

The Role of Amenities in Measuring Park Accessibility:
A Case Study of Downey, California

by

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I would like to dedicate this manuscript to my wife Hilda for her endless support and my Aunt Trini who has always encouraged me in my educational pursuits.

Table of Contents

List of Figures.....	vi
List of Tables	viii
List of Equations.....	ix
Acknowledgements.....	x
List of Abbreviations	xi
Abstract.....	xii
Chapter 1 Introduction	1
1.1 Motivation.....	2
1.2 Theoretical Background.....	5
1.3 Study Site	7
1.4 Research Question	9
1.5 Manuscript Navigation.....	9
Chapter 2 Literature Review.....	11
2.1 Brief histories of parks.....	11
2.2 Parks and Environmental Justice	13
2.3 Measuring Population	13
2.4 Past Methods for Measuring Park Accessibility.....	15
2.5 Network Analysis and Park Accessibility.....	17
2.6 Measuring Park Amenities.....	19
Chapter 3 Methods.....	23
3.1 Dasymetric Mapping.....	24
3.2 Collection of Amenity Data	30

3.3 Park Amenity Scoring.....	33
3.4 Service Area Data Preparation.....	40
3.5 Service Area Analysis.....	43
3.6 Conclusion	46
 Chapter 4 Results	 47
4.1 Quarter Mile Service Area	48
4.2 Half Mile Service Area	52
4.3 One Mile Service Area.....	58
4.4 Two Mile Service Area.....	63
 Chapter 5 Discussion and Conclusion	 71
5.1 Population Mapping.....	72
5.2 Service Area Analysis.....	74
5.3 Amenity Scoring	76
5.4 Limitations and Improvements	77
5.5 Future Directions	80
5.6 Final Conclusions.....	81
 References.....	 83
Appendix A: PARA Operational Definitions and Protocols	88
Appendix B: Adjusted PARA Auditing Instrument	96

List of Figures

Figure 1 City of Downey	20
Figure 2 Downey Population per Census Block.....	37
Figure 3 Downey Residential Land Parcels.....	39
Figure 4 Downey Population Per Parcel.....	41
Figure 5 Histogram of Park Acreage Values	44
Figure 6 Furman and Independence Park Playgrounds	48
Figure 7 Improvised and Designed Physical Activity Amenities.....	49
Figure 8 Half Mile Service Area Results.....	56
Figure 9 Histogram of 0.25-mile SA Parcel Values	60
Figure 10 Histogram of 0.25-mile Play Acre SA Parcel Values	61
Figure 11 Parcel Values for 0.25-mile SA.....	63
Figure 12 Histogram of 0.50-mile SA Parcel Values	65
Figure 13 Histogram of 0.50-mile Disamenity Adjusted Acre SA Parcel Values.....	66
Figure 14 Parcel Values for 0.50-mile SA.....	68
Figure 15 Detail of Byron Zinn Play Acre 0.25-mile SA.....	69
Figure 16 Histogram of 1-mile SA Parcel Values	71
Figure 17 Histogram of 1-mile PA Acre SA Parcel Values	72
Figure 18 Parcel Values for 1-mile SA.....	74
Figure 19 Histogram of 2-mile SA Parcel Values	76
Figure 20 Histogram of 1-mile NA Acre SA Parcel Values.....	77
Figure 21 Parcel Values for 2-mile SA.....	79
Figure 22 Detail of Wilderness Park NA 2-mile SA	80

Figure 23 Service Areas for Discovery Sports Complex and Independence Park 84

Figure 24 Downey Restricted Watering Signs..... 90

Figure 25 Emergency Call Boxes 91

List of Tables

Table 1 List of Parks in Study Area.....	43
Table 2 List of Category Scores for Parks	47
Table 3 Tree Amenity Values	51
Table 4 Parcel Values for Each Service Area.....	53
Table 5 Percent Downey Parcels for Each SA.....	59

List of Equations

Equation 1 Calculation for People per Residential Unit.....	40
Equation 2 Calculation for Population per Land Parcel	40
Equation 3 Calculation for Total Category Acres per Park	46
Equation 4 Calculation for Disamenity Adjusted Acres per Park	46
Equation 5 Calculation for Acres per Person.....	57
Equation 6 Calculation for Category Acres per Person.....	57

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List of Abbreviations

CPAT	Community Park Audit Tool
EAPRS	Environmental Assessment of Public Recreation Spaces
GIS	Geographic information system
L.A.	Los Angeles
LAeGIS	Los Angeles County Enterprise GIS
NA	Nature access amenity category
NRPA	National Recreation and Park Association
PA	Physical activity amenity category
PARA	Physical Activity Resource Assessment
PRORAGIS	Park and Recreation Operating Ratio and Geographic Information System
SA	Service area
SAGE	Systematic Audit of Greenspace Environments
U.S.	United States of America

Abstract

Previous studies of park accessibility have utilized network analysis and dasymetric mapping to investigate pedestrian accessibility to park resources measured in acres per capita. Through a case study of Downey, California, this study extends on previous work in this area by combining network analysis and dasymetric mapping with robust park amenity auditing. The intention of this study is to provide a more detailed examination of how accessibility is affected by park condition and the types of facilities provided to park users. The study uses a method for dasymetrically mapping population data to land parcels, Esri's ArcGIS 10.1 Service Area Network Analyst tool, and a park amenity scoring system based on the Physical Activity Resource Assessment (PARA) instrument. The results of this research reveal that park accessibility in Downey is limited at multiple Service Area (SA) distance levels due to the presence of parks with high pedestrian accessibility but low amenities in the geographic center of the city and parks with low pedestrian accessibility but high amenities on the city's periphery. The results of this case study inform policy suggestions for future park developments. These policy suggestions include planning strategies for increasing pedestrian access to parks with developed amenities, which are distant from residential areas. Also, the study indicates which parks to nominate for development in highly accessible areas with few amenities.

Chapter 1 Introduction

Public parks are a common service offered by governmental bodies at many levels including nation, state, county, and city. The following study investigated access to public parks of all types at the scale of the city. Accessibility will be the main focus of the research discussed in this paper. More specifically, a quantifiable method for measuring accessibility to park amenities will be utilized in a case study of the Los Angeles (L.A.) County City of Downey.

The site chosen for this study is the roughly 12 square mile city of Downey, California. Downey belongs to a conglomerate of southeast L.A. County Governments known as the Gateway Cities. The area in general has a higher average population of Hispanic and Latino residents than the rest of L.A. County. Downey was chosen as a study area because of its surrounding geographical features and its independent city services. As will be explained later in this paper, both of these factors play a large role in making Downey a site of interest.

Network analysis was the method utilized to investigate park accessibility in the city of Downey. Large inspirations for this study were taken from methods utilized by both Parsons (2015) and Ibes (2015) in their studies on park accessibility. In his 2015 thesis on park accessibility in Wake County, North Carolina, Parsons established a method of using both dasymetric mapping and service area analysis to determine population accessibility based on residential land parcel locations. These methods allowed for a more realistic model of accessibility than alternative geodesic distance models that have been utilized.

Ibes (2015) also provided a unique perspective on park accessibility in her work on park equity in Phoenix, Arizona. Utilizing a classification system based on park amenities, Ibes (2015) created a typology for Phoenix parks. Comparing park type to demographic data, Ibes (2015) explained how different demographic groups in Phoenix had differing access to parks

with certain amenities. Using ideas from both Ibes (2015) and Parsons (2015), the following study utilizes network analysis, dasymetric mapping, and a park amenity scoring system to assess how accessible Downey parks are to its residents.

Wolch and Byrne (2009) state five main areas of park research: history and ideology, access and use, fostering sustainable urban life, ecological benefits, and benefits to health and well being of residents. The present study focuses on the area of park access and use. In a review of past accessibility studies, Kabish et al. (2015) explained the different types of statistically observable phenomenon in urban green space research. Kabish et al. (2015) found that in general, city-planning experts in many cities throughout the world agree that there are benefits to increasing accessibility to urban green space. It is also suggested by Kabish et al. (2015) that future research should focus on more generalizable and quantifiable methods such as those that utilize Geographic Information systems (GIS) as opposed to traditional survey methods which can be locally contingent.

The remaining portions of this chapter are divided into four sections that explore the basis of this research in more depth. Section 1.1 looks further at the motivation for this research and what benefits it can provide for urban green space planning and the spatial sciences. In section 1.2, the theoretical background of network analysis in park research is discussed in more detail. The study site of Downey is described in depth in section 1.3. Finally, section 1.4 presents an overview of the entire manuscript.

1.1 Motivation

The impetus for this project was to contribute to the areas of urban planning, public health, and spatial sciences. Urban planning research has often made the argument that public green space is needed in an urban environment (Mehta 2013). Benefits are often associated with

areas of public health. By studying accessibility to parks in a small city like Downey, this research has contributed to an increased understanding of public green space in areas outside of major metropolitan centers. Working with data at the land parcel scale has also helped contribute to the need for more detailed maps to help further spatial science studies. Finally, this case study will provide an additional option for small governments to perform GIS studies at a community-based level.

Studies of public space vary greatly and often use different variables to exemplify the role they play in an urban environment. Mehta (2013) suggests that public space contains a mix of safety, comfort, pleasure-ability, inclusiveness, and meaningful activity. Parks or public green space is one of the most common examples used when discussing public space and the benefits it provides to urban residents (Mehta 2013). Parks have also been the focus of many studies that explore issues of environmental justice and public health (Suminski et al. 2012; Wolch et al. 2014; Parsons et al. 2015)

Environmental Justice involves the understanding of how productive and destructive features of a physical environment are spatially distributed among a population based on social demographics (Parsons et al. 2015; Parsons 2015). In this example, public parks would be an example of a productive feature of the physical environment due to its positive effects on the population (Mehta 2015). An example of a destructive feature would be a landfill or sewage processing plant (Bullard 1996). Studies have shown that areas with lower income and where minority populations are high, often have differential access to quality and quantities of public green space (Taylor et al. 2007; Byrne and Wolch 2009; Marcelli 2010; Suminski et al. 2012; Parsons et al. 2015).

Access to public parks has been associated with different types of benefits for a community. Studies have shown that the presence of public green space promotes social interaction that is often lacking in low-income areas and amongst neighborhoods where income levels are mixed (Coley 1997; Taylor et al. 2007; Krellenberg et al. 2014). Among the many benefits of parks, improved physical health has been linked to public park access, especially in low-income communities (Cohen et al. 2007). Correlations have also been found between access to public green space and better mental health (Richardson et al. 2013). By investigating the accessibility to public green space in Downey the following research has contributed to a better understanding of how smaller communities have differential access to productive environmental features.

In a review of past public green space studies, Kabish et al. (2015) found that GIS methods were most often used in studies of environmental justice and urban green space planning. Considering the importance of GIS analysis in this area of study, detailed methods for determining accessibility should be explored. The use of dasymetric mapping and network analysis in this study contributed to establishing a more accurate and detailed model of accessibility. This benefits the spatial sciences at large because it helps exemplify the ability to widely improve such methods, a direction that has been encouraged to improve future studies (Kabish et al. 2015).

The benefit of using Downey as a case study for this research also helps establish a model for other small cities to engage in their own accessibility analysis. All of the data used in this study was readily available over the Internet. Increasingly, open source GIS software is also becoming more readily accessible to people with less experience in the spatial sciences.

Considering these two aspects, this study hopes to aid in establishing a method for local governments to engage in their own accessibility studies to improve urban planning.

1.2 Theoretical Background

The use of park amenities and network analysis in this study have been informed by previous research which have proven their benefits to urban green space studies. Two studies in particular have been used as primary inspirations for the methodology used in this study.

Dorothy C. Ibes (2015) work on park type access in the Phoenix Arizona area served as an inspiration for looking at park amenities. Jonathan Parsons' (2015) thesis on park accessibility in Wake County North Carolina served as a model for the use of dasymetric mapping and network analysis.

Studying park amenities has often been a focus of environmental justice studies of public green space. Bruton and Floyd (2014) found that parks in North Carolina showed a differing quality of amenities based on their proximity to minority neighborhoods. While this study lends to the common findings of previous environmental justice research, other studies have also found that minority populations use parks in different ways and certain amenities are favored over others (Stodolska et al. 2011; Li 2014). When creating the methodology for this study, it was apparent that general park accessibility needed to be qualified by considering the type of amenities that were accessible.

Ibes (2015) provides a useful model for considering park amenities in urban green space studies. Ibes used a combination of amenity types for determining a park typology. Using this process, it is possible to analyze park accessibility in a way that considers the differing and similar characteristics of parks. By creating a typology, the results of park accessibility have an added layer of context, which can speak to the quality of the type of park that is accessible to city

residents. In this study park amenity and disamenity types were used in a similar fashion to give context to Downey park accessibility. The idea of disamenities has been utilized in past park accessibility research (Weiss et al. 2001; Byrne et al. 2005; Lee et al. 2005; Bruton et al. 2014; Parsons et al. 2015). Disamenities, in this study, are those characteristics of parks that deter or prevent attendees from utilizing its resources. Some examples of disamenities are broken glass, evidence of drug use, graffiti, and dead or overgrown grass.

Prior to network analysis the most common form of studying park accessibility was to use some variant of distance buffers using geodesic measures. (Boone et al. 2009; Sister 2010). Buffering methods of investigation often neglected street networks, walking paths, and other forms of urban travel. Network analysis has been increasingly used as a more acceptable method for more accurately modeling travel distances in an urban environment (Heckert 2013; Morar 2014; Parsons 2015). Using network analysis, models can be built that consider park access points, travel paths that restrict certain transportation methods or constraints that would make a short geodesic distance unavailable.

Recent studies, which have used network analysis to study park accessibility, have used large-scale population measures and have not considered park amenities in analyzing pedestrian accessibility along road networks (Heckert 2013; Morar 2014). Parsons' (2015) methodology of utilizing dasymmetric mapping and network analysis improves upon previous studies by creating a more detailed and accurate model of accessibility. The choice to use network analysis along with a measure for park amenities in this study has expanded upon both the previous methods of Ibes (2015) and Parsons (2015) by providing a more realistic model of accessibility that considers the quality of park facilities.

1.3 Study Site

The City of Downey California is located in southeast L.A. County and is estimated to have a population of approximately 114,000 people according to the 2014 United States (U.S.) Census. Spatially the city only covers 12.4 square miles and is mostly bordered on all sides by smaller municipalities. Demographically Downey differs from the California average in that it is 70% percent Hispanic or Latino (Census 2010). Economically Downey is similar to the 2010 California Median Income, coming in at just over \$60,000. Compared to its neighboring cities Downey is a city of relatively wealthy predominantly Latino residents.

The City of Downey has never been previously studied for park accessibility. In terms of geography, Downey is bordered on both the east and west sides by two riverbeds, the Rio Hondo and Rio San Gabriel respectively. To the north, the Interstate 5 freeway borders Downey. These three features form natural travel barriers for those navigating into and out of Downey. Though small parts of the city are on the outside of these natural borders, all of the cities public parks and recreation spaces are within them. Figure 1 depicts Downey's location in the southeast of L.A. County.

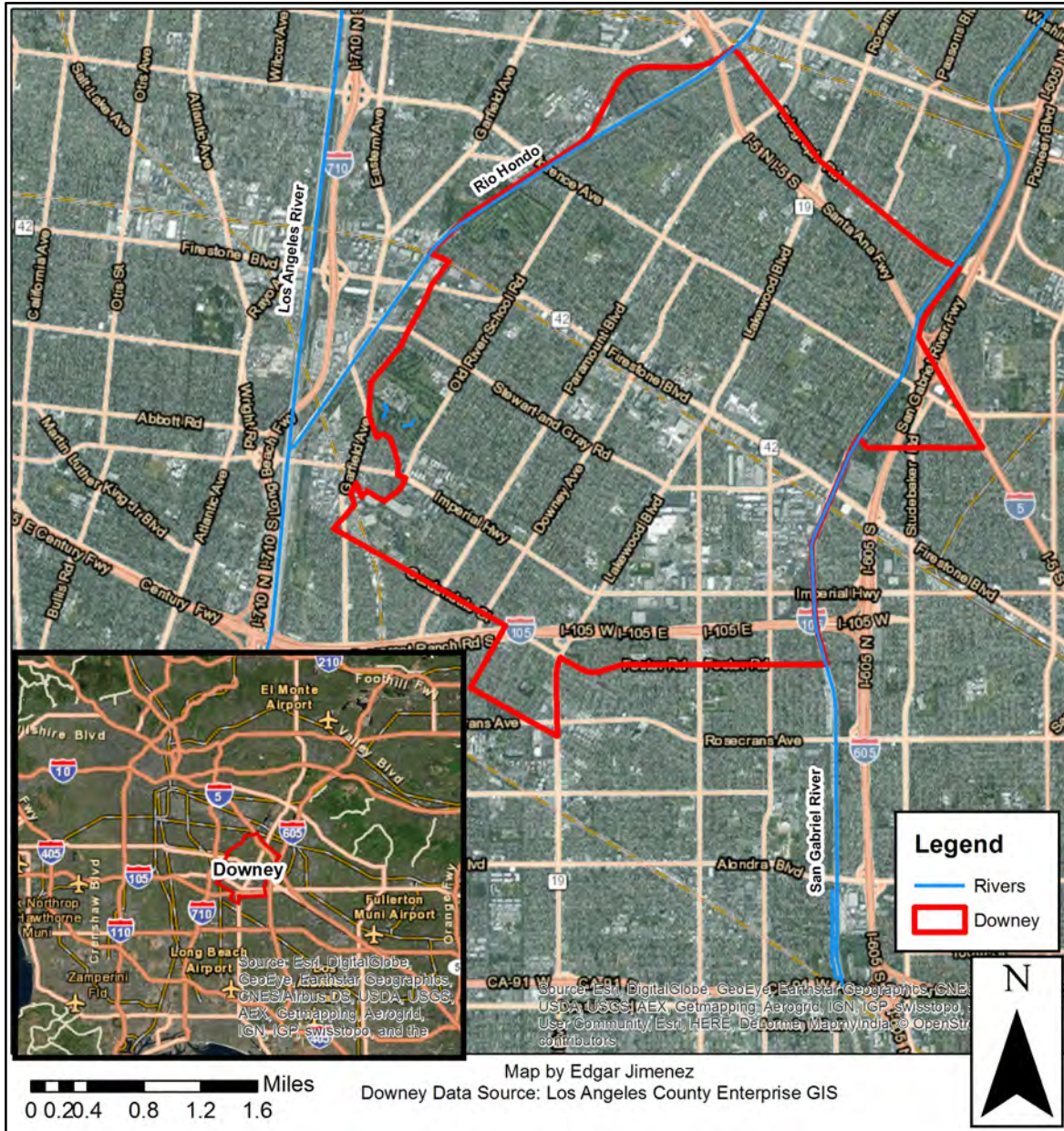


Figure 1 City of Downey

Downey, unlike most of its bordering cities also maintains its own school district, parks, police, and fire services. This is uncharacteristic for the area of L.A. County that Downey is located in. The cities surrounding Downey are more likely to contract city services to L.A. County, contain additional county services within their borders (such as L.A. County owned parks), or cooperate with neighboring city services (such as the Norwalk-La Mirada unified

school district). These factors combined make Downey a much more isolated city in terms of city services that are available to its citizens, but also give the residents a greater opportunity for local control of park services.

1.4 Research Question

The intention of the following study was to determine if there was equity in land parcel access to public parks and their amenities. For the purpose of this study accessibility was seen as the amount of access each land parcel's population has to the nearest park in acres per person. In previous studies, accessibility has been viewed as a ratio that looked at the spatial distribution of public facilities compared to population totals or demographics of administrative units such as census blocks. (Sister et al. 2010; Ibes 2015) Using a model of accessibility that focused on land parcels allowed this study to look at what park accessibility is like for a resident of Downey. This study also went further to investigate how accessibility differs when looking at specific park amenities and how it is affected when factoring in park disamenities.

1.5 Manuscript Navigation

The remaining chapters of this manuscript will contain more detail on how the study was informed, planned, and executed. In an attempt to ease the navigation of the manuscript, quick summaries for each chapter have been provided.

In chapter 2 of this paper, there is a detailed explanation of the past studies on urban green space accessibility. Past methods and models for investigating environmental justice and park amenities is explored. Closer examination is also given to the use of network analysis in public park accessibility research.

Chapter 3 discusses the methods that were used to perform the research. There will be clearer descriptions on how methods from Ibes (2015) and Parsons (2015) have been combined

in a more meaningful way. Data sources will be revealed and all data processing will be detailed. There is also an explanation of the software and analytical tools that were used to accomplish this study. Finally, the details of the workflow for the dasymetric and network analysis are outlined.

Chapter 4 contains the detailed results of service area analysis done on the parks of Downey. There is an exploration of what was learned about park accessibility and the effectiveness of the methodology used. There are detailed explanations on how each method used provided its own insight into the dynamics of park accessibility in Downey.

Chapter 5 contains a comprehensive discussion about the implications of the results from this research. Potential improvements and limitations of the research are explored in detail. There are also suggestions for future research and potential policy directions for the City of Downey.

Chapter 2 Literature Review

The use of GIS methods to analyze park accessibility is not in itself a novel concept. Advancements in methodology have helped improve models of park accessibility by embracing network analysis, making finer scale population estimates, and quantifying amenity characteristics. Though research exists that combines any two of these aspects in one study, no study has yet established a methodology that combines all three. In this chapter, previous research on parks and accessibility will be explored as a means for justifying the need for a methodology that utilizes recent advancements in population estimates, network analysis, and park amenity classifications.

This chapter will first give background on the history of urban parks and their use in section 2.1. The next section (2.2) then provides some further clarification on environmental justice and the motivations behind contemporary accessibility studies. Section 2.3 briefly summarizes advances in spatial population modeling for parks using dasymetric mapping. Section 2.4 is a comprehensive look at past accessibility methods which utilize geodesic measures both with and with out dasymetric population models. Section 2.5 provides a detailed exploration of the current state of network analysis in park accessibility studies. In the final Section 2.6 the study of park amenities will be carefully examined.

2.1 Brief histories of parks

The term public space itself is not an easy term to define. In her creation of a public space index, Mehta (2013) explains that public space does not just pertain to who owns the land. Instead Mehta (2013) explains that public space is effective only when it satisfies five components. These components require the space to be inclusive, support meaningful activity,

pleasurable, safe, and comfortable. Though parks can be seen as an archetypal example of this definition of public space, this has not always been true.

The meaning in an urban landscape has evolved over time. Parks were originally seen as areas where nature could be kept and put on display only for those in higher socioeconomic classes (Byrne et al. 2009). Over time this meaning changed, and parks were viewed as having more of a democratic purpose where people of different backgrounds could interact (Byrne et al. 2009). As recently as the late 1990's, Coley et al. (1997) found that the inclusion of trees and other elements of natural landscaping attracted people and promoted social interaction in an urban environment. These areas of natural landscaping are generally referred to as public green space and have been found to also benefit urban ecology and public health (Wolch et al. 2014). It is because of these benefits that there has been much concern about the idea of public green space in urban environments.

Though the benefits of public green spaces have been recognized for some time, it has only been more recently that the differential access to these spaces have been studied using detailed spatial methods (Wolch et al. 2005; Cohen et al. 2007; Taylor et al. 2007; Byrne et al. 2009; Kabisch et al. 2014). Though there is a general consensus on the desire to increase public green space in cities, methods have not always been effective for those most in need (Wolch et al. 2005; Joassart-Marcelli 2010; Wolch et al. 2014). Efforts to simply increase the acreage of public green space by appropriating unused industrial sites such as rail yards or concrete riverbeds have not always lead to equitable access (Wolch et al. 2014). Studies have shown that programs such as park bond funding and relying on federal or state investment can actually exacerbate park accessibility issues (Wolch et al. 2005; Joassart-Marcelli 2010).

Parks have historically been areas of minority exclusion (Byrne et al. 2009). In light of this, contemporary park planners increasingly look at how ethnically and socioeconomically homogenous areas can be better served by strategic park location and design (Wolch et al. 2005; Byrne et al. 2009; Li 2014; Wolch et al. 2014). Contemporary studies concerning park accessibility often stem from the differing accessibility of demographically homogenous neighborhoods and the ideas of environmental justice.

2.2 Parks and Environmental Justice

Initially environmental justice was seen as the idea that ecological and spatial characteristics of a persons surrounding should not be unduly burdened by the presence of unhealthy locations such as landfills and refineries (Bullard 1994). As research in the field grew, environmental justice advocates also started looking at the lack of access to neighborhood improving services (Taylor et al. 2007).

Parks have been correlated with many benefits for neighborhoods including improved health, improved community engagement, improved property value, and improved environmental conditions (Coley et al. 1997; Cohen et al. 2007; Taylor et al. 2007). The prevalence of parks in neighborhoods of homogenous ethnic and socioeconomic demographics has often been found to be lacking (Cohen et al. 2007; Taylor et al. 2007). It is because of this finding that quantifiable methods for measuring accessibility have been increasingly important for both environmental justice advocates and city planning researchers (Kabisch et al. 2014).

2.3 Measuring Population

When studying the accessibility to an urban amenity such as a public park, it is important to use a scale of reference that appropriately models park accessibility issues. Zhang et al. (2011) provides an example of how traditional methods for measuring accessibility have been

approached. In their study, accessibility was measured at the national level using census tract level data (Zhang et al. 2011). The challenges in using this method are that local accessibility issues can be lost at this scale of analysis. In a review of methodology for studying parks, Kabisch et al. (2014) explains that the current direction of research is moving towards more localized case studies. In order to increase the effectiveness of more localized studies, new methods for analyzing population have been explored.

Dasymetric mapping is the disaggregation of data into more meaningful spatial distributions (Eicher et al. 2001). Eicher et al. (2001) describes two basic methods for dasymetric mapping, the first is a binary raster based method and the second is a vector-based method, which uses limiting variables. The raster method converts data into a field of cells which cover the entire spatial extent of the study area and contain a binary value (Eicher et al. 2001). In terms of studying population, this would mean each cell in the field would either carry a value representing the presence or absence of population. This binary method helps distribute data more accurately across an area that may not be uniformly populated (Eicher et al. 2001).

The limiting variable (vector based) method disaggregates population data in one set of polygons to another more meaningfully distributed set of polygons (Eicher et al. 2001). The population value for each new polygon is proportional to a limiting variable (Eicher et al. 2001). In the study by Eicher et al. (2001), population amongst an entire country was disaggregated according to land type and each land type was given a maximum allowable population density (people per square kilometer) to determine its population. The conclusion of the study found that the limiting variable (vector based) method of dasymetric mapping was a more accurate representation of a population's spatial distribution.

2.4 Past Methods for Measuring Park Accessibility

In their review of public space research Kabisch et al. (2014) suggests that research into the accessibility of parks should be scalable and utilize methods which are comparable to those used by park planners. The use of a GIS to analyze park accessibility satisfies both of these concerns and it is for this reason that the following section will focus its attention on GIS methodology. In terms of GIS methods there are two general areas that vary in their execution amongst past studies. First, some studies use of geodesic measures of distance while others use network distance. Second, some studies use dasymetric-mapping techniques for modeling population while others incorporate whole census tracts or take simple proportional percentages of buffers that intersect tracts.

Of the four methodological combinations possible based on the above variations, the use of Euclidian distance measures and non-dasymetric mapping is the least complex. The most complex method for GIS workflow is network distances with dasymetric mapping. The advantages and disadvantages of each combination of methods will be discussed further in the remainder of this section.

The use of a physical survey of park guests is often associated with contemporary studies of park accessibility (Cohen et al. 2014; Rossi et al. 2015). In studies by both Cohen et al. (2014) and Rossi et al. (2015) surveys of park visitors were used to examine park accessibility. In the study by Cohen et al. (2014), a linear half-mile buffer was used to create the survey area for examining community accessibility to parks. The research by Rossi et al. (2015) surveyed attendees on site and self disclosed attendee origins were aggregated into neighborhoods. In both cases, GIS methods were only lightly utilized in conjunction with surveying methods and both were not easily scalable.

Lara-Valencia et al.'s (2013) study of community access to public spaces used more common GIS methods for accessibility. In the study, Lara-Valencia et al. (2013) used centroids for parks and neighborhoods to determine accessibility by using linear buffers around park centroids to determine service areas. These methods oversimplify park access by using centroids as destinations and risk misrepresenting access by aggregating populations by *colonias*, which are Mexican national population measuring units generally larger than census block groups in U.S. terms (Lara-Valencia et al. 2013). In a 2012 study, Hewko et al. found that disaggregating population data helps increase accuracy of service area estimates for amenities such as playgrounds.

Dasymetric mapping is a commonly used way to provide a more accurate model of population when studying accessibility (Langford et al. 2006; Oh et al. 2007; Boone et al. 2009; Maroko et al. 2009; Sister et al. 2009; Maantay et al. 2013; Morar et al. 2014; Parsons 2015). Maroko et al. (2009) is uncommon in relation to most contemporary studies in that they used a raster data format to model population and public park space. The kernel density method, which was utilized, transformed census block group population data, in the form of centroids and park spaces into two fields of cells (Maroko et al. 2009). However, using this method did not allow for the utilization of the distinct boundaries to travel that exist in an urban landscape. Using a similar model for population, Sister et al. (2009) utilized a combination of the Landsat Population Grid and theissian polygons around park centroids to determine the "PSA (Park Service Area)", to study accessibility. In this instance the model determining service areas could also be improved because they utilized linear distances to determine the "PSA" for each park.

Maantay et al. (2013) and Boone et al. (2009) both provide a method for modeling population that utilizes both dasymetric mapping and the natural boundaries of an urban

environment. In both studies dasymetric methods were used to disaggregate census data to the scale of land parcels (Boone et al. 2009; Maantay et al. 2013). The use of parcels as a unit for measuring population is ideal because it represents the actual location of where people live. In the case of the Maantay et al. (2013) study, dasymetric mapping of the population was used along with a linear buffer around roads to model exposure to air toxins from car traffic. This was a more appropriate model for this study because air toxins can travel linearly and are not limited to network travel. The dasymetric mapping served to model the population while the linear buffers modeled the reach of possible air borne toxins. This type of linear measurement was also used by Boone et al. (2009) to determine park service areas. Linear geodesic measures are not as appropriate for accessibility models because the nature of the urban landscape means that people cannot navigate directly to a destination, instead they must move within predetermined routes of travel.

2.5 Network Analysis and Park Accessibility

When studying accessibility in an urban environment it is difficult to ignore how streets and other routes affect travel. Network analysis is a tool that allows one to study accessibility while also recognizing the travel limitations inherent in a city. In separate studies Nicholls (2001) and Sarah et al. (2001) compared methods of studying accessibility to public parks, both found that network analysis provided a more accurate estimate than traditional geodesic buffers.

One example of network analysis being used to study accessibility was done in 2006. In this study Apparicio et al. (2006) used network analysis to determine the access to various services from public housing locations. Each service (destination) and public housing complex (origin) was visualized as a point to determine what the true distance is between each when accessing a service via the street network. Ultimately these methods would not be directly

applicable to park studies because each park was visualized with only a single access point and each public housing complex had no population value so service density could not be estimated (Apparicio et al. 2006).

Heckert (2012) provides us with an example of an accessibility study that utilized network analysis and population estimates. He used the percentage of census block groups that fell within a 0.5-mile of street access to a park. The difficulty in utilizing this method is that census blocks do not account for differing population densities. The assumption that block groups have uniform population density, even in urban environments, does not account for areas that have been zoned for higher density habitation (i.e. apartments) or lower density habitation (i.e. industrial zones). These concerns also plague similar methods, which utilize postal zip codes to help model population distributions (Comber et al. 2008).

The use of network analysis in conjunction with dasymetric mapping methods has shown much promise in recent research on accessibility. Langford et al. (2006) used network analysis and dasymetric mapping in a raster data format to study accessibility to healthcare services. In their research, they rasterized both the street networks and population in their study area (Langford et al. 2006). As was used in past studies, population was modeled in a binary fashion which meant that each cell in the field had a value which meant it was either populated or not (Langford et al. 2006). Though this method was found to be more effective than population estimates that assumed uniform population across a polygon (Langford et al. 2006), it still did not provide specific population densities for the study area.

Using similar methods, Morar et al. (2014) and Oh et al. (2007) used a more detailed dasymetric mapping method for modeling population. In both studies, the square footage of buildings was used to help estimate population densities (Oh et al. 2007; Morar et al. 2014). In

both cases, the method provided a more detailed way to model population, but the assumption that population density was the same from house to house also leaves room for errors. In the case of Morar et al. (2014), these concerns were even more pronounced because aerial imagery was used to estimate building square footage. This method is also not easily scalable since different urban areas have unique building methods and detailed data on square footage is not always easily accessible.

The final example of network analysis and dasymetric mapping that will be discussed is by Jonathan Parsons (2015). In this study Parsons used census block data and land parcel data to create a more accurate model of population in Wake County, North Carolina (Parsons 2015). Using this method Parsons (2015) was able to create a more accurate spatial distribution of the population that considered both the areas of residential zoning and the approved habitation for each land parcel (i.e. single family home). In addition to this Parsons (2015) also visualized the parks with multiple access points for the network analysis. Parsons (2015) methods currently provide one of the best options for studying park accessibility in a city. The one area which has been given little to no attention in these previously reviewed studies is the idea of accessibility to specific park amenities.

2.6 Measuring Park Amenities

The National Recreation and Park Association (NRPA) is the long cited authority on park planning in the United States. According to the NRPA, cities or communities should set local standards for which park amenities are essential. Since this means there is no nationally set standard for park amenities there have been various methods devised to study this area. In the following section there will be a deeper investigation into the different ways park amenities have been studied.

The Trust for Public Land maintains an assessment instrument for comparing park systems between cities (Trust for Public Land 2015). The assessment instrument is known as ParkScore (Trust for Public Land 2015) and it uses a series of measures based on the areas of acreage, accessibility, investment, and facilities to determine a cities park score. Parks systems are scored out of a total of “100” and the assessment outputs a map that indicates areas serviced by parks and those that are in need (Trust for Public Land 2015).

The advantages of this type of assessment are that city park systems can be compared to each other, and there is associated age and income demographics with the results (Trust for Public Land 2015). The disadvantage to this system is that park amenity data is aggregated into a single score (Trust for Public Land 2015), so accessibility to certain types of park amenities cannot be investigated. ParkScore (Trust for Public Land 2015) also only uses a single 0.5-mile service area distance to determine resident accessibility to parks. In general, ParkScore ‘s (Trust for Public Land 2015) purpose is to investigate an entire park systems quality and give a generalized result of accessibility needs.

Previous work by Moore et al. (2008) and Weiss et al. (2011) utilized raster data formats to create density fields of park features. In the study by Weiss et al. (2011), the focus was specifically on features referred to as “disamenities.” These were characteristics such as incidences of murder, traffic fatalities, and other characteristics that would discourage park attendance (Weiss et al. 2011). In both cases the raster data format generalized the data in such a way that dynamics in specific neighborhoods were not discernible.

Dorothy Ibes (2015) provides a more detailed view of park amenities. She measured various amenities that were available in parks and performed a principal components analysis to form a park typology (Ibes 2015). Once each park was categorized into a type, GIS methods

using linear buffers were used to determine population accessibility to park types (Ibes 2015). While this method is effective at maintaining the detail of a vector data format, it places each park in a typology and does not allow for the consideration of parks serving multiple purposes for a community.

There are many different auditing instruments that exist to systematically survey public parks (Byrne et al. 2005; Lee et al. 2005; Saelens et al. 2006; Greer et al. 2014). The goal of each of these audit instruments is to evaluate the many different amenities and in some cases disamenities of parks. Disamenities in this case are aspects such as graffiti or presence of litter, which may keep people from utilizing parks. Many of these instruments use Likert scales to not only record the presence of features but also the condition or severity of each feature.

Some auditing instruments also focus on park amenities like recreational equipment or landscapes rather than the general quality of the parks environment. The Environmental Assessment of Public Recreation spaces (EAPRS) and Systematic Audit of Greenspace Environments (SAGE) are both good examples of audit surveys that seek detailed information on the amenities at parks but have less focus on any observational disamenities (Byrne et al. 2005; Saelens et al. 2006). In the case of SAGE the recorded disamenities (i.e. Litter) are binary (i.e. present or not present) and do not allow for a more multi dimensional examination (Byrne et al. 2005). EAPRS however does provide a scale by which to rate disamenities but the audit tool uses vague indicators (i.e. perceived degree of safeness) as opposed to specific occurrences of disamenities (Saelens et al. 2006). Though both tools have been shown to be effective in previous studies (Sister et al. 2009; Bruton et al. 2014) they do not provide as comprehensive a view as other audit tools.

The Community Park Audit Tool (CPAT) and Physical Activity Resource Assessment (PARA) are two audit tools that provide more detail on disamenities (Greer et al. 2014; Lee et al. 2005). While CPAT provides more areas to highlight potential disamenities in public parks, PARA provides a more detailed audit instrument because it allows for a degree of severity for each disamenity listed (Greer et al. 2014; Lee et al. 2005). PARA also provides a more thematic recording of amenities that focuses on both the physical landscape of the park and general features that are present (Suminski et al. 2012).

This study draws on the strengths of the various audit instruments discussed above. The next chapter explains the auditing instrument developed for this study and also how this study has combined previous methods in park amenity studies, network analysis, and dasymetric mapping to create model for examining park accessibility in Downey, California.

Chapter 3 Methods

Creating a quantifiable method for measuring park amenity accessibility in Downey, CA involved three general steps: dasymetric mapping of the population, collecting and scoring park amenity data, and performing service area analysis. The overarching objective was to create park accessibility metrics at the level of residential parcels for the entire city. Each step of the methodology was done to specifically address a challenge faced in previous studies. Dasymetric mapping was used to create a more detailed spatial distribution of population density. The collection of amenity data and scoring procedure provided a quantifiable method for comparing park amenity quality. Network service area analysis was used to provide the most accurate model of accessibility in an urban environment.

The use of dasymetric mapping involved redistributing census block population data to the scale of land parcels. This step was needed because the results of the study were visualized as accessibility values for each individual parcel. After the dasymetric mapping was done, amenity data for the parks in the study area was collected and each park scored on the basis of four categories. Three categories represented the types of amenities available for park users, and one scored for disamenities like graffiti or litter that would make a park less attractive to park users. Available park acres were adjusted based on these scores.

The third and final step in the methodology involved the use of network service area analysis to determine accessibility values for each parcel in a park's service area. The service area analysis provided a means for determining, which parcels parks serviced, and which parcels parks did not service. Using service area analysis allowed for the assignment of park amenity scores to parcels in Downey. The result of the service area analysis allowed for a visualization of how parcels in Downey differed in their access to parks. All of the analysis, unless otherwise

stated, was done using Esri's ArcGIS 10.1 software. All data sets for the analysis were on the North American 1983 Geographic Coordinate System. For the purposes of spatial measurements and mapping all data for this study was projected using the State Plan Coordinate System California zone V FIPS 0405. The following chapter will provide a further details of the methodology used in this study.

3.1 Dasymetric Mapping

There were two main data sets that were imported into ArcGIS for the dasymetric mapping: U.S. Census population data and land parcel data provided by the L.A. County Office of the Chief Information Officer and L.A. County Enterprise GIS (LAeGIS). A third data set of political boundaries for L.A. County was also procured from LAeGIS and was used to clip all datasets to the boundaries of the study area.

The U.S. Census data contained population estimates for census block groups according to the 2010 U.S. Census. Population data was downloaded as a data table and joined to a polygon data set of census block polygons based on the GEO.id field. Downey is roughly divided into approximately 83 census blocks. Figure 2 depicts the population of Downey and all census blocks that intersect within a 2-mile buffer of the city (study area). The figure shows a rough estimate of population for the city and all census blocks within the greater study area. In general, it can be seen that more people live in Downey's southern than northern areas. The census block lacking data in the southwest section of the city contained no residential parcels and so this study was unaffected by its absence.

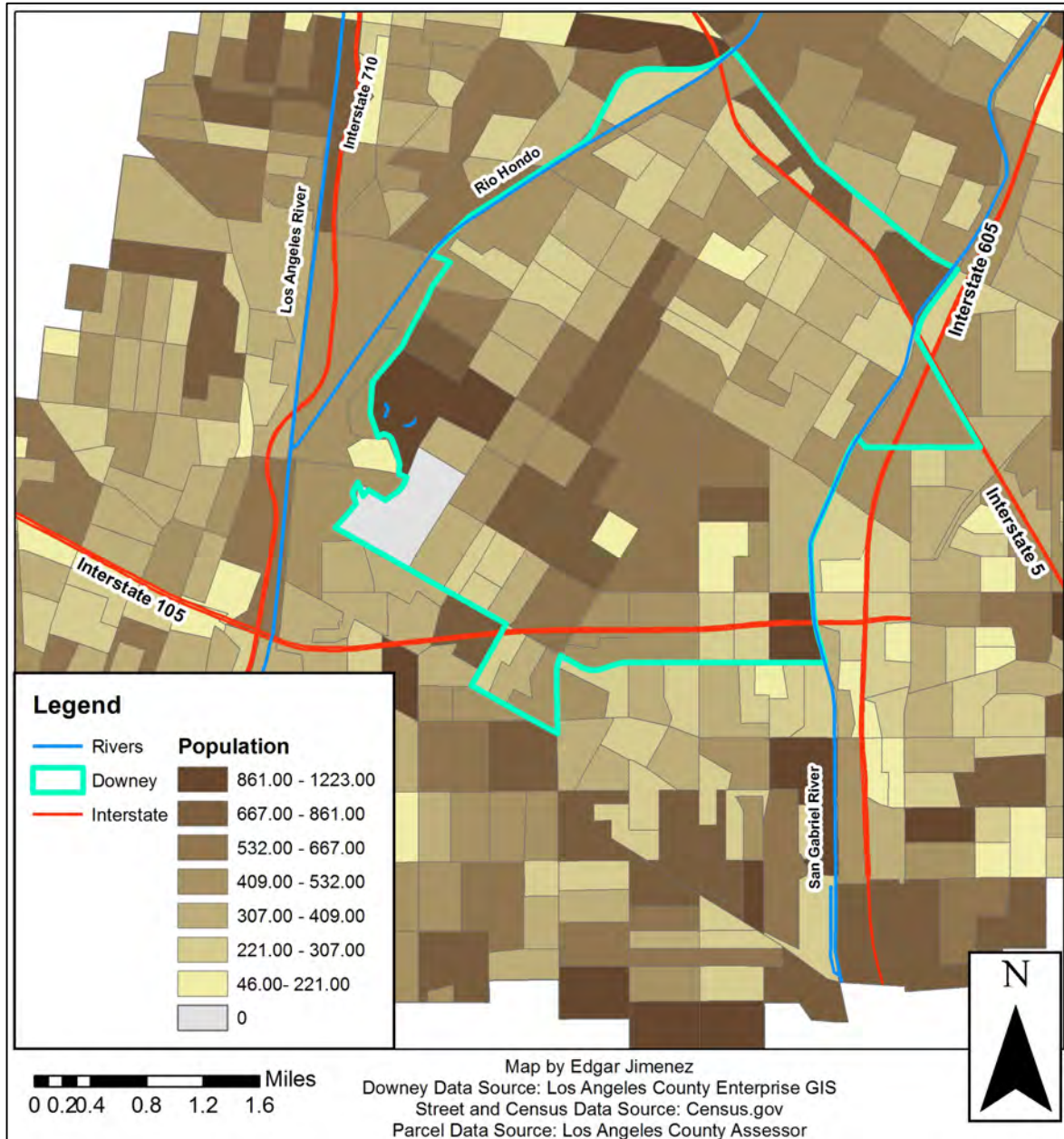


Figure 2 Downey Population per Census Block

Residential land parcel data for the city of Downey was obtained from a larger land parcel data set for all of L.A. County. The land parcel data set was downloaded from the LAeGIS data portal and was compiled by the L.A. County Office of the Assessor. The data set was a polygon data set of 2014 land parcels along with a vast amount of information on each parcel's zoning designation and attributes. Initially, the parcel data was queried to include only those

parcels that were classified as residential. In past dasymetric mapping efforts, parcels were then further reclassified depending on the general zone classification for each parcel (Parsons 2015). While the parcel data set had general classifications for each parcel (single family, duplex, multi-unit, etc.) these were not needed for this study because the data set contained a field specifying the exact number of residential units for each parcel. Due to the authoritative source of the parcel data, no further testing of the data set was done.

In order to create a smaller land parcel data set for the study, the census block polygons of the study area were dissolved into a single polygon and used to select a subset of parcels. Any parcel whose center was contained within a census block was retained for the analysis. Since the study area expanded 2-miles beyond the boundary of Downey, all residential parcels in the city were retained. The 2-mile buffer used to determine the study area was chosen based on the maximum length that would be used in the service area analysis. By clipping all data sets according to the 2-mile buffer, edge effects for Downey parcels were modeled. On the one hand, some of Downey's parcels are serviced by neighboring city parks in adjacent cities. On the other hand, some Downey parks may serve residential parcels in neighboring cities, potentially contributing to overcrowding at these parks.

In Figure 3 the distribution of residential parcels for the study area is shown. The distribution of the parcels shows how the census block data had aggregated data across sections of the city that were not populated. Areas of Downey in the southeast and southwest show large areas where there are no residential parcels. However, if they are visualized solely on the basis of the census block data, they appear to be heavily populated areas. Figure 3 also depicts the parks of Downey and those in neighboring cities that were in the study area. All parks outside of

Downey were given a 2-mile service area (as defined in Section 3.5) and only those parks whose buffer entered or immediately bordered Downey parcels were included.

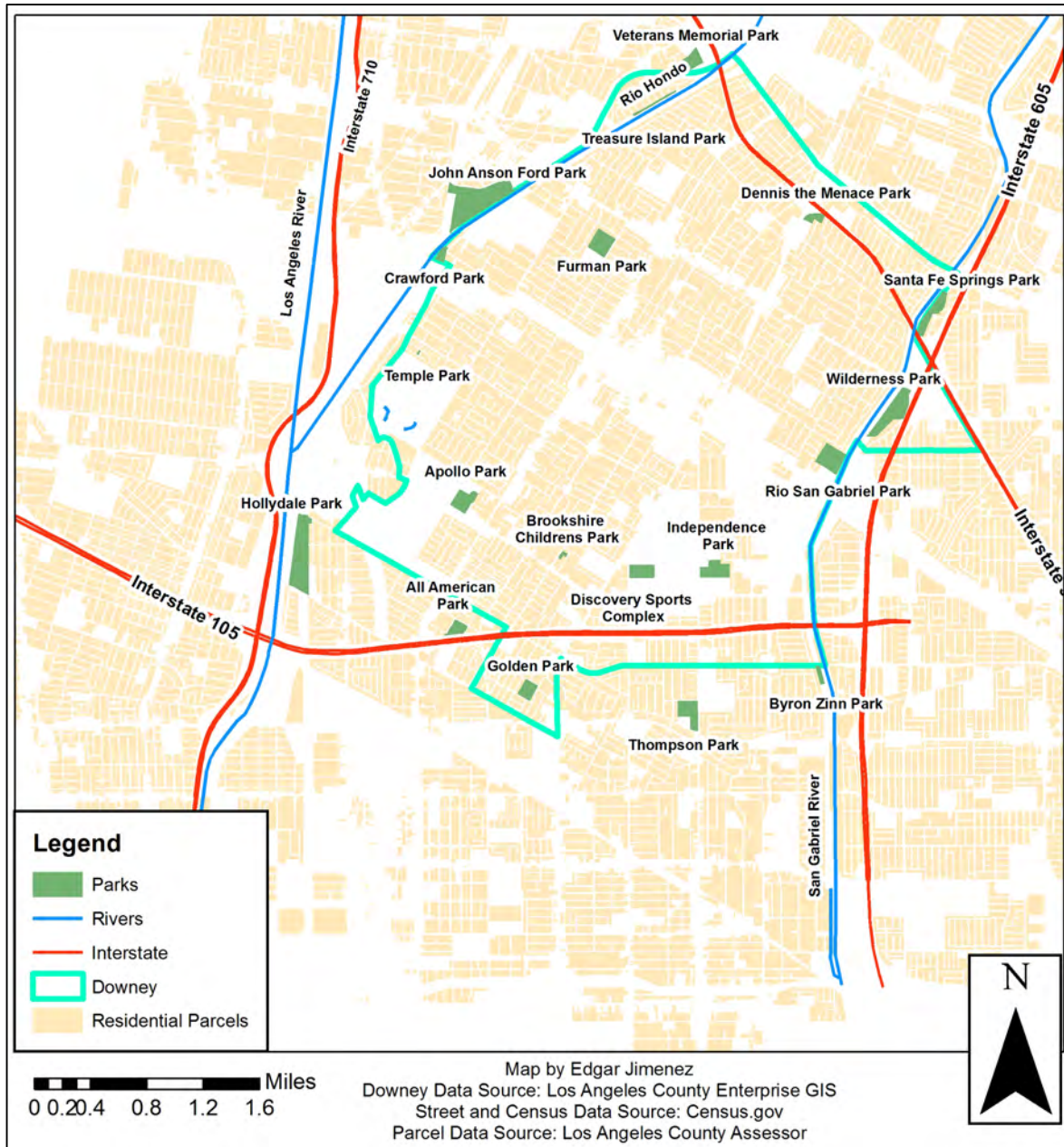


Figure 3 Downey Residential Land Parcels

The calculations for the dasymetric mapping were done using the field calculator, summary statistic and spatial join tools in ArcGIS. In order to do the calculations each residential

parcel needed to be assigned to a census block. To do this, a spatial join was done with the census block polygons and the land parcel polygons. Land parcels were assigned to census blocks based on the location of the land parcel centroids. To verify the parcel, count the number of records in the spatial join data set was compared to the original parcel data set and both were found to be equal.

The ultimate goal of the calculations was to determine the Population Per Parcel (Pp). In order to determine this value, there were two main formulas that were used. The first was the calculation for People Per Unit (Pu) for each parcel and the second for Pp. To determine the Pu for each parcel the total population for each block group (B) was divided by the sum of all units (Bu) for every parcel whose centroid resided in it. Spatially joining the parcels to a census block group and running a summary statistic to add all units for parcels that belonged to a common census block, achieved this. The second calculation to determine the Pp for each parcel was done using the total housing units field (U) provided in the land parcel data set. Each parcels' total units (U) was multiplied by the Pu to determine the total population (Pp) for each residential land parcel. The formulas below summarize the calculations done to determine the Pu and Pp for each parcel.

$$Pu_{(i...j)} = B / Bu \quad (1)$$

$$Pp_{(i...j)} = Pu (U_{(i...j)}) \quad (2)$$

The results of dasymetric mapping calculations allowed for a finer scale spatial distribution of the population in the study area. Figure 4 shows the results of the dasymetric mapping that was done on the study area. According to the dasymetric analysis, the vast majority of Downey consists of land parcels that are mostly within a common range, with some larger multi-unit parcels in the central northern and southern parts of the city. The area void of

residential parcels toward the geometric center of the city is the area known as Downtown Downey and it contains one of the largest clusters of retail businesses in the city. The areas in the western part of the city with no population represent a mix of commercial, industrial, and newly developed retail areas. This parcel population data was eventually used in conjunction with the service area and amenity data to determine accessibility.

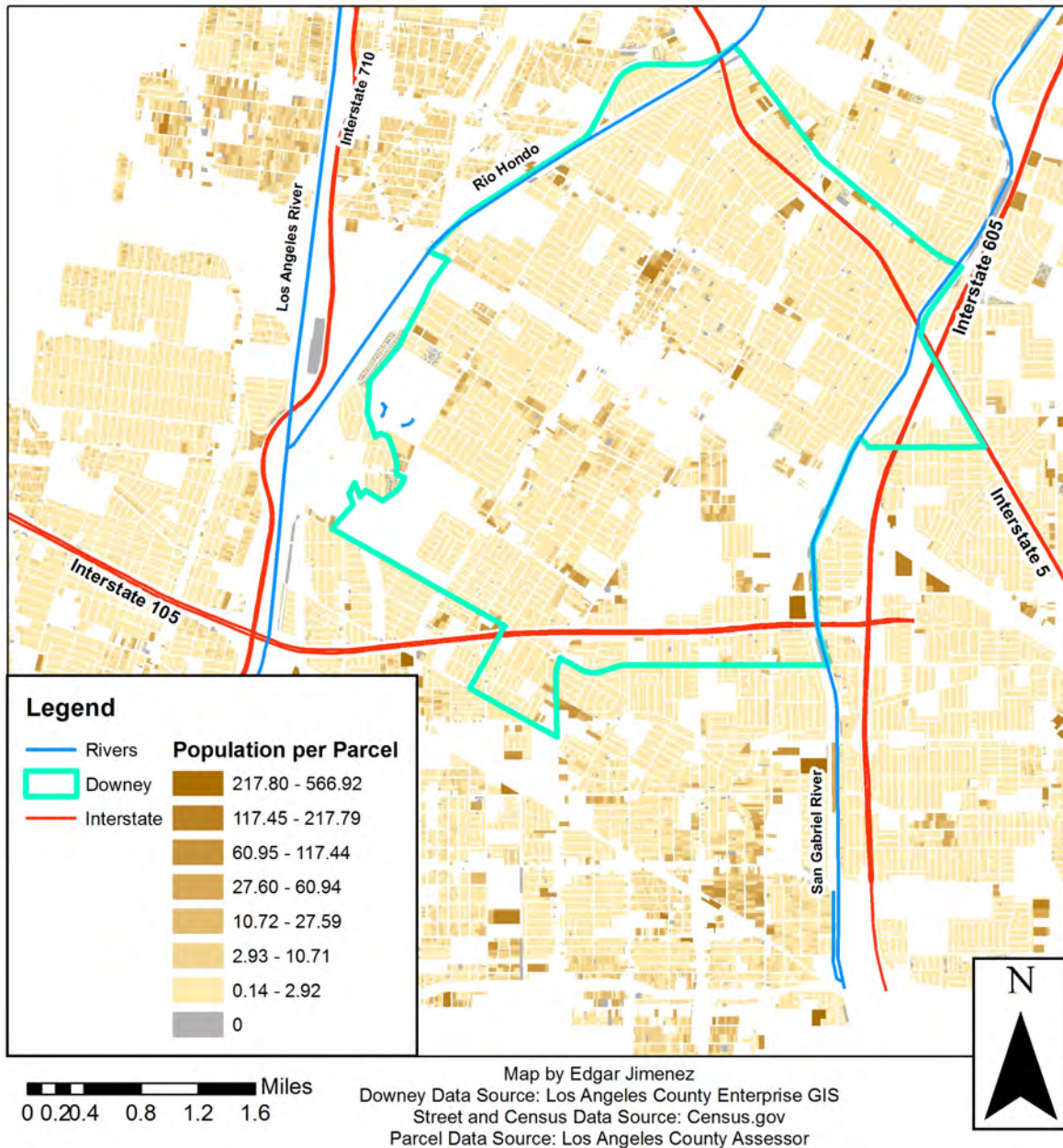


Figure 4 Downey Population Per Parcel

3.2 Collection of Amenity Data

Amenity data was collected for a total of 20 parks that were both in and immediately surrounding Downey. A polygon data set of land type data was downloaded from the LAeGIS data portal. The land type data set is maintained by LAeGIS but its sources are varied. The data itself contained many different types of polygons including but not limited to schools, businesses, and various government services. Within the attribute data was a classification scheme that was queried to isolate public parks from the data set. Other than the fields used for land type classifications and city, no other attribute data was needed for the analysis.

In order to account for any inconsistencies in park location or size, I verified all parks and park locations by referencing the City of Downey Parks and Recreation site and visually comparing the land type data to aerial imagery. Three parks (Temple, Discovery, and Treasure Island) were within Downey and were added to the dataset by referencing aerial imagery. As mentioned above, the study includes all parks outside of Downey's municipal boundary that fell within service areas for Downey parcels. These non-Downey parks whose service areas extended into the city were scored for amenities. Details on the service area analysis will be explained further in Section 3.4.

Table 1 lists all the parks, which were scored for amenities in the study along with the corresponding acreage and the city in which it resides. There were a total of 12 parks in Downey and 8 parks that resided in neighboring cities. The largest park in Downey is just over 24 acres, and the largest two parks are located just outside of Downey's boundaries in neighboring cities. Figure 5 depicts the distribution of park acreages listed in Table 1. The mean value for the parks was 13.2 acres with a standard deviation of 13.1. In Figure 5, the histogram shows a strong skew to the right with most acreage values falling below 20.

Table 1 List of Parks in Study Area

Name	Acres	City
John Anson Ford Park	52	Bell Gardens
Hollydale Park	39.3	South Gate
Wilderness Park	24.4	Downey
Rio San Gabriel Park	17.5	Downey
Furman Park	14.4	Downey
Independence Park	14.2	Downey
Thompson Park	13.9	Bellflower
Santa Fe Springs Park	12.8	Sante Fe Springs
Apollo Park	11.9	Downey
Discovery Sports Complex	10.7	Downey
Veterans Memorial Park	9.7	Bell Gardens
Golden Park	8.1	Downey
All American Park	6.5	Paramount
Dennis the Menace Park	4.7	Downey
Lakeside Park	4.0	Norwalk
Crawford Park	3.7	Downey
Treasure Island Park	3.2	Downey
Byron Zinn Park	2.8	Bellflower
Brookshire Children's Park	1.2	Downey
Temple Park	0.4	Downey

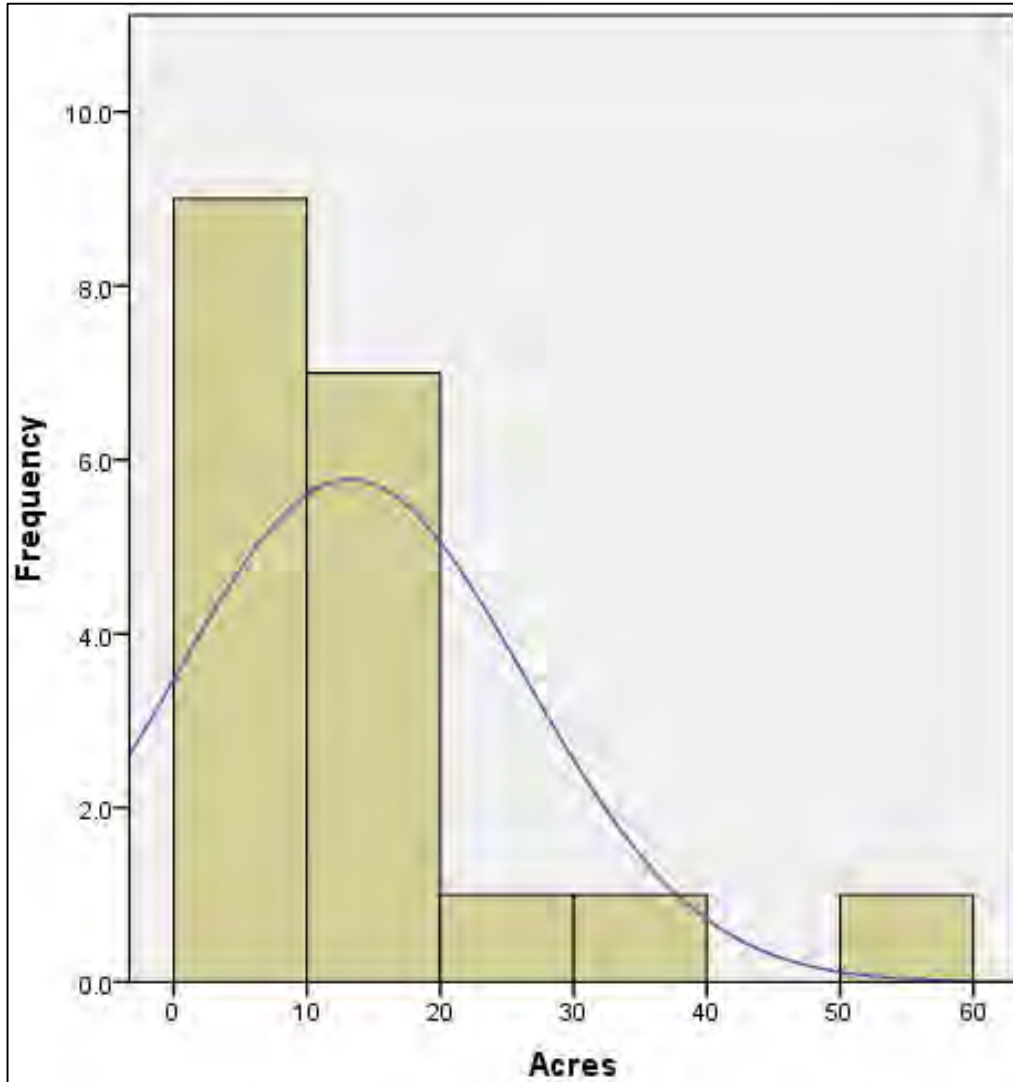


Figure 5 Histogram of Park Acreage Values

Before the collection of the amenity data could begin, an auditing instrument was selected to base observations on. The Physical Activity Resource Assessment (PARA) instrument was chosen as starting point for collecting data on park amenities (Lee et al. 2005; Suminski et al. 2012). PARA is an audit instrument that was designed to measure multiple types of facilities that provide physical activity opportunities for people. PARA's operational definitions and protocols (see Appendix A) provided a simple established framework for gathering data. The areas measured by PARA are generally divided into three different areas:

features, amenities, and incivilities. With the exception of the incivilities, these areas did not remain as operational categories for the analysis. Each survey item on the PARA instrument is presented as a four point Likert scale that ranges from 0-3

Preliminary data collection was done from October 23-24, 2015 between the hours of 11am-5pm. During this time, all 20 parks were surveyed for all the aspects listed in the original PARA instrument. Supplementary visits to audit additional aspects not included in the original PARA survey were done from November 1-2, 2015. The weather was between 65-75 degrees Fahrenheit with no rain during all collection times and there were no special community-wide events that occurred at any one particular park during the audit process that might have affected park use. In addition to the 49 categories listed on the PARA instrument, there were an additional seven survey items added for the purposes of this study (see Appendix B). The seven items added to the survey included physical activity areas, nature access amenities, and various types of disamenities that were not listed in the original PARA instrument. For the purposes of this study, the operational definitions of PARA were augmented to accommodate the park amenity scoring method used.

3.3 Park Amenity Scoring

The method used for scoring the amenities for each park necessitated a grouping of the individual PARA survey items and supplementary items. All the data surveyed from the parks was aggregated into four general categories: play, disamenity, physical activity (PA), and access to nature (NA). The Children's play (play) category covered park amenities such as playgrounds that would enhance park use for young children. The disamenity category measured incivilities such as broken glass and graffiti, which would discourage park use. The physical activity (PA) category covered those amenities, which would be utilized by older park patrons such as adult

size basketball courts and exercise equipment. The final category, nature access (NA), measured park amenities such as nature guide signage and amount of natural landscaping, which would satisfy patron’s desires to connect with nature. Each park contained some mixture of characteristics from each of these categories and none of them belonged exclusively to any one of them. The distance bands for service areas for each category were also different to account for the different types of access expected for each. A comprehensive look at the entire list of 56 items that were scored for each park is included in Appendix B.

Each category was scored based on a percentage of possible points. For example, the play category had a total of 12 possible points, which could be earned if a park scored a “3” for each of the 4 items that were measured. A park’s initial score for each category was determined by dividing the point’s earned in each category by the total possible points. This initial score (Sx) was then multiplied by the total acres (Pa) of the park to determine the number of category acres provided by a given park (Ax). These calculations are summarized in the formulas listed below.

$$Ax_{(i...j)} = Sx (Pa) \tag{3}$$

In this formula, Sx is alternatively the play Score, disamenity Score, PA Score, or NA Score. Calculating the disamenity-adjusted acres (Ad) required a further calculation that involved subtracting the disamenity acres (Ax) from the total acres (Pa) for each park.

$$Ad = Pa - Ax \tag{4}$$

Table 2 lists the category scores for each park in the study area along with the total possible points for each category. Generally, every park had a score for each category with the exception of Byron Zinn Park, which had no children’s play amenities. Because scores are relative within each amenity category, it is not appropriate to compare accessibility values across amenity categories.

Table 2 List of Category Scores for Parks

Park	Nature Points	Nature Score (Sx)	Play Points	Play Score (Sx)	PA Points	PA Score (Sx)	Disamenity Points	Disamenity Score (Sx)
All American Park	6	0.4	3	0.25	12	0.36	31	0.74
Apollo Park	1	0.07	9	0.75	25	0.76	23	0.55
Brookshire Children's Park	5	0.33	2	0.17	8	0.24	31	0.74
Byron Zinn Park	2	0.13	0	0	3	0.09	35	0.83
Crawford Park	2	0.13	2	0.17	6	0.18	33	0.79
Dennis the Menace Park	4	0.27	7	0.58	7	0.21	32	0.76
Discovery Sports Complex	5	0.33	3	0.25	13	0.39	38	0.9
Furman Park	6	0.4	7	0.58	26	0.79	33	0.79
Golden Park	3	0.2	6	0.5	15	0.45	34	0.81
Hollydale Park	4	0.27	4	0.33	15	0.45	28	0.67
Independence Park	2	0.13	5	0.42	15	0.45	26	0.62
John Anson Ford Park	7	0.47	10	0.83	25	0.76	30	0.71
Lakeside Park	1	0.07	2	0.17	8	0.24	35	0.83
Rio San Gabriel Park	4	0.27	5	0.42	18	0.55	34	0.81
Sante Fe Springs Park	4	0.27	7	0.58	14	0.42	24	0.57
Temple Park	4	0.27	3	0.25	3	0.09	42	1
Thompson Park	3	0.2	6	0.5	20	0.61	38	0.9
Treasure Island	7	0.47	4	0.33	7	0.21	36	0.86
Veterans Memorial Park	4	0.27	7	0.58	19	0.58	34	0.81
Wilderness Park	11	0.73	6	0.5	13	0.39	29	0.69
Total Possible	15	1	12	1	33	1	42	1

The play category consisted of items that would be predominantly utilized by children. This category consisted of items such as playgrounds, sand boxes, community centers, and wading pools. Community centers were the only item that was supplemental to the original PARA instrument. According to the PARA protocol, each item on the instrument was rated on a scale from 0-3, with “0” indicating complete lack of the amenity and “3” being an indication that the amenity is in excellent operating order. In addition to scoring whether equipment was in working order, this also considered size and/or number of the amenity. When considering community centers, both the size and components of the center that served children were

considered. An example of a community center with the value of “3” was one where there were advertised structured activities for young children along with facilities to house them. Minimal community centers, which were scored as “1,” advertised activity using only the existing open park area and any constructed facilities were only for the park staff.

Playground equipment was central to the play score. If playgrounds were in perfect working order but were very small relative to the rest of the park or had limited capacity, they were given a lower score. In Figure 6 there is an example of two different playgrounds, which would have both received a score of “3” on the original PARA instrument but were scored differently according to the adjusted standards for this study.



Figure 6 Furman Park Playground vs. Independence Park Playground

On the left in Figure 6 is an image of a playground at Furman Park and on the right is an image of a playground at Independence Park. Both parks are about the same size, but Furman Park’s playground is substantially bigger and can accommodate more children. In this case Furman Park received a score of “3” and Independence received a score of “2”. In general, the goal was to determine the relative amount of playground acres for each park by auditing the prominence of the playground in the park.

Due to the nature of the PARA instrument, the PA category was more detailed than the NA and play categories. In short, the PA category contained items that accounted for structured physical activities such as basketball courts, soccer fields, handball courts, and baseball diamonds (for complete list see Appendix B). As with the play category, the PARA protocols were augmented so that the survey considered both the condition and the prominence of the PA amenity within the park. The two items added to the PA category were horseshoe stations and handball courts. When surveying the PA items, special attention was paid to distinguishing areas designed for a specific activity from areas adapted for physical activities by the public. In Figure 7 there are two examples of PA use at different park facilities. The picture on the left is an empty field that is being utilized for a soccer game and on the right is a tennis court that has specifically been erected for this activity.



Figure 7 Improvised and Specifically Designed PA Amenities

In this example, the park with the empty field that was being utilized effectively as a soccer field received a score of “0” for that amenity since the people at the park are the ones who supplied the resource to utilize the space as a soccer field. However, the park depicted on the right did receive a score for the presence of a tennis court, even though the score was lowered to “1” because the net was broken and the court was in general poorly maintained.

The NA category largely consisted of additional items that were added to those used in the PARA audit. The intended purpose of the NA category was to quantify the accessibility to nature that is provided by public parks. Only two of the items in the PARA audit were used for this category: landscaping efforts and fountains. In each case the original protocols for the PARA audit were used. The supplemental items that were added to this category were access to the riverbed, nature guide signage, and tree coverage.

Due to value of the San Gabriel and Rio Hondo riverbeds as a natural resource, park access to river adjacent walking and bike trails was surveyed as an added value to park attendees who use parks to access nature. Since all the parks surveyed were not directly adjacent to revitalized areas of the riverbed, this type of nature access was simply scored a “1” if present and a “0” if absent. Interpretive signs for nature were only surveyed in a couple of parks in the study area. However, these warranted their own score because of the important role it played in assisting attendees in accessing nature. The scores for the nature guides ranged from a single informational sign (1) to a series of signs or activities through out the park (3). Nature guides, which were vandalized or not maintained, received reduced scores no lower than “1.”

In order to score the tree cover for each park, the iTree Canopy v6.1 web-GIS application was utilized (United States Forest Service 2015). The iTree Canopy software allowed for a convenient method for auditing tree canopies using aerial imagery. iTree Canopy requires an auditor to draw a closed polygon over an area of interest in an aerial image. The auditor is then asked to confirm or deny the presence of a tree on a specific location of an image that is randomly sampled by the program. Over the course of the sampling, iTree Canopy can reduce its error rate at predicting the percentage of tree cover in the area of interest.

Table 3 lists the iTree derived tree cover values and the corresponding standard error for each park in the study area. Each park was sampled in iTree Canopy 150 times or until the standard error fell below 4%. To determine the scores for each park, the mean of percent tree canopy coverage for all parks (Mean = 20.53%) was used as the mid point. All parks with tree canopy percent coverage lower than half a standard deviation (SD = 9.89) below the mean received a score of “1,” and all those with values at least half a standard deviation above the mean were given a “3.”

Table 3 Tree Amenity Values

Park	% Tree	% Non-Tree	SE	Score
All American Park	42.7	57.3	4.04	3
Apollo Park	11.7	88.3	3.9	1
Brookshire Children’s Park	22.5	77.5	3.96	3
Byron Zinn Park	14.6	85.4	3.9	1
Discovery Sports Complex	12.8	87.2	3.79	1
Crawford Park	8.6	91.4	3.86	1
Dennis the Menace Park	46.7	53.3	4.07	3
Furman Park	27.6	72.4	3.96	3
Golden Park	36.7	63.3	3.98	3
Hollydale Park	16.3	83.7	3.98	1
Independence Park	20.4	79.6	3.97	2
John Anson Ford Park	24.1	75.9	3.97	3
Lakeside Park	12.2	87.8	3.9	1
Rio San Gabriel Park	23.7	76.3	3.98	3
Sante Fe Springs Park	28.8	71.2	3.94	3
Temple Park	11.7	88.3	3.9	1
Thompson Park	12.2	87.8	3.61	1
Treasure Island	16.3	83.7	3.98	1
Veterans Memorial Park	22.6	77.4	3.9	3
Wilderness Park	19.4	80.6	3.9	2

When surveying the items for the disamenity category, the PARA protocols were followed very closely. Many of the disamenities were scored based on the number of times the items appeared. During each survey, the auditor spent between 20-40 minutes at each park depending on the size. The parks were surveyed over as large a span as was possible. Generally,

the disamenity category recorded items such as litter, evidence of drug use, graffiti, and noise pollution (for complete list see Appendix B). The only item that was added to this category was the presence of power lines, since power lines are obstructive to the enjoyment of the natural landscape of the park and limit the ability to use areas of the park. The prevalence of power lines on park grounds was scored depending on the severity of their intrusion.

3.4 Service Area Data Preparation

Service areas for this paper are defined as distance-based buffers calculated on publically accessible paths around a park. These depict the location of people who are more likely to utilize the resources of the park. Past studies have most commonly used 0.5 mile (Heckert 2012; Cohen et al. 2014; Greer et al. 2014; Parsons, A. A. et al. 2015) and 0.25-mile measures (Boone et al. 2009) to study either geodesic buffers or network-based service areas for parks. Often these distances were used as a general distance measure for park access that did not consider specific park amenity types. For this study, four different network-based service area distances were used to represent an intuitive sense of appropriate distances for residents to different types of amenities. Since parks could not be classified as anyone particular type of park each park was subjected to all the service area analysis and amenity scoring.

Each amenity category was given a specific service area distance that would best suit the parks intended use. The 0.25- mile service area distance was used for the play category as this was the shortest distance seen in past studies, and it is likely that parents need short travel distances for daily play activity for children to access park facilities. The 0.5-mile service area was used to measure the effects of disamenities on park access. Since the 0.5-mile service area is the most common used in park accessibility studies, this was the service area chosen to see how disamenities affect park access in a way that is most comparable to past studies. The 1.0-mile

service area was used for the PA category. This was chosen because the amenities in the PA category were more likely to be utilized by people willing to travel longer distances by foot, bike, public transit, or automobile. Finally, the 2.0-mile service area was utilized for the NA category. Unlike other L.A. County cities that may have deserts, mountains, or beaches close to them, Downey is in the midst of contiguous urban landscape and it reasonable to assume accessing natural landscape features of significant size might require some travel.

Based on the logic above, each parcel in Downey had scores for the different amenity categories calculated at different distances. Each service area distance had a baseline calculation done for each park to determine the acres per person (Ap). This provided a comparison data set for the amenity category acres per person (Ac) that was calculated. Table 4 lists the amenity type and the service area distance for the 8 calculations that were run for each parcel.

Table 4 Parcel Values for Each Service Area

Amenity Type	Service Area Distance
Acres/Person (Ap)	0.25-mile
Play Acres/Person (Ac)	0.25-mile
Acres/Person (Ap)	0.5-mile
Disamenity Acres/Person (Ac)	0.5-mile
Acres/Person (Ap)	1-mile
PA Acres/Person (Ac)	1-mile
Acres/Person (Ap)	2-mile
Nature Acres/Person (Ac)	2-mile

Before beginning the service area analysis for each park, the amenity data was added to ArcGIS. To do this, initial scores (Sx) based on the audit for each category for each park were calculated using Microsoft Excel and were exported into a .CSV file. The initial scores (Sx) were then joined to the park data set in ArcGIS based on the park names.

To represent access points on the network, the park data was then converted to point data using the vertex to point tool in ArcGIS. The park point data set was edited to only include points that were located or moved to points of park access. To determine access points for each park, a TIGER/Line street centerline data set was used. Using an aerial image as a base map for reference, each park access point was placed on the nearest street line feature. All parks within the 2-mile Downey buffer service area were included in the service area analysis. An initial service area analysis of all parks within the study area revealed that only 8 non-Downey parks contained Downey parcels within their service areas. All other non-Downey parks were included in the service area analysis to allow for more accurate service area population estimates but amenity scores were not needed.

The street data set was downloaded from the LAeGIS GIS data portal and had been previously checked for accuracy by LAeGIS. The data set was clipped so that only the data in the study area was used. The U.S. Census MTCC classification was used to query the TIGER/Line data to separate it into local streets, highways, interstates, railways, and private roads. Of the 5 MTCC classifications, only 2 had limited or no access for park attendees. Railways were not considered navigable routes for determining park access. Interstates were only considered navigable for the 2-mile service area since automobiles are required to navigate them. Though highways can be classified as limited access in some cities, in Downey all state highway routes were lined with sidewalks and were easily accessed. Each one of the street data classifications was then exported into separate shape files and combined into a feature data set. Local roads consisted of all other publically accessible roads smaller than state highway routes. Finally a network data set was built from the feature dataset with points at the end and intersections.

3.5 Service Area Analysis

The service area analysis tool on the ArcGIS 10.1 Network Analyst extension was run for each service area distance. In each use of the tool, the park access points were loaded in as facilities and the analysis settings were set “towards the facility.” Service area polygons were set not to overlap, instead each polygon would go to the nearest facility. This process is similar to the Theissian polygon method used to generate service areas in previous studies (Sister et al. 2009). Service areas for the 0.25-, 0.5-, and 1.0-mile distances were only based on local street and highway network access. The 2.0-mile distance included interstate routes of travel since the two-mile travel distance makes it more likely that public transit or car travel would be used. Figure 8 shows the results for the 0.5-mile service area distance used for scoring disamenities. In the figure both the highways and local streets are depicted as streets and interstates are visualized for reference. Service areas were created for all parks within a 2-mile buffer of Downey. Only parks with service areas that entered or immediately bordered Downey were retained for the study and were scored for amenities.

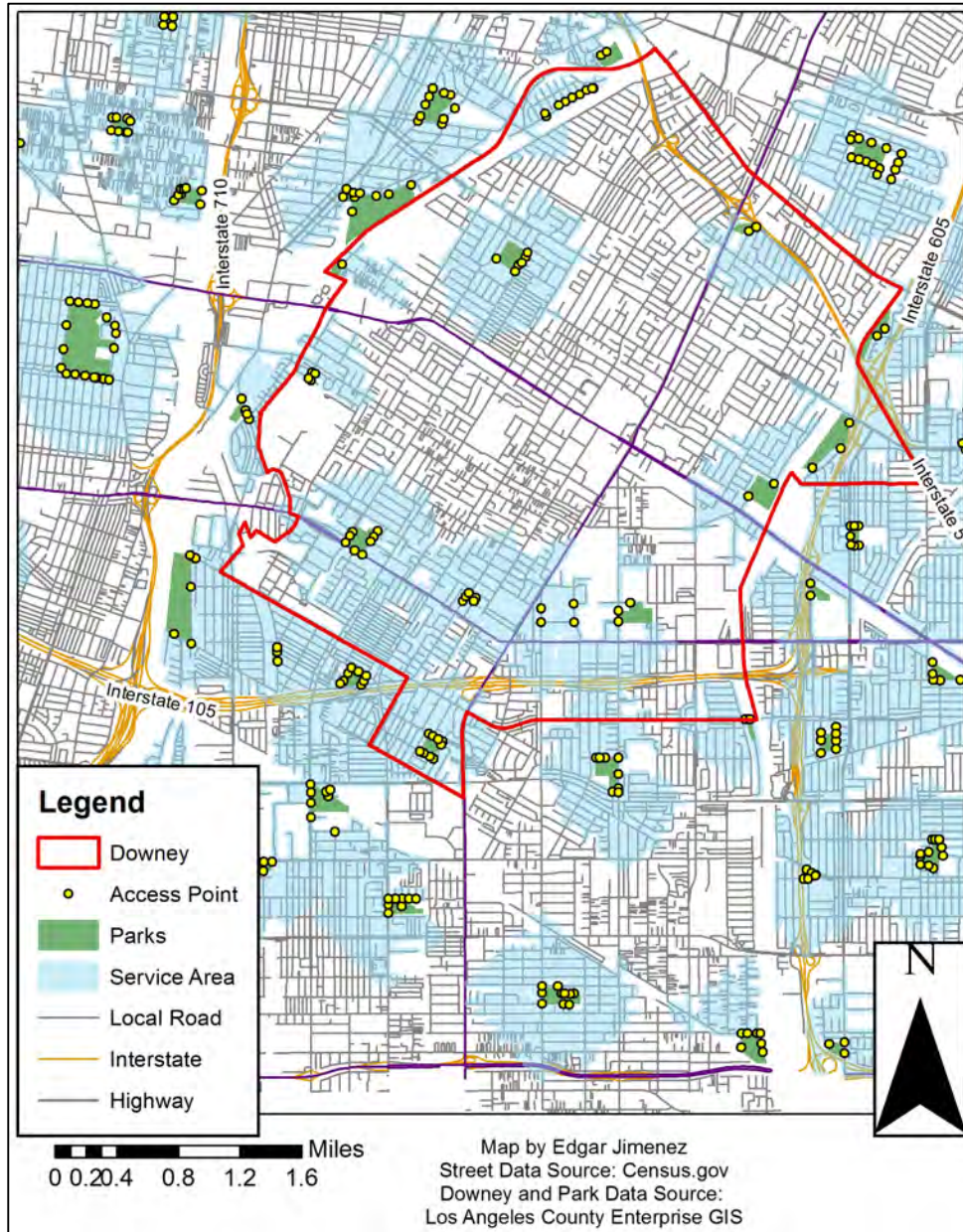


Figure 8 Half-Mile Service Area Results

The next step was to associate parcels with each park’s service area. Once the service area tool was run, the resulting polygon data set was exported to its own shape file. Each service area data set was run through the dissolve tool in ArcGIS with the name of the park used as a dissolve field. The dissolved polygons were then used to select land parcels through the select by location tool. This allowed the creation of separate parcel data sets for each service area

buffer. In each case where service area polygons cover the same parcel, the parcel is allocated based on the location of its center. Only at the distance of two miles are all the parcels in Downey mostly covered by at least one service area.

Calculations for the four service area distances were done in an identical fashion. In each case a spatial join was done to assign each parcel in a service area to a park service area. A summary statistic was then performed to sum the total population of each residential land parcel (Pp) within a service area, using the park name as a case field. The resulting table provided the total population per service area (Ps) for each park. This data was then joined to the polygon park data set to perform the final calculations.

Using the Ps and the acreage (A) of each park, the acreage per person (Ar) was found for each park. Equation 5 below explains how park acres (A) were divided by the total population in its service area (Ps) to determine a park's acres per person (Ar). The same calculation was done for each category by replacing the acreage of the park with the category acreage (Ax), or disamenity adjusted acreage (Ad) to find the category acreage per person (Ac). The formulas below summarize the calculations used to derive both the Ar and the Ac.

$$Ar_{(i...j)} = A/Ps \quad (5)$$

$$Ac_{(i...j)} = Ax/Ps \text{ or } Ad/Ps \quad (6)$$

Since all of the amenity scoring data was previously attached to the park data set, all calculations were done using the field calculator. Once the acres per person (Ar) and category acres per person (Ac) were calculated for each service area that data was spatially joined to the service area parcels and visualized for analysis.

3.6 Conclusion

The methods used for this study involved dasymetric mapping, amenity scoring, and service area analysis. The results of the dasymetric mapping and amenity scoring were both needed to complete the final service area analysis. Dasymetric mapping provided detailed population values at the parcel scale that helped calculate accurate service area populations. Amenity scoring provided category values that allowed for the adjusting of a parks standard acre per person calculation. In the next chapter, the results of each of the service area analyses outlined in Table 4 will be discussed in greater detail.

Chapter 4 Results

When examining park accessibility in Downey from the perspective of residential parcels, it becomes very apparent that park accessibility is not geographically uniform. Generally, Downey's parks are located on the city's periphery. The larger parks maintained by Downey such as Wilderness, Golden, and Furman parks are located at the edges of the city. Generally, this places the service areas of the large parks away from the densely populated areas of the city that are located in the geographic center. Further, some of the parks that serve Downey's residents that are located closer to the city's border or belong to adjacent cities are less accessible to Downey's residents because of restrictions posed by the Interstates and waterways.

The following chapter explores the results of the service area analysis in more detail. The chapter looks closely at what information was obtained from each service area (SA) analysis distance (0.25-mile, 0.5-mile, 1-mile and 2-mile). Each distance is discussed in terms of how effective it is in covering the residential parcels of Downey. There is also an exploration of how park amenity scoring affects parcel accessibility for each SA distance.

As can be expected, it was found that the shorter the distance for the service area threshold, the more parcels were left out of a service area. Table 5 lists the total number of residential parcels in Downey, along with the percentage of parcels that were covered by a service area for each distance. In total there are 22,029 residential parcels in Downey.

Table 5 Percent Downey Parcels for each Service Area

Service Areas	% Accessible Parcels	% Non-Accessible Parcels
0.25- mile	13%	87%
0.5- mile	39%	61%
1-mile	84%	16%
2-mile	97%	3%

When looking at the parcel coverage for each service area it became apparent that the greatest gains in coverage occurred when increasing the service areas to 0.5-mile and 1.0- mile.

Increasing the service area to 0.5-mile raised the total parcel coverage 26%, and increasing the service area to 1.0-mile further raised total coverage by 45%, such that at 1.0-mile 84% of the city’s residential parcels had park access of some kind. Doubling the service area threshold to 2.0-miles only further raised total coverage by only 13%, but was sufficient to grant park access to nearly 100% of Downey’s residential parcels. The parcel coverage is only a brief insight into park accessibility in Downey; the following chapter will reveal the results of the four service area analyses in more detail.

4.1 Quarter Mile Service Area

The quarter mile service area had the lowest parcel coverage and had no overlapping service areas. There were 2,597 residential parcels covered by the 14 Downey parks and 2 parks from a neighboring city. Byron Zinn Park and All American Park in neighboring cities respectively provided 4.1% and 3% of Downey parcel coverage for the 0.25-mile service area.

Figures 9 and 10 show the distribution of acre per person and play acre per person values for the 0.25-mile service area. In both distributions the values were skewed to the left. The mean

value for the 0.25-mile acre per person service area parcels was 0.037 acres per person with a standard deviation of 0.13. The mean for the play acre per person values was 0.018 play acres per person and the standard deviation was 0.059. As expected, the factoring of the play score reduced accessibility across all parks and reduced the mean. The difference in the variance between the two data sets can be explained by the reduction of scores for larger parks. Using the standard acre per person scoring methods, large parks received high scores based solely on their size. When adjusting large park acreage scores for play amenities, scores were reduced. An example of this can be seen with Wilderness Park, which had 0.38 acres per person but only 0.19 play acres per person.

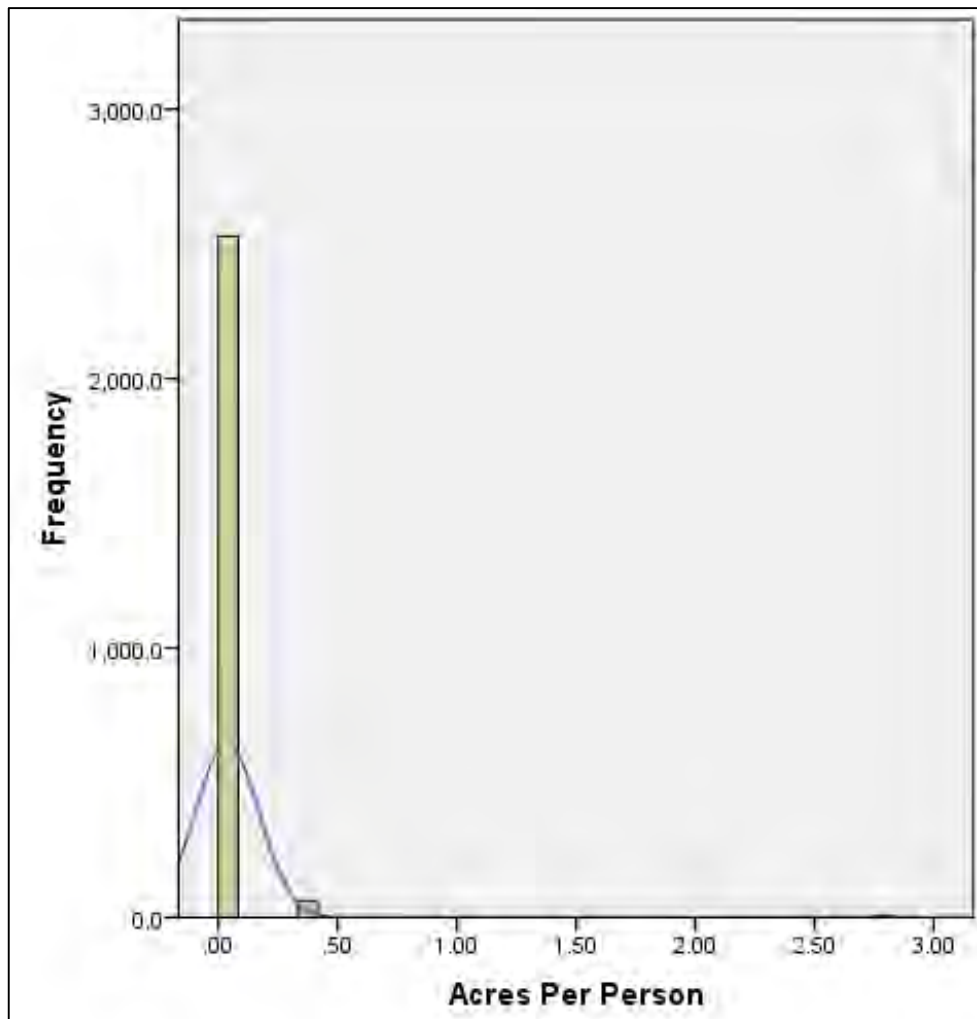


Figure 9 Histogram of 0.25-Mile SA Parcel Values

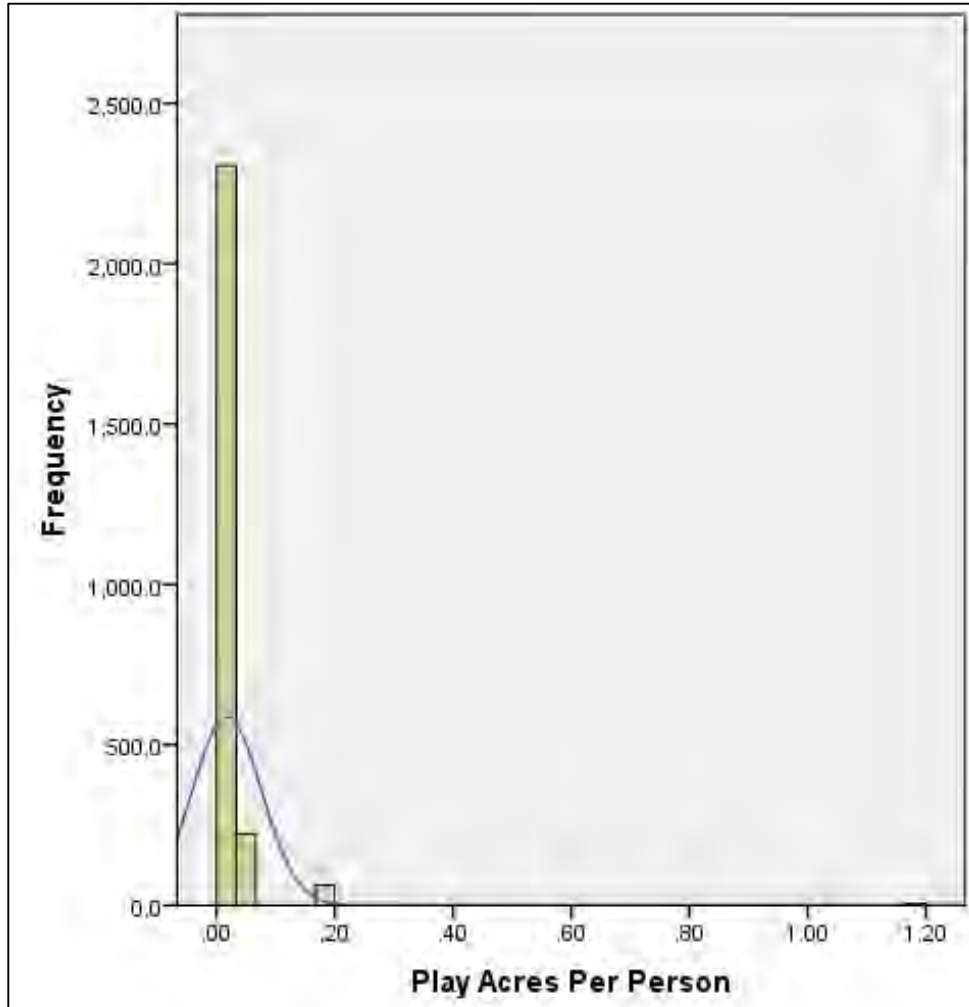


Figure 10 Histogram of 0.25-Mile Play Acre SA Parcel Values

Figure 11 depicts the parcel scores for acres per person for the 0.25-mile park service area on the left and parcel scores for the play acres per person on the right. The maps are visualized with seven interval classes determined by natural breaks and a separate class for all parcel values with “0.” Looking closer at the parcel coverage for the acre per person map, clustering can be seen in the southern part of the city with the service areas of Golden, Brookshire, and Apollo Parks. These three parks serviced just under 40% (1,013) of the total residential parcels covered with the 0.25-mile service areas. Most of the other parcel coverage is distributed in the periphery in the northern and eastern parts of the city. Independence and

Wilderness are two parks with relatively high acre per person values (0.38 Wilderness and 2.78 Independence). In both cases the high value can be attributed to the lack of access by surrounding residential parcels. The Rio San Gabriel River and Interstate 605 restrict Wilderness Park's access, while Independence Park is less accessible because non-residential land parcels mostly surround it.

Most all of the parcels covered by the 0.25-mile service area had access to 0.00029 – 0.23 acres per person. The scoring of parks for 0.25-mile children's play amenities (play) accessibility can be seen in Figure 11 on the right. Though the majority of parcels still fall within the same range as the acre per person map, there is a noticeable difference in parcel coverage. Brookshire, Temple, and Byron Zinn Park all have play acre per person scores, which were below 0.0001 acres per person (1 acre per 1,000 people). When looking at contributing factors, Bryon Zinn Park's score was "0" because it had no children's play amenities. In the cases of Brookshire and Temple parks, the play acres per person score were so low because of the size and condition of the amenities in the park. This result is particularly interesting because Brookshire Park is one of the few parks located toward the center of Downey and it serves a densely populated area of the city. All other parcels, which were serviced by parks with in a 0.25-mile service area, had access to at least 0.0018 play acres per person.

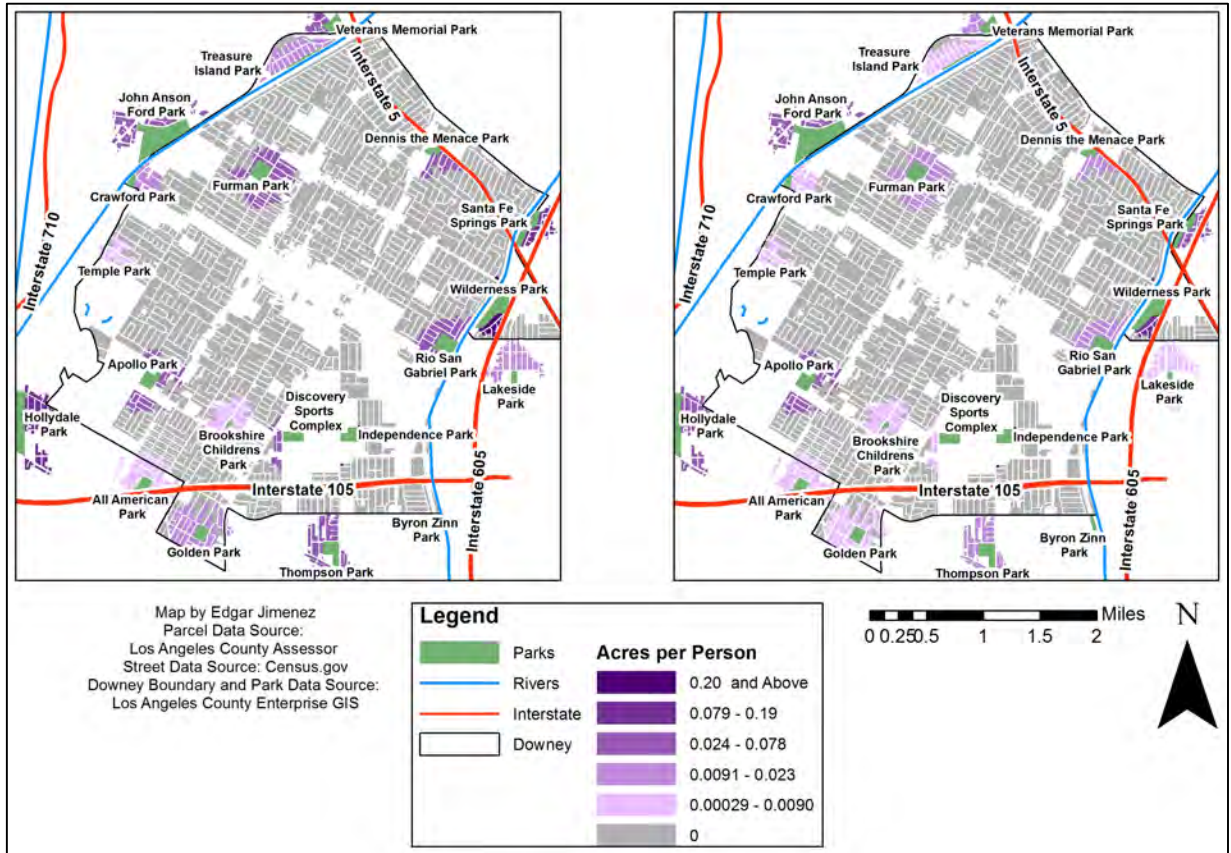


Figure 11 Parcel Values for 0.25-Mile Service Areas

4.2 Half Mile Service Area

As was previously listed in Table 5, the 0.5-mile service area distance saw a large increase in parcel coverage compared to the 0.25-mile service area. At 0.5 miles, park service areas began to overlap with each other; this meant that parcels were assigned to the nearest park. The 0.5-mile service area distance is one of the most commonly used in park accessibility studies (Heckert 2012; Cohen et al. 2014; Greer et al. 2014; Parsons et al. 2015). For this reason, the 0.5-mile service area distance was used to measure the changes disamenities have on accessibility. As expected, the increased service area distance caused parcel coverage to increase but parcel acres per capita values to decrease. There were a total of 8,322 residential parcels covered by the

0.5-mile park SA; non-Downey parks in adjacent cities serviced just fewer than 13% of those parcels.

Figure 12 depicts the distribution of parcel values for 0.5-mile park service areas. The same left skewing data distribution is seen again, though the skew relative to the normal curve is not as dramatic as for 0.25-mile access. The mean acre per person parcel value was 0.0091 and the standard deviation was 0.015. Comparing this to the distribution of disamenity-adjusted acres in Figure 13, it can be seen that the leftward skew of the data remains but values have generally decreased. The mean value for the disamenity-adjusted acres was 0.0068 acres per person and the standard deviation was 0.01.

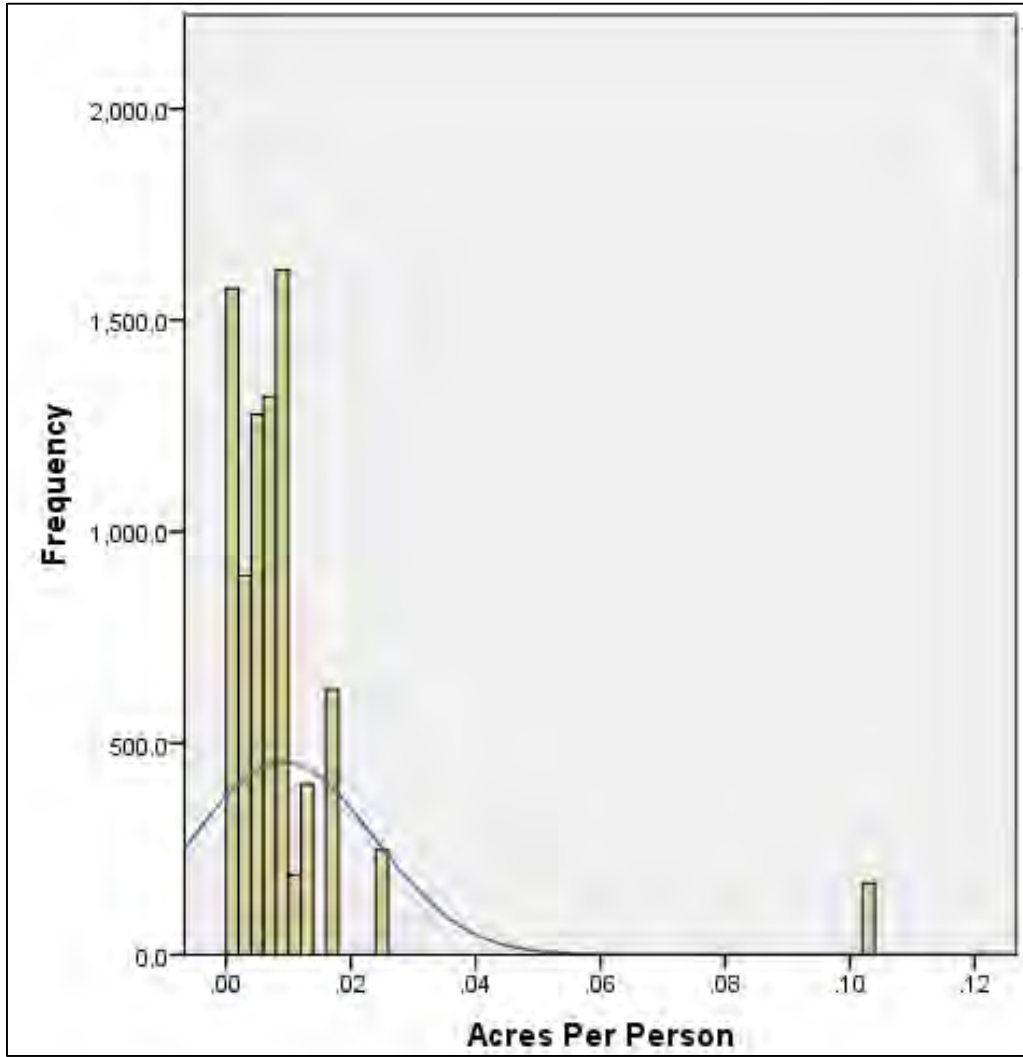


Figure 12 Histogram of 0.5-Mile SA Parcel Values

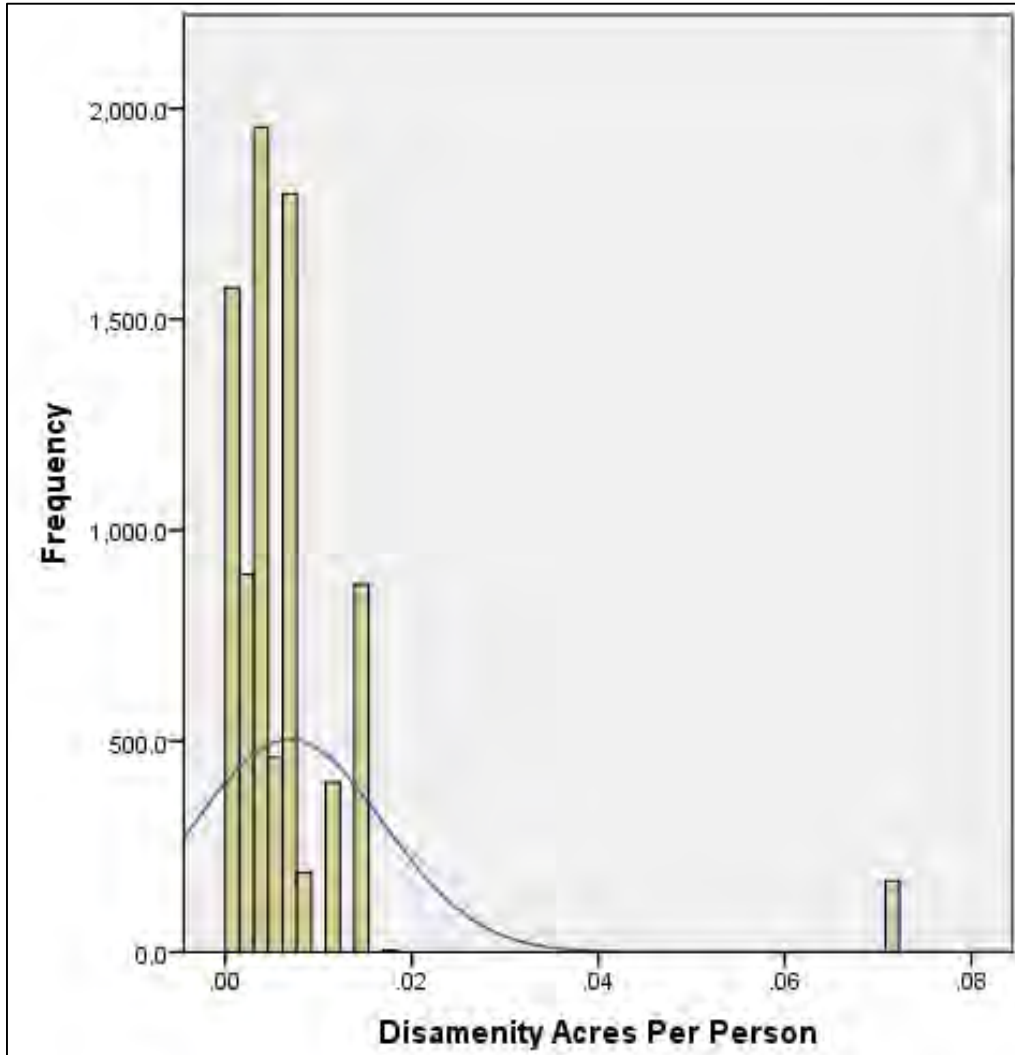


Figure 13 Histogram of 0.5-Mile Disamenity Adjusted SA Parcel Values

Figure 14 depicts both the mapped parcel values for 0.5-mile acre per person SA and the 0.5-mile disamenity acre per person SA. For each map, the parcels visualized with seven interval classes determined by natural breaks and a separate class for all parcel values with “0” value. Unlike the 0.25-mile analysis, there were no parks whose disamenities were so great that they provided “0” disamenity adjusted acres per person. The clustering of park service areas in the south of Downey is more prominent in the 0.5-mile SA analysis. There are three parks in Downey that service more than a third of all parcels covered in the 0.5-mile SA analysis.

Brookshire and Apollo Park in southern Downey both service about 13% of the parcels each while Furman Park in the north services 14%. This is important to note because Furman Park has a larger area than Brookshire and Apollo Park combined. When comparing parcel values, it is clear that accessibility is unequal as those parcels serviced by Brookshire Park have access to 0.0007 acres per person and those by Furman Park have 0.0096 acres per person.

Apollo, Independence, and Wilderness Parks were amongst the lowest scoring parks when it came to adjusting for disamenities. The parcels in Apollo Park's SA had a reduction from 0.0065 acres per person to 0.0035 disamenity adjusted acres per person. This drop in score was mostly due to the large amounts of graffiti and litter observed at the park. Both Wilderness and Independence Park also had high observations of disamenities, however the lack of parcel accessibility at the 0.5-mile distance meant that their scores were not as visibly noticeable in Figure 14. In the case of Independence Park, there are a low number of residential parcels located in its SA this causes high acre per person values for those parcels that are in its SA. Wilderness Park is a different situation because access is limited due to the presence of the San Gabriel Riverbed and Interstate 605, as both present obstacles to easily accessing the park. On average there was a 77% reduction in acres per person after adjusting for disamenities.

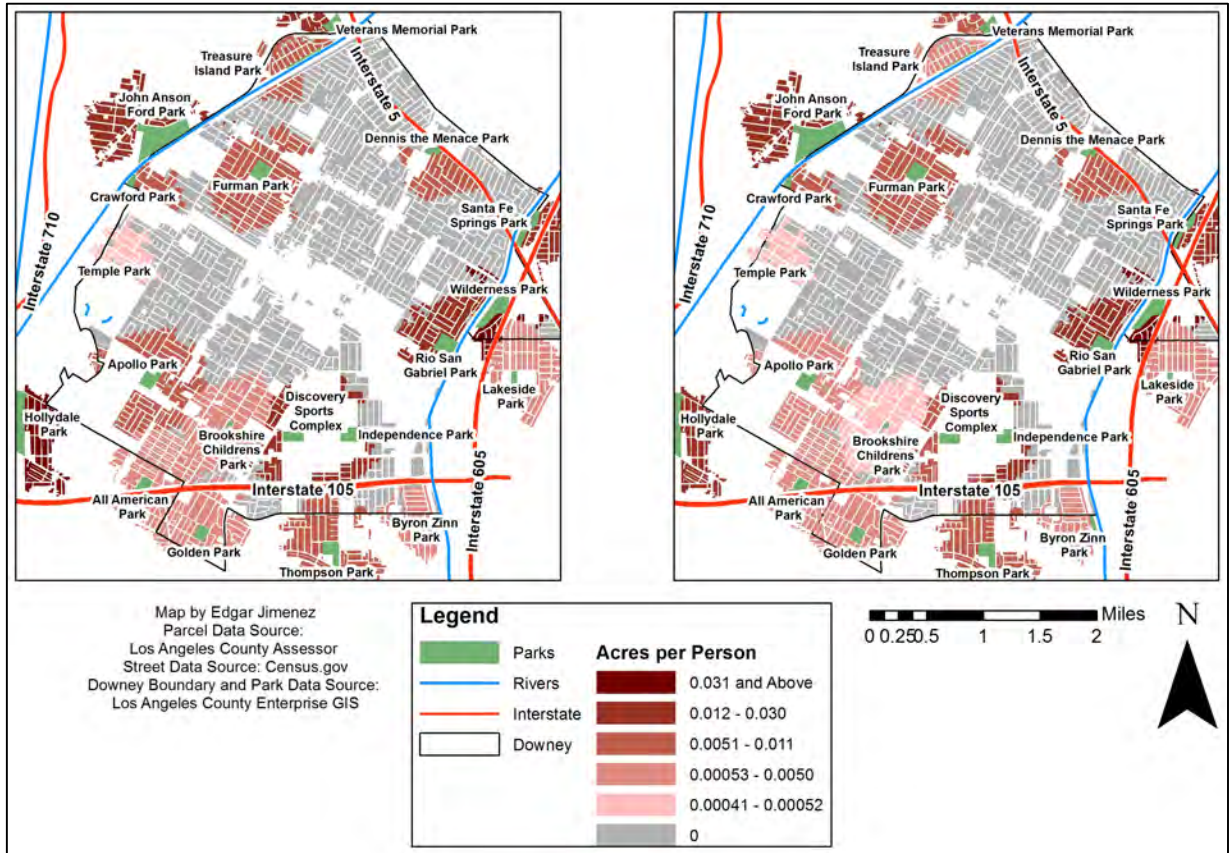


Figure 14 Parcel Values for 0.5-Mile Service Areas

The results of the 0.5-mile SA analysis also revealed details about how Downey parcels are serviced by facilities of neighboring cities. Bryon Zinn and Thompson Park provided a combined 4.9% of the Downey parcel coverage for the standard 0.5-mile SA. This is an interesting occurrence because Byron Zinn and Thompson Parks are maintained by Bellflower but their 0.5-mile service areas extend into an area that is not serviced by a Downey park. Figure 15 provides a more detailed look into the service areas of Byron Zinn and Thompson Park. The specific area of Downey serviced by these two Bellflower parks is particularly susceptible to accessibility problems. The building of Interstate 105 in the 1990's interrupted many local streets that would have normally connected this part of the city to Independence Park.



Figure 15 Detail of Byron Zinn Play Acre 0.50-mile SA

4.3 One Mile Service Area

The 1-mile SA encompasses nearly all the parcels in the city of Downey. Though the 1-mile SA distance is not as commonly used in park accessibility studies, the increased distance was thought to account for those people in Downey who would be willing to commute longer distances to participate in communal physical activities, like baseball or soccer, or to utilize publically available resources for exercise and recreation (e.g., swimming pools). As before, the increase in SA size caused a shift in the data distribution and mean parcel value. Of the 18,305 parcels, about 9% was serviced by non-Downey parks.

Figure 16 and 17 show both the data distributions for the 1-mile acre per person and PA acre per person parcel values. The mean parcel value for the 1-mile SA is 0.0045 acres per

person with a standard deviation of 0.0062. When the parcel values are adjusted for the physical activity (PA) category, the values for the data set generally decrease. The mean parcel value for the PA acres 1-mile SA is 0.0019 acres per person with a standard deviation of 0.0026. Both data sets show a strong leftward skew but there is substantially more variance in the acre per person values compared to the PA acre per person values.

The lack of variance in the PA acre per person values can be explained by the specificity of physical activity amenities located at some parks. An example of this can be seen when comparing Rio San Gabriel and Apollo Park. Rio San Gabriel Park saw a large reduction in its PA service area values compared with its general 1-mile SA values because it had only a baseball and basketball amenity. Though each amenity was in good shape there were few amenities compared to Apollo Park, which had some PA amenities in disarray, but there were a wide variety of facilities. This reduced the SA value differences between the two parks from 0.0081 acres per person to 0.0038 PA acres per person.

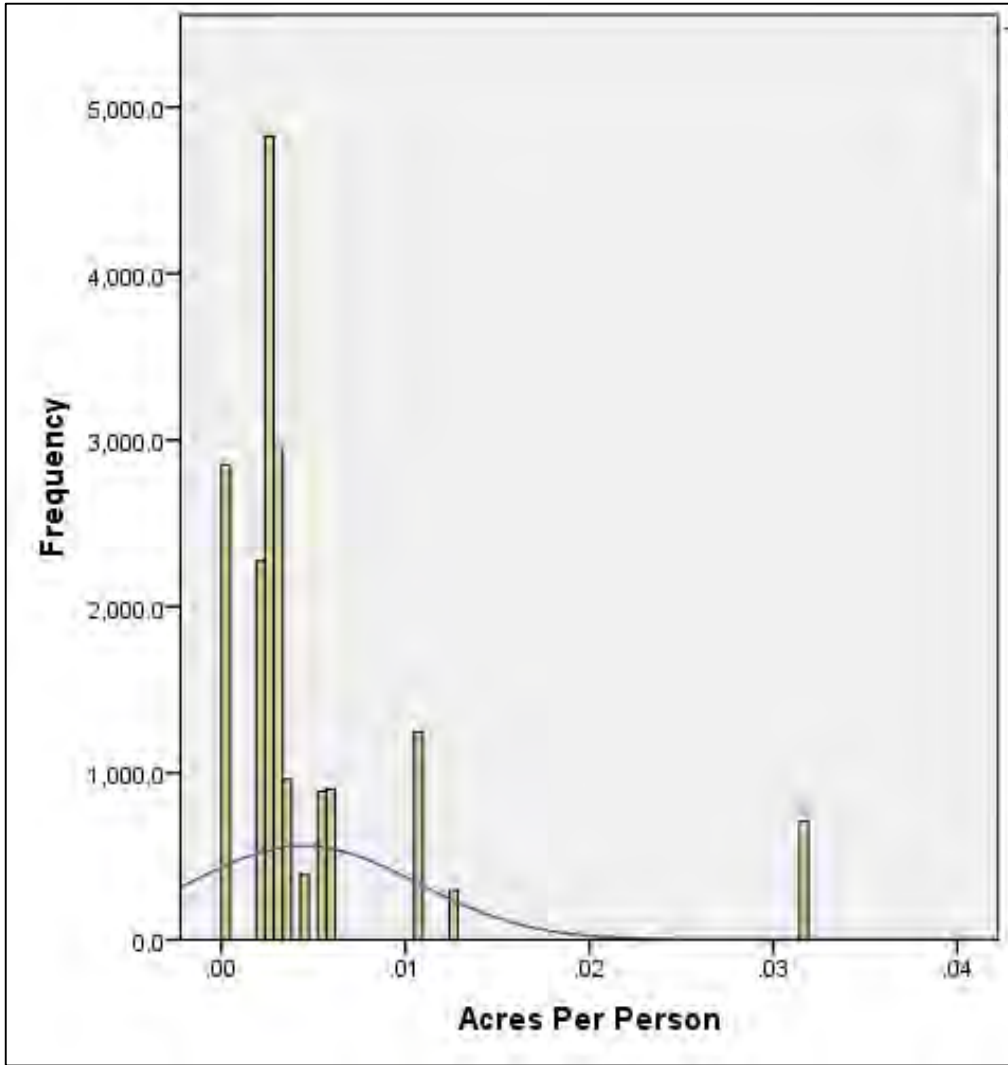


Figure 16 Histogram of 1-Mile SA Parcel Values

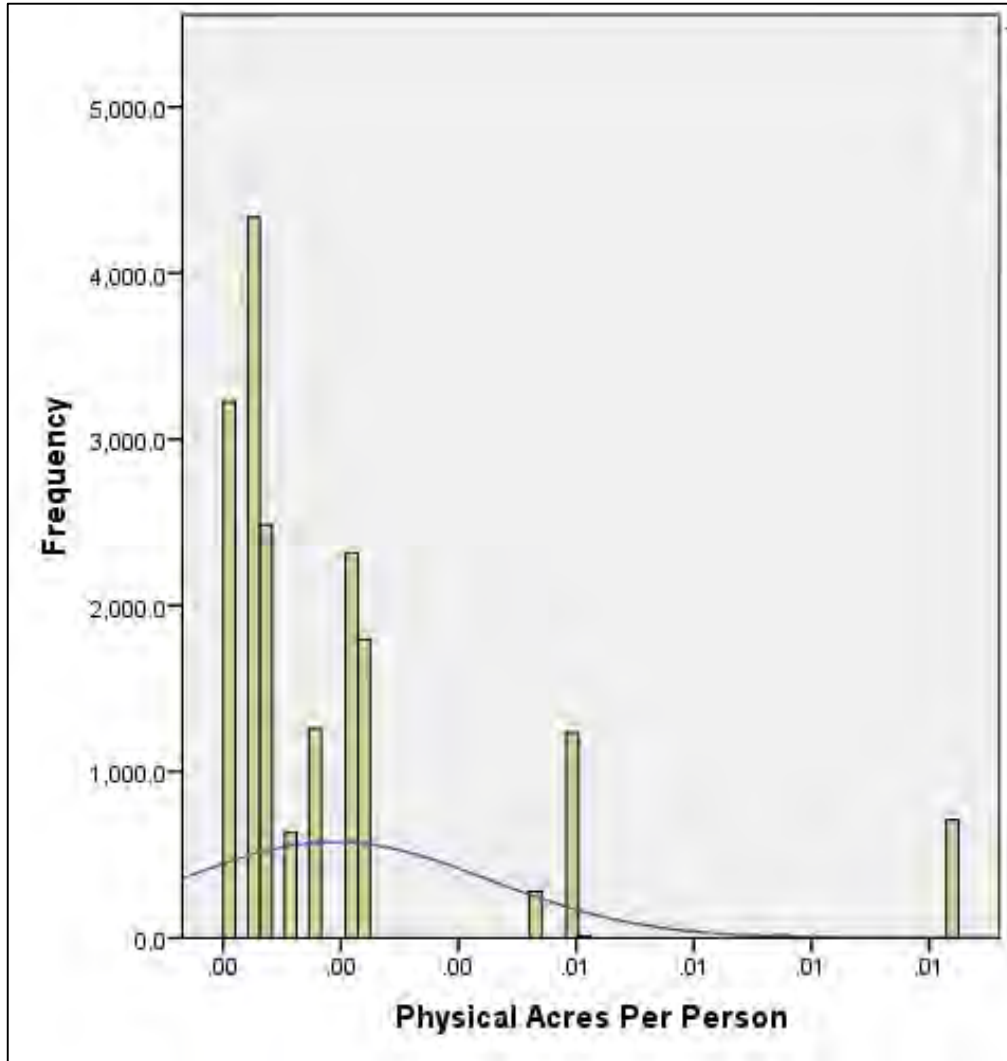


Figure 17 Histogram of 1-Mile Physical Activity Acre SA Parcel Values

Figure 18 depicts both the spatial distribution of parcel values for the 1-mile acre per person and PA acre per person data set. Both data sets were visualized with seven interval classes determined by natural breaks and a separate class for all parcel values with a “0” score. Compared to the prior SA distances, the clustering of coverage in the south of Downey was not as prominent compared to coverage in the north. When reviewing the map on the left of Figure 18, there is a clear clustering of high parcel values in the east of Downey. This is because the parcels on the east side of Downey are serviced by three of the four largest parks in Downey:

Wilderness, Rio San Gabriel, and Independence Park. It is also clear that the service areas for Temple, Dennis the Menace and Brookshire Park are much lower than the surrounding parks. This is directly attributable to the fact that all 3 parks are highly accessible at the 1-mile SA distance but they are relatively small compared to other Downey Parks.

When the maps are compared, two immediate differences are noticed. First, most parks saw a sharp reduction in the acre per person score. Brookshire, Temple, and Treasure Island Parks provided the least amount of PA amenities compared to other Downey Parks. The SA of just Brookshire and Temple Parks accounted for 15.6% (2,852) of total overall parcel coverage. In the case of Brookshire Park, this was a significant reduction in PA acres values because it occurs in a densely populated area of the city. The second difference noticed when the maps were compared, was the continued clustering of parcels with higher values on the east side of Downey. The presence of the high values in this area of Downey is attributed to the large size of the 2 parks and the small amount of residential parcels in their SA.

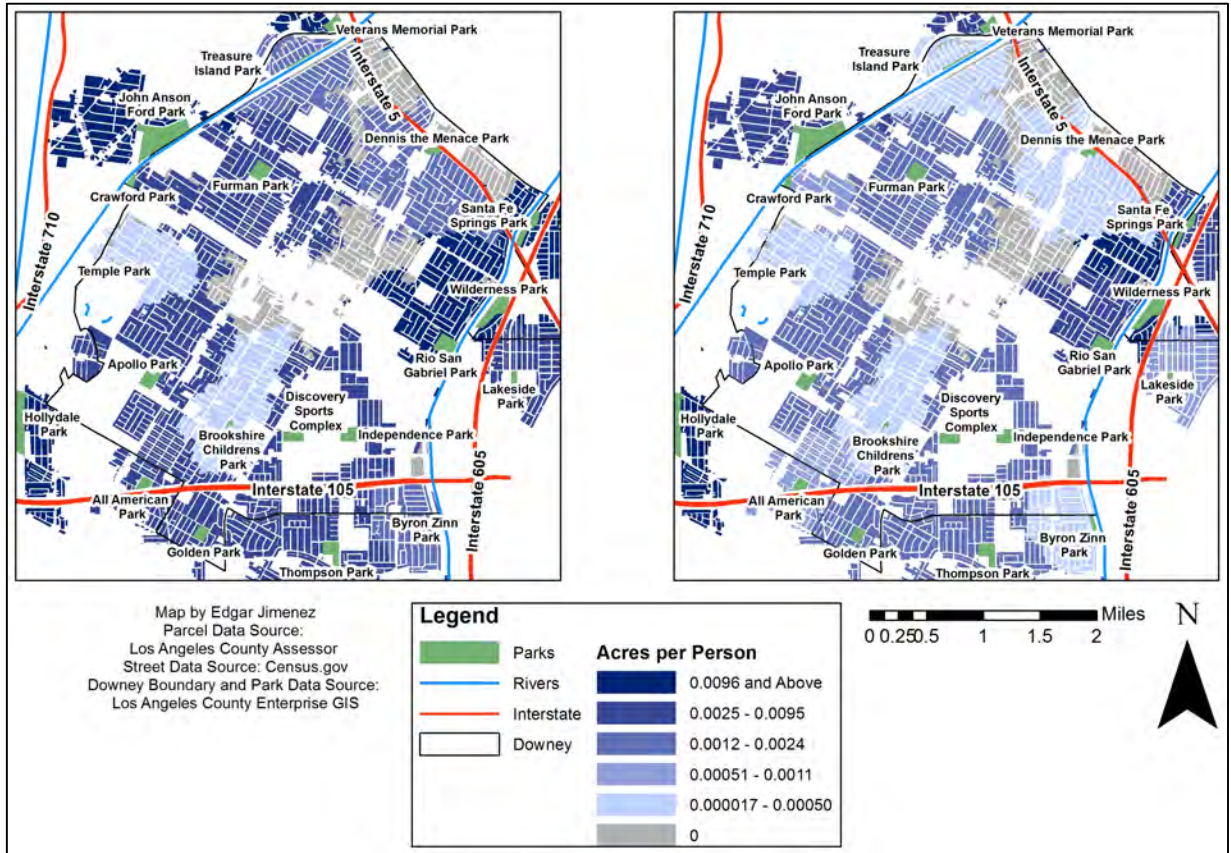


Figure 18 Parcel Values for 1-Mile Service Areas

4.4 Two Mile Service Area

The final SA distance encompassed nearly all the parcels in the entire study area. The 2-mile SA distance was assumed to reflect the amount a reasonable person would commute to access large naturalized landscapes in an urban environment. As a result of the 2-mile distance threshold, this final SA analysis contained the largest data set. Of the 21,167 parcels in Downey that were covered by the 2-mile SA, 9.5% (2,016 parcels) were serviced by non-Downey parks.

Figure 19 shows the distribution of the parcel values for the 2-mile SA analysis. The mean value was 0.0038 acres per person and the standard deviation was 0.0056. Following the trend of the previous data sets the distribution of the parcel values is skewed to the left, although for the 2-mile SA very few parcels (728) have no access at all (i.e., “0” scores). Figure 20 depicts

the distribution of the parcel values for the NA acres per person SA analysis. After adjusting for the NA category, the values skewed even further to the left when compared with the basic 2-mile SA. Furthermore, the mean parcel value decreased to 0.0014 NA acres per person and the standard deviation was 0.004. Compared to the 0.5-mile acre per person and 0.5-mile PA acre per person SA data sets, the variance change between the 2-mile acre per person and 2-mile NA acre per person was not as pronounced.

When closely inspecting the park auditing data, it is clear that parks in Downey either thrived or were severely lacking in this amenity category. This can be seen easily when looking at Treasure Island and Wilderness Parks. Both parks were created with the idea of accessing nature by including native vegetation, nature guides, and integration with a near by riverbed. Since these were the only two parks in Downey that seemed to be designed in this way, their high scores made surrounding parcels high outliers for nature access.

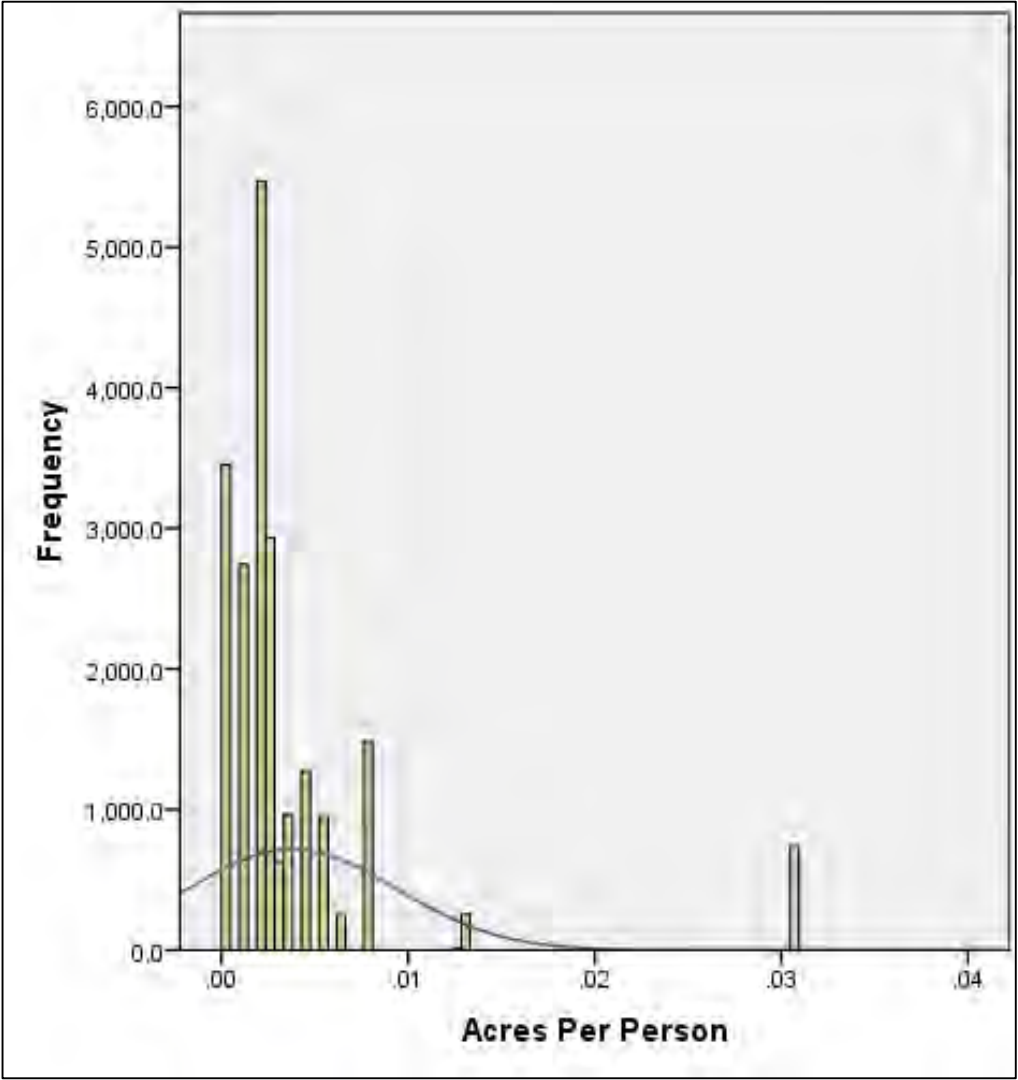


Figure 19 Histogram of 2-Mile SA Parcel Values

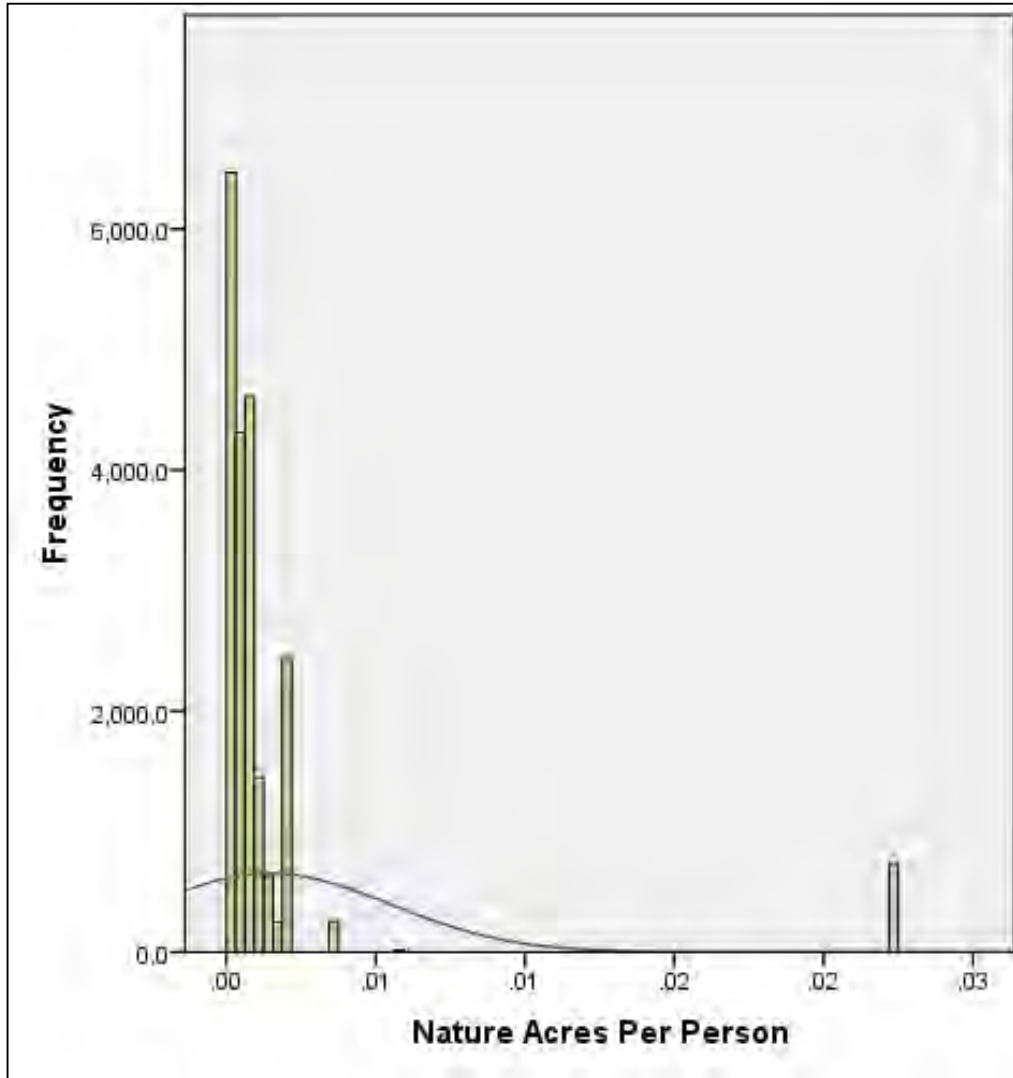


Figure 20 Histogram of 2-Mile Nature Acre SA Parcel Values

Figure 21 depicts the spatial distributions of parcel values for the 2-mile SA analysis. An immediate observation from the standard acre per person map on the right of Figure 21 is that there is still a clustering of high parcel values on the east side of Downey. It is also worth noting that at the 2-mile SA distance all the residential parcels in the geometric center of Downey are within a SA of a park. Another valuable observation is the lack of coverage in the small area of Downey north of Interstate 5. Outside of the eastside of Downey, Golden Park and Crawford Park are the only parks that provide relatively high acre per person values in surrounding parcels.

As was seen in the previous amenity SA analysis, Brookshire and Temple Park lack any NA amenities. The result of this is a drastically reduced NA value for Downey parcels in the south and the east. In this instance, both parks accounted for 16.3% (3,450) of the parcel coverage for the 2-mile SA analysis. Another point of interest when comparing the two maps is the change in the scores for Rio San Gabriel Park. In the initial 2-mile SA analysis, parcels surrounding the Rio San Gabriel Park and Wilderness Park were able to maintain a relatively higher acre per person value compared to the rest of Downey. After adjusting for the NA amenities Rio San Gabriel Park's SA became more in line with the values for the rest of the city while Wilderness Park maintained its relative high value. This change can be attributed to Rio San Gabriel Park's low NA amenity score (0.20) compared to Wilderness Park (0.60). Both Crawford and Golden Parks NA acre per person values also fell to values for in line with other Downey parks.

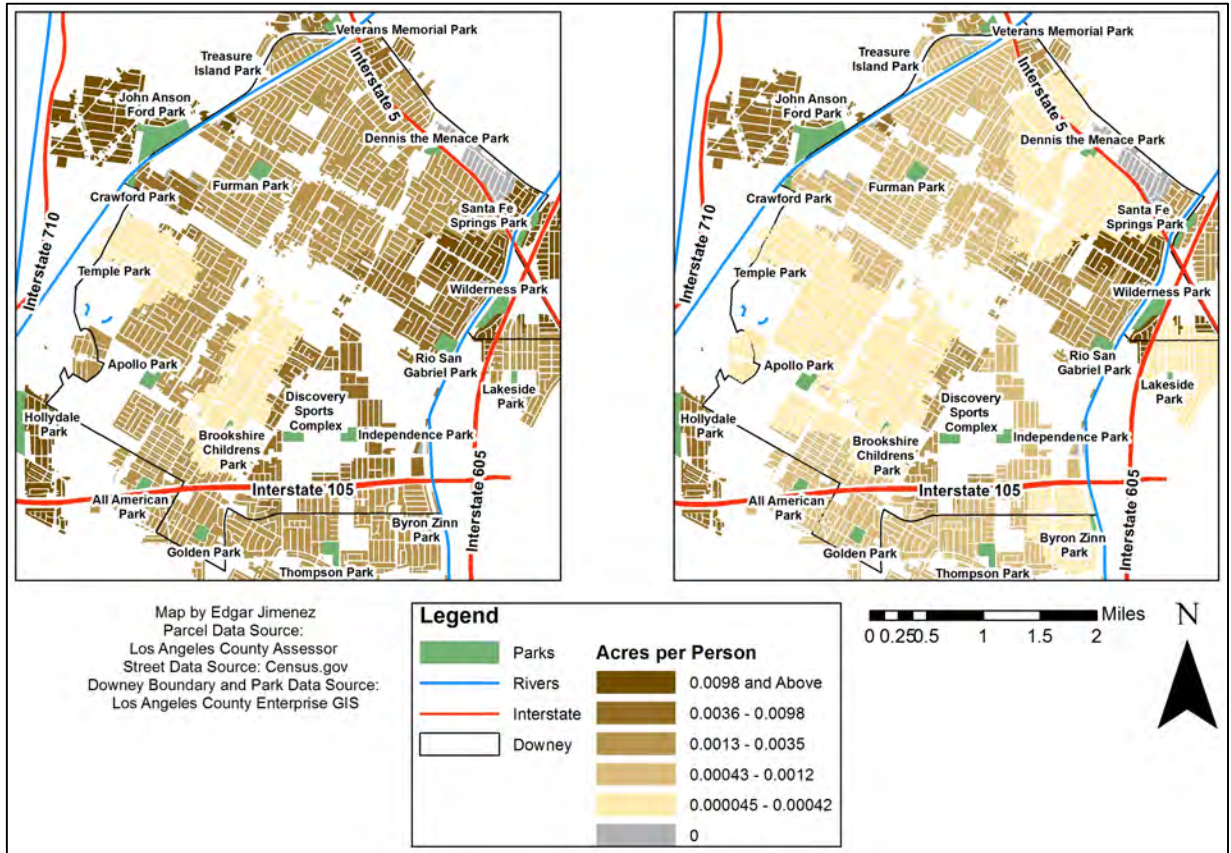


Figure 21 Parcel Values for 2-Mile Service Areas

One final observation was made for the 2-mile SA analysis. Throughout the analysis, there were many observable cases in which non-Downey parks assisted in SA coverage for Downey land parcels. Also, during the final 2-mile SA analysis there was a clear case of a Downey park servicing parcels outside of the city. Figure 22 shows a detailed spatial distribution of the Wilderness park 2-mile SA.

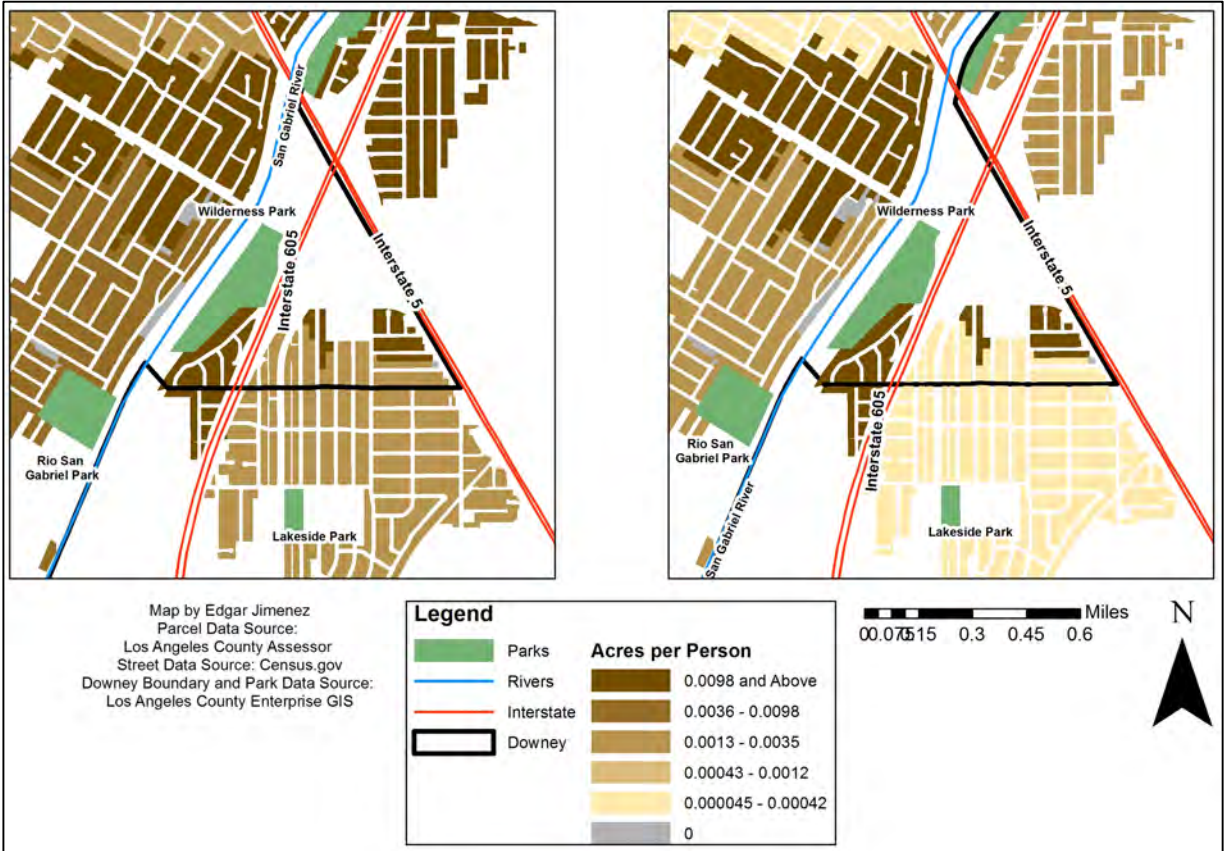


Figure 22 Detail of Wilderness Park Nature Access 2-Mile SA

Wilderness Park was the only Downey Park that had relatively high parcel values for the 2-mile SA analysis. Consequently, it turned out that it was one of the few Downey parks that serviced parcels outside of the city. The parcels with high scores to the south of Wilderness Park are actually in the City of Norwalk. This is notable because in the case of Wilderness Park, it was shown that access was limited at all of the SA distances. Wilderness Park is the largest park in Downey and to find that it is less accessible to Downey residents than those in a neighboring city is quite interesting.

In general the results of the multiple distance SA analysis revealed that areas closest to the geometric center of the city are more likely to face lower park accessibility. After visual inspections of the spatial distribution of the park service areas, it was also found that the south side of Downey has a tighter cluster of park service areas. However, when amenity scores were

integrated into the analysis it was further revealed that parks which provided coverage for dense settlement areas in Downey often did not have sufficient amenities to serve all types of park use. In the next chapter the implications of these results for Downey and the approach taken here for studying park accessibility is discussed in more detail.

Chapter 5 Discussion and Conclusion

The intention of this study was to develop a method to measure the difference in individual land parcel accessibility to parks and park amenities. In order to achieve this, a combination of dasymetric mapping, amenity scoring, and service area (SA) analysis was used. Each individual step in the methodology of the study discussed in this paper was inspired by previous work and in some cases was altered to account for previously unaccounted for aspects of accessibility.

Parsons (2015) served as the inspiration for the dasymetric mapping method used for this study. Of the three steps previously mentioned, dasymetric mapping was the method that was most closely replicated from previous research. Parsons (2015) previously documented the effectiveness of this same type of limiting variable dasymetric mapping. Eicher et al. (2001) provided a well-tested methodology for redistributing census block data population. The built in Service Area Analysis tool in the ArcGIS 10.1 Network Analyst extension also provided a trustworthy method for determining parcels which were serviced by the parks of Downey.

The combined use of the Service Area Tool and Parsons (2015) methods for dasymetric mapping was further developed in this study by incorporating multiple distance thresholds for the service areas and a park amenity scoring system. Using multiple service area thresholds allowed for a closer analysis of how accessibility is affected by different types of park use. The use of the augmented PARA audit instrument allowed for the measurement of park characteristics, which satisfied portions of Mehta's (2013), five benefits of public space. As previously mentioned in chapter 1, Mehta's (2013) five benefits of public space include: inclusivity, support of meaningful activity, pleasurable, safe, and comfortable. The use of the PARA instrument allowed for the measurement of park facilities that support meaningful

activity, pleasure-ability, and safety. The method by which the auditing items were categorized also provides a methodology that can easily be augmented for diverse local needs (Kabish et al. 2015).

The following chapter discusses in more detail the effectiveness of the methods utilized, the implications of the results, and suggests new directions for future studies. Sections 5.1-5.3 are each dedicated to discussing the results for the population mapping, SA analysis, and amenity scoring done for this study. Each of these sections investigates the effectiveness of the method in the context of the study and any augmentations, which proved to be improvements over past research. Section 5.4 contains an introspective critique on the limitations of the study and potential improvements. Finally, Section 5.5 discusses suggestions for future research on park accessibility.

5.1 Population Mapping

The dasymetric mapping methodology used for this study had various benefits that have not been utilized generally in previous research on park accessibility. The research done by Lara-Valencia et al. (2013) provides the most common example of traditional population estimates that use large neighborhood scale aggregations. This type of population mapping could be deceiving in a small analysis scale study such as this. Figure 23 depicts a detailed map of the residential parcels surrounding the Discovery Sports Complex and Independence Park. As can be seen in the map, large portions of the potentially serviceable areas of the parks contain no residential parcels.

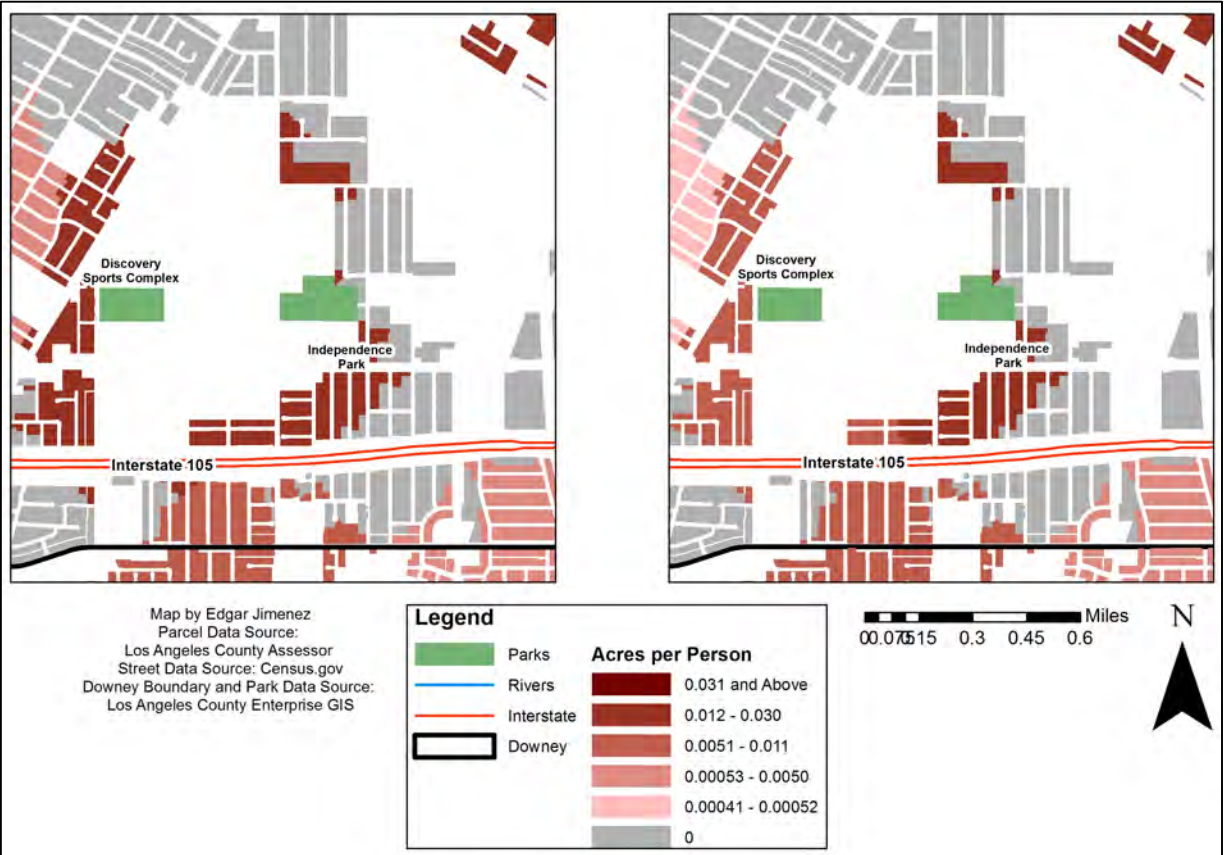


Figure 23 0.50-Mile Service Areas for Discovery Sports Complex and Independence Park

Aggregating population data to census block group or larger would not properly represent the service area for these 2 parks. If census block group data was used the population within the SA of Discovery Sports Complex and Independence Park would have been artificially inflated. This is due to the fact that census block polygons overlap both residential and non-residential parcels. The aggregation of the population numbers within a census block would have given population values even for large areas that have no residential parcels. Other Downey parks that are adjacent to similar non-residential areas are Rio San Gabriel Park, which has a large commercial area to its south, and Apollo Park, which has a non-residential area to the west.

When considering future park developments, the City of Downey should consider carefully the surrounding residential area. In the case of the parks mentioned above, accessibility

might be improved by increasing pedestrian access through non-residential zones to public green space. One way that this can be done is through the development of more bike paths. The 4 parks mentioned above are all easily accessible from either Imperial highway or Firestone Boulevard. Both of these streets are main transportation routes through the city that do not have dedicated bike paths. Investing in bike paths along these routes could help increase accessibility to parks that are not immediately surrounded by residential areas.

The methods used in this study also improve upon previous dasymetric mapping used in previous studies. Some studies of green space and other urban phenomena have previously used building square footage as means to disaggregate population data (Oh et al. 2007; Morar et al. 2014). This approach has the potential for error because the disaggregation of population data based on building square footage cannot account for a buildings use or homes that have large land plots. By using the housing unit values of each land parcel, the dasymetric mapping methods used in this study provide a more accurate assessment of potential population distributions based only on plots that are designated for residential use.

5.2 Service Area Analysis

The way in which SA analysis was utilized for this study also expanded upon previous work. The network analysis approach used in ArcGIS 10.1 allowed for a more realistic model of park accessibility than prior research that used geodesic distance buffers (Boone et al. 2009). Even in cases where past studies used network analysis to determine accessibility, data aggregated to the level of a census tract inhibited the ability to look at neighborhood aspects of park accessibility (Heckert 2012). Since specific population values existed for each land parcel, the SA analysis methods used in this study provided more detail on how a given parks serves its citizens. This is an improvement compared to prior research that uses only simple binary values

for population (Langford et al. 2006) or measures distances from parks to housing units without considering population (Apparicio et al. 2006).

Though large parts of this study were inspired by the methods of Parsons (2015) research in Wake County, NC, augmentations to the final accessibility analysis helped prevent the processing challenges posed by Origin Destination Matrix analysis. By utilizing multiple distances in the SA analysis tool, this study allowed for a more efficient use of computer processing power. Using variable distances for the service areas also allowed for an efficient examination of where there were gaps in park coverage depending on differential use. Using this method allowed for the comparison of how citizens of Downey with differing thresholds of acceptable park distance might be serviced. An example of this can be seen when comparing the 0.25-mile and 0.50-mile service areas of Downey parks.

The difference in parcel coverage between the 0.25-mile and 0.50-mile service areas shows how parks may not be serving communities as well as intended. When considering that the 0.25-mile SA covered only a third (5,598) of the parcels covered by the 0.50-mile SA (14,972), it becomes clear that accessibility is highly dependent on the intended use of the park. Parks such as Furman, Rio San Gabriel, Crawford, Dennis the Menace, Brookshire, and Golden parks represent the best locations for 0.25-mile access because mostly residential areas surround them. Consequently, a large portion of these easily accessible parks is located in the northern part of Downey. It is only at the 0.50-mile level that the SA for the Downey parks in the south starts to show better coverage. This lack of coverage can be explained by the increased amount of commercial and industrial areas in southern Downey. Future park developments, however, should make it a priority to create smaller parks, similar in size to Crawford Park or Brookshire Park with in highly populated residential areas in south Downey.

5.3 Amenity Scoring

One aspect shared by most of the previous research on park accessibility is a lack of attention to how park amenities and disamenities affect accessibility. One of the key enhancements used in this study was its integration of park amenity scoring. In a previous study by Weiss et al. (2011), disamenities were mapped as a density field across the study area using kernel density cluster. This method used incidences of ‘incivilities’ such as traffic accidents and murder to model the negative forces that would discourage people from using a particular park. The methods used for this study were much more direct in that disamenities were recorded at and attributed to specific park locations.

The use of the PARA audit instrument greatly assisted in the amenity scoring because of its simple structure and its ability to record the quality or severity of an amenity or disamenity (Lee et al. 2005; Greer et al. 2014). The way that each category of the audit was scored also allowed for easy expansion to add supplementary items and categories. The addition of the NA category also improved upon previous research with the PARA instrument, which focused mainly on constructed park amenities (Lee et al. 2005; Greer et al. 2014).

Ibes (2015) research on park accessibility to park types in Arizona was a starting point for creating the methodology for this study. However, where Ibes (2015) created a typology for all the parks in the study area, this study embraced the idea that each park in Downey shared similar aspects of 4 main categories. This resulted in the ability to compare all parks based on an amenity category. This insight allowed this study to reveal parks such as Brookshire Park, which provides no amenities for PA or NA to any of the parcels in its SA. This methodology also revealed that parks such as the Discovery Sports Complex and Crawford had relatively higher SA capacities than neighboring parks, because of their lack of disamenities.

Future park development in Downey should consider how park facility improvements affect accessibility. One example of this is the clustering of natural access amenities in northern Downey parks. Both Wilderness and Treasure Island parks scored high in NA and both are located in the northern part of the city. While other Downey parks may have had a large amount of tree canopy coverage, it was only Wilderness and Treasure Island Park, which had nature guides and the most notable signs of purposeful landscaping.

Another aspect of amenity scoring, which could be considered by the City of Downey, is the way in which public schools service residential communities. Downey's schools, though not open for general public use, often make their fields available on weekends and after school for organized youth sports. Since some of these youth athletic organizations cost money to participate, it may be interesting to investigate how public school facilities might be made available for free to supplement the lack of park accessibility.

5.4 Limitations and Improvements

Areas in which this study is limited or can be improved involve, quality, quantity, and the collection of the data used for the analysis. When considering the road network data used for this study, it is important to note that not all routes of travel were included in the network analysis. Though the study included all modes of transportation used by cars it did not consider bike lanes.

Though Downey does not have an extensive bike lane network, most of the Rio Hondo and San Gabriel riverbeds maintain a biking and running path on either side of their banks. Adding these routes of travel proved to be difficult because complete bike route data for the city was unavailable. Time and resource restraints also did not allow for the creation of such a data set. Other road network limitations include the lack of data on roads without sidewalks. This data

would have been helpful in determining potential barriers to pedestrian travel for shorter distance service areas.

It is worth noting that bike lanes also were not scored as part of the PA amenities category. However, the access to riverbed bike lanes at particular parks was scored as a NA amenity because it improved access to naturally redeveloped portions of the riverbed. While many of the parks in this study did not have bike lines within them, some were near bikes lanes that traverse the riverbeds. Not scoring the access to bike lanes as a PA amenity is a further limitation of this study that can be improved.

Other limitations to this study involve the generalized items that were included on the auditing instrument that measured amenities. Some examples of this include unique facilities such as batting cages and skate parks. Facilities such as these were only noted in single locations; because of this, it was difficult to consider the value of such a unique park amenity in the study area. Another aspect of amenity scoring which can be improved is the method in which amenities were scored. Specifically, the methods for scoring play grounds and other spatially variable amenities could be improved by using actual measurements. For example, a similar method as was used for tree canopy coverage could be used to determine the percent of playground coverage. Future studies should investigate methods such as these.

When considering disamenities, it is also important to mention that not all factors were equal. An example of this would be the disamenity scores for brown grass and overgrown grass. In general Downey's parks had very little overgrown grass, but areas of dead grass were much more prevalent. It was, however, hard to determine if this was truly a disamenity because Downey had recently posted signs explaining the rationing of water mandated by the California Governor in 2015 due to a record-setting drought.

Figure 24 shows the clearly posted sign that was present at most Downey parks explaining the occurrence of dead grass. The dead grass disamenity accounted for only 3 of the possible 42 disamenity points for the category. Though it affected all the parks equally, it did cause a general reduction of disamenity-adjusted acres for all parks. These same signs were not posted in parks scored outside of the city, so non-Downey parks did not necessarily suffer from the same disamenity.



Figure 24 Downey Restricted Watering Sign

Other factors, which were not considered in the disamenity scoring methodology, included the lack of acknowledgement of amenities specifically aimed to counteract park incivilities. Figure 25 depicts a call box that was located at Hollydale Park in the neighboring city of Bell Gardens. The effect of an emergency call box's presence on park attendees may counteract disamenities but was not considered in this study.



Figure 25 Emergency Call Boxes

5.5 Future Directions

When looking ahead to future studies on park amenities and its effects on accessibility, data on demographics, service rates, and gravity analysis should be explored. By studying park accessibility, this study hoped to discover more about unrecorded inequalities in park access. In order to advance the ideas of this study, future studies should look at the possibility of integrating demographic data along with population data. The importance of integrating demographic data in areas such as income and race will help explore potential unequal accessibility patterns, which can greatly contribute to the growing research on environmental justice.

Another area that should be explored is the differing service rates of park amenities. In a recent publication, NRPA (2015) discussed the potential for their Park and Recreation Operating Ratio and Geographic Information System (PRORAGIS) to calculate national sourced county

benchmarks for park amenities. Using this data could provide possibility to compare service areas for specific park amenities against national statistics. Since PRORAGIS is still in development this research did not consider it when studying park amenities. Future research should consider integrating this data as a comparative metric for measuring park amenities.

Finally, future research should explore new GIS methods for measuring accessibility at larger distance thresholds, where service areas are likely to overlap. For example, gravity analysis provides a way to model the potential of a person in one park SA to go to another. Gravity analysis works from the premise that possible interactions between parcels and facilities decrease as the distance between them increases (Ttth and Kincses 2015). However, this potential interaction also increases depending on the size and quality of the facilities (Ttth and Kincses 2015). In terms of park access this means that larger parks and parks with more attractive amenities have a higher likelihood of servicing people at farther distances than smaller parks. The advantage to using gravity analysis is that service or ‘market’ areas have fuzzier boundaries, as opposed to models that assign people to the closest service area (Eck and Jong 1999). Gravity analysis is most often used in determining service areas for retail establishments and often they involve the modeling of ‘resistance’ factors that would help explain why someone would not participate in the nearest SA (Eck and Jong 1999; Ttth and Kincses 2015). For parks, such “resistance” factors might include the sorts of disamenities measured in this study.

5.6 Final Conclusions

The results of the combined dasymetric mapping, service area analysis, and amenity scoring have shown that accessibility can be affected by park quality. Though there are still adjustments that can be made to the exact methods used in this study, the importance of park amenity scoring has been exemplified. As more detailed methods are developed for modeling

park accessibility in an urban environment, this study has shown that it is important to consider the quality of parks that are accessible.

Enhancing or acquiring more detailed data sets can alter difficulties that were encountered in this study. Road networks with information on bike trails and pedestrian accommodations should be an immediate goal for future studies built upon this work. More data on park amenity use from larger organizations such as NRPA is also needed to help improve methods of amenity scoring. Gravity analysis and other advanced GIS methods should also be considered for future studies to help model complex interactions between parks and those who live in its service area.

Overall the methods utilized in this study provide a relatively simple and efficient way to study park accessibility given current GIS technologies. Such analysis should be attainable for any city with a competent, professional GIS staff, meaning the study should be beneficial to many small municipalities, which are seeking to understand accessibility as a small scale of analysis.

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Appendix A: PARA Operational Definitions and Protocols

Protocol

General Directions

- At an indoor facility, stop at the reception area and introduce yourself to desk staff and/or management. Briefly describe the project, and explain the purpose of your visit.
- If an outdoor location, drive around the resource perimeter to assess the safety before getting out of the car. If anything looks dangerous or suspicious, write a note on the assessment form and report to Project Manager. Move onto the next physical activity resource to be assessed. If at any time conditions become unsafe, return to the car and continue to the next assessment.
- If there is a physical activity resource that is not on the list, collect data for it in a blank Physical Activity Resource Assessment form. Include resource name and street address.
- The outlying boundary for a physical activity resource(s) will be as follows:
 - If a gate is surrounding the physical activity resource, then the physical activity resource will be assessed from the gate in.
 - If there is no gate, but there is a sidewalk, then the physical activity resource will be assessed from the outer edge of the sidewalk in.
 - If there are no consecutive posts that signify a boundary, then the physical activity resource will be assessed from those posts in.
 - If there is no clear indicating boundary for the physical activity resource, then the physical activity resource will be assessed from the end of the adjacent street(s) in.
 - If there is an outlying ditch that signifies a boundary and there is no sidewalk, gate, or posts, then the physical activity resource will still be assessed from the adjacent street(s) in.
- If there is an activity resource that starts inside the 1 mile diameter boundary and extends beyond the boundary, then that activity resource should be fully surveyed and assessed.

At top of form:

If the form is to assess a pre-identified physical activity resource, there will be a sticker produced from the Excel record of businesses and physical activity resources for each Housing development. The sticker should have the correct street address for the physical activity resource. Please verify that the address on the label is correct. If it is not, please write a note in the comments section of the PARA form.

Complete each field as specified:

- 1) *Date* = Date of data collection
- 2) *Data Collector* = Person on research team who collects the data
- 3) *PA Resource ID* = Unique physical activity resource identifying number
- 4) *Time* = The starting and ending time of data collection

- 5) *Phone Call* = Call the project manager at departure from the office and arrival back to the office, and write in a time of when the phone calls were made
- 6) *Type of Resource* (circle ONE)
 - 1 fitness club – aka health clubs
 - 2 park – city park
 - 3 sport facility – baseball fields, basketball and tennis courts, soccer fields
 - 4 trail – walking or biking trail (other than sidewalk that is part of a street curb)
 - 5 community center – public building, may include outdoor space
 - 6 church or other religious organization
 - 7 school
 - 8 combination of 2 or more resources: describe in detail
- 7) *Approximate Size* (Circle one)
 - 1 sm. = Small = ½ square block,
 - 2 med. = Medium = > ½ square block up to 1 square block,
 - 3 lg. = Large = > 1 sq. block
- 8) *Capacity* = (for an indoor facility) The maximum capacity number which should be posted (in the US), or ask the management
- 9) *Cost* = cost for use of facility
 - 1 Free, no charge to use
 - 2 Pay at the door (You must pay to gain entry in the facility)
 - 3 Pay only for certain program (You can use the facility for free, but certain program/classes have a fee)
 - 4 Other (List any other type of cost or payment fee)
- 10) *Hours of Operation* = The hour that the resource opens and closes (write in US Military Time; 5am = 0500, 6am = 0600, 7am = 0700, 8am = 0800, 9am = 0900, 10am = 1000, 11am = 1100, 12pm = 1200, 1pm = 1300, 2pm = 1400, 3pm = 1500, 4pm = 1600, 5pm = 1700, 6pm = 1800, 7pm = 1900, 8pm = 2000, 9pm = 2100, 10pm = 2200, 11pm = 2300, 12am = 2400)
- 11) *Signage* – Hours of Operation = place a check on the appropriate box
- 12) *Signage* – Rules of Use = place a check on the appropriate box

Features -- Numbers 13 – 25

Rate each item by circling a number. Operational definitions describing each are found below, in the section on *Operational Definitions*.

0 = Not Present 1 = Poor 2 = Mediocre 3 = Good

Special note on item 16) Play Equipment. If it is ‘typical’ equipment such as a slide, swings, horizontal bar; no description is necessary. When the equipment is unusual, please describe and use the *Comments* space as necessary.

Amenities -- Numbers 26 - 37

Rate each item by circling a number. Operational definitions describing each are found below, in the section on *Operational Definitions*.

0 = Not Present 1 = Poor 2 = Mediocre 3 = Good

For Incivilities

Numbers 38 - 49

Rate each item by circling a number. Operational definitions describing each are found below, in the section on *Operational Definitions*.

Feature	Poor	Mediocre	Good
Baseball field – Count	Surface of fields is uneven, unsafe, no overhead lighting, no benches for players, fencing in poor condition or nonexistent	Surface of fields is uneven, slightly unsafe, no overhead lighting, + benches for dugouts. Some fencing existent, but not 100% intact	Surface of fields is uniform, no rocks/barriers to running bases, have overhead lighting, + benches for dugouts. Have bleachers for spectators, intact backstop fencing
Basketball courts – Count (BB courts)	Court of hoop is in very bad condition, almost unstable	Hoop is missing a net, rim is bent, court has cracks or weeds	Hoop is straight and has a net or chain, court is playable
Soccer fields – Count	Grass coverage may be poor in 50% or > of the field, rough surface, hazards and/or trash on the field	Grass coverage may be sparse in a few places, grass may be too high, some trash or debris on field	Field has uniform grass coverage and is well- mowed, no trash or debris on field; nets, if furnished, are intact
Bike Rack	Rack is in poor condition, almost unstable or has poor access	Rack is bent, or missing paint, but otherwise usable	Rack is sturdy, usable, may have a few cosmetic blemishes
Exercise Stations with Signage (Exer. Station)	4 or > stations need major repair – are not safe to use. Signage may be missing or in poor condition for several stations. Path between stations is unsafe.	3 or < stations may need minor repair or maintenance, path between stations need minor improvement	Stations themselves are in good condition and safe. 5 or > stations with safe path between them
Play equipment (describe if different than traditional play equipment – slide, swings, monkey bars)	Several pieces are in need of major repair and is almost or unstable, there is a lot of trash, and the ground is overgrown	Some equipment is in need of minor repair, there is some trash, and the ground needs some improvement	In good condition, variety of pieces, ground in good condition, well-kept and clean

	or barren		
Pool > 3 ft deep	Swimming pool has very discolored water or too little water, surrounding surface is in need of repair, trash in or around pool – not safe for use	Swimming pool or deck needs minor cleaning or treatment	Swimming pool is clean, well-lit. surrounding surface is safe as well as exit/entry points
Sandbox	Sandbox is < or 1/2 full, and/or needs cleaning (replacement sand). Box itself needs major repair, and is almost unusable	Sandbox is only 3/4 full, and is mostly clean; the box or edging could use minor	Sandbox has adequate clean sand, all sides/edging are sturdy
Sidewalk	Sidewalk has major damage and needs repair, almost unusable	Sidewalk has some debris, cracks or uneven surfaces, but otherwise usable	Sidewalk is smooth, clear of debris
Tennis courts – Counts	Courts have cracked surface, nets are in major need of repair, debris is evident; almost unusable	Court surface and nets are in need of some repair, but otherwise usable	Tennis court surface and nets are in fairly good condition
Trails – running/biking	Surface is unsafe in many places, there is a lot of debris, no signage about appropriate use	Surface is in places uneven or in need of minor repair, may be a few hazards or avoidable debris	Surface is smooth, without unmarked hazards or debris , has signage re: appropriate users
VB courts – Count	Playing surface has debris or cracks or bumps all over, net is almost unusable or missing	Playing surface has some debris or cracks or has 1 – 5 bumps, net is sagging or has holes	Playing surface is free of debris and smooth, net is in good condition

Wading Pool < 3 ft.	Wading pool has discolored water, or no water, trash in or around pool – not safe for use	Wading pool needs minor cleaning or repair	Wading pool is clean and well-kept
Amenities	Poor	Mediocre	Good
Access Points	Some appear as potentially unsafe areas, unkempt, not well-marked	Not all access points are clearly marked. Some may have trash or overgrown grass.	Clearly visible, safe, free of debris or overgrown grass. If gated, works properly.
Bathrooms	Bathroom is not clean, not well-stocked. More than 50% of fixtures are in disrepair	Bathroom is fairly clean, stocked, and most sinks' and toilets' plumbing is in good working order.	Bathroom is clean, well-lit, stocked, all plumbing is functioning well.
Benches – all types of affixed seating. Count	Benches are in bad condition, unusable	Benches are missing some paint or boards, may be crooked, but otherwise usable	In good condition but could have minor cosmetic flaws
Drinking fountains – Count	Either all or most (50%) are broken	At least 1 of the total fountains not in working operation	Working, clean fountains with clean surrounding area
Fountains (decorative)	Water is unclean or not flowing. Fountain itself is in disrepair. Area at base is in poor shape	Water is clean; fountain itself is in adequate repair. Area at base could use a little improvement	Water is clean; fountain is in good condition (working). Area at base of fountain is well-kept
Landscaping efforts (this does not include grass)	Shrubs or flowering plants appear dead or more than 50% overgrown with weeds. (Does not	Shrubs or flowering plants in ground, but do not appear healthy and/or colorful.	Attractive live shrubs and/or flowering plants, perhaps decorative material

	include grass)	Existing weeds.	such as rock or mulch
Lighting – Count For an outdoor resource such as a park, this is within the boundaries	Area has limited lighting, inadequate for safety	They are usable, but need minor repair, partially clean	Area or building has effective overhead lighting which sufficient for safety
Picnic tables shaded Count	Tables are in need of major repair, unclean, almost unusable	Tables are usable, but need minor repair, partially clean	Tables are sturdy and in good condition, clean
Picnic tables no-shade Count	Same as above	Same as above	Same as above
Shelters – Count	Structures are not intact – so rain would get into area. If seating/tables are present, they are in major need of repair or are missing	Structures are in need of some repair, provide protection from weather. If seating/tables are present they are usable but need minor repair	Structures are intact, provide protection from weather. If seating/tables are present they are clean.
Shower/Locker room	Unclean, may not be well-lit, inadequate dressing space or receptacles provided, plumbing is almost unusable	Most areas are clean, lockers and/or dressing space provided (but is inadequate), plumbing could be improved, but works	clean, well-lit, lockers and/or dressing space provided, plumbing works well
Trash containers – Count	Unclean and/or in poor condition, more care needed, Full with trash or overflowing.	Partially unclean or in < perfect condition, but scattered, and unstable	Clean on exterior, scattered throughout, not overflowing with trash
Incivilities	1	2	3
Auditory annoyance	Sound is not irritating,	Sound(s) is (are)	Noticeable sounds

	but is (hardly) noticeable	noticeable and interfere(s) with enjoyment of resources	which are unpleasant. Reaction is to leave area.
Broken glass	A few pieces of broken glass (the equivalent of 1 bottle)	Several pieces of broken glass (the equivalent of 2 – 4 bottles)	Many pieces of broken glass (5+ bottles)
Dog refuse	1 refuse pile from dog	2 – 4 dogs refuse piles from dogs	5 or > refuse piles from dogs
Dogs Unattended	1 dog unattended	2 – 4 dogs unattended; may be associated noise	5 or > dogs unattended, definitely unsafe, may be associated noise
Evidence of alcohol use	1 bottles, cans, or bottle caps visible	2 – 4 bottles, cans, or bottle caps visible	5 or > bottles, cans, or bottle caps visible
Evidence of substance use	1 piece: syringes, paint cans, rags, baggies, rolling papers	2 – 4 pieces: syringes, paint cans, rags, baggies, rolling papers	5 or > pieces: syringes, paint cans, rags, baggies, rolling papers
Graffiti/tagging	1-3 small	4+ small or 1 large	2 + large
Litter	A few items (<5) are on the ground	Several items (5-10) are on the ground	Many items are on the ground (11+)
No grass	A small area without grass	A moderate portion of the area without grass	A large area without grass (more than with grass)

Overgrown grass	A little bit, hardly noticeable	A moderate amount, noticeable	A lot, very noticeable, may be obstructing some equipment
Sex paraphernalia	1 used or unused contraceptive devices and/or 1 pieces of pornographic reading material visible	2 - 4 used or unused contraceptive devices and/or 2 - 4 pieces of pornographic reading material visible	5 or > used or unused contraceptive devices and/or 5 or > pieces of pornographic reading material visible
Vandalism	Hardly noticeable, but it appears up to a few pieces of equipment or an area of indoor space has been defaced	Noticeable, more than a few pieces of equipment are vandalized, or < 50 % of the space has been rendered unusable by vandalism	Very noticeable, more equipment in disrepair than in good order, between 50%-100%, because of vandalism. Signs of vandalism are obvious

Source: Lee et al. 2005

Appendix B: Adjusted PARA Auditing Instrument

Adjusted PARA instrument as it was used for this research. Additional items, not part of the original PARA instrument, are marked with “*”.

1. Date
2. Time Started
3. Time Ended
4. Cost: 1 Free, 2 Pay at door, 3 Pay for Certain Programs, 4 Other_____
5. Hours of Operation
6. Signage Hours: Yes, No
7. Signage Rules: Yes, No

General Features

8. Benches: 1,2,3
9. Picnic Tables in shade: 1,2,3
10. Picnic Tables no shade: 1,2,3
11. Shelter: 1,2,3
12. Sidewalk: 1,2,3
13. Restrooms: 1,2,3
14. Drinking Fountains: 1,2,3
15. Lighting: 1,2,3

Children’s Play Amenities

16. Play Equipment: 1,2,3
17. Sandbox: 1,2,3
18. Pool <3ft: 1,2,3
19. Community Center: 1,2,3*

Disamenities

20. Auditory Announce: 1,2,3
21. Broken Glass: 1,2,3
22. Dog Refuse: 1,2,3
23. Dog Unattended: 1,2,3
24. Alcohol Use: 1,2,3
25. Substance Use: 1,2,3
26. Graffiti: 1,2,3
27. Litter: 1,2,3
28. Dead Grass: 1,2,3
29. Overgrown Grass: 1,2,3
30. Sex Paraphernalia: 1,2,3
31. Vandalism: 1,2,3
32. Power Lines: 1,2,3*

Physical Activity Amenities

33. Baseball Fields: 1,2,3
34. Basketball Courts: 1,2,3

- 35. Soccer Fields: 1,2,3
- 36. Bike Rack: 1,2,3
- 37. Exercise Equipment: 1,2,3
- 38. Tennis Court: 1,2,3
- 39. Volleyball Court: 1,2,3
- 40. Pool >3ft: 1,2,3
- 41. Running/Walking Trails: 1,2,3
- 42. Handball Court: 1,2,3*
- 43. Horseshoe Pit: 1,2,3*

Nature Access Amenities

- 44. Fountains (water features): 1,2,3
- 45. Intentional Landscaping: 1,2,3
- 46. Riverbed Access: 1,2,3*
- 47. Tree Coverage: 1,2,3*
- 48. Nature Guides: 1,2,3*

Source: Lee et al. 2005