

## Supporting Information for “The Persistence of Ancient Settlements and Urban Sustainability”

This document contains citations and supporting information for the data portrayed in Figures 1, 2, and 3 of the paper.

### Supporting Information, 1: Citations and Information for Figure 1

Supporting Information, 1, presents the citations supporting the ranges of settlement occupation shown in Figure 1. There is often a distinction between the total span of occupation of a settlement, and the apogee of a settlement. For example, an urban center may grow out of a small village and/or continue to contain to have a small population after a collapse. Where it is possible to make this distinction, we have chosen to show the total span of occupation in Figure 1. The code to generate Figure 1, and a table of dates used, can be found on Github at <https://github.com/mpeeples2008/PopPersistenceFigures>. References for Maya sites courtesy of Adrian Chase.

#### *Alexandria*

Cline, E. (2006). *The Ancient World: Civilization of Africa*. Armonk, NY: Sharpe Reference.

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#### *Angkor*

Coe, Michael D. and Evans, D. (2019) *Angkor and the Khmer Civilization*. 2nd ed. Thames and Hudson, New York.

The start date of 900 CE is generally accepted (p. 124), and there is controversy over the end date for the city; we use 1431 CE, suggested by these authors (p. 240).

#### *Athens*

Boatwright M.T. (2000) *Hadrian and the Cities of the Roman Empire*. Princeton University Press.

#### *Ayutthaya*

Baker, Chris (2003) Ayutthaya rising: from land or sea? *Journal of Southeast Asian Studies* 34(1):41-62.

#### *Bagan*

Hudson, Bob, Lwin Nyein and Win Maung (2001) Origins of Bagan: New Dates and Old Inhabitants. *Asian Perspectives* 40:48-74.

#### *Beijing*

Haw, Stephen (2007) *Beijing: A Concise History*. Routledge, New York.

#### *Byzantium*

See discussion for Figure 3 in Supporting Information, 3.

#### *Cahokia*

Tainter, Joseph A. (2019) Cahokia: Urbanization, Metabolism, and Collapse. *Frontiers in Sustainable Cities* 1(6).

White, A. J., Lora R. Stevens, Varenka Lorenzi, Samuel E. Munoz, Carl P. Lipo, and Sissel Schroeder (2018). "An evaluation of fecal stanols as indicators of population change at Cahokia, Illinois." *Journal of Archaeological Science* 93: 129-134.

#### *Carthage*

Church, A.J. (1998) *The Story of Carthage*. (Rev. ed.) New York: Biblio and Tannen.

#### *Chan Chan*

Topic, John R. (2009) Domestic Economy as Political Economy at Chan Chan, Perú. In *Domestic Life in Prehispanic Capitals: A Study of Specialization, Hierarchy, and Ethnicity*, edited by Linda R. Manzanilla and Claude Chapdelaine, pp. 221-242. Memoirs. vol. 46. University of Michigan, Museum of Anthropology, Ann Arbor.

#### *Chavín de Huántar*

Rodriguez Kembel S & Haas H (2013) Radiocarbon dates from the monumental architecture at Chavín de Huántar. *Journal of Archaeological Method & Theory* 22:345-427.

#### *Copan*

Culbert TP & Rice DS eds (1990) *Precolombian Population History in the Maya Lowlands* (University of New Mexico Press, Albuquerque), page 61.

We do not include the post-collapse Ejar phase due to controversy over its validity as a chronological unit.

#### *Cuzco*

Covey RA (2018) Archaeology and Inka origins. *Journal of Archaeological Research* 26(3):253-304.

#### *Ebla*

Matthiae, P. and Marchetti, N. (2016). *Ebla and its Landscape: Early State Formation in the Ancient Near East*. NY: Routledge.

Astour, Michael C. (1992). "An outline of the history of Ebla (part 1)". In Gordon, Cyrus Herzl; Rendsburg, Gary (eds.). *Eblaite: Essays on the Ebla Archives and Eblaite Language*. 3. Eisenbrauns.

#### *Great Zimbabwe*

Chirikure S (2020) New Perspectives on the Political Economy of Great Zimbabwe. *Journal of Archaeological Research* 28(2):139-186.

Chirikure, Shadreck, Mark Pollard, Munyaradzi Manyanga and Foreman Bandama (2013) A Bayesian chronology for Great Zimbabwe: re-threading the sequence of a vandalized monument. *Antiquity* 87(337):854-872.

Note: We include only periods 2-4.

#### *Jenne Jeno*

McIntosh SK & McIntosh RJ (1986) Recent archaeological research and dates from West Africa. *The Journal of African History* 27(3):413-442.

#### *Kilwa*

Sutton, J. E. G. (1998) Kilwa: A History of the Ancient Swahili Town with a Guide to the Monuments of Kilwa Kisiwani and Adjacent Islands. *Azania* 33:113-169.

Wynne-Jones S, Horton M, Fleisher J, & Olsen J (2018) Dating Kilwa Kisiwani: A Thousand Years of East African History in an Urban Stratigraphy. *Urban Network Evolutions: Towards a High-Definition Archaeology*, eds Raja R & Sindbaek SM (Aarhus University Press, Aarhus), pp 277-285.

#### *Kumasi*

Hull R (1976) *African Cities and Towns Before the European Conquest* (W. W. Norton, New York).

#### *London*

See discussion for Figure 3 in Supporting Information, 3.

#### *Luoyang*

Xie, Keke (2009) *History of Seven Ancient Capital Cities*. Translated by Xiuying Gong. Encyclopedia of China Publishing House, Beijing.

#### *Mohenjo-Daro*

Kenoyer, Jonathan Mark (1998). "Indus Cities, Towns and Villages", *Ancient Cities of the Indus Valley Civilization*. Islamabad: American Institute of Pakistan Studies.

#### *Monte Alban*

Feinman GM & Nicholas LM (2016) After Monte Albán in the Central Valleys of Oaxaca: A Reassessment. *Beyond collapse: Archaeological Perspectives on Resilience, Revitalization, and Transformation in Complex Societies*, (Southern Illinois University, Carbondale, IL), pp 43-69.

Sherman RJ, Balkansky AK, Spencer CS, & Nicholls BD (2010) Expansionary dynamics of the nascent Monte Albán state. *Journal of Anthropological Archaeology* 29(3):278-301.

#### *Moscow*

Alexandrovskiy, A. L., Van Der Plicht, J., Krenke, N., Chichagova, O., Kovaliukh, N., & Sulerzhitsky, L. D. (1997). "The early history of Moscow: 14 C dates from Red Square." *Radiocarbon*, 40(2): 583-589.

#### *Nanjing*

Yuan F, Gao J, & Wu J (2016) Nanjing-an ancient city rising in transitional China. *Cities* 50:82-92.

Xie, Keke (2009) *History of Seven Ancient Capital Cities*. Translated by Xiuying Gong. Encyclopedia of China Publishing House, Beijing.

#### *New York*

Rosenwaike, Ira. 1972. *Population History of New York City*. Syracuse, NY: Syracuse University Press. p 3.

#### *Oc Eo*

Coe, Michael D. and Damian Evans (2019) *Angkor and the Khmer Civilization*. 2nd ed. Thames and Hudson, New York, pp. 92-93.

#### *Orayvi*

Bernardini, Wesley

In press Appendix I, in *Becoming Hopi: A History*. Edited by Wesley Bernardini, Stewart Koyiyumptewa, Gregson Schachner, and Leigh Kuwanwisiwma. University of Arizona Press, Tucson, AZ.

Hargrave, Lyndon Lane

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Whiteley P (1992) Burning culture: Auto-da-fé at Oraibi. *History and Anthropology* 6(1):46-85.

#### *Pueblo Grande*

Abbott D.R. (1994) The Pueblo Grande Project, Volume 3: Ceramics and the Production and Exchange of Pottery in the Central Phoenix Basin (Soil Systems, Phoenix).

Mitchell D.R. (1994) The Pueblo Grande Project: Feature Descriptions, Chronology, and Site Structure (Soil Systems).

#### *Rome*

See discussion for Figure 3 in Supporting Information, 3.

#### *San Juan*

Manucy, A & Torres-Reyes R, *Puerto Rico and the Forts of Old San Juan* (Riverside, CT: Chatham, 1973), p 7.

#### *San Lorenzo*

Hirth K, Cyphers A, Cobean R, De León J, & Glascock MD (2013) Early Olmec obsidian trade and economic organization at San Lorenzo. *Journal of Archaeological Science* 40(6):2784-2798.

#### *Tenochtitlan/Mexico City*

See discussion for Figure 3 in Supporting Information, 3.

#### *Teotihuacan*

See discussion for Figure 3 in Supporting Information, 3.

#### *Tikal*

Culbert TP & Rice D.S. eds (1990) *Precolombian Population History in the Maya Lowlands* (University of New Mexico Press, Albuquerque), pp. 120, 147.

#### *Timbuktu*

Park DP (2010) Prehistoric Timbuktu and its Hinterland. *Antiquity* 84:1076-1088.

Insoll, Timothy (2001) The Archaeology of Post Medieval Timbuktu. *Sahara* 13:7-30.

Note: We include only the pre-historic occupation, not the historic reoccupation of the location.

#### *Tiwanaku*

Janusek J.W. (2009) Residence and ritual in Tiwanaku. *Domestic Life in Prehispanic Capitals: A Study of Specialization, Hierarchy, and Ethnicity*, Memoirs of the Museum of Anthropology, eds Manzanilla LR & Chapdelaine C (University of Michigan Museum of Anthropology, Ann Arbor, MI), pp 159-180.

Marsh E.J. (2012) A Bayesian re-assessment of the earliest radiocarbon dates from Tiwanaku, Bolivia. *Radiocarbon* 54(2):203-218.

#### *Uruk*

McHahon, A. (2013) "Mesopotamia" in P. Clark (ed) *The Oxford Handbook of Cities in World History*. Oxford: Oxford University Press.

#### *Vijayangara*

Lycett MT & Morrison KD (2013) The "Fall" of Vijayanagara Reconsidered: Political Destruction and Historical Construction in South Indian History. *Journal of the Economic and Social History of the Orient* 56(3):433.

Morrison, KD and CM Sinopoli (2006), "Production and landscape in the Vijayanagara metropolitan region: Contributions of the Vijayanagara Metropolitan Survey," in *Vijayanagara: Archaeological Explorations*, JM Fritz, RP Brubaker, TP Raczek, eds., VPR Monograph 10, Manohar, pp 423-434.

#### *Xian/Chang'an*

Xie, Keke (2009) *History of Seven Ancient Capital Cities*. Translated by Xiuying Gong. Encyclopedia of China Publishing House, Beijing.

## Supporting Information, 2: Citations, Data, and Other Information for Figure 2

### Introduction

This figure presents graphs of the distribution of occupation of settlement occupation lengths in two regions: the Basin of Mexico and Central Italy. These regions both have long histories of archaeological research, similar environmental productivity, and contained the capital city of one or more empires. The data sources and analysis methods used for each region are described separately below. The code to generate Figure 2, and a table of values, can be found on Github at <https://github.com/mpeeples2008/PopPersistenceFigures>. These data are being subjected to a wider range of analyses that will be presented in a separate paper.

### Basin of Mexico

#### *Brief History*

The Basin of Mexico is the area of modern Mexico City and its immediately surrounding hinterland. The area was a closed hydrological basin during the prehispanic period, with a series of interlocking lakes in the center that facilitated transportation. There is clear evidence of human activity (mammoth hunting) in the area by at least 11,000-9,000 BP (Ochoa 2012), and occupation continues to the present day, where the modern Mexico City Metropolitan Area is the largest city in the world. During the prehispanic period, the region contained the capitals of the Teotihuacan and Aztec Empires.

#### *Data Sources and Field Methods*

Between the 1950s and 1980s, all portions of the region not under modern settlement (about ¾ of the region) were systematically surveyed for archaeological sites by a single research group, using consistent methods. Archaeologists walked transects across fields, recorded the spatial extent of mounds and artifacts associated with all time periods between the initial formation of villages (Early Formative period), and the Spanish conquest (AD 1521), and made collections of diagnostic artifacts at most sites. The fieldwork divided the region into eight subregions, each of which was surveyed and published as a unit. Original field observations (excluding the Temascalapa subregion) provide systematic data on 3572 sites (one location, one period of occupation), which can be grouped into 2237 spatially and temporally continuous occupations.

Summary data for each site and period is published in two volumes of tables (Gorenflo and Sanders 2007; Parsons et al. 1983), and more detailed textual site descriptions and analyses are published in a series of volumes (Blanton 1972; Parsons 1971, 2008; Parsons and Whalen 1982; Sanders and Gorenflo 2007). The tables in the first data volume are digitized and available through the Digital Archaeological Repository (tDAR) as ID 192, doi:10.6067/XCV8N87C7F. The second data volume has an accompanying CD disk, containing a digital version of the data tables. Data from these two digital sources were previously combined by Ortman et al (2014), and the lead author provided us with a copy of their database. One subregion, Temascalapa, does not yet have a published volume of individual site descriptions and was excluded from our analyses.

#### *Data Manipulation*

The original dataset recorded locations of occupation (“sites”) separately for each chronological period. To convert these series of occupation over time, we carried out the following steps. First, using information on alternate-period occupations given in the extended textual site descriptions, we linked together case records for each occupation location through time. A location was defined by the period of

largest site extent, and may include multiple smaller sites within this footprint during other periods. Second, all subregions were adjusted to use a single sequence of chronological periods. All subregions used the same seven-period basic chronological sequence, but several of them subdivided one or more periods into sub-periods, with sites recorded separately for each sub-period. These subperiods were downsampled to match the master sequence, with the information for the larger sub-period site retained for the entire period. Third, the sequence of occupation periods for each location was subdivided into continuous occupations; if a site was occupied for two consecutive periods, then abandoned for one period, then reoccupied for another two periods, the first and second periods of occupation are treated as two separate datapoints.

#### *Estimation of Occupation Lengths*

The length of occupation for a site was assigned as half the total length of the beginning and end periods of occupation, plus the full length of any intermediate periods. Dates for periods were taken from Nichols (2016), with amendments to the EF and MF based on Stoner and Nichols (2019). Two different methods for estimating settlement longevity based on site foundation and abandonment rates (Dewar 1991; Kintigh 1994) suggest that half-periods are appropriate estimates of occupation length for this dataset because because of the mismatch in data resolution between observable period lengths and probable site occupation spans. As an exception to this method, sites beginning prior to the final period of occupation (Aztec) and extending into it were assigned the full length of this final period, since this was a period of rapid population growth during which very few sites were abandoned.

Code	Period	Start	End	Duration
EF	Early Formative	1640 BC	1100 BC	540
MF	Middle Formative	1100 BC	400 BC	700
LF	Late Formative	400 BC	200 BC	200
TF	Terminal Formative	200 BC	100 AD	300
CL	Classic	100 AD	600 AD	500
ET	Early Toltec	600 AD	900 AD	300
LT	Late Toltec	900 AD	1150 AD	250
AZ	Aztec	1150 AD	1520 AD	370

#### Works Cited:

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1972 *Prehispanic Settlement Patterns of the Ixtapalapa Peninsula Region Mexico*. Occasional Papers in Anthropology No. 6. Department of Anthropology, Pennsylvania State University, University Park, PA.

Dewar, Robert E

1991 Incorporating variation in occupation span into settlement-pattern analysis. *American Antiquity* 56(4):604-620.

Gorenflo, Larry J and William T Sanders

2007 *Archaeological Settlement Pattern Data from the Cuautitlan, Temascalapa, and Teotihuacan Regions, Mexico* Occasional Papers in Anthropology No. 30. Department of Anthropology, The Pennsylvania State University, University Park, PA.

- Kintigh, Keith W  
 1994 Contending with contemporaneity in settlement-pattern studies. *American Antiquity* 59(1):143-148.
- Nichols, Deborah L.  
 2016 Teotihuacan. *Journal of Archaeological Research* 24(1):1-74.
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- Ortman, Scott G., Andrew H. F. Cabaniss, Jennie O. Sturm and Luís M. A. Bettencourt  
 2014 The Pre-History of Urban Scaling. *PLOS ONE* 9(2):e87902.
- Parsons, Jeffrey R  
 1971 *Prehistoric settlement patterns in the Texcoco region, Mexico* Memoirs of the Museum of Anthropology No. 3. University of Michigan Press, Ann Arbor, MI.  
 2008 *Prehispanic Settlement Patterns in the Northwestern Valley of Mexico: The Zumpango Region* Memoirs of the Museum of Anthropology No. 45. University of Michigan, Ann Arbor, MI.
- Parsons, Jeffrey R, Keith W Kintigh and Susan A Gregg  
 1983 *Archaeological settlement pattern data from the Chalco, Xochimilco, Ixtapalapa, Texcoco, and Zumpango regions, Mexico*. University of Michigan Museum of Anthropology.
- Parsons, Jeffrey R and Michael E Whalen  
 1982 *Prehispanic settlement patterns in the southern Valley of Mexico: the Chalco-Xochimilco region* Memoirs of the Museum of Anthropology No. 14. University of Michigan, Ann Arbor, MI.
- Sanders, William T and Larry J Gorenflo (editors)  
 2007 *Prehispanic Settlement Patterns in the Cuautitlan Region, Mexico*. Department of Anthropology, The Pennsylvania State University, University Park, PA.
- Stoner, Wesley D. and Deborah L. Nichols  
 2019 Pottery Trade and The Formation of Early and Middle Formative Style Horizons as Seen from Central Mexico. *Ancient Mesoamerica* 30(2):311-337.



## Central Italy

### *Brief History*

Central Italy is comprised of the present day regions of Lazio, which includes the city of Rome, Tuscany, and a portion of western Umbria. Evidence of human occupation within this area is attested from 10,000 BP based on lithic assemblages (Lo Vetro and Martini 2016), and occupation has continued throughout the region to present day. During the Roman period, the region contained Rome, the capital of the Roman Empire.

### *Data Sources and Field Methods*

The following data, published in two articles by Palmisano et al (2017; 2018), represent the compilation of 59 separate archaeological surveys. The dataset is composed of 7,386 sites from central Italy, dating from the Late Mesolithic (c. 8000 BC) to the Late Imperial period (c. AD 500). The original dataset is openly available, <https://doi.org/10.14324/000.ds.1575442>. It currently exists as the largest published repository of archaeological settlements within Italy.

### *Data Manipulation*

The dataset was first checked for any apparent errors. This included ensuring that consistent chronological terminology was used throughout (e.g. Republican Period instead of Roman Period). The dataset was also checked for individual site and period duplicates. In instances where there was an obvious duplicate, a situation assumed to be the result of data entry errors, the duplicate was deleted. There were also a couple instances of incorrectly associated sites based on their coordinates and references, these were given new identification numbers within the dataset. Second, since the data was already subdivide following the recognized chronological periods of the region, the sequence of occupation periods for each location were combined into continuous occupation phases, termed sub-occupation phases. If a site was occupied for two consecutive periods, then abandoned for one period, then reoccupied for another two periods, the first and second periods of occupation are treated as two separate datapoints.

### *Estimation of Occupation Lengths*

The length of occupation for a site was assigned as its total length of continuous occupation across one or more chronological periods, following the standard chronology used in the original dataset (Palmisano et al 2017). Because the dating of the chronological periods in this dataset is more strongly supported than for the Basin of Mexico data, we did not employ the practice of halving the beginning and ending period lengths. In some instances more precise settlement chronology is known, in which cases the length of occupation reflects these known dates. Sites at a single location that had subsets of continuous occupation based on the presence/absence of occupation following period chronology were given separate sub-occupation lengths. The data presented in this figure represents the total length of each individual sub-occupation phase.

Period	Start	End	Duration
Mesolithic	10,000/9,500 BC	6000/5800 BC	4000
Early Neolithic Period	6000/5800 BC	4500 BC	1500
Middle Neolithic Period	4500 BC	3500 BC	1000
Late Neolithic Period	3500 BC	3000 BC	500
Eneolithic Period	3000 BC	2300 BC	700
Early Bronze Age	2300 BC	1700 BC	600

Middle Bronze Age	1700 BC	1325/1300 BC	375
Recent Bronze Age	1325/1300 BC	1175/1150 BC	150
Late Bronze Age	1175/1150 BC	1020/950 BC	155
Early Iron Age	1020 BC	750/725 BC	270
Late Iron Age	750/725 BC	580 BC	170
Archaic Period	580 BC	480 BC	100
Post-Archaic Period	480 BC	350 BC	130
Republican Period	350 BC	30 BC	320
Early Imperial Period	30 BC	100 AD	130
Mid-Imperial Period	100 AD	300 AD	200
Late Imperial Period	300 AD	500 AD	200

#### Works Cited:

Lo Vetro, Domenico, and Fabio Martini

2016 Mesolithic in Central-Southern Italy: Overview of lithic productions. *Quaternary International* 423: 279–302. DOI: <https://doi.org/10.1016/j.quaint.2015.12.043>

Palmisano, Alessio, Andrew Bevan, and Stephen Shennan

2017 Comparing archaeological proxies for long-term population patterns: An example from central Italy. *Journal of Archaeological Science* 87: 59–72. DOI: <https://doi.org/10.1016/j.jas.2017.10.001>

2018 Regional Demographic Trends and Settlement Patterns in Central Italy: Archaeological Sites and Radiocarbon Dates. *Journal of Open Archaeology Data*, 6: 2. DOI: <https://doi.org/10.5334/joad.43>

## Supporting Information, 3: Citations, Data, and Other Information for Figure 3

### Introduction

Our estimations of the populations of sample cities over time relies on published estimates by archaeologists and historians specializing in each settlement's history. A list of specific sources for each location are included below. Estimates of past populations are notoriously difficult and our figures should be interpreted as general trends over time, rather than specific values. Estimations of long-term population change draw on three primary sources of information: archaeological data, historical censuses made for civil or religious purposes, and more recent censuses by modern nation-states. Archaeological estimates of population are generally made by either counting individually visible house structures dating to a single period and multiplying these by a given number of occupants by household, or by estimating population density in an excavated sample of a site and applying this density to the entire area over which artifacts from that period occur. Historical censuses often only include certain categories of individuals (e.g. heads of household, taxpayers, or individuals above a certain age) and must be adjusted accordingly, to account for the proportion of individuals not included in the counted category. Additionally, territorial subdivisions are not stable over time, meaning that the spatial area being censused as a given named location may vary between one count and another. The code and data to generate Figure 3, and a table of values, can be found on Github at <https://github.com/mppeoples2008/PopPersistenceFigures>.

### Teotihuacan

Teotihuacan is located in the northwestern portion of the State of Mexico, Mexico (19.693017, -98.845898). Settlement at the location began during the Cuicuilco phase (650-200 BC) as three small villages. It can first be considered an urban settlement during the Patlachique phase (150-0 BC). It subsequently grew rapidly, and maintained control of an empire covering the Basin of Mexico and adjacent areas until approximately AD 600 (Cowgill, 2015; Nichols, 2016). Following the collapse of the Teotihuacan state, the city shrank dramatically and did not rebound until the Late Aztec period (AD 1350-1521). At the time of the Spanish conquest, Teotihuacan was minor city-state subject to the Texcoco branch of the Triple Alliance (Aztec) Empire (Garraty, 2006). The regional population was reduced as a result of epidemics during the 16<sup>th</sup> century, and Spanish orders of congregation consolidated population into San Juan Teotihuacan and other larger towns beginning in 1603 (Munch G., 1976).

The prehispanic period (650 BC- AD 1521) populations are derived from full-coverage archaeological survey by the Teotihuacan Mapping Project and Teotihuacan Valley Survey Project, based on the methods described by Robertson (2007). Major period populations are reported in Gorenflo and Sanders (2007), and additional subperiods were calculated by Robertson using the same methodology and provided as a personal communication. Population estimates for periods before and after the Teotihuacan state may combine population estimates for multiple discrete sites within the footprint of the site's maximum extent. The Gorenflo and Sanders estimates of populations for post-Teotihuacan archaeological periods have been reduced to account for the higher surface visibility of artifacts from these periods; Coyotlatelco (-20%), Mazapan (-40%), and Late Aztec (-60%). The source estimates for these three periods are noted as "modified" in the table below. This approximately splits the difference between the "high count" and "low count" estimates for the Coyotlatelco period produced by different

researchers; see Parsons and Sugiura (2012) for an overview of this issue. This adjustment produces an Aztec-period estimate in line with those extrapolated from historical censuses. The Early Aztec period was not recorded separately from the Late Aztec period by the original project researchers. It is estimated as approximately 1/3 of the latter period population, based on the ratio of artifact collections dating to the two periods in a partial reanalysis of the collections (Garraty, 2006).

Colonial and Republication period populations are taken from two compilations of historical demographic data, Sanders (1970) and Slicher van Bath (1981). Population estimates for the 15<sup>th</sup> century are taken from the former source, and for the 16<sup>th</sup> and 17<sup>th</sup> centuries from the latter. These population figures should be construed as general estimates due to two sources of error. First, the actual values recorded are the number of tributaries (taxpayers), a value that has been multiplied by a constant to provide the population estimates given here. Second, the geographic area under the control of San Juan Teotihuacan as a cabecera (head town) was variable over time, so not all figures may represent the same set of subordinate communities.

Modern (AD 1900-2010) data are from historical series census data provided by Mexico's Instituto Nacional de Estadística y Geografía, downloaded from <https://www.inegi.org.mx/programas/ccpv/cpvsh/>. Values are for the municipality of Teotihuacan, an area similar to an American county, which includes both the head town of San Juan Teotihuacan and a number of smaller communities in the surrounding area.

Date	Population	Source
650-200 BC (Cuanalan Phase) (E/L LF)	1,000	Gorenflo and Sanders 2007 (Table 4.4, Sites TE-LF-35, 311)
200-150 BC (Tezoyuca Phase) (EETF)	Unknown	Gorenflo and Sanders 2007, Figure 4.9
150-1 BC (Patlatchique Phase) (LETf)	28,000	Gorenflo and Sanders 2007 (Table 4.6, Sites TE-TF-12, 319-322)
AD 1-150 Tzacualli Phase) (LTF)	40,000	Gorenflo and Sanders 2007 (Table 4.8, Sites TE-TF-48, 139, 200, 213-318)
AD 150-200 (Miccaotli Phase)	78,000	Robertson, Personal Communication
AD 200-350 (Tlamimilolpa Phase)	87,000	Robertson, Personal Communication
AD 350-550 (Xolalpan Phase)	100,000	Gorenflo and Sanders 2007 (Table 4.9, Site TE-CL-1), Smith et al 2019
AD 550-600 (Metepec Phase)	33,000	Robertson, Personal Communication
AD 600-900 (Coyotlatelco Phase)	23,200	Gorenflo and Sanders 2007 (Table 4.10, Sites TE-ET-72, 84, 201, 330, 331) (modified)
AD 900-1150 (Mazapan Phase)	12,000	Gorenflo and Sanders 2007 (Table 4.11, Sites TE-LT-122, 173, 202, 332, 333) (modified)

AD 1150-1350 (Early Aztec Phase)	6,000	Gorenflo and Sanders 2007 (Table 4.12, Sites TE-LA-154, 230, 263) (modified)
AD 1350-1521 (Late Aztec Phase)	17,600	Gorenflo and Sanders 2007 (Table 4.12, Sites TE-LA-154, 230, 263) (modified)
1560	4,620	Sanders 1970 (Table 11)
158	4,420	Sanders 1970 (Table 11)
1596	2,876	Sanders 1970 (Table 11)
1645	1,370	Slicher van Bath (Appendix 1)
1688	1,860	Slicher van Bath (Appendix 1)
1743	4,660	Slicher van Bath (Appendix 1)
1800	9,710	Slicher van Bath (Appendix 1)
1900	5,175	INEGI Series Historicas
1910	5,570	INEGI Series Historicas
1930	5,418	INEGI Series Historicas
1940	6,667	INEGI Series Historicas
1950	8,348	INEGI Series Historicas
1960	10,477	INEGI Series Historicas
1970	16,283	INEGI Series Historicas
1980	30,140	INEGI Series Historicas
1990	30,525	INEGI Series Historicas
2005	46,779	INEGI Series Historicas
2010	53,010	INEGI Series Historicas

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### Tenochtitlan/Mexico City

Tenochtitlan/Mexico City is located in the Mexico City Federal District and portions of the surrounding State of Mexico, Mexico (19.434526, -99.132104). According to Aztec histories, the city was founded on an island in AD 1325, but like many other cities throughout history, there was already a settlement at the site before its canonical founding date. We incorporate an earlier small settlement based on archaeological evidence for an occupation of the island in the Early Aztec period, prior to 1325 (Vega Sosa, 1979); we estimate 100 persons in AD 1100 and 1,000 in 1325. Tenochtitlan became one of the founding members of the Triple Alliance (Aztec Empire) in AD 1428, and over the following ninety years conquered large portions of western Mesoamerica. For the population of Tenochtitlan when Hernán Cortés arrived in 1519 we use a synthesis of historical estimates, discussed in Smith (2008:152).

The city fell to the Spanish in 1521, who retained it as their capital city despite ongoing issues with flooding and disease (Tellman et al., 2018). The population of Mexico City—like the rest of Colonial New Spain—plummeted after 1521 due to European epidemics such as smallpox. The city has remained the capital of Mexico following both independence from Spain (1821) and the Mexican Revolution (1910), and is the fifth largest metropolitan area in the world today. Population estimates between 1519 and 1790 are Smith’s interpretations of Whitmore’s (1991) simulation and of some figures given by Maxson (1920:195). Data for 1790 through 1910 are from (McCaa, 1993:Table 2). Figures from 1920-1942 are from Connolly (2003), adjusted upward based on the higher values from the sources that overlap the beginning (1900, 1910) and end (1950, 1960) of her sequence. Populations for 1950 – 2020 are for the Mexico City Metropolitan Area, from the World Population Review (<https://worldpopulationreview.com/world-cities/mexico-city-population>).

Date (AD)	Population	Source
1100	100	MES estimate
1325	1,000	MES estimate
1519	212,500	Smith 2008: Table 2.1
1600	20,000	MES estimate, based on Whitmore
1746	90,000	Maxson 1920: 196
1790	104,760	McCaa 1993, Table 2, Fed District

1800	115,897	McCaa 1993, Table 2, Fed District
1810	128,218	McCaa 1993, Table 2, Fed District
1820	151,726	McCaa 1993, Table 2, Fed District
1830	179,545	McCaa 1993, Table 2, Fed District
1840	207,887	McCaa 1993, Table 2, Fed District
1850	220,623	McCaa 1993, Table 2, Fed District
1860	228,739	McCaa 1993, Table 2, Fed District
1870	235,285	McCaa 1993, Table 2, Fed District
1880	358,543	McCaa 1993, Table 2, Fed District
1890	433,344	McCaa 1993, Table 2, Fed District
1900	541,516	McCaa 1993, Table 2, Fed District
1910	720,753	McCaa 1993, Table 2, Fed District
1921	926,800	Connolly 2003, adjusted
1930	1,363,700	Connolly 2003, adjusted
1940	1,974,000	Connolly 2003, adjusted
1950	3,365,081	World population review
1955	4,293,878	World population review
1960	5,479,184	World population review
1965	6,969,157	World population review
1970	8,830,947	World population review
1975	10,733,860	World population review
1980	13,027,620	World population review
1985	14,278,216	World population review
1990	15,642,318	World population review
1995	17,017,468	World population review
2000	18,457,028	World population review
2005	19,276,064	World population review
2010	20,136,680	World population review
2015	21,339,780	World population review
2020	21,782,378	World population review

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## Rome:

Rome is located in central Italy off of the River Tiber. Settlement at this location began during the Early Bronze Age (2300 BC) and continued until the city of Rome was founded according to myth in 753 BC (Alessandri 2013; Cornell 1995). During the Republican and Imperial periods Rome grew to dominate the Mediterranean. The city began to decline after the capital was moved from Rome to Constantinople in AD 395, and was in full decline by the 5<sup>th</sup> century AD (Coulston and Dodge 2000). The city, however, was never abandoned and continued to have a reduced population throughout the Medieval and Renaissance periods.

Determining population estimates for Rome during different periods have been contentious (Scheidel 2001). No standard method has been developed for accurately calculating population through time. Therefore, the estimates used within the chart represent approximations of the most widely accepted estimates for each time period, and, in instances where there are a wide range of views, the middle population value. The current population estimates begin when Rome is founded as a city. The early Archaic period (753–350 BC) population is based on the estimated area of Rome. Population estimates during the Republican period (350–30 BC) are largely based off the size of Rome’s water system (Morley 1971: 39). The Imperial period (30 BC – AD 500) population estimates are derived from a combination of areas estimates and population density, calculating the population relative to the city’s grain dole which was given out to adult male citizens, and calculating the density of occupation of residential structures (Oates 1934; Packer 1967; Story 1997; Scheidel 2001). The pre-modern population estimates (AD 1400 – 1800) are based on estimated geographic size and calculated urbanization rates (Malanima 1998; Bosker *et al.* 2008).

Population data from 1950 to the present is taken from the World Population Review, <https://worldpopulationreview.com/world-cities/rome-population>. These figures are for the Roman metropolitan area, which includes the city of Rome and its adjacent suburbs.

Date	Population	Source
-753	-	



-400	50,000	Brunt 1971: 376; Morley 1996: 39; Cornell 2000: 45
-270	150,000	Cornell 2000: 47
-200	200,000	Cornell 2000: 47; Morley 1996: 39
-120	375,000	Cornell 2000: 46-47
-44	750,000	Morley 1996: 33–9;
1	1,000,000	Oates 1934: 109; Morley 1971: 38; Witcher 2006: 6; Jongman 2014: 2104
100	1,000,000	Oates 1934: 109; Witcher 2006: 6; Jongman 2014: 2104
180	800,000	Lo Cascio 2010
400	625,000	Twine 1992; Wickham 2005: 33
500	75,000	Twine 1992
550	30,000	Twine 1992: 135
1300	40,000	Bosker <i>et al.</i> 2008: 129
1400	30,000	Bosker <i>et al.</i> 2008: 129
1500	55,000	Bosker <i>et al.</i> 2008: 129
1600	98,000	Bosker <i>et al.</i> 2008: 129
1700	140,000	Bosker <i>et al.</i> 2008: 129
1800	153,000	Bosker <i>et al.</i> 2008: 129
1861	188,000	Bosker <i>et al.</i> 2008: 129
1950	1,884,065	<a href="https://worldpopulationreview.com/world-cities/rome-population">https://worldpopulationreview.com/world-cities/rome-population</a>
1955	2,142,917	<a href="https://worldpopulationreview.com/world-cities/rome-population">https://worldpopulationreview.com/world-cities/rome-population</a>
1960	2,455,581	<a href="https://worldpopulationreview.com/world-cities/rome-population">https://worldpopulationreview.com/world-cities/rome-population</a>
1965	2,780,218	<a href="https://worldpopulationreview.com/world-cities/rome-population">https://worldpopulationreview.com/world-cities/rome-population</a>
1970	3,134,828	<a href="https://worldpopulationreview.com/world-cities/rome-population">https://worldpopulationreview.com/world-cities/rome-population</a>
1975	3,300,294	<a href="https://worldpopulationreview.com/world-cities/rome-population">https://worldpopulationreview.com/world-cities/rome-population</a>
1980	3,390,480	<a href="https://worldpopulationreview.com/world-cities/rome-population">https://worldpopulationreview.com/world-cities/rome-population</a>
1985	3,538,418	<a href="https://worldpopulationreview.com/world-cities/rome-population">https://worldpopulationreview.com/world-cities/rome-population</a>
1990	3,713,731	<a href="https://worldpopulationreview.com/world-cities/rome-population">https://worldpopulationreview.com/world-cities/rome-population</a>
1995	3,738,572	<a href="https://worldpopulationreview.com/world-cities/rome-population">https://worldpopulationreview.com/world-cities/rome-population</a>
2000	3,708,301	<a href="https://worldpopulationreview.com/world-cities/rome-population">https://worldpopulationreview.com/world-cities/rome-population</a>
2005	3,807,383	<a href="https://worldpopulationreview.com/world-cities/rome-population">https://worldpopulationreview.com/world-cities/rome-population</a>
2010	3,957,247	<a href="https://worldpopulationreview.com/world-cities/rome-population">https://worldpopulationreview.com/world-cities/rome-population</a>
2015	4,113,185	<a href="https://worldpopulationreview.com/world-cities/rome-population">https://worldpopulationreview.com/world-cities/rome-population</a>
2020	4,257,056	<a href="https://worldpopulationreview.com/world-cities/rome-population">https://worldpopulationreview.com/world-cities/rome-population</a>

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## Byzantium/Constantinople/Istanbul

The city of Byzantium dates to the 7<sup>th</sup> century BC when it was founded as a Greek colony, however there is archaeological evidence of earlier habitation within this area dating back to the Neolithic period. In 330 CE the emperor Constantine inaugurated a new capital city, over the Greek city of Byzantium, which he renamed Constantinople (Gregory 2005). Power was subsequently transferred from Rome to Constantinople until the collapse of the Byzantine empire in 1453, when the city was conquered by the Ottomans (Bassett 2005). Constantinople served as an Ottoman capital until 1923 when the capital was moved to Ankara. After the Turkish War of Independence the city's name was changed to Istanbul.

Population estimates have the same challenges as those in the city of Rome, and periods prior to AD 100 are largely uncertain. During the Roman and Byzantine period population is estimated using an average population density of 15 inhabitant/km<sup>2</sup> (Stathakopoulos 2008: 309), wheat distribution records, and area estimates. The city's later period populations are estimated using a range of factors including area and tax records. Population data from 1950 to the present is taken from the World Population Review, <https://worldpopulationreview.com/world-cities/istanbul-population>.

Date (AD)	Population	Source
100	30,000	Chandler 1987
330	300,000	Chandler 1987

413	500,000	Stathakopoulos 2008: 310
500	400,000	Stathakopoulos 2008: 312
542	200,000	Stathakopoulos 2008: 310
600	150,000	Haldon 1990
700	125,000	Haldon 1990
800	250,000	Chandler 1987
1100	250,000	Morris 2015: 148
1200	400,000	Stathakopoulos 2008: 312
1453	50,000	Stathakopoulos 2008: 314
1500	100,000	Faroqhi 2012: 100;
1600	400,000	Jones 2003; Bairoch 1988; Morris 2015: 148
1700	600,000	Cipolla 1993: 304; Braudel 1981; Bairoch 1988
1790	500,000	Başaran 2007
1800	570,000	Chandler 1987
1829	420,000	Başaran 2007
1940	850,000	Faroqhi 2012: 100
1950	967,497	<a href="https://worldpopulationreview.com/world-cities/istanbul-population">https://worldpopulationreview.com/world-cities/istanbul-population</a>
1955	1,248,709	<a href="https://worldpopulationreview.com/world-cities/istanbul-population">https://worldpopulationreview.com/world-cities/istanbul-population</a>
1960	1,453,353	<a href="https://worldpopulationreview.com/world-cities/istanbul-population">https://worldpopulationreview.com/world-cities/istanbul-population</a>
1965	2,001,192	<a href="https://worldpopulationreview.com/world-cities/istanbul-population">https://worldpopulationreview.com/world-cities/istanbul-population</a>
1970	2,772,095	<a href="https://worldpopulationreview.com/world-cities/istanbul-population">https://worldpopulationreview.com/world-cities/istanbul-population</a>
1975	3,600,332	<a href="https://worldpopulationreview.com/world-cities/istanbul-population">https://worldpopulationreview.com/world-cities/istanbul-population</a>
1980	4,397,037	<a href="https://worldpopulationreview.com/world-cities/istanbul-population">https://worldpopulationreview.com/world-cities/istanbul-population</a>
1985	5,407,297	<a href="https://worldpopulationreview.com/world-cities/istanbul-population">https://worldpopulationreview.com/world-cities/istanbul-population</a>
1990	6,552,160	<a href="https://worldpopulationreview.com/world-cities/istanbul-population">https://worldpopulationreview.com/world-cities/istanbul-population</a>
1995	7,665,403	<a href="https://worldpopulationreview.com/world-cities/istanbul-population">https://worldpopulationreview.com/world-cities/istanbul-population</a>
2000	8,743,868	<a href="https://worldpopulationreview.com/world-cities/istanbul-population">https://worldpopulationreview.com/world-cities/istanbul-population</a>
2005	10,465,694	<a href="https://worldpopulationreview.com/world-cities/istanbul-population">https://worldpopulationreview.com/world-cities/istanbul-population</a>
2010	12,584,885	<a href="https://worldpopulationreview.com/world-cities/istanbul-population">https://worldpopulationreview.com/world-cities/istanbul-population</a>
2015	14,126,772	<a href="https://worldpopulationreview.com/world-cities/istanbul-population">https://worldpopulationreview.com/world-cities/istanbul-population</a>

2020	15,190,336	<a href="https://worldpopulationreview.com/world-cities/istanbul-population">https://worldpopulationreview.com/world-cities/istanbul-population</a>
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### London

London, located on the River Thames in what is now southern England was first established as a permanent settlement known as Londinium in the Roman era ca. AD 47 (Tyers 2008; Swain and Williams 2008). Londinium was one of the largest settlements in the region for the next two centuries but by the early 5<sup>th</sup> century AD Londinium was abandoned, though it may have still served as a nexus of interaction for surrounding small communities in the subsequent two centuries (Swain and Williams 2008; Vince 1990). By the 7<sup>th</sup> century AD the Anglo-Saxon settlement of Lundenwic (later Lundenburh and London) began to grow as a major regional population hub and commercial center in the former location of Londinium. The city grew to prominence over the next centuries and was twice the size of the next most populous town in the region by the 12<sup>th</sup> century and perhaps five times larger than the next most populous town by 1300 (Keene 2000; Barron 2000). From the 14<sup>th</sup> century AD on London was the undisputed largest, wealthiest, and most populous settlement in England and continued to grow rapidly

(Schwarz 2000), in particular over the last 200 years as the population expanded from one million to over nine million today.

Estimating population for London through time is difficult due to incomplete archaeological coverage and historic records (see Hardin 1990; Keene 1984). The data we provide here should be considered tentative and illustrative rather than wholly consistent in that we are combining the estimates of populations from archaeological and historical sources by different authors and accepted ranges for these estimates differ. In particular, it is difficult to combine archaeological estimates from Roman Londinium with the later historic record and there are eras where little documentation exists. For Roman Londinium, we relied on the average population estimates prepared by Swain and Williams (2008:Table 1.4.3) which were derived from archaeological estimates of settlement density, residential area, and historic ethnographic parallels for conversions to likely population. For the post-Roman period until the modern era, we relied primarily on general accounts of the population history of London compiled by various authors in the Cambridge Urban History of Britain. For the post-Roman era to AD 1300 , we relied on general estimates provided by Keene (2000), though these are by his own estimate quite rough and based on limited historic references. For the period from AD 1300 to 1540 we relied on general historic estimates compiled and presented by Barron (2000; see also Keene 1984). Again, these numbers are based on limited documents and should be considered tentative. For the period after AD 1540 we have considerably more historic information. Drawing on discussions by Boulton (2000:Table 10.1) we used data from V. Harding (1990) who reviewed a wide variety of published evidence for the population of London from AD 1500 to 1800. We use Harding’s (1990) “high” population estimates here. For the period from 1800 to the present, we rely on official census numbers published by the United Kingdom National Archives.

<b>Year (AD)</b>	<b>Population Estimate</b>	<b>Source</b>	<b>Additional Notes</b>
47	0	Swain and Williams 2008: Table 1.4.3	
60	9306	Swain and Williams 2008: Table 1.4.3	
110	25844	Swain and Williams 2008: Table 1.4.3	
200	30632	Swain and Williams 2008: Table 1.4.3	
400	0	Keene 2000	Londinium served as a focus for small towns in the area but was virtually uninhabited
500	0	Vince 1990; Keene 2000	Little evidence of occupation in the 6 <sup>th</sup> century CE
601	7500	Keene 2000:187	Pope Gregory envisaged London seat of premartial see of England
680	8000	Keene 2000	London is an important commercial settlement to the Bishop of Kent who did business there
700	9000	Keene 2000	London is described as a major commercial center

Year (AD)	Population Estimate	Source	Additional Notes
800	10000	Keene 2000	Rough estimate for commercial London based on historic documents
1100	20000	Keene 2000	Twice as populous as the next largest town in the region
1200	40000	Keene 2000	
1300	80000	Barron 2000:396	Five times the next most populous town (using Barron's lower estimate)
1400	40000	Barron 2000:400	Post-plague population decreased by as much as half
1450	40000	Barron 2000:400	
1499	40000	Barron 2000:400	
1501	40000	Barron 2000:400	
1550	75000	Boulton 2000:Table 10.1; Harding 1990	
1600	200000	Boulton 2000:Table 10.1; Harding 1990	
1650	400000	Boulton 2000:Table 10.1; Harding 1990	
1700	575000	Boulton 2000:Table 10.1; Harding 1990	
1750	637500	Schwarz 2000: Table 19.1	
1760	740000	Schwarz 2000: Table 19.1	
1770	811000	Schwarz 2000: Table 19.1	
1780	890000	Schwarz 2000: Table 19.1	
1801	1090078	Office of National Statistics UK 2011	Census of population for greater London
1811	1294765	Office of National Statistics UK 2011	Census of population for greater London
1821	1560419	Office of National Statistics UK 2011	Census of population for greater London
1831	1862970	Office of National Statistics UK 2011	Census of population for greater London
1841	2185804	Office of National Statistics UK 2011	Census of population for greater London
1851	2630782	Office of National Statistics UK 2011	Census of population for greater London
1861	3155144	Office of National Statistics UK 2011	Census of population for greater London
1871	3840595	Office of National Statistics UK 2011	Census of population for greater London
1881	4711456	Office of National Statistics UK 2011	Census of population for greater London

Year (AD)	Population Estimate	Source	Additional Notes
1891	5567591	Office of National Statistics UK 2011	Census of population for greater London
1901	6506889	Office of National Statistics UK 2011	Census of population for greater London
1911	7157729	Office of National Statistics UK 2011	Census of population for greater London
1921	7382131	Office of National Statistics UK 2011	Census of population for greater London
1931	8098206	Office of National Statistics UK 2011	Census of population for greater London
1939	8615050	Office of National Statistics UK 2011	Census of population for greater London
1951	8161779	Office of National Statistics UK 2011	Census of population for greater London
1961	7975558	Office of National Statistics UK 2011	Census of population for greater London
1971	7403534	Office of National Statistics UK 2011	Census of population for greater London
1981	6483431	Office of National Statistics UK 2011	Census of population for greater London
1991	6679822	Office of National Statistics UK 2011	Census of population for greater London
2001	6679822	Office of National Statistics UK 2011	Census of population for greater London
2011	8173941	Office of National Statistics UK 2011	Census of population for greater London
2020	9304000	Current projection	

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