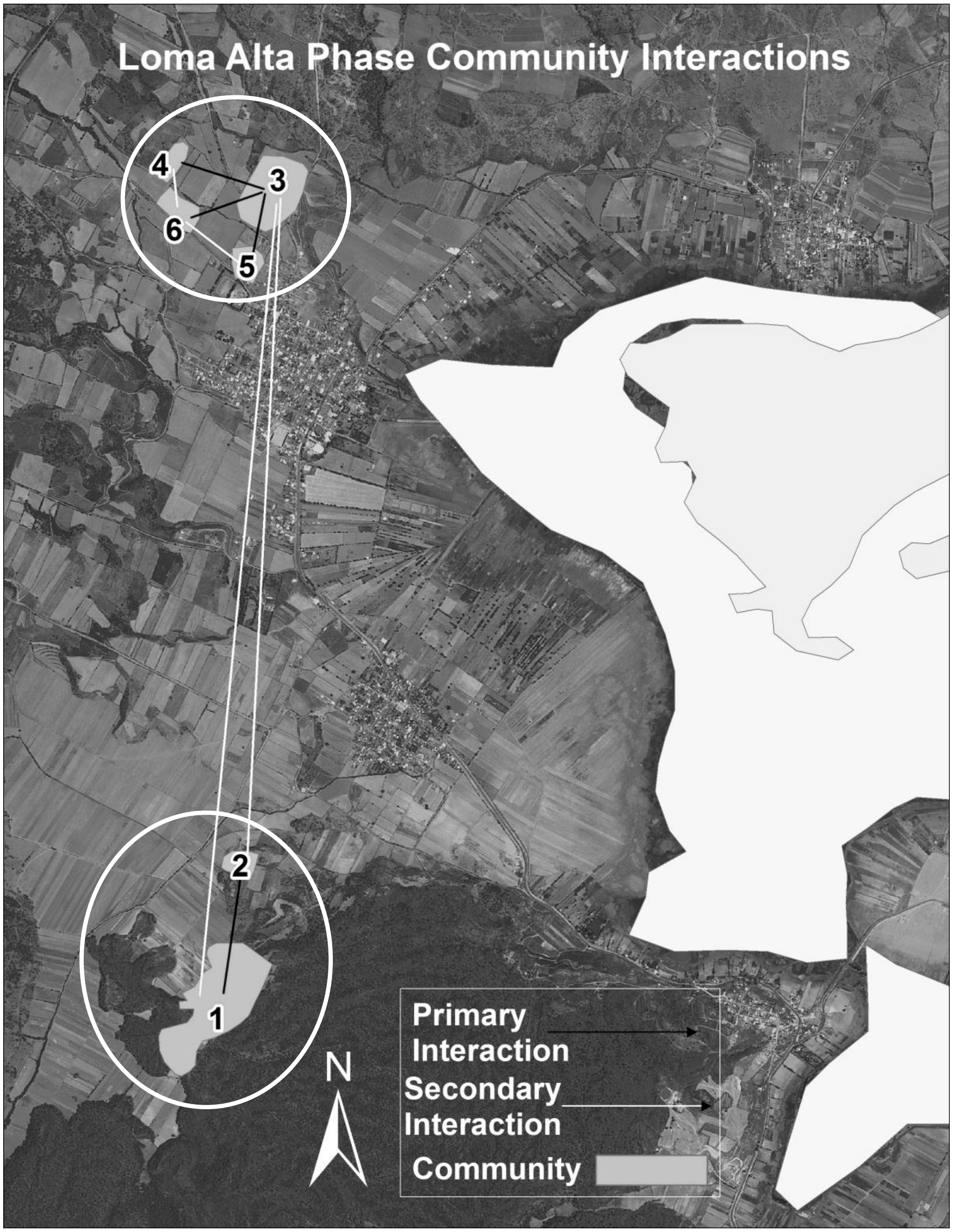
This analysis very deliberately divided the analysis between the two main variables classes; the communities and the landscape. And as was discussed in the previous chapter, the analysis for each was done in a different manner; the community analysis utilized the gravity model between communities to quantify interaction, while the landscape variables utilized the cost allocation model and allocation catchment zones to quantify the community-landscape interaction. Therefore, it must be said that it will be almost impossible to rank all the variables in terms of impact on settlement, when they have had different analyses performed on them. However, this discussion will assess each variable’s impact on the communities and the overall settlement by phase, with the understanding that in reality it is understood that there is not one variable alone that totally influences settlement, but more likely a combination of all variables, with some being of more import given the context of the analysis.  It is in this manner that this section attempts to summarize the analysis and present a settlement systems model, first for each phase, and second for the micro-region of the southwest portion of the basin.

**Discussion: The Community-to-Community Interaction Analysis**

To quickly summarize the community-community analysis, each community was located and delineated based on the artifact clusters from the walkover surveys.  Then, through a combination of ethnohistoric sources, ethnographic data, and archaeological correlates, the population was calculated for each community, providing the “mass” component of the gravity equation.  The distance variable was calculated using a cost-surface, where the least cost path between each community was defined and measured, thus providing a real-world measure of distance.  The interaction values were then calculated for each community to community combination, providing an array of interaction values.  The primary and secondary interaction values were taken and mapped, thus creating a network of interaction between communities for each phase.  The results are discussed below, by phase.

The Loma Alta phase, having the fewest number of communities, had the fewest amount of interaction calculations.  Overall, the primary interactions between communities formed two distinct areas of interaction, the first around communities 3 through 6, the second between communities 1 and 2.  Only the secondary interactions between communities 3 and 1, and 3 and 2 created a link between the two areas.  The interaction numbers overall are very low (mean- 0.014), which shows that distances are still very far, and population still very low.  Only the slightly larger population at community 1, 2 and 3 are large enough to derive a meaningful interaction, and yet these values are still very low.

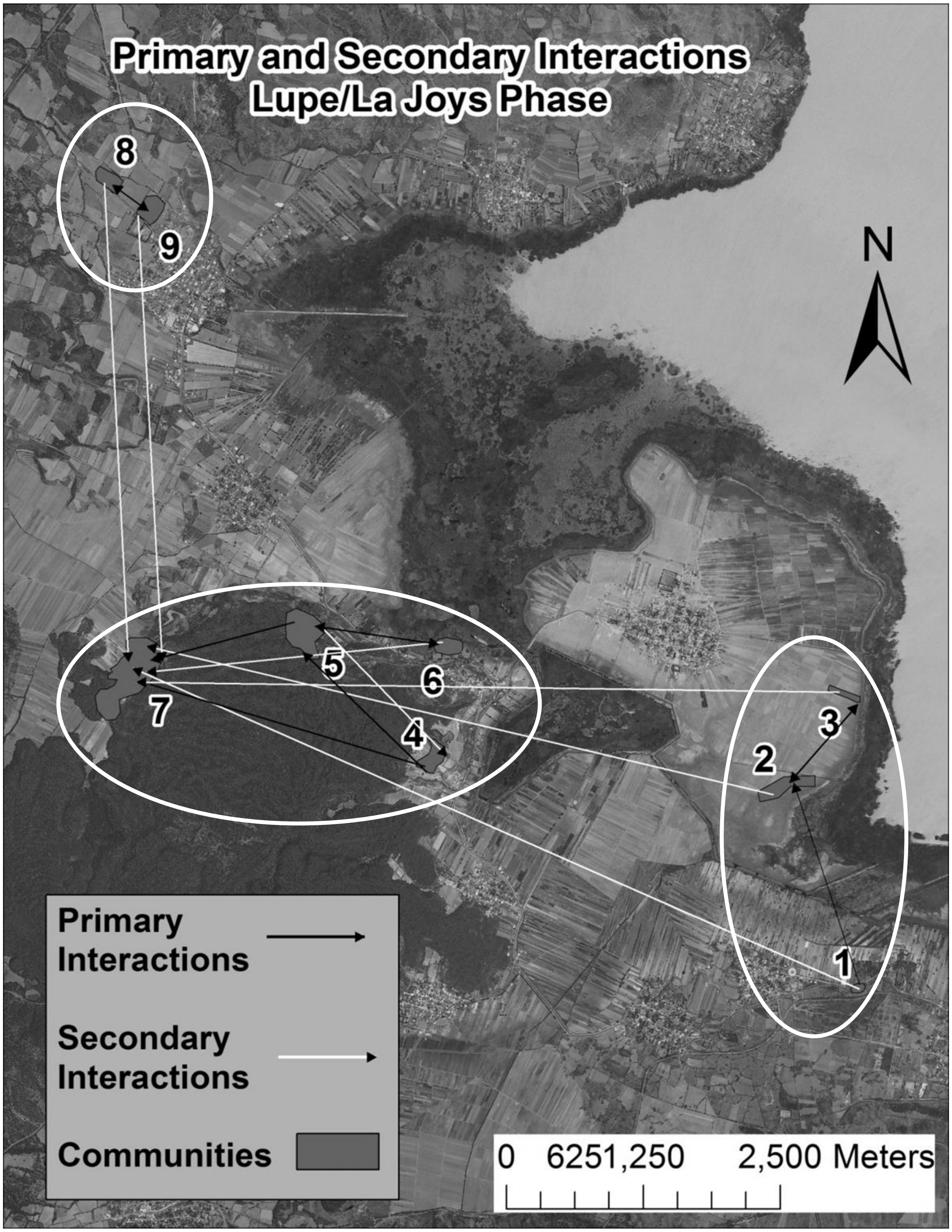
*Figure 52 – The Loma Alta Phase Community Interactions*




These two distinct community interaction zones display the beginning of a unique dynamic that is discussed at length further. That is, the emergence of two major communities in the southwest portion of the basin, with communities 1 and 2 representing Urichu, and communities 3 through 6 representing Erongarícuaro. Excavation evidence and burial remains show that elites were present at later phases at both these locations and that at the time of Spanish conquest, both were regarded as major centers, with Erongarícuaro a rank 2 center (Gorenstein and Pollard 1983). However, the Loma Alta phases show the emergence and territorial development of these centers, while populations are still low. A note must be made that post-analysis, one final community was added to the Loma Alta phase communities. This community was present during the Jaracuaro phase, which was a similar phase of 50 years added onto the end of Loma Alta 3. It was felt that this community and its artifacts most closely representing a Loma Alta occupation, and was then added to the dataset. The community was located on the lakeshore of the island of Jaracuaro, and expands our understanding of the community settlement of this time. It is clear that this community was engaged in a lacustrine based subsistence system, and that communities were very early on locating themselves near these resources.

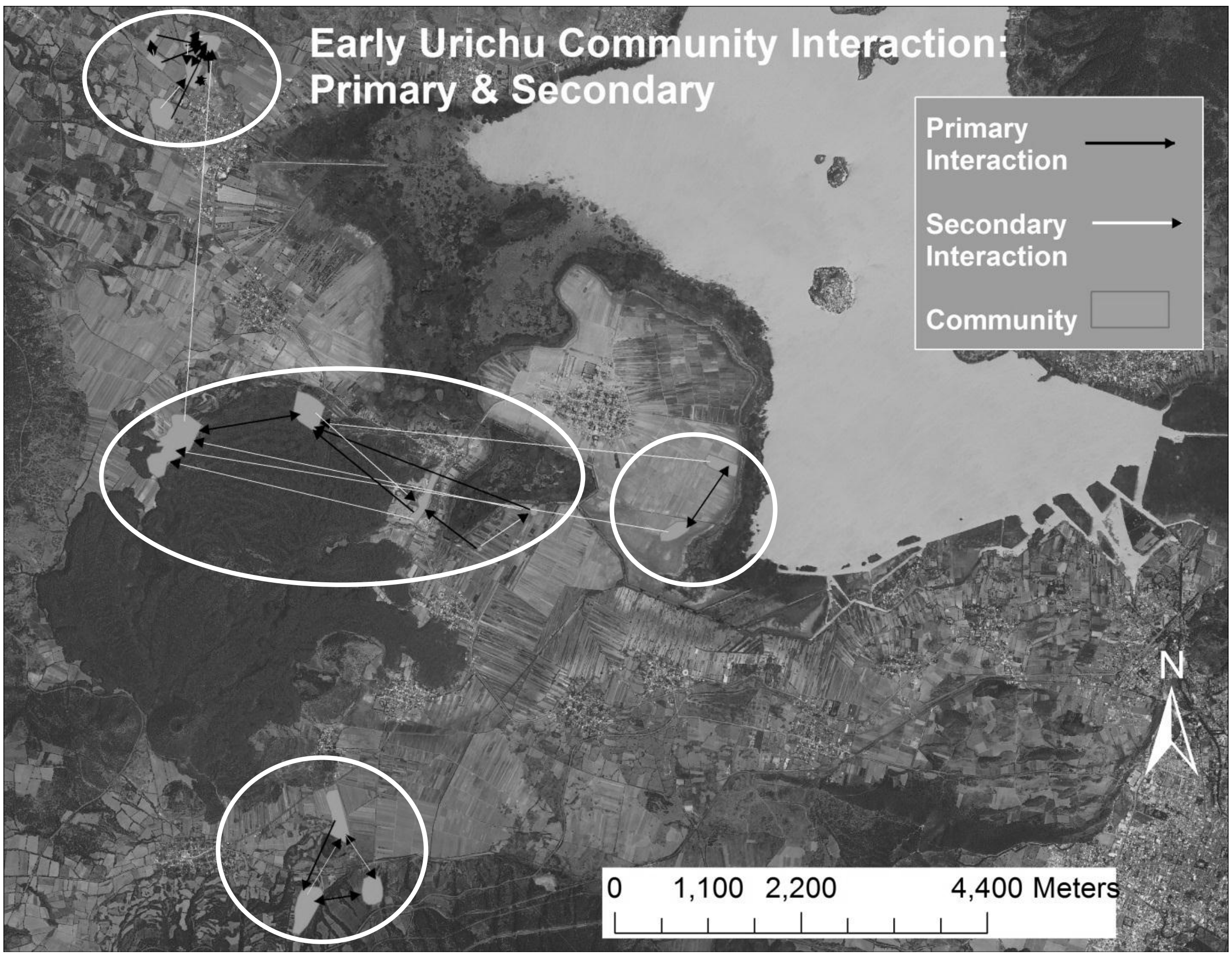
The Lupe/La Joya phase shows a slight increase in communities, to n=9, yet still low population numbers. These lower population numbers (~700-1600) once again result in lower overall interaction values (mean=0.0024). In fact, these numbers are lower than the previous phase. This is because we see the emergence of communities on the lakeshore, on the island/peninsula of Jaracuaro as well as to the north east of Urichu, north of the Malpaís, thus increasing the distance between communities. The interaction map, Figure 52, displays three interaction zones, with a more developed secondary interaction zone. The primary zones are still very much at the local level, while secondary zones show the slightly increased influence of the larger communities at Urichu (communities 5,7) and Erongarícuaro (communities 8,9). This is interpreted as a more independently structured microregional community network, where communities are using more local spheres of interaction first and most, with distance being a major influencing factor.

*Figure 53 – Lupe/La Joya Interaction Zones/Community Boundaries*



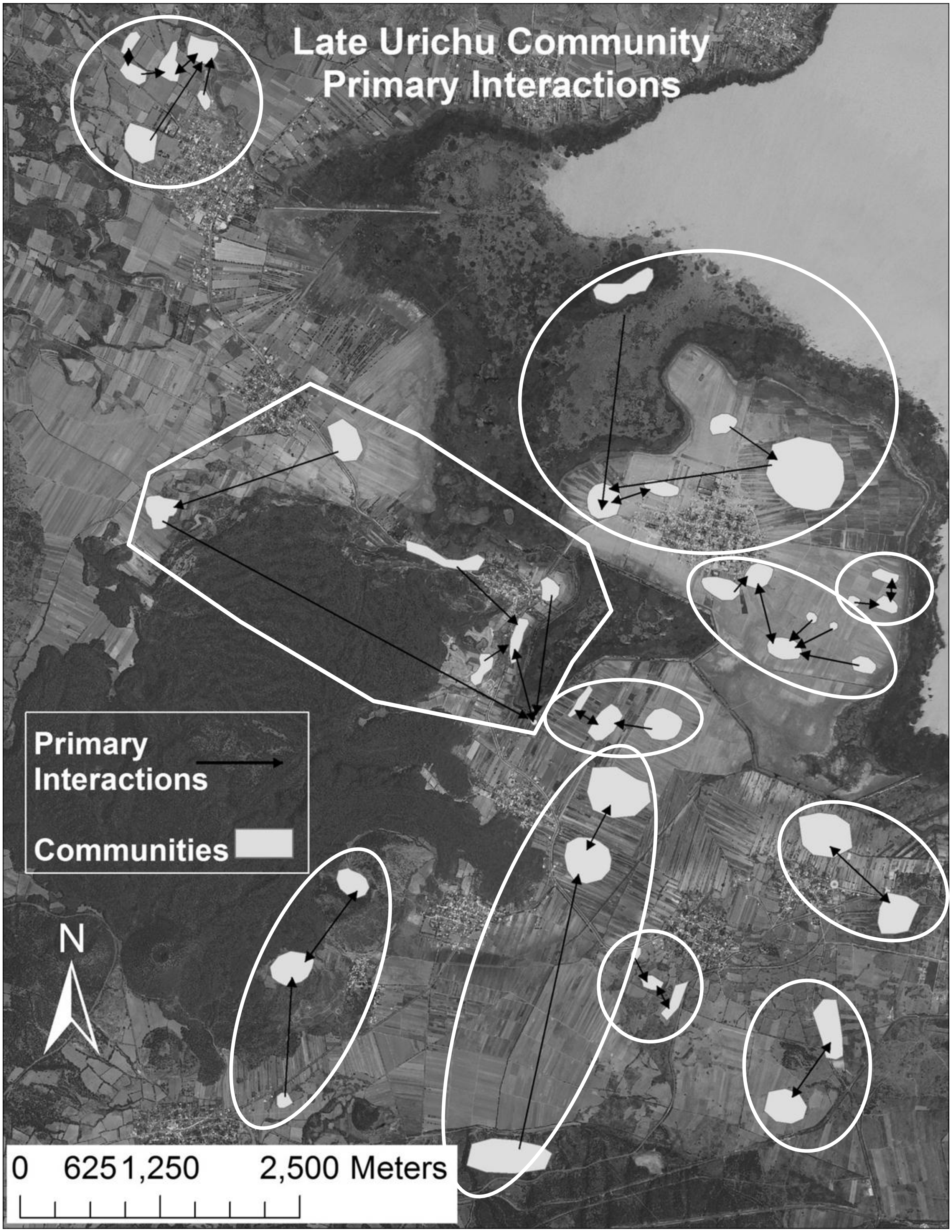

The Early Urichu phase shows a significant increase of communities (n=17), nearly doubling the number from the previous phase. However, most of these communities emerge around the modern town of Erongarícuaro, displaying a growing population at that center. Even with the growth in population for this part of the basin (~900-1800), it is still slightly, and the distances great enough to produce another lower overall interaction value (n=0.003), only slight higher than the previous phase.  As you can see from Figure 53, the interaction zones remain the same as the previous phase, with a slightly more developed secondary interaction relationship between communities.  This is once again interpreted as an independently structured micro-regional community network, with slightly growing centers are Urichu and Erongarícuaro.

*Figure 54 – Early Urichu Interaction Zones/Community Boundaries*



The Late Urichu phase sees the most drastic shift in population to this point. The southwest area population more than doubles and now ranges between 4000 and 8500. We also see the most drastic increase in communities, from n=17 in the last phase, to n=43 in the late Urichu phase. Several things are important to note. Although community number increases, their size decreases, as smaller communities, such as hamlets or villages, are scattered more widely and evenly across the landscape. And even though population drastically increases, it is more uniform across the landscape instead of concentrated at central locations.

*Figure 55 – Late Urichu Primary Interaction Zones/Community Boundaries*



This represents a major shift in the interaction trends and settlement for the area. First, the communities are moving further away from the earlier established centers at Urichu and Erongarícuaro, and the community Urichu decreases in size. Furthermore, growth at the Erongarícuaro communities remains constant in terms of population, yet the communities remain centralized, and did not spread out like those in the southeast portion of the area. The local interaction remains the prevalent form of community structure, as the individual community populations are still relatively lower, and yet distance is less of a factor given the more even distribution across the landscape. The interaction values overall for this phase are still low (n=0.0012) due to this fact. Pockets of local interaction define the primary zones, with the secondary zones display a more micro-regional trend, where interaction is being centralized and distance is less of a factor. This is true for all communities except those at Erongarícuaro, where interactions at all levels occur between local communities.

The final phase, the Tariacuri phase, represents the emergence of the state, and a major shift in the southwest regional settlement system of communities. Overall for this phase, the number of communities went down drastically to n=18 (from n=44 in the last phase), and yet the population for the area increases to between ~7000 and 12500. This shift represents two things; 1.) the move away from smaller communities to larger, more centralized communities with larger populations, and 2.) the decrease in distance between these communities. This is clearly displayed in the interaction values, with the average value being n=58.14, as population is now the deciding factor for interaction, and distance a secondary factor. Three distinct centers emerge, at Jaracuaro (community 1) Urichu (community 15), and Erongarícuaro (community 16 & 17), with much larger interaction zones for each (Figure 55). Also, we can now witness settlement at Pareo, community 18, which is also a regional market during at least the Late Postclassic, and most likely as early as the Middle Postclassic. Furthermore, several other communities had centralized, and although not as large as the three listed above, were mentioned and located in the ethnohistoric documents by Gorenstein and Pollard (1983:20-22). These communities can be interpolated to those present during the Spanish arrival and into the Early Hispanic period, suggesting that it was this drastic shift in settlement and community formation during the Late Postclassic that formed the communities that are still present to this day. Table 17 portrays these community to settlement patterns, as taken from Gorenstein and Pollard (1983). Interaction is now defined on the location to these centers, with almost all primary and secondary interactions occurring between these three. This shift represents the move towards a micro-regional interaction scheme, and quite possibly displays the impact of the emergence of the state on local settlement.

*Figure 56 - Tariacuri Interaction Zones/Community Boundaries*

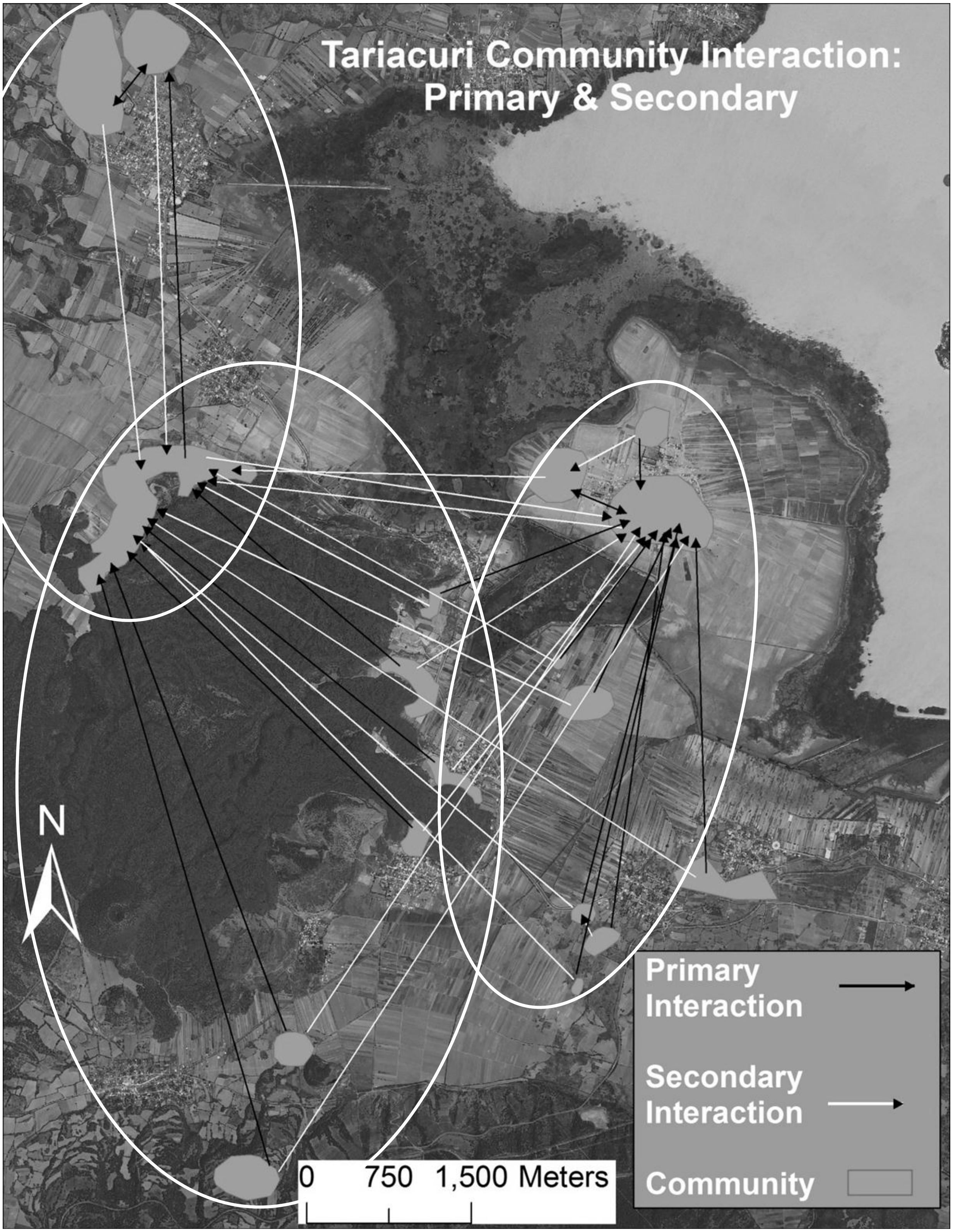


*Table 17 – The Late Postclassic & Early Hispanic Community Correlations*

| **Tariacuri Phase Community** | **Early Hispanic Correlate** | **Survey Sites Comprised** |
|---|---|---|
| Community 1, 2, 3 | Jaracuaro | X-10, X-6-1, X-6-2, X-6-4 to X-6-6 |
| Community 18 | Pareo | P-61, P-64, P-71, P-30, P-29, P-32 |
| Community 15 | Urichu | U-1 to U-8, U-54 to U-57 |
| Community 16, 17 | Erongarícuaro | all Erongarícuaro Survey Sites |
| Community 7 | Arocutin | U-60, P-98, P-96 |
| Community 8 | Nocutzepo | P-114, P-107 |
| Community 5, 6 | Toquaro | P-108 to P-113 |
| Community 11, 12 | Cuyameo | P-19, P-37 to P-39 |

**Discussion: The Community-to-Landscape Interaction Analysis**

The second analysis turns to landscape variables in an effort to quantify their impact on settlement of communities. In brief, the method for analyzing the landscape variables can be broken down into 3 categories: 1.) the analysis of resource zones, 2.) the analysis of slope and terrain, and 3.) the analysis of transport and trade in the region. For each of these analyses, a cost-surface model was used to create cost allocation zones, or as termed in the previous chapter, allocation catchments. In each analysis, the catchments were used to create boundaries for each community's accessible area, with the variables measured accordingly. The area of each resource zone found in each individual allocation catchment was calculated, the slope for each catchment was analyzed, and the transport routes that fell inside these zones were counted and measured. The following is a discussion of each analysis by phase.

The Loma Alta phase landscape analysis, with reference to the resource zones, saw all community allocation catchments containing the lower slopes resource zone, with n=4 containing the lakeshore zone. Only one community (community 2) was located entirely within the lakeshore zone, and yet it occurred on the inner most area of the zone, away from the lake. No community allocation catchments included the marsh area or the open lake, or the upper slope or alpine zones. Only two communities (community 2 and 5) had the lakeshore as the primary resource zone in their catchment. When coupled with the slope analysis, this trend of community location further inland and upland continues. With the lake at this phase occurring at 2035 m.a.s.l., the lake resource zones are at their most accessible, with abundant lakeshore and marsh area. However, the communities are all located above elevations of above 2084 m.a.s.l., and on somewhat uneven terrain, with average slopes all occurring above 4.4 degrees. Although this is not entirely extreme, coupled with the higher elevations, and the fact that the communities exist in transition areas, from the lower lying even terrain of the lake shore to the more uneven, areas, it seems that communities are located in defensible positions, with access to agricultural and lake resource zones.

The transport network proposed for the Loma Alta phase shows that the communities are located near major routes, with an average of n= 2.2 routes per community, and an average distance to routes being 663 meters. Furthermore, the routes that they are located by are more inland occurring routes, specifically the southwest to northeast route inland, and the north to south route out of the basin. Both of these routes have excellent access to the lakeshore and lake resources. However, as discussed in the previous paragraph, no communities have direct lake access for water travel.

The Loma Alta phase communities seem to have organized themselves on the landscape in semi-defensible positions, allowing themselves access, although not direct, to transport routes to the lake, and lower lying agricultural lands near the lakeshore. The fact that most of the communities were inland and upland, in areas with more remote access lends credence to the semi-defensible theory. This is especially true for communities 1 & 2 at Urichu, which were situated on the outer edge of the Malpaís. Overall, it seems that terrain characteristics, followed closely by access to the lakeshore and more even terrain, influenced the community locations on the landscape. Access to travel and trade routes also played an important role, considering that the communities were located in remote areas and required access to the major resource zones. The addition of the lakeshore community on Jaracuaro for this phase adds to our understanding of the role of the lake and lacustrine subsistence for this phase. It is clear that even though it was only one community, the lakeshore did have direct settlement for the lake resources, thus pushing back our notion of when communities settled near the lake and began actively practicing a lacustrine-based subsistence system.

The Lupe/ La Joya phase, with an increase in communities, saw a shift in settlement, from upland to lowland areas. Every community, except community 8, had the lakeshore zone located in their allocation catchment, 7 of 9 communities were located either entirely within the lakeshore zone, or on the border between the lakeshore and the lower slopes. Also, of these n=8 communities that contained the lakeshore zone in their allocation catchment, the lakeshore comprised the majority resource zone. This is a shift from the last phase, where the lower slopes were the majority resource zone represented in the allocation catchments. Furthermore, n=5 of the communities contained the Tule-reed marsh zone in their allocation catchment, with another n=3 containing open water.

The slope analysis is also representative of the shift towards the lower-lying lakeshore zone. Whereas the last phase saw all communities in higher elevations and more uneven terrain, the Lupe/La Joya phase has n=5 communities located on terrain having a slope less than 4 degrees, n=4 communities with allocation catchments averaging a slope less than 4 degrees, and n=5 communities located at elevations below 2100 m.a.s.l., n=4 of those below 2060 m.a.s.l.. However, there still exist n=6 communities that are located in fairly defensible positions along the Malpaís, and further inland near Erongarícuaro. These communities still exist on the border-areas, on the fringes of the lakeshore resources zone and the upper slopes, close enough to flat terrain and lake resources, yet also right on the edge of drastic elevation changes and slope changes.

The travel/transport network analysis for the Lupe/La Joya Phase shows an average of 1.9 routes per community, with an average distance of 682 meters. In this case, the average went down from the last phase, with the distance going up. However, 77% of communities had water access, increasing drastically from the last phase. The same major inland routes still exist for Urichu and Erongarícuaro communities, but with the shift towards the lakeshore, the communities are now closer to more accessible and navigable terrain, meaning more access to the lakeshore routes and water routes.

Overall, the Lupe/La Joya phase showed a slight shift of communities moving towards the lake and lake resources. The lakeshore zone is now the primary resource zone accessed, presumably for both lake and marsh access as well as for the fertile soil and flat terrain for agriculture. However, this shift is only slight, where the majority of communities are still located on the fringes, both for elevation, slope and zones. Although these community locations can still be deemed defensible, it seemed that the lakeshore resources and terrain were a major draw for communities, and seem to be the primary motivator for community settlement and location during this phase. The travel and transport network are still accessible, but don't play as major of a role as the last phase, given the increased distance from routes and the lowering routes per community statistics.

The Early Urichu phase sees the lowest lake levels in the sequence, at 2028 m.a.s.l. The community allocation catchments are pretty evenly divided, with n=14 communities containing the lakeshore resource zone, and n=14 containing the lower slopes zone. However, of these community catchments, n=10 have the primary zone as the lower slopes. Regarding the community locations themselves, n=6 are located within the lakeshore zone, another n=6 on the lakeshore/lower slope zone border, and n=5 within the lower slope zone. One would think that with the lowest lake level seen in the LPB, communities would move to take advantage of the lacustrine soil that has been exposed, or the marsh areas now exposed. However, only n=4 communities are located right on the lakeshore/Tule-reed marsh boundary, with n=6 communities containing the Tule-reed marsh zone in their allocation catchment. Conversely, we see three communities, communities 7, 8, and 9, move the furthest inland of any community yet.

The slope analysis shows a trend towards the higher elevations and more upland terrain. Of the n=17 communities for the Early Urichu phase, only n=5 are below 2060 m.a.s.l., even when the lake is at its lowest at 2028 m.a.s.l.. The majority, n=9 communities, are located above 2100 meters in elevation. The slope, although never drastic in any one area, shows that the lakeshore communities located closest to the lake have the most even terrain, while those located inland, closer to the malpaís or near the fringe boundaries of elevation change have higher slope terrain. Some of the more inland communities had a mean slope of around 6 to 8 degrees (community 5, 7, 8, 9).

This trend inland, however, shouldn't be interpreted entirely as defensible positions. In the case of the Urichu communities, the location on the malpaís seems to be somewhat defensive, although they are in close proximity to agricultural land, the lakeshore, inland springs, and lake resources. In the case of communities 7, 8 and 9, the inland communities, they are located in or around a valley formed by the malpaís to the north, and an elevated hill chain to the south. Current aerial imagery shows the remains of terraces at communities 7 and 8, with community 9 located in the lower valley floor. In fact, according to the elevations and Pollard's resource zones, the lakeshore and fertile soil extends as far back as these communities. Although the slope and elevation analysis may show these to be inland, upland and possibly defensive, it is entirely possible that the communities formed here to take advantage of the fertile soil and terrace agriculture, while still providing a safe community location. In fact, because this valley is between two areas of higher slope and elevation, the proposed travel and transport network runs right through community 9, and very close to communities 7 and 8. And although the average number of routes per community went down from the last phase to n=1.5, the average distance to routes dropped dramatically overall to 373 meters. Communities with direct lake access went down to 41% however, with these moves inland.

Overall, the Early Urichu phase proves somewhat difficult to decipher. Although the lake drops to its lowest point for the sequence, the communities are located in the lower slopes, away from the lakeshore itself. Most seem to have good access to the lakeshore resource zone, however, only a minority of communities seems to be directly accessing the marsh and open water zones. The interpreting of the inland and higher elevation communities is interpreted as mixed. Once again, they are in semi-defensible positions, yet have easy access to good agricultural land, excellent access to transport networks for this phase, and good access to lake resources. In fact, there seems to be a three tier development of settlement for this phase, when discussing landscape resources. One third are located with excellent access to the lake, it's resources and the lake travel routes, another third with medium lake access but excellent lakeshore and agricultural access, as well as good access to the inland travel routes, and a final third in what I consider a defensible position, but with overall fair access to all resource zones and travel routes.

The Late Urichu phase saw an expansion of both communities and the area they covered in the southwest zone. The lake levels fluctuated during this phase, from between the lowest point at the beginning of the phase, ~2030 m.a.s.l., to the end of the phase ~2039 m.a.s.l. With regards to the resource zone analysis, the overwhelming majority of communities are located in the lakeshore (n=30), at the border of the lakeshore, (n=4), or had the lake shore in their allocation catchment (n=40). Furthermore, n=22 (51%) communities had the lakeshore resource zone as the majority zone in their catchment. The second most prevalent resource zone in the allocation catchments was the lower slopes, followed closely by the Tule-reed marsh zone. This expansion of communities towards the lakeshore zone also saw communities right on the water, close to both the Tule-marsh zone and open water. In fact n=22 communities were located within 100 yards of the water. This expansion also meant more communities move inland, although not nearly as many as the lakeshore. For the first time, we have multiple communities that have in their allocation catchments the upper slopes zones. And although the upper slope areas are relatively small and on the edges of their respective catchments, they still represent potential access to a different set of resources than previously witnessed.

With this expansion towards the lakeshore, we also see a movement towards more level terrain and lower elevations. Of the n=43 communities, n=22 occur at elevations lower than 2050 m.a.s.l. Furthermore, for n=22 communities, the average slope for their respective allocation catchments is at or less than 5 degrees. Also, for the individual community locations, n=27 communities occur on a slope of less than 3 degrees. While some communities had located themselves on hillside, or edges of higher elevated land, the majority of communities have now shifted to existing on the lower lying, even terrain of the lakeshore.

Concerning the travel and transport network, the community average for routes within the allocation catchment went down to n=0.97. And yet, the distance to routes remains low, at an average of 442 meters. One of the reasons for this lower number is because the communities that had moved to the peninsula of Jaracuaro all scored zeroes for the analysis, since no major land routes coming in our out of the area would traverse through a peninsula. However, due to their location near the water, they do have access to water travel, as the number of communities that had this access rose to 51%. I believe the reason for the lower routes per community yet lower average distance derives from the fact that these communities are located in areas of very even terrain with potential for greater access and higher walking velocity. Therefore, although they may not have had as many routes at their disposal, the communities had increased access to the routes they are near due to favorable terrain, which included water routes.

Overall, we see a marked difference in the scheme for settlement with concern to landscape variables. The lakeshore is now the prevalent and dominating landscape feature that predicates settlement and community location, with the added benefit of also being located near even and more traversable terrain. It seems that the draw of the lakeshore terrain, the lake resource zones, and potential for agriculture and lacustrine resources was the motivating factor for the Late Urichu phase, even with the unstable lake levels for that period of time. However, the communities at Urichu and Erongarícuaro stay located where they had been in previous phases, in areas of semi-defensible positions. Also for the first time, we see a significant portion of the Jaracuaro peninsula inhabited, which seems to draw communities nearer to lakeshore resources.

The final phase, the Tariacuri phase, marks the emergence of the Tarascan state, around A.D. 1350. In terms of the resource zone analysis, the lake is recorded at its highest in the sequence, at 2043 m.a.s.l., according to the ethnohistoric evidence (i.e. the Beaumont and Seler maps, from Gorenstein and Pollard 1983:14-16). This fluctuation seems to have altered the community scheme for locating across the landscape, considering that now many communities establish in earlier phases are now under water. The resources zones are also altered drastically. Because of the rising water, the Tule-reed marsh area is now smaller is size, as is the area that was previously lakeshore. The open water is easier to access though, which may have led to an increase in water based subsistence practices, especially as key lakeshore agricultural areas are now flooded. Given the pushback from the lake, every community contains the lakeshore in its allocation catchment zone, and the vast majority of communities are located within or on the border of this zone, at n=16. Only one community is located outside the lakeshore, in the lower slopes. However, out of n=18 communities, the lakeshore is the majority resource zone in only n=8 of them. Given the shrinking marsh zone, only n=6 communities have access to that zone in their catchments, with only=5 having direct open water access. The second most frequent resource zone in the allocation catchments is the lower slope zone, with n=14 communities having access, and n=7 of those communities having the lower slopes be the major resource zone in their catchment.

In terms of the slope and terrain analysis, the majority of communities, n=16, are located on land with a slope less than 5 degrees. And yet, due to the push back from the rising lake, and the loss of low lying and flat terrain to the lake, we see the allocation catchment zones consisting of average slopes of above 4 degrees. This is due to the move away from the lake towards the steeper lower slope zone. Overall, it seems that with limited land, the communities are actively locating where land is most flat. When we couple this analysis with the transport network analysis, we see that in fact the lake level has moved the travel routes more interior, yet they are still located on the lower-sloped lakeshore. The average route per community goes up from the late Urichu phase, to 1.6. However, the distance to routes also goes up, to an average of 586 meters. This is primarily because Jaracuaro, once a peninsula, is now an island, and is cut off from the land travel routes. When excluding the Jaracuaro settlements, the remaining communities are in very close proximity to the travel routes, with many being located at major inland/lakeshore route intersections. There were n=8 communities with direct access to water travel, with most communities now in closer proximity to the lake and more indirect access.

The Tariacuri phase doesn't necessarily show a new paradigm for settlement with concern to resource zones. That major shift came in the Late Urichu phase. However, the major event of this phase, the rising lake level and loss of significant resource zone area, does signify a change in settlement with concern to the changing landscape. For the first time in the sequence, the lake rises significantly enough to alter the trend of the last two phases, which was moving to closer proximity to the lake. Now, the move is further back from the lake, as the lake impedes on communal land and overtakes areas previously inhabited. And yet, communities are locating themselves almost entirely within this diminishing lakeshore zone, presumably to take advantage of the remaining resources available, such as prime lacustrine soil and flat agricultural land, the remaining Tule-marsh areas, and access to the open water. Once again, the communities at Urichu and Erongarícuaro now considered major centers according to the ethnohistoric data (Pollard and Gorenstein 1983) have stayed in the same area that they originated at in earlier phases.

**The Testable Settlement Model Revisited**

The previous summary discussed the analyses that were performed for each phase of the sequence, first with the community-to-community analysis and second with the community-to-landscape analysis. This section provides a holistic settlement systems model, as derived from the analysis of this research, which applies to the southwest portion of the basin. This microregional settlement systems model will be discussed by phase, and provides a complete trajectory of settlement, beginning with the Loma Alta phase at 100 B.C. and ending with Spanish Conquest at A.D. 1525. First though, the testable settlement model, presented in Chapter 1, will be revisited. It was this model that the hypothesis for this research was formulated from, and for which the results of the analysis is compared to. This section, then presents first the testable model, derived from Pollard (2008), and will compare and contrast the newly formulated microregional settlement system model, as derived from this analysis. The final portion of this chapter will utilize the data from the southeast survey, completed in 2009, and present a brief analysis on the settlement from that portion of the lake basin in comparison to the microregional settlement systems model. This is done to test for differential variables from a different basin area, and to see if the variables from the southwest analyses are applicable to other portions of the lake basin.

The initial, testable model, presented in Chapter 1, is revisited and presented again here so that a direct comparison may be made between this first model, and the model derived from the southwest settlement systems analysis.

The starting point for the temporal sequence of settlement is in the Late Preclassic (100 B.C.). Population within the lake basin was relatively low (5,000 – 8,000), and all cases of settlement displayed the existence of small-scale, socially ranked agrarian societies (Pollard 2008:220). Furthermore, these ranked societies consisted of a hierarchy that would remain relatively unchanged until the emergence the state. Settlement was located on or very near the shorelines of Lake Pátzcuaro with the primary means of subsistence being lacustrine and wetland based. The shorelines of the lake fluctuated minimally, marking the only movement of settlements.  Furthermore, settlements were not yet centralized spatially, but were situated primarily on or near the key resources of the lake.

The Early Classic (A.D. 600) to Middle Classic (A.D. 700) was marked by a stable population, between 6,000 and 7,000 (Pollard 2008:221).  The settlements remained on or very near the lakeshore, continuing lacustrine and wetland agricultural practices.  Ceramic production remained localized, yet preciosities found their way into the basin and were part of the way elite status was derived and marked.  The goods, however, were finished goods, meaning that local level economic specialization had yet to permeate the economic structure in the basin.  Each settlement had variation in its social hierarchy as well as its spatial composition, with varying types of architecture and no singular style dominating.  This suggests the continuation of a local elite-dominated settlement with a highly agrarian component.

During the Epiclassic (A.D. 700-900) the region of West Mexico began to see political restructuring and climatic changes (Beekman 2009).  The end of this period (A.D. 900) marked a climatic shift towards more arid conditions, with a synchronous drop in the lake level.  The number of sites increased and the population rose to 12,000 at this time (Pollard 2008:224).  These climate shifts and slight rise in population coincided with the beginning of the Early Postclassic (A.D. 900-1100).  Lacustrine settlements, still the primary type of settlement in the basin, moved to these new lake margins as the lake dropped to its lowest elevation in the past two millennia (Pollard 2008:223).

With new arable land and a continued reliance on the lacustrine resources, the small-scale socially ranked societies shifted to larger-scale chiefdom-like societies, a shift that began in the Middle Classic periods.  It is believed that with the rise in population, settlements began to centralize at various distances inland from the lake while continuing to utilize its resources.

During the Middle Postclassic (A.D. 1000-1350), a large population increase occurred as it rose to 48,000, along with the doubling of the area of occupation due to the low lake levels. Near the end of this phase (~A.D. 1300), lake levels rose again, thus forcing settlements away from the low-lying areas around the lake to concentrate around the marsh production zones (Pollard 2008:224). Pollard asserts that due to these expanding, diminishing and shifting resources, competition must have been fierce, leading large-scale chiefdoms into inter-basin warfare. Settlement then shifted primarily due to the larger populations within the basin. Settlements continued to be located near the lake and slightly inland from it, but also moved upland into defensible locations, such as in the malpaís at Urichu (Pollard 2008:224).

The Late Postclassic period marked the emergence of the Tarascan state in A.D. 1350. The continued rise in lake levels forced settlements out of low-lying to new lakeshore and inland areas of high agricultural fertility. The added pressure from climate change and population size drove settlements to develop new economic mechanisms, thus diversifying communities with a heavier reliance on markets and state-run institutions. With the emergence of the state, settlement is now dictated by the royal dynasty at the capital of Tzintzuntzan. Pollard proposes a power shift towards the northern end of the basin, thus altering the spatial orientation of settlement. Resources were managed by the state, and the social model that dominated the basin since 100 B.C. was replaced by the state's rigid social hierarchy system, where a three class system was put into place; an upper elite class (containing the royal family), lower elite class, and a commoner class.

**The Microregional Settlement System Model**

The following settlement system model derives directly from the analysis of this dissertation, and will be discussed phase by phase, providing a longitudinal view of settlement for the ~1,600 year sequence for which the study encapsulates.

The settlement system, for the purposes of this analysis, begins in the Loma Alta phase, during the Late Preclassic and into the Early Classic. At this time, six communities are present in the southwest portion of the lake basin, with a cluster just north of the modern town of Erongarícuaro, and another south of the modern town of Urichu, along the western side of the malpaís. The overall population of these communities is relatively low, and between 200-700 people occupied these communities during both the Loma Alta 2 and Loma Alta 3 phases. The lake level was fairly stable, remaining around 2035 m.a.s.l. Even with a lower lying lake level, and abundant lakeshore resources, most communities at this time were located in upland, semi-defensible positions. However, one community was located directly on the lake shore, thus displaying evidence of an early lacustrine based system of subsistence, though not a regional system. The communities at Erongarícuaro had the best access to fertile agricultural land and lakeshore resources, while the Urichu communities located them on the fringes of the dense and steep malpaís. All communities are located to the north or west of the malpaís, and with the two distinct, very separate clusters, represent two separate, local community zones. The primary interactions for these communities are local in nature, with secondary interactions reaching from Urichu to Erongarícuaro and vice versa. However, because interaction values are so low for this phase, it is thought that distance and terrain are limiting factors in community interaction on a microregional or regional scale, and locating near adjacent communities is not a significant variable for settlement. There is evidence for elites and a ranked social organization, and yet it is believed to be only a local system, given low population numbers. Communities 1 and 2, at Urichu, and community 3 at Erongarícuaro, are believed to have been local administrative center with ranked elites during this early phase (Pollard 2008:220).

The primary variable that determined settlement for this phase was steeper terrain, higher slope and defensible positions. Second most important was access to the flat lower slope resource zone, and the lakeshore zone, presumably for agricultural practices. This access to lower lying terrain also meant access to travel and transport routes, which is the third most important variable. At this time, there is no direct access for communities to the lakeshore, and to the Tule-reed marsh zone or open water. Because of this, it is thought that a lacustrine-based subsistence system didn't play as large of a role as perhaps agriculture did during this phase.

The Lupe-La Joya phase saw a slight increase in both community frequency and community population. The number of communities increased slightly to n=9, and the population for this area of the basin is estimated to be between 450 and 1200. Along with the communities present at Urichu and Erongarícuaro, we see new communities spread to the lakeshore, to the south and east of the malpaís, towards the peninsula of Jaracuaro. However, this movement is only for a few communities, whereas the communities at Erongarícuaro and Urichu remain in upland, semi-defensible positions. Community interaction values are still very low, and now there are three primary interaction zones, located at Erongarícuaro, around the malpaís of Urichu, and on the eastern edge of the Jaracuaro lakeshore. Given the large distance between communities, distance is the primary reason for little interaction, whereas populations, especially for the lakeshore hamlets, are still very small. There occurred a shift in the settlement system for this phase, as several communities moved towards into the lakeshore resource zone, and towards the lake resources, such as the marsh and open water. Evidence of lacustrine-based subsistence practices are witnessed from the artifact assemblage from Community 2, where *recortados*, or circle net weights for fishing were collected. However, not all communities made this move, and several still remain in areas of semi-defensible, upland positions with access to key resource zones.

The primary variable for settlement system for this phase is the lakeshore, as n=6 communities move to either within its zone, or with access to a greater area of this zone. Furthermore, the subsistence strategy seems to have changes to include lacustrine zones to a greater extent. A secondary variable for settlement location is terrain and slope, as several communities are located on or near semi-defensible position, especially around the malpaís of Urichu. However, with the move of several communities towards lower lying areas and more flat terrain, travel routes are also more accessible. And with communities moving away from the established communities at Urichu and Erongarícuaro, community-to-community interaction is a minor variable for settlement location, especially given the lower populations and increased distance between settlements. Community interaction is limited primarily to the local scale. Artifact analysis though, shows these areas, especially community 5 and 7 near Urichu, remain to be centers where local elites are present, possibly both in an administrative and residential capacity.

The Early Urichu phase marks a near doubling of communities from the Lupe/La Joya phase, from n=9 to n=17 communities. The population for these communities is estimated to be between 700 and 2,000, with the population centered around Erongarícuaro, where the number of communities increased, and at Urichu. Artifact evidence once again shows communities 10, and 11, located at Urichu and Erongarícuaro respectively, to be administrative centers due to their higher frequencies of artifacts. Also, community 6 is believed to be an elite residential area, given the artifact assemblage. However, only Erongarícuaro sees community numbers increase around the major center in that portion of the lake basin. Other communities continue to access and utilize the lakeshore and the lacustrine resources, as they continue to locate on or near the lakeshore. Communities 1, 3, 4 and 11, shows evidence of this lacustrine subsistence system in *recortados* found at the sites, used as net weights for vertical nets in the marsh shallows (Phillips 2002). However, given the fact that evidence shows that the lake is at its lowest during this period, at 2028 m.a.s.l., and that there is abundant access to both the Tule-reed marsh and fertile lacustrine soil of the lakeshore, we don't see a majority of communities locate to access these resources. In fact, the lower slope is the primary resource zone accessed by the communities, given their locations. We also see three communities, 7, 8, and 9, locate the furthest inland, away from the lake but still near the lakeshore zone. It is thought that this area, located in the valley between the malpaís and a southern hill chain, was located both near major travel routes in and out of the basin, as well as fertile agricultural land, with access to terraced agriculture on the lower slopes.

Interaction values again rise slightly from the last phase, although they are still low comparatively. This is probably due to an offset occurrence of community location. The large distance between communities 7, 8 and 9 and other communities drove interaction values down, while the growth of communities around Erongarícuaro and the growing population drove the values up, the creating a stable interaction value overall. This brings up the fascinating aspect of this phase; that we see three separate, equally important variables for determining settlement location. The larger population and growth at Erongarícuaro, and the fact it was a major local center created community growth around it. In this case, community-to-community interaction is the primary variable determining settlement. However, communities remain located on or near the lake and in the lakeshore zone, and we see more artifact evidence suggesting more communities are participating in the lacustrine subsistence strategy. In this case, the lake and lakeshore resource zones and marsh zones are the primary variable for settlement structure. And finally, we see communities locating more inland, such as communities 7, 8, and 9, and the fact that Urichu has remained on the fringe of the malpaís. It is probable that access to agricultural land and terraced agriculture is the driving factor for communities 7, 8 and 9, as well as access to the inland travel routes.

The Late Urichu phase marks a dramatic shift in the settlement system structure. Population for the southwest area increases to a range between 4,000 and 8,500, a doubling of population from the last phase. Furthermore, the number of communities present during this phase was at n=43, a major increase from n=17 in the last phase. However, the increase in both communities and population develops in the form of many smaller, hamlet and village size communities, moving away from the upland centers of Urichu, and to a smaller extent Erongarícuaro. This major increase is one aspect of this phase that marks a major paradigm shift. The other is the major increase of communities to the lakeshore zone, on or near the lake. The majority of communities are now located in the peninsula of Jaracuaro, or just south of the peninsula. Furthermore, the lakeshore and the Tule-reed marsh are the most accessed resource zone, and although the lake has fluctuated during this phase, beginning around 2030 m.a.s.l. and ending at 2039 m.a.s.l. at the end of the phase, communities made a clear decision to locate in very close proximity to the lake. The lacustrine zones were the primary means for subsistence for these communities, evidenced from the archaeological remains that show n=8 communities having assemblages including the *recortados*, or net weights.

The higher populations at both the Urichu and Erongarícuaro communities continued for this phase, however, the area of the Urichu communities decreases slightly, whereas the Erongarícuaro communities remain high in number and don’t seem to be as greatly affected by the move of most communities to the water’s edge. Artifact types and high frequency of artifacts at community 30 of Erongarícuaro and community of 28 of Urichu show these to be the major administrative centers in the area. A new development for this phase was the increase of obsidian in the artifact assemblages. Rebnegger's analysis (2010) shows that although many sites contain high frequency of obsidian artifacts (communities 30, 33, 35, 11, 13, 16), they were probably not manufacturing sites, but perhaps part-time craft specialization locations. This increase of more exotic material suggests a development in the trade network for this phase, as well as an established elite trade network. This suggests interaction, at least for the major communities at Erongarícuaro and Urichu, of a more complex regional networks.

The primary mechanism for community settlement for this phase is clearly the lakeshore and lake resource zones. Given the evidence of a more developed and complex trade network, locations near flat terrain and travel routes also became desirable, as did the locations near water routes. By locating near and around the lakeshore zones, these communities had access to both types of travel, as well as the best agricultural land in the area and the abundant lacustrine resources. With the significant increase in population, settlement is more aggressive to expand to the outlying areas that offer these multiple subsistence strategies and pivotal resource allocations. However, given that they settled in smaller communities, such as hamlets or villages, it is believed that this was due to the fact that there was no strong, overarching political system in place, and the "reach" of the elites at Erongarícuaro and Urichu are limited by distance. It is clear, given the location along the lakeshore, that communities are making decisions based on local interactions, both with communities and the landscape, and that there still doesn't exist an overarching community network for interaction.

The Tariacuri phase is the final phase in the sequence, and marks the emergence of the Tarascan state. This also marks a dramatic climatic fluctuation, especially with regard to the lake and lake resources, as the lake rises to its highest point in the sequence, at 2043 m.a.s.l. This phase also marks a second paradigm shift for settlement for the southwest region. Whereas the primary means for settlement in earlier phases had been landscape related, the primary mechanism then shifted for the Tariacuri phase to locating in areas near the major centers in the southwest portion of the basin. Certainly the rising lake levels affected settlement for the communities. However, what we see from the archaeological evidence is a large population increase at three major centers, Urichu (community 15), Erongarícuaro (community 16 and 17) and Jaracuaro (community 1). The evidence shows that when confronted with rising lake levels, diminishing lakeshore resources and diminishing land, the smaller communities of the Late Urichu phase actively moved inland and either formed larger towns or centers, such as at Jaracuaro, or moved into the existing centers at Urichu and Erongarícuaro. However, not all communities made this move to the major centers. And yet the interaction analysis suggests that they settled in key strategic areas that allowed for primary and secondary interaction with these major centers. This is what I am referring to as the creation of the inter-regional settlement network, which was brought about by the emergence of the state. This newly formed, state-level political structure of this phase has permeated through to the smaller sub-regions of the lake basin, and created a system where, due to the high population numbers and loss of habitable land and subsistence resources, centers such as Erongarícuaro, Urichu and Jaracuaro now manage the population and communities through a complex social, political and economic network.

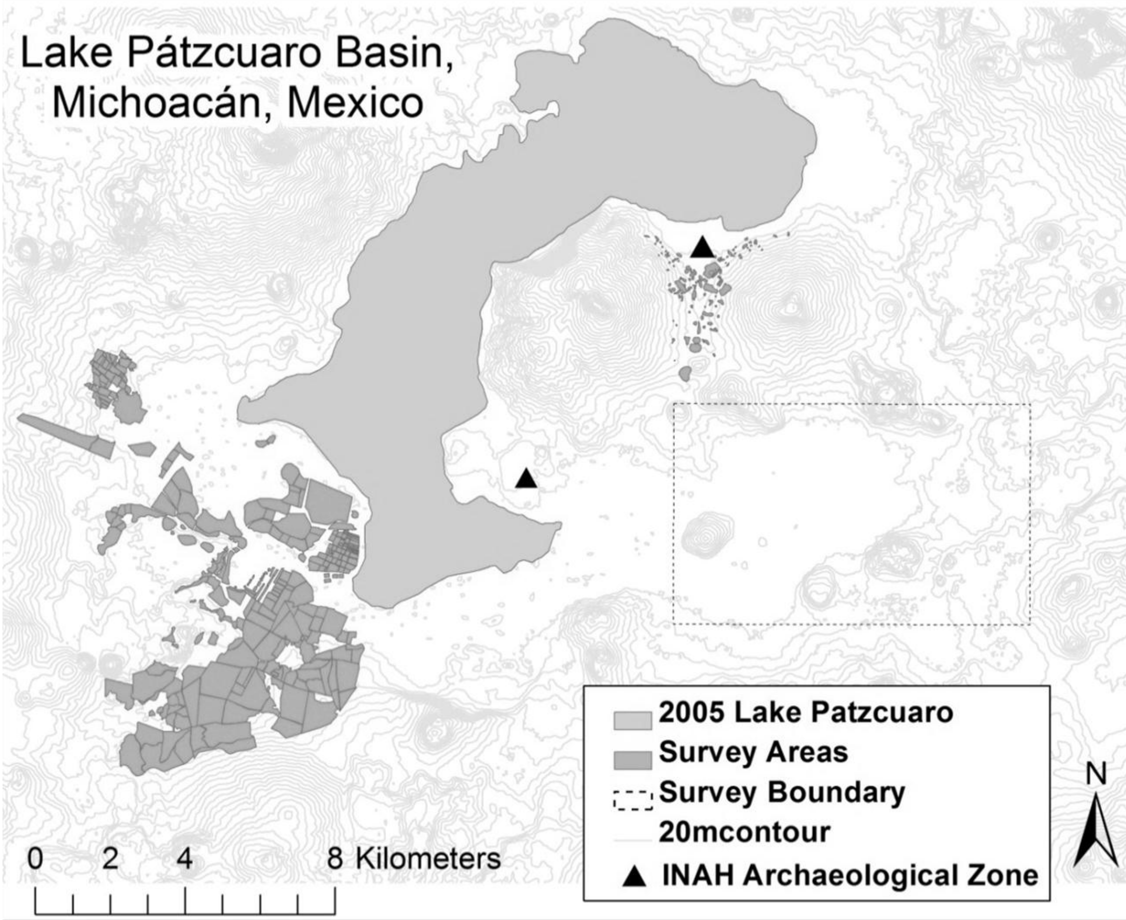
The archaeological evidence shows that at community 15 at Urichu has developed not only into a regional administrative center, but given the high frequency of fine ware ceramics, elite goods, obsidian, and pipes, is also an elite center and ritual center. Community 16 at Erongarícuaro, with its high frequency of artifacts and elite goods, has developed into a regional administrative center, and according to the Relación de Michoacán, is a level two administrative center, with a level one being the capital at Tzintzuntzan. Other artifact evidence shows the continued reliance of lacustrine subsistence practices, as *recortados* continue to be found at lakeshore communities.

Whereas an argument could be made that the rising lake was the motivator for settlement for this phase, I argue that it was merely the catalyst for change in settlement, where the emergence of a new socio-political system, on the regional level, was the primary mechanism for settlement. The southwest areas large population for this phase, estimated at ~10,000, coupled with the loss of significant habitable and subsistence space required an overarching system that could manage the population, and provide a means for these communities to continue to thrive in the lake basin. The Tarascan state was just that, and through a drastic increase in interaction values between communities, it is believed that now communities rely more heavily on inter community and market trade, and specialization has become the primary economic motivator. However, it is clear that communities continued to practice self-subsistence agriculture, and yet also had to participate in the state-run economic systems, meaning that households had to specialize and rely on other communities and trade networks.

**Developing a Regional Model: Comparisons to the Southeast Communities**

In order to begin to discuss a regional settlement system for the Lake Pátzcuaro Basin, other areas of the basin must be analyzed, and then compared to the settlement model from the southwest analysis. In 2009, a survey of the southeast portion of the lake basin was undertaken in order to examine the settlement and human/environment interactions occurring in that extent of the lake basin (Figure 57, Figure 58). Like the southwest portion, the southeast area was also affected greatly by the fluctuating lake levels, as the southeast arm of the lake was constantly moving east as the lake rose, or to the west, exposing great deals of arable land. Another distinguishable trait that the landscapes of the southwest and southeast shared was the existence of a malpaís, or lava flow, such as at Urichu. The 2009 southeast survey focused on such an area, and the results of that malpaís survey are what is analyzed and discussed in this section. Further survey in 2010 has not been included (Pollard and Stawski 2009 -Report to C Fisher, and Fisher 2010 Informe a El Consejo de Arq. del INAH).

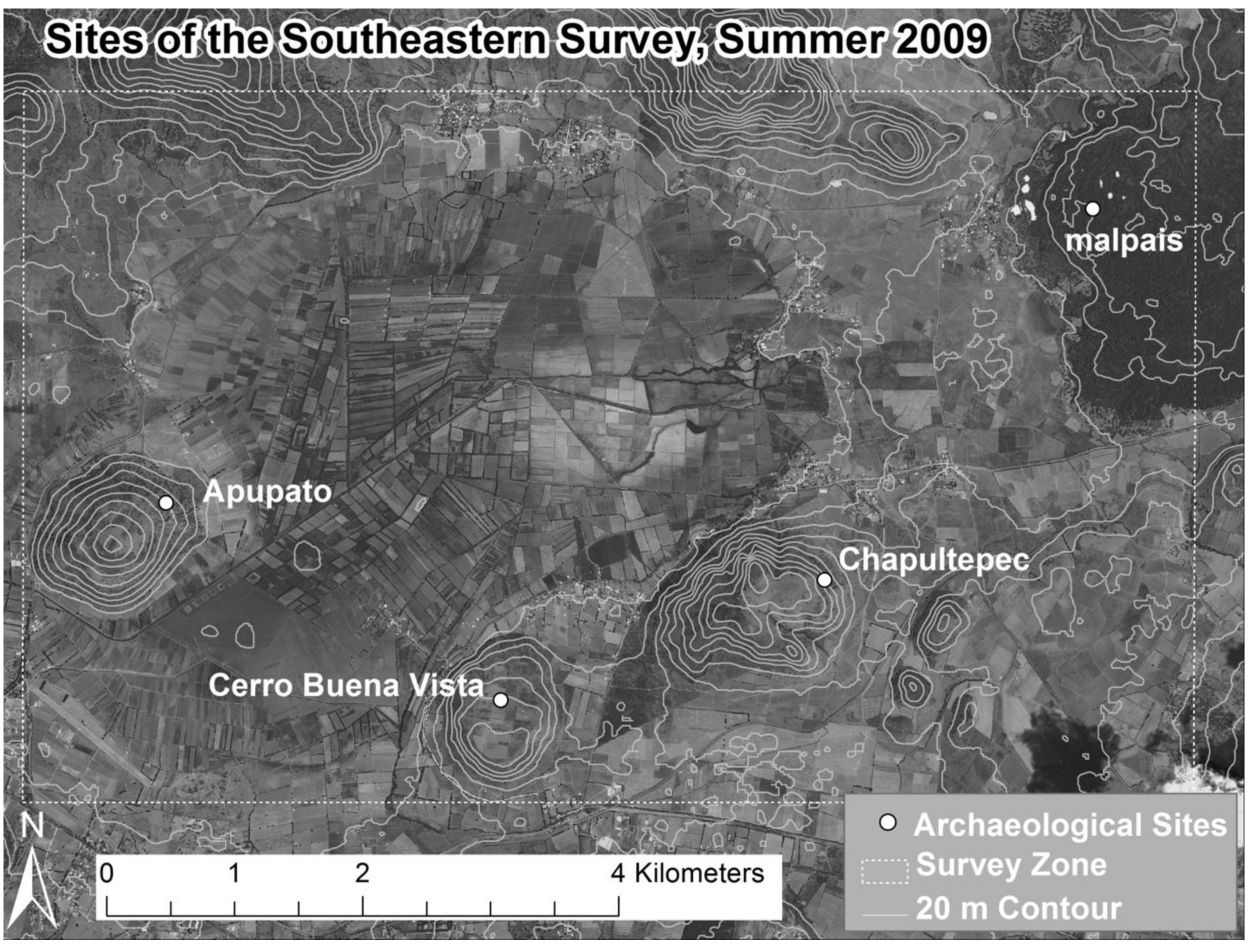
*Figure 57 – The Southeastern Survey Area, Summer 2009*




*Southeast Communities and Landscape*

The nature of the survey for the southeast portion of the basin was very different, both in method and in results, from the southwest portion. Whereas the major survey collection units were the agricultural fields for the southwest survey, the southeast survey used grids, which was the primary provenience for the sites. Also, for the southeast survey, collection sites and features were recorded on-site with a hand help GPS unit, and quickly uploaded and processed through a GIS while in the field and lab. The most distinguishable difference between the two, however, was the very low frequency of artifacts found at the southeast survey site, and equally as surprising was the very high frequency of architectural features found in the southeast survey, both compared to the southwest survey. Therefore, the method for determining community boundaries and size changed from the previous method used for the southwest survey area. Because there were so few artifacts a combination of artifacts, architecture, and topography is used to determine the community boundaries and the population density by phase.

*Figure 58 – Close-up of the Southeastern Survey Zone*



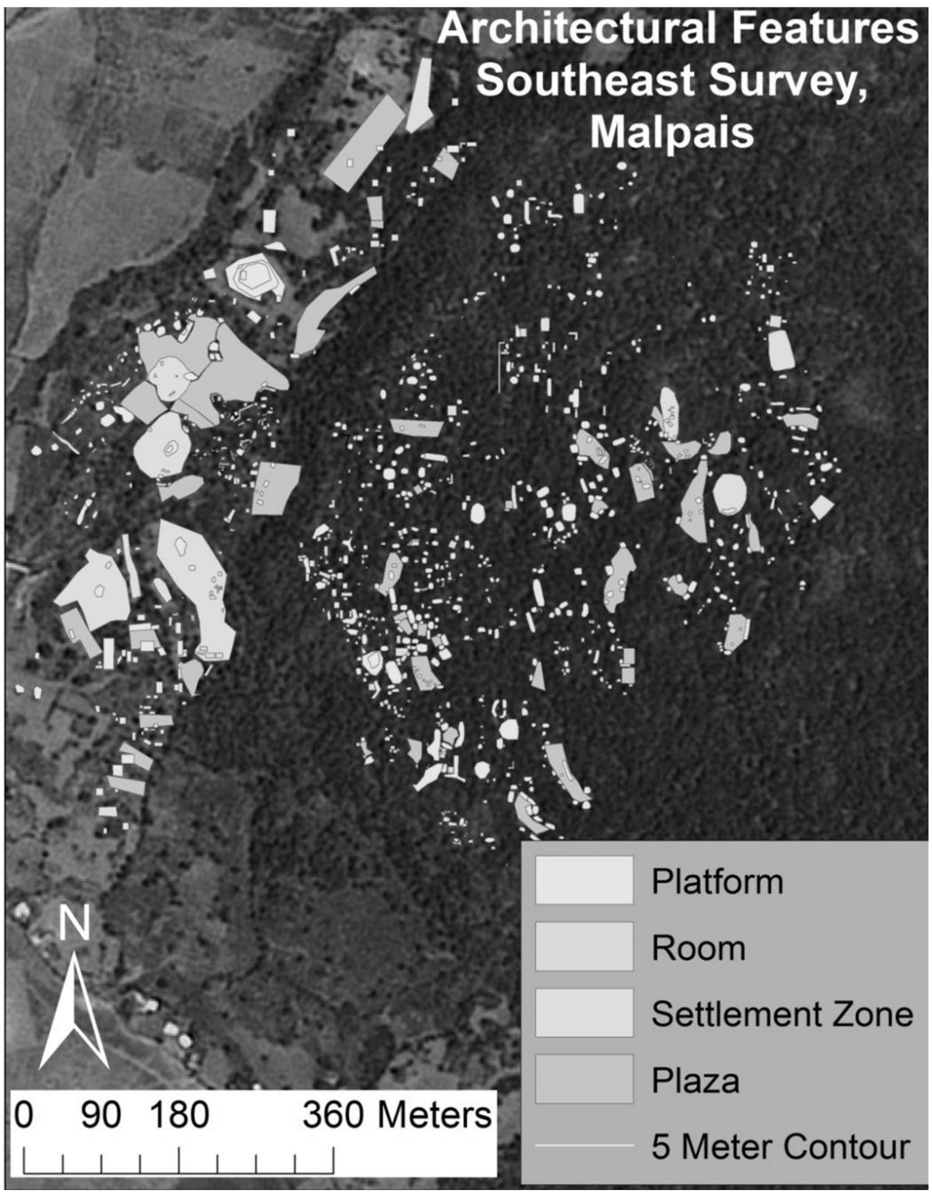
Several key factors played into the creation of communities for the southeast survey zone. First, only one site in the southeast survey zone could be reconstructed in terms of community and demography. Four sites were located, as depicted in Figure 58, including Apupato, Cerro Buena Vista, Chapultepec, and the malpaís sites. However, lack of GIS data meant that no specific provenience could be attributed to the artifact data. However, GIS data was available for the malpaís, and therefore will be the focus of this section. What can be deciphered for all sites however is the sequence of occupation, as determined from artifact data and ceramic sequencing. This data can be seen in Table 18.

*Table 18 – The Archaeological Sites of the Southeast Survey Zone, and Occupation*

| **Site** | **Occupation** |
|---|---|
| Apupato | Lupe/La Joya, Early Urichu, Late Urichu, Tariacuri |
| Chapultepec | Urichu, Tariacuri |
| Cerro Buena Vista | Loma Alta, Lupe/La Joya, Jaracuaro, Early Urichu, Late Urichu, Tariacuri |
| the malpaís | Jaracuaro, Lupe/La Joya, Early Urichu, Late Urichu, Tariacuri |

Concerning the malpaís, the majority of sites were located in the southeast malpaís, and not just on the fringe or lower slopes as at Urichu, but deep in the middle of the malpaís. It was quickly noticed in the field, that the terrain and topography, which was very rocky and steep and formed hills and valleys, was the main delineator for the sites. The sites were located in the lower valleys of the malpaís, between rocky outcrops that were near impassable. These natural features formed what was determined to be plaza groups, which were surrounded by house platforms, walls and rooms. This theory was confirmed through GIS, and the use of 5 meter contours, which showed groups of sites between contour lines and in the lower, flatter terrain of the malpaís. However, the architecture alone couldn't be dated without artifacts, and because of this certain liberties were taken in creating like associations between architectural features that were linked and/or located in very close proximity in the same topographical unit (Figure 58 shows the GIS recorded architecture). If a few sites were able to be phased by the few ceramics, then through law of association, a larger area was delineated and labeled a community. Concerning the objective and intellectual merits of this method, the author can further support this claim as he was one of the lead archaeologists on the survey team, the GIS specialist, and aided in creating the survey method for which these sites were collected and recorded.

*Figure 59 – The Architectural Features of the Malpaís Survey*



Regarding the specifics of the data, communities for four phases of the sequence were located and delineated, with areas and population densities calculated for each. For the population reconstruction, the same methods outlined and performed in Chapter 3 were followed here. The only exception is that, given the abundance of architectural data, individual residences, defined by such features as rooms, platforms, walls and plazas were used to calculate persons per residence (n=5.97 persons per residence), as defined in DeRoche's research (1983). Table 17 summarizes the community analysis for the southeast survey area of the malpaís. It must be noted that due to a lack of artifacts at many of the survey areas, especially in relation to the architecture, it was very hard to delineate boundaries for communities by phase. Therefore, several areas that would have been grouped into communities were not, due to the insufficient artifact data to date them. Therefore, the overall population estimates are predicted to be approximately a third higher than those reported, but for this dissertation, the data reported in Table 19 is used. The community maps for each phase can be found in the appendix.

*Table 19 – The Malpaís: Southeast Survey Community Reconstructions*

| **Period** | **Phase** | **# Comm** | **Total Size of Communities** | **Artifact Density** | **DeRoche** | **Ethno-historic** |
|---|---|---|---|---|---|---|
| Late Preclassic to Early Classic | Loma Alta | 0 | NA | NA | NA | NA |
| Middle Classic - Epiclassic | Jaracuaro, Lupe/La Joya | 1 | 0.29 hectares | 7-10 (8.5 mean) | 24 | NA |
| Early Postclassic | Early Urichu | 7 | 6.53 hectares | 151-262 (207 mean) | 291 | 210-560 (385 mean) |
| Middle Postclassic | Late Urichu | 8 | 5.13 hectares | 145 - 215 (180 mean) | 282 | 240-640 (440 mean) |
| Late Postclassic | Tariacuri | 2 | 8.47 hectares | 248-514 (381 mean) | 292 | 200-1000 (600 mean) |

There are several key issues to discuss for the community reconstruction for the southeast survey area. First, is the very stable population that occurs from the Early Urichu phase through the Tariacuri phase. The only real population change we see is from the Lupe/La Joya to the Early Urichu, signaling the start of major occupation of the malpaís. When analyzing the rank-size graphs for the Early and Late Urichu phases, Figures 59 and 60 respectively, we see a near log-normal curve with very slight areas of primate-ness for both. Both display an even distribution of community sizes, and a stable distribution, as community size, in area, as well as population density remains stable. The overall trend sows a slight population boom in the early Urichu phase, with a stable population that slightly increases into the Tariacuri phase.

*Figure 60 - Early Urichu Rank Size – Southeast Malpaís*

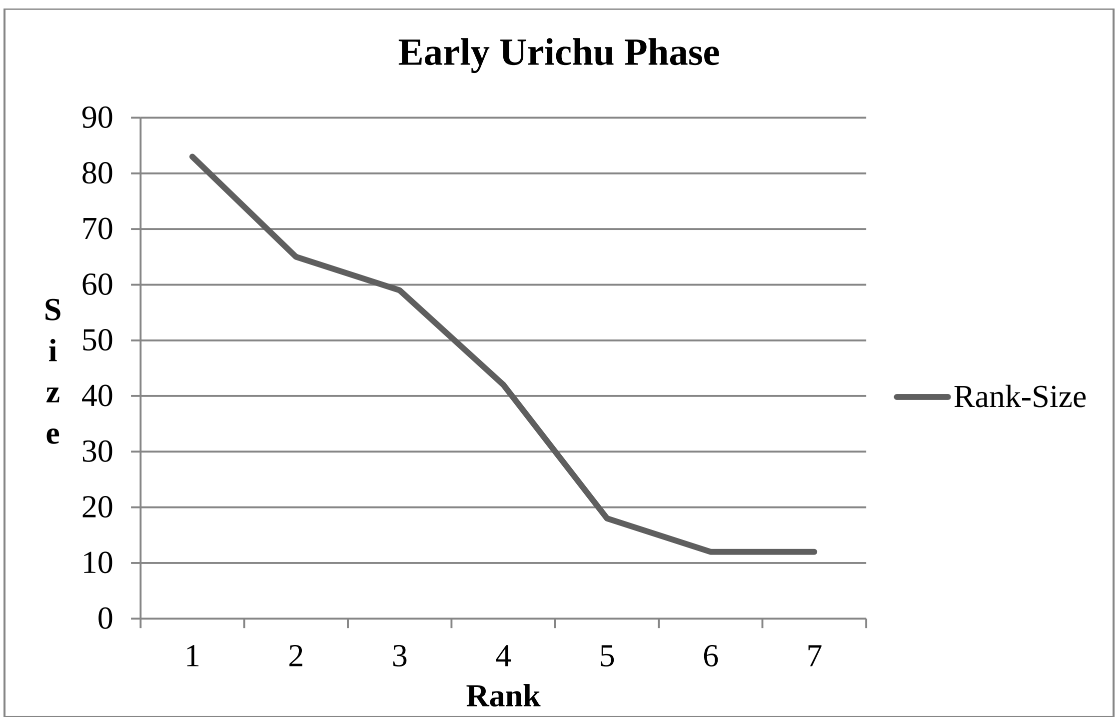
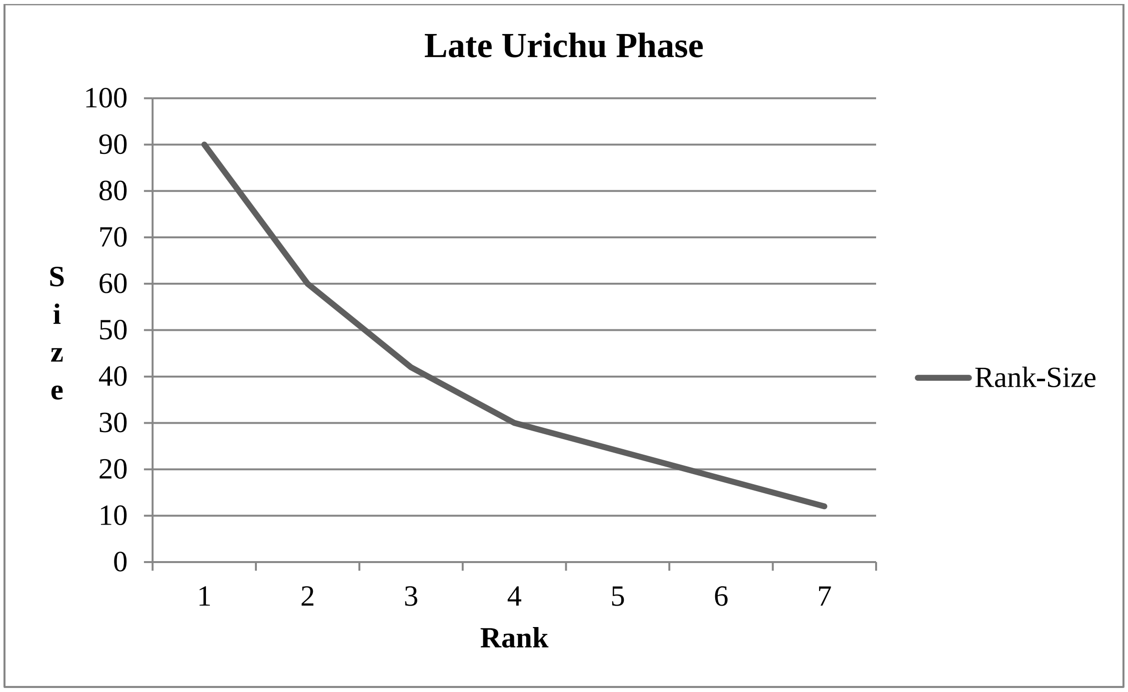


*Figure 61 – Late Urichu Rank Size – Southeast Malpaís*




The final analytical aspect that we must look at in order to compare these communities to the southwest settlement model, is the landscape interaction. Very simply put, every community for every phase that encapsulates the southeastern malpaís survey occurs in the lower slopes resource zone. As you can see from the resource zone map for this area, the lakeshore, given the lower elevations for this area, abuts the malpaís, and the communities are located right on this fringe area. Even given the abundant agricultural area of the lakeshore, the flat terrains, and the closer proximity to the lake and lacustrine resources, the communities, through all phases, continue to occupy the lower slopes zone in the malpaís. When analyzing community location through the phases, only one shift occurs for overall location of communities. From the Lupe/La Joya phase, the community is located on the upper and inner portion of the malpaís. This continues into the Early and Late Urichu phase, and communities spread to the interior of the malpaís, as well as onto the lower slope, below the major incline of the malpaís. And although several communities move or change, this settling on the upper areas of the western edge remained the norm until the Tariacuri phase, where there is a move into the lower slope of the malpaís, into more even and open "lobes" of the lava flow. However, the communities still do not move full into the lakeshore zone below the malpaís during the Late Postclassic, and remain on the malpaís.

There are a few things that can be concluded from this analysis. The lack of influence of the lakeshore resource zone is very apparent, as the malpaís communities are very intentionally settling in the malpaís, where a lack of subsistence resources and water was common. During survey, a major natural spring was recorded and mapped on the south western portion of the malpaís, which may have supplied sufficient water for the communities. It is assumed that perhaps seasonal agricultural camps were located on the lower slopes of the malpaís and perhaps even the lakeshore zone below the malpaís, however no archaeological data supports this claim from the survey. The remaining survey from the southeastern zone recorded a few minor settlements elsewhere in this portion of the basin, however, they seem to have had no effect on the malpaís communities.

The only variable that may provide some insight into the settlement of the malpaís communities is the transport network and the terrain of the lakeshore zone. Ethnohistoric evidence shows the major route that had been established from Morelia, to the northeast of the LPB, into the Pátzcuaro basin had run from the east of the malpaís, and around it to the south (Pollard and Gorenstein 1983). Major routes also existed running north and south, taking advantage of the flat terrain of the lakeshore zone in this portion of the basin. Furthermore, when the higher lake elevations (i.e. 2043 m.a.s.l. lake level) are modeled, it shows that the impeding lake closes off direct travel through the south and eastern portion of the lake and pushes the proposed travel routes closer towards the malpaís. This provides both a positive and negative aspect to the malpaís communities.  The positive is access to this travel and trade, and more access to resources via these routes that may not be available in the malpaís.  However, I believe the negative effects to be more telling of the overall community settlement in the malpaís, which is the possibility for greater inter-basin warfare along these travel routes, especially those going in and out of the basin to the north-east.  Ethnohistoric evidence from 1543, *La Memoria de Melchor Caltzin* (Monzon, Roskamp, Warren, 2009) gives evidence to warfare within the southeastern portion of the basin and on these external travel routes, even after the emergence of the state in 1350.  This may explain the malpaís defensive settlement.

When comparing the settlement structure of the southeastern malpaís communities to the settlement model from the southwest portion of the basin, several key aspects stand out.  With regard to the population of the southeastern communities, we never see a major increase in population during the Middle Postclassic (Early Urichu to late Urichu) such as occurred in the southwestern communities.  This almost doubling of population for the southwestern communities was represented in the population as the communities nearly tripled in number, spreading through the lakeshore resource zone.  However, for the southeastern communities, both the community numbers and the population remain very stable, and no drastic moves towards the lakeshore resource zone occur.  Also of note is the apparent desire of the southwestern communities to locate in areas of more flat and even terrain, during the early, Middle and Late Postclassic.  This was seen as attractive for three reasons; 1.) proximity to lakeshore, marsh and lake resources, including fertile and flat agricultural land, 2.) proximity to travel and transport routes in and out of the basin and long the lakeshore, and 3.) proximity to other communities.  This is in stark contrast to the southeastern communities, who settlement in the harsh terrain and vegetation of the malpaís lacked easily accessible travel routes, lacked accessible or abundant subsistence resources, such a prime agricultural land or lake resources, and really were cut off from any other communities outside of those also existing in the malpaís.

The final comparison includes the last phase, the Tariacuri phase during the emergence of the state. During this phase we see the most drastic shift in settlement for the southeastern communities, as they move into the lower reaches of the malpaís, onto more open and even terrain. They also comprise two larger communities, whereas the previous phase contained n=8 communities. This change in settlement is on par with what we see in the southwestern communities, only not as drastic. The move to larger more inclusive communities and away from the smaller village and hamlet style communities occurred at both locations. The major difference is the amount of increase of population between the two areas. Whereas the southwestern communities had a dramatic increase in the population, the southeastern communities only have a very slight increase. Furthermore, given the population numbers and the landscape resources of the southeastern malpaís communities, it is probable that the malpaís was most likely at its carrying capacity for the population there, resulting in stable populations through time. Also, the nature of the community centers at Erongarícuaro and Urichu were much more established and in their nature, and were major administrative and elite areas for that area of the basin. The artifacts from the southeastern communities did not display the same level of function or class hierarchy as Erongarícuaro or Urichu, and although a ranked social system was most definitely in place, it wasn't to the extent of the southwestern communities.

In summary, it is believed that the communities of the malpaís in the southeastern area had located and settled based primarily on defensive terrain. While recording features during the survey, several very large and very labor intensive walls were found on the outer edges of the malpaís, surrounding the plaza groups. It was interpreted that these were defensive structures, protecting the communities within. Ethnohistoric evidence from Monzon, Roskamp, and Warren (2009), describes warfare in this portion of the basin even after the emergence of the state, and gives insight into the reason for the defensive community locations. It is with the solidifying of the state, we see a change in structure for the settlement system, as the smaller communities of previous phases formed larger, more dynamic communities, and on the lower expanses of the malpaís. This move down into the lower lying slopes of the malpaís is thought to have given the Tariacuri communities more access to travel, trade, resources and other communities. This is similar to the change in structure in the southwestern communities, displaying the effect of the emergence of the Tarascan state on the entire basin.

### The Case for a Regional Settlement System Model

In order to propose a regional settlement model for the Lake Pátzcuaro Basin, we must understand the sub-regional contexts of the communities. This is very clear as this analysis explores two distinct areas of the LPB, and provides two very different views of a settlement system for the same temporal sequence. In summary, the analysis shows three very distinct trends in the overall regional settlement system for the LPB. The first is that defensive positions on the landscape were a primary motivator for settlement in the lake basin. Communities seem to have selected areas of steep terrain and higher elevations, with access, though at times limited, to major resources and travel routes. In these contexts, the communities are smaller in population and in size (area). However, the time length of this trend differs, and is dependent on area and context in the lake basin. We see this trend dissipate in the southwestern communities in the early Postclassic, and for the southeastern communities it continues into the Late Postclassic, due most likely to their location in the basin at a major intersection for inward and outward travel and interaction.

A second theme of settlement for the region is the relationship between the landscape and the communities. The relationship between humans and the environment is highly contextual, dependent in this case on the area of the lake basin the communities are located. In the case of the southwestern communities, and for those that existed along the southern edge of the lake, the climate changes and lake levels fluctuations had the most affect. However, communities on the outer edge of the lake, such as those in the southeastern survey, or in areas where the lake levels are stable, such as on the northern or western areas of the lake seemed to have been less affected by the lake changes. This analysis shows two different areas, one, the southwestern area, and the southeastern area, that had very different relationships with the local resource zones. The southwestern communities moved as the lake levels moved, especially in the Postclassic, as they positioned themselves in the best locations to access the lake and marsh resources. Analysis showed that the lakeshore zone played a significant role in settlement location for the southwestern communities, whereas the southeastern communities, although they had excellent and close access, never fully settled within the lakeshore zone. This suggests different subsistence strategies, different motivations for settlement, and different levels and types of interactions in each sub-region.

The final trend that can be included into a regional settlement system is the emergence of the state, and its influence on regional settlement. With the emergence of the state, at approximately A.D. 1350, we see a drastic transformation in the overall schema for settlement. The data from the southwest portion of the basin suggest two things; 1.) that the catalyst for settlement change in the Late Postclassic was the dramatic increase in the lake levels and shifting resources in the basin, and 2.) that settlement strategy shifted from smaller, hamlet and village communities to larger, more centralized communities. In essence, both the environmental and socio-economic climate produced strains on existing communities, and the state emerged as an answer to the growing tensions put on communities by the shifting lake levels, high populations and dwindling resources.  The emergence of the state introduced a new political economic structure to the basin, predicated on the establishment of administrative centers created for the management of resources and to carry out state policies on a sub-regional and regional level. Therefore, in order to survive in this climate, community settlement shifted towards these larger centers, or created larger centers (such as Jaracuaro) in order to better align themselves with the new regional economic system.  This is even visible in the comparatively smaller settlement in the southeastern malpaís, where communities consolidated and moved in closer to proximity to other major communities, such as the capital Tzintzuntzan, which was a mere 10 kilometers away.  In her model for the emergence of the Tarascan state (2008), Pollard described the "perfect storm", with several variables that occurred at the same time in order to facilitate the rise of a state level institution in the Lake Pátzcuaro Basin.  This analysis details, through the study of two different areas within the lake basin, that this in fact seems to be the case. Specifically with regards to the fluctuating lake, diminishing and shifting resources and the dramatic rise in population during this time, we see a dramatic change in the settlement system for the basin, marked by the emergence of the state.  The primary interactions changed, thus changing the nature of "community" in the lake basin, which can be witnessed in several aspects of the archaeological record.

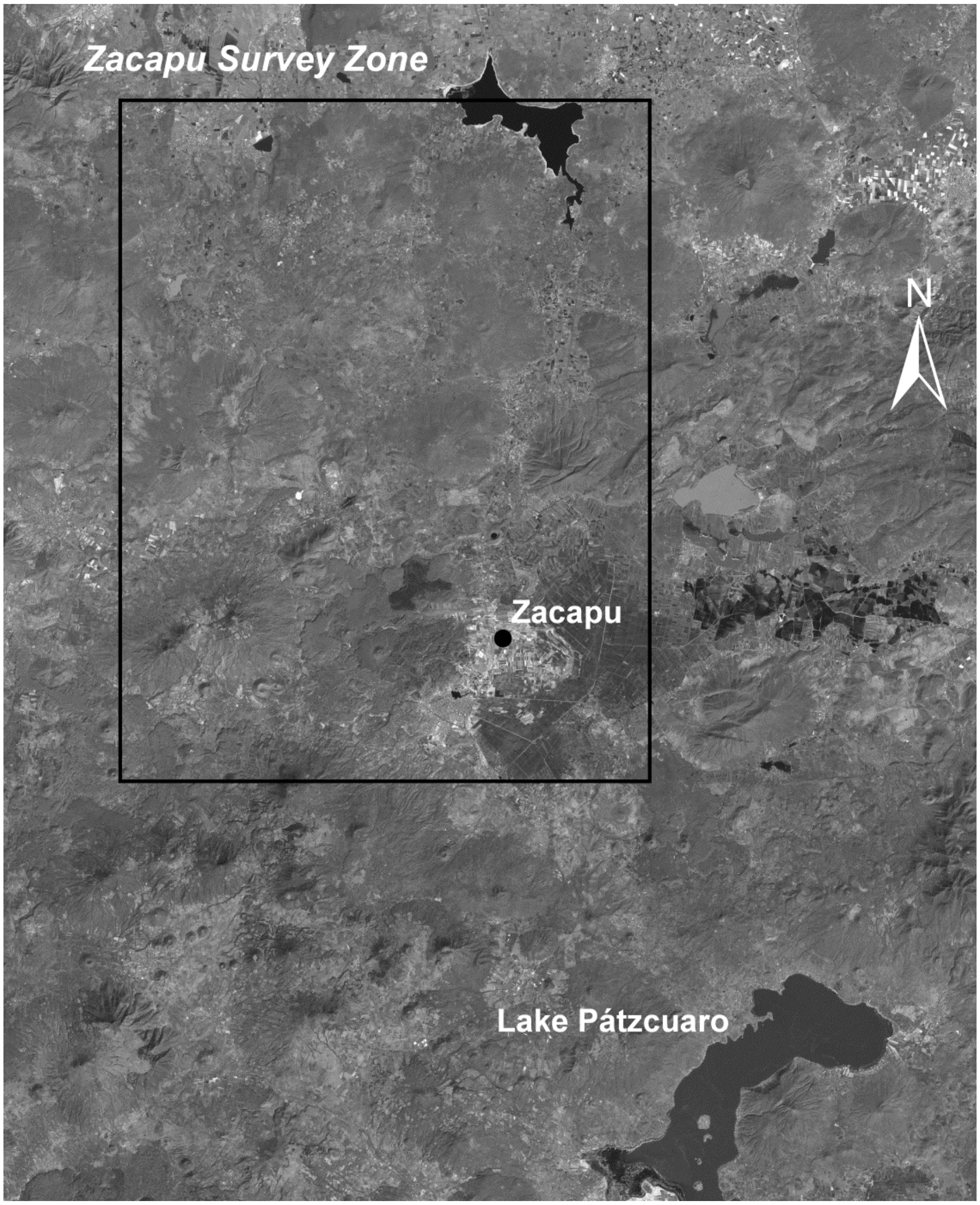
# CHAPTER 7: THE MACROREGIONAL SETTLEMENT SYSTEMS AND CONCLUSIONS

This final chapter will conclude this dissertation with two sections. The first section takes a broader perspective on the Tarascan settlement systems, and looks at a macro-regional model of settlement through the comparative analysis between the Lake Pátzcuaro Basin and the Zacapu Basin, which are adjacent to each other. Archaeological work at the Zacapu basin has been led by primarily French teams of anthropologists, and provides the necessary data to begin to model a macro-regional scheme for settlement. The final section of this chapter will revisit the problem, testable model and hypothesis for this research, and provide overarching commentary on the analysis, the resulting settlement systems model, and future research based on this analysis.

## The Zacapu Basin

The Zacapu Lake Basin is located to the northwest of the Lake Pátzcuaro Basin (see Figure 61). Situated around the modern city of Zacapu, and what used to be the lake or marsh of Zacapu, the basin has been a major area of archaeological research in the West Mexican highlands. The Zacapu Basin, and the sites within, represents an area that was incorporated in the Tarascan state, having similar social stratification and organization as the sites in the lake Pátzcuaro Basin during the Late Postclassic. However, the overall settlement trajectory of the Zacapu area has not been established, as at present there has been no synthetic research published about the settlement system of that region. The following section will attempt to outline and synthesize what the settlement systems could possibly have looked like for the temporal sequence of this research, using several articles and publications from the French archaeological teams.

*Figure 62 – The Zacapu Basin Detailing the French Survey Zone*

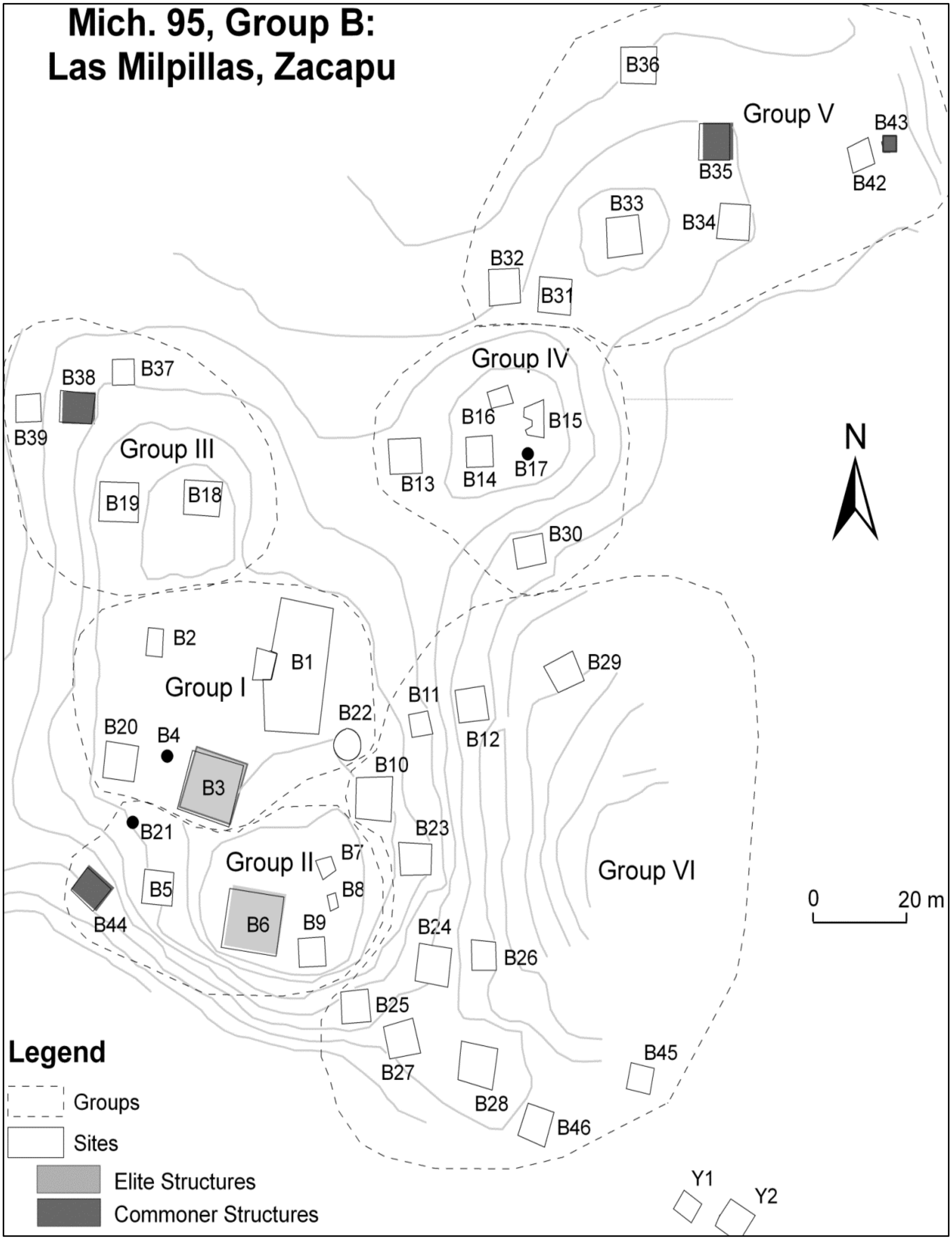



There are several key sites that have been benchmarks for archaeological research in the Zacapu area. One, the site of Loma Alta, is the type site for the phase it's named for, and marks a shift in settlement and community formation. The site details the ceramic tradition that followed the Chupicuaro culture, and the emergence of the sunken plaza architecture, evidence of the civic-ceremonial center. This shift was a marked change from the hamlet style settlements of earlier phases, and along with burials from elsewhere in the basin, we see the possible emergence of a socially ranked system (Pollard 1997:360). The second site, Las Milpillas or Mich. 95 (see Figure 62), details the Postclassic phases, and is located in the malpaís of Zacapu. Nearby, also located in the malpaís of Zacapu is the site of El Palacio, which was the administrative, political and religious center for the immediate Zacapu region during the Late Postclassic.

The discussion begins in the Loma Alta phase, with the Chupicuaro culture, a Late Preclassic culture that was prevalent along the Lerma drainage in southern Guanajuato, the Lake Cuitzeo Basin, and in the Pátzcuaro Basin (Pollard 1997:359). These Chupicuaro communities "appear to have been primarily adapted to lacustrine ecosystems, locating their villages either on islands within marshes or along lakeshores or rivers" (Pollard 1997:360). Pollard also states that this settlement on the floor of the basin, and the general absence of settlements in defensible positions, indicates "minimal local aggression and/or movement of peoples" (1997:360).

With the beginning of the Classic period, around A.D. 400-700, we see a dramatic shift in settlement in the Zacapu region. Evidence from this period details a shift towards the ceremonial center for settlement, as well as both rapid population growth and a doubling of sites, both in the Jaracuaro phase (A.D. 500-700), and again in the Lupe Phase (A.D. 700-850) (Pollard 1997:362). Michelet states, with concern to settlement that "no earlier than 600-700 A.D. the population in the region, initially concentrated in the hills of the ex-lake of Zacapu and over its southern shore, began to spread out over all the region and, notably, north-northwest, to the Lerma slope zone. Basically smaller and medium settlements, villages and hamlets, were founded and occupied" (Michelet: 593). Pollard goes on to confirm this settlement change, as settlements were "located away from the lakeshore, especially in the zone between Zacapu and the Lerma River," (1997:362). According to Michelet, "during this time period (600- 900 A.D., the Malpaís of Zacapu was almost uninhabited" (2008:597).

*Figure 63 – The Site of Milpillas, Mich. 95 in the Zacapu Malpaís*



The start of the Postclassic, A.D. 900, marked a dramatic shift for settlements in the Zacapu Basin. This period marks a peak in settlement coverage for a large part of the basin, and a multiplication of sites, but not necessarily an increase in their size (Michelet 2008:597). Settlement continues to expand into the Lerma slopes, and a slight occupation is noted at El Palacio in the malpaís of Zacapu. Later in this same phase, Pollard notes a dramatic shift in settlement structure, as populations nucleated at defensible positions, a trend that continues until the emergence of the state (1997:365). Beekman also mentions the larger change as well, as he notes "a major increase in population during the Early Postclassic, as the balance of population shifted from the lake basin into the surrounding sierra" with a growing settlement near and within the malpaís of Zacapu (Beekman 2009:29).

The Middle Postclassic, around A.D. 1250, marks a major shift for the Zacapu settlements. Michelet notes that various large sites appear and develop very rapidly at the malpaís of Zacapu, and elsewhere, in the surrounding sierra zone (2008:597). One such site is at El Palacio, estimated to have grown to approximately 20,000 people and 11square kilometers (Pollard 1997:366). Inversely, "occupation more to the north was notable reduced over the Lerma Slope and, aside from small towns, became almost residual", and the lake marsh was abandoned (Michelet 2008:597) (Pollard 1997:366). This is thought to have occurred primarily due to the migrating and shifting populations during this time period in and out of the basin. What Michelet refers to as predatory population, such as nomad hunter-gatherers, and other groups wishing to take control of key resources (2008:617). Even as populations form these larger defensive settlements, research displays fluctuation in these malpaís settlements, as they are abandoned and re-settled throughout the Middle Postclassic and into the Late Postclassic (Migeon 2003). The populations in the defensive sierra and malpaís locations remain in these areas into the Late Postclassic, and as the Tarascan state emerges at the capital of Tzintzuntzan, El Palacio becomes the major center in the

Zacapu area.

The accumulated research from several sources and research projects in the Zacapu basin helps to develop an idea of settlement for the area. The major benchmarks for the Zacapu Basin include a lakeshore settlement occupation during the Loma Alta, composed primarily of smaller village or hamlet communities. The Classic period marks drastic change for the communities of the Zacapu, as they begin to move away from the lakeshore, and form communities in the slope zone of Zacapu. Also during the Classic period, settlements expand, multiply, and population increases. This trend continues into the Terminal Classic, with population continuing to increase, and settlement spreading throughout the slope zones of the Zacapu Basin, away from marsh and lake resources. The Postclassic continues the settlement of the slopes of Zacapu, and introduced a new occupation in the malpaís of Zacapu, although still relatively small. It is during the Early Postclassic, and into the Middle Postclassic that communities nucleated, locating in defensible locations. Populations and settlement begin to grow at a rapid rate in the Malpaís during the Middle Postclassic, as aggressive population continued to move in and out of the basin, competing for resources. Sites are abandoned and re-settled, displaying a level of unrest and disruption for settlement during this time. The emergence of the state and beginning of the Late Postclassic saw the populations remain in the malpaís, and grow to very large numbers, in both community size and population. This increase in population and continued nucleation of settlements suggests two things: 1.) stability and lack of warfare entered with the emergence of the state, allowing for more permanent and large-scale settlements, and 2.) the emergence of the state introduced a new political economy, from which the large settlement of El Palacio benefitted, as the upper-elites aligned themselves with the Tarascan elites of the Lake Pátzcuaro Basin, and participated in long-distance exchange, state ritual and developed even further the complex social hierarchy system that was most likely in place since the Classic period.

**Making the Case for a Macro-Regional Settlement System**

The macro regional analyses are, and must be more general and overarching in their nature in order to derive statements that are true for such large scalar units. However, it was the goal of this dissertation to work explicitly from a growing scalar model, from individual communities, to community groups, to sub-regions, to regions. These intrinsic details, complex multi-scale modeling and sub-regional contexts aid in deriving a more precise picture of the over-arching settlement system, as it pertains to the macro region that encompasses the Lake Pátzcuaro and Zacapu Basins. Not only does this section attempt to provide a macro regional settlement system model, or make the case for one, but it also aids in providing essential information and context regarding the emergence of the Tarascan state.

The comparison between the Zacapu and Lake Pátzcuaro Basins show shared similarities, but also differences, each unique to their own setting. The Loma Alta phase had both regions composed of mostly hamlet and village sized communities. With lower populations, communities from both regions were taking advantage of the lakeshore, situating themselves in close proximity. Evidence from the Zacapu basin shows this to be truer than the LPB, where communities, although in close proximity to the lakeshore, had already begun to locate in defensible positions (i.e. the malpaís at Urichu). Communities seem to be taking advantage of similar resource zones, except at different time periods. The Classic period saw a shift in settlement for both regions into the Lower Slopes zones. The difference being in the LPB, the southwest region also had communities move into the lakeshore, whereas in Zacapu, settlement was moving entirely away from the lakeshore. The Classic, Terminal Classic and Early Postclassic mark several macroregional trends.
P opulation increases rapidly for all areas, and settlements increase in number, but not necessarily size. Settlement is predicated upon local conditions. In the southwest of the LPB, settlement is mixed between defensible positions, lakeshore resources and the lower slopes, with an emphasis on

the malpaís of Urichu.  In the southeast of the LPB, location is predicated solely on defensible positions in the malpaís.  In Zacapu, increased populations and presumably increasing competition drives populations away from the lower lying terrain into defensible areas in the lower slopes, and yet no major settlement is noted in the malpaís of Zacapu.  As the Postclassic period begins, communities centralize and nucleate in Zacapu.  This is true to an extent for Urichu and Erongarícuaro in the LPB, but for the most part the models suggest a greater degree of interaction with the lakeshore resources than with other communities or local centers.

Perhaps the second most influential trend affecting settlement occurs during the Early and Middle Postclassic.  Populations double, as do settlements, and warfare, whether inter-basin or external aggression, seems to be the norm.  This is true for the southeast communities in the LPB, and definitely for the Zacapu area.  However, this is not the case for the southwestern portion of the LPB.  Instead, interaction with the lakeshore and fluctuating lake is driving settlement structure and interaction.  This potentially shows a regional trend of warfare that is located to the northern parts of the LPB and Zacapu, and the east of both regions.  It is possible that pressure from communities deriving from Morelia and the Lake Cuitzeo Basin may have had a larger role than previously thought on these populations.  It is during this time period that interaction with the malpaís areas (at Urichu, southeastern LPB and Zacapu) structures settlement, as these areas provide both defensive locations and also resources and area enough to expand into sizable communities.

The Late Postclassic marks the emergence of the state, and the most influential trend of settlement systems is apparent.  Full centralization and nucleation of communities occurs for several reasons, but primary is the change in the social, economic and political sub-structure of the regions.  Communities now align themselves with the state authority and emerging regional economies, as is evident at Erongarícuaroricuaro, Urichu, and El Palacio.  For the southwestern portion of the basin, the catalyst for change was the rising lake levels, a factor that I believe influenced many communities for the southern half of the LPB to re-settle in accordance with the new state system. Competition for resources became too great, and the state became the great manager of the region, providing a more diverse and regional economic and subsistence system. This trend continues until the arrival of the Spanish, and the conquest of the Tarascan state.

**Problems and Hypothesis Revisited**

The goals of this dissertation were described in Chapter 1, and are worth revisiting in order to perform a “self-analysis”. The primary goal was to determine the structure of the settlement system over a period of approximately 1,625 years leading up to the Spanish conquest. Ancillary to the primary goal is the goal of explaining the role of state formation and the state’s political economy in the latter years of settlement in the Basin. A tertiary goal is the identification of a macroregional settlement of Tarascan society when analyzing the Zacapu and Pátzcuaro Basins. This dissertation performed these tasks through the use of intensive spatial modeling, utilization of a complex GIS database, interaction analysis, landscape analysis, and cost surface analysis, and did so using several scalar levels in order to provide multiple viewpoints of change in settlement and community organization. The hypothesis that was put forth in Chapter One is detailed here;

*The central hypothesis is that the primary variable that determined settlement within the lake basin was the proximity to the lakeshore of Lake Pátzcuaro and its zones of resources. This variable remained the primary settlement determinant until the emergence of the state in A.D. 1350, when the dominance of the capital, Tzintzuntzan, altered the foundations of the political economy of the lake basin. During this period, the primary factor changed, and settlement was now predicated upon proximity to the capital and other major state-run centers of administration, religion, and economy. The lake remained a secondary factor in settlement, primarily affecting peripheral settlement in the basin. Tertiary to all periods of settlement is the variable of proximity* *to arable land both inland and upland, followed by a fourth variable, proximity to travel/trade routes in and out of the basin.*

*An alternative hypothesis is that the lake is only a primary variable until the Middle Postclassic (A.D. 1000 – 1350), when political instability becomes the primary motivator for settlement in upland, defensible positions. Following this period, the emergence of the state and the proximity to the capital of Tzintzuntzan assumes the primary motivator for settlement location until Spanish conquest.*

The analysis, and the resulting settlement systems model for the southwestern potion of the lake basin, proved the hypothesis wrong in certain areas, and failed to prove it wrong in others. The variables that structured the settlement for communities differ based on the analysis from what was hypothesized. The primary, secondary and tertiary variables derived from the settlement systems analysis of this dissertation from the southwest area of the LPB, are detailed in Table 20, whereas the hypothesized can be seen in Table 18 Ultimately, the sub-regional scale and context provided much closer detail into what had actually occurred for these communities, and in some cases there was no single primary variable, but there were multiple variables that affected the communities for the phase equally.

*Table 20 – Hypothesized Settlement Variables, Chapter One*

| ***Period*** | ***Phase*** | ***Primary Variable*** | ***Secondary Variable*** | ***Tertiary Variable*** |
|---|---|---|---|---|
| Late Preclassic | Loma Alta 2 | lake/lacustrine | other communities | travel/trade routes |
| Early Classic | Loma Alta 3 | lake/lacustrine | other communities | travel/trade routes |
| Middle Classic | Jaracuaro | lake/lacustrine | other communities | travel/trade routes |
| Epiclassic | Lupe-La Joya | lake/lacustrine | arable land | travel/trade routes |
| Early Postclassic | Early Urichu | lake/lacustrine | arable land | travel/trade routes |
| Middle Postclassic | Late Urichu | lake/lacustrine | defensible positions | arable land |
| Late Postclassic | Tariacuri | capital/admin. centers | lake/lacustrine | arable land |

*Table 21 – Settlement Variables Derived from the SW Settlement Systems Analysis*

| ***Period*** | ***Phase*** | ***Primary Variable*** | ***Secondary Variable*** | ***Tertiary Variable*** |
|---|---|---|---|---|
| Late Preclassic | Loma Alta 2 | Upland, Steep Terrain and Defensible Positions | lower slope resources | travel/trade routes |
| Early Classic | Loma Alta 3 | Upland, Steep Terrain and Defensible Positions | lower slope resources | travel/trade routes |
| Epiclassic | Lupe-La Joya | Lakeshore/Lacustrine Resources | defensible positions | lower slopes |
| Early Postclassic | Early Urichu | Lakeshore/Communities/ Agricultural land | Lower Slopes | travel/trade routes |
| Middle Postclassic | Late Urichu | Lakeshore/Lacustrine Resources | Level Terrain | travel/trade routes |
| Late Postclassic | Tariacuri | Major Centers, other Communities | Lakeshore/Lacustrine | Agricultural land/flat terrain |

Ultimately, the analysis and the tables above illustrates that the settlement system for the LPB is much more complex than initially hypothesized, and that active decision-making, based on a variety of variables, on the part of communities structured settlement. The analysis shows a high level of interaction between communities and the landscape, which displays the complex human-environment relationships that defined the southern extent of the lake basin. The lakeshore and fluctuating lake levels provided a complex environment to attempt to model, especially when the communities were mapped and added to the analysis. However, it is evident that the communities and the landscape form a symbiotic system that can only be discussed in tandem. This dissertation aided in further investigating these vital relationships, and hopefully provided a unique and useful method, through the utilization of GIS and spatial analysis, to further explore the evolution of coupled human-environment systems.

**Future Research and Directions**

The analysis performed for this dissertation made evident several factors that require further research and analysis. The most glaring of these is the lack of data for the Terminal Preclassic and Early Classic periods in the Lake Pátzcuaro Basin. Evidence from the Zacapu basin demonstrated how the Loma Alta communities relied heavily on lacustrine resources, and situated themselves in close proximity to the lakeshore and lake resources. This may be the case for the LPB as well, but given the apparent lack of Loma Alta sites, the depth of provenience, and the fluctuating lake levels, the artifact assemblages and data just aren't present to accurately model what is really occurring during this time period. Although we do have evidence of defensible positions, which represents the primary variable that structures settlement for this phase, I believe that other Loma Alta communities existed in the lakeshore zones closer to the lake. I also believe that even though the data suggest possible competition and/or conflict, and the need for defensible locations, I feel that the lower populations actually merited a decrease in warfare, and communities did exist in these lower, more exposed areas. However, this is all conjecture until further research is done to test the extent of the settlement and subsistence models for these time periods.

A second trend in the analysis that would be worth doing further research on is the Classic period leading into the Postclassic. This was clearly a time of great change, population growth and a shift in community structure. And as lake levels dropped to their lowest in the sequence, we expected a mass movement towards the lakeshore. However, there were three competing variables during the Early Postclassic that equally structured settlement. It is not until the Late Urichu, when lake levels are on the rise, that we see a mass movement of communities to the lake's edge. Why is this? Could this be the period that warfare plays a greater role in structuring settlement for the communities for the southwest region? If so, what evidence proves this? Further testing of these periods is critical to better understand the emergence of the Tarascan state a few hundred years later in the sequence.  Pollard describes the "perfect storm" for the emergence of the state at the end of the Middle Postclassic, but perhaps evidence suggests that the major changes began in the Early Postclassic, providing an equally advantageous period for state emergence.  If so, why didn't the state emerge earlier?

This analysis presents a settlement systems model, based primarily on the communities and landscape of the southwestern portion of the basin.  This model is one that can only strengthen with future fieldwork in areas where the archaeology and culture history is sorely lacking.  This includes areas both within and outside of the Lake Pátzcuaro Basin, in areas where no archaeological work has been done, and also in areas where older fieldwork must be redone and updated, such as Ihuatzio.  Given the multiple scales of this model, and its appropriateness for application outside the basin as well, it stands to reason that this model may be used as a template for future research to ultimately strengthen and test the settlement systems model for the region and macro region, and further our understanding of Prehispanic communities, human- environment relationships, and the emergence of the Tarascan state.

**Conclusion**

It is with these last thoughts on future research directions that this dissertation hopes to find a place in the significant archaeological literature.  What has been presented is both a model and method that may be replicated and applied to other regions and time periods to help answer questions of settlement, subsistence, state emergence and human-environment relationships. Much of this research was made possible due to the advancing of remote sensing technologies, GIS research strategies and methods, and spatial analysis techniques.  These platforms, along with the advances in geoarchaeology, geology and ecology help to provide a much more abundant and useful toolkit for anthropological archaeology.  This research, I feel, is applicable and useful in its utilization of a multi-disciplinary approach, one that uses multiple lines of evidence to approach the issues at hand.  With this multi-disciplinary approach comes the need for archaeologists to continue to reach out among the social and physical sciences to incorporate, not merely methods, techniques or technologies, but other researchers in order to perform these types of necessary research.  This also means collaboration with American, French and Mexican teams, all of whom do excellent work in the Mexican highlands, and whose shared and contributed research would aid in providing a large scale, holistic and multi-disciplinary view of Prehispanic life ways.  This contributed knowledge leads to progress in our respective fields, and helps to create inclusive relationships and dialogue that may further the field of anthropological archaeology.  It is my hope that this dissertation will be used to help build these relationships, bridge these gaps, and further our shared knowledge of Mesoamerican civilizations.

APPENDIX

*Figure 64 – Loma Alta Phase Communities*

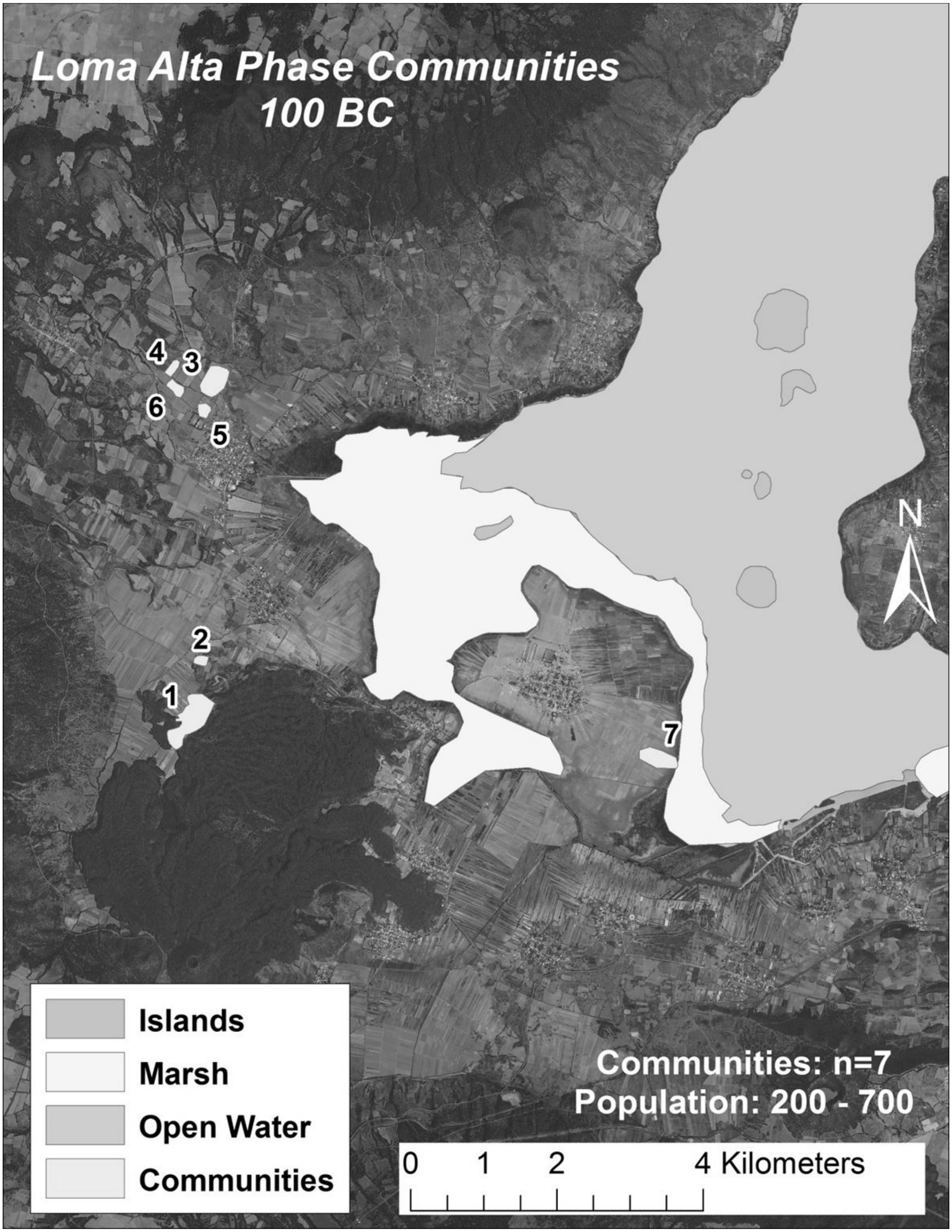


*Figure 65 – Lupe/La Joya Communities*

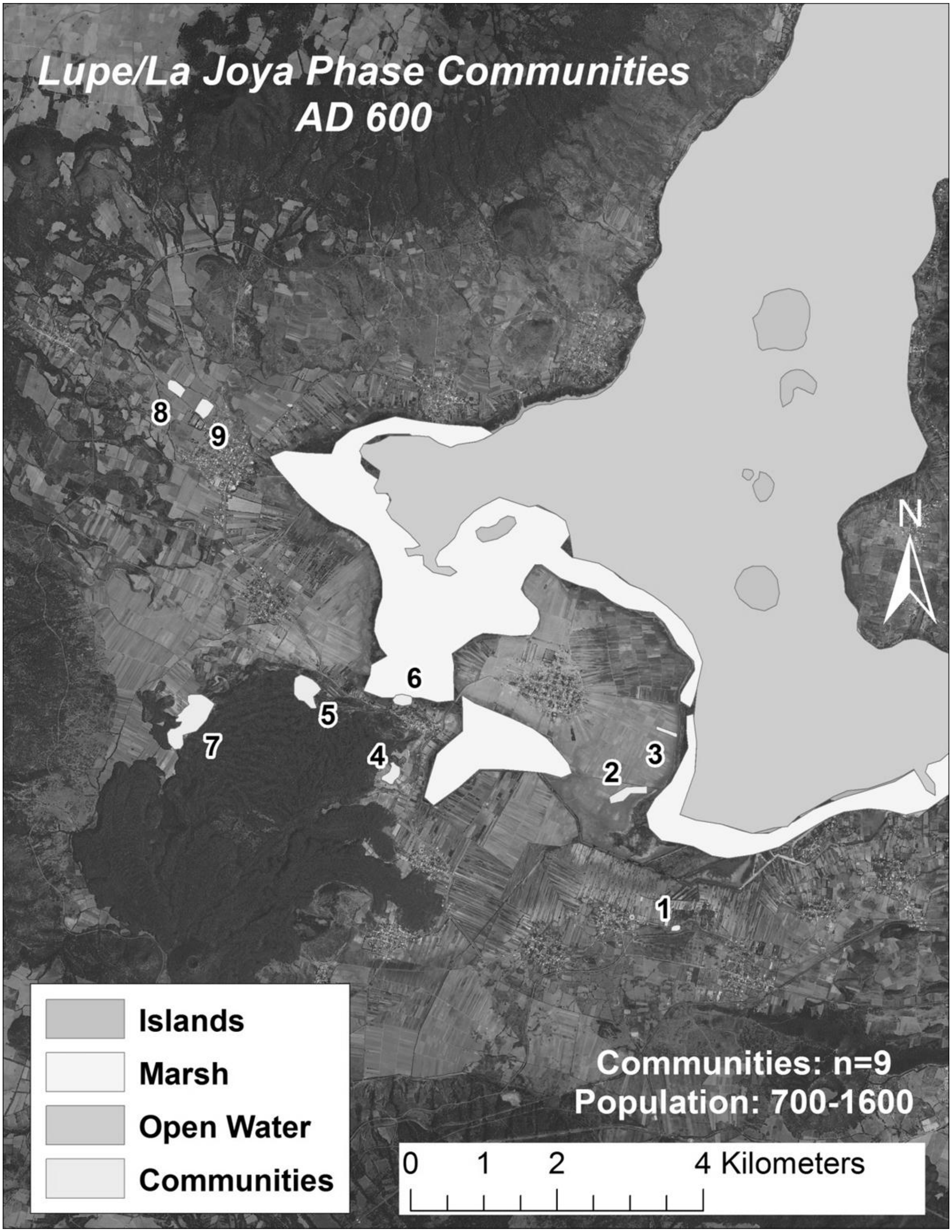


*Figure 66 – Early Urichu Communities*

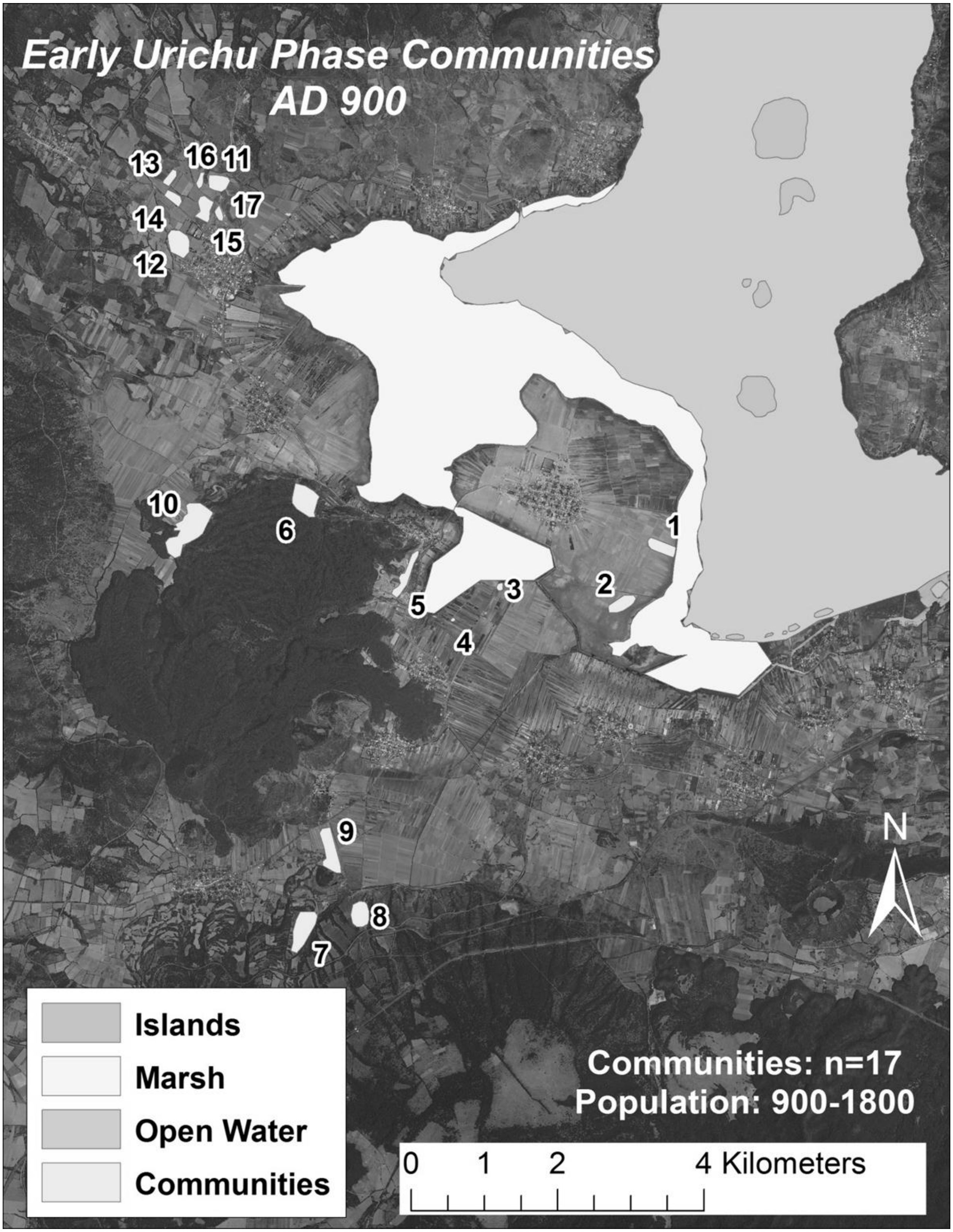


*Figure 67 – Late Urichu Communities*

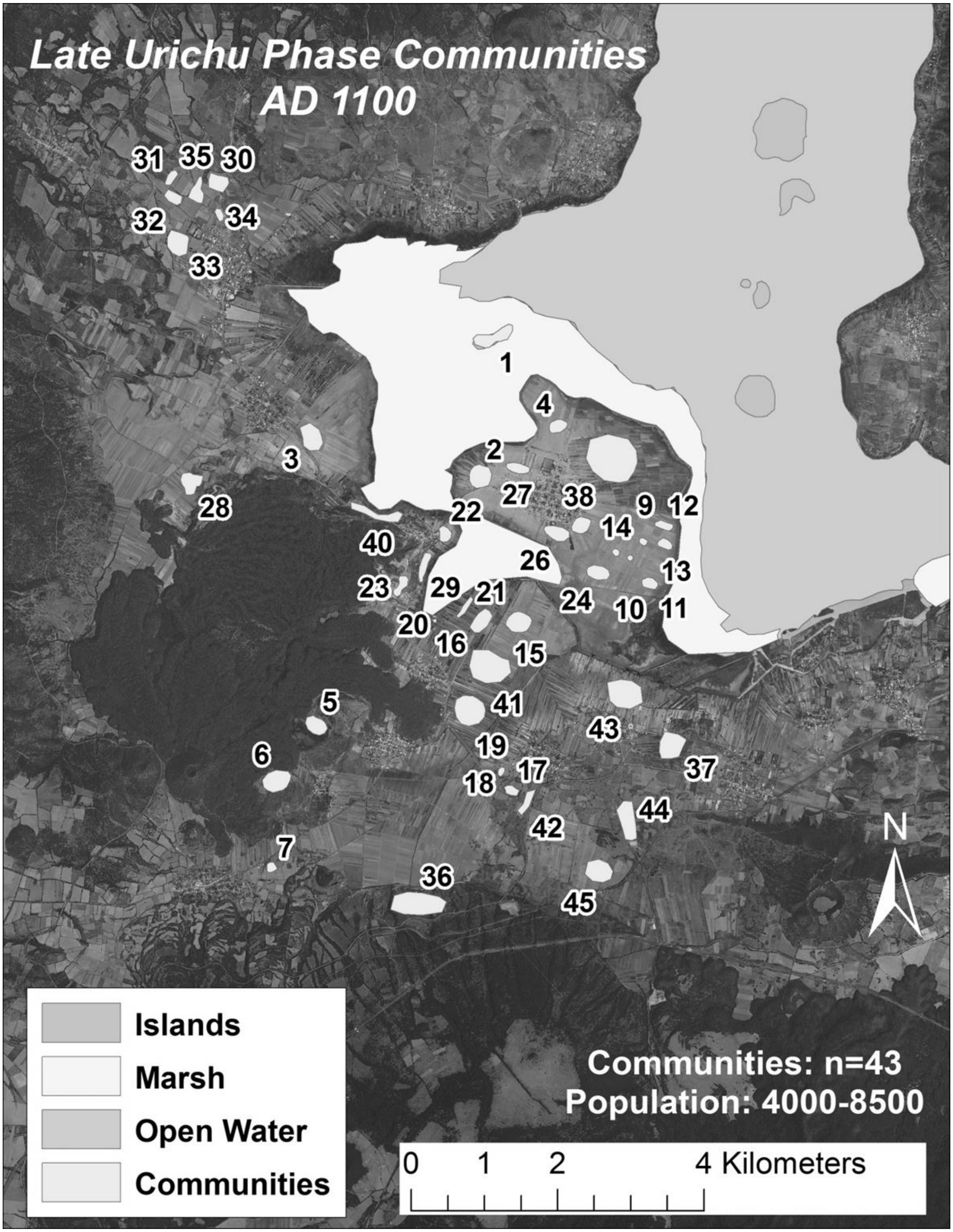


Figure 68 – Tariacuri Communities

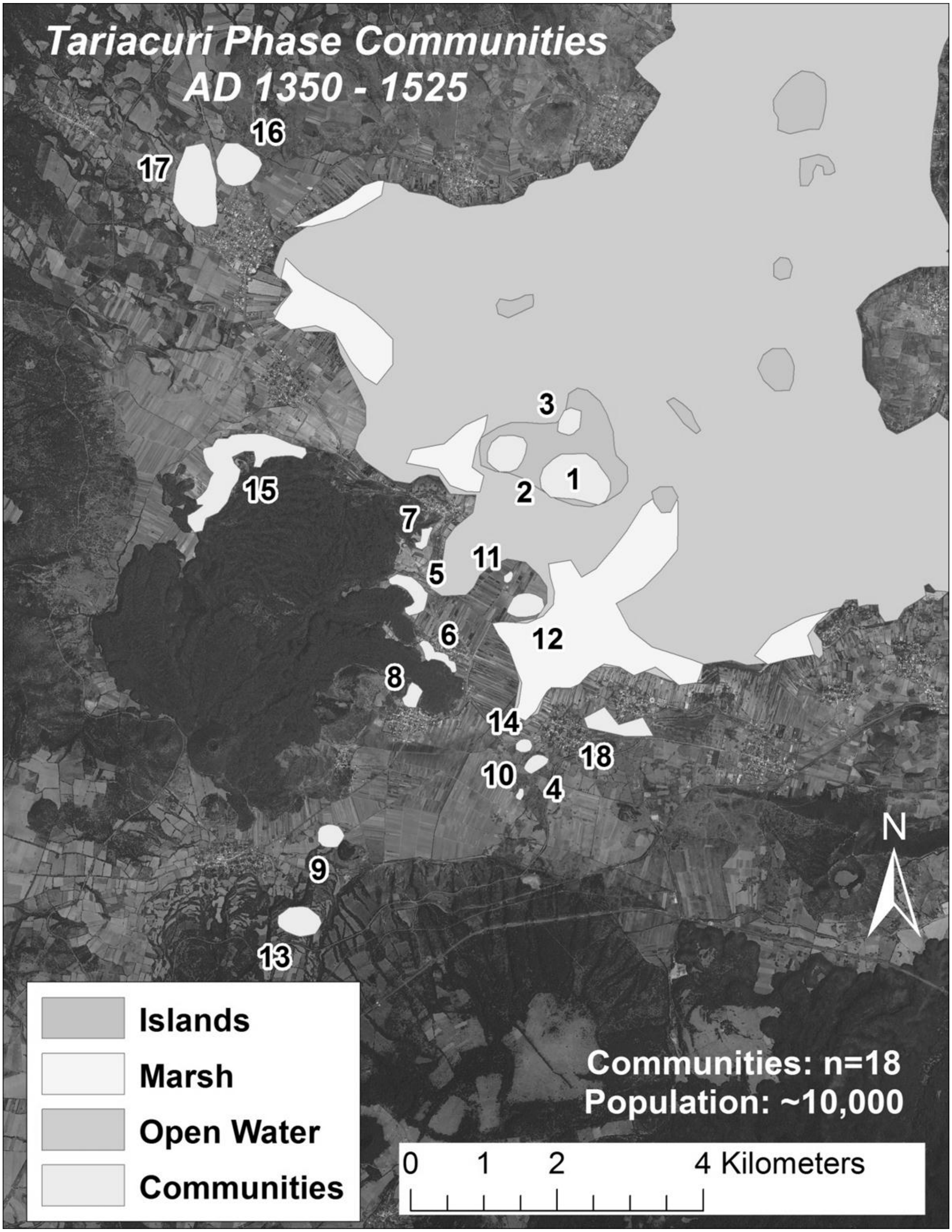


*Table 22 – Loma Alta Community Population Reconstruction*

| Community | Survey Sites | Artifact Density | Area (hectares) | Population 1 | Population 2 | Population 3 |
|---|---|---|---|---|---|---|
| 1 | U-5 | heavy | 23.11 | 231-577 | 693 | 100-500 |
| 2 | U-1 | heavy, medium heavy | 2.38 | 24-60 | 72 | 100-500 |
| 3 | ER-1, ER-3, ER-5, ER-11, ER-13 | heavy | 12.08 | 121-303 | 363 | 100-500 |
| 4 | ER-18 | light | 2.47 | 13-25 | 90 | 30-80 |
| 5 | ER-21 | light | 2.99 | 15-30 | 105 | 30-80 |
| 6 | ER-23 | light | 3.46 | 18-35 | 75 | 30-80 |

*Table 23 – Lupe/La Joya Community Population Reconstruction*

| Community | Survey Sites | Artifact Density | Area (hectares) | Population 1 | Population 2 | Population 3 |
|---|---|---|---|---|---|---|
| 1 | P-63 | medium light | 0.88 | 5 - 9 | 28 | 30 - 80 |
| 2 | X-5-1, X-5-2, X-5-4 | light | 6.03 | 30 - 60 | 180 | 30 - 80 |
| 3 | X-3-8I, X-3-8II | light | 1.57 | 8 - 16 | 47 | 30  -80 |
| 4 | P-99 | medium light | 4.32 | 22 - 43 | 129 | 100 - 500 |
| 5 | U-9, U-65 | medium heavy | 10.92 | 110 - 275 | 330 | 100 - 500 |
| 6 | U-60, U-66 | light | 3.31 | 17 - 33 | 99 | 30 - 80 |
| 7 | U-5 | heavy | 22.91 | 230 - 575 | 330 | 100 - 500 |
| 8 | ER-23 | light | 3.5 | 18 - 35 | 105 | 30 - 80 |
| 9 | ER-21 | light | 4.43 | 22 - 44 | 133 | 30 - 80 |

*Table 24 – Early Urichu Community Population Reconstruction*

| Community | Survey Sites | Artifact Density | Area (hectares) | Population 1 | Population 2 | Population 3 |
|---|---|---|---|---|---|---|
| 1 | X-3-9 to X-3-14 | light | 5.74 | 29 - 57 | 172 | 30 - 80 |
| 2 | X-5-2, X-5-4 | light | 5.62 | 28 - 56 | 169 | 30 - 80 |
| 3 | P-1 | medium | 0.78 | 20 - 27 | 23 | 30 - 80 |
| 4 | P-13 | medium | 0.25 | 7 - 9 | 8 | 30 - 80 |
| 5 | P-96, P-97 | medium light | 6.41 | 32 - 64 | 192 | 30 - 80 |
| 6 | U-9, U-65 | medium heavy | 11.58 | 116 - 290 | 347 | 100 - 500 |
| 7 | P-124 | light | 12.13 | 61 - 121 | 364 | 30 - 80 |
| 8 | P-88 | light | 7.28 | 37 - 73 | 218 | 30 - 80 |
| 9 | P-91 | light | 10.58 | 53 - 106 | 317 | 30 - 80 |
| 10 | U-5 | heavy | 22.86 | 228 - 570 | 686 | 100 - 500 |
| 11 | ER-3 | heavy | 5.46 | 138 - 193 | 164 | 100 - 500 |
| 12 | ER-31, ER-33 | light | 8.75 | 44 - 87 | 263 | 30 - 80 |
| 13 | ER-18 | light | 2.32 | 12 - 23 | 70 | 30 - 80 |
| 14 | ER-23 | light | 2.85 | 14 - 29 | 86 | 30 - 80 |
| 15 | ER-11, ER-13, ER-21 | light | 5.54 | 28 - 56 | 166 | 30 - 80 |
| 16 | ER-23 | light | 1.51 | 8 - 15 | 45 | 30 - 80 |
| 17 | ER-12 | light | 1.62 | 8 - 16 | 49 | 30 - 80 |

*Table 25 – Late Urichu Community Population Reconstruction*

| Community | Survey Sites | Artifact Density | Area (hectares) | Population 1 | Population 2 | Population 3 |
|---|---|---|---|---|---|---|
| 1 | X-OM-1, X-OM-2 | medium | 8.31 | 208 - 291 | 249 | 100-500 |
| 2 | X-7-1 | heavy | 7.89 | 277 - 395 | 237 | 100-500 |
| 3 | U-55b | light | 8.6 | 86-215 | 258 | 30-80 |
| 4 | X-8-2, X-8-4 | light | 3.54 | 35 - 88 | 106 | 30-80 |
| 5 | P-115 | light | 5.54 | 55-138 | 166 | 30-80 |
| 6 | P-117 | light | 8.94 | 89-222 | 268 | 30-80 |
| 7 | P-126 | light | 1.54 | 15-38 | 46 | 30-80 |
| 9 | X-4-12 | light | 0.51 | 5-13 | 15 | 30-80 |
| 10 | X-3-17I, X-3-17II, X-3-18, X-3-18II | light | 2.72 | 27-68 | 82 | 30-80 |
| 11 | X-3-9, X-3-10, X-4-8, X-4-9 | light | 0.91 | 9-23 | 27 | 30-80 |
| 12 | X-3-2, X-3-3, X-3-4 | medium light | 2.26 | 55 - 77 | 68 | 30-80 |
| 13 | X-3-8I, X-3-8II, X-3-11, X-3-12I, X-3-12II | light | 2.26 | 55-77 | 68 | 30-80 |
| 14 | X-6-2 | medium light | 4.53 | 113 - 158 | 136 | 30-80 |
| 15 | P-36, P-37 | medium | 7.68 | 193-270 | 230 | 100-500 |
| 16 | P-8, P-10, P-22 | medium | 6.01 | 150-210 | 180 | 100-500 |
| 17 | P-78e | medium | 2.05 | 50-74 | 62 | 100-500 |
| 18 | P-78b, P-78c | medium | 0.88 | 23-32 | 26 | 30-80 |
| 19 | P-48 | light | 13.86 | 138-345 | 416 | 30-80 |
| 20 | P-24 | heavy | 0.23 | 100-500 | 7 | 100-500 |
| 21 | P-6, P-7, P-9, P-11 | medium | 2.09 | 53-74 | 63 | 100-500 |
| 22 | P-94 | medium light | 2.87 | 70-98 | 86 | 30-80 |
| 23 | P-97 | medium light | 3.11 | 78-109 | 93 | 30-80 |
| 24 | X-4-19 - X-4-22 | medium light | 4.97 | 124 - 174 | 149 | 100-500 |
| 25 | X-4-13, X-4-13b, X-4-14 | medium light | 0.81 | 20-28 | 24 | 30-80 |
| 26 | X-6-3 | light | 5.43 | 54 - 136 | 163 | 30-80 |
| 27 | X-7-2 | medium | 3.57 | 90 - 126 | 107 | 100-500 |
| 28 | U-2 | heavy | 6.42 | 224-320 | 193 | 1000-5000 |
| 29 | P-95 | medium light | 3.61 | 90-126 | 108 | 30-80 |
| 30 | ER-3 | heavy | 5.36 | 190-270 | 161 | 1000-5000 |

*Table 25 (cont'd)*

| | | | | | | |
|---|---|---|---|---|---|---|
| 31<br>32 | ER-18<br>ER-23 | light<br>light | 2.09<br>3.32 | 21-53<br>32-81 | 63<br>100 | 30-80<br>30-80 |
| 33 | ER-31, ER-33 | light | 8.08 | 80-203 | 242 | 30-80 |
| 34 | ER-12 | light | 1.49 | 15-38 | 45 | 30-80 |
| 35 | ER-2, ER-13 | light | 4.57 | 46-115 | 137 | 30-80 |
| 36 | P-82 | light | 18.86 | 189-472 | 566 | 30-80 |
| 37 | P-31, P-63, P-72 | light | 10.25 | 103-256 | 308 | 30-80 |
| 38 | X-9 | light | 36.17 | 181-362 | 1085 | 30-80 |
| 39 | U-60 | light | 6.93 | 69-173 | 208 | 30-80 |
| 40 | P-40, P-41, P-46, P-47 | light | 20.05 | 201-501 | 602 | 30-80 |
| 41 | P-78e, P-78b | light | 3.32 | 33-83 | 100 | 30-80 |
| 42 | P-62 | light | 15.47 | 155-387 | 464 | 30-80 |
| 43 | P-76 | light | 10.21 | 102-255 | 306 | 30-80 |
| 44 | P-75 | light | 9.07 | 91-227 | 272 | 30-80 |

*Table 26 – Tariacuri Community Population Reconstructions*

| Community | Survey Sites | Artifact Density | Area (hectares) | Population 1 | Population 2 | Population 3 |
|---|---|---|---|---|---|---|
| 1 | X-10, X-6-1 to X-6-5 | heavy | 50.92 | 1782-2546 | 1528 | 1000-5000 |
| 2 | X-6-6, X-7-1, X-7-2, X-7-3 | heavy | 21.37 | 748-1068 | 641 | 1000-5000 |
| 3 | X-8-1 | medium heavy | 9.21 | 230-322 | 276 | 100-500 |
| 4 | P-78e, P-78d | medium light | 5.62 | 56-140 | 168 | 30-80 |
| 5 | P-101, P-102, P-112 | medium | 14.02 | 350-491 | 421 | 100-500 |
| 6 | P-109, P-110 | medium light | 7.72 | 77-192 | 232 | 100-500 |
| 7 | P-98 | medium light | 3.77 | 38-94 | 113 | 30-80 |
| 8 | P-114 | medium light | 6.18 | 62-155 | 185 | 100-500 |
| 9 | P-91, P-104, P-105, P-106 | medium light | 9.29 | 93-232 | 279 | 30-80 |
| 10 | P-79c | medium light | 1.27 | 13-32 | 38 | 30-80 |
| 11 | P-4, P-5 | medium | 1.42 | 36-50 | 43 | 30-80 |
| 12 | P-19, P-37 to P-39 | medium light | 13.01 | 130-325 | 390 | 100-500 |
| 13 | P-212, P-124 | light | 18.67 | 94-187 | 560 | 30-80 |
| 14 | P-78b, P-78c | medium | 3.39 | 85-119 | 102 | 100-500 |
| 15 | U-1 to U-8 | heavy | 70.31 | 2461-3515 | 2109 | 1000-5000 |
| 16 | ER-1, ER-2, ER-3, ER-5, ER-6, ER-8, ER-9, ER-10, ER-11, ER-13 | heavy | 27.37 | 959-1370 | 821 | 3000-5000 |
| 17 | ER-14, 15, 17, 18, 22, 23, 24, 26, 27, 28, 29, 30, 31, 32, 33, 37 | light | 55.06 | 550-1375 | 1652 | 100-500 |
| 18 | P-61, P-64, P-71 | light | 19.80 | 198-495 | 594 | 100-500 |

*Table 27 – Loma Alta (1&2) Community Interaction Values*

| A Comm | B Comm | A pop | B pop | distance | A x B | d^1.9 | interaction | value (x1000 |
|---|---|---|---|---|---|---|---|---|
| **1** | **2** | **808** | **42** | **970** | **33936** | **473005.614** | **0.0717** | **71.75** |
| *1* | *3* | *808* | *212* | *5085* | *171296* | *11014196.5* | *0.0156* | *15.55* |
| 1 | 4 | 808 | 19 | 5286 | 15352 | 11856093.1 | 0.0013 | 1.29 |
| 1 | 5 | 808 | 23 | 4632 | 18584 | 9224869.82 | 0.0020 | 2.01 |
| 1 | 6 | 808 | 27 | 5111 | 21816 | 11121443.9 | 0.0020 | 1.96 |
| **2** | **1** | **42** | **808** | **954** | **33936** | **458291.616** | **0.0740** | **74.05** |
| *2* | *3* | *42* | *212* | *4993* | *8904* | *10638661.1* | *0.0008* | *0.84* |
| 2 | 4 | 42 | 19 | 4330 | 798 | 8115719.03 | 0.0001 | 0.10 |
| 2 | 5 | 42 | 23 | 3691 | 966 | 5992025.95 | 0.0002 | 0.16 |
| 2 | 6 | 42 | 27 | 4085 | 1134 | 7265490.11 | 0.0002 | 0.16 |
| 3 | 1 | 212 | 808 | 5162 | 171296 | 11333243 | 0.0151 | 15.11 |
| 3 | 2 | 212 | 42 | 4111 | 8904 | 7353603.44 | 0.0012 | 1.21 |
| 3 | 4 | 212 | 19 | 642 | 4028 | 215931.774 | 0.0187 | 18.65 |
| **3** | **5** | **212** | **23** | **423** | **4876** | **97734.2305** | **0.0499** | **49.89** |
| *3* | *6* | *212* | *27* | *548* | *5724* | *159839.113* | *0.0358* | *35.81* |
| 4 | 1 | 19 | 808 | 5380 | 15352 | 12259882.9 | 0.0013 | 1.25 |
| 4 | 2 | 19 | 42 | 4329 | 798 | 8112158.23 | 0.0001 | 0.10 |
| **4** | **3** | **19** | **212** | **646** | **4028** | **218495.141** | **0.0184** | **18.44** |
| 4 | 5 | 19 | 23 | 801 | 437 | 328777.267 | 0.0013 | 1.33 |
| *4* | *6* | *19* | *27* | *260* | *513* | *38765.8545* | *0.0132* | *13.23* |
| 5 | 1 | 23 | 808 | 4767 | 18584 | 9742396.23 | 0.0019 | 1.91 |
| 5 | 2 | 23 | 42 | 4329 | 966 | 8112158.23 | 0.0001 | 0.12 |
| **5** | **3** | **23** | **212** | **646** | **4876** | **218495.141** | **0.0223** | **22.32** |
| 5 | 4 | 23 | 19 | 801 | 437 | 328777.267 | 0.0013 | 1.33 |
| *5* | *6* | *23* | *27* | *260* | *621* | *38765.8545* | *0.0160* | *16.02* |
| 6 | 1 | 27 | 808 | 5138 | 21816 | 11233337.1 | 0.0019 | 1.94 |
| 6 | 2 | 27 | 42 | 4087 | 1134 | 7272250.19 | 0.0002 | 0.16 |
| **6** | **3** | **27** | **212** | **582** | **5724** | **179206.464** | **0.0319** | **31.94** |
| *6* | *4* | *27* | *19* | *280* | *513* | *44627.2637* | *0.0115* | *11.50* |
| 6 | 5 | 27 | 23 | 502 | 621 | 135312.233 | 0.0046 | 4.59 |

**Bold** = Primary
*Italic* = secondary

*Table 28 – Lupe/La Joya Community Interaction Values*

| A Comm | B Comm | A pop | B pop | distance | A x B | d^1.9 | Interaction | value (x1000) |
|---|---|---|---|---|---|---|---|---|
| **1** | **2** | **7** | **45** | **2351** | **315** | **2543196.96** | **0.0001** | **0.12** |
| 1 | 3 | 7 | 12 | 3290 | 84 | 4815841.74 | 0.0000 | 0.02 |
| 1 | 4 | 7 | 33 | 5158 | 231 | 11316562.9 | 0.0000 | 0.02 |
| 1 | 5 | 7 | 193 | 6740 | 1351 | 18812815.8 | 0.0001 | 0.07 |
| 1 | 6 | 7 | 25 | 6798 | 175 | 19121598.9 | 0.0000 | 0.01 |
| *1* | *7* | *7* | *403* | *8305* | *2821* | *27973403.5* | *0.0001* | *0.10* |
| 1 | 8 | 7 | 27 | 12249 | 189 | 58531709.1 | 0.0000 | 0.00 |
| 1 | 9 | 7 | 33 | 11993 | 231 | 56229326.8 | 0.0000 | 0.00 |
| 2 | 1 | 45 | 7 | 2312 | 315 | 2463637.9 | 0.0001 | 0.13 |
| **2** | **3** | **45** | **12** | **1067** | **540** | **566907.754** | **0.0010** | **0.95** |
| 2 | 4 | 45 | 33 | 3871 | 1485 | 6559398.64 | 0.0002 | 0.23 |
| 2 | 5 | 45 | 193 | 5454 | 8685 | 12582262.9 | 0.0007 | 0.69 |
| 2 | 6 | 45 | 25 | 5511 | 1125 | 12833283.3 | 0.0001 | 0.09 |
| *2* | *7* | *45* | *403* | *7614* | *18135* | *23717256.9* | *0.0008* | *0.76* |
| 2 | 8 | 45 | 27 | 10962 | 1215 | 47401339.6 | 0.0000 | 0.03 |
| 2 | 9 | 45 | 33 | 10707 | 1485 | 45328236.7 | 0.0000 | 0.03 |
| 3 | 1 | 12 | 7 | 3271 | 84 | 4763136.57 | 0.0000 | 0.02 |
| **3** | **2** | **12** | **45** | **1084** | **540** | **584192.041** | **0.0009** | **0.92** |
| 3 | 4 | 12 | 33 | 5337 | 396 | 12074375.7 | 0.0000 | 0.03 |
| 3 | 5 | 12 | 193 | 6919 | 2316 | 19773444.4 | 0.0001 | 0.12 |
| 3 | 6 | 12 | 25 | 6977 | 300 | 20089566.9 | 0.0000 | 0.01 |
| *3* | *7* | *12* | *403* | *8885* | *4836* | *31801611* | *0.0002* | *0.15* |
| 3 | 8 | 12 | 27 | 12428 | 324 | 60167555.1 | 0.0000 | 0.01 |
| 3 | 9 | 12 | 33 | 12172 | 396 | 57834594.2 | 0.0000 | 0.01 |
| 4 | 1 | 33 | 7 | 5191 | 231 | 11454521.6 | 0.0000 | 0.02 |
| 4 | 2 | 33 | 45 | 3938 | 1485 | 6776787.26 | 0.0002 | 0.22 |
| 4 | 3 | 33 | 12 | 5410 | 396 | 12390099.8 | 0.0000 | 0.03 |
| **4** | **5** | **33** | **193** | **1531** | **6369** | **1125778.27** | **0.0057** | **5.66** |
| 4 | 6 | 33 | 25 | 1135 | 825 | 637517.538 | 0.0013 | 1.29 |
| *4* | *7* | *33* | *403* | *3421* | *13299* | *5186696.56* | *0.0026* | *2.56* |
| 4 | 8 | 33 | 27 | 7008 | 891 | 20259502.5 | 0.0000 | 0.04 |
| 4 | 9 | 33 | 33 | 6753 | 1089 | 18881818.8 | 0.0001 | 0.06 |
| 5 | 1 | 193 | 7 | 6666 | 1351 | 18422310.1 | 0.0001 | 0.07 |
| 5 | 2 | 193 | 45 | 5406 | 8685 | 12372699.9 | 0.0007 | 0.70 |
| 5 | 3 | 193 | 12 | 6877 | 2316 | 19546011.3 | 0.0001 | 0.12 |
| *5* | *4* | *193* | *33* | *1469* | *6369* | *1040738* | *0.0061* | *6.12* |
| 5 | 6 | 193 | 25 | 1450 | 4825 | 1015311.26 | 0.0048 | 4.75 |
| **5** | **7** | **193** | **403** | **1661** | **77779** | **1314323.59** | **0.0592** | **59.18** |
| 5 | 8 | 193 | 27 | 5344 | 5211 | 12104483.3 | 0.0004 | 0.43 |
| 5 | 9 | 193 | 33 | 4964 | 6369 | 10521565.6 | 0.0006 | 0.61 |

*Table 28 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6 | 1 | 25 | 7 | 6767 | 175 | 18956263.4 | 0.0000 | 0.01 |
| 6 | 2 | 25 | 45 | 5514 | 1125 | 12846559.9 | 0.0001 | 0.09 |
| 6 | 3 | 25 | 12 | 6986 | 300 | 20138833.2 | 0.0000 | 0.01 |
| 6 | 4 | 25 | 33 | 1129 | 825 | 631129.514 | 0.0013 | 1.31 |
| **6** | **5** | **25** | **193** | **1365** | **4825** | **905215.616** | **0.0053** | **5.33** |
| *6* | *7* | *25* | *403* | *3574* | *10075* | *5636294.04* | *0.0018* | *1.79* |
| 6 | 8 | 25 | 27 | 6089 | 675 | 15510912.6 | 0.0000 | 0.04 |
| 6 | 9 | 25 | 33 | 5834 | 825 | 14300005.6 | 0.0001 | 0.06 |
| 7 | 1 | 403 | 7 | 8332 | 2821 | 28146448 | 0.0001 | 0.10 |
| 7 | 2 | 403 | 45 | 7679 | 18135 | 24103431.1 | 0.0008 | 0.75 |
| 7 | 3 | 403 | 12 | 8923 | 4836 | 32060529.9 | 0.0002 | 0.15 |
| 7 | 4 | 403 | 33 | 3475 | 13299 | 5343356.33 | 0.0025 | 2.49 |
| **7** | **5** | **403** | **193** | **1788** | **77779** | **1511813.7** | **0.0514** | **51.45** |
| *7* | *6* | *403* | *25* | *3579* | *10075* | *5651285.22* | *0.0018* | *1.78* |
| 7 | 8 | 403 | 27 | 5299 | 10881 | 11911554.6 | 0.0009 | 0.91 |
| 7 | 9 | 403 | 33 | 4919 | 13299 | 10341081.5 | 0.0013 | 1.29 |
| 8 | 1 | 27 | 7 | 12150 | 189 | 57636145.4 | 0.0000 | 0.00 |
| 8 | 2 | 27 | 45 | 10898 | 1215 | 46876904.6 | 0.0000 | 0.03 |
| 8 | 3 | 27 | 12 | 12369 | 324 | 59626006.1 | 0.0000 | 0.01 |
| 8 | 4 | 27 | 33 | 6986 | 891 | 20138833.2 | 0.0000 | 0.04 |
| 8 | 5 | 27 | 193 | 5386 | 5211 | 12285874.2 | 0.0004 | 0.42 |
| 8 | 6 | 27 | 25 | 6171 | 675 | 15910196.3 | 0.0000 | 0.04 |
| *8* | *7* | *27* | *403* | *5296* | *10881* | *11898744.9* | *0.0009* | *0.91* |
| **8** | **9** | **27** | **33** | **474** | **891** | **121332.976** | **0.0073** | **7.34** |
| 9 | 1 | 33 | 7 | 11943 | 231 | 55784753.9 | 0.0000 | 0.00 |
| 9 | 2 | 33 | 45 | 10690 | 1485 | 45191591.9 | 0.0000 | 0.03 |
| 9 | 3 | 33 | 12 | 12161 | 396 | 57735329.4 | 0.0000 | 0.01 |
| 9 | 4 | 33 | 33 | 6779 | 1089 | 19020183.6 | 0.0001 | 0.06 |
| 9 | 5 | 33 | 193 | 5064 | 6369 | 10927933 | 0.0006 | 0.58 |
| 9 | 6 | 33 | 25 | 5963 | 825 | 14906755.8 | 0.0001 | 0.06 |
| *9* | *7* | *33* | *403* | *4910* | *13299* | *10305162.3* | *0.0013* | *1.29* |
| **9** | **8** | **33** | **27** | **469** | **891** | **118912.744** | **0.0075** | **7.49** |

**Bold** = primary
*Italic* = secondary

*Table 29 – Early Urichu Community Interaction Values*

| A | B | | B | | | | | value |
|---|---|---|---|---|---|---|---|---|
| Comm | Comm | A pop | pop | distance | A x B | d^1.9 | Interaction(x1000) | |
| **1** | **2** | **43** | **42** | **1099** | **1806** | **599646.93** | **0.0030** | **3.01** |
| 1 | 3 | 43 | 24 | 2676 | 1032 | 3252547.20 | 0.0003 | 0.32 |
| 1 | 4 | 43 | 8 | 2781 | 344 | 3499305.66 | 0.0001 | 0.10 |
| 1 | 5 | 43 | 48 | 4918 | 2064 | 10337087.59 | 0.0002 | 0.20 |
| *1* | *6* | *43* | *203* | *5678* | *8729* | *13582234.91* | *0.0006* | *0.64* |
| 1 | 7 | 43 | 91 | 7896 | 3913 | 25414031.59 | 0.0002 | 0.15 |
| 1 | 8 | 43 | 55 | 7368 | 2365 | 22282518.34 | 0.0001 | 0.11 |
| 1 | 9 | 43 | 80 | 7141 | 3440 | 20996270.67 | 0.0002 | 0.16 |
| 1 | 10 | 43 | 399 | 8292 | 17157 | 27890266.08 | 0.0006 | 0.62 |
| 1 | 11 | 43 | 166 | 11801 | 7138 | 54531286.00 | 0.0001 | 0.13 |
| 1 | 12 | 43 | 66 | 11158 | 2838 | 49024602.21 | 0.0001 | 0.06 |
| 1 | 13 | 43 | 18 | 12341 | 774 | 59369811.41 | 0.0000 | 0.01 |
| 1 | 14 | 43 | 22 | 11825 | 946 | 54742192.04 | 0.0000 | 0.02 |
| 1 | 15 | 43 | 42 | 11268 | 1806 | 49946952.25 | 0.0000 | 0.04 |
| 1 | 16 | 43 | 12 | 11961 | 516 | 55944607.56 | 0.0000 | 0.01 |
| 1 | 17 | 43 | 12 | 11394 | 516 | 51013463.30 | 0.0000 | 0.01 |
| **2** | **1** | **42** | **43** | **1097** | **1806** | **597575.24** | **0.0030** | **3.02** |
| 2 | 3 | 42 | 24 | 1882 | 1008 | 1666392.40 | 0.0006 | 0.60 |
| 2 | 4 | 42 | 8 | 2889 | 336 | 3762013.33 | 0.0001 | 0.09 |
| 2 | 5 | 42 | 48 | 3946 | 2016 | 6802968.40 | 0.0003 | 0.30 |
| 2 | 6 | 42 | 203 | 5557 | 8526 | 13037573.02 | 0.0007 | 0.65 |
| 2 | 7 | 42 | 91 | 6812 | 3822 | 19196489.45 | 0.0002 | 0.20 |
| 2 | 8 | 42 | 55 | 6284 | 2310 | 16468298.68 | 0.0001 | 0.14 |
| 2 | 9 | 42 | 80 | 6057 | 3360 | 15356399.08 | 0.0002 | 0.22 |
| *2* | *10* | *42* | *399* | *7325* | *16758* | *22036087.85* | *0.0008* | *0.76* |
| 2 | 11 | 42 | 166 | 10834 | 6972 | 46355234.18 | 0.0002 | 0.15 |
| 2 | 12 | 42 | 66 | 10192 | 2772 | 41275551.85 | 0.0001 | 0.07 |
| 2 | 13 | 42 | 18 | 11330 | 756 | 50470409.53 | 0.0000 | 0.01 |
| 2 | 14 | 42 | 22 | 10858 | 924 | 46550536.53 | 0.0000 | 0.02 |
| 2 | 15 | 42 | 42 | 10677 | 1764 | 45087230.68 | 0.0000 | 0.04 |
| 2 | 16 | 42 | 12 | 10950 | 504 | 47302797.57 | 0.0000 | 0.01 |
| 2 | 17 | 42 | 12 | 10428 | 504 | 43110389.11 | 0.0000 | 0.01 |
| 3 | 1 | 24 | 43 | 2682 | 1032 | 3266417.32 | 0.0003 | 0.32 |
| 3 | 2 | 24 | 42 | 1911 | 1008 | 1715518.10 | 0.0006 | 0.59 |
| 3 | 4 | 24 | 8 | 817 | 192 | 341367.29 | 0.0006 | 0.56 |
| 3 | 5 | 24 | 48 | 1861 | 1152 | 1631240.93 | 0.0007 | 0.71 |
| **3** | **6** | **24** | **203** | **3477** | **4872** | **5349200.94** | **0.0009** | **0.91** |
| 3 | 7 | 24 | 91 | 6059 | 2184 | 15366034.71 | 0.0001 | 0.14 |
| 3 | 8 | 24 | 55 | 5531 | 1320 | 12921917.12 | 0.0001 | 0.10 |
| 3 | 9 | 24 | 80 | 5107 | 1920 | 11104912.22 | 0.0002 | 0.17 |
| *3* | *10* | *24* | *399* | *5060* | *9576* | *10911538.32* | *0.0009* | *0.88* |
| 3 | 11 | 24 | 166 | 8754 | 3984 | 30916650.06 | 0.0001 | 0.13 |
| 3 | 12 | 24 | 66 | 8112 | 1584 | 26751189.00 | 0.0001 | 0.06 |

*Table 29 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3 | 13 | 24 | 18 | 9251 | 432 | 34336695.24 | 0.0000 | 0.01 |
| 3 | 14 | 24 | 22 | 8779 | 528 | 31084622.19 | 0.0000 | 0.02 |
| 3 | 15 | 24 | 42 | 8597 | 1008 | 29871646.47 | 0.0000 | 0.03 |
| 3 | 16 | 24 | 12 | 8870 | 288 | 31699679.97 | 0.0000 | 0.01 |
| 3 | 17 | 24 | 12 | 8348 | 288 | 28249231.44 | 0.0000 | 0.01 |
| 4 | 1 | 8 | 43 | 3870 | 344 | 6556179.47 | 0.0001 | 0.05 |
| 4 | 2 | 8 | 42 | 2936 | 336 | 3879149.32 | 0.0001 | 0.09 |
| *4* | *3* | *8* | *24* | *818* | *192* | *342161.61* | *0.0006* | *0.56* |
| **4** | **5** | **8** | **48** | **1134** | **384** | **636450.75** | **0.0006** | **0.60** |
| 4 | 6 | 8 | 203 | 2739 | 1624 | 3399576.84 | 0.0005 | 0.48 |
| 4 | 7 | 8 | 91 | 5483 | 728 | 12709681.49 | 0.0001 | 0.06 |
| 4 | 8 | 8 | 55 | 4955 | 440 | 10485350.48 | 0.0000 | 0.04 |
| 4 | 9 | 8 | 80 | 4531 | 640 | 8846443.70 | 0.0001 | 0.07 |
| 4 | 10 | 8 | 399 | 4322 | 3192 | 8087253.36 | 0.0004 | 0.39 |
| 4 | 11 | 8 | 166 | 8017 | 1328 | 26159086.79 | 0.0001 | 0.05 |
| 4 | 12 | 8 | 66 | 7374 | 528 | 22317007.18 | 0.0000 | 0.02 |
| 4 | 13 | 8 | 18 | 8513 | 144 | 29319529.95 | 0.0000 | 0.00 |
| 4 | 14 | 8 | 22 | 8041 | 176 | 26308077.83 | 0.0000 | 0.01 |
| 4 | 15 | 8 | 42 | 7839 | 336 | 25066590.28 | 0.0000 | 0.01 |
| 4 | 16 | 8 | 12 | 8133 | 96 | 26882921.72 | 0.0000 | 0.00 |
| 4 | 17 | 8 | 12 | 7610 | 96 | 23693588.84 | 0.0000 | 0.00 |
| 5 | 1 | 48 | 43 | 5002 | 2064 | 10675125.91 | 0.0002 | 0.19 |
| 5 | 2 | 48 | 42 | 4069 | 2016 | 7211516.65 | 0.0003 | 0.28 |
| 5 | 3 | 48 | 24 | 1951 | 1152 | 1784386.02 | 0.0006 | 0.65 |
| 5 | 4 | 48 | 8 | 1082 | 384 | 582145.84 | 0.0007 | 0.66 |
| **5** | **6** | **48** | **203** | **2004** | **9744** | **1877611.18** | **0.0052** | **5.19** |
| 5 | 7 | 48 | 91 | 6664 | 4368 | 18411809.72 | 0.0002 | 0.24 |
| 5 | 8 | 48 | 55 | 6135 | 2640 | 15734309.09 | 0.0002 | 0.17 |
| 5 | 9 | 48 | 80 | 5711 | 3840 | 13732610.56 | 0.0003 | 0.28 |
| *5* | *10* | *48* | *399* | *3699* | *19152* | *6016725.93* | *0.0032* | *3.18* |
| 5 | 11 | 48 | 166 | 6996 | 7968 | 20193640.55 | 0.0004 | 0.39 |
| 5 | 12 | 48 | 66 | 6354 | 3168 | 16818594.51 | 0.0002 | 0.19 |
| 5 | 13 | 48 | 18 | 7492 | 864 | 23000419.68 | 0.0000 | 0.04 |
| 5 | 14 | 48 | 22 | 7020 | 1056 | 20325466.08 | 0.0001 | 0.05 |
| 5 | 15 | 48 | 42 | 6839 | 2016 | 19341312.73 | 0.0001 | 0.10 |
| 5 | 16 | 48 | 12 | 7112 | 576 | 20834559.42 | 0.0000 | 0.03 |
| 5 | 17 | 48 | 12 | 6590 | 576 | 18025291.13 | 0.0000 | 0.03 |
| 6 | 1 | 203 | 43 | 6670 | 8729 | 18443319.27 | 0.0005 | 0.47 |
| 6 | 2 | 203 | 42 | 5736 | 8526 | 13847053.53 | 0.0006 | 0.62 |
| 6 | 3 | 203 | 24 | 3618 | 4872 | 5768863.58 | 0.0008 | 0.84 |
| 6 | 4 | 203 | 8 | 2839 | 1624 | 3639269.74 | 0.0004 | 0.45 |
| *6* | *5* | *203* | *48* | *2001* | *9744* | *1872274.27* | *0.0052* | *5.20* |
| 6 | 7 | 203 | 91 | 7778 | 18473 | 24697277.63 | 0.0007 | 0.75 |
| 6 | 8 | 203 | 55 | 7250 | 11165 | 21609375.32 | 0.0005 | 0.52 |
| 6 | 9 | 203 | 80 | 6825 | 16240 | 19266154.82 | 0.0008 | 0.84 |
| **6** | **10** | **203** | **399** | **1754** | **80997** | **1457659.94** | **0.0556** | **55.57** |
| 6 | 11 | 203 | 166 | 5787 | 33698 | 14081911.69 | 0.0024 | 2.39 |

*Table 29 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6 | 12 | 203 | 66 | 4565 | 13398 | 8972996.24 | 0.0015 | 1.49 |
| 6 | 13 | 203 | 18 | 5610 | 3654 | 13274844.31 | 0.0003 | 0.28 |
| 6 | 14 | 203 | 22 | 5247 | 4466 | 11690444.43 | 0.0004 | 0.38 |
| 6 | 15 | 203 | 42 | 5059 | 8526 | 10907441.46 | 0.0008 | 0.78 |
| 6 | 16 | 203 | 12 | 5365 | 2436 | 12195018.96 | 0.0002 | 0.20 |
| 6 | 17 | 203 | 12 | 5501 | 2436 | 12789074.74 | 0.0002 | 0.19 |
| 7 | 1 | 91 | 43 | 7817 | 3913 | 24933096.20 | 0.0002 | 0.16 |
| 7 | 2 | 91 | 42 | 6732 | 3822 | 18770411.94 | 0.0002 | 0.20 |
| 7 | 3 | 91 | 24 | 5987 | 2184 | 15020956.57 | 0.0001 | 0.15 |
| 7 | 4 | 91 | 8 | 5413 | 728 | 12403157.30 | 0.0001 | 0.06 |
| 7 | 5 | 91 | 48 | 6551 | 4368 | 17823149.05 | 0.0002 | 0.25 |
| 7 | 6 | 91 | 203 | 7634 | 18473 | 23835765.04 | 0.0008 | 0.78 |
| **7** | **8** | **91** | **55** | **760** | **5005** | **297540.32** | **0.0168** | **16.82** |
| *7* | *9* | *91* | *80* | *982* | *7280* | *484185.55* | *0.0150* | *15.04* |
| 7 | 10 | 91 | 399 | 6015 | 36309 | 15154712.44 | 0.0024 | 2.40 |
| 7 | 11 | 91 | 166 | 12888 | 15106 | 64469232.81 | 0.0002 | 0.23 |
| 7 | 12 | 91 | 66 | 12246 | 6006 | 58504474.76 | 0.0001 | 0.10 |
| 7 | 13 | 91 | 18 | 13384 | 1638 | 69264908.22 | 0.0000 | 0.02 |
| 7 | 14 | 91 | 22 | 12912 | 2002 | 64697527.37 | 0.0000 | 0.03 |
| 7 | 15 | 91 | 42 | 12711 | 3822 | 62797371.45 | 0.0001 | 0.06 |
| 7 | 16 | 91 | 12 | 12984 | 1092 | 65384704.14 | 0.0000 | 0.02 |
| 7 | 17 | 91 | 12 | 12482 | 1092 | 60665242.60 | 0.0000 | 0.02 |
| 8 | 1 | 55 | 43 | 7293 | 2365 | 21853540.43 | 0.0001 | 0.11 |
| 8 | 2 | 55 | 42 | 6208 | 2310 | 16091934.11 | 0.0001 | 0.14 |
| 8 | 3 | 55 | 24 | 5463 | 1320 | 12621741.49 | 0.0001 | 0.10 |
| 8 | 4 | 55 | 8 | 4889 | 440 | 10221580.91 | 0.0000 | 0.04 |
| 8 | 5 | 55 | 48 | 6026 | 2640 | 15207413.05 | 0.0002 | 0.17 |
| 8 | 6 | 55 | 203 | 7110 | 11165 | 20823428.76 | 0.0005 | 0.54 |
| **8** | **7** | **55** | **91** | **760** | **5005** | **297540.32** | **0.0168** | **16.82** |
| *8* | *9* | *55* | *80* | *1070* | *4400* | *569940.05* | *0.0077* | *7.72* |
| 8 | 10 | 55 | 399 | 7134 | 21945 | 20957182.70 | 0.0010 | 1.05 |
| 8 | 11 | 55 | 166 | 12364 | 9130 | 59580218.71 | 0.0002 | 0.15 |
| 8 | 12 | 55 | 66 | 11721 | 3630 | 53831051.77 | 0.0001 | 0.07 |
| 8 | 13 | 55 | 18 | 12860 | 990 | 64203372.33 | 0.0000 | 0.02 |
| 8 | 14 | 55 | 22 | 12388 | 1210 | 59800150.05 | 0.0000 | 0.02 |
| 8 | 15 | 55 | 42 | 12186 | 2310 | 57961048.11 | 0.0000 | 0.04 |
| 8 | 16 | 55 | 12 | 12460 | 660 | 60462246.62 | 0.0000 | 0.01 |
| 8 | 17 | 55 | 12 | 11958 | 660 | 55917950.24 | 0.0000 | 0.01 |
| 9 | 1 | 80 | 43 | 7135 | 3440 | 20962764.58 | 0.0002 | 0.16 |
| 9 | 2 | 80 | 42 | 6050 | 3360 | 15322696.94 | 0.0002 | 0.22 |
| 9 | 3 | 80 | 24 | 5079 | 1920 | 10989516.98 | 0.0002 | 0.17 |
| 9 | 4 | 80 | 8 | 4505 | 640 | 8750242.94 | 0.0001 | 0.07 |
| 9 | 5 | 80 | 48 | 5642 | 3840 | 13419083.51 | 0.0003 | 0.29 |
| 9 | 6 | 80 | 203 | 6726 | 16240 | 18738638.79 | 0.0009 | 0.87 |
| **9** | **7** | **80** | **91** | **1012** | **7280** | **512675.98** | **0.0142** | **14.20** |
| *9* | *8* | *80* | *55* | *1067* | *4400* | *566907.75* | *0.0078* | *7.76* |
| 9 | 10 | 80 | 399 | 6355 | 31920 | 16823624.03 | 0.0019 | 1.90 |

*Table 29 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 9 | 11 | 80 | 166 | 11980 | 13280 | 56113577.04 | 0.0002 | 0.24 |
| 9 | 12 | 80 | 66 | 11338 | 5280 | 50538140.69 | 0.0001 | 0.10 |
| 9 | 13 | 80 | 18 | 12476 | 1440 | 60609848.10 | 0.0000 | 0.02 |
| 9 | 14 | 80 | 22 | 12004 | 1760 | 56327357.15 | 0.0000 | 0.03 |
| 9 | 15 | 80 | 42 | 11803 | 3360 | 54548846.77 | 0.0001 | 0.06 |
| 9 | 16 | 80 | 12 | 12096 | 960 | 57150413.70 | 0.0000 | 0.02 |
| 9 | 17 | 80 | 12 | 11574 | 960 | 52555552.77 | 0.0000 | 0.02 |
| 10 | 1 | 399 | 43 | 8279 | 17157 | 27807245.87 | 0.0006 | 0.62 |
| 10 | 2 | 399 | 42 | 7346 | 16758 | 22156275.44 | 0.0008 | 0.76 |
| 10 | 3 | 399 | 24 | 5095 | 9576 | 11055387.20 | 0.0009 | 0.87 |
| 10 | 4 | 399 | 8 | 4315 | 3192 | 8062384.76 | 0.0004 | 0.40 |
| 10 | 5 | 399 | 48 | 3682 | 19152 | 5964296.02 | 0.0032 | 3.21 |
| **10** | **6** | **399** | **203** | **1754** | **80997** | **1457659.94** | **0.0556** | **55.57** |
| 10 | 7 | 399 | 91 | 6075 | 36309 | 15443222.77 | 0.0024 | 2.35 |
| 10 | 8 | 399 | 55 | 7103 | 21945 | 20784493.61 | 0.0011 | 1.06 |
| 10 | 9 | 399 | 80 | 6309 | 31920 | 16593003.40 | 0.0019 | 1.92 |
| *10* | *11* | *399* | *166* | *5662* | *66234* | *13509607.88* | *0.0049* | *4.90* |
| 10 | 12 | 399 | 66 | 4634 | 26334 | 9232439.19 | 0.0029 | 2.85 |
| 10 | 13 | 399 | 18 | 5679 | 7182 | 13586780.23 | 0.0005 | 0.53 |
| 10 | 14 | 399 | 22 | 5196 | 8778 | 11475493.48 | 0.0008 | 0.76 |
| 10 | 15 | 399 | 42 | 5268 | 16758 | 11779502.70 | 0.0014 | 1.42 |
| 10 | 16 | 399 | 12 | 5565 | 4788 | 13073257.65 | 0.0004 | 0.37 |
| 10 | 17 | 399 | 12 | 5072 | 4788 | 10960757.40 | 0.0004 | 0.44 |
| 11 | 1 | 166 | 43 | 11864 | 7138 | 55085736.74 | 0.0001 | 0.13 |
| 11 | 2 | 166 | 42 | 10931 | 6972 | 47146971.31 | 0.0001 | 0.15 |
| 11 | 3 | 166 | 24 | 8813 | 3984 | 31313756.00 | 0.0001 | 0.13 |
| 11 | 4 | 166 | 8 | 8033 | 1328 | 26258369.62 | 0.0001 | 0.05 |
| 11 | 5 | 166 | 48 | 6977 | 7968 | 20089566.88 | 0.0004 | 0.40 |
| 11 | 6 | 166 | 203 | 5829 | 33698 | 14276728.65 | 0.0024 | 2.36 |
| 11 | 7 | 166 | 91 | 13040 | 15106 | 65921552.03 | 0.0002 | 0.23 |
| 11 | 8 | 166 | 55 | 12512 | 9130 | 60942574.63 | 0.0001 | 0.15 |
| 11 | 9 | 166 | 80 | 12088 | 13280 | 57078619.08 | 0.0002 | 0.23 |
| 11 | 10 | 166 | 399 | 5495 | 66234 | 12762584.30 | 0.0052 | 5.19 |
| 11 | 12 | 166 | 66 | 1187 | 10956 | 694154.86 | 0.0158 | 15.78 |
| 11 | 13 | 166 | 18 | 676 | 2988 | 238176.40 | 0.0125 | 12.55 |
| 11 | 14 | 166 | 22 | 684 | 3652 | 243560.35 | 0.0150 | 14.99 |
| **11** | **15** | **166** | **42** | **416** | **6972** | **94684.16** | **0.0736** | **73.63** |
| *11* | *16* | *166* | *12* | *291* | *1992* | *48017.18* | *0.0415* | *41.49* |
| 11 | 17 | 166 | 12 | 438 | 1992 | 104424.12 | 0.0191 | 19.08 |
| 12 | 1 | 66 | 43 | 11136 | 2838 | 48841109.64 | 0.0001 | 0.06 |
| 12 | 2 | 66 | 42 | 10202 | 2772 | 41352532.01 | 0.0001 | 0.07 |
| 12 | 3 | 66 | 24 | 8084 | 1584 | 26576022.28 | 0.0001 | 0.06 |
| 12 | 4 | 66 | 8 | 7304 | 528 | 21916209.97 | 0.0000 | 0.02 |
| 12 | 5 | 66 | 48 | 6248 | 3168 | 16289506.96 | 0.0002 | 0.19 |
| 12 | 6 | 66 | 203 | 4512 | 13398 | 8776094.13 | 0.0015 | 1.53 |
| 12 | 7 | 66 | 91 | 11347 | 6006 | 50614389.66 | 0.0001 | 0.12 |
| 12 | 8 | 66 | 55 | 11783 | 3630 | 54373359.57 | 0.0001 | 0.07 |

*Table 29 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 9 | 66 | 80 | 11359 | 5280 | 50716139.66 | 0.0001 | 0.10 |
| 12 | 10 | 66 | 399 | 4626 | 26334 | 9202179.36 | 0.0029 | 2.86 |
| **12** | **11** | **66** | **166** | **1211** | **10956** | **721064.10** | **0.0152** | **15.19** |
| 12 | 13 | 66 | 18 | 1035 | 1188 | 535040.51 | 0.0022 | 2.22 |
| 12 | 14 | 66 | 22 | 672 | 1452 | 235505.81 | 0.0062 | 6.17 |
| *12* | *15* | *66* | *42* | *817* | *2772* | *341367.29* | *0.0081* | *8.12* |
| 12 | 16 | 66 | 12 | 1114 | 792 | 615292.84 | 0.0013 | 1.29 |
| 12 | 17 | 66 | 12 | 721 | 792 | 269201.21 | 0.0029 | 2.94 |
| 13 | 1 | 18 | 43 | 12392 | 774 | 59836842.59 | 0.0000 | 0.01 |
| 13 | 2 | 18 | 42 | 11459 | 756 | 51567819.37 | 0.0000 | 0.01 |
| 13 | 3 | 18 | 24 | 9340 | 432 | 34967055.66 | 0.0000 | 0.01 |
| 13 | 4 | 18 | 8 | 8561 | 144 | 29634427.69 | 0.0000 | 0.00 |
| 13 | 5 | 18 | 48 | 7505 | 864 | 23076307.82 | 0.0000 | 0.04 |
| 13 | 6 | 18 | 203 | 7830 | 3654 | 25011938.26 | 0.0001 | 0.15 |
| 13 | 7 | 18 | 91 | 13568 | 1638 | 71085346.77 | 0.0000 | 0.02 |
| 13 | 8 | 18 | 55 | 13040 | 990 | 65921552.03 | 0.0000 | 0.02 |
| 13 | 9 | 18 | 80 | 12616 | 1440 | 61908629.88 | 0.0000 | 0.02 |
| 13 | 10 | 18 | 399 | 7880 | 7182 | 25316275.50 | 0.0003 | 0.28 |
| **13** | **11** | **18** | **166** | **664** | **2988** | **230207.44** | **0.0130** | **12.98** |
| 13 | 12 | 18 | 66 | 2341 | 1188 | 2522683.03 | 0.0005 | 0.47 |
| *13* | *14* | *18* | *22* | *280* | *396* | *44627.26* | *0.0089* | *8.87* |
| 13 | 15 | 18 | 42 | 688 | 756 | 246273.70 | 0.0031 | 3.07 |
| 13 | 16 | 18 | 12 | 376 | 216 | 78137.03 | 0.0028 | 2.76 |
| 13 | 17 | 18 | 12 | 921 | 216 | 428640.59 | 0.0005 | 0.50 |
| 14 | 1 | 22 | 43 | 11823 | 946 | 54724601.81 | 0.0000 | 0.02 |
| 14 | 2 | 22 | 42 | 10890 | 924 | 46811544.61 | 0.0000 | 0.02 |
| 14 | 3 | 22 | 24 | 8771 | 528 | 31030824.20 | 0.0000 | 0.02 |
| 14 | 4 | 22 | 8 | 7992 | 176 | 26004314.09 | 0.0000 | 0.01 |
| 14 | 5 | 22 | 48 | 6936 | 1056 | 19865854.97 | 0.0001 | 0.05 |
| 14 | 6 | 22 | 203 | 5200 | 4466 | 11492284.08 | 0.0004 | 0.39 |
| 14 | 7 | 22 | 91 | 12999 | 2002 | 65528298.78 | 0.0000 | 0.03 |
| 14 | 8 | 22 | 55 | 12471 | 1210 | 60563704.32 | 0.0000 | 0.02 |
| 14 | 9 | 22 | 80 | 12047 | 1760 | 56711342.68 | 0.0000 | 0.03 |
| 14 | 10 | 22 | 399 | 5314 | 8778 | 11975701.02 | 0.0007 | 0.73 |
| **14** | **11** | **22** | **166** | **726** | **3652** | **272759.31** | **0.0134** | **13.39** |
| 14 | 12 | 22 | 66 | 682 | 1452 | 242209.02 | 0.0060 | 5.99 |
| *14* | *13* | *22* | *18* | *300* | *396* | *50878.04* | *0.0078* | *7.78* |
| 14 | 15 | 22 | 42 | 513 | 924 | 141001.26 | 0.0066 | 6.55 |
| 14 | 16 | 22 | 12 | 423 | 264 | 97734.23 | 0.0027 | 2.70 |
| 14 | 17 | 22 | 12 | 709 | 264 | 260752.12 | 0.0010 | 1.01 |
| 15 | 1 | 42 | 43 | 11902 | 1806 | 55421451.68 | 0.0000 | 0.03 |
| 15 | 2 | 42 | 42 | 10969 | 1764 | 47458867.37 | 0.0000 | 0.04 |
| 15 | 3 | 42 | 24 | 8851 | 1008 | 31570789.85 | 0.0000 | 0.03 |
| 15 | 4 | 42 | 8 | 8071 | 336 | 26494880.18 | 0.0000 | 0.01 |
| 15 | 5 | 42 | 48 | 7015 | 2016 | 20297968.92 | 0.0001 | 0.10 |
| 15 | 6 | 42 | 203 | 5867 | 8526 | 14454083.78 | 0.0006 | 0.59 |
| 15 | 7 | 42 | 91 | 13079 | 3822 | 66296656.37 | 0.0001 | 0.06 |

*Table 29 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 15 | 8 | 42 | 55 | 12550 | 2310 | 61294721.91 | 0.0000 | 0.04 |
| 15 | 9 | 42 | 80 | 12126 | 3360 | 57420024.23 | 0.0001 | 0.06 |
| 15 | 10 | 42 | 399 | 5135 | 16758 | 11220878.27 | 0.0015 | 1.49 |
| **15** | **11** | **42** | **166** | **409** | **6972** | **91679.93** | **0.0760** | **76.05** |
| 15 | 12 | 42 | 66 | 798 | 2772 | 326441.60 | 0.0085 | 8.49 |
| 15 | 13 | 42 | 18 | 688 | 756 | 246273.70 | 0.0031 | 3.07 |
| 15 | 14 | 42 | 22 | 500 | 924 | 134289.79 | 0.0069 | 6.88 |
| 15 | 16 | 42 | 12 | 308 | 504 | 53486.77 | 0.0094 | 9.42 |
| *15* | *17* | *42* | *12* | *264* | *504* | *39906.85* | *0.0126* | *12.63* |
| 16 | 1 | 12 | 43 | 12033 | 516 | 56586188.47 | 0.0000 | 0.01 |
| 16 | 2 | 12 | 42 | 11099 | 504 | 48533243.64 | 0.0000 | 0.01 |
| 16 | 3 | 12 | 24 | 8981 | 288 | 32457638.81 | 0.0000 | 0.01 |
| 16 | 4 | 12 | 8 | 8201 | 96 | 27311587.38 | 0.0000 | 0.00 |
| 16 | 5 | 12 | 48 | 7145 | 576 | 21018622.15 | 0.0000 | 0.03 |
| 16 | 6 | 12 | 203 | 5207 | 2436 | 11521695.61 | 0.0002 | 0.21 |
| 16 | 7 | 12 | 91 | 13208 | 1092 | 67544565.84 | 0.0000 | 0.02 |
| 16 | 8 | 12 | 55 | 12680 | 660 | 62506701.51 | 0.0000 | 0.01 |
| 16 | 9 | 12 | 80 | 12256 | 960 | 58595279.39 | 0.0000 | 0.02 |
| 16 | 10 | 12 | 399 | 5256 | 4788 | 11728573.06 | 0.0004 | 0.41 |
| **16** | **11** | **12** | **166** | **286** | **1992** | **46461.74** | **0.0429** | **42.87** |
| 16 | 12 | 12 | 66 | 1040 | 792 | 539962.18 | 0.0015 | 1.47 |
| 16 | 13 | 12 | 18 | 378 | 216 | 78928.60 | 0.0027 | 2.74 |
| 16 | 14 | 12 | 22 | 415 | 264 | 94252.18 | 0.0028 | 2.80 |
| *16* | *15* | *12* | *42* | *310* | *504* | *54148.60* | *0.0093* | *9.31* |
| 16 | 17 | 12 | 12 | 543 | 144 | 157079.56 | 0.0009 | 0.92 |
| 17 | 1 | 12 | 43 | 11506 | 516 | 51970429.07 | 0.0000 | 0.01 |
| 17 | 2 | 12 | 42 | 10573 | 504 | 44256456.81 | 0.0000 | 0.01 |
| 17 | 3 | 12 | 24 | 8455 | 288 | 28941155.23 | 0.0000 | 0.01 |
| 17 | 4 | 12 | 8 | 7675 | 96 | 24079581.23 | 0.0000 | 0.00 |
| 17 | 5 | 12 | 48 | 6619 | 576 | 18176301.76 | 0.0000 | 0.03 |
| 17 | 6 | 12 | 203 | 5470 | 2436 | 12652487.59 | 0.0002 | 0.19 |
| 17 | 7 | 12 | 91 | 12682 | 1092 | 62525435.14 | 0.0000 | 0.02 |
| 17 | 8 | 12 | 55 | 12154 | 660 | 57672202.95 | 0.0000 | 0.01 |
| 17 | 9 | 12 | 80 | 11730 | 960 | 53909614.10 | 0.0000 | 0.02 |
| 17 | 10 | 12 | 399 | 5061 | 4788 | 10915635.90 | 0.0004 | 0.44 |
| **17** | **11** | **12** | **166** | **430** | **1992** | **100830.07** | **0.0198** | **19.76** |
| 17 | 12 | 12 | 66 | 725 | 792 | 272045.92 | 0.0029 | 2.91 |
| 17 | 13 | 12 | 18 | 927 | 216 | 433961.79 | 0.0005 | 0.50 |
| 17 | 14 | 12 | 22 | 697 | 264 | 252430.76 | 0.0010 | 1.05 |
| *17* | *15* | *12* | *42* | *246* | *504* | *34896.08* | *0.0144* | *14.44* |
| 17 | 16 | 12 | 12 | 547 | 144 | 159285.38 | 0.0009 | 0.90 |

**Bold** = primary
*Italic* = secondary

*Table 30 – Late Urichu Community Interaction Values*

**Bold** = Primary *Italic* = Secondary

| A Comm | B Comm | A pop | B pop | distance | A x B | d^1.9 | interaction | value (x1000) |
|---|---|---|---|---|---|---|---|---|
| **1** | **2** | **62** | **271** | **1020** | **16802** | **520403.6409** | **0.0323** | **32.29** |
| 1 | 3 | 62 | 43 | 6846 | 2666 | 19378943.66 | 0.0001 | 0.14 |
| 1 | 5 | 62 | 97 | 9065 | 6014 | 33036865.56 | 0.0002 | 0.18 |
| 1 | 6 | 62 | 156 | 9570 | 9672 | 36621209.33 | 0.0003 | 0.26 |
| 1 | 7 | 62 | 27 | 10117 | 1674 | 40700366.97 | 0.0000 | 0.04 |
| 1 | 9 | 62 | 9 | 2651 | 558 | 3195056.06 | 0.0002 | 0.17 |
| 1 | 10 | 62 | 48 | 2970 | 2976 | 3964945.788 | 0.0008 | 0.75 |
| 1 | 11 | 62 | 16 | 2332 | 992 | 2504287.799 | 0.0004 | 0.40 |
| 1 | 12 | 62 | 66 | 2376 | 4092 | 2594825.929 | 0.0016 | 1.58 |
| 1 | 13 | 62 | 66 | 2559 | 4092 | 2987676.308 | 0.0014 | 1.37 |
| 1 | 14 | 62 | 136 | 1847 | 8432 | 1608003.913 | 0.0052 | 5.24 |
| 1 | 15 | 62 | 232 | 3793 | 14384 | 6310552.747 | 0.0023 | 2.28 |
| 1 | 16 | 62 | 180 | 4294 | 11160 | 7987996.689 | 0.0014 | 1.40 |
| 1 | 17 | 62 | 62 | 7134 | 3844 | 20957182.7 | 0.0002 | 0.18 |
| 1 | 18 | 62 | 28 | 6856 | 1736 | 19432762.23 | 0.0001 | 0.09 |
| 1 | 19 | 62 | 242 | 6421 | 15004 | 17157147.02 | 0.0009 | 0.87 |
| 1 | 20 | 62 | 300 | 5245 | 18600 | 11681979.39 | 0.0016 | 1.59 |
| 1 | 21 | 62 | 64 | 4787 | 3968 | 9820204.057 | 0.0004 | 0.40 |
| 1 | 22 | 62 | 84 | 5923 | 5208 | 14717338.95 | 0.0004 | 0.35 |
| 1 | 23 | 62 | 94 | 5387 | 5828 | 12290208.58 | 0.0005 | 0.47 |
| 1 | 24 | 62 | 149 | 2335 | 9238 | 2510412.457 | 0.0037 | 3.68 |
| 1 | 25 | 62 | 24 | 2170 | 1488 | 2184104.906 | 0.0007 | 0.68 |
| 1 | 26 | 62 | 95 | 2349 | 5890 | 2539087.877 | 0.0023 | 2.32 |
| 1 | 27 | 62 | 108 | 834 | 6696 | 354989.4907 | 0.0189 | 18.86 |
| 1 | 28 | 62 | 272 | 9715 | 16864 | 37682640.7 | 0.0004 | 0.45 |
| 1 | 29 | 62 | 108 | 5167 | 6696 | 11354109.46 | 0.0006 | 0.59 |
| 1 | 30 | 62 | 230 | 12424 | 14260 | 60130766.67 | 0.0002 | 0.24 |
| 1 | 31 | 62 | 37 | 13103 | 2294 | 66527990.85 | 0.0000 | 0.03 |
| 1 | 32 | 62 | 57 | 13609 | 3534 | 71494034.7 | 0.0000 | 0.05 |
| 1 | 33 | 62 | 142 | 12892 | 8804 | 64507255.36 | 0.0001 | 0.14 |
| 1 | 34 | 62 | 27 | 12078 | 1674 | 56988935.92 | 0.0000 | 0.03 |
| 1 | 35 | 62 | 81 | 12639 | 5022 | 62123248.34 | 0.0001 | 0.08 |
| 1 | 36 | 62 | 331 | 9035 | 20522 | 32829441.77 | 0.0006 | 0.63 |
| 1 | 37 | 62 | 180 | 5592 | 11160 | 13194034.31 | 0.0008 | 0.85 |
| *1* | *2* | *62* | *336* | *1438* | *20832* | *999405.8414* | *0.0208* | *20.84* |
| 1 | 39 | 62 | 121 | 5806 | 7502 | 14169886.12 | 0.0005 | 0.53 |
| 1 | 40 | 62 | 351 | 4637 | 21762 | 9243798.76 | 0.0024 | 2.35 |
| 1 | 41 | 62 | 58 | 6797 | 3596 | 19116254.9 | 0.0002 | 0.19 |
| 1 | 42 | 62 | 271 | 4892 | 16802 | 10233501.37 | 0.0016 | 1.64 |
| 1 | 43 | 62 | 179 | 6597 | 11098 | 18061687.33 | 0.0006 | 0.61 |
| 1 | 44 | 62 | 159 | 7840 | 9858 | 25072666.22 | 0.0004 | 0.39 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2 | 3 | 336 | 43 | 7558 | 14448 | 23386923.03 | 0.0006 | 0.62 |
| 2 | 4 | 336 | 62 | 1438 | 20832 | 999405.8414 | 0.0208 | 20.84 |
| 2 | 5 | 336 | 97 | 7436 | 32592 | 22674870.95 | 0.0014 | 1.44 |
| 2 | 6 | 336 | 156 | 8599 | 52416 | 29884851.56 | 0.0018 | 1.75 |
| 2 | 7 | 336 | 27 | 8995 | 9072 | 32553839.55 | 0.0003 | 0.28 |
| 2 | 9 | 336 | 9 | 2870 | 3024 | 3715143.589 | 0.0008 | 0.81 |
| 2 | 10 | 336 | 48 | 3396 | 16128 | 5114917.049 | 0.0032 | 3.15 |
| 2 | 11 | 336 | 16 | 2749 | 5376 | 3423197.889 | 0.0016 | 1.57 |
| 2 | 12 | 336 | 66 | 2843 | 22176 | 3649018.233 | 0.0061 | 6.08 |
| 2 | 13 | 336 | 66 | 2979 | 22176 | 3987805.391 | 0.0056 | 5.56 |
| 2 | 14 | 336 | 136 | 1667 | 45696 | 1323358.891 | 0.0345 | 34.53 |
| 2 | 15 | 336 | 232 | 3658 | 77952 | 5890647.461 | 0.0132 | 13.23 |
| 2 | 16 | 336 | 180 | 3674 | 60480 | 5939698.337 | 0.0102 | 10.18 |
| 2 | 17 | 336 | 62 | 5681 | 20832 | 13595873.01 | 0.0015 | 1.53 |
| 2 | 18 | 336 | 28 | 5417 | 9408 | 12420577.46 | 0.0008 | 0.76 |
| 2 | 19 | 336 | 242 | 5173 | 81312 | 11379173.23 | 0.0071 | 7.15 |
| 2 | 20 | 336 | 300 | 4116 | 100800 | 7370605.987 | 0.0137 | 13.68 |
| 2 | 21 | 336 | 64 | 3697 | 21504 | 6010546.427 | 0.0036 | 3.58 |
| 2 | 22 | 336 | 84 | 5676 | 28224 | 13573146.45 | 0.0021 | 2.08 |
| 2 | 23 | 336 | 94 | 4486 | 31584 | 8680257.557 | 0.0036 | 3.64 |
| 2 | 24 | 336 | 149 | 2366 | 50064 | 2574115.363 | 0.0194 | 19.45 |
| 2 | 25 | 336 | 24 | 2530 | 8064 | 2923674.3 | 0.0028 | 2.76 |
| 2 | 26 | 336 | 95 | 1592 | 31920 | 1212528.124 | 0.0263 | 26.33 |
| **2** | **27** | **336** | **108** | **588** | **36288** | **182732.9728** | **0.1986** | **198.58** |
| 2 | 28 | 336 | 272 | 8626 | 91392 | 30063390.79 | 0.0030 | 3.04 |
| 2 | 29 | 336 | 108 | 4921 | 36288 | 10349071.65 | 0.0035 | 3.51 |
| 2 | 30 | 336 | 230 | 12507 | 77280 | 60896311.02 | 0.0013 | 1.27 |
| 2 | 31 | 336 | 37 | 13185 | 12432 | 67321262.96 | 0.0002 | 0.18 |
| 2 | 32 | 336 | 57 | 12585 | 19152 | 61619918.25 | 0.0003 | 0.31 |
| 2 | 33 | 336 | 142 | 11868 | 47712 | 55121029.65 | 0.0009 | 0.87 |
| 2 | 34 | 336 | 27 | 12161 | 9072 | 57735329.42 | 0.0002 | 0.16 |
| 2 | 35 | 336 | 81 | 12721 | 27216 | 62891272.2 | 0.0004 | 0.43 |
| 2 | 36 | 336 | 331 | 7849 | 111216 | 25127381.02 | 0.0044 | 4.43 |
| 2 | 37 | 336 | 180 | 5352 | 60480 | 12138935.37 | 0.0050 | 4.98 |
| *2* | *38* | *336* | *271* | *1963* | *91056* | *1805296.621* | *0.0504* | *50.44* |
| 2 | 39 | 336 | 121 | 5853 | 40656 | 14388621.75 | 0.0028 | 2.83 |
| 2 | 40 | 336 | 351 | 4337 | 117936 | 8140665.353 | 0.0145 | 14.49 |
| 2 | 41 | 336 | 58 | 6007 | 19488 | 15116439.17 | 0.0013 | 1.29 |
| 2 | 42 | 336 | 271 | 4269 | 91056 | 7899865.444 | 0.0115 | 11.53 |
| 2 | 43 | 336 | 179 | 5967 | 60144 | 14925760.61 | 0.0040 | 4.03 |
| 2 | 44 | 336 | 159 | 6674 | 53424 | 18464339.82 | 0.0029 | 2.89 |
| 3 | 2 | 43 | 336 | 7558 | 14448 | 23386923.03 | 0.0006 | 0.62 |
| 3 | 4 | 43 | 62 | 6846 | 2666 | 19378943.66 | 0.0001 | 0.14 |
| 3 | 5 | 43 | 97 | 5116 | 4171 | 11142124.79 | 0.0004 | 0.37 |
| 3 | 6 | 43 | 156 | 5621 | 6708 | 13324343.25 | 0.0005 | 0.50 |
| 3 | 7 | 43 | 27 | 6913 | 1161 | 19740877.71 | 0.0001 | 0.06 |
| 3 | 9 | 43 | 9 | 6800 | 387 | 19132289.08 | 0.0000 | 0.02 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3 | 10 | 43 | 48 | 7226 | 2064 | 21473662.29 | 0.0001 | 0.10 |
| 3 | 11 | 43 | 16 | 7125 | 688 | 20906977.43 | 0.0000 | 0.03 |
| 3 | 12 | 43 | 66 | 7527 | 2838 | 23205003.62 | 0.0001 | 0.12 |
| 3 | 13 | 43 | 66 | 7940 | 2838 | 25683780.79 | 0.0001 | 0.11 |
| 3 | 14 | 43 | 136 | 4995 | 5848 | 10646759.3 | 0.0005 | 0.55 |
| 3 | 15 | 43 | 232 | 4586 | 9976 | 9051586.286 | 0.0011 | 1.10 |
| 3 | 16 | 43 | 180 | 4112 | 7740 | 7357002.462 | 0.0011 | 1.05 |
| 3 | 17 | 43 | 62 | 6271 | 2666 | 16403628.36 | 0.0002 | 0.16 |
| 3 | 18 | 43 | 28 | 5998 | 1204 | 15073436.53 | 0.0001 | 0.08 |
| 3 | 19 | 43 | 242 | 4979 | 10406 | 10582055.62 | 0.0010 | 0.98 |
| 3 | 20 | 43 | 300 | 3465 | 12900 | 5314178.696 | 0.0024 | 2.43 |
| 3 | 21 | 43 | 64 | 3844 | 2752 | 6472743.84 | 0.0004 | 0.43 |
| 3 | 22 | 43 | 84 | 2649 | 3612 | 3190477.754 | 0.0011 | 1.13 |
| 3 | 23 | 43 | 94 | 2732 | 4042 | 3383088.201 | 0.0012 | 1.19 |
| 3 | 24 | 43 | 149 | 6077 | 6407 | 15452884.16 | 0.0004 | 0.41 |
| 3 | 25 | 43 | 24 | 6663 | 1032 | 18406560.61 | 0.0001 | 0.06 |
| 3 | 26 | 43 | 95 | 6062 | 4085 | 15380493.51 | 0.0003 | 0.27 |
| 3 | 27 | 43 | 108 | 7252 | 4644 | 21620703.02 | 0.0002 | 0.21 |
| **3** | **28** | **43** | **272** | **2344** | **11696** | **2528828.946** | **0.0046** | **4.63** |
| 3 | 29 | 43 | 108 | 2695 | 4644 | 3296565.142 | 0.0014 | 1.41 |
| 3 | 30 | 43 | 230 | 4460 | 9890 | 8584919.587 | 0.0012 | 1.15 |
| 3 | 31 | 43 | 37 | 4700 | 1591 | 9483877.377 | 0.0002 | 0.17 |
| 3 | 32 | 43 | 57 | 6381 | 2451 | 16954641.64 | 0.0001 | 0.14 |
| 3 | 33 | 43 | 142 | 5648 | 6106 | 13446210.54 | 0.0005 | 0.45 |
| 3 | 34 | 43 | 27 | 4088 | 1161 | 7275631.349 | 0.0002 | 0.16 |
| 3 | 35 | 43 | 81 | 4367 | 3483 | 8247988.84 | 0.0004 | 0.42 |
| 3 | 36 | 43 | 331 | 7797 | 14233 | 24812031 | 0.0006 | 0.57 |
| 3 | 37 | 43 | 180 | 7564 | 7740 | 23422210.96 | 0.0003 | 0.33 |
| 3 | 38 | 43 | 271 | 7674 | 11653 | 24073620.52 | 0.0005 | 0.48 |
| *3* | *39* | *43* | *121* | *1683* | *5203* | *1347596.332* | *0.0039* | *3.86* |
| 3 | 40 | 43 | 351 | 4694 | 15093 | 9460887.145 | 0.0016 | 1.60 |
| 3 | 41 | 43 | 58 | 6597 | 2494 | 18061687.33 | 0.0001 | 0.14 |
| 3 | 42 | 43 | 271 | 6448 | 11653 | 17294481.84 | 0.0007 | 0.67 |
| 3 | 43 | 43 | 179 | 7904 | 7697 | 25462976.55 | 0.0003 | 0.30 |
| 3 | 44 | 43 | 159 | 8367 | 6837 | 28371517.22 | 0.0002 | 0.24 |
| *4* | *2* | *62* | *336* | *1438* | *20832* | *999405.8414* | *0.0208* | *20.84* |
| 4 | 3 | 62 | 43 | 6846 | 2666 | 19378943.66 | 0.0001 | 0.14 |
| 4 | 5 | 62 | 97 | 9065 | 6014 | 33036865.56 | 0.0002 | 0.18 |
| 4 | 6 | 62 | 156 | 9570 | 9672 | 36621209.33 | 0.0003 | 0.26 |
| 4 | 7 | 62 | 27 | 10117 | 1674 | 40700366.97 | 0.0000 | 0.04 |
| 4 | 9 | 62 | 9 | 2651 | 558 | 3195056.06 | 0.0002 | 0.17 |
| 4 | 10 | 62 | 48 | 2970 | 2976 | 3964945.788 | 0.0008 | 0.75 |
| 4 | 11 | 62 | 16 | 2332 | 992 | 2504287.799 | 0.0004 | 0.40 |
| 4 | 12 | 62 | 66 | 2376 | 4092 | 2594825.929 | 0.0016 | 1.58 |
| 4 | 13 | 62 | 66 | 2559 | 4092 | 2987676.308 | 0.0014 | 1.37 |
| 4 | 14 | 62 | 136 | 1847 | 8432 | 1608003.913 | 0.0052 | 5.24 |
| 4 | 15 | 62 | 232 | 3793 | 14384 | 6310552.747 | 0.0023 | 2.28 |
| 4 | 16 | 62 | 180 | 4294 | 11160 | 7987996.689 | 0.0014 | 1.40 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4 | 17 | 62 | 62 | 7134 | 3844 | 20957182.7 | 0.0002 | 0.18 |
| 4 | 18 | 62 | 28 | 6856 | 1736 | 19432762.23 | 0.0001 | 0.09 |
| 4 | 19 | 62 | 242 | 6421 | 15004 | 17157147.02 | 0.0009 | 0.87 |
| 4 | 20 | 62 | 300 | 5245 | 18600 | 11681979.39 | 0.0016 | 1.59 |
| 4 | 21 | 62 | 64 | 4787 | 3968 | 9820204.057 | 0.0004 | 0.40 |
| 4 | 22 | 62 | 84 | 5923 | 5208 | 14717338.95 | 0.0004 | 0.35 |
| 4 | 23 | 62 | 94 | 5387 | 5828 | 12290208.58 | 0.0005 | 0.47 |
| 4 | 24 | 62 | 149 | 2335 | 9238 | 2510412.457 | 0.0037 | 3.68 |
| 4 | 25 | 62 | 24 | 2170 | 1488 | 2184104.906 | 0.0007 | 0.68 |
| 4 | 26 | 62 | 95 | 2349 | 5890 | 2539087.877 | 0.0023 | 2.32 |
| 4 | 27 | 62 | 108 | 834 | 6696 | 354989.4907 | 0.0189 | 18.86 |
| 4 | 28 | 62 | 272 | 9715 | 16864 | 37682640.7 | 0.0004 | 0.45 |
| 4 | 29 | 62 | 108 | 5167 | 6696 | 11354109.46 | 0.0006 | 0.59 |
| 4 | 30 | 62 | 230 | 12424 | 14260 | 60130766.67 | 0.0002 | 0.24 |
| 4 | 31 | 62 | 37 | 13103 | 2294 | 66527990.85 | 0.0000 | 0.03 |
| 4 | 32 | 62 | 57 | 13609 | 3534 | 71494034.7 | 0.0000 | 0.05 |
| 4 | 33 | 62 | 142 | 12892 | 8804 | 64507255.36 | 0.0001 | 0.14 |
| 4 | 34 | 62 | 27 | 12078 | 1674 | 56988935.92 | 0.0000 | 0.03 |
| 4 | 35 | 62 | 81 | 12639 | 5022 | 62123248.34 | 0.0001 | 0.08 |
| 4 | 36 | 62 | 331 | 9035 | 20522 | 32829441.77 | 0.0006 | 0.63 |
| 4 | 37 | 62 | 180 | 5592 | 11160 | 13194034.31 | 0.0008 | 0.85 |
| **4** | **38** | **62** | **271** | **1020** | **16802** | **520403.6409** | **0.0323** | **32.29** |
| 4 | 39 | 62 | 121 | 5806 | 7502 | 14169886.12 | 0.0005 | 0.53 |
| 4 | 40 | 62 | 351 | 4637 | 21762 | 9243798.76 | 0.0024 | 2.35 |
| 4 | 41 | 62 | 58 | 6797 | 3596 | 19116254.9 | 0.0002 | 0.19 |
| 4 | 42 | 62 | 271 | 4892 | 16802 | 10233501.37 | 0.0016 | 1.64 |
| 4 | 43 | 62 | 179 | 6597 | 11098 | 18061687.33 | 0.0006 | 0.61 |
| 4 | 44 | 62 | 159 | 7840 | 9858 | 25072666.22 | 0.0004 | 0.39 |
| 5 | 2 | 97 | 336 | 7436 | 32592 | 22674870.95 | 0.0014 | 1.44 |
| 5 | 3 | 97 | 43 | 5116 | 4171 | 11142124.79 | 0.0004 | 0.37 |
| 5 | 4 | 97 | 62 | 9065 | 6014 | 33036865.56 | 0.0002 | 0.18 |
| **5** | **6** | **97** | **156** | **845** | **15132** | **363938.2873** | **0.0416** | **41.58** |
| 5 | 7 | 97 | 27 | 2512 | 2619 | 2884279.257 | 0.0009 | 0.91 |
| 5 | 9 | 97 | 9 | 6716 | 873 | 18685740.2 | 0.0000 | 0.05 |
| 5 | 10 | 97 | 48 | 6276 | 4656 | 16428487.3 | 0.0003 | 0.28 |
| 5 | 11 | 97 | 16 | 6797 | 1552 | 19116254.9 | 0.0001 | 0.08 |
| 5 | 12 | 97 | 66 | 7095 | 6402 | 20740038.57 | 0.0003 | 0.31 |
| 5 | 13 | 97 | 66 | 6759 | 6402 | 18913706.62 | 0.0003 | 0.34 |
| 5 | 14 | 97 | 136 | 6028 | 13192 | 15217004.29 | 0.0009 | 0.87 |
| 5 | 15 | 97 | 232 | 4224 | 22504 | 7742396.85 | 0.0029 | 2.91 |
| 5 | 16 | 97 | 180 | 3897 | 17460 | 6643359.751 | 0.0026 | 2.63 |
| 5 | 17 | 97 | 62 | 3296 | 6014 | 4832542.54 | 0.0012 | 1.24 |
| 5 | 18 | 97 | 28 | 3083 | 2716 | 4256471.178 | 0.0006 | 0.64 |
| 5 | 19 | 97 | 242 | 2600 | 23474 | 3079281.276 | 0.0076 | 7.62 |
| *5* | *20* | *97* | *300* | *2772* | *29100* | *3477820.229* | *0.0084* | *8.37* |
| 5 | 21 | 97 | 64 | 3291 | 6208 | 4818623.301 | 0.0013 | 1.29 |
| 5 | 22 | 97 | 84 | 3262 | 8148 | 4738266.872 | 0.0017 | 1.72 |
| 5 | 23 | 97 | 94 | 2517 | 9118 | 2895196.93 | 0.0031 | 3.15 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 5 | 24 | 97 | 149 | 5492 | 14453 | 12749348.84 | 0.0011 | 1.13 |
| 5 | 25 | 97 | 24 | 5905 | 2328 | 14632475.77 | 0.0002 | 0.16 |
| 5 | 26 | 97 | 95 | 5912 | 9215 | 14665450.5 | 0.0006 | 0.63 |
| 5 | 27 | 97 | 108 | 7122 | 10476 | 20890255.02 | 0.0005 | 0.50 |
| 5 | 28 | 97 | 272 | 4167 | 26384 | 7545093.932 | 0.0035 | 3.50 |
| 5 | 29 | 97 | 108 | 2486 | 10476 | 2827822.438 | 0.0037 | 3.70 |
| 5 | 30 | 97 | 230 | 9188 | 22310 | 33893769.71 | 0.0007 | 0.66 |
| 5 | 31 | 97 | 37 | 9117 | 3589 | 33397865.71 | 0.0001 | 0.11 |
| 5 | 32 | 97 | 57 | 8693 | 5529 | 30508607.9 | 0.0002 | 0.18 |
| 5 | 33 | 97 | 142 | 8020 | 13774 | 26177688.75 | 0.0005 | 0.53 |
| 5 | 34 | 97 | 27 | 8816 | 2619 | 31334011.96 | 0.0001 | 0.08 |
| 5 | 35 | 97 | 81 | 8782 | 7857 | 31104807.81 | 0.0003 | 0.25 |
| 5 | 36 | 97 | 331 | 3185 | 32107 | 4528015.759 | 0.0071 | 7.09 |
| 5 | 37 | 97 | 180 | 6151 | 17460 | 15812366.84 | 0.0011 | 1.10 |
| 5 | 38 | 97 | 271 | 7975 | 26287 | 25899317.18 | 0.0010 | 1.01 |
| 5 | 39 | 97 | 121 | 3560 | 11737 | 5594419.077 | 0.0021 | 2.10 |
| 5 | 40 | 97 | 351 | 3343 | 34047 | 4964312.538 | 0.0069 | 6.86 |
| 5 | 41 | 97 | 58 | 3607 | 5626 | 5735584.341 | 0.0010 | 0.98 |
| 5 | 42 | 97 | 271 | 5035 | 26287 | 10809335.64 | 0.0024 | 2.43 |
| 5 | 43 | 97 | 179 | 5679 | 17363 | 13586780.23 | 0.0013 | 1.28 |
| 5 | 44 | 97 | 159 | 5077 | 15423 | 10981296.31 | 0.0014 | 1.40 |
| 6 | 2 | 156 | 336 | 8599 | 52416 | 29884851.56 | 0.0018 | 1.75 |
| 6 | 3 | 156 | 43 | 5621 | 6708 | 13324343.25 | 0.0005 | 0.50 |
| 6 | 4 | 156 | 62 | 9570 | 9672 | 36621209.33 | 0.0003 | 0.26 |
| **6** | **5** | **156** | **97** | **845** | **15132** | **363938.2873** | **0.0416** | **41.58** |
| 6 | 7 | 156 | 27 | 1260 | 4212 | 777506.513 | 0.0054 | 5.42 |
| 6 | 9 | 156 | 9 | 7258 | 1404 | 21654702.99 | 0.0001 | 0.06 |
| 6 | 10 | 156 | 48 | 6818 | 7488 | 19228627.85 | 0.0004 | 0.39 |
| 6 | 11 | 156 | 16 | 7447 | 2496 | 22738644.52 | 0.0001 | 0.11 |
| 6 | 12 | 156 | 66 | 7745 | 10296 | 24498568.14 | 0.0004 | 0.42 |
| 6 | 13 | 156 | 66 | 7450 | 10296 | 22756052.04 | 0.0005 | 0.45 |
| 6 | 14 | 156 | 136 | 7106 | 21216 | 20801175.87 | 0.0010 | 1.02 |
| 6 | 15 | 156 | 232 | 4763 | 36192 | 9726869.85 | 0.0037 | 3.72 |
| 6 | 16 | 156 | 180 | 4391 | 28080 | 8334326.892 | 0.0034 | 3.37 |
| 6 | 17 | 156 | 62 | 3366 | 9672 | 5029407.35 | 0.0019 | 1.92 |
| 6 | 18 | 156 | 28 | 3190 | 4368 | 4541531.155 | 0.0010 | 0.96 |
| 6 | 19 | 156 | 242 | 3094 | 37752 | 4285372.593 | 0.0088 | 8.81 |
| 6 | 20 | 156 | 300 | 4606 | 46800 | 9126735.697 | 0.0051 | 5.13 |
| 6 | 21 | 156 | 64 | 4620 | 9984 | 9179515.374 | 0.0011 | 1.09 |
| 6 | 22 | 156 | 84 | 6364 | 13104 | 16868921.8 | 0.0008 | 0.78 |
| 6 | 23 | 156 | 94 | 5471 | 14664 | 12656882.78 | 0.0012 | 1.16 |
| 6 | 24 | 156 | 149 | 6570 | 23244 | 17921493.63 | 0.0013 | 1.30 |
| 6 | 25 | 156 | 24 | 6894 | 3744 | 19637917.46 | 0.0002 | 0.19 |
| 6 | 26 | 156 | 95 | 6989 | 14820 | 20155267.98 | 0.0007 | 0.74 |
| 6 | 27 | 156 | 108 | 8200 | 16848 | 27305260.21 | 0.0006 | 0.62 |
| 6 | 28 | 156 | 272 | 4651 | 42432 | 9296897.548 | 0.0046 | 4.56 |
| 6 | 29 | 156 | 108 | 5588 | 16848 | 13176108.28 | 0.0013 | 1.28 |
| 6 | 30 | 156 | 230 | 9589 | 35880 | 36759475.44 | 0.0010 | 0.98 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6 | 31 | 156 | 37 | 9605 | 5772 | 36876101.48 | 0.0002 | 0.16 |
| 6 | 32 | 156 | 57 | 9211 | 8892 | 34055156.97 | 0.0003 | 0.26 |
| 6 | 33 | 156 | 142 | 8509 | 22152 | 29293360.41 | 0.0008 | 0.76 |
| 6 | 34 | 156 | 27 | 9218 | 4212 | 34104346.9 | 0.0001 | 0.12 |
| 6 | 35 | 156 | 81 | 9270 | 12636 | 34470810.49 | 0.0004 | 0.37 |
| *6* | *36* | *156* | *331* | *2895* | *51636* | *3776872.11* | *0.0137* | *13.67* |
| 6 | 37 | 156 | 180 | 6683 | 28080 | 18511677.52 | 0.0015 | 1.52 |
| 6 | 38 | 156 | 271 | 8725 | 42276 | 30722342.59 | 0.0014 | 1.38 |
| 6 | 39 | 156 | 121 | 5012 | 18876 | 10715711.64 | 0.0018 | 1.76 |
| 6 | 40 | 156 | 351 | 3837 | 54756 | 6450366.904 | 0.0085 | 8.49 |
| 6 | 41 | 156 | 58 | 3692 | 9048 | 5995110.82 | 0.0015 | 1.51 |
| 6 | 42 | 156 | 271 | 5567 | 42276 | 13082186.03 | 0.0032 | 3.23 |
| 6 | 43 | 156 | 179 | 5528 | 27924 | 12908603.62 | 0.0022 | 2.16 |
| 6 | 44 | 156 | 159 | 5223 | 24804 | 11589055.67 | 0.0021 | 2.14 |
| 7 | 2 | 27 | 336 | 8995 | 9072 | 32553839.55 | 0.0003 | 0.28 |
| 7 | 3 | 27 | 43 | 6913 | 1161 | 19740877.71 | 0.0001 | 0.06 |
| 7 | 4 | 27 | 62 | 10117 | 1674 | 40700366.97 | 0.0000 | 0.04 |
| 7 | 5 | 27 | 97 | 2512 | 2619 | 2884279.257 | 0.0009 | 0.91 |
| **7** | **6** | **27** | **156** | **1260** | **4212** | **777506.513** | **0.0054** | **5.42** |
| 7 | 9 | 27 | 9 | 7695 | 243 | 24198942.41 | 0.0000 | 0.01 |
| 7 | 10 | 27 | 48 | 7254 | 1296 | 21632033.53 | 0.0001 | 0.06 |
| 7 | 11 | 27 | 16 | 7882 | 432 | 25328485.25 | 0.0000 | 0.02 |
| 7 | 12 | 27 | 66 | 8181 | 1782 | 27185175.81 | 0.0001 | 0.07 |
| 7 | 13 | 27 | 66 | 7885 | 1782 | 25346805.11 | 0.0001 | 0.07 |
| 7 | 14 | 27 | 136 | 7542 | 3672 | 23292945.11 | 0.0002 | 0.16 |
| 7 | 15 | 27 | 232 | 5477 | 6264 | 12683269.12 | 0.0005 | 0.49 |
| 7 | 16 | 27 | 180 | 5105 | 4860 | 11096650.77 | 0.0004 | 0.44 |
| 7 | 17 | 27 | 62 | 3965 | 1674 | 6865340.221 | 0.0002 | 0.24 |
| 7 | 18 | 27 | 28 | 3710 | 756 | 6050766.981 | 0.0001 | 0.12 |
| 7 | 19 | 27 | 242 | 3668 | 6534 | 5921281.68 | 0.0011 | 1.10 |
| 7 | 20 | 27 | 300 | 5320 | 8100 | 12001405.27 | 0.0007 | 0.67 |
| 7 | 21 | 27 | 64 | 5251 | 1728 | 11707383.23 | 0.0001 | 0.15 |
| 7 | 22 | 27 | 84 | 7077 | 2268 | 20640179.58 | 0.0001 | 0.11 |
| 7 | 23 | 27 | 94 | 6184 | 2538 | 15973938.71 | 0.0002 | 0.16 |
| 7 | 24 | 27 | 149 | 7006 | 4023 | 20248518.48 | 0.0002 | 0.20 |
| 7 | 25 | 27 | 24 | 7331 | 648 | 22070395.57 | 0.0000 | 0.03 |
| 7 | 26 | 27 | 95 | 7426 | 2565 | 22616968.61 | 0.0001 | 0.11 |
| 7 | 27 | 27 | 108 | 8635 | 2916 | 30123015.8 | 0.0001 | 0.10 |
| 7 | 28 | 27 | 272 | 5856 | 7344 | 14402637.47 | 0.0005 | 0.51 |
| 7 | 29 | 27 | 108 | 6302 | 2916 | 16558041.16 | 0.0002 | 0.18 |
| 7 | 30 | 27 | 230 | 12595 | 6210 | 61712981.18 | 0.0001 | 0.10 |
| 7 | 31 | 27 | 37 | 10807 | 999 | 46135984 | 0.0000 | 0.02 |
| 7 | 32 | 27 | 57 | 10394 | 1539 | 42843718.16 | 0.0000 | 0.04 |
| 7 | 33 | 27 | 142 | 9711 | 3834 | 37653167.2 | 0.0001 | 0.10 |
| 7 | 34 | 27 | 27 | 12224 | 729 | 58304939.41 | 0.0000 | 0.01 |
| 7 | 35 | 27 | 81 | 10654 | 2187 | 44902871.6 | 0.0000 | 0.05 |
| *7* | *36* | *27* | *331* | *2712* | *8937* | *3336187.124* | *0.0027* | *2.68* |
| 7 | 37 | 27 | 180 | 7005 | 4860 | 20243027.51 | 0.0002 | 0.24 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 7 | 38 | 27 | 271 | 9139 | 7317 | 33551155.89 | 0.0002 | 0.22 |
| 7 | 39 | 27 | 121 | 6622 | 3267 | 18191957.6 | 0.0002 | 0.18 |
| 7 | 40 | 27 | 351 | 4551 | 9477 | 8920783.252 | 0.0011 | 1.06 |
| 7 | 41 | 27 | 58 | 4285 | 1566 | 7956216.088 | 0.0002 | 0.20 |
| 7 | 42 | 27 | 271 | 5803 | 7317 | 14155978.16 | 0.0005 | 0.52 |
| 7 | 43 | 27 | 179 | 5144 | 4833 | 11258274.25 | 0.0004 | 0.43 |
| 7 | 44 | 27 | 159 | 4838 | 4293 | 10019940.48 | 0.0004 | 0.43 |
| 9 | 2 | 9 | 336 | 2870 | 3024 | 3715143.589 | 0.0008 | 0.81 |
| 9 | 3 | 9 | 43 | 6800 | 387 | 19132289.08 | 0.0000 | 0.02 |
| 9 | 4 | 9 | 62 | 2651 | 558 | 3195056.06 | 0.0002 | 0.17 |
| 9 | 5 | 9 | 97 | 6716 | 873 | 18685740.2 | 0.0000 | 0.05 |
| 9 | 6 | 9 | 156 | 7258 | 1404 | 21654702.99 | 0.0001 | 0.06 |
| 9 | 7 | 9 | 27 | 7695 | 243 | 24198942.41 | 0.0000 | 0.01 |
| 9 | 10 | 9 | 48 | 522 | 432 | 145738.386 | 0.0030 | 2.96 |
| 9 | 11 | 9 | 16 | 256 | 144 | 37640.5477 | 0.0038 | 3.83 |
| 9 | 12 | 9 | 66 | 664 | 594 | 230207.4376 | 0.0026 | 2.58 |
| 9 | 13 | 9 | 66 | 580 | 594 | 178038.1971 | 0.0033 | 3.34 |
| 9 | 14 | 9 | 136 | 799 | 1224 | 327219.277 | 0.0037 | 3.74 |
| 9 | 15 | 9 | 232 | 2088 | 2088 | 2029962.145 | 0.0010 | 1.03 |
| 9 | 16 | 9 | 180 | 2646 | 1620 | 3183616.125 | 0.0005 | 0.51 |
| 9 | 17 | 9 | 62 | 4687 | 558 | 9434098.616 | 0.0001 | 0.06 |
| 9 | 18 | 9 | 28 | 4409 | 252 | 8399359.847 | 0.0000 | 0.03 |
| 9 | 19 | 9 | 242 | 3974 | 2178 | 6894978.865 | 0.0003 | 0.32 |
| 9 | 20 | 9 | 300 | 3562 | 2700 | 5600392.157 | 0.0005 | 0.48 |
| 9 | 21 | 9 | 64 | 2874 | 576 | 3724987.77 | 0.0002 | 0.15 |
| 9 | 22 | 9 | 84 | 4905 | 756 | 10285232.71 | 0.0001 | 0.07 |
| 9 | 23 | 9 | 94 | 4121 | 846 | 7387627.131 | 0.0001 | 0.11 |
| **9** | **24** | **9** | **149** | **540** | **1341** | **155434.7588** | **0.0086** | **8.63** |
| *9* | *25* | *9* | *24* | *247* | *216* | *35166.10036* | *0.0061* | *6.14* |
| 9 | 26 | 9 | 95 | 1200 | 855 | 708670.5209 | 0.0012 | 1.21 |
| 9 | 27 | 9 | 108 | 2356 | 972 | 2553483.428 | 0.0004 | 0.38 |
| 9 | 28 | 9 | 272 | 8154 | 2448 | 27014960.91 | 0.0001 | 0.09 |
| 9 | 29 | 9 | 108 | 4129 | 972 | 7414899.643 | 0.0001 | 0.13 |
| 9 | 30 | 9 | 230 | 11157 | 2070 | 49016254.57 | 0.0000 | 0.04 |
| 9 | 31 | 9 | 37 | 11836 | 333 | 54838986.18 | 0.0000 | 0.01 |
| 9 | 32 | 9 | 57 | 11236 | 513 | 49677792.37 | 0.0000 | 0.01 |
| 9 | 33 | 9 | 142 | 10519 | 1278 | 43827981 | 0.0000 | 0.03 |
| 9 | 34 | 9 | 27 | 10812 | 243 | 46176548.74 | 0.0000 | 0.01 |
| 9 | 35 | 9 | 81 | 11352 | 729 | 50656773.73 | 0.0000 | 0.01 |
| 9 | 36 | 9 | 331 | 6587 | 2979 | 18009703.4 | 0.0002 | 0.17 |
| 9 | 37 | 9 | 180 | 3144 | 1620 | 4417909.559 | 0.0004 | 0.37 |
| 9 | 38 | 9 | 271 | 1529 | 2439 | 1122985.69 | 0.0022 | 2.17 |
| 9 | 39 | 9 | 121 | 5194 | 1089 | 11467102.54 | 0.0001 | 0.09 |
| 9 | 40 | 9 | 351 | 2733 | 3159 | 3385441.395 | 0.0009 | 0.93 |
| 9 | 41 | 9 | 58 | 4342 | 522 | 8158506.358 | 0.0001 | 0.06 |
| 9 | 42 | 9 | 271 | 2445 | 2439 | 2739869.265 | 0.0009 | 0.89 |
| 9 | 43 | 9 | 179 | 4150 | 1611 | 7486716.427 | 0.0002 | 0.22 |
| 9 | 44 | 9 | 159 | 5392 | 1431 | 12311891.48 | 0.0001 | 0.12 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 10 | 2 | 48 | 336 | 3396 | 16128 | 5114917.049 | 0.0032 | 3.15 |
| 10 | 3 | 48 | 43 | 7226 | 2064 | 21473662.29 | 0.0001 | 0.10 |
| 10 | 4 | 48 | 62 | 2970 | 2976 | 3964945.788 | 0.0008 | 0.75 |
| 10 | 5 | 48 | 97 | 6276 | 4656 | 16428487.3 | 0.0003 | 0.28 |
| 10 | 6 | 48 | 156 | 6818 | 7488 | 19228627.85 | 0.0004 | 0.39 |
| 10 | 7 | 48 | 27 | 7254 | 1296 | 21632033.53 | 0.0001 | 0.06 |
| 10 | 9 | 48 | 9 | 522 | 432 | 145738.386 | 0.0030 | 2.96 |
| 10 | 11 | 48 | 16 | 668 | 768 | 232849.4834 | 0.0033 | 3.30 |
| 10 | 12 | 48 | 66 | 967 | 3168 | 470229.965 | 0.0067 | 6.74 |
| *10* | *13* | *48* | *66* | *687* | *3168* | *245594.0271* | *0.0129* | *12.90* |
| 10 | 14 | 48 | 136 | 1318 | 6528 | 846913.9365 | 0.0077 | 7.71 |
| 10 | 15 | 48 | 232 | 2518 | 11136 | 2897382.809 | 0.0038 | 3.84 |
| 10 | 16 | 48 | 180 | 3076 | 8640 | 4238127.61 | 0.0020 | 2.04 |
| 10 | 17 | 48 | 62 | 4155 | 2976 | 7503863.985 | 0.0004 | 0.40 |
| 10 | 18 | 48 | 28 | 3877 | 1344 | 6578729.382 | 0.0002 | 0.20 |
| 10 | 19 | 48 | 242 | 3480 | 11616 | 5357973.527 | 0.0022 | 2.17 |
| 10 | 20 | 48 | 300 | 4016 | 14400 | 7034091.897 | 0.0020 | 2.05 |
| 10 | 21 | 48 | 64 | 3352 | 3072 | 4989736.581 | 0.0006 | 0.62 |
| 10 | 22 | 48 | 84 | 5382 | 4032 | 12268543.79 | 0.0003 | 0.33 |
| 10 | 23 | 48 | 94 | 4542 | 4512 | 8887293.99 | 0.0005 | 0.51 |
| **10** | **24** | **48** | **149** | **850** | **7152** | **368040.7939** | **0.0194** | **19.43** |
| 10 | 25 | 48 | 24 | 717 | 1152 | 266370.6655 | 0.0043 | 4.32 |
| 10 | 26 | 48 | 95 | 1663 | 4560 | 1317332.097 | 0.0035 | 3.46 |
| 10 | 27 | 48 | 108 | 2850 | 5184 | 3666107.825 | 0.0014 | 1.41 |
| 10 | 28 | 48 | 272 | 8608 | 13056 | 29944308.66 | 0.0004 | 0.44 |
| 10 | 29 | 48 | 108 | 5607 | 5184 | 13261359.75 | 0.0004 | 0.39 |
| 10 | 30 | 48 | 230 | 11579 | 11040 | 52598699.03 | 0.0002 | 0.21 |
| 10 | 31 | 48 | 37 | 12258 | 1776 | 58613448.32 | 0.0000 | 0.03 |
| 10 | 32 | 48 | 57 | 11657 | 2736 | 53273951.78 | 0.0001 | 0.05 |
| 10 | 33 | 48 | 142 | 10940 | 6816 | 47220753.39 | 0.0001 | 0.14 |
| 10 | 34 | 48 | 27 | 11233 | 1296 | 49652593.96 | 0.0000 | 0.03 |
| 10 | 35 | 48 | 81 | 11774 | 3888 | 54294477.72 | 0.0001 | 0.07 |
| 10 | 36 | 48 | 331 | 6093 | 15888 | 15530278.31 | 0.0010 | 1.02 |
| 10 | 37 | 48 | 180 | 2612 | 8640 | 3106340.278 | 0.0028 | 2.78 |
| 10 | 38 | 48 | 271 | 1946 | 13008 | 1775707.333 | 0.0073 | 7.33 |
| 10 | 39 | 48 | 121 | 5616 | 5808 | 13301832.91 | 0.0004 | 0.44 |
| 10 | 40 | 48 | 351 | 3227 | 16848 | 4642137.865 | 0.0036 | 3.63 |
| 10 | 41 | 48 | 58 | 3818 | 2784 | 6389814.576 | 0.0004 | 0.44 |
| 10 | 42 | 48 | 271 | 1913 | 13008 | 1718930.997 | 0.0076 | 7.57 |
| 10 | 43 | 48 | 179 | 3618 | 8592 | 5768863.577 | 0.0015 | 1.49 |
| 10 | 44 | 48 | 159 | 4861 | 7632 | 10110640.77 | 0.0008 | 0.75 |
| 11 | 2 | 16 | 336 | 2749 | 5376 | 3423197.889 | 0.0016 | 1.57 |
| 11 | 3 | 16 | 43 | 7125 | 688 | 20906977.43 | 0.0000 | 0.03 |
| 11 | 4 | 16 | 62 | 2332 | 992 | 2504287.799 | 0.0004 | 0.40 |
| 11 | 5 | 16 | 97 | 6797 | 1552 | 19116254.9 | 0.0001 | 0.08 |
| 11 | 6 | 16 | 156 | 7447 | 2496 | 22738644.52 | 0.0001 | 0.11 |
| 11 | 7 | 16 | 27 | 7882 | 432 | 25328485.25 | 0.0000 | 0.02 |
| 11 | 9 | 16 | 9 | 256 | 144 | 37640.5477 | 0.0038 | 3.83 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 11 | 10 | 16 | 48 | 668 | 768 | 232849.4834 | 0.0033 | 3.30 |
| *11* | *12* | *16* | *66* | *389* | *1056* | *83349.73867* | *0.0127* | *12.67* |
| **11** | **13** | **16** | **66** | **321** | **1056** | **57857.48635** | **0.0183** | **18.25** |
| 11 | 14 | 16 | 136 | 957 | 2176 | 461033.7104 | 0.0047 | 4.72 |
| 11 | 15 | 16 | 232 | 2370 | 3712 | 2582390.155 | 0.0014 | 1.44 |
| 11 | 16 | 16 | 180 | 2630 | 2880 | 3147138.98 | 0.0009 | 0.92 |
| 11 | 17 | 16 | 62 | 4203 | 992 | 7669425.639 | 0.0001 | 0.13 |
| 11 | 18 | 16 | 28 | 3925 | 448 | 6734344.916 | 0.0001 | 0.07 |
| 11 | 19 | 16 | 242 | 4171 | 3872 | 7558861.027 | 0.0005 | 0.51 |
| 11 | 20 | 16 | 300 | 3844 | 4800 | 6472743.84 | 0.0007 | 0.74 |
| 11 | 21 | 16 | 64 | 3265 | 1024 | 4746549.919 | 0.0002 | 0.22 |
| 11 | 22 | 16 | 84 | 5295 | 1344 | 11894476.5 | 0.0001 | 0.11 |
| 11 | 23 | 16 | 94 | 4403 | 1504 | 8377655.591 | 0.0002 | 0.18 |
| 11 | 24 | 16 | 149 | 862 | 2384 | 377975.6348 | 0.0063 | 6.31 |
| 11 | 25 | 16 | 24 | 504 | 384 | 136338.3454 | 0.0028 | 2.82 |
| 11 | 26 | 16 | 95 | 1515 | 1520 | 1103529.64 | 0.0014 | 1.38 |
| 11 | 27 | 16 | 108 | 2246 | 1728 | 2331731.44 | 0.0007 | 0.74 |
| 11 | 28 | 16 | 272 | 8436 | 4352 | 28817711.22 | 0.0002 | 0.15 |
| 11 | 29 | 16 | 108 | 4519 | 1728 | 8801981.441 | 0.0002 | 0.20 |
| 11 | 30 | 16 | 230 | 11439 | 3680 | 51396945.99 | 0.0001 | 0.07 |
| 11 | 31 | 16 | 37 | 12118 | 592 | 57348069.32 | 0.0000 | 0.01 |
| 11 | 32 | 16 | 57 | 11517 | 912 | 52064871.04 | 0.0000 | 0.02 |
| 11 | 33 | 16 | 142 | 10800 | 2272 | 46079221.74 | 0.0000 | 0.05 |
| 11 | 34 | 16 | 27 | 11093 | 432 | 48483406.32 | 0.0000 | 0.01 |
| 11 | 35 | 16 | 81 | 11664 | 1296 | 53334750.87 | 0.0000 | 0.02 |
| 11 | 36 | 16 | 331 | 6784 | 5296 | 19046847.06 | 0.0003 | 0.28 |
| 11 | 37 | 16 | 180 | 3341 | 2880 | 4958671.105 | 0.0006 | 0.58 |
| 11 | 38 | 16 | 271 | 1237 | 4336 | 750762.2536 | 0.0058 | 5.78 |
| 11 | 39 | 16 | 121 | 5476 | 1936 | 12678869.59 | 0.0002 | 0.15 |
| 11 | 40 | 16 | 351 | 2947 | 5616 | 3906809.707 | 0.0014 | 1.44 |
| 11 | 41 | 16 | 58 | 4539 | 928 | 8876144.162 | 0.0001 | 0.10 |
| 11 | 42 | 16 | 271 | 2642 | 4336 | 3174478.172 | 0.0014 | 1.37 |
| 11 | 43 | 16 | 179 | 4347 | 2864 | 8176365.863 | 0.0004 | 0.35 |
| 11 | 44 | 16 | 159 | 5589 | 2544 | 13180588.71 | 0.0002 | 0.19 |
| 12 | 2 | 66 | 336 | 2843 | 22176 | 3649018.233 | 0.0061 | 6.08 |
| 12 | 3 | 66 | 43 | 7527 | 2838 | 23205003.62 | 0.0001 | 0.12 |
| 12 | 4 | 66 | 62 | 2376 | 4092 | 2594825.929 | 0.0016 | 1.58 |
| 12 | 5 | 66 | 97 | 7095 | 6402 | 20740038.57 | 0.0003 | 0.31 |
| 12 | 6 | 66 | 156 | 7745 | 10296 | 24498568.14 | 0.0004 | 0.42 |
| 12 | 7 | 66 | 27 | 8181 | 1782 | 27185175.81 | 0.0001 | 0.07 |
| 12 | 9 | 66 | 9 | 664 | 594 | 230207.4376 | 0.0026 | 2.58 |
| 12 | 10 | 66 | 48 | 967 | 3168 | 470229.965 | 0.0067 | 6.74 |
| 12 | 11 | 66 | 16 | 389 | 1056 | 83349.73867 | 0.0127 | 12.67 |
| **12** | **13** | **66** | **66** | **290** | **4356** | **47704.15374** | **0.0913** | **91.31** |
| *12* | *14* | *66* | *136* | *577* | *8976* | *176292.5846* | *0.0509* | *50.92* |
| 12 | 15 | 66 | 232 | 2691 | 15312 | 3287274.916 | 0.0047 | 4.66 |
| 12 | 16 | 66 | 180 | 3578 | 11880 | 5648285.477 | 0.0021 | 2.10 |
| 12 | 17 | 66 | 62 | 4462 | 4092 | 8592235.568 | 0.0005 | 0.48 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 18 | 66 | 28 | 4184 | 1848 | 7603686.177 | 0.0002 | 0.24 |
| 12 | 19 | 66 | 242 | 3749 | 15972 | 6172190.714 | 0.0026 | 2.59 |
| 12 | 20 | 66 | 300 | 4078 | 19800 | 7241853.263 | 0.0027 | 2.73 |
| 12 | 21 | 66 | 64 | 3585 | 4224 | 5669299.543 | 0.0007 | 0.75 |
| 12 | 22 | 66 | 84 | 5615 | 5544 | 13297333.01 | 0.0004 | 0.42 |
| 12 | 23 | 66 | 94 | 4724 | 6204 | 9576102.566 | 0.0006 | 0.65 |
| 12 | 24 | 66 | 149 | 1143 | 9834 | 646082.2917 | 0.0152 | 15.22 |
| 12 | 25 | 66 | 24 | 825 | 1584 | 347746.2875 | 0.0046 | 4.56 |
| 12 | 26 | 66 | 95 | 1072 | 6270 | 571965.8405 | 0.0110 | 10.96 |
| 12 | 27 | 66 | 108 | 2327 | 7128 | 2494095.784 | 0.0029 | 2.86 |
| 12 | 28 | 66 | 272 | 8670 | 17952 | 30355422.73 | 0.0006 | 0.59 |
| 12 | 29 | 66 | 108 | 4840 | 7128 | 10027812.09 | 0.0007 | 0.71 |
| 12 | 30 | 66 | 230 | 11760 | 15180 | 54171880.44 | 0.0003 | 0.28 |
| 12 | 31 | 66 | 37 | 12439 | 2442 | 60268778.41 | 0.0000 | 0.04 |
| 12 | 32 | 66 | 57 | 11838 | 3762 | 54856593.82 | 0.0001 | 0.07 |
| 12 | 33 | 66 | 142 | 11121 | 9372 | 48716187.96 | 0.0002 | 0.19 |
| 12 | 34 | 66 | 27 | 11414 | 1782 | 51183732.1 | 0.0000 | 0.03 |
| 12 | 35 | 66 | 81 | 11955 | 5346 | 55891298.93 | 0.0001 | 0.10 |
| 12 | 36 | 66 | 331 | 7044 | 21846 | 20457697.84 | 0.0011 | 1.07 |
| 12 | 37 | 66 | 180 | 3601 | 11880 | 5717470.475 | 0.0021 | 2.08 |
| 12 | 38 | 66 | 271 | 1302 | 17886 | 827486.4101 | 0.0216 | 21.61 |
| 12 | 39 | 66 | 121 | 5797 | 7986 | 14128181.67 | 0.0006 | 0.57 |
| 12 | 40 | 66 | 351 | 3189 | 23166 | 4538826.549 | 0.0051 | 5.10 |
| 12 | 41 | 66 | 58 | 4806 | 3828 | 9894392.999 | 0.0004 | 0.39 |
| 12 | 42 | 66 | 271 | 2902 | 17886 | 3794242.422 | 0.0047 | 4.71 |
| 12 | 43 | 66 | 179 | 4607 | 11814 | 9130500.893 | 0.0013 | 1.29 |
| 12 | 44 | 66 | 159 | 5849 | 10494 | 14369944.16 | 0.0007 | 0.73 |
| 13 | 2 | 66 | 336 | 2979 | 22176 | 3987805.391 | 0.0056 | 5.56 |
| 13 | 3 | 66 | 43 | 7940 | 2838 | 25683780.79 | 0.0001 | 0.11 |
| 13 | 4 | 66 | 62 | 2559 | 4092 | 2987676.308 | 0.0014 | 1.37 |
| 13 | 5 | 66 | 97 | 6759 | 6402 | 18913706.62 | 0.0003 | 0.34 |
| 13 | 6 | 66 | 156 | 7450 | 10296 | 22756052.04 | 0.0005 | 0.45 |
| 13 | 7 | 66 | 27 | 7885 | 1782 | 25346805.11 | 0.0001 | 0.07 |
| 13 | 9 | 66 | 9 | 580 | 594 | 178038.1971 | 0.0033 | 3.34 |
| 13 | 10 | 66 | 48 | 687 | 3168 | 245594.0271 | 0.0129 | 12.90 |
| *13* | *11* | *66* | *16* | *321* | *1056* | *57857.48635* | *0.0183* | *18.25* |
| **13** | **12** | **66** | **66** | **290** | **4356** | **47704.15374** | **0.0913** | **91.31** |
| 13 | 14 | 66 | 136 | 1256 | 8976 | 772823.4915 | 0.0116 | 11.61 |
| 13 | 15 | 66 | 232 | 3167 | 15312 | 4479518.354 | 0.0034 | 3.42 |
| 13 | 16 | 66 | 180 | 3724 | 11880 | 6094223.498 | 0.0019 | 1.95 |
| 13 | 17 | 66 | 62 | 4864 | 4092 | 10122499.78 | 0.0004 | 0.40 |
| 13 | 18 | 66 | 28 | 4586 | 1848 | 9051586.286 | 0.0002 | 0.20 |
| 13 | 19 | 66 | 242 | 4129 | 15972 | 7414899.643 | 0.0022 | 2.15 |
| 13 | 20 | 66 | 300 | 4765 | 19800 | 9734631.574 | 0.0020 | 2.03 |
| 13 | 21 | 66 | 64 | 4061 | 4224 | 7184601.424 | 0.0006 | 0.59 |
| 13 | 22 | 66 | 84 | 6092 | 5544 | 15525435.81 | 0.0004 | 0.36 |
| 13 | 23 | 66 | 94 | 5199 | 6204 | 11488085.34 | 0.0005 | 0.54 |
| 13 | 24 | 66 | 149 | 1108 | 9834 | 609011.5718 | 0.0161 | 16.15 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 13 | 25 | 66 | 24 | 790 | 1584 | 320251.7219 | 0.0049 | 4.95 |
| 13 | 26 | 66 | 95 | 1751 | 6270 | 1452926.609 | 0.0043 | 4.32 |
| 13 | 27 | 66 | 108 | 2484 | 7128 | 2823501.507 | 0.0025 | 2.52 |
| 13 | 28 | 66 | 272 | 9318 | 17952 | 34810730.87 | 0.0005 | 0.52 |
| 13 | 29 | 66 | 108 | 5316 | 7128 | 11984266.2 | 0.0006 | 0.59 |
| 13 | 30 | 66 | 230 | 12235 | 15180 | 58404666.72 | 0.0003 | 0.26 |
| 13 | 31 | 66 | 37 | 12914 | 2442 | 64716569.18 | 0.0000 | 0.04 |
| 13 | 32 | 66 | 57 | 12313 | 3762 | 59114139.35 | 0.0001 | 0.06 |
| 13 | 33 | 66 | 142 | 11596 | 9372 | 52745521.76 | 0.0002 | 0.18 |
| 13 | 34 | 66 | 27 | 11889 | 1782 | 55306493.1 | 0.0000 | 0.03 |
| 13 | 35 | 66 | 81 | 12430 | 5346 | 60185953.38 | 0.0001 | 0.09 |
| 13 | 36 | 66 | 331 | 6743 | 21846 | 18828728.94 | 0.0012 | 1.16 |
| 13 | 37 | 66 | 180 | 3322 | 11880 | 4905229.071 | 0.0024 | 2.42 |
| 13 | 38 | 66 | 271 | 1511 | 17886 | 1098000.359 | 0.0163 | 16.29 |
| 13 | 39 | 66 | 121 | 6272 | 7986 | 16408598.72 | 0.0005 | 0.49 |
| 13 | 40 | 66 | 351 | 3876 | 23166 | 6575505.72 | 0.0035 | 3.52 |
| 13 | 41 | 66 | 58 | 4519 | 3828 | 8801981.441 | 0.0004 | 0.43 |
| 13 | 42 | 66 | 271 | 2622 | 17886 | 3128975.092 | 0.0057 | 5.72 |
| 13 | 43 | 66 | 179 | 4327 | 11814 | 8105038.85 | 0.0015 | 1.46 |
| 13 | 44 | 66 | 159 | 5570 | 10494 | 13095584.01 | 0.0008 | 0.80 |
| 14 | 2 | 136 | 336 | 1667 | 45696 | 1323358.891 | 0.0345 | 34.53 |
| 14 | 3 | 136 | 43 | 4995 | 5848 | 10646759.3 | 0.0005 | 0.55 |
| 14 | 4 | 136 | 62 | 1847 | 8432 | 1608003.913 | 0.0052 | 5.24 |
| 14 | 5 | 136 | 97 | 6028 | 13192 | 15217004.29 | 0.0009 | 0.87 |
| 14 | 6 | 136 | 156 | 7106 | 21216 | 20801175.87 | 0.0010 | 1.02 |
| 14 | 7 | 136 | 27 | 7542 | 3672 | 23292945.11 | 0.0002 | 0.16 |
| 14 | 9 | 136 | 9 | 799 | 1224 | 327219.277 | 0.0037 | 3.74 |
| 14 | 10 | 136 | 48 | 1318 | 6528 | 846913.9365 | 0.0077 | 7.71 |
| 14 | 11 | 136 | 16 | 957 | 2176 | 461033.7104 | 0.0047 | 4.72 |
| *14* | *12* | *136* | *66* | *577* | *8976* | *176292.5846* | *0.0509* | *50.92* |
| 14 | 13 | 136 | 66 | 1256 | 8976 | 772823.4915 | 0.0116 | 11.61 |
| 14 | 15 | 136 | 232 | 2139 | 31552 | 2125203.344 | 0.0148 | 14.85 |
| 14 | 16 | 136 | 180 | 2748 | 24480 | 3420832.298 | 0.0072 | 7.16 |
| 14 | 17 | 136 | 62 | 4291 | 8432 | 7977396.487 | 0.0011 | 1.06 |
| 14 | 18 | 136 | 28 | 4026 | 3808 | 7067408.005 | 0.0005 | 0.54 |
| 14 | 19 | 136 | 242 | 3660 | 32912 | 5896768.283 | 0.0056 | 5.58 |
| 14 | 20 | 136 | 300 | 2972 | 40800 | 3970020.32 | 0.0103 | 10.28 |
| 14 | 21 | 136 | 64 | 2493 | 8704 | 2842970.342 | 0.0031 | 3.06 |
| 14 | 22 | 136 | 84 | 4473 | 11424 | 8632526.228 | 0.0013 | 1.32 |
| 14 | 23 | 136 | 94 | 3581 | 12784 | 5657286.979 | 0.0023 | 2.26 |
| **14** | **24** | **136** | **149** | **629** | **20264** | **207699.8708** | **0.0976** | **97.56** |
| 14 | 25 | 136 | 24 | 607 | 3264 | 194114.7393 | 0.0168 | 16.81 |
| 14 | 26 | 136 | 95 | 586 | 12920 | 181553.8531 | 0.0712 | 71.16 |
| 14 | 27 | 136 | 108 | 1832 | 14688 | 1583282.428 | 0.0093 | 9.28 |
| 14 | 28 | 136 | 272 | 7462 | 36992 | 22825745.2 | 0.0016 | 1.62 |
| 14 | 29 | 136 | 108 | 3697 | 14688 | 6010546.427 | 0.0024 | 2.44 |
| 14 | 30 | 136 | 230 | 10617 | 31280 | 44607044.86 | 0.0007 | 0.70 |
| 14 | 31 | 136 | 37 | 11296 | 5032 | 50183032.2 | 0.0001 | 0.10 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 14 | 32 | 136 | 57 | 10696 | 7752 | 45239797.17 | 0.0002 | 0.17 |
| 14 | 33 | 136 | 142 | 9979 | 19312 | 39652022.41 | 0.0005 | 0.49 |
| 14 | 34 | 136 | 27 | 10272 | 3672 | 41893295.04 | 0.0001 | 0.09 |
| 14 | 35 | 136 | 81 | 10812 | 11016 | 46176548.74 | 0.0002 | 0.24 |
| 14 | 36 | 136 | 331 | 6463 | 45016 | 17371003.04 | 0.0026 | 2.59 |
| 14 | 37 | 136 | 180 | 3693 | 24480 | 5998196.437 | 0.0041 | 4.08 |
| 14 | 38 | 136 | 271 | 1395 | 36856 | 943389.405 | 0.0391 | 39.07 |
| 14 | 39 | 136 | 121 | 4654 | 16456 | 9308294.602 | 0.0018 | 1.77 |
| 14 | 40 | 136 | 351 | 2824 | 47736 | 3602822.908 | 0.0132 | 13.25 |
| 14 | 41 | 136 | 58 | 4616 | 7888 | 9164420.756 | 0.0009 | 0.86 |
| 14 | 42 | 136 | 271 | 2744 | 36856 | 3411377.678 | 0.0108 | 10.80 |
| 14 | 43 | 136 | 179 | 4442 | 24344 | 8519208.611 | 0.0029 | 2.86 |
| 14 | 44 | 136 | 159 | 5283 | 21624 | 11843311.72 | 0.0018 | 1.83 |
| 15 | 2 | 232 | 336 | 3658 | 77952 | 5890647.461 | 0.0132 | 13.23 |
| 15 | 3 | 232 | 43 | 4586 | 9976 | 9051586.286 | 0.0011 | 1.10 |
| 15 | 4 | 232 | 62 | 3793 | 14384 | 6310552.747 | 0.0023 | 2.28 |
| 15 | 5 | 232 | 97 | 4224 | 22504 | 7742396.85 | 0.0029 | 2.91 |
| 15 | 6 | 232 | 156 | 4763 | 36192 | 9726869.85 | 0.0037 | 3.72 |
| 15 | 7 | 232 | 27 | 5477 | 6264 | 12683269.12 | 0.0005 | 0.49 |
| 15 | 9 | 232 | 9 | 2088 | 2088 | 2029962.145 | 0.0010 | 1.03 |
| 15 | 10 | 232 | 48 | 2518 | 11136 | 2897382.809 | 0.0038 | 3.84 |
| 15 | 11 | 232 | 16 | 2370 | 3712 | 2582390.155 | 0.0014 | 1.44 |
| 15 | 12 | 232 | 66 | 2691 | 15312 | 3287274.916 | 0.0047 | 4.66 |
| 15 | 13 | 232 | 66 | 3167 | 15312 | 4479518.354 | 0.0034 | 3.42 |
| 15 | 14 | 232 | 136 | 2139 | 31552 | 2125203.344 | 0.0148 | 14.85 |
| **15** | **16** | **232** | **180** | **602** | **41760** | **191087.9641** | **0.2185** | **218.54** |
| 15 | 17 | 232 | 62 | 2565 | 14384 | 3001000.045 | 0.0048 | 4.79 |
| 15 | 18 | 232 | 28 | 2301 | 6496 | 2441414.814 | 0.0027 | 2.66 |
| 15 | 19 | 232 | 242 | 1773 | 56144 | 1487807 | 0.0377 | 37.74 |
| 15 | 20 | 232 | 300 | 1296 | 69600 | 820256.1645 | 0.0849 | 84.85 |
| 15 | 21 | 232 | 64 | 797 | 14848 | 325664.7932 | 0.0456 | 45.59 |
| 15 | 22 | 232 | 84 | 2777 | 19488 | 3489748.84 | 0.0056 | 5.58 |
| 15 | 23 | 232 | 94 | 1792 | 21808 | 1518246.226 | 0.0144 | 14.36 |
| 15 | 24 | 232 | 149 | 1592 | 34568 | 1212528.124 | 0.0285 | 28.51 |
| 15 | 25 | 232 | 24 | 1966 | 5568 | 1810542.299 | 0.0031 | 3.08 |
| 15 | 26 | 232 | 95 | 2011 | 22040 | 1890091.957 | 0.0117 | 11.66 |
| 15 | 27 | 232 | 108 | 3222 | 25056 | 4628481.355 | 0.0054 | 5.41 |
| 15 | 28 | 232 | 272 | 5796 | 63104 | 14123551.44 | 0.0045 | 4.47 |
| 15 | 29 | 232 | 108 | 2001 | 25056 | 1872274.268 | 0.0134 | 13.38 |
| 15 | 30 | 232 | 230 | 8829 | 53360 | 31421859.47 | 0.0017 | 1.70 |
| 15 | 31 | 232 | 37 | 9508 | 8584 | 36171742.36 | 0.0002 | 0.24 |
| 15 | 32 | 232 | 57 | 8907 | 13224 | 31951390.23 | 0.0004 | 0.41 |
| 15 | 33 | 232 | 142 | 8190 | 32944 | 27242026.64 | 0.0012 | 1.21 |
| 15 | 34 | 232 | 27 | 8483 | 6264 | 29123528.23 | 0.0002 | 0.22 |
| 15 | 35 | 232 | 81 | 9024 | 18792 | 32753541.45 | 0.0006 | 0.57 |
| 15 | 36 | 232 | 331 | 4756 | 76792 | 9699726.914 | 0.0079 | 7.92 |
| 15 | 37 | 232 | 180 | 3159 | 41760 | 4458043.37 | 0.0094 | 9.37 |
| 15 | 38 | 232 | 271 | 3634 | 62872 | 5817432.511 | 0.0108 | 10.81 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 15 | 39 | 232 | 121 | 2865 | 28072 | 3702855.717 | 0.0076 | 7.58 |
| *15* | *40* | *232* | *351* | *909* | *81432* | *418091.5384* | *0.1948* | *194.77* |
| 15 | 41 | 232 | 58 | 2891 | 13456 | 3766963.171 | 0.0036 | 3.57 |
| 15 | 42 | 232 | 271 | 2043 | 62872 | 1947645.432 | 0.0323 | 32.28 |
| 15 | 43 | 232 | 179 | 3415 | 41528 | 5169426.267 | 0.0080 | 8.03 |
| 15 | 44 | 232 | 159 | 3978 | 36888 | 6908171.007 | 0.0053 | 5.34 |
| 16 | 2 | 180 | 336 | 3674 | 60480 | 5939698.337 | 0.0102 | 10.18 |
| 16 | 3 | 180 | 43 | 4112 | 7740 | 7357002.462 | 0.0011 | 1.05 |
| 16 | 4 | 180 | 62 | 4294 | 11160 | 7987996.689 | 0.0014 | 1.40 |
| 16 | 5 | 180 | 97 | 3897 | 17460 | 6643359.751 | 0.0026 | 2.63 |
| 16 | 6 | 180 | 156 | 4391 | 28080 | 8334326.892 | 0.0034 | 3.37 |
| 16 | 7 | 180 | 27 | 5105 | 4860 | 11096650.77 | 0.0004 | 0.44 |
| 16 | 9 | 180 | 9 | 2646 | 1620 | 3183616.125 | 0.0005 | 0.51 |
| 16 | 10 | 180 | 48 | 3076 | 8640 | 4238127.61 | 0.0020 | 2.04 |
| 16 | 11 | 180 | 16 | 2630 | 2880 | 3147138.98 | 0.0009 | 0.92 |
| 16 | 12 | 180 | 66 | 3578 | 11880 | 5648285.477 | 0.0021 | 2.10 |
| 16 | 13 | 180 | 66 | 3724 | 11880 | 6094223.498 | 0.0019 | 1.95 |
| 16 | 14 | 180 | 136 | 2748 | 24480 | 3420832.298 | 0.0072 | 7.16 |
| *16* | *15* | *180* | *232* | *602* | *41760* | *191087.9641* | *0.2185* | *218.54* |
| 16 | 17 | 180 | 62 | 2643 | 11160 | 3176761.494 | 0.0035 | 3.51 |
| 16 | 18 | 180 | 28 | 2370 | 5040 | 2582390.155 | 0.0020 | 1.95 |
| 16 | 19 | 180 | 242 | 1453 | 43560 | 1019306.203 | 0.0427 | 42.73 |
| 16 | 20 | 180 | 300 | 745 | 54000 | 286481.7218 | 0.1885 | 188.49 |
| **16** | **21** | **180** | **64** | **246** | **11520** | **34896.08479** | **0.3301** | **330.12** |
| 16 | 22 | 180 | 84 | 2225 | 15120 | 2290482.77 | 0.0066 | 6.60 |
| 16 | 23 | 180 | 94 | 1333 | 16920 | 865321.0805 | 0.0196 | 19.55 |
| 16 | 24 | 180 | 149 | 2106 | 26820 | 2063340.473 | 0.0130 | 13.00 |
| 16 | 25 | 180 | 24 | 2480 | 4320 | 2814869.035 | 0.0015 | 1.53 |
| 16 | 26 | 180 | 95 | 2144 | 17100 | 2134651.997 | 0.0080 | 8.01 |
| 16 | 27 | 180 | 108 | 3355 | 19440 | 4998224.933 | 0.0039 | 3.89 |
| 16 | 28 | 180 | 272 | 5255 | 48960 | 11724333.64 | 0.0042 | 4.18 |
| 16 | 29 | 180 | 108 | 1450 | 19440 | 1015311.264 | 0.0191 | 19.15 |
| 16 | 30 | 180 | 230 | 8368 | 41400 | 28377960.24 | 0.0015 | 1.46 |
| 16 | 31 | 180 | 37 | 9048 | 6660 | 32919249.43 | 0.0002 | 0.20 |
| 16 | 32 | 180 | 57 | 8447 | 10260 | 28889148.34 | 0.0004 | 0.36 |
| 16 | 33 | 180 | 142 | 7730 | 25560 | 24408497.04 | 0.0010 | 1.05 |
| 16 | 34 | 180 | 27 | 8023 | 4860 | 26196296.98 | 0.0002 | 0.19 |
| 16 | 35 | 180 | 81 | 8564 | 14580 | 29654161.7 | 0.0005 | 0.49 |
| 16 | 36 | 180 | 331 | 4476 | 59580 | 8643530.084 | 0.0069 | 6.89 |
| 16 | 37 | 180 | 180 | 3616 | 32400 | 5762806.023 | 0.0056 | 5.62 |
| 16 | 38 | 180 | 271 | 4034 | 48780 | 7094114.575 | 0.0069 | 6.88 |
| 16 | 39 | 180 | 121 | 2406 | 21780 | 2657429.083 | 0.0082 | 8.20 |
| 16 | 40 | 180 | 351 | 850 | 63180 | 368040.7939 | 0.1717 | 171.67 |
| 16 | 41 | 180 | 58 | 2969 | 10440 | 3962409.675 | 0.0026 | 2.63 |
| 16 | 42 | 180 | 271 | 2500 | 48780 | 2858156.575 | 0.0171 | 17.07 |
| 16 | 43 | 180 | 179 | 3247 | 32220 | 4696954.449 | 0.0069 | 6.86 |
| 16 | 44 | 180 | 159 | 3809 | 28620 | 6361226.333 | 0.0045 | 4.50 |
| 17 | 2 | 62 | 336 | 5681 | 20832 | 13595873.01 | 0.0015 | 1.53 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 17 | 3 | 62 | 43 | 6271 | 2666 | 16403628.36 | 0.0002 | 0.16 |
| 17 | 4 | 62 | 62 | 7134 | 3844 | 20957182.7 | 0.0002 | 0.18 |
| 17 | 5 | 62 | 97 | 3296 | 6014 | 4832542.54 | 0.0012 | 1.24 |
| 17 | 6 | 62 | 156 | 3366 | 9672 | 5029407.35 | 0.0019 | 1.92 |
| 17 | 7 | 62 | 27 | 3965 | 1674 | 6865340.221 | 0.0002 | 0.24 |
| 17 | 9 | 62 | 9 | 4687 | 558 | 9434098.616 | 0.0001 | 0.06 |
| 17 | 10 | 62 | 48 | 4155 | 2976 | 7503863.985 | 0.0004 | 0.40 |
| 17 | 11 | 62 | 16 | 4203 | 992 | 7669425.639 | 0.0001 | 0.13 |
| 17 | 12 | 62 | 66 | 4462 | 4092 | 8592235.568 | 0.0005 | 0.48 |
| 17 | 13 | 62 | 66 | 4864 | 4092 | 10122499.78 | 0.0004 | 0.40 |
| 17 | 14 | 62 | 136 | 4291 | 8432 | 7977396.487 | 0.0011 | 1.06 |
| 17 | 15 | 62 | 232 | 2565 | 14384 | 3001000.045 | 0.0048 | 4.79 |
| 17 | 16 | 62 | 180 | 2643 | 11160 | 3176761.494 | 0.0035 | 3.51 |
| *17* | *18* | *62* | *28* | *273* | *1736* | *42531.33642* | *0.0408* | *40.82* |
| 17 | 19 | 62 | 242 | 1223 | 15004 | 734700.3866 | 0.0204 | 20.42 |
| 17 | 20 | 62 | 300 | 2980 | 18600 | 3990349.189 | 0.0047 | 4.66 |
| 17 | 21 | 62 | 64 | 2994 | 3968 | 4026043.031 | 0.0010 | 0.99 |
| 17 | 22 | 62 | 84 | 4669 | 5208 | 9365379.071 | 0.0006 | 0.56 |
| 17 | 23 | 62 | 94 | 3845 | 5828 | 6475943.542 | 0.0009 | 0.90 |
| 17 | 24 | 62 | 149 | 3745 | 9238 | 6159684.412 | 0.0015 | 1.50 |
| 17 | 25 | 62 | 24 | 3946 | 1488 | 6802968.401 | 0.0002 | 0.22 |
| 17 | 26 | 62 | 95 | 4185 | 5890 | 7607139.465 | 0.0008 | 0.77 |
| 17 | 27 | 62 | 108 | 5396 | 6696 | 12329250.82 | 0.0005 | 0.54 |
| 17 | 28 | 62 | 272 | 6756 | 16864 | 18897759.5 | 0.0009 | 0.89 |
| 17 | 29 | 62 | 108 | 3893 | 6696 | 6630409.735 | 0.0010 | 1.01 |
| 17 | 30 | 62 | 230 | 10662 | 14260 | 44966955.92 | 0.0003 | 0.32 |
| 17 | 31 | 62 | 37 | 11341 | 2294 | 50563550.96 | 0.0000 | 0.05 |
| 17 | 32 | 62 | 57 | 10741 | 3534 | 45602112.48 | 0.0001 | 0.08 |
| 17 | 33 | 62 | 142 | 10023 | 8804 | 39984869.94 | 0.0002 | 0.22 |
| 17 | 34 | 62 | 27 | 10316 | 1674 | 42234906.16 | 0.0000 | 0.04 |
| 17 | 35 | 62 | 81 | 10857 | 5022 | 46542391.17 | 0.0001 | 0.11 |
| 17 | 36 | 62 | 331 | 2270 | 20522 | 2379299.584 | 0.0086 | 8.63 |
| 17 | 37 | 62 | 180 | 3717 | 11160 | 6072476.826 | 0.0018 | 1.84 |
| 17 | 38 | 62 | 271 | 6208 | 16802 | 16091934.11 | 0.0010 | 1.04 |
| 17 | 39 | 62 | 121 | 4922 | 7502 | 10353067.79 | 0.0007 | 0.72 |
| 17 | 40 | 62 | 351 | 2018 | 21762 | 1902611.895 | 0.0114 | 11.44 |
| **17** | **41** | **62** | **58** | **323** | **3596** | **58544.32357** | **0.0614** | **61.42** |
| 17 | 42 | 62 | 271 | 2427 | 16802 | 2701671.709 | 0.0062 | 6.22 |
| 17 | 43 | 62 | 179 | 1843 | 11098 | 1601393.778 | 0.0069 | 6.93 |
| 17 | 44 | 62 | 159 | 1792 | 9858 | 1518246.226 | 0.0065 | 6.49 |
| 18 | 2 | 28 | 336 | 5417 | 9408 | 12420577.46 | 0.0008 | 0.76 |
| 18 | 3 | 28 | 43 | 5998 | 1204 | 15073436.53 | 0.0001 | 0.08 |
| 18 | 4 | 28 | 62 | 6856 | 1736 | 19432762.23 | 0.0001 | 0.09 |
| 18 | 5 | 28 | 97 | 3083 | 2716 | 4256471.178 | 0.0006 | 0.64 |
| 18 | 6 | 28 | 156 | 3190 | 4368 | 4541531.155 | 0.0010 | 0.96 |
| 18 | 7 | 28 | 27 | 3710 | 756 | 6050766.981 | 0.0001 | 0.12 |
| 18 | 9 | 28 | 9 | 4409 | 252 | 8399359.847 | 0.0000 | 0.03 |
| 18 | 10 | 28 | 48 | 3877 | 1344 | 6578729.382 | 0.0002 | 0.20 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 18 | 11 | 28 | 16 | 3925 | 448 | 6734344.916 | 0.0001 | 0.07 |
| 18 | 12 | 28 | 66 | 4184 | 1848 | 7603686.177 | 0.0002 | 0.24 |
| 18 | 13 | 28 | 66 | 4586 | 1848 | 9051586.286 | 0.0002 | 0.20 |
| 18 | 14 | 28 | 136 | 4026 | 3808 | 7067408.005 | 0.0005 | 0.54 |
| 18 | 15 | 28 | 232 | 2301 | 6496 | 2441414.814 | 0.0027 | 2.66 |
| 18 | 16 | 28 | 180 | 2370 | 5040 | 2582390.155 | 0.0020 | 1.95 |
| **18** | **17** | **28** | **62** | **273** | **1736** | **42531.33642** | **0.0408** | **40.82** |
| *18* | *19* | *28* | *242* | *925* | *6776* | *432184.6045* | *0.0157* | *15.68* |
| 18 | 20 | 28 | 300 | 2653 | 8400 | 3199637.477 | 0.0026 | 2.63 |
| 18 | 21 | 28 | 64 | 2646 | 1792 | 3183616.125 | 0.0006 | 0.56 |
| 18 | 22 | 28 | 84 | 4391 | 2352 | 8334326.892 | 0.0003 | 0.28 |
| 18 | 23 | 28 | 94 | 3498 | 2632 | 5410752.014 | 0.0005 | 0.49 |
| 18 | 24 | 28 | 149 | 3492 | 4172 | 5393131.957 | 0.0008 | 0.77 |
| 18 | 25 | 28 | 24 | 3816 | 672 | 6383456.386 | 0.0001 | 0.11 |
| 18 | 26 | 28 | 95 | 3911 | 2660 | 6688779.052 | 0.0004 | 0.40 |
| 18 | 27 | 28 | 108 | 5122 | 3024 | 11166965.92 | 0.0003 | 0.27 |
| 18 | 28 | 28 | 272 | 6668 | 7616 | 18432813.25 | 0.0004 | 0.41 |
| 18 | 29 | 28 | 108 | 3615 | 3024 | 5759778.377 | 0.0005 | 0.53 |
| 18 | 30 | 28 | 230 | 10246 | 6440 | 41692051.73 | 0.0002 | 0.15 |
| 18 | 31 | 28 | 37 | 10925 | 1036 | 47097813.62 | 0.0000 | 0.02 |
| 18 | 32 | 28 | 57 | 10326 | 1596 | 42312728.31 | 0.0000 | 0.04 |
| 18 | 33 | 28 | 142 | 9608 | 3976 | 36897988.35 | 0.0001 | 0.11 |
| 18 | 34 | 28 | 27 | 9901 | 756 | 39065214.65 | 0.0000 | 0.02 |
| 18 | 35 | 28 | 81 | 10441 | 2268 | 43212558.65 | 0.0001 | 0.05 |
| 18 | 36 | 28 | 331 | 2395 | 9268 | 2634392.515 | 0.0035 | 3.52 |
| 18 | 37 | 28 | 180 | 3418 | 5040 | 5178058.003 | 0.0010 | 0.97 |
| 18 | 38 | 28 | 271 | 5851 | 7588 | 14379281.52 | 0.0005 | 0.53 |
| 18 | 39 | 28 | 121 | 4575 | 3388 | 9010379.582 | 0.0004 | 0.38 |
| 18 | 40 | 28 | 351 | 1720 | 9828 | 1404442.778 | 0.0070 | 7.00 |
| 18 | 41 | 28 | 58 | 535 | 1624 | 152711.6557 | 0.0106 | 10.63 |
| 18 | 42 | 28 | 271 | 2302 | 7588 | 2443431.153 | 0.0031 | 3.11 |
| 18 | 43 | 28 | 179 | 2063 | 5012 | 1984031.363 | 0.0025 | 2.53 |
| 18 | 44 | 28 | 159 | 2011 | 4452 | 1890091.957 | 0.0024 | 2.36 |
| 19 | 2 | 242 | 336 | 5173 | 81312 | 11379173.23 | 0.0071 | 7.15 |
| 19 | 3 | 242 | 43 | 4979 | 10406 | 10582055.62 | 0.0010 | 0.98 |
| 19 | 4 | 242 | 62 | 6421 | 15004 | 17157147.02 | 0.0009 | 0.87 |
| 19 | 5 | 242 | 97 | 2600 | 23474 | 3079281.276 | 0.0076 | 7.62 |
| 19 | 6 | 242 | 156 | 3094 | 37752 | 4285372.593 | 0.0088 | 8.81 |
| 19 | 7 | 242 | 27 | 3668 | 6534 | 5921281.68 | 0.0011 | 1.10 |
| 19 | 9 | 242 | 9 | 3974 | 2178 | 6894978.865 | 0.0003 | 0.32 |
| 19 | 10 | 242 | 48 | 3480 | 11616 | 5357973.527 | 0.0022 | 2.17 |
| 19 | 11 | 242 | 16 | 4171 | 3872 | 7558861.027 | 0.0005 | 0.51 |
| 19 | 12 | 242 | 66 | 3749 | 15972 | 6172190.714 | 0.0026 | 2.59 |
| 19 | 13 | 242 | 66 | 4129 | 15972 | 7414899.643 | 0.0022 | 2.15 |
| 19 | 14 | 242 | 136 | 3660 | 32912 | 5896768.283 | 0.0056 | 5.58 |
| 19 | 15 | 242 | 232 | 1773 | 56144 | 1487807 | 0.0377 | 37.74 |
| 19 | 16 | 242 | 180 | 1453 | 43560 | 1019306.203 | 0.0427 | 42.73 |
| 19 | 17 | 242 | 62 | 1223 | 15004 | 734700.3866 | 0.0204 | 20.42 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 19 | 18 | 242 | 28 | 925 | 6776 | 432184.6045 | 0.0157 | 15.68 |
| *19* | *20* | *242* | *300* | *1683* | *72600* | *1347596.332* | *0.0539* | *53.87* |
| 19 | 21 | 242 | 64 | 2451 | 15488 | 2752658.221 | 0.0056 | 5.63 |
| 19 | 22 | 242 | 84 | 3441 | 20328 | 5244461.215 | 0.0039 | 3.88 |
| 19 | 23 | 242 | 94 | 2548 | 22748 | 2963322.407 | 0.0077 | 7.68 |
| 19 | 24 | 242 | 149 | 3063 | 36058 | 4204160.562 | 0.0086 | 8.58 |
| 19 | 25 | 242 | 24 | 3476 | 5808 | 5346278.258 | 0.0011 | 1.09 |
| 19 | 26 | 242 | 95 | 3482 | 22990 | 5363825.701 | 0.0043 | 4.29 |
| 19 | 27 | 242 | 108 | 4693 | 26136 | 9457058.01 | 0.0028 | 2.76 |
| 19 | 28 | 242 | 272 | 5594 | 65824 | 13203001.66 | 0.0050 | 4.99 |
| 19 | 29 | 242 | 108 | 2665 | 26136 | 3227191.265 | 0.0081 | 8.10 |
| 19 | 30 | 242 | 230 | 9172 | 55660 | 33781714.52 | 0.0016 | 1.65 |
| 19 | 31 | 242 | 37 | 9851 | 8954 | 38691236.24 | 0.0002 | 0.23 |
| 19 | 32 | 242 | 57 | 9252 | 13794 | 34343747.76 | 0.0004 | 0.40 |
| 19 | 33 | 242 | 142 | 8534 | 34364 | 29457101.64 | 0.0012 | 1.17 |
| 19 | 34 | 242 | 27 | 8827 | 6534 | 31408336.89 | 0.0002 | 0.21 |
| 19 | 35 | 242 | 81 | 9367 | 19602 | 35159362.21 | 0.0006 | 0.56 |
| 19 | 36 | 242 | 331 | 3074 | 80102 | 4232893.483 | 0.0189 | 18.92 |
| 19 | 37 | 242 | 180 | 3692 | 43560 | 5995110.82 | 0.0073 | 7.27 |
| 19 | 38 | 242 | 271 | 5476 | 65582 | 12678869.59 | 0.0052 | 5.17 |
| 19 | 39 | 242 | 121 | 3625 | 29282 | 5790088.752 | 0.0051 | 5.06 |
| **19** | **40** | **242** | **351** | **879** | **84942** | **392264.3703** | **0.2165** | **216.54** |
| 19 | 41 | 242 | 58 | 1500 | 14036 | 1082862.695 | 0.0130 | 12.96 |
| 19 | 42 | 242 | 271 | 2539 | 65582 | 2943466.732 | 0.0223 | 22.28 |
| 19 | 43 | 242 | 179 | 3349 | 43318 | 4981255.065 | 0.0087 | 8.70 |
| 19 | 44 | 242 | 159 | 3157 | 38478 | 4452682.263 | 0.0086 | 8.64 |
| 20 | 2 | 300 | 336 | 4116 | 100800 | 7370605.987 | 0.0137 | 13.68 |
| 20 | 3 | 300 | 43 | 3465 | 12900 | 5314178.696 | 0.0024 | 2.43 |
| 20 | 4 | 300 | 62 | 5245 | 18600 | 11681979.39 | 0.0016 | 1.59 |
| 20 | 5 | 300 | 97 | 2772 | 29100 | 3477820.229 | 0.0084 | 8.37 |
| 20 | 6 | 300 | 156 | 4606 | 46800 | 9126735.697 | 0.0051 | 5.13 |
| 20 | 7 | 300 | 27 | 5320 | 8100 | 12001405.27 | 0.0007 | 0.67 |
| 20 | 9 | 300 | 9 | 3562 | 2700 | 5600392.157 | 0.0005 | 0.48 |
| 20 | 10 | 300 | 48 | 4016 | 14400 | 7034091.897 | 0.0020 | 2.05 |
| 20 | 11 | 300 | 16 | 3844 | 4800 | 6472743.84 | 0.0007 | 0.74 |
| 20 | 12 | 300 | 66 | 4078 | 19800 | 7241853.263 | 0.0027 | 2.73 |
| 20 | 13 | 300 | 66 | 4765 | 19800 | 9734631.574 | 0.0020 | 2.03 |
| 20 | 14 | 300 | 136 | 2972 | 40800 | 3970020.32 | 0.0103 | 10.28 |
| 20 | 15 | 300 | 232 | 1296 | 69600 | 820256.1645 | 0.0849 | 84.85 |
| *20* | *16* | *300* | *180* | *745* | *54000* | *286481.7218* | *0.1885* | *188.49* |
| 20 | 17 | 300 | 62 | 2980 | 18600 | 3990349.189 | 0.0047 | 4.66 |
| 20 | 18 | 300 | 28 | 2653 | 8400 | 3199637.477 | 0.0026 | 2.63 |
| 20 | 19 | 300 | 242 | 1683 | 72600 | 1347596.332 | 0.0539 | 53.87 |
| 20 | 21 | 300 | 64 | 471 | 19200 | 119878.0648 | 0.1602 | 160.16 |
| 20 | 22 | 300 | 84 | 1204 | 25200 | 713165.4992 | 0.0353 | 35.34 |
| 20 | 23 | 300 | 94 | 713 | 28200 | 263554.3002 | 0.1070 | 107.00 |
| 20 | 24 | 300 | 149 | 2660 | 44700 | 3215696.919 | 0.0139 | 13.90 |
| 20 | 25 | 300 | 24 | 3575 | 7200 | 5639290.765 | 0.0013 | 1.28 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 20 | 26 | 300 | 95 | 2545 | 28500 | 2956696.823 | 0.0096 | 9.64 |
| 20 | 27 | 300 | 108 | 3755 | 32400 | 6190972.695 | 0.0052 | 5.23 |
| 20 | 28 | 300 | 272 | 4534 | 81600 | 8857575.85 | 0.0092 | 9.21 |
| **20** | **29** | **300** | **108** | **428** | **32400** | **99940.87815** | **0.3242** | **324.19** |
| 20 | 30 | 300 | 230 | 7735 | 69000 | 24438503.28 | 0.0028 | 2.82 |
| 20 | 31 | 300 | 37 | 8414 | 11100 | 28675088.35 | 0.0004 | 0.39 |
| 20 | 32 | 300 | 57 | 7813 | 17100 | 24908860.83 | 0.0007 | 0.69 |
| 20 | 33 | 300 | 142 | 7096 | 42600 | 20745592.98 | 0.0021 | 2.05 |
| 20 | 34 | 300 | 27 | 7389 | 8100 | 22403339.82 | 0.0004 | 0.36 |
| 20 | 35 | 300 | 81 | 7930 | 24300 | 25622355.7 | 0.0009 | 0.95 |
| 20 | 36 | 300 | 331 | 4790 | 99300 | 9831900.516 | 0.0101 | 10.10 |
| 20 | 37 | 300 | 180 | 4398 | 54000 | 8359589.033 | 0.0065 | 6.46 |
| 20 | 38 | 300 | 271 | 4177 | 81300 | 7579533.957 | 0.0107 | 10.73 |
| 20 | 39 | 300 | 121 | 1772 | 36300 | 1486213.026 | 0.0244 | 24.42 |
| 20 | 40 | 300 | 351 | 1171 | 105300 | 676484.89 | 0.1557 | 155.66 |
| 20 | 41 | 300 | 58 | 3282 | 17400 | 4793616.602 | 0.0036 | 3.63 |
| 20 | 42 | 300 | 271 | 3245 | 81300 | 4691459.075 | 0.0173 | 17.33 |
| 20 | 43 | 300 | 179 | 4381 | 53700 | 8298300.949 | 0.0065 | 6.47 |
| 20 | 44 | 300 | 159 | 4843 | 47700 | 10039625 | 0.0048 | 4.75 |
| 21 | 2 | 64 | 336 | 3697 | 21504 | 6010546.427 | 0.0036 | 3.58 |
| 21 | 3 | 64 | 43 | 3844 | 2752 | 6472743.84 | 0.0004 | 0.43 |
| 21 | 4 | 64 | 62 | 4787 | 3968 | 9820204.057 | 0.0004 | 0.40 |
| 21 | 5 | 64 | 97 | 3291 | 6208 | 4818623.301 | 0.0013 | 1.29 |
| 21 | 6 | 64 | 156 | 4620 | 9984 | 9179515.374 | 0.0011 | 1.09 |
| 21 | 7 | 64 | 27 | 5251 | 1728 | 11707383.23 | 0.0001 | 0.15 |
| 21 | 9 | 64 | 9 | 2874 | 576 | 3724987.77 | 0.0002 | 0.15 |
| 21 | 10 | 64 | 48 | 3352 | 3072 | 4989736.581 | 0.0006 | 0.62 |
| 21 | 11 | 64 | 16 | 3265 | 1024 | 4746549.919 | 0.0002 | 0.22 |
| 21 | 12 | 64 | 66 | 3585 | 4224 | 5669299.543 | 0.0007 | 0.75 |
| 21 | 13 | 64 | 66 | 4061 | 4224 | 7184601.424 | 0.0006 | 0.59 |
| 21 | 14 | 64 | 136 | 2493 | 8704 | 2842970.342 | 0.0031 | 3.06 |
| 21 | 15 | 64 | 232 | 797 | 14848 | 325664.7932 | 0.0456 | 45.59 |
| **21** | **16** | **64** | **180** | **246** | **11520** | **34896.08479** | **0.3301** | **330.12** |
| 21 | 17 | 64 | 62 | 2994 | 3968 | 4026043.031 | 0.0010 | 0.99 |
| 21 | 18 | 64 | 28 | 2646 | 1792 | 3183616.125 | 0.0006 | 0.56 |
| 21 | 19 | 64 | 242 | 2451 | 15488 | 2752658.221 | 0.0056 | 5.63 |
| *21* | *20* | *64* | *300* | *471* | *19200* | *119878.0648* | *0.1602* | *160.16* |
| 21 | 22 | 64 | 84 | 1990 | 5376 | 1852767.164 | 0.0029 | 2.90 |
| 21 | 23 | 64 | 94 | 668 | 6016 | 232849.4834 | 0.0258 | 25.84 |
| 21 | 24 | 64 | 149 | 2293 | 9536 | 2425312.494 | 0.0039 | 3.93 |
| 21 | 25 | 64 | 24 | 2903 | 1536 | 3796726.977 | 0.0004 | 0.40 |
| 21 | 26 | 64 | 95 | 2178 | 6080 | 2199429.082 | 0.0028 | 2.76 |
| 21 | 27 | 64 | 108 | 3388 | 6912 | 5092047.699 | 0.0014 | 1.36 |
| 21 | 28 | 64 | 272 | 4519 | 17408 | 8801981.441 | 0.0020 | 1.98 |
| 21 | 29 | 64 | 108 | 1214 | 6912 | 724461.8237 | 0.0095 | 9.54 |
| 21 | 30 | 64 | 230 | 8135 | 14720 | 26895483.67 | 0.0005 | 0.55 |
| 21 | 31 | 64 | 37 | 8841 | 2368 | 31503052.87 | 0.0001 | 0.08 |
| 21 | 32 | 64 | 57 | 8213 | 3648 | 27387567.65 | 0.0001 | 0.13 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 21 | 33 | 64 | 142 | 7496 | 9088 | 23023757.27 | 0.0004 | 0.39 |
| 21 | 34 | 64 | 27 | 7789 | 1728 | 24763683.08 | 0.0001 | 0.07 |
| 21 | 35 | 64 | 81 | 8330 | 5184 | 28133612.58 | 0.0002 | 0.18 |
| 21 | 36 | 64 | 331 | 4634 | 21184 | 9232439.193 | 0.0023 | 2.29 |
| 21 | 37 | 64 | 180 | 3974 | 11520 | 6894978.865 | 0.0017 | 1.67 |
| 21 | 38 | 64 | 271 | 4644 | 17344 | 9270330.146 | 0.0019 | 1.87 |
| 21 | 39 | 64 | 121 | 1741 | 7744 | 1437201.511 | 0.0054 | 5.39 |
| 21 | 40 | 64 | 351 | 1007 | 22464 | 507874.0162 | 0.0442 | 44.23 |
| 21 | 41 | 64 | 58 | 3126 | 3712 | 4369975.982 | 0.0008 | 0.85 |
| 21 | 42 | 64 | 271 | 2822 | 17344 | 3597976.462 | 0.0048 | 4.82 |
| 21 | 43 | 64 | 179 | 4186 | 11456 | 7610593.496 | 0.0015 | 1.51 |
| 21 | 44 | 64 | 159 | 4749 | 10176 | 9672619.908 | 0.0011 | 1.05 |
| 22 | 2 | 84 | 336 | 5676 | 28224 | 13573146.45 | 0.0021 | 2.08 |
| 22 | 3 | 84 | 43 | 2649 | 3612 | 3190477.754 | 0.0011 | 1.13 |
| 22 | 4 | 84 | 62 | 5923 | 5208 | 14717338.95 | 0.0004 | 0.35 |
| 22 | 5 | 84 | 97 | 3262 | 8148 | 4738266.872 | 0.0017 | 1.72 |
| 22 | 6 | 84 | 156 | 6364 | 13104 | 16868921.8 | 0.0008 | 0.78 |
| 22 | 7 | 84 | 27 | 7077 | 2268 | 20640179.58 | 0.0001 | 0.11 |
| 22 | 9 | 84 | 9 | 4905 | 756 | 10285232.71 | 0.0001 | 0.07 |
| 22 | 10 | 84 | 48 | 5382 | 4032 | 12268543.79 | 0.0003 | 0.33 |
| 22 | 11 | 84 | 16 | 5295 | 1344 | 11894476.5 | 0.0001 | 0.11 |
| 22 | 12 | 84 | 66 | 5615 | 5544 | 13297333.01 | 0.0004 | 0.42 |
| 22 | 13 | 84 | 66 | 6092 | 5544 | 15525435.81 | 0.0004 | 0.36 |
| 22 | 14 | 84 | 136 | 4473 | 11424 | 8632526.228 | 0.0013 | 1.32 |
| 22 | 15 | 84 | 232 | 2777 | 19488 | 3489748.84 | 0.0056 | 5.58 |
| 22 | 16 | 84 | 180 | 2225 | 15120 | 2290482.77 | 0.0066 | 6.60 |
| 22 | 17 | 84 | 62 | 4669 | 5208 | 9365379.071 | 0.0006 | 0.56 |
| 22 | 18 | 84 | 28 | 4391 | 2352 | 8334326.892 | 0.0003 | 0.28 |
| 22 | 19 | 84 | 242 | 3441 | 20328 | 5244461.215 | 0.0039 | 3.88 |
| **22** | **20** | **84** | **300** | **1204** | **25200** | **713165.4992** | **0.0353** | **35.34** |
| 22 | 21 | 84 | 64 | 1990 | 5376 | 1852767.164 | 0.0029 | 2.90 |
| 22 | 23 | 84 | 94 | 1033 | 7896 | 533077.8174 | 0.0148 | 14.81 |
| 22 | 24 | 84 | 149 | 4344 | 12516 | 8165647.94 | 0.0015 | 1.53 |
| 22 | 25 | 84 | 24 | 4878 | 2016 | 10177928.89 | 0.0002 | 0.20 |
| 22 | 26 | 84 | 95 | 3241 | 7980 | 4680477.469 | 0.0017 | 1.70 |
| 22 | 27 | 84 | 108 | 4451 | 9072 | 8552034.203 | 0.0011 | 1.06 |
| 22 | 28 | 84 | 272 | 5135 | 22848 | 11220878.27 | 0.0020 | 2.04 |
| *22* | *29* | *84* | *108* | *735* | *9072* | *279219.6281* | *0.0325* | *32.49* |
| 22 | 30 | 84 | 230 | 6958 | 19320 | 19985747.97 | 0.0010 | 0.97 |
| 22 | 31 | 84 | 37 | 7636 | 3108 | 23847631.24 | 0.0001 | 0.13 |
| 22 | 32 | 84 | 57 | 7046 | 4788 | 20468735.49 | 0.0002 | 0.23 |
| 22 | 33 | 84 | 142 | 6328 | 11928 | 16688076.96 | 0.0007 | 0.71 |
| 22 | 34 | 84 | 27 | 6612 | 2268 | 18139796.28 | 0.0001 | 0.13 |
| 22 | 35 | 84 | 81 | 7152 | 6804 | 21057764.33 | 0.0003 | 0.32 |
| 22 | 36 | 84 | 331 | 6503 | 27804 | 17575841.71 | 0.0016 | 1.58 |
| 22 | 37 | 84 | 180 | 6115 | 15120 | 15636994.26 | 0.0010 | 0.97 |
| 22 | 38 | 84 | 271 | 5862 | 22764 | 14430688.32 | 0.0016 | 1.58 |
| 22 | 39 | 84 | 121 | 1101 | 10164 | 601722.0218 | 0.0169 | 16.89 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 22 | 40 | 84 | 351 | 2887 | 29484 | 3757066.563 | 0.0078 | 7.85 |
| 22 | 41 | 84 | 58 | 4998 | 4872 | 10658912.04 | 0.0005 | 0.46 |
| 22 | 42 | 84 | 271 | 4999 | 22764 | 10662964.41 | 0.0021 | 2.13 |
| 22 | 43 | 84 | 179 | 6096 | 15036 | 15544810.1 | 0.0010 | 0.97 |
| 22 | 44 | 84 | 159 | 6559 | 13356 | 17864526.05 | 0.0007 | 0.75 |
| 23 | 2 | 94 | 336 | 4486 | 31584 | 8680257.557 | 0.0036 | 3.64 |
| 23 | 3 | 94 | 43 | 2732 | 4042 | 3383088.201 | 0.0012 | 1.19 |
| 23 | 4 | 94 | 62 | 5387 | 5828 | 12290208.58 | 0.0005 | 0.47 |
| 23 | 5 | 94 | 97 | 2517 | 9118 | 2895196.93 | 0.0031 | 3.15 |
| 23 | 6 | 94 | 156 | 5471 | 14664 | 12656882.78 | 0.0012 | 1.16 |
| 23 | 7 | 94 | 27 | 6184 | 2538 | 15973938.71 | 0.0002 | 0.16 |
| 23 | 9 | 94 | 9 | 4121 | 846 | 7387627.131 | 0.0001 | 0.11 |
| 23 | 10 | 94 | 48 | 4542 | 4512 | 8887293.99 | 0.0005 | 0.51 |
| 23 | 11 | 94 | 16 | 4403 | 1504 | 8377655.591 | 0.0002 | 0.18 |
| 23 | 12 | 94 | 66 | 4724 | 6204 | 9576102.566 | 0.0006 | 0.65 |
| 23 | 13 | 94 | 66 | 5199 | 6204 | 11488085.34 | 0.0005 | 0.54 |
| 23 | 14 | 94 | 136 | 3581 | 12784 | 5657286.979 | 0.0023 | 2.26 |
| 23 | 15 | 94 | 232 | 1792 | 21808 | 1518246.226 | 0.0144 | 14.36 |
| 23 | 16 | 94 | 180 | 1333 | 16920 | 865321.0805 | 0.0196 | 19.55 |
| 23 | 17 | 94 | 62 | 3845 | 5828 | 6475943.542 | 0.0009 | 0.90 |
| 23 | 18 | 94 | 28 | 3498 | 2632 | 5410752.014 | 0.0005 | 0.49 |
| 23 | 19 | 94 | 242 | 2548 | 22748 | 2963322.407 | 0.0077 | 7.68 |
| *23* | *20* | *94* | *300* | *713* | *28200* | *263554.3002* | *0.1070* | *107.00* |
| 23 | 21 | 94 | 64 | 668 | 6016 | 232849.4834 | 0.0258 | 25.84 |
| 23 | 22 | 94 | 84 | 1033 | 7896 | 533077.8174 | 0.0148 | 14.81 |
| 23 | 24 | 94 | 149 | 3338 | 14006 | 4950214.654 | 0.0028 | 2.83 |
| 23 | 25 | 94 | 24 | 3952 | 2256 | 6822635.635 | 0.0003 | 0.33 |
| 23 | 26 | 94 | 95 | 3303 | 8930 | 4852061.423 | 0.0018 | 1.84 |
| 23 | 27 | 94 | 108 | 4513 | 10152 | 8779790.108 | 0.0012 | 1.16 |
| 23 | 28 | 94 | 272 | 3737 | 25568 | 6134707.858 | 0.0042 | 4.17 |
| **23** | **29** | **94** | **108** | **322** | **10152** | **58200.42503** | **0.1744** | **174.43** |
| 23 | 30 | 94 | 230 | 6992 | 21620 | 20171709.14 | 0.0011 | 1.07 |
| 23 | 31 | 94 | 37 | 7671 | 3478 | 24055742.55 | 0.0001 | 0.14 |
| 23 | 32 | 94 | 57 | 7070 | 5358 | 20601407.2 | 0.0003 | 0.26 |
| 23 | 33 | 94 | 142 | 6352 | 13348 | 16808537.6 | 0.0008 | 0.79 |
| 23 | 34 | 94 | 27 | 6646 | 2538 | 18317434.2 | 0.0001 | 0.14 |
| 23 | 35 | 94 | 81 | 7187 | 7614 | 21253992.61 | 0.0004 | 0.36 |
| 23 | 36 | 94 | 331 | 5579 | 31114 | 13135816.91 | 0.0024 | 2.37 |
| 23 | 37 | 94 | 180 | 5189 | 16920 | 11446137.91 | 0.0015 | 1.48 |
| 23 | 38 | 94 | 271 | 4934 | 25474 | 10401078.54 | 0.0024 | 2.45 |
| 23 | 39 | 94 | 121 | 1027 | 11374 | 527210.2471 | 0.0216 | 21.57 |
| 23 | 40 | 94 | 351 | 1960 | 32994 | 1800058.152 | 0.0183 | 18.33 |
| 23 | 41 | 94 | 58 | 4072 | 5452 | 7221622.154 | 0.0008 | 0.75 |
| 23 | 42 | 94 | 271 | 4073 | 25474 | 7224992.143 | 0.0035 | 3.53 |
| 23 | 43 | 94 | 179 | 5170 | 16826 | 11366638.08 | 0.0015 | 1.48 |
| 23 | 44 | 94 | 159 | 5633 | 14946 | 13378441.6 | 0.0011 | 1.12 |
| 24 | 2 | 149 | 336 | 2366 | 50064 | 2574115.363 | 0.0194 | 19.45 |
| 24 | 3 | 149 | 43 | 6077 | 6407 | 15452884.16 | 0.0004 | 0.41 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 24 | 4 | 149 | 62 | 2335 | 9238 | 2510412.457 | 0.0037 | 3.68 |
| 24 | 5 | 149 | 97 | 5492 | 14453 | 12749348.84 | 0.0011 | 1.13 |
| 24 | 6 | 149 | 156 | 6570 | 23244 | 17921493.63 | 0.0013 | 1.30 |
| 24 | 7 | 149 | 27 | 7007 | 4023 | 20254010.15 | 0.0002 | 0.20 |
| 24 | 9 | 149 | 9 | 540 | 1341 | 155434.7588 | 0.0086 | 8.63 |
| 24 | 10 | 149 | 48 | 850 | 7152 | 368040.7939 | 0.0194 | 19.43 |
| 24 | 11 | 149 | 16 | 862 | 2384 | 377975.6348 | 0.0063 | 6.31 |
| 24 | 12 | 149 | 66 | 1143 | 9834 | 646082.2917 | 0.0152 | 15.22 |
| 24 | 13 | 149 | 66 | 1108 | 9834 | 609011.5718 | 0.0161 | 16.15 |
| **24** | **14** | **149** | **136** | **629** | **20264** | **207699.8708** | **0.0976** | **97.56** |
| 24 | 15 | 149 | 232 | 1592 | 34568 | 1212528.124 | 0.0285 | 28.51 |
| 24 | 16 | 149 | 180 | 2106 | 26820 | 2063340.473 | 0.0130 | 13.00 |
| 24 | 17 | 149 | 62 | 3745 | 9238 | 6159684.412 | 0.0015 | 1.50 |
| 24 | 18 | 149 | 28 | 3492 | 4172 | 5393131.957 | 0.0008 | 0.77 |
| 24 | 19 | 149 | 242 | 3063 | 36058 | 4204160.562 | 0.0086 | 8.58 |
| 24 | 20 | 149 | 300 | 2660 | 44700 | 3215696.919 | 0.0139 | 13.90 |
| 24 | 21 | 149 | 64 | 2293 | 9536 | 2425312.494 | 0.0039 | 3.93 |
| 24 | 22 | 149 | 84 | 4344 | 12516 | 8165647.94 | 0.0015 | 1.53 |
| 24 | 23 | 149 | 94 | 3338 | 14006 | 4950214.654 | 0.0028 | 2.83 |
| 24 | 25 | 149 | 24 | 389 | 3576 | 83349.73867 | 0.0429 | 42.90 |
| *24* | *26* | *149* | *95* | *717* | *14155* | *266370.6655* | *0.0531* | *53.14* |
| 24 | 27 | 149 | 108 | 2283 | 16092 | 2405255.585 | 0.0067 | 6.69 |
| 24 | 28 | 149 | 272 | 7684 | 40528 | 24133259.16 | 0.0017 | 1.68 |
| 24 | 29 | 149 | 108 | 3513 | 16092 | 5454921.242 | 0.0029 | 2.95 |
| 24 | 30 | 149 | 230 | 10434 | 34270 | 43157530.04 | 0.0008 | 0.79 |
| 24 | 31 | 149 | 37 | 11113 | 5513 | 48649625.03 | 0.0001 | 0.11 |
| 24 | 32 | 149 | 57 | 10512 | 8493 | 43772582.43 | 0.0002 | 0.19 |
| 24 | 33 | 149 | 142 | 9795 | 21158 | 38274403.99 | 0.0006 | 0.55 |
| 24 | 34 | 149 | 27 | 10088 | 4023 | 40478987.39 | 0.0001 | 0.10 |
| 24 | 35 | 149 | 81 | 10629 | 12069 | 44702887.18 | 0.0003 | 0.27 |
| 24 | 36 | 149 | 331 | 5922 | 49319 | 14712618.23 | 0.0034 | 3.35 |
| 24 | 37 | 149 | 180 | 2986 | 26820 | 4005628.113 | 0.0067 | 6.70 |
| 24 | 38 | 149 | 271 | 2071 | 40379 | 1998675.035 | 0.0202 | 20.20 |
| 24 | 39 | 149 | 121 | 4470 | 18029 | 8621529.012 | 0.0021 | 2.09 |
| 24 | 40 | 149 | 351 | 2175 | 52299 | 2193676.569 | 0.0238 | 23.84 |
| 24 | 41 | 149 | 58 | 4075 | 8642 | 7231734.357 | 0.0012 | 1.20 |
| 24 | 42 | 149 | 271 | 2053 | 40379 | 1965798.52 | 0.0205 | 20.54 |
| 24 | 43 | 149 | 179 | 3751 | 26671 | 6178448.37 | 0.0043 | 4.32 |
| 24 | 44 | 149 | 159 | 4743 | 23691 | 9649413.933 | 0.0025 | 2.46 |
| 25 | 2 | 24 | 336 | 2530 | 8064 | 2923674.3 | 0.0028 | 2.76 |
| 25 | 3 | 24 | 43 | 6663 | 1032 | 18406560.61 | 0.0001 | 0.06 |
| 25 | 4 | 24 | 62 | 2170 | 1488 | 2184104.906 | 0.0007 | 0.68 |
| 25 | 5 | 24 | 97 | 5905 | 2328 | 14632475.77 | 0.0002 | 0.16 |
| 25 | 6 | 24 | 156 | 6894 | 3744 | 19637917.46 | 0.0002 | 0.19 |
| 25 | 7 | 24 | 27 | 7331 | 648 | 22070395.57 | 0.0000 | 0.03 |
| 25 | 9 | 24 | 9 | 247 | 216 | 35166.10036 | 0.0061 | 6.14 |
| 25 | 10 | 24 | 48 | 717 | 1152 | 266370.6655 | 0.0043 | 4.32 |
| 25 | 11 | 24 | 16 | 504 | 384 | 136338.3454 | 0.0028 | 2.82 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 25 | 12 | 24 | 66 | 825 | 1584 | 347746.2875 | 0.0046 | 4.56 |
| 25 | 13 | 24 | 66 | 790 | 1584 | 320251.7219 | 0.0049 | 4.95 |
| *25* | *14* | *24* | *136* | *607* | *3264* | *194114.7393* | *0.0168* | *16.81* |
| 25 | 15 | 24 | 232 | 1966 | 5568 | 1810542.299 | 0.0031 | 3.08 |
| 25 | 16 | 24 | 180 | 2480 | 4320 | 2814869.035 | 0.0015 | 1.53 |
| 25 | 17 | 24 | 62 | 3946 | 1488 | 6802968.401 | 0.0002 | 0.22 |
| 25 | 18 | 24 | 28 | 3816 | 672 | 6383456.386 | 0.0001 | 0.11 |
| 25 | 19 | 24 | 242 | 3476 | 5808 | 5346278.258 | 0.0011 | 1.09 |
| 25 | 20 | 24 | 300 | 3575 | 7200 | 5639290.765 | 0.0013 | 1.28 |
| 25 | 21 | 24 | 64 | 2903 | 1536 | 3796726.977 | 0.0004 | 0.40 |
| 25 | 22 | 24 | 84 | 4878 | 2016 | 10177928.89 | 0.0002 | 0.20 |
| 25 | 23 | 24 | 94 | 3952 | 2256 | 6822635.635 | 0.0003 | 0.33 |
| **25** | **24** | **24** | **149** | **398** | **3576** | **87051.8163** | **0.0411** | **41.08** |
| 25 | 26 | 24 | 95 | 899 | 2280 | 409395.8296 | 0.0056 | 5.57 |
| 25 | 27 | 24 | 108 | 2127 | 2592 | 2102607.605 | 0.0012 | 1.23 |
| 25 | 28 | 24 | 272 | 8062 | 6528 | 26438773.74 | 0.0002 | 0.25 |
| 25 | 29 | 24 | 108 | 4145 | 2592 | 7469587.453 | 0.0003 | 0.35 |
| 25 | 30 | 24 | 230 | 11001 | 5520 | 47722272.13 | 0.0001 | 0.12 |
| 25 | 31 | 24 | 37 | 11680 | 888 | 53473843.57 | 0.0000 | 0.02 |
| 25 | 32 | 24 | 57 | 11079 | 1368 | 48367213.58 | 0.0000 | 0.03 |
| 25 | 33 | 24 | 142 | 10362 | 3408 | 42593449.85 | 0.0001 | 0.08 |
| 25 | 34 | 24 | 27 | 10655 | 648 | 44910879.78 | 0.0000 | 0.01 |
| 25 | 35 | 24 | 81 | 11196 | 1944 | 49342311.49 | 0.0000 | 0.04 |
| 25 | 36 | 24 | 331 | 6216 | 7944 | 16131357.31 | 0.0005 | 0.49 |
| 25 | 37 | 24 | 180 | 3363 | 4320 | 5020893.944 | 0.0009 | 0.86 |
| 25 | 38 | 24 | 271 | 1733 | 6504 | 1424679.808 | 0.0046 | 4.57 |
| 25 | 39 | 24 | 121 | 5038 | 2904 | 10821575.9 | 0.0003 | 0.27 |
| 25 | 40 | 24 | 351 | 2681 | 8424 | 3264103.691 | 0.0026 | 2.58 |
| 25 | 41 | 24 | 58 | 4226 | 1392 | 7749363.559 | 0.0002 | 0.18 |
| 25 | 42 | 24 | 271 | 2332 | 6504 | 2504287.799 | 0.0026 | 2.60 |
| 25 | 43 | 24 | 179 | 4038 | 4296 | 7107485.752 | 0.0006 | 0.60 |
| 25 | 44 | 24 | 159 | 5277 | 3816 | 11817768.52 | 0.0003 | 0.32 |
| 26 | 2 | 95 | 336 | 1592 | 31920 | 1212528.124 | 0.0263 | 26.33 |
| 26 | 3 | 95 | 43 | 6062 | 4085 | 15380493.51 | 0.0003 | 0.27 |
| 26 | 4 | 95 | 62 | 2349 | 5890 | 2539087.877 | 0.0023 | 2.32 |
| 26 | 5 | 95 | 97 | 5912 | 9215 | 14665450.5 | 0.0006 | 0.63 |
| 26 | 6 | 95 | 156 | 6989 | 14820 | 20155267.98 | 0.0007 | 0.74 |
| 26 | 7 | 95 | 27 | 7426 | 2565 | 22616968.61 | 0.0001 | 0.11 |
| 26 | 9 | 95 | 9 | 1200 | 855 | 708670.5209 | 0.0012 | 1.21 |
| 26 | 10 | 95 | 48 | 1663 | 4560 | 1317332.097 | 0.0035 | 3.46 |
| 26 | 11 | 95 | 16 | 1515 | 1520 | 1103529.64 | 0.0014 | 1.38 |
| 26 | 12 | 95 | 66 | 1072 | 6270 | 571965.8405 | 0.0110 | 10.96 |
| 26 | 13 | 95 | 66 | 1751 | 6270 | 1452926.609 | 0.0043 | 4.32 |
| **26** | **14** | **95** | **136** | **586** | **12920** | **181553.8531** | **0.0712** | **71.16** |
| 26 | 15 | 95 | 232 | 2011 | 22040 | 1890091.957 | 0.0117 | 11.66 |
| 26 | 16 | 95 | 180 | 2144 | 17100 | 2134651.997 | 0.0080 | 8.01 |
| 26 | 17 | 95 | 62 | 4185 | 5890 | 7607139.465 | 0.0008 | 0.77 |
| 26 | 18 | 95 | 28 | 3911 | 2660 | 6688779.052 | 0.0004 | 0.40 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 26 | 19 | 95 | 242 | 3482 | 22990 | 5363825.701 | 0.0043 | 4.29 |
| 26 | 20 | 95 | 300 | 2545 | 28500 | 2956696.823 | 0.0096 | 9.64 |
| 26 | 21 | 95 | 64 | 2178 | 6080 | 2199429.082 | 0.0028 | 2.76 |
| 26 | 22 | 95 | 84 | 3241 | 7980 | 4680477.469 | 0.0017 | 1.70 |
| 26 | 23 | 95 | 94 | 3303 | 8930 | 4852061.423 | 0.0018 | 1.84 |
| *26* | *24* | *95* | *149* | *717* | *14155* | *266370.6655* | *0.0531* | *53.14* |
| 26 | 25 | 95 | 24 | 899 | 2280 | 409395.8296 | 0.0056 | 5.57 |
| 26 | 27 | 95 | 108 | 1197 | 10260 | 705308.1232 | 0.0145 | 14.55 |
| 26 | 28 | 95 | 272 | 7157 | 25840 | 21085744.16 | 0.0012 | 1.23 |
| 26 | 29 | 95 | 108 | 3432 | 10260 | 5218429.618 | 0.0020 | 1.97 |
| 26 | 30 | 95 | 230 | 10352 | 21850 | 42515383.44 | 0.0005 | 0.51 |
| 26 | 31 | 95 | 37 | 11031 | 3515 | 47969841.19 | 0.0001 | 0.07 |
| 26 | 32 | 95 | 57 | 10430 | 5415 | 43126100.04 | 0.0001 | 0.13 |
| 26 | 33 | 95 | 142 | 9713 | 13490 | 37667902.59 | 0.0004 | 0.36 |
| 26 | 34 | 95 | 27 | 10006 | 2565 | 39856113.53 | 0.0001 | 0.06 |
| 26 | 35 | 95 | 81 | 10547 | 7695 | 44049907.16 | 0.0002 | 0.17 |
| 26 | 36 | 95 | 331 | 6627 | 31445 | 18218064.87 | 0.0017 | 1.73 |
| 26 | 37 | 95 | 180 | 3819 | 17100 | 6392994.796 | 0.0027 | 2.67 |
| 26 | 38 | 95 | 271 | 1829 | 25745 | 1578359.906 | 0.0163 | 16.31 |
| 26 | 39 | 95 | 121 | 4389 | 11495 | 8327115.789 | 0.0014 | 1.38 |
| 26 | 40 | 95 | 351 | 2808 | 33345 | 3564137.88 | 0.0094 | 9.36 |
| 26 | 41 | 95 | 58 | 4603 | 5510 | 9115444.523 | 0.0006 | 0.60 |
| 26 | 42 | 95 | 271 | 2735 | 25745 | 3390150.109 | 0.0076 | 7.59 |
| 26 | 43 | 95 | 179 | 4433 | 17005 | 8486442.822 | 0.0020 | 2.00 |
| 26 | 44 | 95 | 159 | 5271 | 15105 | 11792251.44 | 0.0013 | 1.28 |
| **27** | **2** | **108** | **336** | **589** | **36288** | **183323.8883** | **0.1979** | **197.94** |
| 27 | 3 | 108 | 43 | 7252 | 4644 | 21620703.02 | 0.0002 | 0.21 |
| 27 | 4 | 108 | 62 | 834 | 6696 | 354989.4907 | 0.0189 | 18.86 |
| 27 | 5 | 108 | 97 | 7122 | 10476 | 20890255.02 | 0.0005 | 0.50 |
| 27 | 6 | 108 | 156 | 8200 | 16848 | 27305260.21 | 0.0006 | 0.62 |
| 27 | 7 | 108 | 27 | 8635 | 2916 | 30123015.8 | 0.0001 | 0.10 |
| 27 | 9 | 108 | 9 | 2356 | 972 | 2553483.428 | 0.0004 | 0.38 |
| 27 | 10 | 108 | 48 | 2850 | 5184 | 3666107.825 | 0.0014 | 1.41 |
| 27 | 11 | 108 | 16 | 2246 | 1728 | 2331731.44 | 0.0007 | 0.74 |
| 27 | 12 | 108 | 66 | 2327 | 7128 | 2494095.784 | 0.0029 | 2.86 |
| 27 | 13 | 108 | 66 | 2484 | 7128 | 2823501.507 | 0.0025 | 2.52 |
| 27 | 14 | 108 | 136 | 1832 | 14688 | 1583282.428 | 0.0093 | 9.28 |
| 27 | 15 | 108 | 232 | 3222 | 25056 | 4628481.355 | 0.0054 | 5.41 |
| 27 | 16 | 108 | 180 | 3355 | 19440 | 4998224.933 | 0.0039 | 3.89 |
| 27 | 17 | 108 | 62 | 5396 | 6696 | 12329250.82 | 0.0005 | 0.54 |
| 27 | 18 | 108 | 28 | 5122 | 3024 | 11166965.92 | 0.0003 | 0.27 |
| 27 | 19 | 108 | 242 | 4693 | 26136 | 9457058.01 | 0.0028 | 2.76 |
| 27 | 20 | 108 | 300 | 3755 | 32400 | 6190972.695 | 0.0052 | 5.23 |
| 27 | 21 | 108 | 64 | 3388 | 6912 | 5092047.699 | 0.0014 | 1.36 |
| 27 | 22 | 108 | 84 | 4451 | 9072 | 8552034.203 | 0.0011 | 1.06 |
| 27 | 23 | 108 | 94 | 4513 | 10152 | 8779790.108 | 0.0012 | 1.16 |
| 27 | 24 | 108 | 149 | 2283 | 16092 | 2405255.585 | 0.0067 | 6.69 |
| 27 | 25 | 108 | 24 | 2127 | 2592 | 2102607.605 | 0.0012 | 1.23 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 27 | 26 | 108 | 95 | 1197 | 10260 | 705308.1232 | 0.0145 | 14.55 |
| 27 | 28 | 108 | 272 | 8256 | 29376 | 27660651.19 | 0.0011 | 1.06 |
| 27 | 29 | 108 | 108 | 4530 | 11664 | 8842734.462 | 0.0013 | 1.32 |
| 27 | 30 | 108 | 230 | 11451 | 24840 | 51499437.78 | 0.0005 | 0.48 |
| 27 | 31 | 108 | 37 | 12130 | 3996 | 57456017.71 | 0.0001 | 0.07 |
| 27 | 32 | 108 | 57 | 11529 | 6156 | 52167991.26 | 0.0001 | 0.12 |
| 27 | 33 | 108 | 142 | 10812 | 15336 | 46176548.74 | 0.0003 | 0.33 |
| 27 | 34 | 108 | 27 | 11105 | 2916 | 48583105.21 | 0.0001 | 0.06 |
| 27 | 35 | 108 | 81 | 11646 | 8748 | 53178476.72 | 0.0002 | 0.16 |
| 27 | 36 | 108 | 331 | 7540 | 35748 | 23281210.48 | 0.0015 | 1.54 |
| 27 | 37 | 108 | 180 | 5564 | 19440 | 13068794.55 | 0.0015 | 1.49 |
| *27* | *38* | *108* | *271* | *1465* | *29268* | *1035360.249* | *0.0283* | *28.27* |
| 27 | 39 | 108 | 121 | 5487 | 13068 | 12727304.2 | 0.0010 | 1.03 |
| 27 | 40 | 108 | 351 | 3900 | 37908 | 6653080.118 | 0.0057 | 5.70 |
| 27 | 41 | 108 | 58 | 5716 | 6264 | 13755463.16 | 0.0005 | 0.46 |
| 27 | 42 | 108 | 271 | 3786 | 29268 | 6288443.428 | 0.0047 | 4.65 |
| 27 | 43 | 108 | 179 | 5485 | 19332 | 12718491.4 | 0.0015 | 1.52 |
| 27 | 44 | 108 | 159 | 6360 | 17172 | 16848782.33 | 0.0010 | 1.02 |
| 28 | 2 | 272 | 336 | 8626 | 91392 | 30063390.79 | 0.0030 | 3.04 |
| 28 | 3 | 272 | 43 | 2344 | 11696 | 2528828.946 | 0.0046 | 4.63 |
| 28 | 4 | 272 | 62 | 9715 | 16864 | 37682640.7 | 0.0004 | 0.45 |
| 28 | 5 | 272 | 97 | 4167 | 26384 | 7545093.932 | 0.0035 | 3.50 |
| 28 | 6 | 272 | 156 | 4651 | 42432 | 9296897.548 | 0.0046 | 4.56 |
| 28 | 7 | 272 | 27 | 5856 | 7344 | 14402637.47 | 0.0005 | 0.51 |
| 28 | 9 | 272 | 9 | 8154 | 2448 | 27014960.91 | 0.0001 | 0.09 |
| 28 | 10 | 272 | 48 | 8608 | 13056 | 29944308.66 | 0.0004 | 0.44 |
| 28 | 11 | 272 | 16 | 8436 | 4352 | 28817711.22 | 0.0002 | 0.15 |
| 28 | 12 | 272 | 66 | 8670 | 17952 | 30355422.73 | 0.0006 | 0.59 |
| 28 | 13 | 272 | 66 | 9318 | 17952 | 34810730.87 | 0.0005 | 0.52 |
| 28 | 14 | 272 | 136 | 7462 | 36992 | 22825745.2 | 0.0016 | 1.62 |
| 28 | 15 | 272 | 232 | 5796 | 63104 | 14123551.44 | 0.0045 | 4.47 |
| 28 | 16 | 272 | 180 | 5255 | 48960 | 11724333.64 | 0.0042 | 4.18 |
| 28 | 17 | 272 | 62 | 6756 | 16864 | 18897759.5 | 0.0009 | 0.89 |
| 28 | 18 | 272 | 28 | 6668 | 7616 | 18432813.25 | 0.0004 | 0.41 |
| 28 | 19 | 272 | 242 | 5594 | 65824 | 13203001.66 | 0.0050 | 4.99 |
| **28** | **20** | **272** | **300** | **4534** | **81600** | **8857575.85** | **0.0092** | **9.21** |
| 28 | 21 | 272 | 64 | 4519 | 17408 | 8801981.441 | 0.0020 | 1.98 |
| 28 | 22 | 272 | 84 | 5135 | 22848 | 11220878.27 | 0.0020 | 2.04 |
| 28 | 23 | 272 | 94 | 3737 | 25568 | 6134707.858 | 0.0042 | 4.17 |
| 28 | 24 | 272 | 149 | 7684 | 40528 | 24133259.16 | 0.0017 | 1.68 |
| 28 | 25 | 272 | 24 | 8062 | 6528 | 26438773.74 | 0.0002 | 0.25 |
| 28 | 26 | 272 | 95 | 7157 | 25840 | 21085744.16 | 0.0012 | 1.23 |
| 28 | 27 | 272 | 108 | 8256 | 29376 | 27660651.19 | 0.0011 | 1.06 |
| 28 | 29 | 272 | 108 | 4069 | 29376 | 7211516.653 | 0.0041 | 4.07 |
| 28 | 30 | 272 | 230 | 4820 | 62560 | 9949227.753 | 0.0063 | 6.29 |
| 28 | 31 | 272 | 37 | 4998 | 10064 | 10658912.04 | 0.0009 | 0.94 |
| 28 | 32 | 272 | 57 | 4635 | 15504 | 9236224.98 | 0.0017 | 1.68 |
| 28 | 33 | 272 | 142 | 3902 | 38624 | 6659564.102 | 0.0058 | 5.80 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 28 | 34 | 272 | 27 | 4353 | 7344 | 8197821.686 | 0.0009 | 0.90 |
| 28 | 35 | 272 | 81 | 4672 | 22032 | 9376815.802 | 0.0023 | 2.35 |
| 28 | 36 | 272 | 331 | 7543 | 90032 | 23298813.48 | 0.0039 | 3.86 |
| 28 | 37 | 272 | 180 | 8881 | 48960 | 31774414.24 | 0.0015 | 1.54 |
| 28 | 38 | 272 | 271 | 8793 | 73712 | 31178874.87 | 0.0024 | 2.36 |
| 28 | 39 | 272 | 121 | 4152 | 32912 | 7493573.22 | 0.0044 | 4.39 |
| *28* | *40* | *272* | *351* | *5654* | *95472* | *13473363.53* | *0.0071* | *7.09* |
| 28 | 41 | 272 | 58 | 7246 | 15776 | 21586728.35 | 0.0007 | 0.73 |
| 28 | 42 | 272 | 271 | 4689 | 73712 | 9441748.81 | 0.0078 | 7.81 |
| 28 | 43 | 272 | 179 | 8867 | 48688 | 31679312.36 | 0.0015 | 1.54 |
| 28 | 44 | 272 | 159 | 8913 | 43248 | 31992296.96 | 0.0014 | 1.35 |
| 29 | 2 | 108 | 336 | 4921 | 36288 | 10349071.65 | 0.0035 | 3.51 |
| 29 | 3 | 108 | 43 | 2695 | 4644 | 3296565.142 | 0.0014 | 1.41 |
| 29 | 4 | 108 | 62 | 5167 | 6696 | 11354109.46 | 0.0006 | 0.59 |
| 29 | 5 | 108 | 97 | 2486 | 10476 | 2827822.438 | 0.0037 | 3.70 |
| 29 | 6 | 108 | 156 | 5580 | 16848 | 13140290.85 | 0.0013 | 1.28 |
| 29 | 7 | 108 | 27 | 6302 | 2916 | 16558041.16 | 0.0002 | 0.18 |
| 29 | 9 | 108 | 9 | 4129 | 972 | 7414899.643 | 0.0001 | 0.13 |
| 29 | 10 | 108 | 48 | 4607 | 5184 | 9130500.893 | 0.0006 | 0.57 |
| 29 | 11 | 108 | 16 | 4519 | 1728 | 8801981.441 | 0.0002 | 0.20 |
| 29 | 12 | 108 | 66 | 4840 | 7128 | 10027812.09 | 0.0007 | 0.71 |
| 29 | 13 | 108 | 66 | 5316 | 7128 | 11984266.2 | 0.0006 | 0.59 |
| 29 | 14 | 108 | 136 | 3697 | 14688 | 6010546.427 | 0.0024 | 2.44 |
| 29 | 15 | 108 | 232 | 2001 | 25056 | 1872274.268 | 0.0134 | 13.38 |
| 29 | 16 | 108 | 180 | 1450 | 19440 | 1015311.264 | 0.0191 | 19.15 |
| 29 | 17 | 108 | 62 | 3893 | 6696 | 6630409.735 | 0.0010 | 1.01 |
| 29 | 18 | 108 | 28 | 3615 | 3024 | 5759778.377 | 0.0005 | 0.53 |
| 29 | 19 | 108 | 242 | 2665 | 26136 | 3227191.265 | 0.0081 | 8.10 |
| **29** | **20** | **108** | **300** | **428** | **32400** | **99940.87815** | **0.3242** | **324.19** |
| 29 | 21 | 108 | 64 | 1214 | 6912 | 724461.8237 | 0.0095 | 9.54 |
| 29 | 22 | 108 | 84 | 735 | 9072 | 279219.6281 | 0.0325 | 32.49 |
| *29* | *23* | *108* | *94* | *322* | *10152* | *58200.42503* | *0.1744* | *174.43* |
| 29 | 24 | 108 | 149 | 3513 | 16092 | 5454921.242 | 0.0029 | 2.95 |
| 29 | 25 | 108 | 24 | 4145 | 2592 | 7469587.453 | 0.0003 | 0.35 |
| 29 | 26 | 108 | 95 | 3432 | 10260 | 5218429.618 | 0.0020 | 1.97 |
| 29 | 27 | 108 | 108 | 4530 | 11664 | 8842734.462 | 0.0013 | 1.32 |
| 29 | 28 | 108 | 272 | 4069 | 29376 | 7211516.653 | 0.0041 | 4.07 |
| 29 | 30 | 108 | 230 | 6963 | 24840 | 20013044.03 | 0.0012 | 1.24 |
| 29 | 31 | 108 | 37 | 7642 | 3996 | 23883246.63 | 0.0002 | 0.17 |
| 29 | 32 | 108 | 57 | 7041 | 6156 | 20441146.66 | 0.0003 | 0.30 |
| 29 | 33 | 108 | 142 | 6323 | 15336 | 16663032.66 | 0.0009 | 0.92 |
| 29 | 34 | 108 | 27 | 6617 | 2916 | 18165868.07 | 0.0002 | 0.16 |
| 29 | 35 | 108 | 81 | 7158 | 8748 | 21091342.23 | 0.0004 | 0.41 |
| 29 | 36 | 108 | 331 | 5762 | 35748 | 13966551.35 | 0.0026 | 2.56 |
| 29 | 37 | 108 | 180 | 5372 | 19440 | 12225268.54 | 0.0016 | 1.59 |
| 29 | 38 | 108 | 271 | 5009 | 29268 | 10703528.26 | 0.0027 | 2.73 |
| 29 | 39 | 108 | 121 | 932 | 13068 | 438419.8746 | 0.0298 | 29.81 |
| 29 | 40 | 108 | 351 | 2143 | 37908 | 2132760.678 | 0.0178 | 17.77 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 29 | 41 | 108 | 58 | 4254 | 6264 | 7847209.053 | 0.0008 | 0.80 |
| 29 | 42 | 108 | 271 | 4239 | 29268 | 7794719.503 | 0.0038 | 3.75 |
| 29 | 43 | 108 | 179 | 5353 | 19332 | 12143245.14 | 0.0016 | 1.59 |
| 29 | 44 | 108 | 159 | 5816 | 17172 | 14216292.68 | 0.0012 | 1.21 |
| 30 | 2 | 230 | 336 | 12507 | 77280 | 60896311.02 | 0.0013 | 1.27 |
| 30 | 3 | 230 | 43 | 4460 | 9890 | 8584919.587 | 0.0012 | 1.15 |
| 30 | 4 | 230 | 62 | 12424 | 14260 | 60130766.67 | 0.0002 | 0.24 |
| 30 | 5 | 230 | 97 | 9188 | 22310 | 33893769.71 | 0.0007 | 0.66 |
| 30 | 6 | 230 | 156 | 9589 | 35880 | 36759475.44 | 0.0010 | 0.98 |
| 30 | 7 | 230 | 27 | 12595 | 6210 | 61712981.18 | 0.0001 | 0.10 |
| 30 | 9 | 230 | 9 | 11157 | 2070 | 49016254.57 | 0.0000 | 0.04 |
| 30 | 10 | 230 | 48 | 11579 | 11040 | 52598699.03 | 0.0002 | 0.21 |
| 30 | 11 | 230 | 16 | 11439 | 3680 | 51396945.99 | 0.0001 | 0.07 |
| 30 | 12 | 230 | 66 | 11760 | 15180 | 54171880.44 | 0.0003 | 0.28 |
| 30 | 13 | 230 | 66 | 12235 | 15180 | 58404666.72 | 0.0003 | 0.26 |
| 30 | 14 | 230 | 136 | 10617 | 31280 | 44607044.86 | 0.0007 | 0.70 |
| 30 | 15 | 230 | 232 | 8829 | 53360 | 31421859.47 | 0.0017 | 1.70 |
| 30 | 16 | 230 | 180 | 8368 | 41400 | 28377960.24 | 0.0015 | 1.46 |
| 30 | 17 | 230 | 62 | 10662 | 14260 | 44966955.92 | 0.0003 | 0.32 |
| 30 | 18 | 230 | 28 | 10246 | 6440 | 41692051.73 | 0.0002 | 0.15 |
| 30 | 19 | 230 | 242 | 9172 | 55660 | 33781714.52 | 0.0016 | 1.65 |
| 30 | 20 | 230 | 300 | 7735 | 69000 | 24438503.28 | 0.0028 | 2.82 |
| 30 | 21 | 230 | 64 | 8135 | 14720 | 26895483.67 | 0.0005 | 0.55 |
| 30 | 22 | 230 | 84 | 6958 | 19320 | 19985747.97 | 0.0010 | 0.97 |
| 30 | 23 | 230 | 94 | 6992 | 21620 | 20171709.14 | 0.0011 | 1.07 |
| 30 | 24 | 230 | 149 | 10434 | 34270 | 43157530.04 | 0.0008 | 0.79 |
| 30 | 25 | 230 | 24 | 11001 | 5520 | 47722272.13 | 0.0001 | 0.12 |
| 30 | 26 | 230 | 95 | 10352 | 21850 | 42515383.44 | 0.0005 | 0.51 |
| 30 | 27 | 230 | 108 | 11451 | 24840 | 51499437.78 | 0.0005 | 0.48 |
| 30 | 28 | 230 | 272 | 4820 | 62560 | 9949227.753 | 0.0063 | 6.29 |
| 30 | 29 | 230 | 108 | 6963 | 24840 | 20013044.03 | 0.0012 | 1.24 |
| 30 | 31 | 230 | 37 | 689 | 8510 | 246954.2597 | 0.0345 | 34.46 |
| *30* | *32* | *230* | *57* | *689* | *13110* | *246954.2597* | *0.0531* | *53.09* |
| 30 | 33 | 230 | 142 | 1224 | 32660 | 735842.2054 | 0.0444 | 44.38 |
| 30 | 34 | 230 | 27 | 467 | 6210 | 117951.1211 | 0.0526 | 52.65 |
| **30** | **35** | **230** | **81** | **353** | **18630** | **69306.1765** | **0.2688** | **268.81** |
| 30 | 36 | 230 | 331 | 11926 | 76130 | 55633979.93 | 0.0014 | 1.37 |
| 30 | 37 | 230 | 180 | 12263 | 41400 | 58658882.32 | 0.0007 | 0.71 |
| 30 | 38 | 230 | 271 | 12015 | 62330 | 56425468.38 | 0.0011 | 1.10 |
| 30 | 39 | 230 | 121 | 6023 | 27830 | 15193031.56 | 0.0018 | 1.83 |
| 30 | 40 | 230 | 351 | 9034 | 80730 | 32822538.3 | 0.0025 | 2.46 |
| 30 | 41 | 230 | 58 | 10942 | 13340 | 47237156.83 | 0.0003 | 0.28 |
| 30 | 42 | 230 | 271 | 11131 | 62330 | 48799452.24 | 0.0013 | 1.28 |
| 30 | 43 | 230 | 179 | 12244 | 41170 | 58486321.84 | 0.0007 | 0.70 |
| 30 | 44 | 230 | 159 | 12707 | 36570 | 62759829.76 | 0.0006 | 0.58 |
| 31 | 2 | 37 | 336 | 13185 | 12432 | 67321262.96 | 0.0002 | 0.18 |
| 31 | 3 | 37 | 43 | 4700 | 1591 | 9483877.377 | 0.0002 | 0.17 |
| 31 | 4 | 37 | 62 | 13103 | 2294 | 66527990.85 | 0.0000 | 0.03 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 31 | 5 | 37 | 97 | 9177 | 3589 | 33816712.89 | 0.0001 | 0.11 |
| 31 | 6 | 37 | 156 | 9605 | 5772 | 36876101.48 | 0.0002 | 0.16 |
| 31 | 7 | 37 | 27 | 10807 | 999 | 46135984 | 0.0000 | 0.02 |
| 31 | 9 | 37 | 9 | 11836 | 333 | 54838986.18 | 0.0000 | 0.01 |
| 31 | 10 | 37 | 48 | 12258 | 1776 | 58613448.32 | 0.0000 | 0.03 |
| 31 | 11 | 37 | 16 | 12118 | 592 | 57348069.32 | 0.0000 | 0.01 |
| 31 | 12 | 37 | 66 | 12439 | 2442 | 60268778.41 | 0.0000 | 0.04 |
| 31 | 13 | 37 | 66 | 12914 | 2442 | 64716569.18 | 0.0000 | 0.04 |
| 31 | 14 | 37 | 136 | 11296 | 5032 | 50183032.2 | 0.0001 | 0.10 |
| 31 | 15 | 37 | 232 | 9508 | 8584 | 36171742.36 | 0.0002 | 0.24 |
| 31 | 16 | 37 | 180 | 9048 | 6660 | 32919249.43 | 0.0002 | 0.20 |
| 31 | 17 | 37 | 62 | 11341 | 2294 | 50563550.96 | 0.0000 | 0.05 |
| 31 | 18 | 37 | 28 | 10925 | 1036 | 47097813.62 | 0.0000 | 0.02 |
| 31 | 19 | 37 | 242 | 9851 | 8954 | 38691236.24 | 0.0002 | 0.23 |
| 31 | 20 | 37 | 300 | 8414 | 11100 | 28675088.35 | 0.0004 | 0.39 |
| 31 | 21 | 37 | 64 | 8814 | 2368 | 31320507.3 | 0.0001 | 0.08 |
| 31 | 22 | 37 | 84 | 7636 | 3108 | 23847631.24 | 0.0001 | 0.13 |
| 31 | 23 | 37 | 94 | 7671 | 3478 | 24055742.55 | 0.0001 | 0.14 |
| 31 | 24 | 37 | 149 | 11113 | 5513 | 48649625.03 | 0.0001 | 0.11 |
| 31 | 25 | 37 | 24 | 11680 | 888 | 53473843.57 | 0.0000 | 0.02 |
| 31 | 26 | 37 | 95 | 11031 | 3515 | 47969841.19 | 0.0001 | 0.07 |
| 31 | 27 | 37 | 108 | 12130 | 3996 | 57456017.71 | 0.0001 | 0.07 |
| 31 | 28 | 37 | 272 | 4998 | 10064 | 10658912.04 | 0.0009 | 0.94 |
| 31 | 29 | 37 | 108 | 7642 | 3996 | 23883246.63 | 0.0002 | 0.17 |
| *31* | *30* | *37* | *230* | *689* | *8510* | *246954.2597* | *0.0345* | *34.46* |
| **31** | **32** | **37** | **57** | **280** | **2109** | **44627.26375** | **0.0473** | **47.26** |
| 31 | 33 | 37 | 142 | 1018 | 5254 | 518466.593 | 0.0101 | 10.13 |
| 31 | 34 | 37 | 27 | 720 | 999 | 268492.2431 | 0.0037 | 3.72 |
| 31 | 35 | 37 | 81 | 445 | 2997 | 107617.778 | 0.0278 | 27.85 |
| 31 | 36 | 37 | 331 | 12738 | 12247 | 63051056 | 0.0002 | 0.19 |
| 31 | 37 | 37 | 180 | 12986 | 6660 | 65403841.47 | 0.0001 | 0.10 |
| 31 | 38 | 37 | 271 | 12430 | 10027 | 60185953.38 | 0.0002 | 0.17 |
| 31 | 39 | 37 | 121 | 6780 | 4477 | 19025514.86 | 0.0002 | 0.24 |
| 31 | 40 | 37 | 351 | 9637 | 12987 | 37109878.47 | 0.0003 | 0.35 |
| 31 | 41 | 37 | 58 | 11538 | 2146 | 52245394.85 | 0.0000 | 0.04 |
| 31 | 42 | 37 | 271 | 11734 | 10027 | 53944548.11 | 0.0002 | 0.19 |
| 31 | 43 | 37 | 179 | 12847 | 6623 | 64080114.02 | 0.0001 | 0.10 |
| 31 | 44 | 37 | 159 | 13310 | 5883 | 68539085.49 | 0.0001 | 0.09 |
| 32 | 2 | 57 | 336 | 12585 | 19152 | 61619918.25 | 0.0003 | 0.31 |
| 32 | 3 | 57 | 43 | 6381 | 2451 | 16954641.64 | 0.0001 | 0.14 |
| 32 | 4 | 57 | 62 | 13609 | 3534 | 71494034.7 | 0.0000 | 0.05 |
| 32 | 5 | 57 | 97 | 8693 | 5529 | 30508607.9 | 0.0002 | 0.18 |
| 32 | 6 | 57 | 156 | 9211 | 8892 | 34055156.97 | 0.0003 | 0.26 |
| 32 | 7 | 57 | 27 | 10394 | 1539 | 42843718.16 | 0.0000 | 0.04 |
| 32 | 9 | 57 | 9 | 11236 | 513 | 49677792.37 | 0.0000 | 0.01 |
| 32 | 10 | 57 | 48 | 11657 | 2736 | 53273951.78 | 0.0001 | 0.05 |
| 32 | 11 | 57 | 16 | 11517 | 912 | 52064871.04 | 0.0000 | 0.02 |
| 32 | 12 | 57 | 66 | 11838 | 3762 | 54856593.82 | 0.0001 | 0.07 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 32 | 13 | 57 | 66 | 12312 | 3762 | 59105017.87 | 0.0001 | 0.06 |
| 32 | 14 | 57 | 136 | 10696 | 7752 | 45239797.17 | 0.0002 | 0.17 |
| 32 | 15 | 57 | 232 | 8907 | 13224 | 31951390.23 | 0.0004 | 0.41 |
| 32 | 16 | 57 | 180 | 8447 | 10260 | 28889148.34 | 0.0004 | 0.36 |
| 32 | 17 | 57 | 62 | 10741 | 3534 | 45602112.48 | 0.0001 | 0.08 |
| 32 | 18 | 57 | 28 | 10326 | 1596 | 42312728.31 | 0.0000 | 0.04 |
| 32 | 19 | 57 | 242 | 9252 | 13794 | 34343747.76 | 0.0004 | 0.40 |
| 32 | 20 | 57 | 300 | 7813 | 17100 | 24908860.83 | 0.0007 | 0.69 |
| 32 | 21 | 57 | 64 | 8213 | 3648 | 27387567.65 | 0.0001 | 0.13 |
| 32 | 22 | 57 | 84 | 7046 | 4788 | 20468735.49 | 0.0002 | 0.23 |
| 32 | 23 | 57 | 94 | 7070 | 5358 | 20601407.2 | 0.0003 | 0.26 |
| 32 | 24 | 57 | 149 | 10512 | 8493 | 43772582.43 | 0.0002 | 0.19 |
| 32 | 25 | 57 | 24 | 11079 | 1368 | 48367213.58 | 0.0000 | 0.03 |
| 32 | 26 | 57 | 95 | 10430 | 5415 | 43126100.04 | 0.0001 | 0.13 |
| 32 | 27 | 57 | 108 | 11529 | 6156 | 52167991.26 | 0.0001 | 0.12 |
| 32 | 28 | 57 | 272 | 4635 | 15504 | 9236224.98 | 0.0017 | 1.68 |
| 32 | 29 | 57 | 108 | 7041 | 6156 | 20441146.66 | 0.0003 | 0.30 |
| *32* | *30* | *57* | *230* | *689* | *13110* | *246954.2597* | *0.0531* | *53.09* |
| 32 | 31 | 57 | 37 | 280 | 2109 | 44627.26375 | 0.0473 | 47.26 |
| 32 | 33 | 57 | 142 | 677 | 8094 | 238846.2739 | 0.0339 | 33.89 |
| 32 | 34 | 57 | 27 | 739 | 1539 | 282113.8663 | 0.0055 | 5.46 |
| **32** | **35** | **57** | **81** | **351** | **4617** | **68562.00687** | **0.0673** | **67.34** |
| 32 | 36 | 57 | 331 | 12021 | 18867 | 56479017.68 | 0.0003 | 0.33 |
| 32 | 37 | 57 | 180 | 11488 | 10260 | 51816062.88 | 0.0002 | 0.20 |
| 32 | 38 | 57 | 271 | 11616 | 15447 | 52918502.56 | 0.0003 | 0.29 |
| 32 | 39 | 57 | 121 | 5910 | 6897 | 14656025.56 | 0.0005 | 0.47 |
| 32 | 40 | 57 | 351 | 8920 | 20007 | 32040052.82 | 0.0006 | 0.62 |
| 32 | 41 | 57 | 58 | 10821 | 3306 | 46249607.81 | 0.0001 | 0.07 |
| 32 | 42 | 57 | 271 | 11017 | 15447 | 47854233.45 | 0.0003 | 0.32 |
| 32 | 43 | 57 | 179 | 12130 | 10203 | 57456017.71 | 0.0002 | 0.18 |
| 32 | 44 | 57 | 159 | 12593 | 9063 | 61694363.27 | 0.0001 | 0.15 |
| 33 | 2 | 142 | 336 | 11868 | 47712 | 55121029.65 | 0.0009 | 0.87 |
| 33 | 3 | 142 | 43 | 5648 | 6106 | 13446210.54 | 0.0005 | 0.45 |
| 33 | 4 | 142 | 62 | 12892 | 8804 | 64507255.36 | 0.0001 | 0.14 |
| 33 | 5 | 142 | 97 | 8020 | 13774 | 26177688.75 | 0.0005 | 0.53 |
| 33 | 6 | 142 | 156 | 8509 | 22152 | 29293360.41 | 0.0008 | 0.76 |
| 33 | 7 | 142 | 27 | 9711 | 3834 | 37653167.2 | 0.0001 | 0.10 |
| 33 | 9 | 142 | 9 | 10519 | 1278 | 43827981 | 0.0000 | 0.03 |
| 33 | 10 | 142 | 48 | 10940 | 6816 | 47220753.39 | 0.0001 | 0.14 |
| 33 | 11 | 142 | 16 | 10800 | 2272 | 46079221.74 | 0.0000 | 0.05 |
| 33 | 12 | 142 | 66 | 11121 | 9372 | 48716187.96 | 0.0002 | 0.19 |
| 33 | 13 | 142 | 66 | 11596 | 9372 | 52745521.76 | 0.0002 | 0.18 |
| 33 | 14 | 142 | 136 | 9979 | 19312 | 39652022.41 | 0.0005 | 0.49 |
| 33 | 15 | 142 | 232 | 8190 | 32944 | 27242026.64 | 0.0012 | 1.21 |
| 33 | 16 | 142 | 180 | 7730 | 25560 | 24408497.04 | 0.0010 | 1.05 |
| 33 | 17 | 142 | 62 | 10023 | 8804 | 39984869.94 | 0.0002 | 0.22 |
| 33 | 18 | 142 | 28 | 9608 | 3976 | 36897988.35 | 0.0001 | 0.11 |
| 33 | 19 | 142 | 242 | 8534 | 34364 | 29457101.64 | 0.0012 | 1.17 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 33 | 20 | 142 | 300 | 7096 | 42600 | 20745592.98 | 0.0021 | 2.05 |
| 33 | 21 | 142 | 64 | 7496 | 9088 | 23023757.27 | 0.0004 | 0.39 |
| 33 | 22 | 142 | 84 | 6328 | 11928 | 16688076.96 | 0.0007 | 0.71 |
| 33 | 23 | 142 | 94 | 6352 | 13348 | 16808537.6 | 0.0008 | 0.79 |
| 33 | 24 | 142 | 149 | 9795 | 21158 | 38274403.99 | 0.0006 | 0.55 |
| 33 | 25 | 142 | 24 | 10362 | 3408 | 42593449.85 | 0.0001 | 0.08 |
| 33 | 26 | 142 | 95 | 9713 | 13490 | 37667902.59 | 0.0004 | 0.36 |
| 33 | 27 | 142 | 108 | 10812 | 15336 | 46176548.74 | 0.0003 | 0.33 |
| 33 | 28 | 142 | 272 | 3902 | 38624 | 6659564.102 | 0.0058 | 5.80 |
| 33 | 29 | 142 | 108 | 6323 | 15336 | 16663032.66 | 0.0009 | 0.92 |
| **33** | **30** | **142** | **230** | **1224** | **32660** | **735842.2054** | **0.0444** | **44.38** |
| 33 | 31 | 142 | 37 | 1018 | 5254 | 518466.593 | 0.0101 | 10.13 |
| 33 | 32 | 142 | 57 | 677 | 8094 | 238846.2739 | 0.0339 | 33.89 |
| 33 | 34 | 142 | 27 | 724 | 3834 | 271333.4118 | 0.0141 | 14.13 |
| *33* | *35* | *142* | *81* | *806* | *11502* | *332687.5735* | *0.0346* | *34.57* |
| 33 | 36 | 142 | 331 | 11344 | 47002 | 50588967.29 | 0.0009 | 0.93 |
| 33 | 37 | 142 | 180 | 11364 | 25560 | 50758564.06 | 0.0005 | 0.50 |
| 33 | 38 | 142 | 271 | 11224 | 38482 | 49577035.05 | 0.0008 | 0.78 |
| 33 | 39 | 142 | 121 | 5233 | 17182 | 11631250.15 | 0.0015 | 1.48 |
| 33 | 40 | 142 | 351 | 8135 | 49842 | 26895483.67 | 0.0019 | 1.85 |
| 33 | 41 | 142 | 58 | 10144 | 8236 | 40906993.05 | 0.0002 | 0.20 |
| 33 | 42 | 142 | 271 | 10232 | 38482 | 41583880.09 | 0.0009 | 0.93 |
| 33 | 43 | 142 | 179 | 11345 | 25418 | 50597440.74 | 0.0005 | 0.50 |
| 33 | 44 | 142 | 159 | 11808 | 22578 | 54592760.43 | 0.0004 | 0.41 |
| 34 | 2 | 27 | 336 | 12161 | 9072 | 57735329.42 | 0.0002 | 0.16 |
| 34 | 3 | 27 | 43 | 4088 | 1161 | 7275631.349 | 0.0002 | 0.16 |
| 34 | 4 | 27 | 62 | 12078 | 1674 | 56988935.92 | 0.0000 | 0.03 |
| 34 | 5 | 27 | 97 | 8816 | 2619 | 31334011.96 | 0.0001 | 0.08 |
| 34 | 6 | 27 | 156 | 9218 | 4212 | 34104346.9 | 0.0001 | 0.12 |
| 34 | 7 | 27 | 27 | 12224 | 729 | 58304939.41 | 0.0000 | 0.01 |
| 34 | 9 | 27 | 9 | 10812 | 243 | 46176548.74 | 0.0000 | 0.01 |
| 34 | 10 | 27 | 48 | 11233 | 1296 | 49652593.96 | 0.0000 | 0.03 |
| 34 | 11 | 27 | 16 | 11093 | 432 | 48483406.32 | 0.0000 | 0.01 |
| 34 | 12 | 27 | 66 | 11414 | 1782 | 51183732.1 | 0.0000 | 0.03 |
| 34 | 13 | 27 | 66 | 11889 | 1782 | 55306493.1 | 0.0000 | 0.03 |
| 34 | 14 | 27 | 136 | 10272 | 3672 | 41893295.04 | 0.0001 | 0.09 |
| 34 | 15 | 27 | 232 | 8483 | 6264 | 29123528.23 | 0.0002 | 0.22 |
| 34 | 16 | 27 | 180 | 8023 | 4860 | 26196296.98 | 0.0002 | 0.19 |
| 34 | 17 | 27 | 62 | 10316 | 1674 | 42234906.16 | 0.0000 | 0.04 |
| 34 | 18 | 27 | 28 | 9901 | 756 | 39065214.65 | 0.0000 | 0.02 |
| 34 | 19 | 27 | 242 | 8827 | 6534 | 31408336.89 | 0.0002 | 0.21 |
| 34 | 20 | 27 | 300 | 7389 | 8100 | 22403339.82 | 0.0004 | 0.36 |
| 34 | 21 | 27 | 64 | 7789 | 1728 | 24763683.08 | 0.0001 | 0.07 |
| 34 | 22 | 27 | 84 | 6612 | 2268 | 18139796.28 | 0.0001 | 0.13 |
| 34 | 23 | 27 | 94 | 6646 | 2538 | 18317434.2 | 0.0001 | 0.14 |
| 34 | 24 | 27 | 149 | 10088 | 4023 | 40478987.39 | 0.0001 | 0.10 |
| 34 | 25 | 27 | 24 | 10655 | 648 | 44910879.78 | 0.0000 | 0.01 |
| 34 | 26 | 27 | 95 | 1006 | 2565 | 506916.1916 | 0.0051 | 5.06 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 34 | 27 | 27 | 108 | 11105 | 2916 | 48583105.21 | 0.0001 | 0.06 |
| 34 | 28 | 27 | 272 | 4353 | 7344 | 8197821.686 | 0.0009 | 0.90 |
| 34 | 29 | 27 | 108 | 6617 | 2916 | 18165868.07 | 0.0002 | 0.16 |
| **34** | **30** | **27** | **230** | **467** | **6210** | **117951.1211** | **0.0526** | **52.65** |
| 34 | 31 | 27 | 37 | 720 | 999 | 268492.2431 | 0.0037 | 3.72 |
| 34 | 32 | 27 | 57 | 739 | 1539 | 282113.8663 | 0.0055 | 5.46 |
| 34 | 33 | 27 | 142 | 724 | 3834 | 271333.4118 | 0.0141 | 14.13 |
| *34* | *35* | *27* | *81* | *505* | *2187* | *136852.7782* | *0.0160* | *15.98* |
| 34 | 36 | 27 | 331 | 11761 | 8937 | 54180633.04 | 0.0002 | 0.16 |
| 34 | 37 | 27 | 180 | 11882 | 4860 | 55244639.16 | 0.0001 | 0.09 |
| 34 | 38 | 27 | 271 | 11551 | 7317 | 52357296.01 | 0.0001 | 0.14 |
| 34 | 39 | 27 | 121 | 5642 | 3267 | 13419083.51 | 0.0002 | 0.24 |
| 34 | 40 | 27 | 351 | 8653 | 9477 | 30242433.69 | 0.0003 | 0.31 |
| 34 | 41 | 27 | 58 | 10560 | 1566 | 44153124.77 | 0.0000 | 0.04 |
| 34 | 42 | 27 | 271 | 10750 | 7317 | 45674739.81 | 0.0002 | 0.16 |
| 34 | 43 | 27 | 179 | 11863 | 4833 | 55076915.18 | 0.0001 | 0.09 |
| 34 | 44 | 27 | 159 | 12326 | 4293 | 59232779.23 | 0.0001 | 0.07 |
| 35 | 2 | 81 | 336 | 12721 | 27216 | 62891272.2 | 0.0004 | 0.43 |
| 35 | 3 | 81 | 43 | 4367 | 3483 | 8247988.84 | 0.0004 | 0.42 |
| 35 | 4 | 81 | 62 | 12639 | 5022 | 62123248.34 | 0.0001 | 0.08 |
| 35 | 5 | 81 | 97 | 8782 | 7857 | 31104807.81 | 0.0003 | 0.25 |
| 35 | 6 | 81 | 156 | 9270 | 12636 | 34470810.49 | 0.0004 | 0.37 |
| 35 | 7 | 81 | 27 | 10654 | 2187 | 44902871.6 | 0.0000 | 0.05 |
| 35 | 9 | 81 | 9 | 11352 | 729 | 50656773.73 | 0.0000 | 0.01 |
| 35 | 10 | 81 | 48 | 11774 | 3888 | 54294477.72 | 0.0001 | 0.07 |
| 35 | 11 | 81 | 16 | 11664 | 1296 | 53334750.87 | 0.0000 | 0.02 |
| 35 | 12 | 81 | 66 | 11955 | 5346 | 55891298.93 | 0.0001 | 0.10 |
| 35 | 13 | 81 | 66 | 12430 | 5346 | 60185953.38 | 0.0001 | 0.09 |
| 35 | 14 | 81 | 136 | 10812 | 11016 | 46176548.74 | 0.0002 | 0.24 |
| 35 | 15 | 81 | 232 | 9024 | 18792 | 32753541.45 | 0.0006 | 0.57 |
| 35 | 16 | 81 | 180 | 8564 | 14580 | 29654161.7 | 0.0005 | 0.49 |
| 35 | 17 | 81 | 62 | 10857 | 5022 | 46542391.17 | 0.0001 | 0.11 |
| 35 | 18 | 81 | 28 | 10441 | 2268 | 43212558.65 | 0.0001 | 0.05 |
| 35 | 19 | 81 | 242 | 9367 | 19602 | 35159362.21 | 0.0006 | 0.56 |
| 35 | 20 | 81 | 300 | 7930 | 24300 | 25622355.7 | 0.0009 | 0.95 |
| 35 | 21 | 81 | 64 | 8330 | 5184 | 28133612.58 | 0.0002 | 0.18 |
| 35 | 22 | 81 | 84 | 7152 | 6804 | 21057764.33 | 0.0003 | 0.32 |
| 35 | 23 | 81 | 94 | 7187 | 7614 | 21253992.61 | 0.0004 | 0.36 |
| 35 | 24 | 81 | 149 | 10629 | 12069 | 44702887.18 | 0.0003 | 0.27 |
| 35 | 25 | 81 | 24 | 11196 | 1944 | 49342311.49 | 0.0000 | 0.04 |
| 35 | 26 | 81 | 95 | 10547 | 7695 | 44049907.16 | 0.0002 | 0.17 |
| 35 | 27 | 81 | 108 | 11646 | 8748 | 53178476.72 | 0.0002 | 0.16 |
| 35 | 28 | 81 | 272 | 4672 | 22032 | 9376815.802 | 0.0023 | 2.35 |
| 35 | 29 | 81 | 108 | 7158 | 8748 | 21091342.23 | 0.0004 | 0.41 |
| **35** | **30** | **81** | **230** | **353** | **18630** | **69306.1765** | **0.2688** | **268.81** |
| 35 | 31 | 81 | 37 | 445 | 2997 | 107617.778 | 0.0278 | 27.85 |
| *35* | *32* | *81* | *57* | *351* | *4617* | *68562.00687* | *0.0673* | *67.34* |
| 35 | 33 | 81 | 142 | 806 | 11502 | 332687.5735 | 0.0346 | 34.57 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 35 | 34 | 81 | 27 | 505 | 2187 | 136852.7782 | 0.0160 | 15.98 |
| 35 | 36 | 81 | 331 | 12432 | 26811 | 60204354.28 | 0.0004 | 0.45 |
| 35 | 37 | 81 | 180 | 12560 | 14580 | 61387551.98 | 0.0002 | 0.24 |
| 35 | 38 | 81 | 271 | 12312 | 21951 | 59105017.87 | 0.0004 | 0.37 |
| 35 | 39 | 81 | 121 | 6320 | 9801 | 16648014.63 | 0.0006 | 0.59 |
| 35 | 40 | 81 | 351 | 9331 | 28431 | 34903064.51 | 0.0008 | 0.81 |
| 35 | 41 | 81 | 58 | 11231 | 4698 | 49635798.38 | 0.0001 | 0.09 |
| 35 | 42 | 81 | 271 | 11428 | 21951 | 51303080.16 | 0.0004 | 0.43 |
| 35 | 43 | 81 | 179 | 12541 | 14499 | 61211231.76 | 0.0002 | 0.24 |
| 35 | 44 | 81 | 159 | 13004 | 12879 | 65576196.82 | 0.0002 | 0.20 |
| 36 | 2 | 331 | 336 | 7849 | 111216 | 25127381.02 | 0.0044 | 4.43 |
| 36 | 3 | 331 | 43 | 7797 | 14233 | 24812031 | 0.0006 | 0.57 |
| 36 | 4 | 331 | 62 | 9035 | 20522 | 32829441.77 | 0.0006 | 0.63 |
| 36 | 5 | 331 | 97 | 3185 | 32107 | 4528015.759 | 0.0071 | 7.09 |
| 36 | 6 | 331 | 156 | 2895 | 51636 | 3776872.11 | 0.0137 | 13.67 |
| 36 | 7 | 331 | 27 | 2712 | 8937 | 3336187.124 | 0.0027 | 2.68 |
| 36 | 9 | 331 | 9 | 6587 | 2979 | 18009703.4 | 0.0002 | 0.17 |
| 36 | 10 | 331 | 48 | 6093 | 15888 | 15530278.31 | 0.0010 | 1.02 |
| 36 | 11 | 331 | 16 | 6784 | 5296 | 19046847.06 | 0.0003 | 0.28 |
| 36 | 12 | 331 | 66 | 7044 | 21846 | 20457697.84 | 0.0011 | 1.07 |
| 36 | 13 | 331 | 66 | 6743 | 21846 | 18828728.94 | 0.0012 | 1.16 |
| 36 | 14 | 331 | 136 | 6463 | 45016 | 17371003.04 | 0.0026 | 2.59 |
| 36 | 15 | 331 | 232 | 4756 | 76792 | 9699726.914 | 0.0079 | 7.92 |
| 36 | 16 | 331 | 180 | 4476 | 59580 | 8643530.084 | 0.0069 | 6.89 |
| 36 | 17 | 331 | 62 | 2270 | 20522 | 2379299.584 | 0.0086 | 8.63 |
| 36 | 18 | 331 | 28 | 2395 | 9268 | 2634392.515 | 0.0035 | 3.52 |
| **36** | **19** | **331** | **242** | **3074** | **80102** | **4232893.483** | **0.0189** | **18.92** |
| 36 | 20 | 331 | 300 | 4790 | 99300 | 9831900.516 | 0.0101 | 10.10 |
| 36 | 21 | 331 | 64 | 4634 | 21184 | 9232439.193 | 0.0023 | 2.29 |
| 36 | 22 | 331 | 84 | 6503 | 27804 | 17575841.71 | 0.0016 | 1.58 |
| 36 | 23 | 331 | 94 | 5579 | 31114 | 13135816.91 | 0.0024 | 2.37 |
| 36 | 24 | 331 | 149 | 5922 | 49319 | 14712618.23 | 0.0034 | 3.35 |
| 36 | 25 | 331 | 24 | 6216 | 7944 | 16131357.31 | 0.0005 | 0.49 |
| 36 | 26 | 331 | 95 | 6627 | 31445 | 18218064.87 | 0.0017 | 1.73 |
| 36 | 27 | 331 | 108 | 7540 | 35748 | 23281210.48 | 0.0015 | 1.54 |
| 36 | 28 | 331 | 272 | 7543 | 90032 | 23298813.48 | 0.0039 | 3.86 |
| 36 | 29 | 331 | 108 | 5762 | 35748 | 13966551.35 | 0.0026 | 2.56 |
| 36 | 30 | 331 | 230 | 11926 | 76130 | 55633979.93 | 0.0014 | 1.37 |
| 36 | 31 | 331 | 37 | 12738 | 12247 | 63051056 | 0.0002 | 0.19 |
| 36 | 32 | 331 | 57 | 12021 | 18867 | 56479017.68 | 0.0003 | 0.33 |
| 36 | 33 | 331 | 142 | 11344 | 47002 | 50588967.29 | 0.0009 | 0.93 |
| 36 | 34 | 331 | 27 | 11761 | 8937 | 54180633.04 | 0.0002 | 0.16 |
| 36 | 35 | 331 | 81 | 12432 | 26811 | 60204354.28 | 0.0004 | 0.45 |
| 36 | 37 | 331 | 180 | 5963 | 59580 | 14906755.83 | 0.0040 | 4.00 |
| 36 | 38 | 331 | 271 | 8012 | 89701 | 26128097.45 | 0.0034 | 3.43 |
| 36 | 39 | 331 | 121 | 5963 | 40051 | 14906755.83 | 0.0027 | 2.69 |
| *36* | *40* | *331* | *351* | *3891* | *116181* | *6623939.216* | *0.0175* | *17.54* |
| 36 | 41 | 331 | 58 | 2655 | 19198 | 3204222.003 | 0.0060 | 5.99 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 36 | 42 | 331 | 271 | 4831 | 89701 | 9992412.897 | 0.0090 | 8.98 |
| 36 | 43 | 331 | 179 | 3842 | 59249 | 6466346.684 | 0.0092 | 9.16 |
| 36 | 44 | 331 | 159 | 3637 | 52629 | 5826560.657 | 0.0090 | 9.03 |
| 37 | 2 | 180 | 336 | 5352 | 60480 | 12138935.37 | 0.0050 | 4.98 |
| 37 | 3 | 180 | 43 | 7564 | 7740 | 23422210.96 | 0.0003 | 0.33 |
| 37 | 4 | 180 | 62 | 5592 | 11160 | 13194034.31 | 0.0008 | 0.85 |
| 37 | 5 | 180 | 97 | 6151 | 17460 | 15812366.84 | 0.0011 | 1.10 |
| 37 | 6 | 180 | 156 | 6683 | 28080 | 18511677.52 | 0.0015 | 1.52 |
| 37 | 7 | 180 | 27 | 7005 | 4860 | 20243027.51 | 0.0002 | 0.24 |
| 37 | 9 | 180 | 9 | 3144 | 1620 | 4417909.559 | 0.0004 | 0.37 |
| 37 | 10 | 180 | 48 | 2612 | 8640 | 3106340.278 | 0.0028 | 2.78 |
| 37 | 11 | 180 | 16 | 3341 | 2880 | 4958671.105 | 0.0006 | 0.58 |
| 37 | 12 | 180 | 66 | 3601 | 11880 | 5717470.475 | 0.0021 | 2.08 |
| 37 | 13 | 180 | 66 | 3322 | 11880 | 4905229.071 | 0.0024 | 2.42 |
| 37 | 14 | 180 | 136 | 3693 | 24480 | 5998196.437 | 0.0041 | 4.08 |
| 37 | 15 | 180 | 232 | 3159 | 41760 | 4458043.37 | 0.0094 | 9.37 |
| 37 | 16 | 180 | 180 | 3616 | 32400 | 5762806.023 | 0.0056 | 5.62 |
| 37 | 17 | 180 | 62 | 3717 | 11160 | 6072476.826 | 0.0018 | 1.84 |
| 37 | 18 | 180 | 28 | 3418 | 5040 | 5178058.003 | 0.0010 | 0.97 |
| 37 | 19 | 180 | 242 | 3692 | 43560 | 5995110.82 | 0.0073 | 7.27 |
| 37 | 20 | 180 | 300 | 4398 | 54000 | 8359589.033 | 0.0065 | 6.46 |
| 37 | 21 | 180 | 64 | 3974 | 11520 | 6894978.865 | 0.0017 | 1.67 |
| 37 | 22 | 180 | 84 | 6115 | 15120 | 15636994.26 | 0.0010 | 0.97 |
| 37 | 23 | 180 | 94 | 5189 | 16920 | 11446137.91 | 0.0015 | 1.48 |
| 37 | 24 | 180 | 149 | 2986 | 26820 | 4005628.113 | 0.0067 | 6.70 |
| 37 | 25 | 180 | 24 | 3363 | 4320 | 5020893.944 | 0.0009 | 0.86 |
| 37 | 26 | 180 | 95 | 3819 | 17100 | 6392994.796 | 0.0027 | 2.67 |
| 37 | 27 | 180 | 108 | 5564 | 19440 | 13068794.55 | 0.0015 | 1.49 |
| 37 | 28 | 180 | 272 | 8881 | 48960 | 31774414.24 | 0.0015 | 1.54 |
| 37 | 29 | 180 | 108 | 5372 | 19440 | 12225268.54 | 0.0016 | 1.59 |
| 37 | 30 | 180 | 230 | 12263 | 41400 | 58658882.32 | 0.0007 | 0.71 |
| 37 | 31 | 180 | 37 | 12986 | 6660 | 65403841.47 | 0.0001 | 0.10 |
| 37 | 32 | 180 | 57 | 11488 | 10260 | 51816062.88 | 0.0002 | 0.20 |
| 37 | 33 | 180 | 142 | 11364 | 25560 | 50758564.06 | 0.0005 | 0.50 |
| 37 | 34 | 180 | 27 | 11882 | 4860 | 55244639.16 | 0.0001 | 0.09 |
| 37 | 35 | 180 | 81 | 12560 | 14580 | 61387551.98 | 0.0002 | 0.24 |
| 37 | 36 | 180 | 331 | 5963 | 59580 | 14906755.83 | 0.0040 | 4.00 |
| 37 | 38 | 180 | 271 | 4530 | 48780 | 8842734.462 | 0.0055 | 5.52 |
| 37 | 39 | 180 | 121 | 5863 | 21780 | 14435365.98 | 0.0015 | 1.51 |
| 37 | 40 | 180 | 351 | 3374 | 63180 | 5052143.163 | 0.0125 | 12.51 |
| 37 | 41 | 180 | 58 | 2671 | 10440 | 3241010.121 | 0.0032 | 3.22 |
| **37** | **42** | **180** | **271** | **1234** | **48780** | **747306.5752** | **0.0653** | **65.27** |
| *37* | *43* | *180* | *179* | *1349* | *32220* | *885161.8838* | *0.0364* | *36.40* |
| 37 | 44 | 180 | 159 | 2310 | 28620 | 2459590.244 | 0.0116 | 11.64 |
| **38** | **2** | **271** | **336** | **1963** | **91056** | **1805296.621** | **0.0504** | **50.44** |
| 38 | 3 | 271 | 43 | 7674 | 11653 | 24073620.52 | 0.0005 | 0.48 |
| 38 | 4 | 271 | 62 | 1020 | 16802 | 520403.6409 | 0.0323 | 32.29 |
| 38 | 5 | 271 | 97 | 7975 | 26287 | 25899317.18 | 0.0010 | 1.01 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 38 | 6 | 271 | 156 | 8725 | 42276 | 30722342.59 | 0.0014 | 1.38 |
| 38 | 7 | 271 | 27 | 9139 | 7317 | 33551155.89 | 0.0002 | 0.22 |
| 38 | 9 | 271 | 9 | 1529 | 2439 | 1122985.69 | 0.0022 | 2.17 |
| 38 | 10 | 271 | 48 | 1946 | 13008 | 1775707.333 | 0.0073 | 7.33 |
| 38 | 11 | 271 | 16 | 1237 | 4336 | 750762.2536 | 0.0058 | 5.78 |
| 38 | 12 | 271 | 66 | 1302 | 17886 | 827486.4101 | 0.0216 | 21.61 |
| 38 | 13 | 271 | 66 | 1511 | 17886 | 1098000.359 | 0.0163 | 16.29 |
| *38* | *14* | *271* | *136* | *1394* | *36856* | *942104.9163* | *0.0391* | *39.12* |
| 38 | 15 | 271 | 232 | 3634 | 62872 | 5817432.511 | 0.0108 | 10.81 |
| 38 | 16 | 271 | 180 | 4034 | 48780 | 7094114.575 | 0.0069 | 6.88 |
| 38 | 17 | 271 | 62 | 6208 | 16802 | 16091934.11 | 0.0010 | 1.04 |
| 38 | 18 | 271 | 28 | 5815 | 7588 | 14211648.79 | 0.0005 | 0.53 |
| 38 | 19 | 271 | 242 | 5476 | 65582 | 12678869.59 | 0.0052 | 5.17 |
| 38 | 20 | 271 | 300 | 4177 | 81300 | 7579533.957 | 0.0107 | 10.73 |
| 38 | 21 | 271 | 64 | 4644 | 17344 | 9270330.146 | 0.0019 | 1.87 |
| 38 | 22 | 271 | 84 | 5862 | 22764 | 14430688.32 | 0.0016 | 1.58 |
| 38 | 23 | 271 | 94 | 4934 | 25474 | 10401078.54 | 0.0024 | 2.45 |
| 38 | 24 | 271 | 149 | 2071 | 40379 | 1998675.035 | 0.0202 | 20.20 |
| 38 | 25 | 271 | 24 | 1733 | 6504 | 1424679.808 | 0.0046 | 4.57 |
| 38 | 26 | 271 | 95 | 1829 | 25745 | 1578359.906 | 0.0163 | 16.31 |
| 38 | 27 | 271 | 108 | 1465 | 29268 | 1035360.249 | 0.0283 | 28.27 |
| 38 | 28 | 271 | 272 | 8793 | 73712 | 31178874.87 | 0.0024 | 2.36 |
| 38 | 29 | 271 | 108 | 5009 | 29268 | 10703528.26 | 0.0027 | 2.73 |
| 38 | 30 | 271 | 230 | 12015 | 62330 | 56425468.38 | 0.0011 | 1.10 |
| 38 | 31 | 271 | 37 | 12430 | 10027 | 60185953.38 | 0.0002 | 0.17 |
| 38 | 32 | 271 | 57 | 11616 | 15447 | 52918502.56 | 0.0003 | 0.29 |
| 38 | 33 | 271 | 142 | 11224 | 38482 | 49577035.05 | 0.0008 | 0.78 |
| 38 | 34 | 271 | 27 | 11551 | 7317 | 52357296.01 | 0.0001 | 0.14 |
| 38 | 35 | 271 | 81 | 12312 | 21951 | 59105017.87 | 0.0004 | 0.37 |
| 38 | 36 | 271 | 331 | 8012 | 89701 | 26128097.45 | 0.0034 | 3.43 |
| 38 | 37 | 271 | 180 | 4530 | 48780 | 8842734.462 | 0.0055 | 5.52 |
| 38 | 39 | 271 | 121 | 5675 | 32791 | 13568603.29 | 0.0024 | 2.42 |
| 38 | 40 | 271 | 351 | 3932 | 95121 | 6757182.792 | 0.0141 | 14.08 |
| 38 | 41 | 271 | 58 | 5797 | 15718 | 14128181.67 | 0.0011 | 1.11 |
| 38 | 42 | 271 | 271 | 3894 | 73441 | 6633646.117 | 0.0111 | 11.07 |
| 38 | 43 | 271 | 179 | 5599 | 48509 | 13225432.65 | 0.0037 | 3.67 |
| 38 | 44 | 271 | 159 | 6840 | 43089 | 19346686.46 | 0.0022 | 2.23 |
| 39 | 2 | 121 | 336 | 5853 | 40656 | 14388621.75 | 0.0028 | 2.83 |
| 39 | 3 | 121 | 43 | 1683 | 5203 | 1347596.332 | 0.0039 | 3.86 |
| 39 | 4 | 121 | 62 | 5806 | 7502 | 14169886.12 | 0.0005 | 0.53 |
| 39 | 5 | 121 | 97 | 3560 | 11737 | 5594419.077 | 0.0021 | 2.10 |
| 39 | 6 | 121 | 156 | 5012 | 18876 | 10715711.64 | 0.0018 | 1.76 |
| 39 | 7 | 121 | 27 | 6622 | 3267 | 18191957.6 | 0.0002 | 0.18 |
| 39 | 9 | 121 | 9 | 5194 | 1089 | 11467102.54 | 0.0001 | 0.09 |
| 39 | 10 | 121 | 48 | 5616 | 5808 | 13301832.91 | 0.0004 | 0.44 |
| 39 | 11 | 121 | 16 | 5476 | 1936 | 12678869.59 | 0.0002 | 0.15 |
| 39 | 12 | 121 | 66 | 5797 | 7986 | 14128181.67 | 0.0006 | 0.57 |
| 39 | 13 | 121 | 66 | 6272 | 7986 | 16408598.72 | 0.0005 | 0.49 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 39 | 14 | 121 | 136 | 4654 | 16456 | 9308294.602 | 0.0018 | 1.77 |
| 39 | 15 | 121 | 232 | 2865 | 28072 | 3702855.717 | 0.0076 | 7.58 |
| 39 | 16 | 121 | 180 | 2406 | 21780 | 2657429.083 | 0.0082 | 8.20 |
| 39 | 17 | 121 | 62 | 4922 | 7502 | 10353067.79 | 0.0007 | 0.72 |
| 39 | 18 | 121 | 28 | 4575 | 3388 | 9010379.582 | 0.0004 | 0.38 |
| 39 | 19 | 121 | 242 | 3625 | 29282 | 5790088.752 | 0.0051 | 5.06 |
| *39* | *20* | *121* | *300* | *1772* | *36300* | *1486213.026* | *0.0244* | *24.42* |
| 39 | 21 | 121 | 64 | 1741 | 7744 | 1437201.511 | 0.0054 | 5.39 |
| 39 | 22 | 121 | 84 | 1101 | 10164 | 601722.0218 | 0.0169 | 16.89 |
| 39 | 23 | 121 | 94 | 1027 | 11374 | 527210.2471 | 0.0216 | 21.57 |
| 39 | 24 | 121 | 149 | 4470 | 18029 | 8621529.012 | 0.0021 | 2.09 |
| 39 | 25 | 121 | 24 | 5038 | 2904 | 10821575.9 | 0.0003 | 0.27 |
| 39 | 26 | 121 | 95 | 4389 | 11495 | 8327115.789 | 0.0014 | 1.38 |
| 39 | 27 | 121 | 108 | 4587 | 13068 | 9055336.766 | 0.0014 | 1.44 |
| 39 | 28 | 121 | 272 | 4152 | 32912 | 7493573.22 | 0.0044 | 4.39 |
| **39** | **29** | **121** | **108** | **932** | **13068** | **438419.8746** | **0.0298** | **29.81** |
| 39 | 30 | 121 | 230 | 6023 | 27830 | 15193031.56 | 0.0018 | 1.83 |
| 39 | 31 | 121 | 37 | 6780 | 4477 | 19025514.86 | 0.0002 | 0.24 |
| 39 | 32 | 121 | 57 | 5910 | 6897 | 14656025.56 | 0.0005 | 0.47 |
| 39 | 33 | 121 | 142 | 5233 | 17182 | 11631250.15 | 0.0015 | 1.48 |
| 39 | 34 | 121 | 27 | 5642 | 3267 | 13419083.51 | 0.0002 | 0.24 |
| 39 | 35 | 121 | 81 | 6320 | 9801 | 16648014.63 | 0.0006 | 0.59 |
| 39 | 36 | 121 | 331 | 5963 | 40051 | 14906755.83 | 0.0027 | 2.69 |
| 39 | 37 | 121 | 180 | 5863 | 21780 | 14435365.98 | 0.0015 | 1.51 |
| 39 | 38 | 121 | 271 | 5675 | 32791 | 13568603.29 | 0.0024 | 2.42 |
| 39 | 40 | 121 | 351 | 2996 | 42471 | 4031154.441 | 0.0105 | 10.54 |
| 39 | 41 | 121 | 58 | 5107 | 7018 | 11104912.22 | 0.0006 | 0.63 |
| 39 | 42 | 121 | 271 | 5109 | 32791 | 11113176.58 | 0.0030 | 2.95 |
| 39 | 43 | 121 | 179 | 6205 | 21659 | 16077162.19 | 0.0013 | 1.35 |
| 39 | 44 | 121 | 159 | 6668 | 19239 | 18432813.25 | 0.0010 | 1.04 |
| 40 | 2 | 351 | 336 | 4337 | 117936 | 8140665.353 | 0.0145 | 14.49 |
| 40 | 3 | 351 | 43 | 4694 | 15093 | 9460887.145 | 0.0016 | 1.60 |
| 40 | 4 | 351 | 62 | 4637 | 21762 | 9243798.76 | 0.0024 | 2.35 |
| 40 | 5 | 351 | 97 | 3343 | 34047 | 4964312.538 | 0.0069 | 6.86 |
| 40 | 6 | 351 | 156 | 3837 | 54756 | 6450366.904 | 0.0085 | 8.49 |
| 40 | 7 | 351 | 27 | 4551 | 9477 | 8920783.252 | 0.0011 | 1.06 |
| 40 | 9 | 351 | 9 | 2733 | 3159 | 3385441.395 | 0.0009 | 0.93 |
| 40 | 10 | 351 | 48 | 3227 | 16848 | 4642137.865 | 0.0036 | 3.63 |
| 40 | 11 | 351 | 16 | 2947 | 5616 | 3906809.707 | 0.0014 | 1.44 |
| 40 | 12 | 351 | 66 | 3189 | 23166 | 4538826.549 | 0.0051 | 5.10 |
| 40 | 13 | 351 | 66 | 3876 | 23166 | 6575505.72 | 0.0035 | 3.52 |
| 40 | 14 | 351 | 136 | 2824 | 47736 | 3602822.908 | 0.0132 | 13.25 |
| *40* | *15* | *351* | *232* | *909* | *81432* | *418091.5384* | *0.1948* | *194.77* |
| 40 | 16 | 351 | 180 | 850 | 63180 | 368040.7939 | 0.1717 | 171.67 |
| 40 | 17 | 351 | 62 | 2018 | 21762 | 1902611.895 | 0.0114 | 11.44 |
| 40 | 18 | 351 | 28 | 1720 | 9828 | 1404442.778 | 0.0070 | 7.00 |
| **40** | **19** | **351** | **242** | **879** | **84942** | **392264.3703** | **0.2165** | **216.54** |
| 40 | 20 | 351 | 300 | 1171 | 105300 | 676484.89 | 0.1557 | 155.66 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 40 | 21 | 351 | 64 | 1007 | 22464 | 507874.0162 | 0.0442 | 44.23 |
| 40 | 22 | 351 | 84 | 2887 | 29484 | 3757066.563 | 0.0078 | 7.85 |
| 40 | 23 | 351 | 94 | 1960 | 32994 | 1800058.152 | 0.0183 | 18.33 |
| 40 | 24 | 351 | 149 | 2175 | 52299 | 2193676.569 | 0.0238 | 23.84 |
| 40 | 25 | 351 | 24 | 2681 | 8424 | 3264103.691 | 0.0026 | 2.58 |
| 40 | 26 | 351 | 95 | 2808 | 33345 | 3564137.88 | 0.0094 | 9.36 |
| 40 | 27 | 351 | 108 | 3900 | 37908 | 6653080.118 | 0.0057 | 5.70 |
| 40 | 28 | 351 | 272 | 5654 | 95472 | 13473363.53 | 0.0071 | 7.09 |
| 40 | 29 | 351 | 108 | 2143 | 37908 | 2132760.678 | 0.0178 | 17.77 |
| 40 | 30 | 351 | 230 | 9034 | 80730 | 32822538.3 | 0.0025 | 2.46 |
| 40 | 31 | 351 | 37 | 9637 | 12987 | 37109878.47 | 0.0003 | 0.35 |
| 40 | 32 | 351 | 57 | 8920 | 20007 | 32040052.82 | 0.0006 | 0.62 |
| 40 | 33 | 351 | 142 | 8135 | 49842 | 26895483.67 | 0.0019 | 1.85 |
| 40 | 34 | 351 | 27 | 8653 | 9477 | 30242433.69 | 0.0003 | 0.31 |
| 40 | 35 | 351 | 81 | 9331 | 28431 | 34903064.51 | 0.0008 | 0.81 |
| 40 | 36 | 351 | 331 | 3891 | 116181 | 6623939.216 | 0.0175 | 17.54 |
| 40 | 37 | 351 | 180 | 3374 | 63180 | 5052143.163 | 0.0125 | 12.51 |
| 40 | 38 | 351 | 271 | 3932 | 95121 | 6757182.792 | 0.0141 | 14.08 |
| 40 | 39 | 351 | 121 | 2996 | 42471 | 4031154.441 | 0.0105 | 10.54 |
| 40 | 41 | 351 | 58 | 2272 | 20358 | 2383284.132 | 0.0085 | 8.54 |
| 40 | 42 | 351 | 271 | 2263 | 95121 | 2365378.541 | 0.0402 | 40.21 |
| 40 | 43 | 351 | 179 | 3225 | 62829 | 4636672.974 | 0.0136 | 13.55 |
| 40 | 44 | 351 | 159 | 3687 | 55809 | 5979694.016 | 0.0093 | 9.33 |
| 41 | 2 | 58 | 336 | 6007 | 19488 | 15116439.17 | 0.0013 | 1.29 |
| 41 | 3 | 58 | 43 | 6597 | 2494 | 18061687.33 | 0.0001 | 0.14 |
| 41 | 4 | 58 | 62 | 6797 | 3596 | 19116254.9 | 0.0002 | 0.19 |
| 41 | 5 | 58 | 97 | 3607 | 5626 | 5735584.341 | 0.0010 | 0.98 |
| 41 | 6 | 58 | 156 | 3692 | 9048 | 5995110.82 | 0.0015 | 1.51 |
| 41 | 7 | 58 | 27 | 4285 | 1566 | 7956216.088 | 0.0002 | 0.20 |
| 41 | 9 | 58 | 9 | 4342 | 522 | 8158506.358 | 0.0001 | 0.06 |
| 41 | 10 | 58 | 48 | 3818 | 2784 | 6389814.576 | 0.0004 | 0.44 |
| 41 | 11 | 58 | 16 | 4539 | 928 | 8876144.162 | 0.0001 | 0.10 |
| 41 | 12 | 58 | 66 | 4806 | 3828 | 9894392.999 | 0.0004 | 0.39 |
| 41 | 13 | 58 | 66 | 4519 | 3828 | 8801981.441 | 0.0004 | 0.43 |
| 41 | 14 | 58 | 136 | 4616 | 7888 | 9164420.756 | 0.0009 | 0.86 |
| 41 | 15 | 58 | 232 | 2891 | 13456 | 3766963.171 | 0.0036 | 3.57 |
| 41 | 16 | 58 | 180 | 2969 | 10440 | 3962409.675 | 0.0026 | 2.63 |
| **41** | **17** | **58** | **62** | **323** | **3596** | **58544.32357** | **0.0614** | **61.42** |
| 41 | 18 | 58 | 28 | 535 | 1624 | 152711.6557 | 0.0106 | 10.63 |
| *41* | *19* | *58* | *242* | *1500* | *14036* | *1082862.695* | *0.0130* | *12.96* |
| 41 | 20 | 58 | 300 | 3282 | 17400 | 4793616.602 | 0.0036 | 3.63 |
| 41 | 21 | 58 | 64 | 3126 | 3712 | 4369975.982 | 0.0008 | 0.85 |
| 41 | 22 | 58 | 84 | 4998 | 4872 | 10658912.04 | 0.0005 | 0.46 |
| 41 | 23 | 58 | 94 | 4072 | 5452 | 7221622.154 | 0.0008 | 0.75 |
| 41 | 24 | 58 | 149 | 4075 | 8642 | 7231734.357 | 0.0012 | 1.20 |
| 41 | 25 | 58 | 24 | 4226 | 1392 | 7749363.559 | 0.0002 | 0.18 |
| 41 | 26 | 58 | 95 | 4603 | 5510 | 9115444.523 | 0.0006 | 0.60 |
| 41 | 27 | 58 | 108 | 5716 | 6264 | 13755463.16 | 0.0005 | 0.46 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 41 | 28 | 58 | 272 | 7246 | 15776 | 21586728.35 | 0.0007 | 0.73 |
| 41 | 29 | 58 | 108 | 4254 | 6264 | 7847209.053 | 0.0008 | 0.80 |
| 41 | 30 | 58 | 230 | 10942 | 13340 | 47237156.83 | 0.0003 | 0.28 |
| 41 | 31 | 58 | 37 | 11538 | 2146 | 52245394.85 | 0.0000 | 0.04 |
| 41 | 32 | 58 | 57 | 10821 | 3306 | 46249607.81 | 0.0001 | 0.07 |
| 41 | 33 | 58 | 142 | 10144 | 8236 | 40906993.05 | 0.0002 | 0.20 |
| 41 | 34 | 58 | 27 | 10560 | 1566 | 44153124.77 | 0.0000 | 0.04 |
| 41 | 35 | 58 | 81 | 11231 | 4698 | 49635798.38 | 0.0001 | 0.09 |
| 41 | 36 | 58 | 331 | 2655 | 19198 | 3204222.003 | 0.0060 | 5.99 |
| 41 | 37 | 58 | 180 | 2671 | 10440 | 3241010.121 | 0.0032 | 3.22 |
| 41 | 38 | 58 | 271 | 5797 | 15718 | 14128181.67 | 0.0011 | 1.11 |
| 41 | 39 | 58 | 121 | 5107 | 7018 | 11104912.22 | 0.0006 | 0.63 |
| 41 | 40 | 58 | 351 | 2272 | 20358 | 2383284.132 | 0.0085 | 8.54 |
| 41 | 42 | 58 | 271 | 2235 | 15718 | 2310081.5 | 0.0068 | 6.80 |
| 41 | 43 | 58 | 179 | 1528 | 10382 | 1121590.632 | 0.0093 | 9.26 |
| 41 | 44 | 58 | 159 | 1477 | 9222 | 1051533.084 | 0.0088 | 8.77 |
| 42 | 2 | 271 | 336 | 4269 | 91056 | 7899865.444 | 0.0115 | 11.53 |
| 42 | 3 | 271 | 43 | 6448 | 11653 | 17294481.84 | 0.0007 | 0.67 |
| 42 | 4 | 271 | 62 | 4892 | 16802 | 10233501.37 | 0.0016 | 1.64 |
| 42 | 5 | 271 | 97 | 5035 | 26287 | 10809335.64 | 0.0024 | 2.43 |
| 42 | 6 | 271 | 156 | 5567 | 42276 | 13082186.03 | 0.0032 | 3.23 |
| 42 | 7 | 271 | 27 | 5803 | 7317 | 14155978.16 | 0.0005 | 0.52 |
| 42 | 9 | 271 | 9 | 2445 | 2439 | 2739869.265 | 0.0009 | 0.89 |
| 42 | 10 | 271 | 48 | 1913 | 13008 | 1718930.997 | 0.0076 | 7.57 |
| 42 | 11 | 271 | 16 | 2642 | 4336 | 3174478.172 | 0.0014 | 1.37 |
| 42 | 12 | 271 | 66 | 2902 | 17886 | 3794242.422 | 0.0047 | 4.71 |
| 42 | 13 | 271 | 66 | 2622 | 17886 | 3128975.092 | 0.0057 | 5.72 |
| 42 | 14 | 271 | 136 | 2744 | 36856 | 3411377.678 | 0.0108 | 10.80 |
| 42 | 15 | 271 | 232 | 2043 | 62872 | 1947645.432 | 0.0323 | 32.28 |
| 42 | 16 | 271 | 180 | 2500 | 48780 | 2858156.575 | 0.0171 | 17.07 |
| 42 | 17 | 271 | 62 | 2427 | 16802 | 2701671.709 | 0.0062 | 6.22 |
| 42 | 18 | 271 | 28 | 2302 | 7588 | 2443431.153 | 0.0031 | 3.11 |
| 42 | 19 | 271 | 242 | 2539 | 65582 | 2943466.732 | 0.0223 | 22.28 |
| 42 | 20 | 271 | 300 | 3245 | 81300 | 4691459.075 | 0.0173 | 17.33 |
| 42 | 21 | 271 | 64 | 2822 | 17344 | 3597976.462 | 0.0048 | 4.82 |
| 42 | 22 | 271 | 84 | 4999 | 22764 | 10662964.41 | 0.0021 | 2.13 |
| 42 | 23 | 271 | 94 | 4073 | 25474 | 7224992.143 | 0.0035 | 3.53 |
| 42 | 24 | 271 | 149 | 2053 | 40379 | 1965798.52 | 0.0205 | 20.54 |
| 42 | 25 | 271 | 24 | 2332 | 6504 | 2504287.799 | 0.0026 | 2.60 |
| 42 | 26 | 271 | 95 | 2735 | 25745 | 3390150.109 | 0.0076 | 7.59 |
| 42 | 27 | 271 | 108 | 3786 | 29268 | 6288443.428 | 0.0047 | 4.65 |
| 42 | 28 | 271 | 272 | 4689 | 73712 | 9441748.81 | 0.0078 | 7.81 |
| 42 | 29 | 271 | 108 | 4239 | 29268 | 7794719.503 | 0.0038 | 3.75 |
| 42 | 30 | 271 | 230 | 11131 | 62330 | 48799452.24 | 0.0013 | 1.28 |
| 42 | 31 | 271 | 37 | 11734 | 10027 | 53944548.11 | 0.0002 | 0.19 |
| 42 | 32 | 271 | 57 | 11017 | 15447 | 47854233.45 | 0.0003 | 0.32 |
| 42 | 33 | 271 | 142 | 10232 | 38482 | 41583880.09 | 0.0009 | 0.93 |
| 42 | 34 | 271 | 27 | 10750 | 7317 | 45674739.81 | 0.0002 | 0.16 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 42 | 35 | 271 | 81 | 11428 | 21951 | 51303080.16 | 0.0004 | 0.43 |
| 42 | 36 | 271 | 331 | 4831 | 89701 | 9992412.897 | 0.0090 | 8.98 |
| **42** | **37** | **271** | **180** | **1234** | **48780** | **747306.5752** | **0.0653** | **65.27** |
| 42 | 38 | 271 | 271 | 3894 | 73441 | 6633646.117 | 0.0111 | 11.07 |
| 42 | 39 | 271 | 121 | 5109 | 32791 | 11113176.58 | 0.0030 | 2.95 |
| *42* | *40* | *271* | *351* | *2263* | *95121* | *2365378.541* | *0.0402* | *40.21* |
| 42 | 41 | 271 | 58 | 2235 | 15718 | 2310081.5 | 0.0068 | 6.80 |
| 42 | 43 | 271 | 179 | 2022 | 48509 | 1909783.722 | 0.0254 | 25.40 |
| 42 | 44 | 271 | 159 | 3264 | 43089 | 4743788.142 | 0.0091 | 9.08 |
| 43 | 2 | 179 | 336 | 5967 | 60144 | 14925760.61 | 0.0040 | 4.03 |
| 43 | 3 | 179 | 43 | 7904 | 7697 | 25462976.55 | 0.0003 | 0.30 |
| 43 | 4 | 179 | 62 | 6597 | 11098 | 18061687.33 | 0.0006 | 0.61 |
| 43 | 5 | 179 | 97 | 5679 | 17363 | 13586780.23 | 0.0013 | 1.28 |
| 43 | 6 | 179 | 156 | 5528 | 27924 | 12908603.62 | 0.0022 | 2.16 |
| 43 | 7 | 179 | 27 | 5144 | 4833 | 11258274.25 | 0.0004 | 0.43 |
| 43 | 9 | 179 | 9 | 4150 | 1611 | 7486716.427 | 0.0002 | 0.22 |
| 43 | 10 | 179 | 48 | 3618 | 8592 | 5768863.577 | 0.0015 | 1.49 |
| 43 | 11 | 179 | 16 | 4347 | 2864 | 8176365.863 | 0.0004 | 0.35 |
| 43 | 12 | 179 | 66 | 4607 | 11814 | 9130500.893 | 0.0013 | 1.29 |
| 43 | 13 | 179 | 66 | 4327 | 11814 | 8105038.85 | 0.0015 | 1.46 |
| 43 | 14 | 179 | 136 | 4442 | 24344 | 8519208.611 | 0.0029 | 2.86 |
| 43 | 15 | 179 | 232 | 3415 | 41528 | 5169426.267 | 0.0080 | 8.03 |
| 43 | 16 | 179 | 180 | 3247 | 32220 | 4696954.449 | 0.0069 | 6.86 |
| 43 | 17 | 179 | 62 | 1843 | 11098 | 1601393.778 | 0.0069 | 6.93 |
| 43 | 18 | 179 | 28 | 2063 | 5012 | 1984031.363 | 0.0025 | 2.53 |
| 43 | 19 | 179 | 242 | 3349 | 43318 | 4981255.065 | 0.0087 | 8.70 |
| 43 | 20 | 179 | 300 | 4381 | 53700 | 8298300.949 | 0.0065 | 6.47 |
| 43 | 21 | 179 | 64 | 4186 | 11456 | 7610593.496 | 0.0015 | 1.51 |
| 43 | 22 | 179 | 84 | 6096 | 15036 | 15544810.1 | 0.0010 | 0.97 |
| 43 | 23 | 179 | 94 | 5170 | 16826 | 11366638.08 | 0.0015 | 1.48 |
| 43 | 24 | 179 | 149 | 3751 | 26671 | 6178448.37 | 0.0043 | 4.32 |
| 43 | 25 | 179 | 24 | 4038 | 4296 | 7107485.752 | 0.0006 | 0.60 |
| 43 | 26 | 179 | 95 | 4433 | 17005 | 8486442.822 | 0.0020 | 2.00 |
| 43 | 27 | 179 | 108 | 5485 | 19332 | 12718491.4 | 0.0015 | 1.52 |
| 43 | 28 | 179 | 272 | 8867 | 48688 | 31679312.36 | 0.0015 | 1.54 |
| 43 | 29 | 179 | 108 | 5353 | 19332 | 12143245.14 | 0.0016 | 1.59 |
| 43 | 30 | 179 | 230 | 12244 | 41170 | 58486321.84 | 0.0007 | 0.70 |
| 43 | 31 | 179 | 37 | 12847 | 6623 | 64080114.02 | 0.0001 | 0.10 |
| 43 | 32 | 179 | 57 | 12130 | 10203 | 57456017.71 | 0.0002 | 0.18 |
| 43 | 33 | 179 | 142 | 11345 | 25418 | 50597440.74 | 0.0005 | 0.50 |
| 43 | 34 | 179 | 27 | 11863 | 4833 | 55076915.18 | 0.0001 | 0.09 |
| 43 | 35 | 179 | 81 | 12451 | 14499 | 60379295.71 | 0.0002 | 0.24 |
| 43 | 36 | 179 | 331 | 3842 | 59249 | 6466346.684 | 0.0092 | 9.16 |
| *43* | *37* | *179* | *180* | *1349* | *32220* | *885161.8838* | *0.0364* | *36.40* |
| 43 | 38 | 179 | 271 | 5599 | 48509 | 13225432.65 | 0.0037 | 3.67 |
| 43 | 39 | 179 | 121 | 6205 | 21659 | 16077162.19 | 0.0013 | 1.35 |
| 43 | 40 | 179 | 351 | 3225 | 62829 | 4636672.974 | 0.0136 | 13.55 |
| 43 | 41 | 179 | 58 | 1528 | 10382 | 1121590.632 | 0.0093 | 9.26 |

*Table 30 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 43 | 42 | 179 | 271 | 2022 | 48509 | 1909783.722 | 0.0254 | 25.40 |
| **43** | **44** | **179** | **159** | **1053** | **28461** | **552858.3907** | **0.0515** | **51.48** |
| 44 | 2 | 159 | 336 | 6674 | 53424 | 18464339.82 | 0.0029 | 2.89 |
| 44 | 3 | 159 | 43 | 8367 | 6837 | 28371517.22 | 0.0002 | 0.24 |
| 44 | 4 | 159 | 62 | 7840 | 9858 | 25072666.22 | 0.0004 | 0.39 |
| 44 | 5 | 159 | 97 | 5077 | 15423 | 10981296.31 | 0.0014 | 1.40 |
| 44 | 6 | 159 | 156 | 5223 | 24804 | 11589055.67 | 0.0021 | 2.14 |
| 44 | 7 | 159 | 27 | 4838 | 4293 | 10019940.48 | 0.0004 | 0.43 |
| 44 | 9 | 159 | 9 | 5392 | 1431 | 12311891.48 | 0.0001 | 0.12 |
| 44 | 10 | 159 | 48 | 4861 | 7632 | 10110640.77 | 0.0008 | 0.75 |
| 44 | 11 | 159 | 16 | 5589 | 2544 | 13180588.71 | 0.0002 | 0.19 |
| 44 | 12 | 159 | 66 | 5849 | 10494 | 14369944.16 | 0.0007 | 0.73 |
| 44 | 13 | 159 | 66 | 5570 | 10494 | 13095584.01 | 0.0008 | 0.80 |
| 44 | 14 | 159 | 136 | 5283 | 21624 | 11843311.72 | 0.0018 | 1.83 |
| 44 | 15 | 159 | 232 | 3978 | 36888 | 6908171.007 | 0.0053 | 5.34 |
| 44 | 16 | 159 | 180 | 3809 | 28620 | 6361226.333 | 0.0045 | 4.50 |
| 44 | 17 | 159 | 62 | 1792 | 9858 | 1518246.226 | 0.0065 | 6.49 |
| 44 | 18 | 159 | 28 | 2011 | 4452 | 1890091.957 | 0.0024 | 2.36 |
| 44 | 19 | 159 | 242 | 3157 | 38478 | 4452682.263 | 0.0086 | 8.64 |
| 44 | 20 | 159 | 300 | 4843 | 47700 | 10039625 | 0.0048 | 4.75 |
| 44 | 21 | 159 | 64 | 4749 | 10176 | 9672619.908 | 0.0011 | 1.05 |
| 44 | 22 | 159 | 84 | 6559 | 13356 | 17864526.05 | 0.0007 | 0.75 |
| 44 | 23 | 159 | 94 | 5633 | 14946 | 13378441.6 | 0.0011 | 1.12 |
| 44 | 24 | 159 | 149 | 4743 | 23691 | 9649413.933 | 0.0025 | 2.46 |
| 44 | 25 | 159 | 24 | 5277 | 3816 | 11817768.52 | 0.0003 | 0.32 |
| 44 | 26 | 159 | 95 | 5271 | 15105 | 11792251.44 | 0.0013 | 1.28 |
| 44 | 27 | 159 | 108 | 6360 | 17172 | 16848782.33 | 0.0010 | 1.02 |
| 44 | 28 | 159 | 272 | 8913 | 43248 | 31992296.96 | 0.0014 | 1.35 |
| 44 | 29 | 159 | 108 | 5816 | 17172 | 14216292.68 | 0.0012 | 1.21 |
| 44 | 30 | 159 | 230 | 12707 | 36570 | 62759829.76 | 0.0006 | 0.58 |
| 44 | 31 | 159 | 37 | 13310 | 5883 | 68539085.49 | 0.0001 | 0.09 |
| 44 | 32 | 159 | 57 | 12593 | 9063 | 61694363.27 | 0.0001 | 0.15 |
| 44 | 33 | 159 | 142 | 11808 | 22578 | 54592760.43 | 0.0004 | 0.41 |
| 44 | 34 | 159 | 27 | 12326 | 4293 | 59232779.23 | 0.0001 | 0.07 |
| 44 | 35 | 159 | 81 | 13004 | 12879 | 65576196.82 | 0.0002 | 0.20 |
| 44 | 36 | 159 | 331 | 3537 | 52629 | 5525945.707 | 0.0095 | 9.52 |
| *44* | *37* | *159* | *180* | *2310* | *28620* | *2459590.244* | *0.0116* | *11.64* |
| 44 | 38 | 159 | 271 | 6840 | 43089 | 19346686.46 | 0.0022 | 2.23 |
| 44 | 39 | 159 | 121 | 6668 | 19239 | 18432813.25 | 0.0010 | 1.04 |
| 44 | 40 | 159 | 351 | 3687 | 55809 | 5979694.016 | 0.0093 | 9.33 |
| 44 | 41 | 159 | 58 | 1477 | 9222 | 1051533.084 | 0.0088 | 8.77 |
| 44 | 42 | 159 | 271 | 3264 | 43089 | 4743788.142 | 0.0091 | 9.08 |
| **44** | **43** | **159** | **179** | **1053** | **28461** | **552858.3907** | **0.0515** | **51.48** |

*Table 31 – Tariacuri Community Interaction Values*

**Bold** = primary
*Italic* = secondary

| A Comm | B Comm | A pop | B pop | distance | A x B | d^1.9 | Interaction | value (x1000) |
|---|---|---|---|---|---|---|---|---|
| **1** | **2** | **2164** | **908** | **642** | **1964912** | **1219.8** | **1610.85** | **1610847.68** |
| 1 | 3 | 2164 | 276 | 1181 | 597264 | 2243.9 | 266.17 | 266172.2893 |
| 1 | 4 | 2164 | 98 | 4193 | 212072 | 7966.7 | 26.62 | 26619.80494 |
| 1 | 5 | 2164 | 421 | 2930 | 911044 | 5567 | 163.65 | 163650.7994 |
| 1 | 6 | 2164 | 135 | 3413 | 292140 | 6484.7 | 45.05 | 45050.6577 |
| 1 | 7 | 2164 | 66 | 2446 | 142824 | 4647.4 | 30.73 | 30732.02221 |
| 1 | 8 | 2164 | 109 | 4902 | 235876 | 9313.8 | 25.33 | 25325.43108 |
| 1 | 9 | 2164 | 163 | 6633 | 352732 | 12602.7 | 27.99 | 27988.60562 |
| 1 | 10 | 2164 | 23 | 4891 | 49772 | 9292.9 | 5.36 | 5355.916883 |
| 1 | 11 | 2164 | 43 | 1838 | 93052 | 3492.2 | 26.65 | 26645.66749 |
| 1 | 12 | 2164 | 228 | 2270 | 493392 | 4313 | 114.40 | 114396.4758 |
| 1 | 13 | 2164 | 141 | 8278 | 305124 | 15728.2 | 19.40 | 19399.80417 |
| 1 | 14 | 2164 | 102 | 4008 | 220728 | 7615.2 | 28.99 | 28985.18752 |
| *1* | *15* | *2164* | *2988* | *6389* | *6466032* | *12139.1* | *532.66* | *532661.5647* |
| 1 | 16 | 2164 | 2329 | 7535 | 5039956 | 14316.5 | 352.04 | 352038.2775 |
| 1 | 17 | 2164 | 963 | 7753 | 2083932 | 14730.7 | 141.47 | 141468.6335 |
| **2** | **1** | **908** | **2164** | **642** | **1964912** | **1219.8** | **1610.85** | **1610847.68** |
| 2 | 3 | 908 | 276 | 1043 | 250608 | 1981.7 | 126.46 | 126461.1192 |
| 2 | 4 | 908 | 98 | 4899 | 88984 | 9308.1 | 9.56 | 9559.845726 |
| 2 | 5 | 908 | 421 | 2776 | 382268 | 5274.4 | 72.48 | 72476.11103 |
| 2 | 6 | 908 | 135 | 3176 | 122580 | 6034.4 | 20.31 | 20313.53573 |
| 2 | 7 | 908 | 66 | 1193 | 59928 | 2266.7 | 26.44 | 26438.43473 |
| 2 | 8 | 908 | 109 | 5315 | 98972 | 10098.5 | 9.80 | 9800.663465 |
| 2 | 9 | 908 | 163 | 6834 | 148004 | 12984.6 | 11.40 | 11398.42583 |
| 2 | 10 | 908 | 23 | 5287 | 20884 | 10045.3 | 2.08 | 2078.982211 |
| 2 | 11 | 908 | 43 | 2079 | 39044 | 3950.1 | 9.88 | 9884.306726 |
| 2 | 12 | 908 | 228 | 2662 | 207024 | 5057.8 | 40.93 | 40931.63035 |
| 2 | 13 | 908 | 141 | 8478 | 128028 | 16108.2 | 7.95 | 7948.001639 |
| 2 | 14 | 908 | 102 | 4624 | 92616 | 8785.6 | 10.54 | 10541.79567 |
| *2* | *15* | *908* | *2988* | *5101* | *2713104* | *9691.9* | *279.94* | *279935.2036* |
| 2 | 16 | 908 | 2329 | 5892 | 2114732 | 11194.8 | 188.90 | 188903.0621 |
| 2 | 17 | 908 | 963 | 6104 | 874404 | 11597.6 | 75.40 | 75395.25419 |
| **3** | **1** | **276** | **2164** | **1181** | **597264** | **2243.9** | **266.17** | **266172.2893** |
| *3* | *2* | *276* | *908* | *1043* | *250608* | *1981.7* | *126.46* | *126461.1192* |
| 3 | 4 | 276 | 98 | 6076 | 27048 | 11544.4 | 2.34 | 2342.95416 |
| 3 | 5 | 276 | 421 | 3947 | 116196 | 7499.3 | 15.49 | 15494.24613 |
| 3 | 6 | 276 | 135 | 4468 | 37260 | 8489.2 | 4.39 | 4389.106158 |
| 3 | 7 | 276 | 66 | 3170 | 18216 | 6023 | 3.02 | 3024.406442 |
| 3 | 8 | 276 | 109 | 6492 | 30084 | 12334.8 | 2.44 | 2438.953206 |
| 3 | 9 | 276 | 163 | 8131 | 44988 | 15448.9 | 2.91 | 2912.051991 |

*Table 31 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 3 | 10 | 276 | 23 | 6583 | 6348 | 12507.7 | 0.51 | 507.5273631 |
| 3 | 11 | 276 | 43 | 3256 | 11868 | 6186.4 | 1.92 | 1918.401655 |
| 3 | 12 | 276 | 228 | 3789 | 62928 | 7199.1 | 8.74 | 8741.092637 |
| 3 | 13 | 276 | 141 | 9775 | 38916 | 18572.5 | 2.10 | 2095.356037 |
| 3 | 14 | 276 | 102 | 5800 | 28152 | 11020 | 2.55 | 2554.627949 |
| 3 | 15 | 276 | 2988 | 5845 | 824688 | 11105.5 | 74.26 | 74259.42101 |
| 3 | 16 | 276 | 2329 | 6138 | 642804 | 11662.2 | 55.12 | 55118.58826 |
| 3 | 17 | 276 | 963 | 6468 | 265788 | 12289.2 | 21.63 | 21627.77073 |
| **4** | **1** | **98** | **2164** | **4193** | **212072** | **7966.7** | **26.62** | **26619.80494** |
| 4 | 2 | 98 | 908 | 4899 | 88984 | 9308.1 | 9.56 | 9559.845726 |
| 4 | 3 | 98 | 276 | 6076 | 27048 | 11544.4 | 2.34 | 2342.95416 |
| 4 | 5 | 98 | 421 | 2968 | 41258 | 5639.2 | 7.32 | 7316.285998 |
| 4 | 6 | 98 | 135 | 4183 | 13230 | 7947.7 | 1.66 | 1664.632535 |
| 4 | 7 | 98 | 66 | 3781 | 6468 | 7183.9 | 0.90 | 900.3466084 |
| 4 | 8 | 98 | 109 | 2401 | 10682 | 4561.9 | 2.34 | 2341.568206 |
| 4 | 9 | 98 | 163 | 3394 | 15974 | 6448.6 | 2.48 | 2477.126818 |
| 4 | 10 | 98 | 23 | 616 | 2254 | 1170.4 | 1.93 | 1925.837321 |
| 4 | 11 | 98 | 43 | 2945 | 4214 | 5595.5 | 0.75 | 753.1051738 |
| 4 | 12 | 98 | 228 | 3190 | 22344 | 6061 | 3.69 | 3686.520376 |
| 4 | 13 | 98 | 141 | 5022 | 13818 | 9541.8 | 1.45 | 1448.154436 |
| ***4*** | ***14*** | ***98*** | ***102*** | ***222*** | ***9996*** | ***421.8*** | ***23.70*** | ***23698.43528*** |
| 4 | 15 | 98 | 2988 | 6742 | 292824 | 12809.8 | 22.86 | 22859.37329 |
| 4 | 16 | 98 | 2329 | 10351 | 228242 | 19666.9 | 11.61 | 11605.38773 |
| 4 | 17 | 98 | 963 | 9778 | 94374 | 18578.2 | 5.08 | 5079.824741 |
| *5* | *1* | *421* | *2164* | *2930* | *911044* | *5567* | *163.65* | *163650.7994* |
| 5 | 2 | 421 | 908 | 2776 | 382268 | 5274.4 | 72.48 | 72476.11103 |
| 5 | 3 | 421 | 276 | 3947 | 116196 | 7499.3 | 15.49 | 15494.24613 |
| 5 | 4 | 421 | 98 | 3290 | 41258 | 6251 | 6.60 | 6600.223964 |
| 5 | 6 | 421 | 135 | 1022 | 56835 | 1941.8 | 29.27 | 29269.23473 |
| 5 | 7 | 421 | 66 | 761 | 27786 | 1445.9 | 19.22 | 19217.09662 |
| 5 | 8 | 421 | 109 | 1750 | 45889 | 3325 | 13.80 | 13801.20301 |
| 5 | 9 | 421 | 163 | 4780 | 68623 | 9082 | 7.56 | 7555.934816 |
| 5 | 10 | 421 | 23 | 3768 | 9683 | 7159.2 | 1.35 | 1352.525422 |
| 5 | 11 | 421 | 43 | 1796 | 18103 | 3412.4 | 5.31 | 5305.063885 |
| 5 | 12 | 421 | 228 | 2175 | 95988 | 4132.5 | 23.23 | 23227.58621 |
| 5 | 13 | 421 | 141 | 6424 | 59361 | 12205.6 | 4.86 | 4863.423347 |
| 5 | 14 | 421 | 102 | 2988 | 42942 | 5677.2 | 7.56 | 7563.93997 |
| **5** | **15** | **421** | **2988** | **3746** | **1257948** | **7117.4** | **176.74** | **176742.6307** |
| 5 | 16 | 421 | 2329 | 7366 | 980509 | 13995.4 | 70.06 | 70059.37665 |
| 5 | 17 | 421 | 963 | 6793 | 405423 | 12906.7 | 31.41 | 31411.82487 |
| *6* | *1* | *135* | *2164* | *3413* | *292140* | *6484.7* | *45.05* | *45050.6577* |
| 6 | 2 | 135 | 908 | 3176 | 122580 | 6034.4 | 20.31 | 20313.53573 |
| 6 | 3 | 135 | 276 | 4468 | 37260 | 8489.2 | 4.39 | 4389.106158 |
| 6 | 4 | 135 | 98 | 2540 | 13230 | 4826 | 2.74 | 2741.400746 |
| 6 | 5 | 135 | 421 | 897 | 56835 | 1704.3 | 33.35 | 33348.00211 |
| 6 | 7 | 135 | 66 | 1656 | 8910 | 3146.4 | 2.83 | 2831.80778 |
| 6 | 8 | 135 | 109 | 703 | 14715 | 1335.7 | 11.02 | 11016.69537 |
| 6 | 9 | 135 | 163 | 2990 | 22005 | 5681 | 3.87 | 3873.437775 |

*Table 31 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6 | 10 | 135 | 23 | 3991 | 3105 | 7582.9 | 0.41 | 409.473948 |
| 6 | 11 | 135 | 43 | 1607 | 5805 | 3053.3 | 1.90 | 1901.221629 |
| 6 | 12 | 135 | 228 | 1875 | 30780 | 3562.5 | 8.64 | 8640 |
| 6 | 13 | 135 | 141 | 4634 | 19035 | 8804.6 | 2.16 | 2161.938078 |
| 6 | 14 | 135 | 102 | 2238 | 13770 | 4252.2 | 3.24 | 3238.323691 |
| **6** | **15** | **135** | **2988** | **4392** | **403380** | **8344.8** | **48.34** | **48339.08542** |
| 6 | 16 | 135 | 2329 | 8284 | 314415 | 15739.6 | 19.98 | 19976.04768 |
| 6 | 17 | 135 | 963 | 7711 | 130005 | 14650.9 | 8.87 | 8873.516303 |
| **7** | **1** | **66** | **2164** | **2446** | **142824** | **4647.4** | **30.73** | **30732.02221** |
| 7 | 2 | 66 | 908 | 1193 | 59928 | 2266.7 | 26.44 | 26438.43473 |
| 7 | 3 | 66 | 276 | 3170 | 18216 | 6023 | 3.02 | 3024.406442 |
| 7 | 4 | 66 | 98 | 3961 | 6468 | 7525.9 | 0.86 | 859.4320945 |
| 7 | 5 | 66 | 421 | 782 | 27786 | 1485.8 | 18.70 | 18701.03648 |
| 7 | 6 | 66 | 135 | 1693 | 8910 | 3216.7 | 2.77 | 2769.919483 |
| 7 | 8 | 66 | 109 | 2421 | 7194 | 4599.9 | 1.56 | 1563.947042 |
| 7 | 9 | 66 | 163 | 5451 | 10758 | 10356.9 | 1.04 | 1038.727805 |
| 7 | 10 | 66 | 23 | 4438 | 1518 | 8432.2 | 0.18 | 180.024193 |
| 7 | 11 | 66 | 43 | 2466 | 2838 | 4685.4 | 0.61 | 605.7113587 |
| 7 | 12 | 66 | 228 | 2846 | 15048 | 5407.4 | 2.78 | 2782.853127 |
| 7 | 13 | 66 | 141 | 7095 | 9306 | 13480.5 | 0.69 | 690.3304774 |
| 7 | 14 | 66 | 102 | 3658 | 6732 | 6950.2 | 0.97 | 968.60522 |
| *7* | *15* | *66* | *2988* | *3555* | *197208* | *6754.5* | *29.20* | *29196.53564* |
| 7 | 16 | 66 | 2329 | 6948 | 153714 | 13201.2 | 11.64 | 11643.94146 |
| 7 | 17 | 66 | 963 | 6375 | 63558 | 12112.5 | 5.25 | 5247.306502 |
| *8* | *1* | *109* | *2164* | *4902* | *235876* | *9313.8* | *25.33* | *25325.43108* |
| 8 | 2 | 109 | 908 | 5315 | 98972 | 10098.5 | 9.80 | 9800.663465 |
| 8 | 3 | 109 | 276 | 6492 | 30084 | 12334.8 | 2.44 | 2438.953206 |
| 8 | 4 | 109 | 98 | 2474 | 10682 | 4700.6 | 2.27 | 2272.475854 |
| 8 | 5 | 109 | 421 | 2419 | 45889 | 4596.1 | 9.98 | 9984.334545 |
| 8 | 6 | 109 | 135 | 702 | 14715 | 1333.8 | 11.03 | 11032.38866 |
| 8 | 7 | 109 | 66 | 2378 | 7194 | 4518.2 | 1.59 | 1592.226993 |
| 8 | 9 | 109 | 163 | 2277 | 17767 | 4326.3 | 4.11 | 4106.742482 |
| 8 | 10 | 109 | 23 | 2434 | 2507 | 4624.6 | 0.54 | 542.1009385 |
| 8 | 11 | 109 | 43 | 3182 | 4687 | 6045.8 | 0.78 | 775.2489331 |
| 8 | 12 | 109 | 228 | 3451 | 24852 | 6556.9 | 3.79 | 3790.205737 |
| 8 | 13 | 109 | 141 | 3922 | 15369 | 7451.8 | 2.06 | 2062.454709 |
| 8 | 14 | 109 | 102 | 2078 | 11118 | 3948.2 | 2.82 | 2815.96677 |
| **8** | **15** | **109** | **2988** | **4716** | **325692** | **8960.4** | **36.35** | **36347.9309** |
| 8 | 16 | 109 | 2329 | 8983 | 253861 | 17067.7 | 14.87 | 14873.76741 |
| 8 | 17 | 109 | 963 | 8410 | 104967 | 15979 | 6.57 | 6569.05939 |
| *9* | *1* | *163* | *2164* | *6633* | *352732* | *12602.7* | *27.99* | *27988.60562* |
| 9 | 2 | 163 | 908 | 6834 | 148004 | 12984.6 | 11.40 | 11398.42583 |
| 9 | 3 | 163 | 276 | 8131 | 44988 | 15448.9 | 2.91 | 2912.051991 |
| 9 | 4 | 163 | 98 | 3337 | 15974 | 6340.3 | 2.52 | 2519.439143 |
| 9 | 5 | 163 | 421 | 4798 | 68623 | 9116.2 | 7.53 | 7527.588249 |
| 9 | 6 | 163 | 135 | 3140 | 22005 | 5966 | 3.69 | 3688.400939 |
| 9 | 7 | 163 | 66 | 5578 | 10758 | 10598.2 | 1.02 | 1015.078032 |
| 9 | 8 | 163 | 109 | 2380 | 17767 | 4522 | 3.93 | 3929.013711 |

*Table 31 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 9 | 10 | 163 | 23 | 2937 | 3749 | 5580.3 | 0.67 | 671.8276795 |
| 9 | 11 | 163 | 43 | 4982 | 7009 | 9465.8 | 0.74 | 740.4551121 |
| 9 | 12 | 163 | 228 | 5251 | 37164 | 9976.9 | 3.73 | 3725.004761 |
| 9 | 13 | 163 | 141 | 1653 | 22983 | 3140.7 | 7.32 | 7317.795396 |
| 9 | 14 | 163 | 102 | 3420 | 16626 | 6498 | 2.56 | 2558.633426 |
| **9** | **15** | **163** | **2988** | **5927** | **487044** | **11261.3** | **43.25** | **43249.35842** |
| 9 | 16 | 163 | 2329 | 12206 | 379627 | 23191.4 | 16.37 | 16369.30069 |
| 9 | 17 | 163 | 963 | 11633 | 156969 | 22102.7 | 7.10 | 7101.802042 |
| **10** | **1** | **23** | **2164** | **4891** | **49772** | **9292.9** | **5.36** | **5355.916883** |
| 10 | 2 | 23 | 908 | 5287 | 20884 | 10045.3 | 2.08 | 2078.982211 |
| 10 | 3 | 23 | 276 | 6583 | 6348 | 12507.7 | 0.51 | 507.5273631 |
| 10 | 4 | 23 | 98 | 624 | 2254 | 1185.6 | 1.90 | 1901.147099 |
| 10 | 5 | 23 | 421 | 3648 | 9683 | 6931.2 | 1.40 | 1397.01639 |
| 10 | 6 | 23 | 135 | 3084 | 3105 | 5859.6 | 0.53 | 529.8996519 |
| 10 | 7 | 23 | 66 | 4427 | 1518 | 8411.3 | 0.18 | 180.4715086 |
| 10 | 8 | 23 | 109 | 2427 | 2507 | 4611.3 | 0.54 | 543.6644764 |
| 10 | 9 | 23 | 163 | 3016 | 3749 | 5730.4 | 0.65 | 654.2300712 |
| 10 | 11 | 23 | 43 | 3831 | 989 | 7278.9 | 0.14 | 135.8721785 |
| 10 | 12 | 23 | 228 | 4100 | 5244 | 7790 | 0.67 | 673.1707317 |
| 10 | 13 | 23 | 141 | 4186 | 3243 | 7953.4 | 0.41 | 407.7501446 |
| 10 | 14 | 23 | 102 | 779 | 2346 | 1480.1 | 1.59 | 1585.028039 |
| *10* | *15* | *23* | *2988* | *7389* | *68724* | *14039.1* | *4.90* | *4895.185589* |
| 10 | 16 | 23 | 2329 | 10977 | 53567 | 20856.3 | 2.57 | 2568.384613 |
| 10 | 17 | 23 | 963 | 10404 | 22149 | 19767.6 | 1.12 | 1120.46986 |
| **11** | **1** | **43** | **2164** | **1838** | **93052** | **3492.2** | **26.65** | **26645.66749** |
| 11 | 2 | 43 | 908 | 2079 | 39044 | 3950.1 | 9.88 | 9884.306726 |
| 11 | 3 | 43 | 276 | 3256 | 11868 | 6186.4 | 1.92 | 1918.401655 |
| 11 | 4 | 43 | 98 | 3080 | 4214 | 5852 | 0.72 | 720.0956938 |
| 11 | 5 | 43 | 421 | 1660 | 18103 | 3154 | 5.74 | 5739.695625 |
| 11 | 6 | 43 | 135 | 1671 | 5805 | 3174.9 | 1.83 | 1828.404044 |
| 11 | 7 | 43 | 66 | 2439 | 2838 | 4634.1 | 0.61 | 612.4166505 |
| 11 | 8 | 43 | 109 | 3242 | 4687 | 6159.8 | 0.76 | 760.901328 |
| 11 | 9 | 43 | 163 | 4881 | 7009 | 9273.9 | 0.76 | 755.7769655 |
| 11 | 10 | 43 | 23 | 3866 | 989 | 7345.4 | 0.13 | 134.6420889 |
| 11 | 12 | 43 | 228 | 609 | 9804 | 1157.1 | 8.47 | 8472.906404 |
| 11 | 13 | 43 | 141 | 6525 | 6063 | 12397.5 | 0.49 | 489.0502117 |
| 11 | 14 | 43 | 102 | 2778 | 4386 | 5278.2 | 0.83 | 830.9651017 |
| *11* | *15* | *43* | *2988* | *5421* | *128484* | *10299.9* | *12.47* | *12474.29587* |
| 11 | 16 | 43 | 2329 | 9068 | 100147 | 17229.2 | 5.81 | 5812.632043 |
| 11 | 17 | 43 | 963 | 8495 | 41409 | 16140.5 | 2.57 | 2565.533905 |
| **12** | **1** | **228** | **2164** | **2270** | **493392** | **4313** | **114.40** | **114396.4758** |
| 12 | 2 | 228 | 908 | 2662 | 207024 | 5057.8 | 40.93 | 40931.63035 |
| 12 | 3 | 228 | 276 | 3789 | 62928 | 7199.1 | 8.74 | 8741.092637 |
| 12 | 4 | 228 | 98 | 3212 | 22344 | 6102.8 | 3.66 | 3661.270237 |
| 12 | 5 | 228 | 421 | 1974 | 95988 | 3750.6 | 25.59 | 25592.70517 |
| 12 | 6 | 228 | 135 | 1814 | 30780 | 3446.6 | 8.93 | 8930.540243 |
| 12 | 7 | 228 | 66 | 2773 | 15048 | 5268.7 | 2.86 | 2856.112514 |
| 12 | 8 | 228 | 109 | 3385 | 24852 | 6431.5 | 3.86 | 3864.106352 |

*Table 31 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 9 | 228 | 163 | 5019 | 37164 | 9536.1 | 3.90 | 3897.190675 |
| 12 | 10 | 228 | 23 | 4009 | 5244 | 7617.1 | 0.69 | 688.4509853 |
| 12 | 11 | 228 | 43 | 569 | 9804 | 1081.1 | 9.07 | 9068.541301 |
| 12 | 13 | 228 | 141 | 6663 | 32148 | 12659.7 | 2.54 | 2539.396668 |
| 12 | 14 | 228 | 102 | 2911 | 23256 | 5530.9 | 4.20 | 4204.740639 |
| *12* | *15* | *228* | *2988* | *6772* | *681264* | *12866.8* | *52.95* | *52947.4306* |
| 12 | 16 | 228 | 2329 | 9381 | 531012 | 17823.9 | 29.79 | 29792.13303 |
| 12 | 17 | 228 | 963 | 8808 | 219564 | 16735.2 | 13.12 | 13119.89101 |
| *13* | *1* | *141* | *2164* | *8278* | *305124* | *15728.2* | *19.40* | *19399.80417* |
| 13 | 2 | 141 | 908 | 8478 | 128028 | 16108.2 | 7.95 | 7948.001639 |
| 13 | 3 | 141 | 276 | 4977 | 38916 | 9456.3 | 4.12 | 4115.35167 |
| 13 | 4 | 141 | 98 | 4977 | 13818 | 9456.3 | 1.46 | 1461.248057 |
| 13 | 5 | 141 | 421 | 6499 | 59361 | 12348.1 | 4.81 | 4807.298289 |
| 13 | 6 | 141 | 135 | 4752 | 19035 | 9028.8 | 2.11 | 2108.253589 |
| 13 | 7 | 141 | 66 | 7189 | 9306 | 13659.1 | 0.68 | 681.3040391 |
| 13 | 8 | 141 | 109 | 3991 | 15369 | 7582.9 | 2.03 | 2026.797136 |
| 13 | 9 | 141 | 163 | 1596 | 22983 | 3032.4 | 7.58 | 7579.145231 |
| 13 | 10 | 141 | 23 | 4578 | 3243 | 8698.2 | 0.37 | 372.8357591 |
| 13 | 11 | 141 | 43 | 6594 | 6063 | 12528.6 | 0.48 | 483.9327618 |
| 13 | 12 | 141 | 228 | 6862 | 32148 | 13037.8 | 2.47 | 2465.753425 |
| 13 | 14 | 141 | 102 | 5060 | 14382 | 9614 | 1.50 | 1495.943416 |
| **13** | **15** | **141** | **2988** | **7124** | **421308** | **13535.6** | **31.13** | **31125.9198** |
| 13 | 16 | 141 | 2329 | 12079 | 328389 | 22950.1 | 14.31 | 14308.82654 |
| 13 | 17 | 141 | 963 | 11506 | 135783 | 21861.4 | 6.21 | 6211.084377 |
| **14** | **1** | **102** | **2164** | **4088** | **220728** | **7767.2** | **28.42** | **28417.96272** |
| 14 | 2 | 102 | 908 | 4624 | 92616 | 8785.6 | 10.54 | 10541.79567 |
| 14 | 3 | 102 | 276 | 5800 | 28152 | 11020 | 2.55 | 2554.627949 |
| 14 | 4 | 102 | 98 | 292 | 9996 | 554.8 | 18.02 | 18017.30353 |
| 14 | 5 | 102 | 421 | 2782 | 42942 | 5285.8 | 8.12 | 8124.030421 |
| 14 | 6 | 102 | 135 | 2218 | 13770 | 4214.2 | 3.27 | 3267.524085 |
| 14 | 7 | 102 | 66 | 3561 | 6732 | 6765.9 | 0.99 | 994.9895801 |
| 14 | 8 | 102 | 109 | 2037 | 11118 | 3870.3 | 2.87 | 2872.645531 |
| 14 | 9 | 102 | 163 | 3458 | 16626 | 6570.2 | 2.53 | 2530.516575 |
| 14 | 10 | 102 | 23 | 774 | 2346 | 1470.6 | 1.60 | 1595.267238 |
| 14 | 11 | 102 | 43 | 2723 | 4386 | 5173.7 | 0.85 | 847.749193 |
| 14 | 12 | 102 | 228 | 2967 | 23256 | 5637.3 | 4.13 | 4125.379171 |
| 14 | 13 | 102 | 141 | 4629 | 14382 | 8795.1 | 1.64 | 1635.228707 |
| *14* | *15* | *102* | *2988* | *6543* | *304776* | *12431.7* | *24.52* | *24516.03562* |
| 14 | 16 | 102 | 2329 | 10189 | 237558 | 19359.1 | 12.27 | 12271.12831 |
| 14 | 17 | 102 | 963 | 9616 | 98226 | 18270.4 | 5.38 | 5376.236973 |
| *15* | *1* | *2988* | *2164* | *6389* | *6466032* | *12139.1* | *532.66* | *532661.5647* |
| 15 | 2 | 2988 | 908 | 5101 | 2713104 | 9691.9 | 279.94 | 279935.2036 |
| 15 | 3 | 2988 | 276 | 5845 | 824688 | 11105.5 | 74.26 | 74259.42101 |
| 15 | 4 | 2988 | 98 | 6860 | 292824 | 13034 | 22.47 | 22466.16541 |
| 15 | 5 | 2988 | 421 | 3636 | 1257948 | 6908.4 | 182.09 | 182089.63 |
| 15 | 6 | 2988 | 135 | 4422 | 403380 | 8401.8 | 48.01 | 48011.14047 |
| 15 | 7 | 2988 | 66 | 3583 | 197208 | 6807.7 | 28.97 | 28968.37405 |
| 15 | 8 | 2988 | 109 | 4689 | 325692 | 8909.1 | 36.56 | 36557.228 |

*Table 31 (cont'd)*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 15 | 9 | 2988 | 163 | 5858 | 487044 | 11130.2 | 43.76 | 43758.78241 |
| 15 | 10 | 2988 | 23 | 7337 | 68724 | 13940.3 | 4.93 | 4929.879558 |
| 15 | 11 | 2988 | 43 | 5379 | 128484 | 10220.1 | 12.57 | 12571.69695 |
| 15 | 12 | 2988 | 228 | 5758 | 681264 | 10940.2 | 62.27 | 62271.62209 |
| 15 | 13 | 2988 | 141 | 7124 | 421308 | 13535.6 | 31.13 | 31125.9198 |
| 15 | 14 | 2988 | 102 | 6557 | 304776 | 12458.3 | 24.46 | 24463.69087 |
| **15** | **16** | **2988** | **2329** | **4973** | **6959052** | **9448.7** | **736.51** | **736508.9377** |
| 15 | 17 | 2988 | 963 | 4400 | 2877444 | 8360 | 344.19 | 344191.866 |
| 16 | 1 | 2329 | 2164 | 7535 | 5039956 | 14316.5 | 352.04 | 352038.2775 |
| 16 | 2 | 2329 | 908 | 5892 | 2114732 | 11194.8 | 188.90 | 188903.0621 |
| 16 | 3 | 2329 | 276 | 6138 | 642804 | 11662.2 | 55.12 | 55118.58826 |
| 16 | 4 | 2329 | 98 | 10646 | 228242 | 20227.4 | 11.28 | 11283.80316 |
| 16 | 5 | 2329 | 421 | 7358 | 980509 | 13980.2 | 70.14 | 70135.54885 |
| 16 | 6 | 2329 | 135 | 8398 | 314415 | 15956.2 | 19.70 | 19704.87961 |
| 16 | 7 | 2329 | 66 | 6966 | 153714 | 13235.4 | 11.61 | 11613.85376 |
| 16 | 8 | 2329 | 109 | 9007 | 253861 | 17113.3 | 14.83 | 14834.13485 |
| 16 | 9 | 2329 | 163 | 12315 | 379627 | 23398.5 | 16.22 | 16224.4161 |
| 16 | 10 | 2329 | 23 | 11124 | 53567 | 21135.6 | 2.53 | 2534.444255 |
| 16 | 11 | 2329 | 43 | 9152 | 100147 | 17388.8 | 5.76 | 5759.281837 |
| 16 | 12 | 2329 | 228 | 9531 | 531012 | 18108.9 | 29.32 | 29323.26094 |
| 16 | 13 | 2329 | 141 | 12087 | 328389 | 22965.3 | 14.30 | 14299.35598 |
| 16 | 14 | 2329 | 102 | 10343 | 237558 | 19651.7 | 12.09 | 12088.41983 |
| *16* | *15* | *2329* | *2988* | *4963* | *6959052* | *9429.7* | *737.99* | *737992.9372* |
| **16** | **17** | **2329** | **963** | **933** | **2242827** | **1772.7** | **1265.20** | **1265203.926** |
| 17 | 1 | 963 | 2164 | 7753 | 2083932 | 14730.7 | 141.47 | 141468.6335 |
| 17 | 2 | 963 | 908 | 6104 | 874404 | 11597.6 | 75.40 | 75395.25419 |
| 17 | 3 | 963 | 276 | 6468 | 265788 | 12289.2 | 21.63 | 21627.77073 |
| 17 | 4 | 963 | 98 | 10062 | 94374 | 19117.8 | 4.94 | 4936.446662 |
| 17 | 5 | 963 | 421 | 6774 | 405423 | 12870.6 | 31.50 | 31499.93007 |
| 17 | 6 | 963 | 135 | 7814 | 130005 | 14846.6 | 8.76 | 8756.550321 |
| 17 | 7 | 963 | 66 | 6383 | 63558 | 12127.7 | 5.24 | 5240.729899 |
| 17 | 8 | 963 | 109 | 8423 | 104967 | 16003.7 | 6.56 | 6558.92075 |
| 17 | 9 | 963 | 163 | 11732 | 156969 | 22290.8 | 7.04 | 7041.873778 |
| 17 | 10 | 963 | 23 | 10540 | 22149 | 20026 | 1.11 | 1106.012184 |
| 17 | 11 | 963 | 43 | 8568 | 41409 | 16279.2 | 2.54 | 2543.675365 |
| 17 | 12 | 963 | 228 | 8947 | 219564 | 16999.3 | 12.92 | 12916.06125 |
| 17 | 13 | 963 | 141 | 11503 | 135783 | 21855.7 | 6.21 | 6212.704237 |
| 17 | 14 | 963 | 102 | 9760 | 98226 | 18544 | 5.30 | 5296.915444 |
| *17* | *15* | *963* | *2988* | *4379* | *2877444* | *8320.1* | *345.84* | *345842.4779* |
| **17** | **16** | **963** | **2329** | **917** | **2242827** | **1742.3** | **1287.28** | **1287279.458** |

*Table 32a – Loma Alta Allocation Catchment Resource Zone Analysis*

| Community | Community Zone | Catchment Area ($m^2$) | Open Water ($m^2$) | % | Tule-Reed Marsh ($m^2$) | % |
|---|---|---|---|---|---|---|
| 1 | Lower Slopes/Lakeshore | 5695832.75 | NA | 0 | NA | 0 |
| 2 | Lakeshore | 10477547.5 | NA | 0 | NA | 0 |
| 3 | Lower Slopes/Lakeshore | 4367042.21 | NA | 0 | NA | 0 |
| 4 | Lower Slopes | 4939059.49 | NA | 0 | NA | 0 |
| 5 | Lower Slopes | 3996119.49 | NA | 0 | NA | 0 |
| 6 | Lower Slopes | 1638473.09 | NA | 0 | NA | 0 |

*Table 32b– Loma Alta Allocation Catchment Resource Zone Analysis*

| Lakeshore ($m^2$) | % | Lower Slopes ($m^2$) | % | Upper Slopes ($m^2$) | % |
|---|---|---|---|---|---|
| 695480.9 | 12.2 | 5000351.9 | 87.8 | NA | 0 |
| 7007452.2 | 66.9 | 3470095.3 | 33.1 | NA | 0 |
| 1798290.1 | 41.2 | 2568752.1 | 58.8 | NA | 0 |
| NA | 0.0 | 4939059.5 | 100.0 | NA | 0 |
| 2784230.7 | 69.7 | 1211888.7 | 30.3 | NA | 0 |
| NA | 0.0 | 1638473.1 | 100.0 | NA | 0 |

*Table 33 – Loma Alta Slope Analysis*

| Community | Comm Slope | Comm Elevation | Max | Min | Mean | St. Dev |
|---|---|---|---|---|---|---|
| 1 | 10.8 | 2098 masl | 25.2 | 0 | 4.9 | 4.2 |
| 2 | 4.1 | 2084 masl | 19.5 | 0 | 4.4 | 3.7 |
| 3 | 6.7 | 2108 masl | 24.1 | 0 | 4.9 | 3.3 |
| 4 | 5 | 2130 masl | 33.6 | 0 | 5.8 | 3.4 |
| 5 | 1.8 | 2103 masl | 21.3 | 0 | 4.6 | 3.4 |
| 6 | 2.6 | 2125 masl | 24.1 | 0 | 5.9 | 3.4 |

*Table 34a – Lupe/La Joya Allocation Catchment Resource Zone Analysis*

| **Community** | **Community Zone** | **Catchment Area ($m^2$)** | **Open Water ($m^2$)** | **%** | **Tule-Reed Marsh ($m^2$)** | **%** |
|---|---|---|---|---|---|---|
| 1 | Lakeshore | 8248283.76 | 47639.87 | 0.6 | 65812.98 | 0.8 |
| 2 | Lakeshore | 7154027.26 | 445865.07 | 6.2 | 832349.31 | 11.6 |
| 3 | Lakeshore | 8539433.72 | 3914455.2 | 45.8 | 1221796 | 14.3 |
| 4 | Lower Slopes/Lakeshore | 4048871.38 | NA | NA | 184021.97 | 4.5 |
| 5 | Lakeshore/Lower Slopes | 5055961.95 | NA | NA | NA | NA |
| 6 | Lakeshore | 9366567.43 | NA | NA | 3801385.2 | 40.6 |
| 7 | Lower Slopes/Lakeshore | 8040922.12 | NA | NA | NA | NA |
| 8 | Lower Slopes | 5475789.52 | NA | NA | NA | NA |
| 9 | Lower Slopes | 7836987.67 | NA | NA | NA | NA |

*Table 34b - Lupe/La Joya Allocation Catchment Resource Zone Analysis*

| **Lakeshore ($m^2$)** | **%** | **Lower Slopes ($m^2$)** | **%** | **Upper Slopes ($m^2$)** |
|---|---|---|---|---|
| 5296027.7 | 64.2 | 2783691 | 33.7 | NA |
| 6172583.5 | 86.3 | NA | NA | NA |
| 3614288.1 | 42.3 | NA | NA | NA |
| 2864811.8 | 70.8 | 1000038 | 24.7 | NA |
| 714461.68 | 14.1 | 4341500 | 85.9 | NA |
| 5508264.6 | 58.8 | 56917.68 | 0.6 | NA |
| 3839851.4 | 47.8 | 4201071 | 52.2 | NA |
| NA | NA | 5475790 | 100.0 | NA |
| 4280530.9 | 54.6 | 3556457 | 45.4 | NA |

*Table 35 – Lupe/La Joya Slope Analysis*

| Community | Comm Slope | Comm Elevation | Max | Min | Mean | St. Dev |
|---|---|---|---|---|---|---|
| 1 | 4.2 | 2057 masl | 36.3 | 0 | 3.7 | 3.8 |
| 2 | 2.5 | 2044 masl | 28.6 | 0 | 2.4 | 2.3 |
| 3 | 0.5 | 2048 masl | 13 | 0 | 1.4 | 1.7 |
| 4 | 5.6 | 2104 masl | 37.4 | 0 | 5.5 | 5.5 |
| 5 | 3.4 | 2115 masl | 36.7 | 0 | 4.8 | 4.7 |
| 6 | 1.1 | 2040 masl | 32.3 | 0 | 2.4 | 2.7 |
| 7 | 9.4 | 2095 masl | 25.2 | 0 | 5.4 | 4.2 |
| 8 | 4.9 | 2125 masl | 33.6 | 0 | 5.8 | 3.4 |
| 9 | 3.2 | 2103 masl | 29 | 0 | 4.9 | 3.6 |

*Table 36 – Early Urichu Allocation Catchment Resource Zone Analysis*

| Comm | Community Zone | Catchment Area ($m^2$) | Open Water (m2) | % | Tule-Reed Marsh (m2) | % |
|---|---|---|---|---|---|---|
| 1 | Lakeshore | 8140401.77 | 3821789 | 46.9 | 1109885.27 | 13.6 |
| 2 | Lakeshore | 5298156.07 | 176047.9 | 3.3 | 1358879.62 | 25.6 |
| 3 | Lakeshore | 5476922.62 | NA | NA | 2108097.65 | 38.5 |
| 4 | Lakeshore | 5248878.32 | NA | NA | 257056.3 | 4.9 |
| 5 | Lakeshore | 1134432.37 | NA | NA | NA | NA |
| 6 | Lakeshore/Lower Slopes | 7085739.41 | NA | NA | 384967.51 | 5.4 |
| 7 | Lower Slopes | 4710081.21 | NA | NA | NA | NA |
| 8 | Lower Slopes/Lakeshore | 3578955.17 | NA | NA | NA | NA |
| 9 | Lakeshore | 9719357.9 | NA | NA | NA | NA |
| 10 | Lower Slopes/Lakeshore | 9351776.84 | NA | NA | NA | NA |
| 11 | Lower Slopes/Lakeshore | 2707153.38 | NA | NA | NA | NA |
| 12 | Lower Slopes/lakeshore | 4926840.56 | NA | NA | NA | NA |
| 13 | Lower Slopes | 4539648.11 | NA | NA | NA | NA |
| 14 | Lower Slopes | 1043818.11 | NA | NA | NA | NA |
| 15 | Lower Slopes | 159590.74 | NA | NA | NA | NA |
| 16 | Lower Slopes | 1207657.57 | NA | NA | NA | NA |
| 17 | Lakeshore/Lower Slopes | 3089309.48 | NA | NA | 785247.09 | 25.4 |

*Table 36 (cont'd)*

| **Lakeshore (m2)** | **%** | **Lower Slopes (m2)** | **%** | **Upper Slopes (m2)** | **%** |
|---|---|---|---|---|---|
| 3220051 | 39.6 | NA | NA | NA | NA |
| 3767287 | 71.1 | NA | NA | NA | NA |
| 3368825 | 61.5 | NA | NA | NA | NA |
| 4546001 | 86.6 | 445820.5 | 8.5 | NA | NA |
| 477895 | 42.1 | 656537.4 | 57.9 | NA | NA |
| 3341802 | 47.2 | 3358970 | 47.4 | NA | NA |
| 448026 | 9.5 | 4262055 | 90.5 | NA | NA |
| 201073 | 5.6 | 2758732 | 77.1 | 619150.8 | 17.3 |
| 6055986 | 62.3 | 3663372 | 37.7 | NA | NA |
| 4245259 | 45.4 | 5106518 | 54.6 | NA | NA |
| 885561 | 32.7 | 1821593 | 67.3 | NA | NA |
| 2184256 | 44.3 | 2742584 | 55.7 | NA | NA |
| NA | NA | 4539648 | 100.0 | NA | NA |
| NA | NA | 1043818 | 100.0 | NA | NA |
| 18234.8 | 11.4 | 141356 | 88.6 | NA | NA |
| NA | NA | 1207658 | 100.0 | NA | NA |
| 2246233 | 72.7 | 57829.8 | 1.9 | NA | NA |

*Table 37– Early Urichu Slope Analysis*

| Community | Slope at Comm | Elevation at Comm | Max | Min | Mean | St. Dev. |
|---|---|---|---|---|---|---|
| 1 | 3.9 | 2045 masl | 13 | 0 | 1.3 | 1.6 |
| 2 | 4.3 | 2044 masl | 29.6 | 0 | 2.3 | 2.5 |
| 3 | 1.6 | 2043 masl | 20.9 | 0 | 2.6 | 1.9 |
| 4 | 1.1 | 2042 masl | 37.4 | 0 | 3.6 | 4.1 |
| 5 | 7.9 | 2095 masl | 30.4 | 0 | 7.8 | 5.9 |
| 6 | 6.4 | 2111 masl | 36.7 | 0 | 3.4 | 3.9 |
| 7 | 5.1 | 2117 masl | 32.7 | 0 | 6.4 | 4.7 |
| 8 | 9.9 | 2111 masl | 20.8 | 0 | 8.1 | 2.3 |
| 9 | 2.7 | 2058 masl | 39.9 | 0 | 6.1 | 6 |
| 10 | 11.6 | 2103 masl | 25.2 | 0 | 5.3 | 4.1 |
| 11 | 2.5 | 2100 masl | 27.2 | 0 | 5.6 | 3.8 |
| 12 | 5.3 | 2099 masl | 24.1 | 0 | 4.9 | 3.7 |
| 13 | 7.6 | 2132 masl | 33.6 | 0 | 5.7 | 3.2 |
| 14 | 4.9 | 2125 masl | 17.6 | 0 | 5.8 | 2.9 |
| 15 | 1.4 | 2109 masl | 17.5 | 0 | 4.3 | 3.2 |
| 16 | 3.1 | 2111 masl | 32.1 | 0 | 5.9 | 3.7 |
| 17 | 2.9 | 2097 masl | 19.3 | 0 | 3 | 2.5 |

*Table 38a– Late Urichu Allocation Catchment Resource Zone Analysis*

| Comm | Community Zone | Catchment Area ($m^2$) | Open Water (m2) | % | Tule-Reed Marsh (m2) | % |
|---|---|---|---|---|---|---|
| 1 | Tule-Reed Marsh | 8749553.09 | 2553533.81 | 29.2 | 4624108.07 | 52.8 |
| 2 | Lakeshore | 822173.24 | NA | NA | 409900.89 | 49.9 |
| 3 | Lakeshore | 7197972.35 | NA | NA | 1369947.39 | 19.0 |
| 4 | Lakeshore | 1885566.16 | 442067.99 | 23.4 | 682605.64 | 36.2 |
| 5 | Lower Slopes | 3694429.77 | NA | NA | NA | NA |
| 6 | Lower Slopes | 2518997.39 | NA | NA | NA | NA |
| 7 | Lakeshore | 6998652.80 | NA | NA | NA | NA |
| 9 | Lakeshore | 156144.32 | NA | NA | NA | NA |
| 10 | Lakeshore | 2538212.12 | 1632603.79 | 64.3 | 868698.84 | 34.2 |
| 11 | Lakeshore | 251728.40 | NA | NA | NA | NA |
| 12 | Lakeshore | 3925010.86 | 2984507.84 | 76.0 | 446423.36 | 11.4 |
| 13 | Lakeshore | 209433.74 | 19158.40 | 9.1 | 76471.88 | 36.5 |
| 14 | Lakeshore | 447364.79 | NA | NA | NA | NA |
| 15 | Lakeshore | 1195390.29 | NA | NA | 36324.45 | 3.0 |
| 16 | Lakeshore | 70640.74 | NA | NA | NA | NA |
| 17 | Lakeshore | 774278.40 | NA | NA | NA | NA |
| 18 | Lakeshore | 1202495.08 | NA | NA | NA | NA |
| 19 | Lakeshore | 3072480.99 | NA | NA | NA | NA |
| 20 | Lakeshore | 1741369.66 | NA | NA | 114434.50 | 6.6 |
| 21 | Lakeshore | 691273.99 | NA | NA | 390309.21 | 56.5 |
| 22 | Lakeshore | 666820.98 | NA | NA | 299440.71 | 44.9 |
| 23 | Lower Slopes | 1213484.66 | NA | NA | NA | NA |
| 24 | Lakeshore | 634770.87 | NA | NA | NA | NA |
| 25 | Lakeshore | 114488.93 | NA | NA | NA | NA |
| 26 | Lakeshore | 1071918.00 | NA | NA | 461152.86 | 43.0 |
| 27 | Lakeshore | 1037434.27 | NA | NA | 196128.91 | 18.9 |
| 28 | Lakeshore | 10443990.31 | NA | NA | NA | NA |
| 29 | Lakeshore | 222248.62 | NA | NA | 44446.68 | 20.0 |
| 30 | Lower Slopes/Lakeshore | 3175149.93 | NA | NA | NA | NA |
| 31 | Lower Slopes | 4778771.08 | NA | NA | NA | NA |
| 32 | Lower Slopes | 1004455.94 | NA | NA | NA | NA |
| 33 | Lakeshore/Lower Slopes | 3241457.39 | NA | NA | NA | NA |
| 34 | Lakeshore/Lower Slopes | 1564987.12 | NA | NA | NA | NA |
| 35 | Lower Slopes | 529548.60 | NA | NA | NA | NA |

*Table 38a (cont'd)*

| | | | | | | |
|---|---|---|---|---|---|---|
| 36 | Lower Slopes/Lakeshore | 6366919.77 | NA | NA | NA | NA |
| 37 | Lakeshore | 1071063.76 | NA | NA | NA | NA |
| 38 | Lakeshore | 2523826.94 | 860341.25 | 34.1 | 514453.91 | 20.4 |
| 39 | Lakeshore | 1985014.68 | NA | NA | 575368.11 | 29.0 |
| 40 | Lakeshore | 756110.92 | NA | NA | NA | NA |
| 41 | Lakeshore | 1291888.78 | NA | NA | NA | NA |
| 42 | Lakeshore | 6436876.73 | 112698.37 | 1.8 | 85873.45 | 1.3 |
| 43 | Lower Slopes | 2721333.44 | NA | NA | NA | NA |
| 44 | Lower Slopes | 5954794.84 | NA | NA | NA | NA |

*Table 38b - Late Urichu Allocation Catchment Resource Zone Analysis*

| **Lakeshore (m2)** | **%** | **Lower Slopes (m2)** | **%** | **Upper Slopes (m2)** | **%** |
|---|---|---|---|---|---|
| 1588002.02 | 18.1 | NA | NA | NA | NA |
| 412272.35 | 50.1 | NA | NA | NA | NA |
| 5477715.10 | 76.1 | 350309.82 | 4.9 | NA | NA |
| 765865.26 | 40.6 | NA | NA | NA | NA |
| 127882.67 | 3.5 | 3566547.06 | 96.5 | 4071.53 | 0.1 |
| 299343.90 | 11.9 | 2159283.88 | 85.7 | 60369.63 | 2.4 |
| 2100948.65 | 30.0 | 4897704.14 | 70.0 | NA | NA |
| 156144.32 | 100.0 | NA | NA | NA | NA |
| 573213.35 | 22.6 | NA | NA | NA | NA |
| 251728.40 | 100.0 | NA | NA | NA | NA |
| 546282.11 | 13.9 | NA | NA | NA | NA |
| 120311.00 | 57.4 | NA | NA | NA | NA |
| 447364.79 | 100.0 | NA | NA | NA | NA |
| 1159065.84 | 97.0 | NA | NA | NA | NA |
| 70640.74 | 100.0 | NA | NA | NA | NA |
| 774278.40 | 100.0 | NA | NA | NA | NA |
| 1202495.08 | 100.0 | NA | NA | NA | NA |
| 3072480.99 | 100.0 | NA | NA | NA | NA |
| 1553996.93 | 89.2 | 72938.22 | 4.2 | NA | NA |
| 300964.79 | 43.5 | NA | NA | NA | NA |
| 356856.61 | 53.5 | 10523.66 | 1.6 | NA | NA |
| 233592.00 | 19.2 | 979892.66 | 80.8 | NA | NA |
| 634770.87 | 100.0 | NA | NA | NA | NA |
| 114488.93 | 100.0 | NA | NA | NA | NA |
| 610765.14 | 57.0 | NA | NA | NA | NA |

*Table 38b (cont'd)*

| | | | | | |
|---|---|---|---|---|---|
| 841305.37 | 81.1 | NA | NA | NA | NA |
| 4213629.13 | 40.3 | 6230361.18 | 59.7 | NA | NA |
| 151898.25 | 68.3 | 25903.68 | 11.7 | NA | NA |
| 810085.82 | 25.5 | 2365064.11 | 74.5 | NA | NA |
| NA | NA | 4778771.08 | 100.0 | NA | NA |
| NA | NA | 1004455.94 | 100.0 | NA | NA |
| 919335.93 | 28.4 | 2322121.46 | 71.6 | NA | NA |
| 1445911.98 | 92.4 | 119075.14 | 7.6 | NA | NA |
| NA | NA | 529548.60 | 100.0 | NA | NA |
| 2104320.50 | 33.1 | 3181762.24 | 50.0 | 1080837.01 | 17.0 |
| 1027565.08 | 95.9 | 43498.68 | 4.1 | NA | NA |
| 1153494.16 | 45.7 | NA | NA | NA | NA |
| 582497.53 | 29.3 | 827149.03 | 41.7 | NA | NA |
| 756110.92 | 100.0 | NA | NA | NA | NA |
| 413725.31 | 32.0 | 878163.47 | 68.0 | NA | NA |
| 6115295.49 | 95.0 | 179120.67 | 2.8 | NA | NA |
| 677620.86 | 24.9 | 2043712.58 | 75.1 | NA | NA |
| NA | NA | 5487385.50 | 92.2 | 467409.34 | 7.8 |

*Table 39 – Late Urichu Slope Analysis*

| Comm | Comm Slope | Comm Elevation | Max | Min | Mean | St. Dev. |
|---|---|---|---|---|---|---|
| 1 | 1.6 | 2045 masl | 17.4 | 0 | 1.6 | 1.8 |
| 2 | 2.5 | 2059 masl | 12.8 | 0 | 2.5 | 1.7 |
| 3 | 1.6 | 2050 masl | 17.8 | 0 | 2.4 | 2.5 |
| 4 | 2.9 | 2046 masl | 8.2 | 0 | 1.7 | 1.5 |
| 5 | 14.2 | 2138 masl | 39.9 | 0 | 7.8 | 7.3 |
| 6 | 9.1 | 2117 masl | 34.7 | 0 | 10.9 | 8.4 |
| 7 | 5.6 | 2081 masl | 32.7 | 0 | 6 | 4.7 |
| 9 | 1.4 | 2045 masl | 8.2 | 0 | 2.6 | 1.4 |
| 10 | 1.5 | 2044 masl | 15.3 | 0 | 1.4 | 2.1 |
| 11 | 1.6 | 2047 masl | 8.5 | 0 | 2.1 | 1.4 |
| 12 | 0.5 | 2046 masl | 34.7 | 0 | 0.8 | 2.3 |
| 13 | 2.1 | 2047 masl | 8.2 | 0 | 2.4 | 1.5 |
| 14 | 3 | 2047 masl | 8.5 | 0 | 2.6 | 1.5 |
| 15 | 1 | 2045 masl | 8.1 | 0 | 2.1 | 1.3 |
| 16 | 2.3 | 2049 masl | 6.7 | 0 | 3.1 | 1.4 |
| 17 | 1.5 | 2064 masl | 9.5 | 0 | 3.4 | 1.9 |
| 18 | 3.9 | 2054 masl | 7.7 | 0 | 2.2 | 1.2 |
| 19 | 1.1 | 2047 masl | 32.1 | 0 | 3.2 | 3.5 |
| 20 | 1.1 | 2042 masl | 30.7 | 0 | 4.7 | 4.8 |
| 21 | 2.1 | 2045 masl | 6.1 | 0 | 1.8 | 1 |
| 22 | 8.9 | 2059 masl | 23.3 | 0 | 4.4 | 4 |
| 23 | 4 | 2104 masl | 36.7 | 0 | 5.9 | 5.6 |
| 24 | 1.6 | 2043 masl | 7.1 | 0 | 2.1 | 1.2 |
| 25 | 2 | 2048 masl | 10.9 | 0 | 2.7 | 1.6 |
| 26 | 2.7 | 2044 masl | 11.6 | 0 | 2.7 | 1.8 |
| 27 | 1.8 | 2051 masl | 9 | 0 | 2.5 | 1.5 |
| 28 | 3 | 2080 masl | 20.6 | 0 | 4.9 | 3.9 |
| 29 | 9.5 | 2050 masl | 24.3 | 0 | 7.9 | 6.3 |
| 30 | 0.7 | 2101 masl | 27.2 | 0 | 5.9 | 3.7 |
| 31 | 6.2 | 2136 masl | 33.6 | 0 | 5.8 | 3.3 |
| 32 | 7.1 | 2129 masl | 17.6 | 0 | 5.7 | 2.8 |
| 33 | 6.1 | 2098 masl | 24.1 | 0 | 5.8 | 3.9 |
| 34 | 2.9 | 2099 masl | 19.3 | 0 | 3.7 | 2.9 |
| 35 | 5.2 | 2111 masl | 19.3 | 0 | 4.4 | 2.5 |
| 36 | 10.7 | 2101 masl | 20.8 | 0 | 6.9 | 3.5 |
| 37 | 7 | 2061 masl | 10.6 | 0 | 4.2 | 1.9 |
| 38 | 2.7 | 2048 masl | 9.3 | 0 | 1.5 | 1.6 |
| 39 | 11.8 | 2048 masl | 32.3 | 0 | 4.5 | 4.5 |
| 40 | 1.4 | 2043 masl | 7.1 | 0 | 1.9 | 1.2 |
| 41 | 7.9 | 2091 masl | 11.3 | 0 | 4.4 | 2.4 |
| 42 | 1.5 | 2040 masl | 36.5 | 0 | 2.6 | 4 |
| 43 | 2.1 | 2106 masl | 20.9 | 0 | 4.5 | 2.9 |
| 44 | 4 | 2144 masl | 23.9 | 0 | 6.3 | 4.1 |

*Table 40 – Tariacuri Allocation Catchment Resource Zone Analysis*

| **Comm** | **Comm Zone** | **Catchment Area (m$^2$)** | **Open Water (m2)** | **%** | **Tule-Reed Marsh (m2)** | **%** |
|---|---|---|---|---|---|---|
| 1 | Lakeshore | 511177.801 | NA | NA | NA | NA |
| 2 | Lakeshore | 6228053.73 | 2299445.37 | 36.9 | 398218.68 | 6.4 |
| 3 | Lakeshore | 9802666.39 | 7346665.13 | 74.9 | 256854.26 | 2.6 |
| 4 | Lakeshore | 1681287.61 | NA | NA | NA | NA |
| 5 | Lakeshore | 1352378.66 | NA | NA | 7542.262505 | 0.6 |
| 6 | Lakeshore | 1705523.96 | NA | NA | NA | NA |
| 7 | Lower Slopes/Lakeshore | 1534480.15 | NA | NA | NA | NA |
| 8 | Lakeshore | 3407648.4 | NA | NA | NA | NA |
| 9 | Lakeshore | 5908960.06 | NA | NA | NA | NA |
| 10 | Lakeshore | 4816956.25 | NA | NA | NA | NA |
| 11 | Lakeshore | 3940259.61 | 2625894.05 | 66.6 | 243659.216 | 6.2 |
| 12 | Lakeshore | 8261412.38 | 4848299.92 | 58.7 | 616199.203 | 7.5 |
| 13 | Lower Slopes | 8266863.05 | NA | NA | NA | NA |
| 14 | Lakeshore | 825696.164 | NA | NA | NA | NA |
| 15 | Lakeshore/Lower Slopes | 10415633 | NA | NA | NA | NA |
| 16 | Lower Slopes/Lakeshore | 5321004.65 | NA | NA | NA | NA |
| 17 | Lower Slopes/Lakeshore | 6245673.68 | NA | NA | NA | NA |
| 18 | Lakeshore | 1664448.4 | NA | NA | 124833.6302 | 7.5 |

*Table 40 (cont'd)*

| Lakeshore (m2) | % | Lower Slopes (m2) | % | Upper Slopes (m2) | % |
|---|---|---|---|---|---|
| 511177.8006 | 100.0 | NA | NA | NA | NA |
| 3480845.45 | 55.9 | NA | NA | NA | NA |
| 1763960.15 | 18.0 | NA | NA | NA | NA |
| 377179 | 22.4 | 1304108.608 | 77.6 | NA | NA |
| 797961.58 | 59.0 | 546874.8 | 40.4 | NA | NA |
| 973005.34 | 57.1 | 732518.616 | 42.9 | NA | NA |
| 94950.34473 | 6.2 | 1439529.81 | 93.8 | NA | NA |
| 2452594.765 | 72.0 | 955053.63 | 28.0 | NA | NA |
| 2965799.42 | 50.2 | 2943160.644 | 49.8 | NA | NA |
| 1831541.1 | 38.0 | 2985415.145 | 62.0 | NA | NA |
| 1071394.68 | 27.2 | 19062.5 | 0.5 | NA | NA |
| 2449371.74 | 29.6 | 388265.45 | 4.7 | NA | NA |
| 113189.28 | 1.4 | 8009488.07 | 96.9 | 144185.69 | 1.7 |
| 825696.1635 | 100.0 | NA | NA | NA | NA |
| 4620027.67 | 44.4 | 5795605.29 | 55.6 | NA | NA |
| 825501.79 | 15.5 | 4495502.859 | 84.5 | NA | NA |
| 1310786.33 | 21.0 | 4934887.348 | 79.0 | NA | NA |
| 907124.3795 | 54.5 | 632490.393 | 38.0 | NA | NA |

*Table 41 – Tariacuri Slope Analysis*

| Community | Comm Slope | Comm Elevation | Max | Min | Mean | St. Dev. |
|---|---|---|---|---|---|---|
| 1 | 2.5 | 2067 masl | 11.6 | 0 | 3.4 | 2.1 |
| 2 | 2.1 | 2060 masl | 32.3 | 0 | 3.2 | 3.6 |
| 3 | 3.1 | 2045 masl | 24.1 | 0 | 2.3 | 2.2 |
| 4 | 1.6 | 2063 masl | 15.3 | 0 | 3.8 | 2.2 |
| 5 | 2.5 | 2051 masl | 36.7 | 0 | 6.8 | 5.9 |
| 6 | 1.6 | 2057 masl | 27.6 | 0 | 5.4 | 4.8 |
| 7 | 4.8 | 2106 masl | 22.6 | 0 | 3.7 | 2.9 |
| 8 | 3.7 | 2053 masl | 39.9 | 0 | 6.7 | 7.5 |
| 9 | 6.1 | 2074 masl | 34.7 | 0 | 6.4 | 5.9 |
| 10 | 5.7 | 2066 masl | 20.6 | 0 | 5.9 | 3.6 |
| 11 | 2.5 | 2046 masl | 25.6 | 0 | 2.8 | 2.9 |
| 12 | 1.1 | 2046 masl | 12.5 | 0 | 2.3 | 1.6 |
| 13 | 0.5 | 2155 masl | 32.7 | 0 | 6.4 | 4.4 |
| 14 | 4.3 | 2054 masl | 7.3 | 0 | 2.2 | 1.3 |
| 15 | 3.2 | 2085 masl | 27.5 | 0 | 4.7 | 3.9 |
| 16 | 2.9 | 2103 masl | 33.6 | 0 | 5.4 | 3.6 |
| 17 | 1.1 | 2108 masl | 24.1 | 0 | 5.7 | 3.5 |
| 18 | 2.5 | 2057 masl | 7.1 | 0 | 3.5 | 2.2 |

*Table 42– Loma Alta Travel/Transportation Network Analysis*

| **Community** | **Travel Routes (Land)** | **Average Distance to Routes (meters)** | **Water Access** | **Water Routes** |
|---|---|---|---|---|
| 1 | 2 | 629 | no | NA |
| 2 | 4 | 650 | no | NA |
| 3 | 2 | 614 | no | NA |
| 4 | 1 | 362 | no | NA |
| 5 | 3 | 1322 | no | NA |
| 6 | 1 | 406 | no | NA |

*Table 43– Lupe/La Joya Travel/Transportation Network Analysis*

| Community | Travel Routes (Land) | Average Distance to Routes (meters) | Water Access | Water Routes |
|---|---|---|---|---|
| 1 | 2 | 784 | yes | 1 |
| 2 | 2 | 522 | yes | 0 |
| 3 | 0 | NA | yes | 2 |
| 4 | 2 | 305 | yes | 1 |
| 5 | 2 | 730 | yes | 0 |
| 6 | 2 | 650 | no | NA |
| 7 | 3 | 1067 | yes | 4 |
| 8 | 1 | 797 | no | NA |
| 9 | 3 | 606 | yes | 0 |

*Table 44 – Early Urichu Travel/Transportation Network Analysis*

| Community | Travel Routes (Land) | Average Distance to Routes (meters) | Water Access | Water Routes |
|---|---|---|---|---|
| 1 | 0 | NA | yes | 2 |
| 2 | 2 | 515 | yes | 2 |
| 3 | 1 | 786 | yes | 2 |
| 4 | 2 | 116 | yes | 1 |
| 5 | 1 | 89 | yes | 0 |
| 6 | 3 | 881 | yes | 2 |
| 7 | 1 | 503 | no | NA |
| 8 | 0 | NA | no | NA |
| 9 | 2 | 171 | no | NA |
| 10 | 2 | 622 | no | NA |
| 11 | 2 | 481 | no | NA |
| 12 | 1 | 248 | no | NA |
| 13 | 1 | 314 | no | NA |
| 14 | 1 | 396 | no | NA |
| 15 | 2 | 40 | no | NA |
| 16 | 1 | 20 | no | NA |
| 17 | 3 | 415 | yes | 1 |

*Table 45 - Late Urichu Travel/Transportation Network Analysis*

| Community | Travel Routes (Land) | Average Distance to Routes (meters) | Water Access | Water Routes |
|---|---|---|---|---|
| 1 | 1 | 1492 | yes | 4 |
| 2 | 0 | NA | yes | 1 |
| 3 | 5 | 495 | yes | 3 |
| 4 | 0 | NA | yes | 1 |
| 5 | 2 | 1371 | no | NA |
| 6 | 2 | 1185 | no | NA |
| 7 | 2 | 158 | no | NA |
| 9 | 0 | NA | yes | 0 |
| 10 | 0 | NA | yes | 0 |
| 11 | 0 | NA | yes | 0 |
| 12 | 0 | NA | yes | 2 |
| 13 | 0 | NA | yes | 0 |
| 14 | 0 | NA | no | NA |
| 15 | 2 | 309 | yes | 0 |
| 16 | 2 | 210 | yes | 0 |
| 17 | 1 | 482 | no | NA |
| 18 | 1 | 221 | no | NA |
| 19 | 1 | 193 | no | NA |
| 20 | 2 | 53 | yes | 0 |
| 21 | 2 | 86 | yes | 1 |
| 22 | 0 | NA | yes | 2 |
| 23 | 1 | 10 | yes | 0 |
| 24 | 1 | 546 | yes | 0 |
| 25 | 0 | NA | no | 0 |
| 26 | 0 | NA | yes | 1 |
| 27 | 0 | NA | yes | 0 |
| 28 | 2 | 674 | no | NA |
| 29 | 0 | NA | yes | 0 |
| 30 | 2 | 602 | no | NA |
| 31 | 1 | 334 | no | NA |
| 32 | 1 | 410 | no | NA |
| 33 | 1 | 262 | no | NA |
| 34 | 2 | 175 | no | NA |
| 35 | 1 | 78 | no | NA |
| 36 | 1 | 818 | no | NA |
| 37 | 1 | 718 | no | NA |
| 38 | 0 | NA | yes | 1 |
| 39 | 1 | 101 | yes | 1 |
| 40 | 2 | 174 | no | 0 |
| 41 | 0 | NA | no | NA |
| 42 | 2 | 356 | yes | 0 |
| 43 | 0 | NA | no | NA |
| 44 | 0 | NA | no | NA |

*Table 46 - Tariacuri Travel/Transportation Network Analysis*

| Community | Travel Routes (Land) | Average Distance to Routes (meters) | Water Access | Water Routes |
|---|---|---|---|---|
| 1 | 0 | NA | yes | 0 |
| 2 | 3 | 2394 | yes | 4 |
| 3 | 0 | NA | yes | 6 |
| 4 | 1 | 755 | no | NA |
| 5 | 2 | 50 | yes | 0 |
| 6 | 1 | 346 | no | NA |
| 7 | 1 | 359 | yes | 0 |
| 8 | 3 | 797 | no | NA |
| 9 | 3 | 133 | no | NA |
| 10 | 1 | 132 | no | NA |
| 11 | 0 | NA | yes | 2 |
| 12 | 2 | 1108 | yes | 2 |
| 13 | 2 | 970 | no | NA |
| 14 | 2 | 279 | yes | NA |
| 15 | 3 | 730 | no | NA |
| 16 | 2 | 219 | no | NA |
| 17 | 1 | 388 | no | NA |
| 18 | 2 | 50 | yes | 1 |

*Figure 69 – The Lupe/La Joya Communities for the Southeast Malpaís Survey*

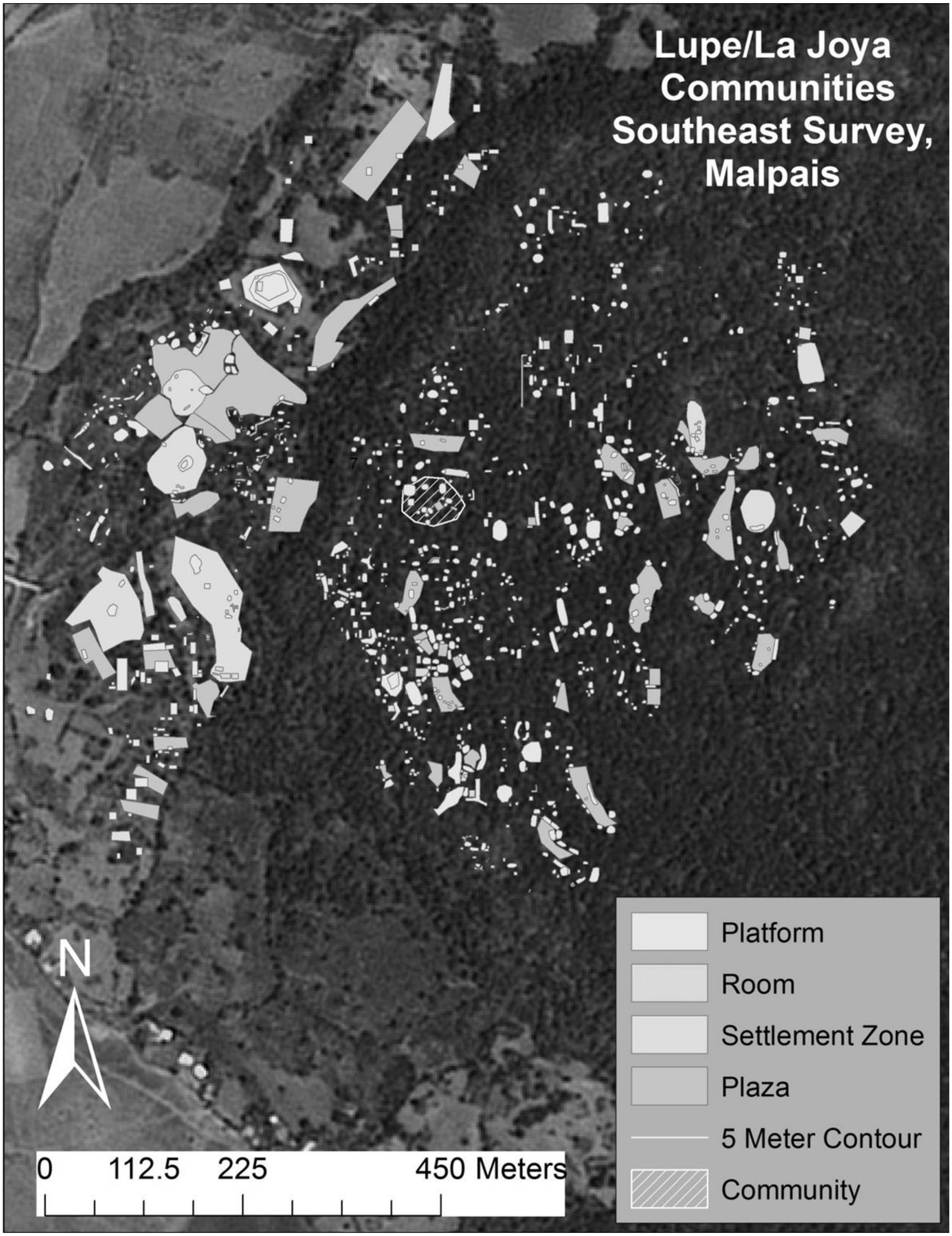


*Figure 70 - The Early Urichu Communities for the Southeast Malpaís Survey*

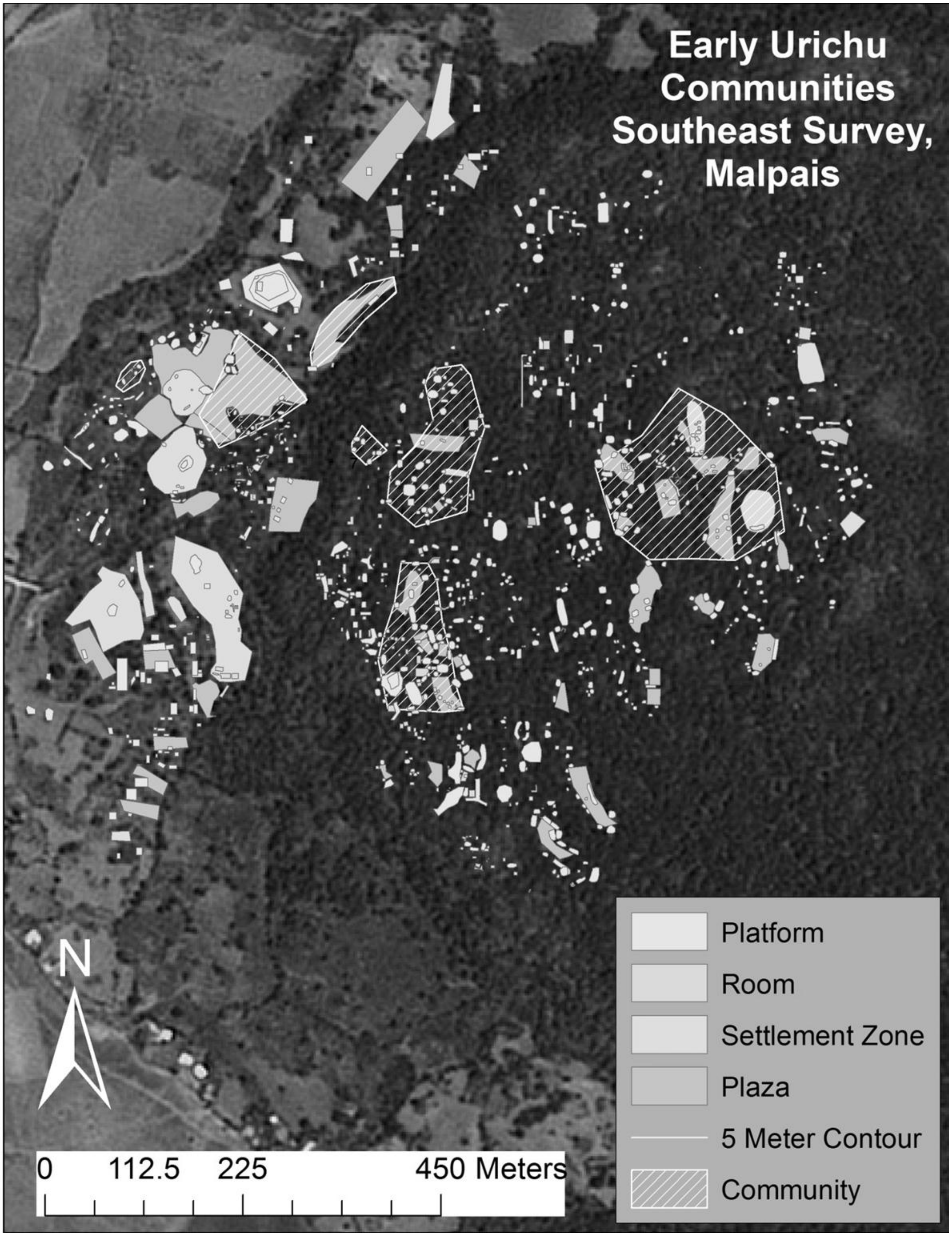


*Figure 71 - The Late Urichu Communities for the Southeast Malpaís Survey*

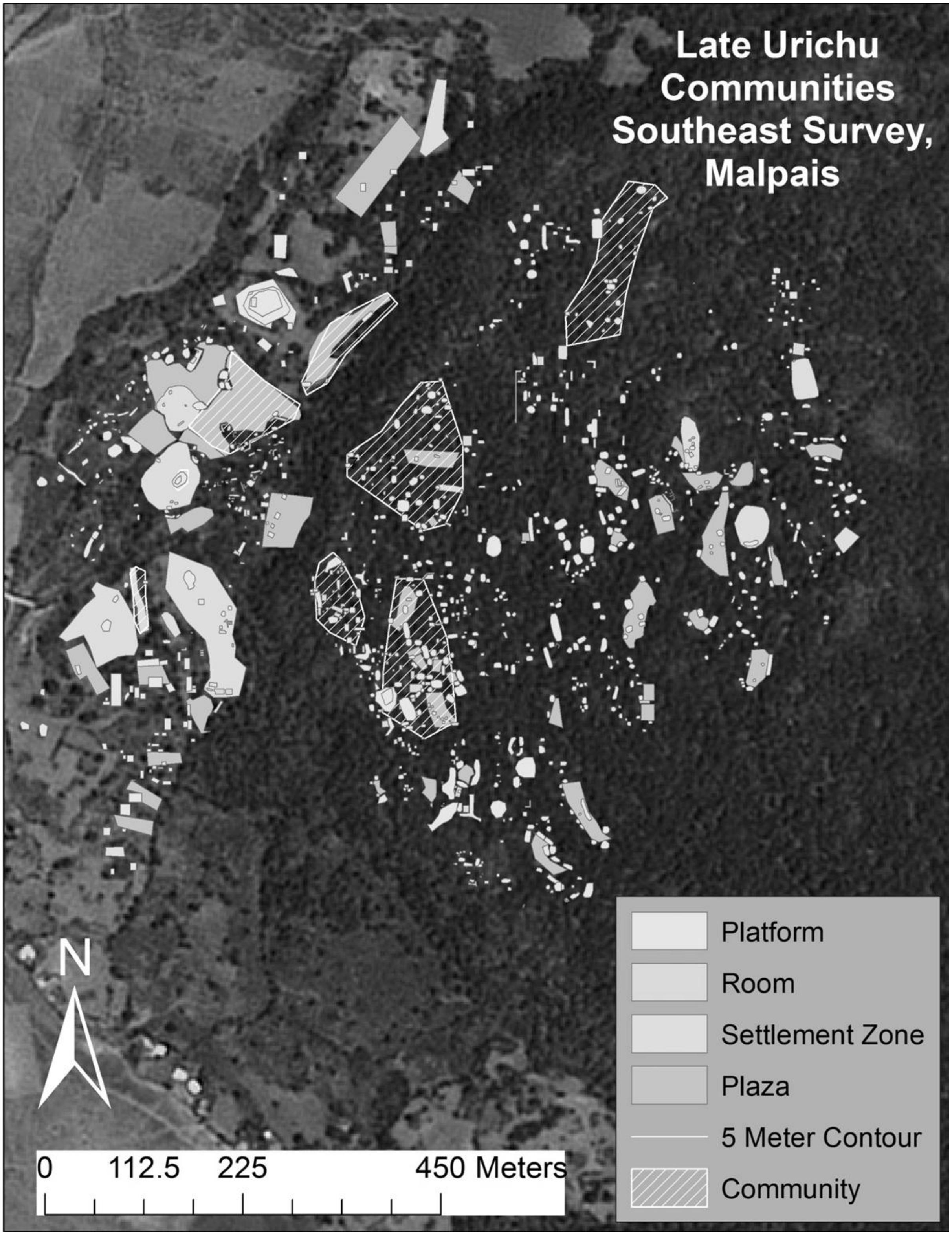
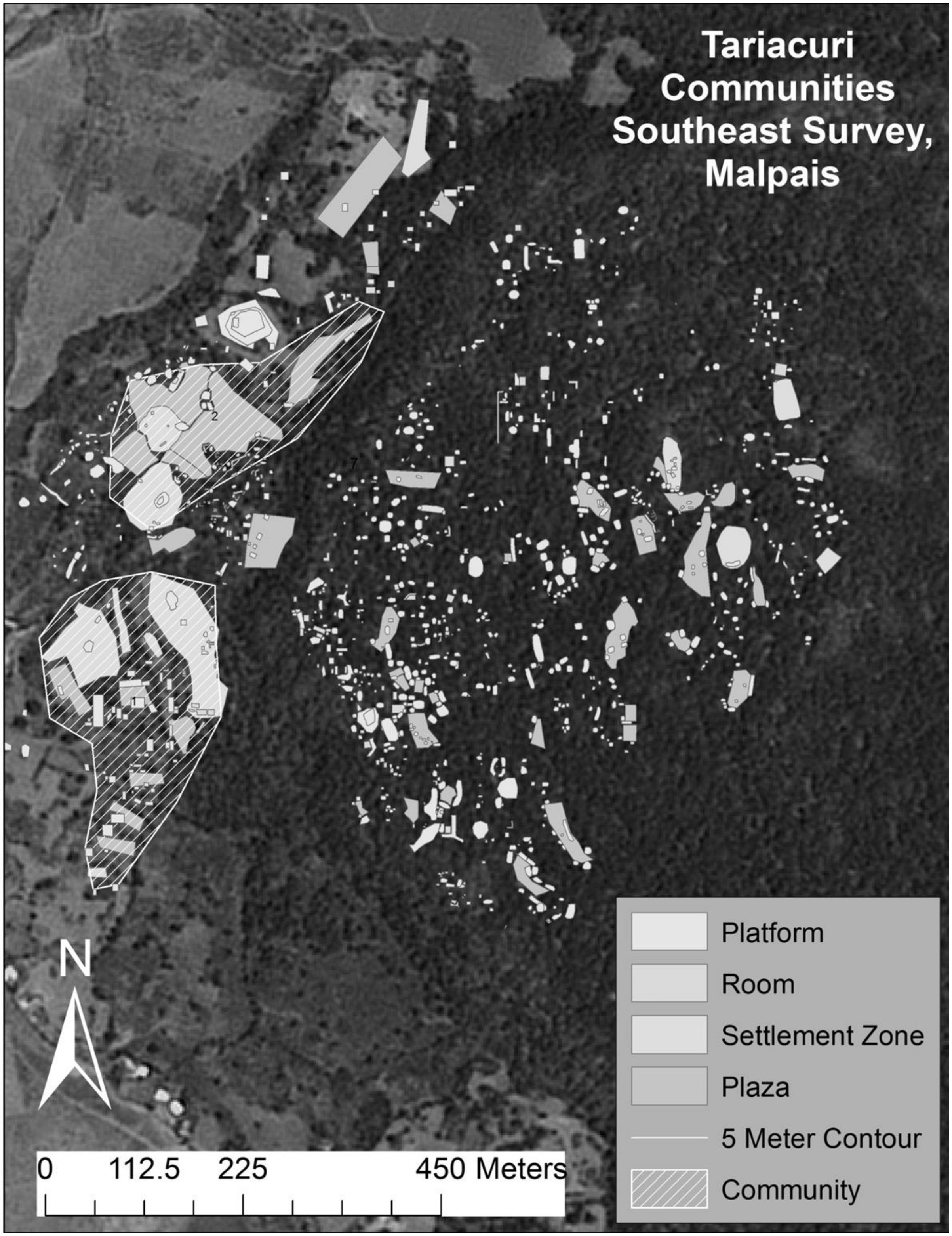


*Figure 72 - The Tariacuri Communities for the Southeast Malpaís Survey*



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