Advancing Sustainable Urbanism through Civic Space Planning & Design

by

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ABSTRACT

The lack of substantive, multi-dimensional perspectives on civic space planning and design has undermined the potential role of these valuable social and ecological amenities in advancing urban sustainability goals. Responding to these deficiencies, this dissertation utilized mixed quantitative and qualitative methods and synthesized multiple social and natural science perspectives to inform the development of progressive civic space planning and design, theory, and public policy aimed at improving the social, economic, and environmental health of cities. Using Phoenix, Arizona as a case study, the analysis was tailored to arid cities, yet the products and findings are flexible enough to be geographically customized to the social, environmental, built, and public policy goals of other urbanized regions.

Organized into three articles, the first paper applies geospatial and statistical methods to analyze and classify urban parks in Phoenix based on multiple social, ecological, and built criteria, including landuse-land cover, 'greenness,' and site amenities, as well as the socio-economic and built characteristics of park neighborhoods. The second article uses spatial empirical analysis to rezone the City of Phoenix following transect form-based code. The current park system was then assessed within this framework and recommendations are presented to inform the planning and design of civic spaces sensitive to their social and built context. The final paper culminates in the development of a planning tool and site design guidelines for civic space planning and design across the urban-to-natural gradient augmented with multiple ecosystem service considerations and tailored to desert cities.

DEDICATION

To my mother, you are missed.

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Chapter 1

INTRODUCTION

"Cities change all the time and every change holds opportunity."
- Peter Harnik, Director, Trust for Public Land's Center for City Park Excellence

"Anything that is not improving is in a state of decline."
- Anonymous

In recent years, decision-makers across the United States have rediscovered the potential of urban parks and civic spaces—including plazas, greens, preserves, and other outdoor public space—to improve urban quality of life and battle the most pressing social and environmental ills of our time (Sherer 2003; Harnik 2010). "With the rebirth of the city has come the rebirth of the city park," states Harnik (2010:1). Access to urban civic space has been shown to improve human quality of life (Maas et al. 2006; Harnik 2010), facilitate social cohesion, democracy, and equity (Mitchell 1995; Low et al. 2005), as well as enhance human physical, mental, and spiritual health and well-being (Sherer 2003; Chiesura 2004; Bedimo-Rung et al. 2005). These areas also play a vital role in protecting biodiversity, ecological processes and function, and ecosystem services within cities (Bolund and Hunhammer 1999; Forsyth and Musacchio 2005), even non-native landscapes heavily altered by human activity (Rosenzweig 2003; Marris 2009). By increasing property values and attracting tourism, many public spaces also provide economic benefits to communities (Lutzenhiser and Netusil 2001; Nicholls and Crompton 2005; Harnik and Welle 2009).

Yet despite the abundance of research on urban parks, major gaps in knowledge and understanding exist. Most research undermines the diverse social, environmental, and spatial context of these areas, specifically the characteristics of the local built environment, dynamic social needs and preferences of the community, spatial distribution, and the historic and environmental characteristics of place (Jacobs 1961; Low et al. 2005; Parés et al. 2006; Byrne and Wolch 2009; Harnik 2010). Often, scholars generically refer to these areas simply as 'parks' or 'green' space (e.g. Maas et al. 2006; CABE Space 2010; Schilling 2010), ignoring variations in the quantity, quality, and mix of social and ecological services and functions provided by diverse public spaces. The underlying assumption is that all civic spaces are more or less the same, and that more is always better (Harnik 2010). Jacobs (1961: 90, 95) argued that orthodox urban planning treats open space in "an amazingly uncritical fashion," although, "often, there are no people where the parks are and no parks where the people are." Static, generic cookie-cutter park models and standardized people-to-parkland ratios don't always result in socially and environmentally functional civic space; rather such models have led to an abundance of underutilized, unsafe, public spaces that actually degrade the social and ecological health of cities (Massey 1994; Madanipour 1999; Marne 2001; Boone et al. 2009). Further, civic space research often promotes urban 'greening' without considering the water tradeoffs associated with irrigated landscaping in arid cities or the benefits of 'brown' (e.g. xeric, desert) or 'grey' civic spaces (plazas, squares, and playgrounds) (e.g. Maas et al. 2006; CABE Space 2010; Schilling 2010). Such considerations are increasingly important given the rapidly changing demographics of U.S. cities and ethno-racially differentiated patterns of park use and preferences (Payne et al. 2002; Byrne and Wolch 2009), as well as the growing impact of human resource use on ecological systems necessary for the maintenance of human health and well-being (MA 2005).

Cities are dynamic systems, constantly evolving either towards or away from a more socially, economically, and environmentally healthy state. Every action and decision, whether made by a government official or an individual citizen, either detracts from or contributes to the goal of urban sustainability. The impacts of certain decisions may vary by degrees of magnitude, but there are no neutral actions. Even inaction has an effect, potentially leading to undesirable outcomes in the form of missed opportunities, or worse, if corrupt interests are driving changes in the absence of progressive influence.

The overarching goal of this research is to foster the evolution of more sustainable cities by informing and inspiring positive, proactive civic space planning, design, and decision-making—particularly in desert cities in the United States, as these are arguably some of the most unsustainable human settlements on earth (Ross 2011). The investigation is applied to the City of Phoenix, Arizona, where bourgeoning populations, extreme heat, water scarcity, and auto-dependent urban morphology make the goal of urban sustainability in this region particularly challenging. Yet the combination of these challenges presents an opportunity to implement sustainable policies in the region that could make Phoenix a model for other desert cities.

Study Area

Home to over 1.4 million people, Phoenix is the sixth largest city in the United States. The city extends more than 500 square miles across the Salt River Valley of Maricopa County, making it geographically larger than Los Angeles. The Phoenix Metropolitan Area, which includes the City of Phoenix and 32 municipalities, has a population of over 4 million and is the 14th largest metro area in the nation (U.S. Census 2010).

The City is situated in the Sonoran Desert, a desert ecosystem shown to have low ecological resilience (Walker et al. 2006; Liu et al. 2007). Mean annual precipitation in the area is just over eight inches (20 cm), while monthly temperatures average 53–93 degrees Fahrenheit. Annually over 45% of days are over 90 degrees, and for three months of the year (May to July) 74-100% of days reach max temperatures of 90 degrees or more (Schmidli 1996; Climatezone.com 2003). The urban landscape is comprised primarily of non-native plant taxa (Martin et al. 2003) that are heavily irrigated, resulting in a landscape that is more lush and biologically diverse than the surrounding natural desert ecosystem (Hope et al. 2003; Walker et al. 2009).

Demographically, the City of Phoenix is made up of 46.5% non-Hispanic White, 40.8% Hispanic or Latino, 6.5% Black, 3.2% Asian, 2.2 % American Indian, and 3.8% other or mixed ethnicities and races (U.S. Census 2010). The median household income in the city is $48,823 and 19.1% of people live below the poverty level, compared to 13.8% nationally. A little over a third of the population is under age 18 (28.2%) and 8.4% are 65 years or older (U.S. Census 2010).

The Trust for Public Land's Center for City Park Excellence gathered urban park statistics for the 100 largest U.S. cities in 2011. According to TPL (2011), Phoenix contains 202 parks that cover 45,020 acres, or 14.8% of the total land area of the city. Compared to other large nearby desert cities, Denver has 5902 acres of parks (6.7% of total land area) and Los Angeles has 23,938 acres (covering 8%). Ranked eighth among the cities, there are 28.2 acres of parkland per 1000 residents in Phoenix, which is more than twice the median rate of 12.4 acres a person. Yet, Phoenix is underperforming with respect to access to playgrounds, with only one per 1000 residents, which is half the median rate among all the cities. Spending on parks (in 2009) amounted to $125 million, or $78 per resident, ranking Phoenix 49th in expenditures per resident among the cities which ranged from $15 to $375 per resident. Phoenix contains four of the 100 largest city parks in the country, including South Mountain Preserve (16,094 acres) and North Mountain Preserve (7500 acres), ranked fourth and tenth respectively. Three units— Encanto Park, South Mountain Preserve, and Adobe Dam Recreation Area—were among the most visited city parks with annual visitation of over 2.7 million (TPL 2011).

Definitions

There are several key terms used in this dissertation that require clarification. *Cities, urban areas*, or *urbanized areas* are defined as dense human settlements (500-1,000 people per acre), comprised of 2,500 or more people (US Census 2010). An *arid region* is a geographic area located in a desert biome, characterized by low rainfall (less than 50 cm/year) and (where unaltered by human activities) predominantly xeric vegetation (UCMP 2013). A *desert city* is simply a city located in a desert biome or arid region. This research uses the term *urbanism* to refer to the "study or appreciation of the processes of change in towns and cities; the process of becoming urban (as a result of development on formerly rural land for example); the product of town planning or development," and "patterns of social life characteristic of urban areas" (Cowan 2005). *Urban planning* involves collective action for the common good "that concentrates on building and shaping the shared physical infrastructure for present needs and future growth" (Fishman 2000: 2).

Although the exact meaning and parameters of *sustainability* are as yet highly contested (Lorr 2012), the multitudinous definitions do address similar concerns. The common threads include the ability to sustain something long-term, the health of organisms and their environment, place-specific conditions and sense of place, interrelationships among system components, and the evolution of relationships between and among natural, human, and economic systems. As applied to cities, these concerns are related to the ecological concepts of carrying capacity (the ability to meet the needs of citizens and the environment), fitness (the suitability of the built environment to both human and non-human inhabitants), resilience (the ability of the urban ecosystem to resist or recover from disturbances), diversity (including the harmonious co-existence of human and non-human inhabitants in cities), and balance (between the various needs and preferences of urban inhabitants and the natural environment) (Adhya et al. 2010).

Drawing together these common threads, this research defines *urban sustainability* as a place-specific, evolutionary process aimed at continually improving the health of all organisms and the built and natural environment across an urbanized region. Changes to the built environment of a city striving towards sustainability emphasize resilience to disturbances while harmoniously balancing and supporting the multiple needs and preferences of diverse human and non-human life. Although urban sustainability is more an intention than a reachable goal, the ultimate vision is a city with a high quality of life that is socially equitable, just, inclusive and democratic, economically vibrant, biologically diverse, and ecologically functional. The urban form is human-scaled, supports multiple modes of transportation (e.g. walking, biking, public transit), and provides a variety of human and non-human habitats for diverse needs and preferences.

For the purposes of this research, the terms *urban park* and *civic space* are used interchangeably to refer to a variety of publicly owned and operated land uses within the municipal boundary of a city. Such spaces may be managed by a municipal, county, regional, state, or national government and include plazas, greenways, preserves, recreational facilities, natural areas, and other publicly-accessible open spaces.

As referred to in this research, a *sustainable urban park or civic space system* (or an urban park system that contributes to urban sustainability) is one that provides a variety of amenities and habitats to satisfy the different needs and preferences of diverse human and non-human life. Such parks are clean, safe, aesthetically pleasing, well maintained, and culturally sensitive. Though not all parks can or should support all goals and activities, as appropriate to geographic context, civic spaces should foster social interaction, cohesion, and the generation of social capital, as well as support biological diversity and ecological functioning. These areas should be welcoming and accessible to a diversity of ages, genders, sexual orientations, and ethnic/cultural groups, via various modes of transportation, including walking, biking, and public transportation. The design of and urban form around parks should be appropriate to their place along the urban-to-natural transect, with generally more active uses and dense settlements surrounding smaller parks in the urban core, and sparse development surrounding larger, less disturbed landscapes in suburban and rural areas. Where appropriate, retail (e.g. food, entertainment, hotels) and other active land uses should be incorporated in and around parks to enliven the space and expand park uses and benefits. Particularly in arid urban regions, civic spaces should provide drinking water, restrooms, shade structures, and in some cases green vegetation to provide relief from the local climate and urban heat island effect, thereby improving human health and comfort and extending the usability of these amenities year-round. Arid urban parks should also support native biodiversity when possible by protecting, creating, and supporting suitable habitat.

Dissertation Structure

This dissertation is organized into five chapters. The first chapter introduces the research problem, provides an overview of the study area, and defines key terms used in the dissertation. The second, third, and fourth chapters represent three papers in the process of being submitted for publication in peer-reviewed academic journals in the fields of geography, urban planning, urban ecology, and other related subject areas. The first paper (Chapter 2), entitled "A multi-dimensional assessment and classification of urban parks for the enhanced sustainability of arid cities: The case of Phoenix, Arizona," applies geospatial and statistical methods to develop a multi-dimensional typology of urban parks in Phoenix based on multiple social, ecological, and built criteria, including landuse-land cover, 'greenness,' and site amenities, as well as the socio-economic and built characteristics of park neighborhoods. The second paper can be found in Chapter 3. This manuscript, entitled "Civic spaces along the transect: Towards a more coherent, sustainable urbanism," uses spatial empirical analysis to rezone the City of Phoenix according to transect form-based code. The current park system is then assessed within this framework and recommendations are presented to inform the planning and design of civic spaces sensitive to their social and built context. In Chapter 4, the final publishable manuscript, "Integrating ecosystem services into urban park planning and design," culminates in the development of a planning tool and standards for civic space design across the urban-to-natural gradient augmented with multiple ecosystem service considerations and tailored to desert cities. The final chapter is an overall conclusion that outlines a brief research review, summary of contributions, key findings and policy implications, and opportunities for future research.

Chapter 2

A MULTI-DIMENSIONAL ASSESSMENT OF URBAN PARKS FOR THE ENHANCED SUSTAINABILITY OF ARID CITIES: THE CASE OF PHOENIX, ARIZONA

INTRODUCTION

Cities across the United States are rediscovering the potential of urban parks and civic spaces—including plazas, greens, natural areas, and other outdoor public space—to improve urban quality of life and battle the most pressing social and environmental ills of our time (Sherer 2003; Harnik 2010). Time and again these urban elements have been shown to enhance the social, economic, and environmental sustainability of cities. Access to urban civic spaces has been shown to improve human quality of life (Maas et al. 2009; Harnik 2010), facilitate social cohesion, democracy, and equity (Mitchell 1995; Low et al. 2005), as well as enhance human physical, mental, and spiritual health and well-being (Sherer 2003; Chiesura 2004; Bedimo-Rung et al. 2005). These areas also play a vital role in protecting biodiversity, ecological processes and function, and ecosystem services within cities (Forsyth and Musacchio 2005), even non-native landscapes heavily altered by human activity (Rosenzweig 2003; Marris 2009). By increasing property values and attracting tourism, these spaces can also provide critical economic benefits to communities (Lutzenhiser and Netusil 2001; Nicholls and Crompton 2005; Harnik and Welle 2009).

Yet despite the abundance of research on urban parks, major gaps in knowledge and understanding exist. Most research undermines the diverse social, environmental, and spatial context of these areas, specifically the characteristics of the local built environment, dynamic social needs and preferences, spatial distribution, and the historic and environmental characteristics of place (Jacobs 1961; Low et al. 2005; Parés et al. 2006; Byrne and Wolch 2009; Harnik 2010). Often, scholars generically refer to these areas simply as 'parks' or 'green' space, ignoring variations in the quantity, quality, and mix of social and ecological services and functions provided by diverse public spaces (e.g. Kweon et al. 1998; Maas et al. 2006; CABE Space 2010; Schilling 2010). The underlying assumption is that all civic spaces are more or less the same, and that more is always better (Harnik 2010). Jacobs (1961: 90, 95) argued that orthodox urban planning treats open space in "an amazingly uncritical fashion" though "often, there are no people where the parks are and no parks where the people are." Further, a focus on urban 'greening' ignores the water tradeoffs associated with irrigated landscaping in arid cities and the benefits of 'brown' or 'grey' civic spaces, including plazas, squares, playgrounds, and desert parks and preserves.

Socially and ecologically sustainable urban parks must cater to the often dynamic needs and preferences of a city's human and natural systems, at multiple scales. For this reason, static, generic cookie-cutter park models and standardized people-parkland ratios rarely result in socially and ecologically functional civic space; rather such models have led to an abundance of underutilized, degraded urban landscapes (Massey 1994; Boone et al. 2009). Such considerations are increasingly important given the rapidly changing demographics of U.S. cities and ethno-racially differentiated patterns of park use and preferences (Payne et al. 2002; Byrne and Wolch 2009), as well as the growing impact of human resource use on ecological systems necessary for the maintenance of human health and well-being (MA 2005).

These gaps in urban parks scholarship highlight the need for empirical research that enhances understanding of these complex urban elements so that they may more substantially contribute to the advancement of sustainable urban planning and design.

Specifically, Talen (2010) saw a need for improved methods of measurement, assessment, and representation of such complex urban phenomena. Song and Knapp (2007) propose that a multi-dimensional, quantitative classification of urban elements facilitates understanding, discussion, and analysis of diverse, complex urban features and assists in the development and evaluation of public policy aimed at improving cities through urban planning and design.

With the overarching goal of advancing the sustainability of Phoenix through urban park[1] planning and design, the present research asks:

1. How can parks in Phoenix be classified to reflect their diverse social, ecological, built, and spatial characteristics?, and
2. How do these findings inform public policy aimed at enhancing the sustainability of the park system and the city overall?

This research contributes to scholarship in urban planning, geography, ecology, leisure sciences, public health, community development, park planning, management, and design in multiple ways. First, the study advances the urban parks discourse by going beyond simple classifications of these spaces, conceptualizing them as complex human-environment systems that support multiple and distinct social and ecological functions and conditions that are, themselves, heavily impacted by their socio-spatial context. This research also serves to highlight the unique opportunities and challenges related to the planning and design of urban parks in arid regions, including the importance of 'brown' and 'grey' spaces and the consideration of water tradeoffs when developing 'green' parks in desert ecosystems. Further, findings of this study greatly enhance understanding of the current physical,

[1] For the purposes of this research, the terms urban parks, city parks, or civic spaces refer to a variety of outdoor public spaces within cities including squares, plazas, greens, playgrounds, greenways, recreational areas, and nature reserves. Golf courses and other private or potentially cost-prohibited spaces are not included in this definition.

ecological, social, built, and spatial characteristics of Phoenix parks. As such, findings are invaluable to city planners, park designers, policy-makers, residents, and other stakeholders interested in urban parks and urban sustainability more broadly. This research can therefore aid in the development and evaluation of public policy aimed at enhancing the sustainability of Phoenix through urban park planning and design. Finally, as the approach used to measure, assess, and represent parks in this study is described in detail, it can easily be customized and applied to park systems in any city, representing an additional methodological and empirical contribution to parks research more broadly.

The following sections of the paper are organized as follows. First, a review of literature drawing from multiple fields of study across the social and natural sciences will explore thought, theory, and practice related to urban sustainability and sustainable urban park management, evaluation, planning and design, highlighting the unique considerations related to desert city civic spaces. A description of the study area will then detail the particular social, geographic, ecological, and built characteristics of Phoenix, Arizona. Subsequent sections will detail the data used and collected in this study, the steps of the spatial and statistical analyses, and the results. The manuscript concludes with a discussion and conclusion component that explores key findings and their implications for urban sustainability policy related to park planning and design.

BACKGROUND

Sustainability science is an integrative, interdisciplinary field of research that seeks to simultaneously enhance the health of social, economic, and ecological systems. Although the exact meaning of sustainability is still highly contested (Lorr 2012), the multitudinous definitions do contain some common concerns, namely the ability to sustain something long-term, the health of organisms and their environment, place-specific conditions, interrelationships among system components, and the evolution of relationships between and among natural, human, and economic systems. As applied to cities, these concerns are echo the ecological concepts of carrying capacity (the ability to meet the needs of citizens and the environment), fitness (the suitability of the built environment to both human and non-human inhabitants), resilience (the ability of the urban ecosystem to resist or recover from disturbances), diversity (including the harmonious co-existence of human and non-human inhabitants in cities), and balance (between the various needs and preferences of urban inhabitants and the natural environment) (Adhya et al. 2010). Drawing together these common threads, the present research defines urban sustainability as: *a place-specific, evolutionary process aimed at continually improving the health of all organisms and the built and natural environment across an urbanized region.* Changes to the built environment of a city striving towards sustainability would emphasize resilience to disturbances while harmoniously balancing and supporting the multiple needs and preferences of diverse human and non-human life. Although urban sustainability is more an intention than a reachable end point, the ultimate vision is a city with a high quality of life that is socially equitable, just, and democratic, economically vibrant, biologically diverse, and ecologically functional. The urban form is human-scaled, supports multiple modes of transportation, and provides a variety of habitats for the diverse needs and preferences of both human and non-human life.

Informed by this definition of urban sustainability and inspired by thought and theory across multiple perspectives on sustainability, the present study proposes a vision of a healthy city park system, which is itself evolving towards a more sustainable state, while contributing to the overall sustainability of an urbanized region. Specifically, a *sustainable urban park or civic space system* (or an urban park system that contributes to urban sustainability) is one that provides a variety of amenities and habitats to satisfy the different needs and preferences of diverse human and non-human life. Such parks are clean, safe, aesthetically pleasing, well maintained, and culturally sensitive. Though not all parks can or should support all goals and activities, as appropriate to geographic context, civic spaces should foster social interaction, cohesion, and the generation of social capital, as well as support biological diversity and ecological functioning. These areas should be welcoming and accessible to a diversity of ages, genders, sexual orientations, and ethnic/cultural groups, via various modes of transportation, including walking, biking, and public transportation. The design of and urban form around parks should be appropriate to their place along the urban-to-natural transect, with generally more active uses and dense settlements surrounding smaller parks in the urban core, and sparse development surrounding larger, less disturbed landscapes in suburban and rural areas. Where appropriate, retail (e.g. food, entertainment, hotels) and other active land uses should be incorporated in and around parks to enliven the space and expand park uses and benefits. Particularly in arid urban regions, civic spaces should provide drinking water, restrooms, shade structures, and in some cases green vegetation to provide relief from the local climate and urban heat island effect, thereby improving human health and comfort and extending the usability of these amenities year-round. Arid urban parks should also support native biodiversity when possible by protecting, creating, and supporting suitable habitat.

Balancing Multiple Sustainability Goals in Urban Parks

A key area of tension in the urban park discourse is balancing the multiple dimensions of sustainability in civic space planning and design. Some scholars argue that park planning must strive to balance all aspects of sustainability (social, economic, and ecological), while others claim that this is not only unreasonable, but unnecessary. Campbell (1996) asserted that there are always tradeoffs between these multiple dimensions and that it is impossible to give equal balance to all aspects in every situation. Similarly, Lindsey (2003) noted that the enhancement of one principle often degrades another, and Parés and Saurí (2007) argued that parks with negative environmental impact may still be valuable if they fulfill social or political sustainability goals, while other parks may best emphasize more ecological objectives. As such, the notion that not all parks can nor should provide all possible benefits may, ultimately, be the most reasonable and robust model.

However, there is evidence that sustainability goals can often be synergistic, positively reinforcing and supporting each other. According to Cranz and Boland (2004), the 1990s ushered in a new type of park in America, very different from previous models which focused predominantly on the social benefits of these spaces. The 'sustainable park' model integrates both social and ecological values, merging ideals of sustainable development with human health and well-being. These spaces emphasize landscape restoration through the use of native and non-invasive plants, natural system restoration, stormwater management, wildlife habitat, recycling, and sustainable construction and maintenance practices. This ideal also supports human well-being by supporting access to nature, opportunities for social integration, environmental education, community gardens, and sense-of-place, while facilitating community stewardship, public-private partnerships, and the development of community and regional pride. Finally, this most recent park template promotes a new ecologically-minded, lower maintenance urban park aesthetic which fundamentally changes not only the role of nature in the city, but also the way urban nature is thought about, experienced, and designed (ibid.). In this way, sustainable parks redefine the role of urban planners and designers in the park development process, as it requires both community input and regional ecological consideration.

Also striving to balance both the social and ecological health of urban parks, Forsyth and Musacchio (2005) developed detailed park design guidelines with respect to park size, shape, number, context, location, and trade-offs. Their guidelines emphasized the importance of connectivity, diversity, and access for both human and non-human life. In addition, authors noted, the relationship of park boundaries or edges to the city's patchwork of natural areas is critical. Hard edges are those that do not connect to other vegetation, while soft edges provide a transition zone for wildlife to travel from one patch of habitat to the next. A soft edge can be easily designed by placing parks adjacent to other urban vegetation, such as backyards, yet this may reduce access by humans and blur the line between public and private space, potentially leading to social conflict. Of course the balancing of social and ecological goals in this way necessitates trade-offs, but Forsyth and Musacchio (2005: 6) acknowledged that not all parks can be all things to every species; in the end, the values that are emphasized "will depend on the park's context and in many cases will be highly contested, not only between social and ecological values, but within them." Regardless, often simple additions such as a bench or bird houses, or other modifications can expand park benefits into both social and ecological realms (Rosenzweig 2003).

Another example of integrated sustainability in urban park design has been implemented in the City of Curitiba, Brazil. In the 1960s an urban renovation project was initiated to improve quality of life in the city (Rabinovitch 1992: 63). The plan expanded city parks and green areas from 0.5 to 52 square meters per resident, one of the highest averages in the world. The 'green' infrastructure provided a secondary benefit of flood protection, replacing alternative plans for costly flood infrastructure, ultimately saving the city millions of dollars. A 'green guard' was also deployed to maintain the parks and provide environmental education to visitors. To foster community responsibility and participation in park maintenance and safety, programs were initiated to encourage the formation of citizen groups such as Friends of the Park and the Boy Scout Bicycle Watch. Interpretive centers throughout the park system teach about the ecology of the area. On the weekends, green buses transport people to the various parks and the 43-acre botanical garden for free (Rabinovitch 1992).

Study Area

Founded in 1876, the City of Phoenix is situated in the Sonoran Desert of Central Arizona, at the confluence of the Salt and Gila rivers. Surrounded by mountains in the 'Valley of the Sun,' Phoenix receives an average of some 280 days of sunshine and 8.01 inches (about 20 cm) of precipitation annually (NOAA 2004; 2010). The abundance of easily-developed, flat land with minimal vegetation has facilitated urban sprawl in the region, but has also helped to preserve several massive, minimally-developed open spaces within the city including North Mountain Park, Phoenix Mountains Preserve, Camelback Mountain, and Lookout Mountain Preserve (Gober 2006).

Metropolitan Phoenix boasts over 200 diverse parks that range from 1000-acre plus nature preserves to half-acre mini parks. One of the largest municipal parks, at over 16,000 acres, South Mountain Preserve is located five miles south of downtown Phoenix. A winding seven-mile paved road takes automobile visitors to Dobbins Point, a scenic lookout at 2600 feet. Meanwhile hikers, bikers, and horseback riders can explore 58 trails that wind through the habitat of over 300 species of plants and a variety of native wildlife including foxes, lizards, birds, snakes, and rabbits. Around two miles north of downtown is another large, but very different type of civic space. Encanto Park is a highly irrigated 222-acre 'oasis' park with grass, trees, picnic areas, a swimming pool, amusement park, two golf courses, and a 7.5-acre lake stocked with a variety of non-native species of fish including bluegill, rainbow trout, tilapia, and channel catfish (City of Phoenix 2009). Scattered across neighborhoods in Phoenix are 19 mini parks less than half an acre in size. Eototo Park, in South Phoenix, consists of a basketball hoop, a picnic bench, and some large decorative rocks. Roosevelt Mini Park in downtown contains several large trees, small patches of grass, and four benches.

A key issue with the Phoenix park system is that there is such a variety of public spaces providing different sets of social and ecological benefits, but the city's classification system is quite arbitrary and simplistic. In addition, to date there has been no large-scale assessment of these areas though examinations of park systems have been conducted in many other major U.S. cities including New York (Low et al. 2005), Baltimore (Boone et al. 2009), Cleveland (Payne et al. 2002), Chicago (Gobster 2002), and Los Angeles (Sister et al. 2008). The lack of understanding regarding the diverse social, physical, ecological, built, and spatial characteristics of the urban park system in Phoenix, the sixth most populous city in the nation (U.S. Census 2010), represents a major gap in the literature and limits the potential of civic space planning and design aimed at enhancing the region's sustainability. Responding to this need, this study used spatial and statistical methods to develop a multi-dimensional typology of parks in Phoenix, providing a more nuanced, structured, and organized understanding of these complex urban amenities. The results represent a baseline assessment of the park system and a point of departure for the development of public policy aimed at enhancing urban sustainability through civic space planning and design.

DATA & ANALYSIS

Data Collection

The data for this research reflects the physical, ecological, social, built, and spatial characteristics of urban parks in Phoenix and their surrounding neighborhoods (Table 2.1). Data on location, size, and amenities associated with each park was obtained from the City of Phoenix Parks and Recreation Department. GIS shapefiles for the boundary of Phoenix (2010) and the city center were accessed through the ASU GIS data repository. Data on landuse and land cover was obtained from the Central Arizona-Phoenix Long Term Ecological Research project (CAP-LTER) and represents 2.4 meter resolution classification based on Quickbird satellite data. SAVI (Social-adjusted Vegetation Index) data was obtained through CAP-LTER and was created from a Landsat Thematic Mapper image. SAVI is used to measure vegetation or 'greenness' in areas where there is significant soil exposure and low vegetative cover, such as desert regions where light reflectivity of the soil can alter NDVI (Normalized Difference Vegetation Index) values, making them inaccurate. SAVI is used in urban areas as a proxy measure for temperature and has been used to demonstrate that parks aid in urban heat island mitigation. Research conducted in Phoenix has linked higher SAVI scores with cooler surface temperatures (Jenerette et al. 2007) and lower air temperatures (Hedquist and Brazel 2006). Census data for population density, ethnicity, and household income was obtained through the U.S. Census Bureau and represents data from the 2010 census. Parcel data for the study was obtained through the Phoenix Urban Research Lab (PURL).

Table 2.1 Data and associated variables used in this study

	Description	Dataset	Source
Physical park characteristics	Location & area	Park Boundaries (2012)	City of Phoenix Parks & Rec. Dept.
	Amenities (n=10): community center, paths/trails, ball field/court, playground, pool, water body, shade area, drinking fountain, restroom, picnic area	Parks database (2010)	City of Phoenix Parks & Rec. Dept. website
	Distance to city center	City center shapefile	ASU GIS data repository
Ecological/ environmental park characteristics	% grass % trees % green (grass + trees) % soil	Quickbird, classified (2.4 meter spatial resolution)	CAP-LTER, created by Soe Myint, Chris Galletti, Shai Kaplan, Won Kim, Chao Fan
	Average greenness based on Soil-adjusted Vegetation Index (SAVI) (range= -1.5 to 1.5)	SAVI index (2005)	CAP-LTER
Social characteristics of park neighborhoods (areas within ¼-mile buffer of park)	Average number of people per acre within ¼-mile buffer of park	Census block (2010)	U.S. Census Bureau
	Median annual household income (dollars) % Hispanic % white % black % other ethnicity	Census block group (2010)	
Built environment of park neighborhoods	% impervious % buildings % developed (impervious + buildings)	Quickbird, classified (2.4 meter spatial resolution)	CAP-LTER, created by Soe Myint, Chris Galletti, Shai Kaplan, Won Kim, Chao Fan
	% single-family parcels in park neighborhood	Parcels (2010)	PURL

	% multi-family parcels in park neighborhood % retail parcels in park neighborhood % commercial/industrial parcels in park neighborhood % C/I and retail parcels in park neighborhood Mix of commercial/industrial (C/I), single-family (SF), and multi-family (MF) land uses within ¼-mile buffer of park		
	Distance from city center calculated from park center points	Park Boundaries (2012)	City of Phoenix Parks & Rec. Dept.
Other	City boundary	Phoenix boundary (2010)	ASU GIS data repository

Variable Computations

As the first step in developing a multi-dimensional classification system of the urban parks in Phoenix, 33 variables related to the social, physical, ecological, and urban morphological characteristics were identified and calculated. These variables included ten park amenities, park size, the landuse-land cover mix (grass, trees, impervious surfaces, soil and buildings), average 'greenness,' as well as average park neighborhood population density, median household income, and landuse mix (reflecting urban intensity). Park neighborhoods in this study are defined as areas within ¼-mile of each civic space as this represents a standard distance threshold for park visitation in the literature (Trust for Public Land 2004; Boone et al. 2009).

To determine their size and location, parks within the City of Phoenix (n=220) were mapped using data obtained through the City of Phoenix Parks and Recreation Department, and their size and distance from the city center (from city center to the nearest park edge) was calculated in ArcGIS. After removing undeveloped parks (n=29) and those missing data for other variables (n=14), the final sample contained 162 sites.

Referencing alphabetical park listings and descriptions from the City of Phoenix Park & Recreation website (City of Phoenix 2013), a database of the sample parks and their amenities was created. Data was collected to determine the presence or absence of (not counts for) the following amenities (n=10): community centers, walking/hiking/biking paths/trails, restrooms, a lake or lagoon water feature, drinking fountains, playgrounds, shaded areas, picnic areas, ball courts, and pools.

To determine percentages and acres of different landuse and land cover types in parks—grass, trees, soil, impervious cover, and buildings—zonal statistics were run on the Quickbird classified LULC raster, specifying park boundaries as the zones. Cell size was set at 10 and cell assignment was set at center. From these values, percent coverage for the different land uses was calculated. SAVI values were computed by running zonal statistics on the SAVI raster using the park boundaries as the zones to be averaged.

Average population density in park neighborhoods was computed by first intersecting the park layer with census blocks containing data on population density, then summarizing the average population density for all blocks within ¼-mile of each park. Average median household income in park neighborhoods was computed by first intersecting the park layer with block groups containing data on median household income, then summarizing income for all block groups within ¼-mile of each park. Ethnic mix in park neighborhoods was computed by first intersecting the park layer with block groups containing data on population ethnicities, then summarizing average values of white, black, Hispanic, and other race for all block groups within ¼-mile of each park.

To calculate urban intensity and landuse mix around parks, all single-family, multi-family, commercial/industrial, and retail parcels within ¼-mile of parks were selected, then values for each category were summarized by park. Retail included the following land uses: convenience stores, strip malls, restaurants, bars, car dealers, banks, motels, hotels, and store/office combos. The various levels (1-5) correlate to a gradient of urban intensity, with lower levels comprised of more low-density residential land uses and fewer commercial/industrial and retail uses. Moving higher in the gradient, the land uses become less residential and increasingly dense and diverse.

Level 1: >50% Single-family homes
Level 2: >50% Single-family homes & >30% commercial/industrial mix
Level 3: >50% Multi-family homes
Level 4: >50% Multi-family homes & >30% commercial/industrial mix
Level 5: >50% Commercial/industrial mix

Eight park neighborhoods that did not fit in these levels were classified as follows:

Level 1: 40-50% Single-family homes
Level 3: 40-50% Multi-family or >30% single-family + >40% commercial/industrial
Level 4: >40% commercial/industrial & >30% multi-family.

Analysis

The analysis of these results progressed through several steps. First, all data were entered into a SPSS database, and descriptive statistics and correlations were computed and analyzed to obtain an overall picture of the variables, individual park sites (cases) and their relationship to each other. Next, a Principal Component Analysis (PCA) was run on the variables to reduce the overlap and redundancy in data, and reveal which factors explained the majority of the variance in park and park neighborhood characteristics. The PCA was conducted using Varimax rotation, and variables were saved as factor scores using regression. Three variables (drinking fountains, water features, and SAVI values) were removed in this stage because they failed to be included in a component above a significance value of 0.4. The best solution was five factors that explained 56% of variance.

Next, a two-step cluster analysis was run using the components identified in the PCA. Cluster analysis (CA) is a "statistical method of partitioning a sample into homogeneous classes to produce an operational classification" (Burns and Burns 2008: 553). CA is an exploratory method of data analysis that clusters individual cases (in this research, parks) into groups in a way that statistically maximizes the similarity of cases within each group as well as the differences *between* groups. Widely used and recommended for its rigor, this study applied a two-step method that included both a Ward's Hierarchical test and k-means test (Song and Knapp 2007; Burns and Burns 2008). A Hierarchical Cluster Analysis (using Ward's method and Squared Euclidean Distance) was run on regression factor scores identified in the PCA to determine the appropriate number of clusters. Then, the k-means method was used to form the clusters, assigning each case a specific group based on their similarities with regards to the factors.

Finally, a profile analysis was conducted to test the validity of the results. This consisted of running descriptives on each cluster, ANOVA tests on clusters for each factor, and finally f-tests to help describe the clusters. The clusters were also plotted on a map to facilitate further examination of the results, spatially.

RESULTS

The 162 parks analyzed in this study (Figure 2.1) ranged in size from 0.17 to over 16,000 acres with a mean size of nearly 180 acres and a standard deviation of 1320. The total acreage of all parks in the study was 29,116 acres. Five parks were over 1000 acres. The majority of the parks (59%) were five or more miles from the city center, while a small percentage (15%, n=24) were within a two-mile radius of the core.

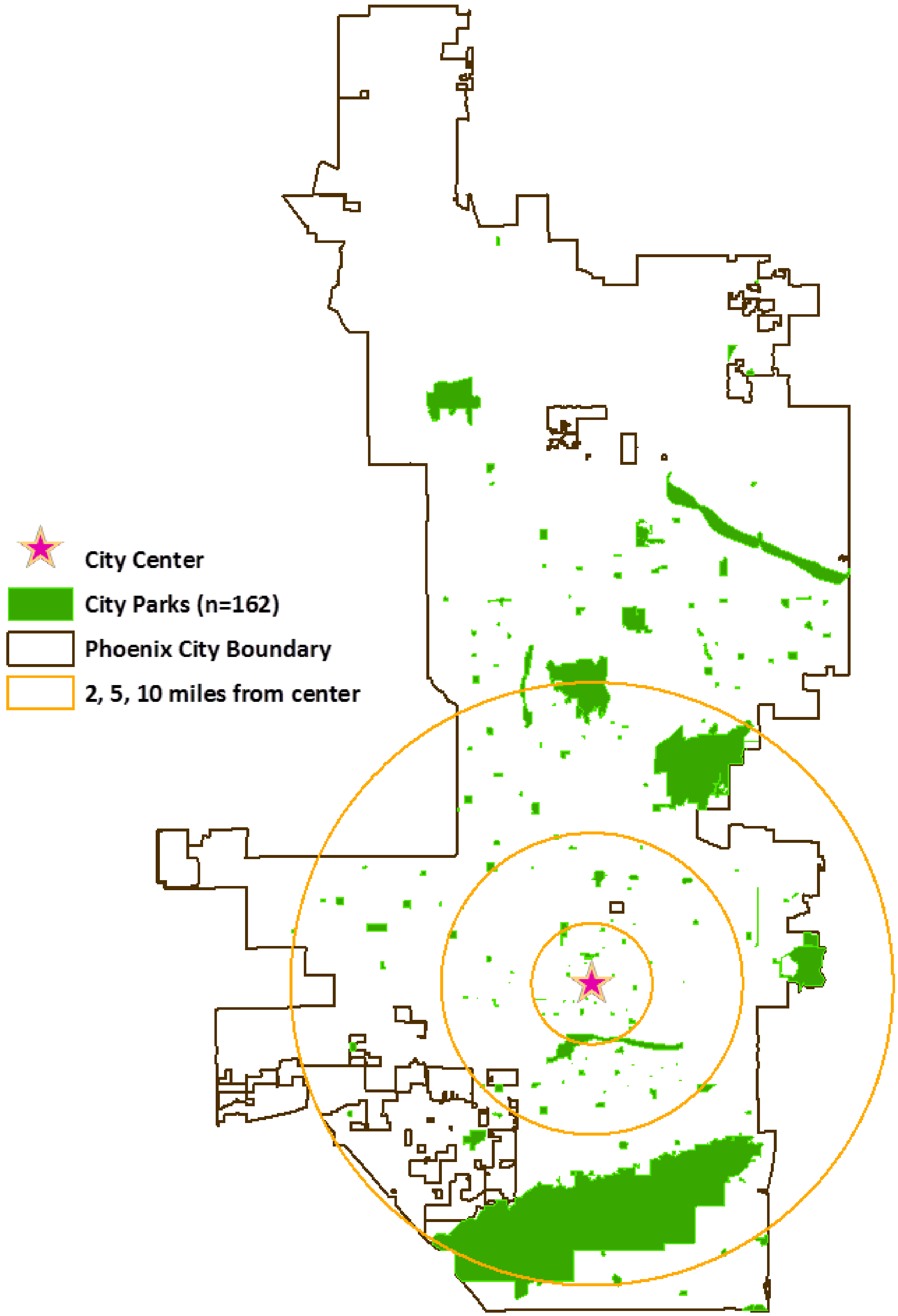


Figure 2.1 Map of parks in study sample and Phoenix city center

More than three-quarters of the 162 parks were equipped with playgrounds (n=135), ball courts or fields (n=130), and/or picnic areas or grilling facilities (n=123) (Figure 2.2). About two-thirds of the sites had some sort of shaded area and half the parks had restrooms. More than a quarter of the parks included pools (n=43). Few parks had paths or trails (14%, n=23), community centers (12%, n=20), drinking fountains (11%, n=18), or water features such as a lake or lagoon (10%, n=16). The average number of amenities (out of ten possible), for each park was 4.3, while some sites had no amenities and others provided as many as eight of the then.

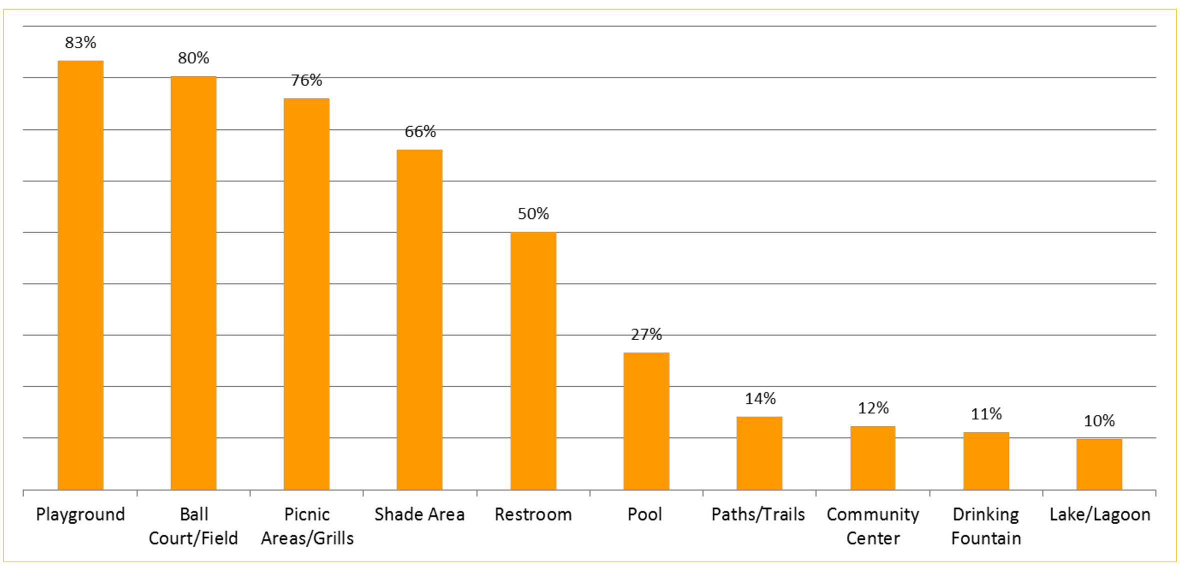


Figure 2.2 Percent of parks with various amenities

The area of soil, grass, trees, and grass + trees in each park varied greatly. Some parks contained no grass while others had as much as 93% grass coverage. Likewise, some parks had no trees, while others contained up to 62% tree coverage. Combining grass and tree areas (i.e. grass + trees), values ranged from 0 to 97%, with an average of just over 50%. Average coverage of soil ('brown') in the parks was 33%, ranging from 0-97%. Regarding the level of development, here defined as the percentage of building area plus other impervious cover, parks were on average 14% developed, with a range of 0-79%. Average 'greenness' or SAVI values (based on a scale of 0-1) for the parks ranged from 0.07 to 0.95, with a mean of 0.48.

With respect to the characteristics of the neighborhoods surrounding the 162 study sites, the median household income ranged from $9277-$154,548 with an average of $52,036 (Table 2.2). The average median household income for all the census block groups (n=1039) was $56,186, $4150 higher than for the park neighborhoods. The average population density of all park neighborhoods was 7.2 people per acre, with a maximum density of 23.2 people per acre and a minimum density of 0.24 people per acre. Average density for all census blocks in the city (n=10,684), was 9.2 people per acre. The total population of all census blocks (n=21,428) was 1,460,666. The largest ethnicity was white (47%), followed by Hispanic (41%), and all other ethnicities combined represented the remaining 12% of the population. Some 43% of all the parks were located in Hispanic-dominated neighborhoods and 44% in predominantly white neighborhoods. When compared to the total. The dwelling-type in park neighborhoods was overwhelmingly single-family zoned. Of the 120,128 parcels within ¼-mile of the parks, 81% were single-family, 12% were multi-family, 6% were commercial/industrial, and just 2% were zoned retail.

Table 2.2 Descriptive Statistics for Variables

Variable	Mean	Median	Std. Dev.	Minimum	Maximum
Area (acres)	179.68	10.20	1320.51	0.17	16289.27
Community Centers	0.12	0.00	0.33	0.00	1.00
Paths Trails	0.14	0.00	0.35	0.00	1.00
Ball Court	0.80	1.00	0.40	0.00	1.00
Playground	0.83	1.00	0.37	0.00	1.00
Pool	0.27	0.00	0.44	0.00	1.00
Water	0.10	0.00	0.30	0.00	1.00
Shade	0.66	1.00	0.48	0.00	1.00
Drinking Fount	0.11	0.00	0.32	0.00	1.00
Restroom	0.50	0.50	0.50	0.00	1.00
Picnic	0.76	1.00	0.43	0.00	1.00
% 10 Amenities	0.43	0.45	0.19	0.00	0.80
Grass	0.36	0.36	0.24	0.00	0.93
Trees	0.16	0.12	0.13	0.00	0.62
Trees Grass	0.52	0.55	0.26	0.00	0.97
Soil	0.33	0.28	0.24	0.00	0.97
Impervious	0.07	0.05	0.08	0.00	0.58
Buildings	0.07	0.04	0.10	0.00	0.61
Developed	0.14	0.12	0.14	0.00	0.79
SAVI	0.48	0.47	0.19	0.07	0.95
Nbhd Income	52037	41988	27821	9277	154548
Nbhd Pop Den	7.17	7.06	4.09	0.24	23.20
% Hispanic	0.44	0.41	0.29	0.04	0.93
% White	0.43	0.41	0.30	0.03	0.92
% Black	0.07	0.04	0.08	0.00	0.47
% Other Ethnicity	0.04	0.04	0.03	0.00	0.14
% Single family	0.79	0.86	0.24	0.04	1.00
% Multi family	0.10	0.03	0.16	0.00	0.84
% Retail	0.02	0.01	0.03	0.00	0.13
% CI	0.09	0.03	0.14	0.00	0.70
CI and Retail	0.11	0.04	0.16	0.00	0.73
Landuse Mix	1.37	1.00	1.00	1.00	5.00
Distance to center (miles)	179.68	10.20	1320.51	0.17	16289.27

Correlations

All the following correlation results are statistically significant at either the 0.01 or 0.05 level based on a two-tailed test (Table 2.3).

Physical

Larger parks were statistically more likely to have ball courts/fields, playgrounds, pools, water features, restrooms, picnic areas, and overall a larger percentage and diversity of total amenities. Larger parks also tended to be less developed overall, surrounded by fewer retail and commercial parcels, and generally exhibited higher SAVI values. The neighborhoods around larger parks tended to be higher income, less Hispanic and more white. Larger parks were also located farther from the city center. Parks with a large diversity of amenities were generally larger and less developed. High amenity parks also tended to have the following amenities more than others did: community centers, ball courts/fields, playgrounds, pools, water features, shade structures, drinking fountains, restrooms, and picnic facilities. These parks also tended to have higher average SAVI values.

Ecological & Environmental

Greener parks (i.e. those with more grass and trees) had statistically higher SAVI values, less paths/trails, more ball courts/fields, and more picnic facilities. These parks were generally in higher density neighborhoods with less commercial and industrial parcels. Parks with more soil land cover were farther from the city center with more paths/trails, less impervious cover, and were located in neighborhoods with higher incomes and lower population density. Parks with higher average vegetation (SAVI) tended to be larger and were more likely to have restrooms, picnic areas, and a higher diversity of amenities overall.

As predicted, higher SAVI values were also significantly correlated with less impervious and building cover and more grass + trees. Parks with high average SAVI also were surrounded by less commercial/industrial and retail parcels and were farther from the city center.

Social

Parks in high-income neighborhoods were significantly more likely to be larger, farther from the city center, and in less 'urban' (i.e. high density, mixed-use) neighborhoods. These parks also tended to have more soil coverage and were less developed overall. High-income neighborhoods with parks were also significantly less Hispanic and black and more white, with more single-family and less commercial/industrial and retail parcels. Parks in high-density neighborhoods were correlated with more grass + trees, particularly more grass. These neighborhoods were lower income, more Hispanic, and less white and contained less commercial/industrial and retail parcels. Parks in neighborhoods with larger Hispanic populations were smaller with fewer paths/trails, drinking fountains, trees, and were more developed. These parks were located closer to the urban core and were generally surrounded by fewer single- and multi-family parcels, but more commercial/industrial and retail parcels.

Built Environment

More developed parks (i.e. those with more impervious cover and building area) tended to not have restrooms, picnic areas, and had fewer amenities overall. Predictably, they had lower SAVI values and less grass + trees. These parks were located closer to the urban core, mostly in lower-income neighborhoods with more Hispanic and black, fewer white residents, and more commercial/industrial and retail parcels.

Parks in neighborhoods comprised of predominantly single-family parcels tended to be outside the urban center, with higher SAVI values, income, and percentages of white residents. Parks in predominantly multi-family neighborhoods were correlated with fewer playgrounds, higher urban intensity, and more retail parcels. Parks in neighborhoods with lots of commercial and industrial uses were closer to the urban center, less developed, and retained lower SAVI values. These neighborhoods had fewer single-family parcels, were of higher urban intensity, and had higher Hispanic and black populations, as compared to white. Park neighborhoods with more retail parcels were correlated with lower-income neighborhoods with more Hispanic and fewer white residents, as well as fewer single-family and more multi-family parcels.

Parks in neighborhoods with a higher urban intensity (i.e. higher levels of landuse mix) were negatively correlated with SAVI, income, population density, percentages of white residents, and distance to the city center. These park neighborhoods tended to have more commercial/industrial, multi-family, and retail parcels. Parks closer to the city center were smaller with fewer paths and trails, less soil, and were located in neighborhoods that were lower income and less white. Smaller parks were more developed and in neighborhoods that were more Hispanic with more commercial/industrial and retail land uses.

Table 2.3 Person's Correlations	Area	Comm. Centers	Paths/ Trails	Ball Court	Playgr ound	Pool	Water	Shade	Drink Fount.	Rest- room	Picnic
Area	1	.125	.117	.291**	.176*	.299**	.360**	.157	.087	.419**	.220**
Comm. Centers	.125	1	-.045	.092	.067	.199*	.064	.071	.046	.263**	.036
Paths/Trails	.117	-.045	1	-.198*	.245**	.116	.043	.030	.138	-.053	-.185*
Ball Court	.291**	.092	-.198*	1	.319**	.088	.060	.234**	-.022	.372**	.228**
Playground	.176*	.067	-.245**	.319**	1	.119	-.019	.379**	.000	.315**	.484**
Pool	.299**	.199*	.116	.088	.119	1	.129	.077	.099	.210**	.175*
Water	.360**	.064	.043	.060	-.019	.129	1	.106	-.051	.207**	.138
Shade	.157	.071	.030	.234**	.379**	.077	.106	1	.005	.352**	.511**
Drink Fount.	.087	.046	.138	-.022	.000	.099	-.051	.005	1	.000	.015
Restroom	.419**	.263**	-.053	.372**	.315**	.210**	.207**	.352**	.000	1	.476**
Picnic	.220**	.036	-.185*	.228**	.484**	.175*	.138	.511**	.015	.476**	1
% Amenities	.475**	.360**	.096	.491**	.547**	.486**	.322**	.640**	.216**	.723**	.665**
Grass	.050	-.004	-.302**	.219**	.161*	.008	-.133	.155*	-.005	.104	.268**
Trees	.064	-.148	-.079	-.030	-.115	.002	.111	-.044	.024	-.071	.071
Trees + Grass	.081	-.080	-.313**	.183*	.085	.009	-.063	.117	.007	.058	.278**
Soil	.060	-.009	.391**	-.113	-.029	-.031	-.007	-.002	.008	.033	-.151
% Impervious	-.017	.167*	.062	-.140	-.063	.116	.204**	-.108	.023	-.055	-.030
Buildings	.332**	.108	-.143	-.115	-.124	-.075	-.134	.229**	-.039	.215**	.372**
Developed	.258**	.177*	-.070	-.167*	-.129	.012	.019	.232**	-.015	-.191*	.293**
SAVI	.277**	-.013	.046	.137	.071	.077	-.004	.153	-.056	.167*	.183*
Nbhd Income	.250**	-.164*	.193*	-.007	-.041	-.030	.041	.068	.094	.002	.056
Nbhd Pop Den	-.152	.085	-.202**	.017	.029	.073	-.140	.061	-.081	-.141	.077
% Hispanic	.282**	.121	-.279**	.131	.108	-.055	-.089	.049	-.216**	.110	.047
% White	.257**	-.103	.282**	-.132	-.074	.070	.075	-.050	.207**	-.129	.011
% Black	-.096	-.061	-.141	.014	-.068	-.097	-.020	-.048	-.072	.030	.231**
% Other Ethn.	.290**	.051	.190*	.043	-.097	.065	.121	.168*	.150	.185*	.046
% Single family	.124	-.073	-.009	.053	.178*	.121	-.071	.082	-.007	.063	.120
% Multi family	.006	-.009	.081	-.128	.213**	-.006	.038	-.031	.061	-.110	-.096
% Retail	-.183*	.183*	-.026	-.001	-.023	-.061	.101	-.087	-.022	-.058	-.130
% CI	-.189*	.098	-.071	.055	-.060	-.188*	.058	-.087	-.052	.029	-.070
CI and Retail	-.199*	.118	-.067	.048	-.057	-.176*	.068	-.091	-.049	.015	-.085
Landuse Mix	-.096	.049	.062	.045	-.067	-.182*	.043	-.074	-.013	.012	-.095
Mi to center	.266**	.010	.296**	.059	.063	.126	-.074	.063	.165*	-.131	-.003

** Correlation is significant at the 0.01 level (2-tailed); * Significant at the 0.05 level (2-tailed).

Table 2.3 Continued.						
	% Amen-ities	Grass	Trees	Trees + Grass	Soil	% Imper-vious
Area	.475**	.050	.064	.081	.060	-.017
Comm. Centers	.360**	-.004	-.148	-.080	-.009	.167*
Paths/Trails	.096	.302**	-.079	.313**	.391**	.062
Ball Court	.491**	.219**	-.030	.183*	-.113	-.140
Playground	.547**	.161*	-.115	.085	-.029	-.063
Pool	.486**	.008	.002	.009	-.031	.116
Water	.322**	-.133	.111	-.063	-.007	.204**
Shade	.640**	.155*	-.044	.117	-.002	-.108
Drink Fount.	.216**	-.005	.024	.007	.008	.023
Restroom	.723**	.104	-.071	.058	.033	-.055
Picnic	.665**	.268**	.071	.278**	-.151	-.030
% Amenities	1	.129	-.061	.085	.008	.014
Grass	.129	1	-.087	.858**	.714**	-.267**
Trees	-.061	-.087	1	.437**	.394**	.064
Trees + Grass	.085	.858**	.437**	1	.848**	-.209**
Soil	.008	.714**	.394**	.848**	1	-.180*
% Impervious	.014	.267**	.064	.209**	-.180*	1
Buildings	-.302**	.317**	.265**	.422**	.005	.129
Developed	-.216**	.390**	-.159*	.435**	-.101	.678**
SAVI	.183*	.219**	.133	.266**	-.108	-.251**
Nbhd Income	.043	-.043	.116	.021	.159*	-.139
Nbhd Pop Den	-.037	.313**	.047	.307**	.371**	.106
% Hispanic	.008	-.008	.207**	-.114	-.052	.110
% White	.010	.023	.243**	.146	.036	-.086
% Black	-.142	-.109	-.191*	-.197*	.054	-.074
% Other Ethn.	.196*	.102	.019	.102	.003	.019
% Single family	.113	.077	.058	.099	-.044	-.053
% Multi family	-.100	.013	.051	.038	-.017	-.032
% Retail	-.046	.268**	-.046	.266**	.117	.220**
% CI	-.070	-.092	-.147	-.159*	.071	.082
CI and Retail	-.070	-.128	-.137	-.186*	.083	.111
Landuse Mix	-.059	-.056	-.033	-.068	.071	-.041
Mi to center	.107	.035	-.022	.021	.176*	-.183*

Principal Component Analysis

The PCA uncovered five statistically significant dimensions in the data, explaining 56% percent of the total variation (Table 2.4). Three variables (drinking fountains, water features, SAVI) did not fit into a factor group above the cut off of 0.4, and so were removed from the subsequent steps. The final five factors are:

- Factor 1: *Neighborhood landuse* (parks located in neighborhoods of high urban intensity/diverse landuse mix. Fewer single-family parcels correlated with more multi-family, commercial/industrial, and retail parcels)
- Factor 2: *Ethnicity & urban location* (parks located in affluent, white-dominated neighborhoods with few Hispanic or black residents correlated with large distances from the city center and fewer buildings).
- Factor 3: *Amenities* (parks with a high diversity of amenities overall and likely to contain restrooms, picnic areas, shade areas, playgrounds, and ball courts)
- Factor 4: *Size, land cover, neighborhood density* (smaller parks dominated by trees and grass, in densely populated neighborhoods correlated with less soil cover and fewer paths/trails).
- Factor 5: *Level of development* (highly developed parks dominated by impervious surfaces and buildings, with community centers and pools)

Table 2.4 Rotated Component Matrix for PCA

	Component				
	1	2	3	4	5
% Single family	-0.923	0.001	0.116	-0.018	-0.048
CI and Retail	0.889	-0.271	0.02	-0.115	0.049
% CI	0.87	-0.261	0.027	-0.11	-0.001
Landuse Mix	0.837	-0.088	-0.006	-0.088	-0.128
% Retail	0.711	-0.236	-0.02	-0.1	0.277
% Multi family	0.501	0.272	-0.196	0.143	0.024
% White	-0.209	0.883	-0.156	-0.074	-0.103
% Hispanic	0.193	-0.844	0.175	0.111	0.116
Nbhd Income	-0.412	0.645	-0.043	-0.253	-0.211
Distance to center	-0.439	0.602	-0.01	-0.179	-0.137
Buildings	0.006	-0.582	-0.355	-0.159	0.379
% Black	0.102	-0.517	-0.085	-0.126	-0.031
% Other Ethnicity	-0.008	0.426	0.145	-0.004	0.025
Drinking Fount	*0.028*	*0.314*	*0.04*	*-0.025*	*0.181*
% 10 Amenities	-0.034	0.2	0.935	-0.033	0.231
Restroom	0.029	0.003	0.765	-0.067	0.052

Picnic	-0.06	0.11	0.725	0.211	-0.027
Shade	-0.06	0.062	0.661	-0.018	-0.069
Playground	-0.141	-0.14	0.63	0.053	-0.018
Ball Court	0.015	-0.093	0.555	0.118	-0.106
Soil	0.024	-0.008	0.018	-0.925	-0.084
Trees + Grass	-0.039	0.223	0.142	0.872	-0.337
Grass	-0.052	0.046	0.234	0.725	-0.39
Nbhd Pop Den	-0.189	-0.233	-0.027	0.562	0.131
Paths/Trails	0.021	0.403	-0.09	-0.484	0.081
Trees	0.014	0.353	-0.134	0.421	0.03
Area	-0.028	0.113	-0.082	-0.406	-0.192
Impervious	0.049	0.011	-0.126	0.092	0.803
Developed	0.033	-0.425	-0.337	-0.064	0.748
Community Centers	0.089	-0.024	0.291	-0.007	0.419
Pool	-0.159	0.186	0.33	0.036	0.409
Water	*0.157*	*0.245*	*0.24*	*-0.048*	*0.324*
SAVI	*-0.3*	*0.117*	*0.228*	*0.121*	*-0.303*

Two-Step Cluster Analysis

The first step of the two-step cluster analysis involved running a Hierarchical Cluster Analysis using Ward' s method and Euclidean Distance on the 162 parks, using the components identified in the PCA. This revealed an optimal number of nine clusters. Setting the fixed number of clusters at nine, the k-means test then revealed a set of distinct park types. Table 2.5 presents data on the cluster centroids which indicate the general attributes of the cases in each group, or park type, as well as how they differ from the other park types with regards to the five dimensions revealed in the PCA. The results of the profile analysis support the validity of these findings. ANOVA tests revealed that all clusters are statistically significant at the 0.000 level (Table 2.6). The map in Figure 2.3 displays the spatial distribution of the various park types, and figure 2.4 shows the spatial distribution of each individual park type.

Table 2.5 Final Cluster Centers

Dimen-sions	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Cluster 9
N	10	43	12	21	6	16	16	27	11
Factor 1	0.4682	0.5286	0.2235	0.3369	0.0807	0.5036	2.1084	0.0026	0.4709
Factor 2	0.8935	0.1056	1.8598	1.0735	0.3816	0.8388	0.6225	0.2737	0.2710
Factor 3	0.0833	0.2294	1.5416	0.1283	1.5509	1.3978	0.3553	0.8766	0.8264
Factor 4	2.4593	0.7536	0.7582	0.3437	0.3868	0.8520	0.4258	0.3441	0.9024
Factor 5	0.7845	0.6332	0.3507	0.3036	2.8605	0.5637	0.4192	0.9811	0.3125

Park Type #1 (n=10): *Minimally developed large desert parks in affluent, white neighborhoods*

Ten cases (6.2%) fell into the first park type. This park type is most similar to dimension two and extremely different from factor four. As such, these parks are generally large and more 'brown' (contain more soil cover and lower percentages of grass and tree cover), and contain paths or trails for walking, hiking, biking, and/or horse riding. These parks are generally located in the city fringes in affluent, low-density, white-dominated neighborhoods with few minorities.

Park Type #2 (n=43)*: Small, green parks*

The majority of the parks in this study, 26.5% (n=43), fell into category #2. This park type is very similar to factor four, most different from factor five. This category consists predominantly of smaller, green parks dominated by trees and grass and located in densely populated neighborhoods. They tend to be less developed overall with less impervious cover, and fewer community centers or pools.

Park Type # 3 (n=12): *Low-amenity, urban parks in minority neighborhoods*

Twelve cases (7.4%) were classified under park type #3, which is most different from factors two and three. These parks tend to be closer to the city center and have few amenities overall, particularly fewer restrooms, picnic areas, shade areas, playgrounds, and ball courts. The neighborhoods around these parks are predominantly Hispanic and other minority, with fewer white residents.

Park Type #4 (n=21): *Parks in affluent white neighborhoods*

Twenty-one sites (13%) were designated as park type #4. This group is very similar to factor #2 and is slightly different from factors one and four. These parks are best characterized as those located in white, affluent neighborhoods with few black or Hispanic residents. They tend to be somewhat farther from the city center.

Park Type #5 (n=6): *Community center parks*

Cluster five contained only six parks (3.7%), making it the smallest number of all the types. This group is extremely similar to factor five and quite different from the third factor. This park type tends to be highly developed parks dominated by impervious surfaces and buildings, with community centers and pools. These sites often do not have other types of amenities though, likely because the majority of the amenities are located inside the community centers themselves.

Park Type #6 (n=16): *Small, green park in affluent, white neighborhoods outside city center*

The sixth cluster, containing nearly a tenth of the cases (n=16), is very different from factor three, but quite similar to both the second and fourth dimensions. These parks are generally smaller and greener in more affluent, white neighborhoods outside the urban center with few park amenities such as restrooms, picnic areas, playgrounds, and ball courts/fields.

Park Type #7 (n=16): *Parks in low-income highly 'urban,' minority neighborhoods*

The seventh park type is quite similar to factor one, and most different from the second dimension. This category contains nearly 10% of all the sites and is predominantly comprised of parks close to the city center, located in lower-income, minority neighborhoods of high urban intensity.

Park Type #8 (n=27): *Highly-developed, high amenity parks*

The eighth park type is the second largest group, containing almost 17% (n=27) of the cases. It is quite similar to both factor three and five. As such, these parks are highly developed with a large diversity of amenities, particularly restrooms, picnic areas, shade structures, playgrounds, and ball courts/fields.

Park Type #9 (n=11): *Large, high amenity desert parks*

The final park type contains eleven cases, is most similar to factor three, and most different from factor four. Generally, these are larger parks with a high diversity of amenities overall, particularly likely to contain restrooms, picnic areas, shade areas, playgrounds, ball courts, and trails/paths. These parks are more 'brown' (have more soil and less grass and tree coverage) and located in less dense neighborhoods.

Table 2.6 ANOVA Test for Clusters by Each Factor

		Sum of Squares	df	Mean Square	F	Sig.
Factor 1	Between Groups	94.848	8	11.856	27.421	.000
	Within Groups	66.152	153	0.432		
	Total	161	161			
Factor 2	Between Groups	95.33	8	11.916	27.763	.000
	Within Groups	65.67	153	0.429		
	Total	161	161			
Factor 3	Between Groups	107.171	8	13.396	38.077	.000
	Within Groups	53.829	153	0.352		
	Total	161	161			
Factor 4	Between Groups	121.847	8	15.231	59.518	.000
	Within Groups	39.153	153	0.256		
	Total	161	161			
Factor 5	Between Groups	110.861	8	13.858	42.287	.000
	Within Groups	50.139	153	0.328		
	Total	161	161			

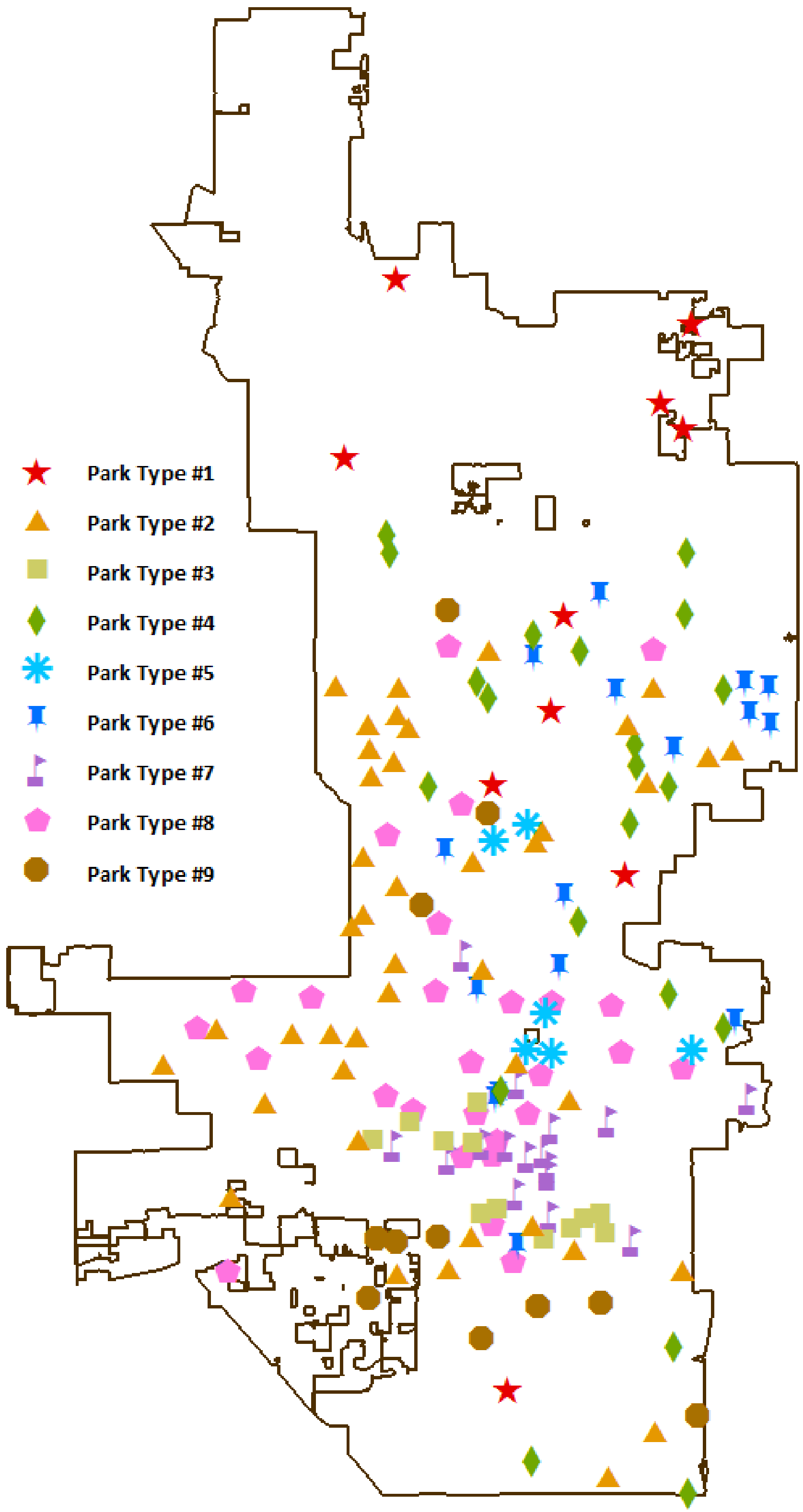


Figure 2.3 Map of all parks by cluster/ park type membership.

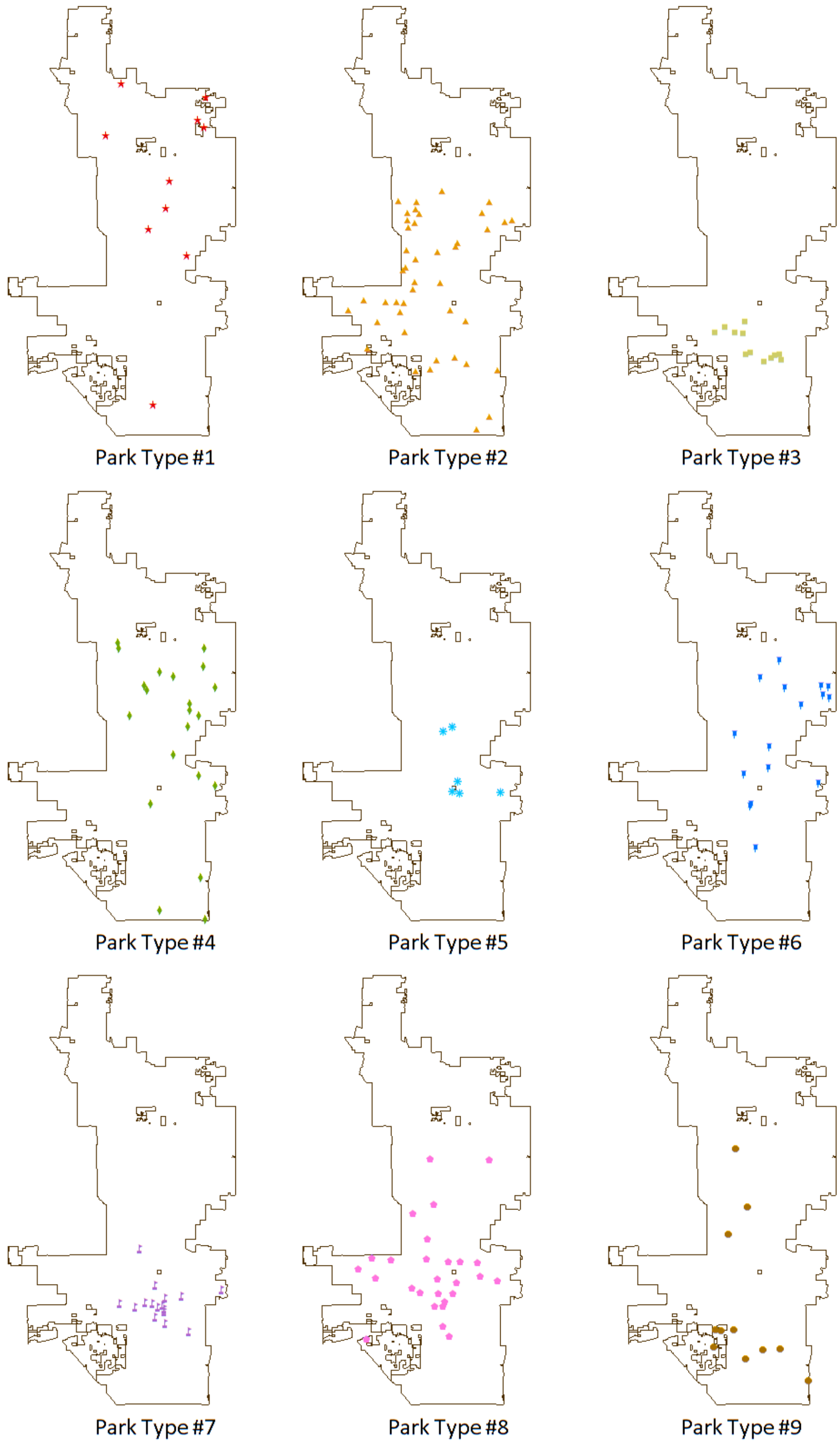


Figure 2.4 Maps for each of the nine park types.

DISCUSSION

This exploration has served to enhance understanding of the physical, ecological, social, and built characteristics of the civic space system in Phoenix through quantitative analysis and classification methods. The results reveal numerous points of departure for advancing the social and ecological sustainability of the city's civic space system, and by extension the city itself. The policy implications of key findings and recommendations for improvements are discussed below.

Results from the descriptive statistics and correlations conducted on the 33 variables for the 162 parks highlighted the strengths and weaknesses of the Phoenix parks system with regards to sustainability measures. Several findings suggest the city's parks are successfully contributing to the sustainability of the city, in some cases synergistically amplifying both social and ecological health. The presence of several very large parks, outside the city center, minimally developed, and not highly irrigated suggests these parks are protecting native biodiversity and ecological functioning (Esbah et al. 2009), while providing recreational benefits for urban residents. The presence of playgrounds, ball courts/fields, and picnic areas in most of the city parks indicates that existing parks are also providing important recreational amenities shown to reduce rates of obesity and facilitate social interaction in parks (Bauman et al. 1999; Giles-Corti and Donovan 2002; Low et al. 2005; Gordon-Larsen et al. 2006).

Several key findings also indicate equity with regards to park distribution and the amount of 'green' vegetation in Phoenix. First, the fact that neighborhoods around parks were found to have lower household incomes than the city as a whole indicates that these amenities are not disproportionately located in affluent neighborhoods. Second, the number of parks in Hispanic and white-dominated neighborhoods were found to be nearly equal.

Since the Hispanic population of the city is slightly smaller than the white population, this suggests that proportionally Hispanics have higher access (based on proximity) to parks overall. Finally, parks in higher density, low-income, Hispanic neighborhoods tended to be more 'green' (i.e. with more grass and trees coverage), which is an attribute linked to increased human health and well-being in the parks literature (Chiesura 2004; White et al. 2013).

Alternatively, some results highlight areas for improvement of the Phoenix parks system. Only half the parks had restrooms which are critical for encouraging park use (Molotch and Noren 2010). Most, but not all parks provided some form of shade structure, but very few had drinking fountains. These amenities should be provided in most if not all parks as they are critical in hot arid cities. Very few parks had paths or trails which are important recreational amenities that encourage exercise and therefore can reduce rates of neighborhood obesity (Kaczynski et al. 2008). Overall, the city parks averaged about four of the ten amenities measured, but this varied greatly across parks, wherein some parks had no amenities and some had up to 80%. The land area of all the parks in this study totaled 29,116 acres, about one-third of which was soil and another one-third grass. Increasing grass cover in certain areas may help reduce the urban heat island effect, but this should be balanced by water tradeoff considerations (Jenerette et al. 2011).

Evidence that population density around parks was lower than for the city overall, and that park neighborhoods were dominated by single-family residential land uses and few active uses (i.e. retail), suggests that park accessibility in Phoenix is limited. Increasing the density of developments around parks and integrating more active uses is recommended to expand the use and vitality of these spaces (Talen 2010). Although some measures pointed to environmental equity with regards to park distribution and physical characteristics, other findings suggested otherwise. Results indicated that low-income and minority populations had less access to *large* parks than wealthy, white populations. A similar result was found in a parks study conducted in Baltimore, Maryland, wherein black residents had higher access to parks within walking distance, but white residents had access to more park acreage (Boone et al. 2009). Also, parks in neighborhoods with more multi-family parcels were correlated with fewer playgrounds. These areas are likely to have more children of lower-income, and as such have a higher need for playgrounds and public space in general as these homes often have less 'private' outdoor space.

Policy Implications of Park Types

The principal component analysis identified five key factors that typified the park system in Phoenix. Using these factors, the cluster analysis produced nine distinct park types, each with a unique mix of physical, ecological, social, built, and spatial characteristics—and therefore particular implications with respect to sustainability policy.

The first park type was minimally-developed large desert parks in affluent, white neighborhoods. This group represents just 6.2% of the cases, but these parks play a critical role in the overall ecological sustainability of Phoenix. Parks in this category include South Mountain, Deem Hills, North Mountain Shaw Butte, Piestewa Peak—all large desert mountain preserves of over 1000 acres each (Figure 2.5). These are the areas that protect the majority of the cities native biodiversity habitat and highly valued scenic features, which is likely why these parks are surrounded by high-income neighborhoods. Yet the location of these parks in wealthy, white neighborhoods suggests an environmental injustice with regards to distribution of the aesthetic and recreation benefits provided by these spaces. Encouraging higher density, mixed-use land uses around these parks may extend their benefits, but could hamper their environmental quality. Because of their high ecological value, it is recommended areas around these parks remain of low urban intensity, but higher access by lower-income, minority communities should be pursued in other ways, perhaps through enhanced public transportation and/or outreach efforts.


Figure 2.5 Arial view of Piestewa Peak (left) (www.adamparonto.com) and bikers in South Mountain Park (right) (http://photos.anapana.com/hidden-valley-on-south-mountain-phoenix)

The largest group identified in the cluster analysis was park type #2. These parks are generally smaller (though they range in size from less than an acre to over 40 acres), dominated by grass and trees (with little impervious cover), and scattered throughout the city, particularly in more densely populated neighborhoods. A typical example of this park is El Prado, a 35-acre green park in South Phoenix (Figure 2.6). This park type responds to what Kunstler (2009:1) called for when he said, "what would benefit most American cities would be parks, squares, plazas, and other urban devices for public gathering designed on the small and intimate scale, distributed equitably around the city." These small to medium sized green parks are providing social benefit through the provisioning of public space, and are increasing human health and comfort by providing relief from the urban heat island. The benefits of these civic spaces could be further extended by increasing housing density and active uses in the surrounding neighborhoods. Field assessments of these parks are recommended to assess their quality, how they are being used, by whom, and what their potential ecological value is, or could be given small adjustments (e.g. installing bird feeders, planting native vegetation, or installing community gardens).

Figure 2.6 El Prado park (Google 2012).

The third park type—low-amenity urban parks in minority neighborhoods—seems to have low recreational and ecological value. This type includes several mini parks, including Eototo, Ho-E, Ninos, Kipok, and Toho (Figure 2.7). As the surrounding neighborhoods of these parks represent high-need populations, these areas should be targeted for improvements such as increased vegetation and the development of facilities such as picnic areas, playgrounds, and shade structures. Community participation is encouraged to determine the particular preferences and needs of the residents near these parks.

Figure 2.7 Yapa (left) and Eototo (right) mini parks (Google 2012).

The third most populated category of park were those located in affluent, white neighborhoods outside the urban center with few black or Hispanic residents (park type #4). These include Arcadia and Cashman parks, both located in high-income neighborhoods with large homes often equipped with private pools and quality private outdoor space (Figure 2.8). Similarly, parks in the sixth group (about 10% of all sites) were also located in white, affluent neighborhoods. The abundance of these parks in neighborhoods where residents are likely to have their own private outside spaces suggests questionable equity standards and future efforts should strive to remedy this inequity.

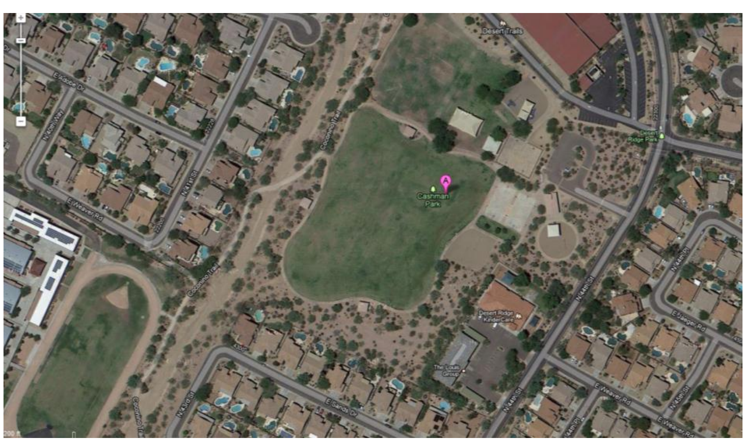


Figure 2.8 Cashman Park (Google Earth 2012)

Community center parks (#5) are mostly clustered in one area of the city, and they number only six. Future community center parks should be prioritized in high density neighborhoods and should be more evenly distributed around the city.

The seventh park type is highly clustered in the urban center. These parks are located in primarily low-income, minority neighborhoods of high urban intensity with a diverse landuse mix. Examples include the Rio Salado Restoration Area and Papago District Park. These areas provide needed social benefits in these high need neighborhoods.

High amenity parks (#8) represented the second largest park type in Phoenix. One of the most visited parks in the nation, Encanto Park (TPL 2011), is included in this group. These parks are not highly clustered in a single area of the city, therefore it can be said that they are providing necessary recreational benefits to a large portion of the city. Nonetheless, these parks are not correlated with high density neighborhoods, meaning their accessibility is limited. Encouraging higher density development around these parks is recommended. Future planning and redesign efforts in these two park types should focus on enhancing the social benefits of these civic spaces as their ecological value may be limited.

The final park type consisting of high amenity 'brown' parks with a diversity of amenities, include Mountain Vista and Cesar Chavez park (Figure 2.9). These civic space types provide both social recreational value and native biodiversity and habitat protection. More detailed field work in these parks should be conducted to determine how the ecological value of these larger, desert parks can be increased.

Figure 2.9 Cesar Chavez Park (Google 2012)

CONCLUSION

This research has moved beyond current simplistic classification schemes to generate a nuanced, multi-dimensional understanding of the physical, ecological, social, built, and spatial characteristics of the Phoenix park system that can help direct targeted efforts aimed at advancing the region's sustainability through civic space planning and design. This research also provided a place-specific means of quantitatively analyzing urban parks that can be adapted for use in other cities based on their specific social, economic, environmental, and climatic conditions, urban form, and public policy goals. And finally, this study provided a point of departure for the development, realization, and evaluation of public policy and initiatives focused on urban sustainability in Phoenix.

Results of this study suggest that in many respects, the park system in Phoenix is socially and environmentally functional. Large, minimally disturbed desert parks are serving a critical ecological function by protecting native biodiversity and providing low-impact recreation for residents, while a number of smaller, often irrigated 'green' and/or amenity-rich parks are providing relief from the urban heat island and environments conducive to physical activity and social integration. Findings also suggest that access (via proximity) to parks by low-income and minority populations is relatively equitable and access to green parks was higher in Hispanic neighborhoods, likely because many larger parks in Phoenix maintain native xeric vegetation. However, correlations between wealthy, white neighborhoods with large desert parks of high recreational and scenic values indicate an environmental injustice, echoing findings by Boone et al. (2009) who determined that wealthy, white populations in Phoenix have access to more park acreage than low-income minorities. Since affluent residents are more likely than poorer residents to maintain large private yards, this finding is particularly problematic. Efforts aimed at achieving more equitable access to mountain parks in Phoenix are recommended.

Several other critical areas for improvement to the Phoenix park system were also revealed by this study. The lack of restrooms, trails, and drinking fountains in most parks should be remedied as such features enhance park access and use for physical activity, particularly in hot regions. Also the abundance of single-family homes and low population density around parks, as well as negative correlations between multi-family parcels and playgrounds, indicates that access to parks overall is limited, particularly access to children's recreational amenities. In response to these findings, access may be increased not necessarily by creating new parks, but by incorporating playgrounds into existing parks and encouraging higher density housing and mixed use development around smaller civic spaces (e.g. not mountain preserves). Lastly, community center parks were found to be highly clustered, limiting the reach of these valuable amenities. The location of future recreation centers should consider geographic distribution and socio-economic variables of potential neighborhoods, targeting low-income areas currently underserved by these facilities.

In sum, this research paints an optimistic picture of the present and potential future state of Phoenix's urban park system. Over time, targeted improvements—sensitive to the social, ecological, built, and geographic context of the city—will serve to continually enhance the contribution of public spaces to the sustainability of this unique desert city, potentially making it a model for other large arid urban regions worldwide. To expand the likelihood of success, the development of specific policies should be preceded by in-depth field assessments at individual parks to assess their social and ecological characteristics, and planners should strive to incorporate community participation into each stage of the decision-making process.

Chapter 3

CIVIC SPACES ALONG THE TRANSECT: TOWARDS A MORE COHERENT, SUSTAINABLE URBANISM

INTRODUCTION

Phoenix, Arizona is known for being one of the most unsustainable cities in the United States (Overpeck and Udall 2010; Ross 2011). The culprit, according to many urban scholars is the City's poor urban form, itself a product of post-WWII rapid growth and government programs. The explosion of post-war births and 'white flight' out of inner cities, coupled with subsidies for highway expansion, private automobiles, and the development of new single-family housing outside of cities, has molded the landscape of many American cities in particular ways. The effect was the creation of expansive, sprawling cities with excessive road systems and abandoned urban centers (Gammage 1999; Duany 2000; Artibise et al. 2008). In Phoenix, the abundance of cheap, flat land and the adoption of Euclidean zoning in 1930 further contributed to isolated land uses and diffuse development. Subsequent auto-dependency has created even more problems—including high rates of fossil fuel pollution and hazardous air quality, particularly in low-income neighborhoods—contributing to degraded human health, social injustices, and ecological decline (Ross 2011).

Further, scholars worry that the pattern of development in Phoenix has led to reduced access to urban services, including urban civic spaces (Ewing 1997), which are critical amenities linked to enhanced quality of life, physical and psychological health, social equity, environmental functioning, and economic vitality in cities (Jacobs and Apple yard 1987; Mitchell 1995; Chiesura 2004; Bedimo-Rung et al. 2005; Forsyth and Musacchio 2005;

Harnik and Welle 2009; Harnik 2010). Complicating matters , urbanists warn that although parks are essential amenities, improper planning that ignores geographic context can lead to underutilized, unsafe, degraded civic spaces that disrupt the urban fabric and impede good urbanism (Jacobs 1961; Kunstler 1996; Duany and Talen 2001). Such shortcomings, it is argued, stem partly from urban design that assumes more and bigger is always better (Harnik 2010), and therefore ignores the "spatial context of urban civic spaces in a way that would empirically inform how parks are distributed relative to other urban characteristics" (Talen 2010: 474). As such, the improvement of urban form, more generally, and the careful planning of quality, location appropriate civic spaces are interconnected, and thus mutually beneficial or detrimental (Talen 2010).

To this end, this study explores a holistic framework for urban planning and civic space design—transect planning—that steers cities towards more sustainable (i.e. compact, mixed use, bikeable/walkable) urban form while preserving a variety of human and non-human habitats (Duany 2002; Duany and Talen 2002). Drawing from Patrick Geddes's (1915) *Valley Section*, Ian McHarg's (1965) *Design with Nature*, and Christopher Alexander's (1977) *Pattern Language*, transect planning was inspired by the concept of an ecological transect, in which one type of habitat transitions into another along a continuum. As applied to cities, transect planning organizes the built and natural environment along a gradient of six zones (T-zones) of varying urban intensity, each with its own unique character: T1-rural preserve, T2-rural reserve, T3-sub-urban, T4-general urban, T5-urban center, and T6-urban core. Although each of these zones is generically defined – e.g., T3 zones generally consist of single-family homes and duplexes while T6 zones contain high-rises – translating these ideals to actual coding requirements requires local calibration. Step-by-step guides for transect coding are outlined by Talen (2009b), Criterion Planners (2005), and the Phoenix Urban Research Lab (PURL 2011). Once a city is rezoned according to the transect, guidelines for design appropriate to each transect zone can be found in the SmartCode (2009) manual, which provides detailed standards for urban elements including civic spaces, building types, and tree placement.

With the overarching goal of advancing urban sustainability and promoting good urban form in the region, this research progressed through three main phases. First, zoning in Phoenix was reimagined using transect planning procedures to introduce and assess an alternative to Euclidean zoning. Transect planning promotes the evolution of a more compact, sustainable urban form, while supporting a variety of habitats for both human and natural systems. In the second phase, a macroanalysis of the entire city park system, as well as a more focused microanalysis of a sample of civic spaces in high need neighborhoods, was applied to evaluate current conditions and inform the intentional, coherent planning and design of context-appropriate civic spaces that contribute to good urban form. Finally, by applying transect-based code – the "SmartCode" – this research provides an empirical test and evaluation of these approaches in the context of a large, sprawling, desert city, thereby highlighting the strengths and weaknesses of each approach, while recommending place-specific alterations. Using spatial empirical analysis, archival, and visual methods, the analysis is guided by the following research questions:

1. What does the application of transect-based coding reveal about the urban morphology of Phoenix and how might it inform more compact, context-appropriate sustainable design in the city?
2. How and to what extent does the Phoenix parks system align with SmartCode guidelines for civic spaces?
3. How would transect planning inform the design of more context-sensitive civic spaces?

4. What does the application of transect planning to Phoenix and its civic spaces reveal about the strengths and weaknesses of each approach as applied to the study site?

BACKGROUND

Phoenix has been accused of being the most unsustainable city in the United States, and even the world (Overpeck and Udall 2010; Ross 2011). Andrew Ross wrote a book on the topic titled *Bird on Fire: Lessons from the World's Least Sustainable City*. Ross (2011: 4) notes:

> The metropolis, whose six-lane arterial roads and canal networks spread out to connect single-family tract housing all across the Phoenix Basin, [is] a horizontal hymn to unsustainable development. With less than eight inches of rain a year, and the hottest summer temperatures of any city in the Northern Hemisphere, the 1,000-square-mile sprawl known as the Valley of the Sun appeared to subsist in a state of denial about its inhospitable location.

Whether or not such claims are exaggerated, there is no doubt that the city faces substantial social, economic, and environmental challenges with serious implications for urban quality of life, social justice, economic stability and equity, as well as ecological health and functioning. Much blame for Phoenix's unfavorable condition has been attributed to poor urban form or "bad urbanism." According to Talen (2011: 2), a city that exhibits bad urbanism is "disconnected, automobile dependent, land consumptive, environmentally degrading, single use, homogeneous, inequitable, and inaccessible, and with a low-quality, poorly designed public realm."

Phoenix is not only one of the fastest growing metropolitan areas in the nation (O'Grady 2012) with a 45.3 percent growth rate per decade (Keys et al. 2007), but maintains one of the highest residential water use rates in the nation (Walton 2010; Duckett 2012). The city is infamous for its sprawling urban form dominated by single-family homes, isolated land uses, haphazard zoning, abandoned and underutilized land, as well as a wasteful, overengineered street system paired with poor infrastructure for alternative modes of transportation (Gober 2006; Artibise et al. 2008; Ross 2011; Talen 2010). Phoenix is also one of the most dangerous U.S. cities for pedestrians (Ernst 2004). In the 30 years between 1970 and 2000, over 16 percent of the land area of Phoenix was converted from agricultural to urban land uses (mostly residential), 12 percent of the city's open space was developed, and desert remnants became increasingly fragmented—trends with catastrophic implications for native ecology (Keys et al. 2007).

Like a domino effect, Phoenix's pattern of urbanization has led to regional auto-dependency, which itself has contributed to degraded human health, social injustices, and ecological decline. Reliance on automobile transportation has made the region one of the top producers of fossil fuel generated pollution in the nation, causing notoriously hazardous air quality and environmental degradation. Environmental injustices have amplified these problems for lower-income minority populations, particularly in South Phoenix, "the dirtiest zip code in the country" which experiences the city's worst air pollution and exposure to some 40 percent of the region's hazardous industrial emissions (Ross 2011:5). Low-income populations also are less likely to be able to afford costly private transportation, causing reduced access to urban amenities and conveniences, thereby reducing their quality of life.

Of particular relevance to this study, there is evidence that sprawling, haphazard urban form can reduce access to key urban amenities, including urban civic spaces (Ewing 1997; Talen 2010). This finding is particularly alarming considering the central role of quality urban space in the pursuit for more socially just, environmentally sound, and economically vibrant cities (Lynch 1981; Jacobs and Appleyard 1987).

Feeding back, there is also evidence that improper planning and design can result in underutilized, unsafe, degraded, and inequitable parks that perpetuate bad urban form (Jacobs 1961; Marne 2001; Boone et al. 2009). Echoing the sentiments of Lewis Mumford (1937), Jane Jacobs (1961: 90, 95) wrote extensively on the importance of neighborhood parks for a healthy urban citizenry, but argued that orthodox urban planning treats parks in "an amazingly uncritical fashion" though, "often, there are no people where the parks are and no parks where the people are." Jacobs (1961) and other scholars (Talen 2010) argue that such outcomes are the result of two-dimensional approaches to park planning and design that fail to consider the spatial and built context of urban parks and open spaces, specifically how the success of these spaces are influenced by a variety of factors including their location, design, historical, cultural, and geographic context, as well as the age of surrounding buildings, size of blocks, and surrounding uses (Talen 2010). Such single-minded design can disrupt connected, compact, transit-friendly urban form, thus perpetuating sprawl and leading to urban blight (Jacobs 1961; Kunstler 1996; Duany and Brain 2005; Talen 2005). As noted by Duany (2002: 253-4), urban greening often reinforces urban sprawl by "aestheticizing it," yet, "suburban development cannot coalesce into urbanism when the priority is given to the natural connectivity which cauterizes the urban pattern." For these reasons, urban scholars warn against the belief that all parks are 'good' and that more and bigger is always better (Harnik 2010). Instead, balanced, context-sensitive approaches to urban park and open space design are deemed essential for the promotion of coherent, sustainable urban form (Ewing 1997; Talen 2010).

The question then remains, how did Phoenix get into this predicament and what can be done to mitigate 'bad' urban form while enhancing access to valuable amenities such as civic spaces? A brief historical review of urban planning and growth in the region points to several key causes. Currently, Phoenix is the sixth most populous city in the nation with over 1.4 million inhabitants (U.S. Census 2010). The vast majority of the city's growth (some 90%) occurred in the post-WWII era, a time when subsidies for highway expansion and sub-urban single-family subdivisions encouraged car-dependent, sprawling patterns of urban development (Gammage 1999; Duany 2000). The abundance of cheap, flat land paired with the adoption of Euclidean zoning in 1930, which applied strict landuse separation requirements, further propelled diffuse, fragmented development (Tuccillo 2012). Although the intent of these zoning practices and post-war incentives was to improve human health and safety, enhance urban mobility and accessibility, and make homeownership accessible to middle-class Americans (Archibugi 1997), the result can perhaps more aptly be called "socially, environmentally, and economically dysfunctional" (Lara 2004: 1).

Given this history, it appears a move towards a more sustainable, favorable urbanism—including a quality, accessible public realm—requires changes to the current system of planning and zoning in Phoenix. In an assessment of the 'spatial logic' of parks in Phoenix, Talen (2010) proposes that their contribution to appropriate urban form could be improved by enacting new zoning codes aimed at repairing the relationship between these spaces and their social, built, and spatial surroundings. New Urbanist Andres Duany argued that codes "counter antiurbanistic practices," and "are the most powerful tools available to affect reform" (Talen 2012: xi). The power of urban planning codes, Duany adds, is that they provide a logical structure for coordinating multiple agents—including city planners, landscape architects, and engineers—in the pursuit of good urbanism. This study adopts Talon's (2012: 1-2) definition of good urbanism as,

> Compact urban form that encourages pedestrian activity and minimizes environmental degradation; encourages social, economic, and landuse diversity as opposed to homogeneity; connects uses and functions; has a quality public realm that provides opportunities for interaction and exchange; offers equitable access to goods, services and facilities; and protects environmental and human health.

Transect Planning

Transect planning is a method of city zoning that integrates a variety of context-appropriate urban civic spaces, while supporting a transition to an overall more coherent and sustainable urban form with a diversity of habitat types (i.e. zones) across the urban-to-natural gradient of an urbanized region (Duany and Talen 2002). Developed by New Urbanists, the approach is inspired by the concept of a *transect*, "a theoretical and analytical framework for understanding the differentiation of places along a continuum from the most urban and dominated landscapes to the most apparently 'natural' condition" (Brain 2005: 19). Mimicking ecological systems in which one form of habitat transitions into the next along a continuum, transect planning organizes the built and natural environment along a gradient of six zones (T-zones) of varying urban intensity, each with its own unique character: T1-rural preserve, T2-rural reserve, T3-sub-urban, T4-general urban, T5-urban center, and T6-urban core.

A normative planning framework, transect planning advocates the principle that "certain forms and elements belong in certain environments" (Low 2008: I30). A skyscraper, for example, would ruin the character of a rural village, as would a large farm in the middle of a bustling urban center. As such, each zone maintains a distinct character based on a variety of factors including building and civic space types, as well as landuse mix, density, and level of disturbance (Figure 3.1). In this way, urban (human-dominated) and natural (undeveloped) areas retain their distinctiveness, enhancing their particular sense-of-place in a way that is complimentary and balanced. The protection of such distinctions is deemed important because different people, flora, and fauna prefer different environments. Low (2008: I31) calls transect planning the "antidote to the one-size-fits-all development of today," which often results in monotonous, car-dependent, sprawl-like urban forms.

The unique mix of natural and built elements in each transect zone results in a variety of interconnected and complimentary 'habitat types' that satisfy diverse human preferences and ecological requirements (Duany and Talen 2002). The result is a range of 'habitats' including dense, walkable, lively urban neighborhoods close to entertainment and conveniences, as well as sparsely developed sub-urban neighborhoods with ample open spaces, and minimally disturbed natural areas. Transect planning is a powerful approach to urban planning because of its flexibility, adaptability, emphasis on diversity, and evolutionary design. Zone classifications are not static but evolve over time as needed. A sub-urban neighborhood will eventually transition to general urban zone, while developed, environmentally-sensitive areas (e.g. homes in a floodplain) may become protected areas when houses are sold or abandoned. As such, the approach can be used to assess current conditions, as well as outline a structure for the ordered, but flexible evolution of an urbanized or urbanizing region (Low 2008).

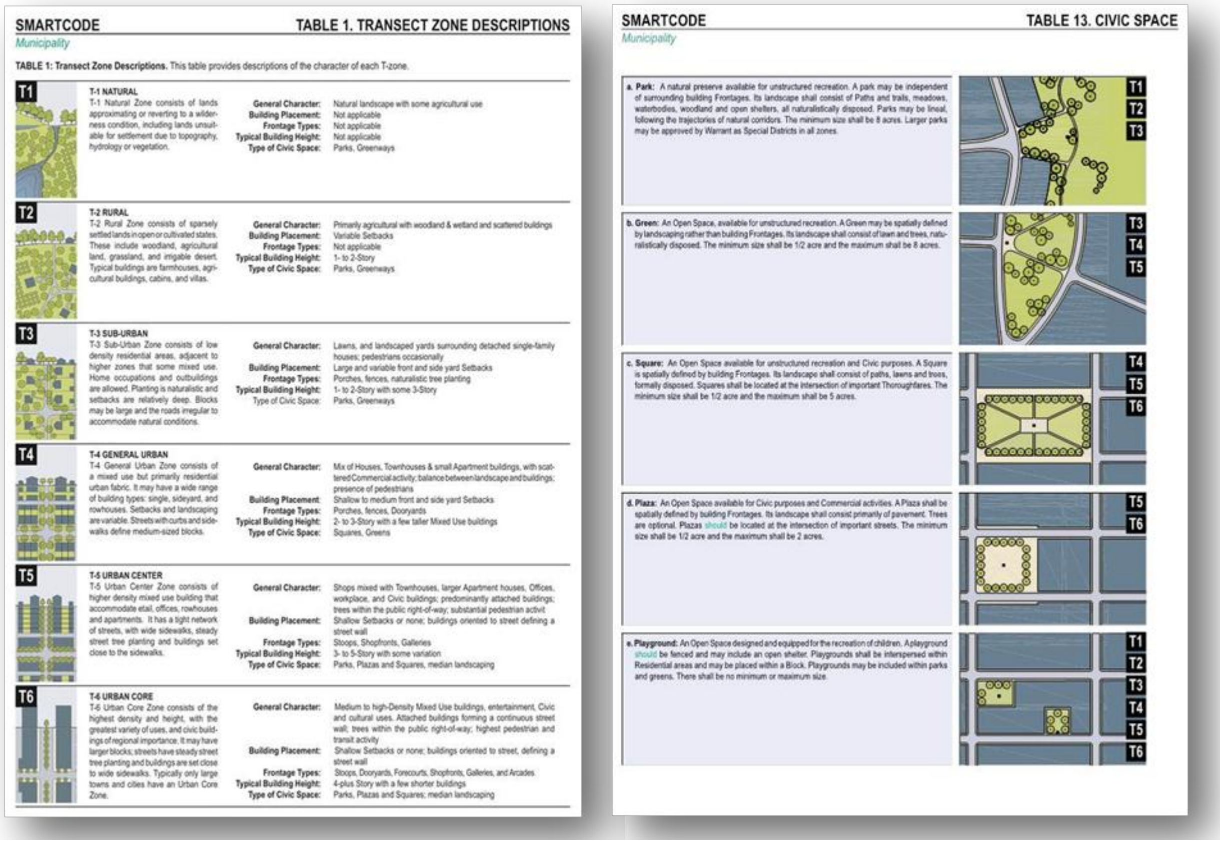
The transect approach is advocated as a more socially and ecologically sustainable approach to urban planning because it represents an alternative to unsustainable urban sprawl-like development that dominates the contemporary American urban landscape (Duany and Talen 2001; Duany and Talen 2002). Although there lacks hard empirical evidence to back up the claim that transect planning is more 'sustainable,' many of the principles embedded in transect planning are in alignment with sustainable development.

First, transect planning directs city development towards a more spatially contextualized, compact, walkable/bikeable urban form that reduces dependency on environmentally, economically, and psychologically injurious private transportation (Gärling et al. 2002). By extension, the promotion of dense, accessible cities serves to curtail sprawling development that often engulfs natural areas and open spaces in and around cities (Keys et al. 2007). Transect style planning also promotes a vibrant public realm and equitable access to affordable housing and urban amenities such as schools, shopping, and public transportation—all characteristics of a socially functional city (Mitchell 1995; Duany and Talen 2002; Low et al. 2005).

Civic Spaces Along the Transect

The open-source model zoning ordinance, SmartCode, offers a framework for calibrating and applying transect planning to local environmental conditions. The Code, developed by Duany, Plater-Zyberk and Co., outlines detailed standards for urban elements by transect zone. Following transect planning, the goal of the SmartCode is to inform the design of more compact, sustainable cities that support human-scaled, transect-oriented, mixed use, mixed-income neighborhoods with sense of place, vibrant nodes of activity, and accessible, equitable civic spaces. These ideals are consequently in opposition to sprawling development patterns, automobile dependency, underutilized civic spaces, and social inequity (Swift 2010).

With respect to civic space design and placement, the SmartCode designates five types appropriate to specific zones along the transect, and one designation (*Special Districts*) for areas of exception (Figure 3.1). *Parks* are undeveloped natural preserves that support unstructured activity with paths, trails, open areas, water features, and open shelters. Their minimum size is eight acres and their landscaping is naturally distributed. *Greens*, designed to support unstructured activities, are one half to eight acres in size and defined spatially by naturally arranged landscaping (lawn and trees). *Squares*, one half to five acres in size, should be situated on or near busy intersections. These areas support unstructured recreation and civic activities, and are formally landscaped with paths, turf, and trees. *Plazas* are one half to two acres in size and primarily covered in pavement. These spaces are formally landscaped, spatially defined by buildings, and situated near or on busy intersections. *Playgrounds* have no size restrictions and can be located in residential areas or inside other park types; these areas are designed for children's recreation and must be fenced. *Special Districts* are defined as "areas that usually cannot or should not be regulated by normative Transect Zoning because of their special purpose or large size. Includes airports, railyards, shipyards, freight distribution centers, refineries, some university or hospital campuses, some large civic spaces (parks, greenways, sports complexes)" (CATS 2013: *Special District).*



SMARTCODE — TABLE 1. TRANSECT ZONE DESCRIPTIONS

Municipality

TABLE 1: Transect Zone Descriptions. This table provides descriptions of the character of each T-zone.

Zone	Description	General Character	Building Placement	Frontage Types	Typical Building Height	Type of Civic Space
T1	**T-1 NATURAL** T-1 Natural Zone consists of lands approximating or reverting to a wilderness condition, including lands unsuitable for settlement due to topography, hydrology or vegetation.	Natural landscape with some agricultural use	Not applicable	Not applicable	Not applicable	Parks, Greenways
T2	**T-2 RURAL** T-2 Rural Zone consists of sparsely settled lands in open or cultivated states. These include woodland, agricultural land, grassland, and irrigable desert. Typical buildings are farmhouses, agricultural buildings, cabins, and villas.	Primarily agricultural with woodland & wetland and scattered buildings	Variable Setbacks	Not applicable	1- to 2-Story	Parks, Greenways
T3	**T-3 SUB-URBAN** T-3 Sub-Urban Zone consists of low density residential areas, adjacent to higher zones that some mixed use. Home occupations and outbuildings are allowed. Planting is naturalistic and setbacks are relatively deep. Blocks may be large and the roads irregular to accommodate natural conditions.	Lawns, and landscaped yards surrounding detached single-family houses; pedestrians occasionally	Large and variable front and side yard Setbacks	Porches, fences, naturalistic tree planting	1- to 2-Story with some 3-Story	Parks, Greenways
T4	**T-4 GENERAL URBAN** T-4 General Urban Zone consists of a mixed use but primarily residential urban fabric. It may have a wide range of building types: single, sideyard, and rowhouses. Setbacks and landscaping are variable. Streets with curbs and sidewalks define medium-sized blocks.	Mix of Houses, Townhouses & small Apartment buildings, with scattered Commercial activity; balance between landscape and buildings; presence of pedestrians	Shallow to medium front and side yard Setbacks	Porches, fences, Dooryards	2- to 3-Story with a few taller Mixed Use buildings	Squares, Greens
T5	**T-5 URBAN CENTER** T-5 Urban Center Zone consists of higher density mixed use building that accommodate etail, offices, rowhouses and apartments. It has a tight network of streets, with wide sidewalks, steady street tree planting and buildings set close to the sidewalks.	Shops mixed with Townhouses, larger Apartment houses, Offices, workplace, and Civic buildings; predominantly attached buildings; trees within the public right-of-way; substantial pedestrian activit	Shallow Setbacks or none; buildings oriented to street defining a street wall	Stoops, Shopfronts, Galleries	3- to 5-Story with some variation	Parks, Plazas and Squares, median landscaping
T6	**T-6 URBAN CORE** T-6 Urban Core Zone consists of the highest density and height, with the greatest variety of uses, and civic buildings of regional importance. It may have larger blocks; streets have steady street tree planting and buildings are set close to wide sidewalks. Typically only large towns and cities have an Urban Core Zone.	Medium to high-Density Mixed Use buildings, entertainment, Civic and cultural uses. Attached buildings forming a continuous street wall; trees within the public right-of-way; highest pedestrian and transit activity	Shallow Setbacks or none; buildings oriented to street, defining a street wall	Stoops, Dooryards, Forecourts, Shopfronts, Galleries, and Arcades	4-plus Story with a few shorter buildings	Parks, Plazas and Squares; median landscaping

SMARTCODE — TABLE 13. CIVIC SPACE

Municipality

a. Park: A natural preserve available for unstructured recreation. A park may be independent of surrounding building Frontages. Its landscape shall consist of Paths and trails, meadows, waterbodies, woodland and open shelters, all naturalistically disposed. Parks may be lineal, following the trajectories of natural corridors. The minimum size shall be 8 acres. Larger parks may be approved by Warrant as Special Districts in all zones. (T1, T2, T3)

b. Green: An Open Space, available for unstructured recreation. A Green may be spatially defined by landscaping rather than building Frontages. Its landscape shall consist of lawn and trees, naturalistically disposed. The minimum size shall be 1/2 acre and the maximum shall be 8 acres. (T3, T4, T5)

c. Square: An Open Space available for unstructured recreation and Civic purposes. A Square is spatially defined by building Frontages. Its landscape shall consist of paths, lawns and trees, formally disposed. Squares shall be located at the intersection of important Thoroughfares. The minimum size shall be 1/2 acre and the maximum shall be 5 acres. (T4, T5, T6)

d. Plaza: An Open Space available for Civic purposes and Commercial activities. A Plaza shall be spatially defined by building Frontages. Its landscape shall consist primarily of pavement. Trees are optional. Plazas should be located at the intersection of important streets. The minimum size shall be 1/2 acre and the maximum shall be 2 acres. (T5, T6)

e. Playground: An Open Space designed and equipped for the recreation of children. A playground should be fenced and may include an open shelter. Playgrounds shall be interspersed within Residential areas and may be placed within a Block. Playgrounds may be included within parks and greens. There shall be no minimum or maximum size. (T1, T2, T3, T4, T5, T6)

Figure 3.1 Excerpts from the SmartCode manual. Left: transect zone descriptions. Right: civic space guidelines.

Civic Spaces in Phoenix

According to the City of Phoenix Parks and Recreation Department (City of Phoenix 2013), there are 176 developed parks within the city's limits. The Parks Department classifies these areas as mini parks, neighborhood parks, community parks, district parks, desert parks, mountain preserves, and basins. The exact guidelines for the designations are somewhat tenuous, but basic parameters are outlined in the City's General Plan (City of Phoenix 2002). An updated General Plan was scheduled to be release in 2012, but the most current available version as of April 2013 was published in 2002. The 2002 General Plan, includes no formal description of mini parks, but these tend to be under an acre in size. Neighborhood parks are said to cater to populations of around 4000 to 7000 and are around 15 acres in size. They are located near local or collector roads and often contain playgrounds, picnic areas, turf, restrooms, and ball courts/fields. Community parks are usually 40 acres or more and serve about 20,000 to 50,000 people. These areas cater to structured (e.g. organized) and unstructured recreation, and often contain playgrounds, picnic areas, and restrooms. District parks are designed to serve around 100,000-200,000 residents and are 200 or more acres. They offer facilities for both structured and unstructured recreation similar to those available in neighborhood and community parks, but may also contain golf courses, festival areas, and amphitheaters. They are situated near major roads and/or in areas with significant commercial and industrial activity. The main differences between neighborhood, community, and district parks are their size, the number of residents they cater to, and the number of facilities, while their purposes are similar in that they focus on recreational benefits, rather than aesthetic or environmental values. There are no official guidelines regarding what constitutes a mountain preserve or desert park, but they are generally less developed, naturally landscaped, larger parks focused on environmental protection as well as recreation. Basins are parks located in water basins, although no further specifications are made in the General Plan (City of Phoenix 2002).

The major difference between the Phoenix and SmartCode civic space systems is that Phoenix's typology is based primarily on size specifications and recreational features *within* the park, with no guidelines concerning the proper landscaping, spatial orientation, or the built environment surrounding the site. Meanwhile SmartCode civic spaces are highly contextualized. That is, the SmartCode system outlines the ideal type and mix of land uses around parks as well as the proper spatial orientation and location of different civic space types along the urban-to-natural gradient. Also, although guidelines related to ecological considerations in the Phoenix system are weak (e.g. they are only discussed in relation to mountain preserves), SmartCode is particularly lacking in this arena. SmartCode guidelines for civic spaces do not address any potential ecological purposes of these sites, but rather focus exclusively on recreational, cultural, and civic purposes.

DATA & ANALYSIS

The analysis conducted for this research progressed through three major steps. First, the City of Phoenix was rezoned following transect-based protocols found in the SmartCode. Protected areas and other lands of cultural and environmental significance were identified and set aside, while remaining blocks were assigned a specific transect zone based on multiple criteria, including population density, proximity to major thoroughfares, block perimeter, and landuse mix. In the second phase, a macroanalysis of the city park system and microanalysis of a small sample of parks was conducted using SmartCode guidelines. To assess the park system, the location of current civic spaces were overlaid on the new zoning map, assigned a transect zone, and analyzed with respect to the city's current park typology and SmartCode civic space guidelines across the transect. Then, one park in each urban transect zone (urban center, urban core, general urban, and sub-urban) from a high-need neighborhood was selected for the microanalysis. Finally, reflecting on the previous steps, an empirical evaluation of SmartCode civic space guidelines, as applied to the City of Phoenix, highlighted the strengths and weaknesses of the approach while recommending place-specific alterations.

Data Collection

Data for this research was obtained through the U.S. Census Bureau, City of Phoenix Parks and Recreation Department, Phoenix Urban Research Lab (PURL), and the ASU GIS data repository (see Table 3.1). Census block data (2010) was obtained through the U.S. Census Bureau. Spatial data for major roads, mile streets, and elevation (DEM) was supplied by the ASU GIS data repository, as were files for hydrological features including lakes, major rivers, and floodplains. The Phoenix Urban Research Lab (PURL) supplied data on parcels (2010) in Phoenix. Spatial files for parks and preserves, future parklands, and golf courses represent 2012 data from the City of Phoenix Parks and Recreation Department.

Table 3.1 Data used in this study

Description (temporal scale)	Source
Park and preserve boundaries (2010)	Phoenix Parks & Recreation Department
Park and preserve amenities (2012)	www.phoenix.gov/parks/alphapks.html
Lakes (2010) and major rivers (2010)	ASU GIS data repository
100-year floodplain (2004)	ASU GIS data repository
Major roads (2006), light rail (2006), airports (2011)	ASU GIS data repository
Parcels (2010)	PURL (Phoenix Urban Research Lab)
Census blocks (2010)	U.S. Census Bureau
Slope	Calculated from DEM obtained through ASU GIS data repository, using spatial analyst in ArcGIS

Transect Zoning

Following previous work on transect coding (Criterion Planners 2005; Talen 2009b; PURL 2011), this study applied spatial empirical analysis to delineate transect zones for the City of Phoenix, according to the following steps. These steps can be used to apply transect planning to any city, given proper customization to regional geographic, institutional, social, and economic characteristics.

First, the study area boundary, surface water, and regional thoroughfares (major roads and highways) were mapped. Parcels classified as underutilized (salvage and vacant areas) or undevelopable (e.g. parking, transportation, utility) were removed from the final planning area. Then, the preserved and reserved regional sectors were designated, representing zones to remain undeveloped. The preserve transect zone (T1) included areas currently protected, i.e. developed parks, preserves, golf courses, and agricultural regions. In this study, agricultural areas included fallow land, field crops, high-density agriculture, mature citrus trees, mature crop trees, nurseries, greenhouses, pasture, and livestock parcels. The reserve transect zone (T2) included environmentally-sensitive areas that should remain undeveloped. These areas included future parklands, water bodies (lakes and major rivers), 300 meter buffers around water features, the 100-year floodplains, and steep slopes. Although exact buffers for the protection of urban water quality and biodiversity are extremely place specific, a 300-meter distance around lakes and major rivers was selected for this study based on ecological research on reptile biodiversity in riparian zones by Semlitsch and Bodie (2003). Steep slopes were classified as those over 15 percent following LEED-ND guidelines that indicate that slopes greater than 15 percent should be protected to protect biodiversity and habitat, natural drainage patterns, and to control erosion (Planundrum 2013).

Next, to delineate the urban T-zones (T3 - T6), the census blocks outside the reserve and preserve zones (n=16,360) were classified according to their relationship to major thoroughfares, population density, block perimeter, and landuse mix (based on parcel level data) (Table 3.2). Street type classifications reflect the proximity of each block to major thoroughfares: adjacent, near (within ¼ mile), or far (beyond ¼ mile). Population density was classified into five levels using natural breaks (as recommended by Talen 2009b). Blocks were categorized based on their perimeter following break levels used in previous transect research in Phoenix (PURL 2011). Finally, to calculate landuse mix, blocks were classified based on their composition of single family, multi-family, retail, active, and commercial/industrial parcels (Table 3.3). Blocks that contained none of these land uses were classified as transitional. Multi-family uses included condominiums, townhouses, and apartments. Actives uses included clubs, convenience markets, retail strips, supermarkets, department stores, hotels, motels, resorts, restaurants, bars, shopping centers, and banks. Commercial/industrial uses included office buildings, warehouses, industrial parks, and store/office combos. The metrics for landuse mix used in this analysis were necessarily adjusted from those used in previous transect coding research (i.e. Criterion Planners 2005; Talen 2009b; PURL 2011). The city's sprawling urban form, combined with the prevalence of single-family homes and single land uses necessitated lowering the bar for 'landuse diversity' in Phoenix to facilitate the usable distribution and differentiation of T-zones.

In the final stage of the zoning process, blocks were assigned a transect zone (T3-T6) based on proximity to major roads, population density, perimeter, and landuse mix. Special criteria for blocks comprised of 100 percent single-family homes or those within a half-mile of the light rail line superseded initial designations (see Table 3.3 for details). Blocks that did not fit into one of these categories (n=3,081, 22 percent of all blocks) were classified as 'transitional.'

Table 3.2 Classification levels and criterion for parameters

Level	Proximity to Major Roads	Block Perimeter	Population Density*	Landuse Mix/ Intensity
1	Adjacent (<= 100 ft.)	<2400	<5.58	50% or more single-family
2	Near (<= 1/4 mi.)	2400 - 3000	5.97-13.72	50% or more single-family + 5% or more commercial/industrial/active or 10% or more multi-family
3	Far (> 1/4 mi.)	>3000	13.73-29.89	25% or more multi-family
4	n/a	n/a	29.9-66.95	25% or more multi-family + 5% or more commercial/industrial/active
5	n/a	n/a	66.95-152.56	10% or more active uses, or 25% or more commercial/industrial and active uses

* Based on natural breaks. Eleven outliers were removed > 179.45-845.90.

Table 3.3 Urban T-zone criteria and parameters

	Proximity to Major Roads	Block Perimeter	Population Density (NB)	Landuse Mix/ Intensity
T3 Suburban*	Not adjacent	Large (3)	Low (1-2)	Low intensity (1)
T4 General Urban	Near (2)	Moderate to large (2-3)	Low to moderate (2-3)	Low to moderate intensity (1-3)
T5 Urban Center	Near to adjacent (1-2)	Moderate to small (1-2)	Moderate to high (3-5)	Moderate to high intensity (3-5)
T6 Urban Core	Adjacent (1)	Small (1)	Moderate to high (3-5)	High intensity (4-5)

* Special Criteria that overrides other parameters: 100% single family blocks=T3; blocks within 1/2 mi of light rail= T5; blocks within 1/4 mile of light rail =T6

Macroanalysis & Microanalysis

After applying transect coding, the 176 civic spaces in Phoenix were mapped and allocated a T-zone. Civic spaces classified as mountain preserves, basin parks, or desert parks by the city parks department were designated *Special Districts*. As *Special Districts* do not have to conform to the particular standards, these sites were excluded from the following steps. Eight other civic spaces were removed because of incomplete or inaccurate attribute data. The remaining sites were assigned a T-zone based on the dominant adjacent transect zone.

For example, if a park was surrounded by some T4 but mostly T3 zoning it was designated a T3 park. If a park was completely surrounded by transitional zones it was labeled a transitional park, and if there was an equal amount of more than one transect zone adjacent a space, the higher transect zone was applied. Sites not directly adjacent to any transect zone were evaluated based on their immediate surrounding land uses. If the majority of the land uses were single-family, the park would be T3; if the majority were multi-family, then T4; if the park was surrounded by mostly commercial/industrial and active uses it would be T6 or T5 if combined with residential land uses.

The remaining sample included 145 mini (n=23), neighborhood (n=77), community (n=39), and district (n=6) parks. As a means of emphasizing the improvement of parks particularly in high need areas, the four park sites were chosen for the microanalysis based on the median household income and population density of their neighborhoods. First, median household income and population density were calculated for each park neighborhood (i.e. areas within ¼-mile of the site). Then one civic space with above average population density and the lowest neighborhood income was chosen in each urban T-zone.

Recommendations for enhancing the context-sensitivity of each of the four parks were based on guidelines in the SmartCode manual for civic spaces across the transect, and information on each site was obtained through analysis of satellite imagery and park descriptions posted on the City of Phoenix Parks and Recreation website (City of Phoenix 2013). As the park typologies of the City of Phoenix do not match up directly with those outlined in SmartCode, for the purposes of comparison and analysis the certain equivalents were assumed in this study. As district and community parks are most similar to SmartCode *parks*, neighborhood parks most similar to SmartCode *greens,* and mini parks closest to *squares* or *plazas, the* following matches were deemed appropriate:

- T1 and T2: District and community parks
- T3: District, community, and neighborhood parks
- T4: Community and neighborhood parks
- T5 and T6: Neighborhood and mini parks

RESULTS & DISCUSSION

Transect Recode

Preserve & Reserve Transect Zones

This study began with an initial planning area that included the entire extent of Phoenix, which spans approximately 518 square miles (331,418 acres). In the first step of the transect recoding, 8.5 percent of the city's land area was designated as underutilized (salvage and vacant areas) or undevelopable (e.g. parking, transportation, utility), and was therefore removed from the final planning area (16,543 and 11,581 acres respectively) (Figures 3.2 and 3.3).

Figure 3.2 Image of salvage and vacant parcels near city center (Google 2013)

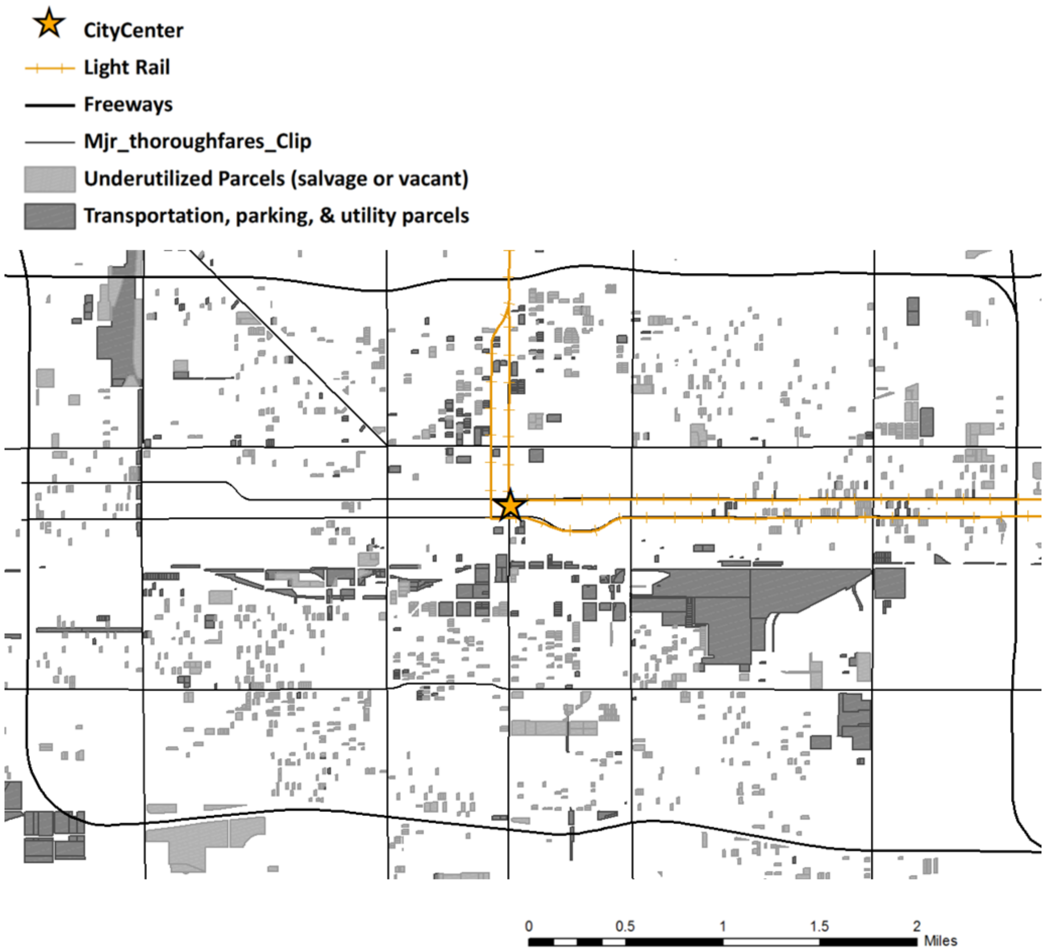


Figure 3.3 Underutilized (salvage and vacant areas) and undevelopable land near the city center.

Next, areas that were protected or should be protected were also removed from the urban planning area (Figure 3.4). At over 133,779 acres, the preserve and reserve zones cover over 40 percent of the total land area of the city. Currently, protected areas in Phoenix (T1-preserve) include 50,035 acres of developed parks, mountain preserves, golf courses, and agricultural regions. Developed parks alone represent over 11,000 acres and mountain preserves over 23,000 acres. These are areas of high cultural, social, economic, and environmental value, and as such should remain undeveloped in perpetuity. Phoenix also contains an abundance of environmentally sensitive and hazardous (e.g. flood zone and steep slope) areas that would ideally be protected following transect code guidelines. The 83,744 acres classified as T2-reserve, include designated future parklands (by the city), water bodies (lakes and major rivers), buffer zones around water features, the 100-year floodplains, and steep slopes (>15%). Future parklands should remain protected, while water bodies and areas near them (at least a 300-m buffer) should be minimally developed. Development that has already occurred in the 100-year floodplain and on steep slopes cannot, of course, be instantaneously protected, but as parcels in these areas are sold or abandoned, future development should be restricted or limited. Ideally, areas in the floodplain, around water bodies, and steep slopes would be turned into parkland, which would provide not only recreational benefits and aesthetic values, but also cost-effective protection from floods and soil erosion. Such landuse transformations have greatly improved urban quality of life, while reducing flood hazards and associated costs in cities like Toronto, Canada (Ibes 2008) and Curitiba, Brazil (Rabinovitch 1992; Lara 2010).

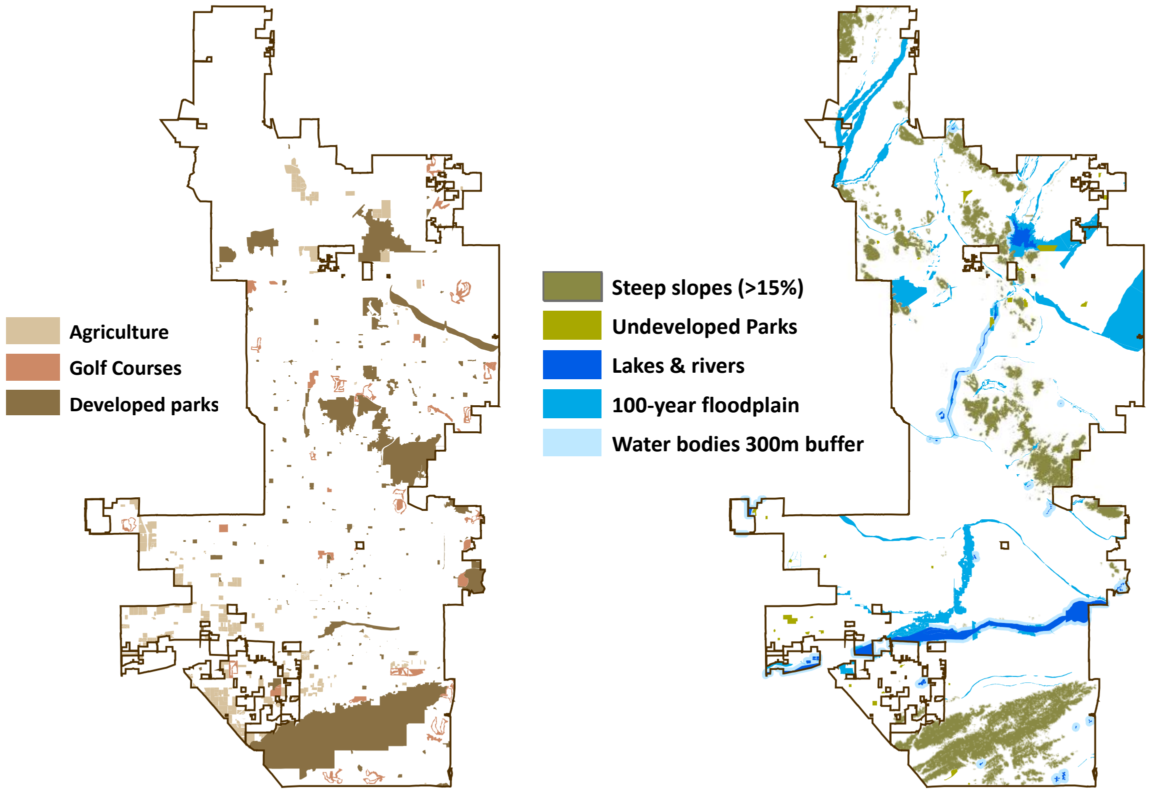


Figure 3.4 Preserve and reserve zones.

Urban Transect Zones

After removing all the underutilized, undevelopable, protected, or reserved areas of the city, 131,674 acres representing 39.7 percent of the area of the entire city, and 16,360 blocks, remained to be designated one of the urban T-zones (Table 3.4). Of these blocks, 5232 (32%) were classified as transitional. These were areas that do not fit the parameters of any of the urban transect zones, including blocks without any single-family, multi-family, commercial, industrial, or active land uses. Nearly half of the blocks in the urban planning area (45.7%) were zoned T3-sub-urban. This high ratio was a result of the high percentage of single-family homes in the study area, wherein single-family land uses make up 77.9 percent (n=349,916) of all the parcels within the City of Phoenix (n=448,903). Ideally, according to proper transect planning, T3 zones would not be too extensive (i.e. too sprawling) but would be interspersed with other zones to create diverse neighborhood types. In the subsequent steps of transect coding, which focus on finer scales of planning and are beyond the scope of this analysis, transect zones would be "balanced within a neighborhood structure" (Sorlien and Talen N/A). In this way, neighborhoods would include a variety of transect zones in close proximity.

The general urban, urban center, and urban core T-zones (T4 - T6) made up 22.4 percent of the urban blocks (n=3653) and 21.3 percent of the urban planning land area (28,156 acres). This finding, along with the fact that the other 77.6 percent of the urban planning area blocks were zoned either sub-urban or transitional, further highlights the challenges of applying the transect—which emphasizes compact, mixed-use urban form—to a sprawling, low-density, homogeneous urban landscape dominated by large tracts of single-family homes, single land uses, and large city blocks. Adding further challenge, much of the areas zoned as T5-urban center and T6-urban core in this study were classified as such due to their proximity to the light rail to encourage higher density development in this area. However, as proximity to the light rail was an overriding factor, few of these areas actually exhibit the other characteristics of these T-zones, namely small blocks, high population densities, and a diverse landuse mix. These areas will require significant changes to transform them into urban center and urban core zones.

Spatial Patterns

Referencing the map of Phoenix rezoned following transect principles (Figure 3.5 with close-up in figure 3.6), several interesting patterns can be noted. First, extensive preserve areas break up the city, yet these are relatively clustered in the south and north of the center. Reserve zones are primarily in the very northern parts of the city that maintain minimal development, but they also cut through more centrally located areas south and west of the light rail. These particular areas are mostly in flood hazard zones (the 100-year flood plain) and around major water bodies, such as the Salt River that runs just south of downtown Phoenix. The sub-urban zones are concentrated along the fringes of the city, while the general urban, urban center, and urban core zones are scattered relatively randomly. The only exception is the concentration of urban center and core zones around the light rail corridor as this was an overriding special consideration. The lack of spatial clustering reflects the polycentric character of the city as noted by other Phoenix scholars (Leslie and ÓhUallacháin 2006).

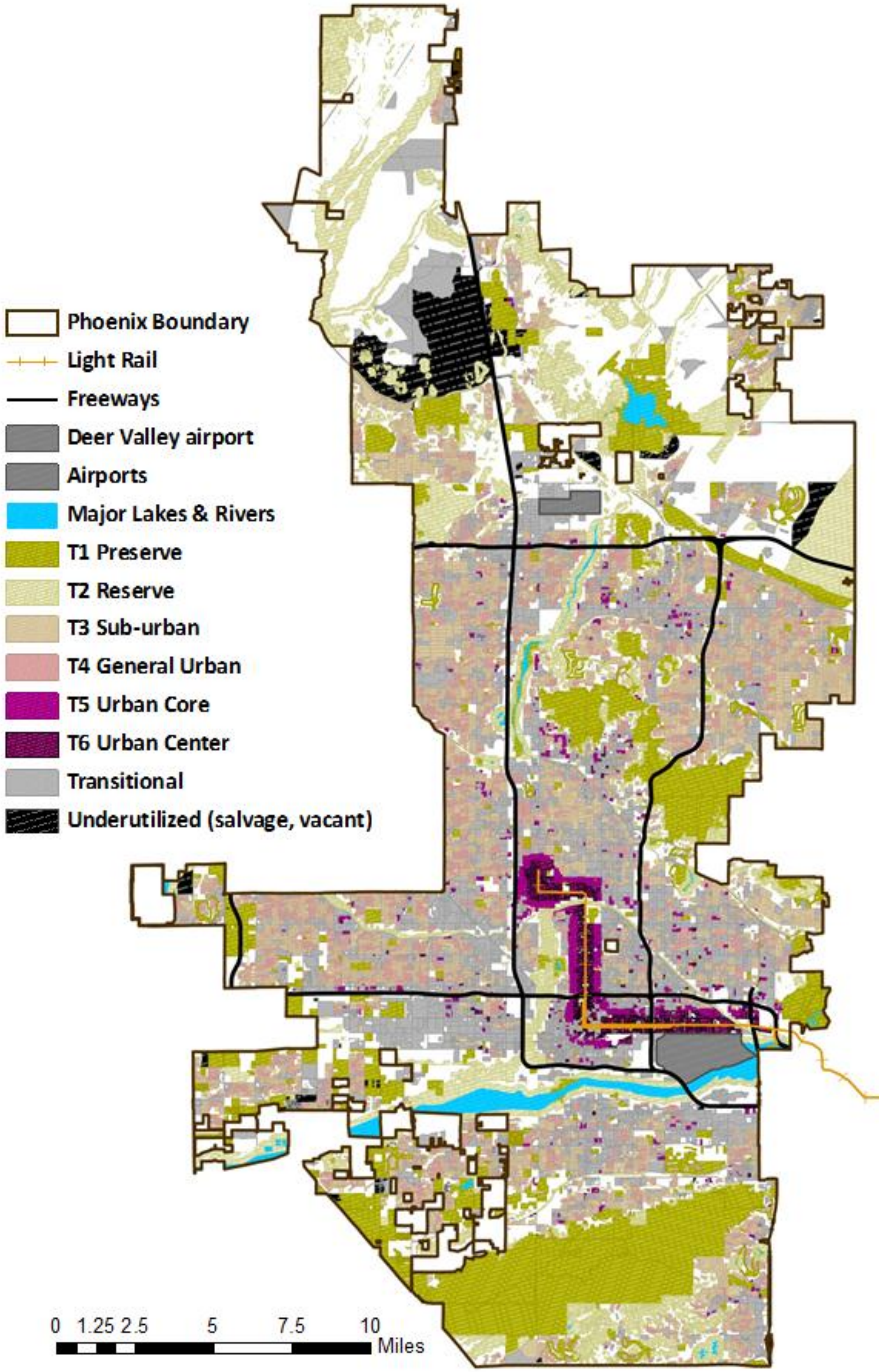


Figure 3.5 Map of Phoenix rezoned following the transect.

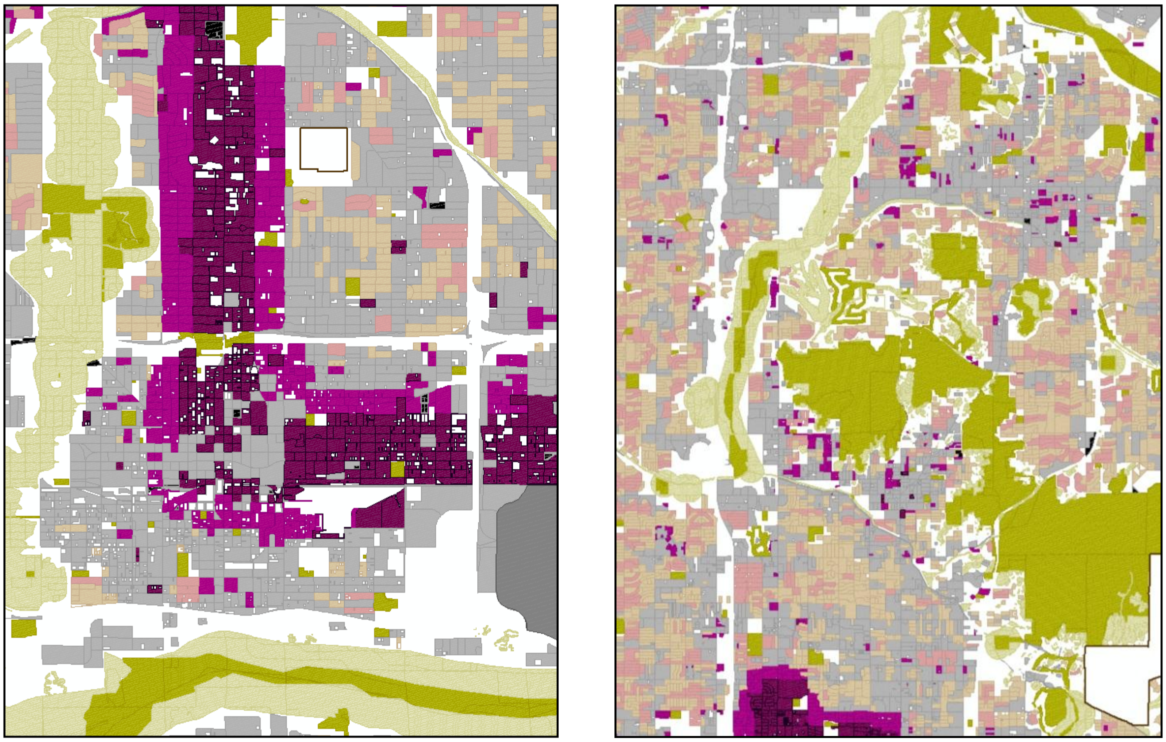


Figure 3.6 Close-up of transect zoning around light rail elbow (left) and region above light rail corridor (right).

Table 3.4 Urban planning area distribution by urban t-zones

	Area (acres)	Urban Plan. Area %)	Blocks (count)	Blocks (%)
T3 Sub-urban	46,354	35.2%	7475	45.7%
T4 General Urban	19,786	15.0%	2169	13.3%
T5 Urban Center	4487	3.4%	994	6.1%
T6 Urban Core	3883	2.9%	490	3.0%
Transitional	57,165	43.4%	5232	32.0%
Total	131,674	100%	16,360	100.0%

Civic Space Along the transect

Macroanalysis

The next step in the analysis was to map the civic spaces of Phoenix and compare them to the adjacent transect zones to determine their context-sensitivity as outlined in the SmartCode manual. Overall, the 176 civic spaces covered 35,025 acres (54.73 sq. mi.), nearly 11 percent of the city. All mountain preserves, desert parks, and basins (n=23) were designated *Special Districts* given their unique and significant social, economic, and environmental value. A single neighborhood park, Old Cross Cut Canal, was also labeled a *Special District* given that it follows a water body and has a linear basin-like shape. Of the remaining 152 parks, there were 14 in the preserve (n=3) and reserve (n=11) T-zones, while the remaining 138 sites were located in the urban T-zones (Table 3.5). The largest concentration of civic spaces (n=60, 39.5%) was in the T3-general urban zone, while 33 sites (21.7%) were zoned T4-general urban. Thirty-one parks were zoned T5-urban center (n=19) and T6-urban core (n=12). Overall, 111 parks (73%) were located in a transect zone appropriate to their equivalent SmartCode classification, while 27 (17.8%) were mismatched. The remaining 14 sites (9.2% of total) were zoned transitional as they were completely surrounded by or situated in transitional transect zones. Appendix A contains details on each civic space, including their city classification and T-zone designation. Figure 3.7 shows the spatial distribution of the park types across the city, Figure 3.8 provides a close-up of parks in the downtown area, and Figure 3.9 provides a detail of select parks and their surrounding zoning.

When compared to the equivalent SmartCode civic space typologies and appropriate transect zone locations (as outlined in Table 3.5 and 3.6), the Phoenix park system is, for the most, part successfully context-sensitive. Appropriately, the majority of the parks zoned as preserve and reserve were larger community and district parks. Likewise, most of the civic spaces in T3 through T6 were context-appropriate. Parks zoned as T3-sub-urban in this study were mostly neighborhood and community parks, which is in keeping with SmartCode specifications. Neighborhood and community parks also suitably dominated T4-general urban. The most obvious mismatch was the concentration of mini parks (most appropriate to areas of higher urban intensity) in reserve, sub-urban, and general urban areas. Also mismatched with SmartCode guidelines for civic spaces along the transect, four of the larger community parks were located in the most urban transect zones.

Table 3.5 Crosstabs: City of Phoenix Park Type Designations vs. T-zone allocation

	T1	T2	T3	T4	T5	T6	Transitional
Mini		2	8	5	3	3	5
Neighborhood		7	32	21	12	4	5
Community	2	5	19	6	2	2	3
District	1	2	1	1			1
Total (n= 152)	3	16	60	33	17	9	14

* Shading denotes conformation to SmartCode equivalent design guidelines

Table 3.6 City of Phoenix Park Type Designations by Appropriate T-zone

	T1	T2	T3	T4	T5	T6
Mini					x	x
Neighborhood			x	x	x	x
Community	x	x	x	x		
District	x	x	x			

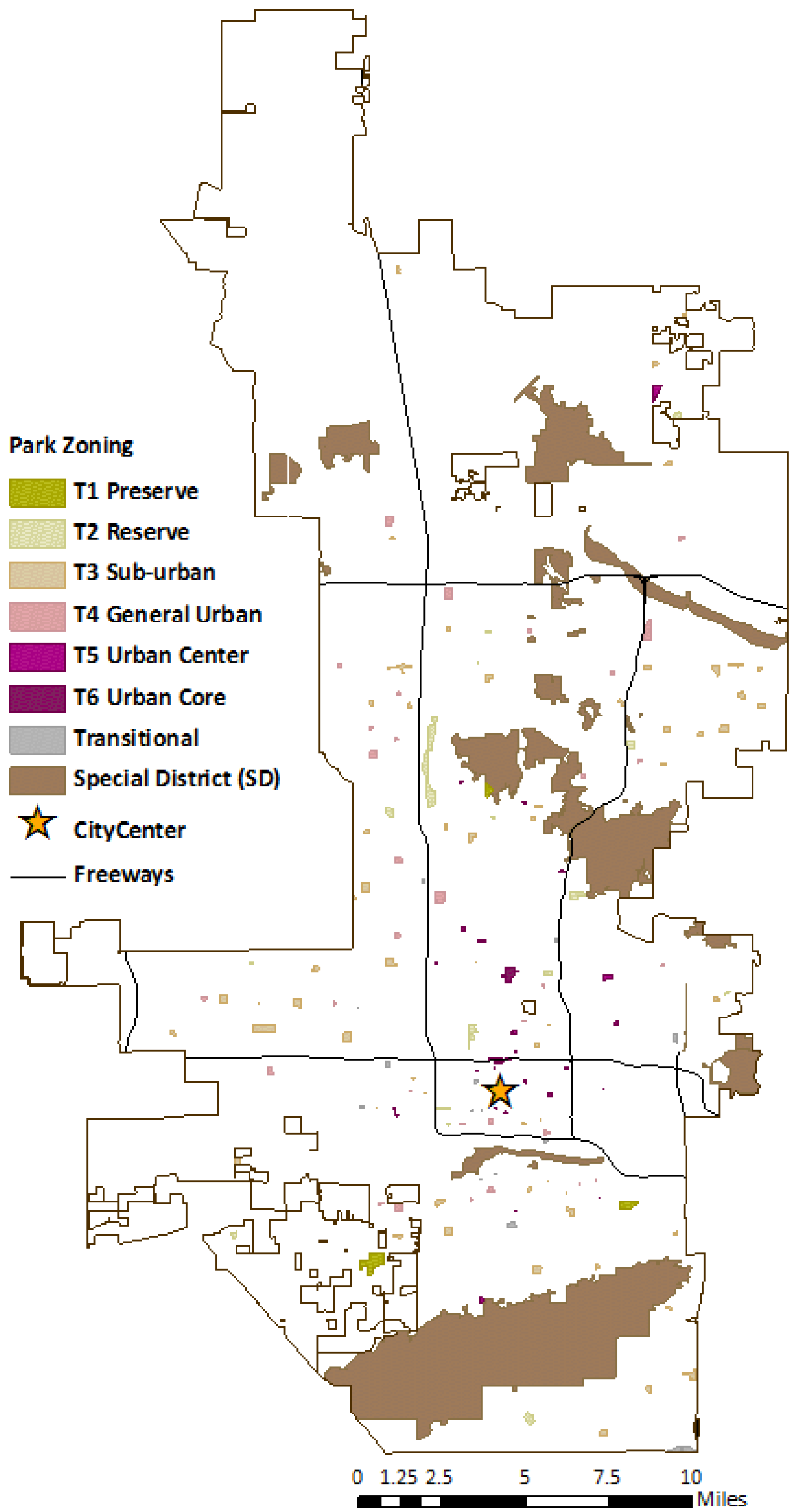


Figure 3.7 Locations and t-zone classifications for all 176 civic spaces in Phoenix.

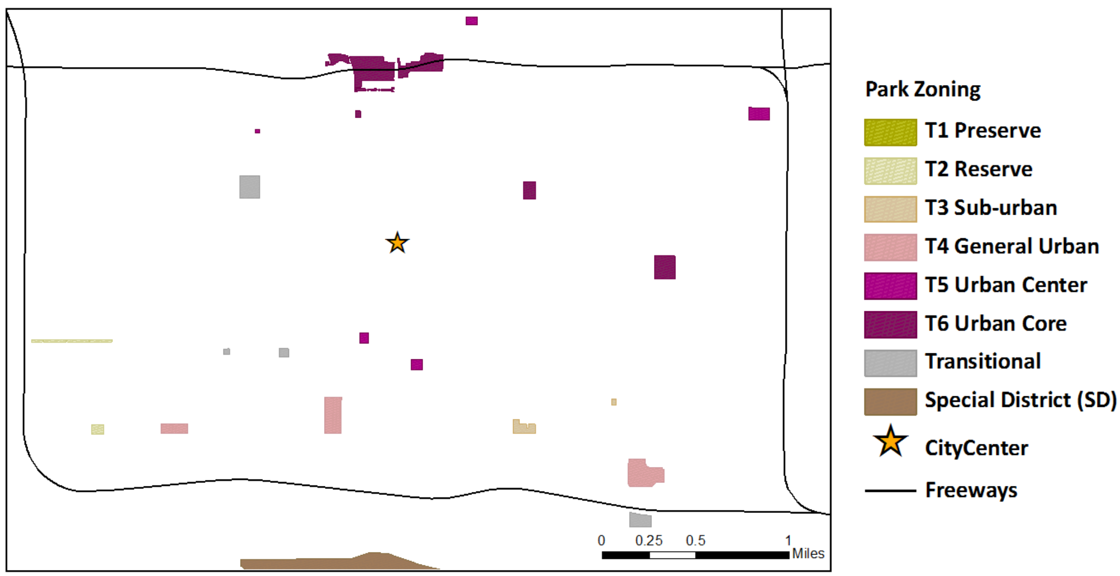


Figure 3.8 Close-ups of park zoning near the city center.

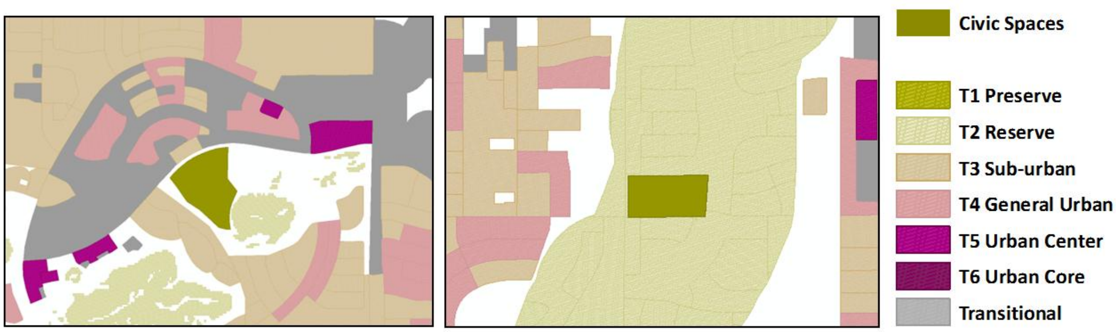


Figure 3.9 Close-ups of select parks and surrounding zoning. Left: Sunray Community Park, surrounded by several different land uses, was zoned T3 due to prominence of sub-urban zoning in surrounding areas. Right: Werner's Field Neighborhood Park was classified as T2 Reserve based on surrounding transect zoning.

Microanalysis

For the microanalysis, this study narrowed in on a sample of four parks (one in each urban transect zone). The context-sensitivity of each was assessed and recommendations were made to enhance their suitability to the built environment using SmartCode guidelines for civic spaces along the transect. Since *Special Districts* have no set parameters, they were removed from this phase, while eight other sites with incomplete or inaccurate were also removed. The final sample included 145 of the 176 original sites.

Focusing in on high need areas, the sites for the microanalysis were chosen based on the population density and income of their neighborhoods (i.e. low-income and high population density). To select the sites, income and density were calculated for all park neighborhoods. The median annual household income for the 145 park neighborhoods ranged from $9,277 to $154,508 with an average of $50,109. Fifty-five park neighborhoods (38%) were above the mean income, and 90 (6%) were below average. The population density in park neighborhoods ranged from 0.39 to 15.77 people per acre, with a mean of 6.06 people per acre. Fifty-seven civic space neighborhoods (3%) were above the mean value for population density, and 88 (6%) were below average.

To identify the final four high-need parks, first sites with above average neighborhood population density were highlighted. Then, from this list, one park from each urban transect zone (T3-T4) with the lowest income was selected. The final sites are Willow, Harmon, Kuban Community, and Perry parks (Figures 3.9 and 3.10). All four parks are labeled *neighborhood* parks by the City of Phoenix Parks and Recreation Department. The sites are clustered in south and central Phoenix. The median household income for the neighborhoods around each site ranged from $16,833 to $30,316, and the population density ranged from 6.11 to 11.19 people per acre. The size of the sites spanned 2.21 to 10.99 acres.

SmartCode Redesign

The final step of this research involved assessing the context-sensitivity of the four microanalysis parks per SmartCode guidelines (Table 3.7), and offering recommendations to enhance their suitability to the surrounding built environment (i.e. surrounding land uses, see Figure 3.12). This process also served as an evaluation of the SmartCode approach to civic space planning and design as applied to the study area. Here, SmartCode guidelines for civic space design across the transect were consulted and compared to the park sample. Details on each site were obtained from the City of Phoenix Parks and Recreation Website (City of Phoenix 2013) and satellite imagery. According to SmartCode (2009) guidelines, civic spaces appropriate to T3-sub-urban zones include parks and greens, those in T4-general urban should be greens or squares, and civic spaces in T5-urban center or T6-urban core should be squares or plazas. Playgrounds are appropriate in all T-zones and within other civic space types. The Code refers to formal versus naturalistic landscaping types, i.e. organized rows of trees and manicured vegetation versus trees and vegetation distributed in a more random, informal, 'natural' manner. The Code also refers to 'unstructured' recreation, which consists of unorganized activities such as noncompetitive ball sports in a family or social settings, biking, walking, dog socialization and exercise, and skateboarding. Alternatively, structured recreation involves "recreational activities involving elements of instruction, choice and skill development" (Laidlaw Foundation 2000).

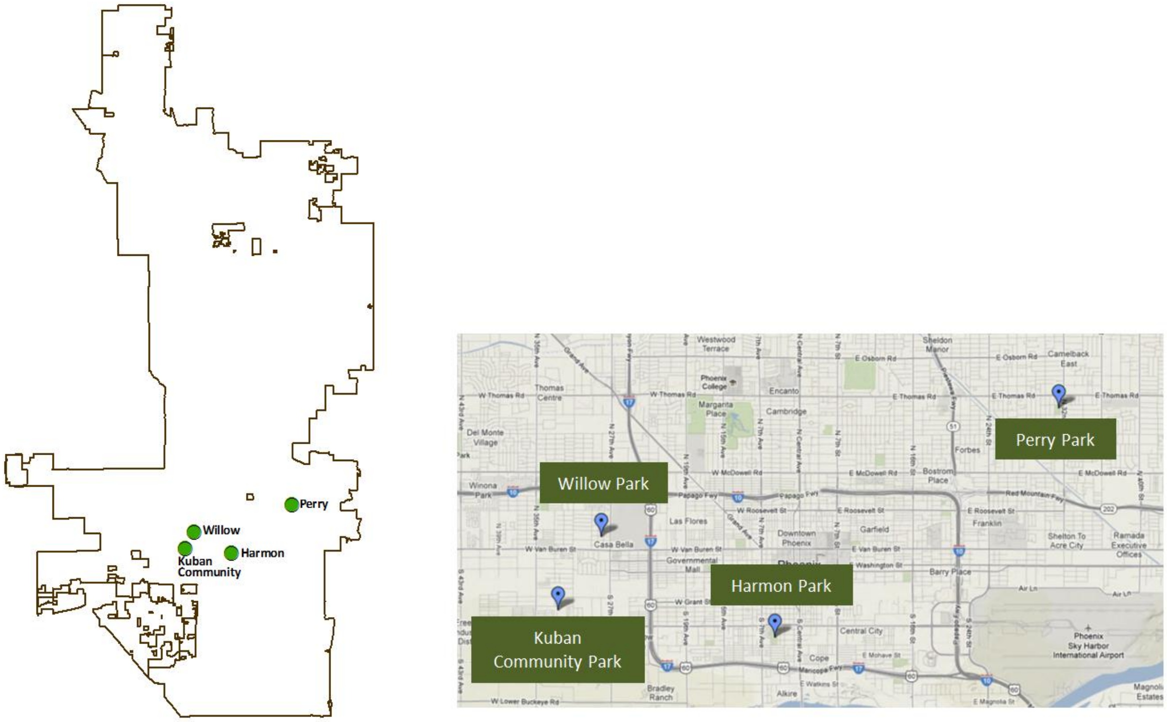


Figure 3.10 Location of the four civic spaces chosen for microanalysis.

Sub-urban (T3): Willow Park

Surrounded by single-family homes and one commercial/industrial parcel, 2.2-acre Willow Park (Figure 3.11) is equipped with a lighted basketball court, grills, picnic areas, a playground, and a ramada. The entire park is fenced in and there is a cluster of trees in one corner of the park that provide some natural shade, and a large unshaded lawn area. Following SmartCode design guidelines, Willow Park (located adjacent to T3 sub-urban areas) should be between one-half to eight acres, naturally landscaped, composed of mostly lawn and trees, and designed for unstructured recreation. The park follows the standards with respect to size, turf, and the support of unstructured recreation, but the site contains few trees and is not naturalistically landscaped. Context-sensitive improvements to this T3 civic space might include planting more trees and creating a more naturalistic park setting through landscaping. However, SmartCode guidelines regarding trees, particularly in a lower-intensity T-zone, maybe somewhat inappropriate in a water-scarce desert ecosystem. As an alternative, a native garden with xeric landscaping may provide a more naturalistic park feel, while maintaining sensitivity to the local environmental and climatic conditions.

Figure 3.11. Imagery of Willow Park (Google Maps 2013)

Figure 3.12 Landuse around microanalysis parks. Top left to bottom right: Willow Neighborhood Park (T3 Sub-urban), Harmon Neighborhood Park (T4 General Urban), Kuban Community Neighborhood Park (T5 Urban Center), and Perry Neighborhood Park (T6 Urban Core).

General Urban (T4): Harmon Park

Eleven-acre Harmon Park (Figure 3.13) is equipped with lighted baseball, basketball, volleyball, racquetball, and tennis courts, a gymnasium, picnic areas, a playground, pool, recreation building, shuffleboard, lighted soccer and softball fields, grills, ramadas, restrooms, a playground with shade structure, and a spray pad. The park is adjacent to the Phoenix Memorial Hospital and surrounded by single-family homes to the north and south and multi-family homes to the east. This study designated Harmon Park as T4 general urban, therefore the site should follow the guidelines of a green or square. Greens (one half to eight acres) are designed for unstructured activity, are naturally landscaped with lawn and trees, and are spatially defined by these elements. The main purpose of a square (one half to five acres) is also participation in unstructured activities, but these civic space types are defined spatially by the buildings around them and are to be located on major intersections. Harmon Park does provide ample opportunities for unstructured recreation but does not follow the SmartCode guidelines for this T-zone with respect to size, landscaping, or urban context. The park is larger than a green or square, it is not spatially defined by buildings or landscaping, and it is not located on a busy intersection (though it is less than a quarter mile from a major road). Alterations to make this park more context-sensitive would therefore require increasing the density and mixed-use nature of surrounding development and/or spatially defining the park more formally with landscaping.

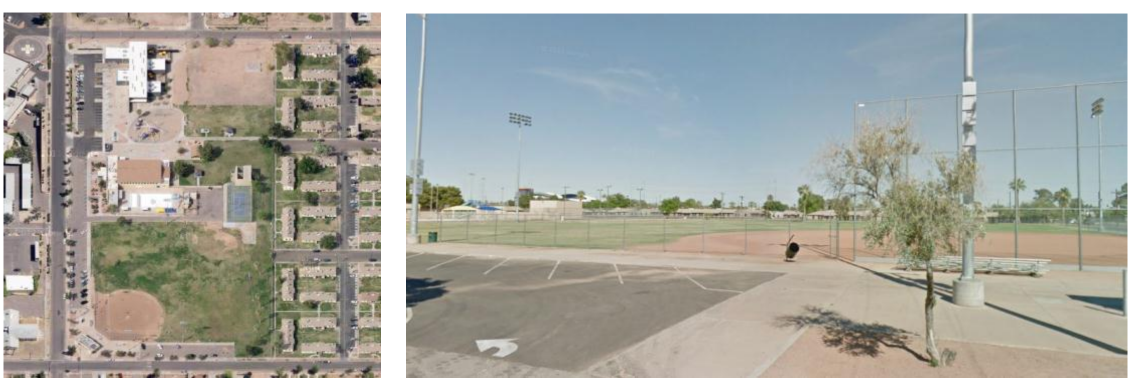


Figure 3.13 Imagery of Harmon Park (Google Maps 2013).

Urban Center & Core (T5-6): Kuban Community & Perry Parks

The two high need parks zoned as T5 and T6 in this study were Kuban Community Park and Perry Park. Kuban Community Park (Figure 3.14) is 9.3 acres in size and is equipped with a playground, lighted basketball and sand volleyball courts, a ramada, picnic tables, grills, open turf areas, and a plaza. To the east and adjacent to the site are an elementary school and a mobile home development. To the north of the park is a steel company (TWR Steel Works) and to the east are single-family homes. At 8.4 acres, Perry Park (Figure 3.15) has lighted baseball, volleyball, tennis, and basketball courts, a lighted softball field, playground, pool, ramada, picnic areas, restrooms, and grills. To the east of Perry Park is a church and commercial stripmall. To the south is a mobile home development and Family Dollar store, and to the north there is another church and a rehabilitation center. Single-family homes line the west side of the park.

According to SmartCode, Kuban Community and Perry parks should follow the design guidelines for squares or plazas. These civic space types range from one half to five acres, and support unstructured, civic, or commercial activities. Such parks are defined spatially by buildings, located at key urban intersections, and landscaped formally, whether with lawns, trees, paths, or pavement. Both Kuban Community and Perry Park exceeded the size limitations of squares and plazas; they are also not spatially defined by buildings and do not support sufficient civic or commercial activities. However, in keeping with SmartCode guidelines, the landscaping of both sites is formal, they are both located on major roads (though not major 'intersections'), and they support recreational uses. To increase the context-sensitivity of these parks and their use and value in these most urban T-zones, more high-density housing, civic, mixed-use, and commercial land uses should be encouraged in the surrounding areas. Safe bike and walking paths to and throughout these spaces may enhance access, while the integration of other uses and activities such as community gardens, festivals, and art fairs can increase their use.

Figure 3.14 Imagery of Kuban Community Park (Google Maps 2013; Sexton 2011)

Figure 3.15 Imagery of Perry Park (Google Maps 2013)

Table 3.7 Comparison: SmartCode design parameters and actual park characteristics

		Civic Space Type	Size (acres)	Landscaping
Willow (T3)	**SmartCode**	Park, green	> 0.5 acres	Natural preserves that may include naturalistically disposed paths, trails, meadows, water bodies, woodlands and open shelters. May be lineal, following natural corridors. Or open space consisting of lawn and trees. Naturalistically disposed.
	Actual	Neighborhood	2.2	Landscaping is formal and developed, site does not contain naturalistically disposed features.
Harmon (T4)	**SmartCode**	Green, square	0.5 - 8 acres	Open space consisting of lawn and trees. Naturalistically disposed. Or open space consisting of paths, lawns, trees. Formally disposed.
	Actual	Neighborhood	11.0	Large open space with few scattered trees.
Kuban Community (T5)	**SmartCode**	Green, square, plaza	0.5 - 8 acres	Open space consisting of lawn and trees. Naturalistically disposed. Or open space consisting of paths, lawns, trees. Formally disposed. Or open space consisting primarily of pavement; trees optional.
	Actual	Neighborhood	9.3	Formally disposed open spaces, lawn and trees.
Perry (T6)	**SmartCode**	Square, plaza	0.5 - 5 acres	Open space consisting of paths, lawns, trees. Formally disposed. Or open space consisting primarily of pavement; trees optional.
	Actual	Neighborhood	8.4	Formally disposed open space with lawn and trees.

* Darker shaded cells denote a match with SmartCode guidelines for civic spaces along the transect, lighter shade denotes partial conformation, and white cells reflect a mismatch.

Table 3.7 continued

		Spatial Orientation	Surrounding Landuses	Purpose (facilities)
Willow (T3)	**SmartCode**	May be spatially defined by building frontages or landscaping, may line natural corridors.	Low density residential areas, adjacent to higher zones with some mixed use. Planting is naturalistic, blocks may be large and roads irregular to accommodate natural conditions.	Unstructured recreation.
	Actual	Not spatially defined by landscaping.	Surrounded by single-family homes and one commercial/industrial parcel	Lighted basketball court, grills, picnic areas, a playground, and a ramada.
Harmon (T4)	**SmartCode**	May be spatially defined by building frontages or landscaping.	Mixed use but primarily residential urban fabric Landscapes are variable. Streets with curbs and sidewalks define medium-sized blocks.	Unstructured recreation and civic purposes.
	Actual	Not spatially defined by buildings or landscaping and not located on a busy intersection (yet < 1/4 mile from a major road).	Adjacent to the Phoenix Memorial Hospital and surrounded by single-family homes to the north and south and multi-family homes to the east	Lighted baseball, basketball, volleyball, racquetball, and tennis courts, gymnasium, picnic areas, pool, recreation building, shuffleboard, lighted soccer and softball fields, grills, ramadas, restrooms, a playground with shade structure, & spray pad.
Kuban Community (T5)	**SmartCode**	May be spatially defined by building frontages or landscaping.	Higher density mixed use buildings that accommodate retail, offices, row houses and apartments. Tight network of streets, wide sidewalks, steady street tree planting and buildings close to sidewalks.	Unstructured recreation and/or civic and commercial purposes.
	Actual	Not spatially defined by buildings but located on a major road.	East and adjacent to the site are an elementary school and a mobile home development. To the north of the park is a steel company (TWR Steel Works) and to the east are single-family homes.	Playground, lighted basketball and sand volleyball courts, a ramada, picnic tables, grills, open turf areas and a plaza
Perry (T6)	**SmartCode**	Spatially defined by buildings and located at major intersections.	Highest density areas with greatest variety of uses and civic buildings of regional importance. May have larger blocks, streets have steady street planting and buildings close to wide sidewalks.	Unstructured recreation and/or civic and commercial purposes.
	Actual	Not spatially defined by buildings but located on a major road.	To the east are a church and commercial strip mall. To the south is a mobile home park and Family Dollar store, and to the north there is another church and a rehabilitation center. Single-family homes line the west side of the park.	Lighted baseball, volleyball, tennis, and basketball courts, a lighted softball field, playground, pool, ramada, picnic areas, restrooms, and grills

CONCLUSION

This study was designed to fulfill three fundamental goals. The first was to introduce and assess an alternative approach to urban growth in Phoenix that, over time, promotes the evolution of a more compact, sustainable urban form. Addressing this goal, results illuminated key obstacles and opportunities associated with the adoption of transect planning in Phoenix. On one hand, the monotonous, sprawling, polycentric urban form of the city, dominated by single-family home developments, makes the integration of diverse transect zones problematic. This conclusion parallels Talen (2010: 483) who noted, "The ability of Phoenix to exhibit a better spatial logic in terms of parks distribution is probably severely limited by its low-density, sprawling urban pattern." Such homogeneity not only appeals to a narrow range of human preferences, but also is extremely socially and environmentally unsustainable (Duany et al. 2000; Overpeck and Udall 2010; Ross 2011). The city may retain such developments for those who prefer them, but should also strive to expand the range of human habitat types by prioritizing the development of higher density housing and mixed land uses, particularly in areas identified in this study as T5 and T6.

However, other results highlight the strength and flexibility of the transect approach to simultaneously retain certain characteristics of the region, while appropriately and efficiently diversifying its range of habitats. This study revealed that, with proper planning Phoenix could prove a model city for the adoption of transect code without sacrificing either its characteristic low-density developments or extensive protected areas. Specifically, because the city is so expansive there is room to develop a more diverse range of habitat types (including compact, walkable, transit-oriented, mixed-use neighborhoods) while maintaining suburban-style housing and the region's significant natural, scenic, and cultural features. In this way transect planning is a good fit for Phoenix. The only requirement is the thoughtful targeting of specific types of development where they are supported by the current infrastructure and built environment as is described in this study. Specifically, the urban character of areas identified as suitable for T4 - T6 could be improved over time by integrating more mixed residential, commercial, and active land uses, as well as higher-density housing. Transitional zones could be reevaluated over time for appropriate T-zone designation (as outlined in this study) as the city continues to develop. Meanwhile, preserve areas should remain protected and reserve areas should transition to preserve designations as they are able to be set aside.

The abundance of underutilized land in Phoenix—much of which is located near major thoroughfares and the urban center—presents both challenges and opportunities to transect-based planning in the region. Underutilized areas are problematic in that they serve to disrupt the urban fabric in areas that may, otherwise, be quite compact and vibrant. However, because these areas are vacant or salvage land, they are easy targets for transect appropriate development. As such, underutilized land in Phoenix could serve a central role in steering urban growth towards the development of more diverse neighborhood types that would appeal to a larger variety of lifestyle preferences in the coming decades. Also the transformation of these areas could greatly improve the overall aesthetic and continuity of the urban fabric. In order to do so in a coherent manner, these areas should be rezoned to complement their adjacent T-zones, while development appropriate to the surrounding zones should be encouraged through tax incentives. Specifically, areas with more 'urban' qualities—i.e. relatively higher commercial/industrial/active surrounding land uses, smaller blocks, higher population density rather than low density, less populated zones—should be prioritized for intensification.

In sum, these findings indicated that the adoption of transect zoning in Phoenix would drastically impact the trajectory of growth in the region, directing it towards the evolution of an overall more heterogeneous, compact urban form. Yet, the transect can also accommodate existing preferences for low-density, auto-dependent, single use development patterns prevalent in the region. As such, the transect approach satisfies a broader range of lifestyles than is currently found in Phoenix. The heterogeneity and flexibility afforded by transect planning is important given evidence that nationally, particularly among the youth (teens - early 30s), lifestyle preferences are reflecting transect-style urban design. Many young people are shunning suburban living with long commutes and large homes, for more convenient, compact, mixed-use, walkable, transit-oriented urban centers (Benfield 2010, 2011, 2012a). This trend is even spreading to smaller cities with populations under 250,000 (Benfield 2012b). Specific to the study area, Phoenix's recently updated downtown master plan (Downtown Development Office 2007) also points to shifting local preferences for more convenient, mixed-use, transit-oriented living. The new plan emphasizes a "vibrant downtown" with an integrated light rail system, increased population density, retail, mixed-use development, and new residences and office spaces. The plan also outlines already completed enhancements to cultural amenities downtown including the renovation of Symphony Hall and other historical sites, the expansion of the Phoenix Art Museum and Convention Center, and a downtown public market that provides "locally-grown produce and other unique items" (ibid: 15). The apex of the downtown plan is the CityScape development. Once the location of two parking lots, the site is now, "an inspiring multi-block, pedestrian-oriented, high-rise, mixed-use urban destination for downtown Phoenix and the valley" (ibid: 16).

A second goal of this study was to assess current conditions and inform the planning and design of more context-sensitive civic spaces in Phoenix through a macroanalysis of the entire city park system in addition to a more focused microanalysis of a sample of sites in high need neighborhoods. The macroanalysis revealed some stark mismatches, but also some coherent patterns, between the park system in Phoenix and the guidelines for context-appropriate civic space design across the transect outlined in SmartCode. The microanalysis of parks in the urban T-zones likewise highlighted both matches and mismatches between the guidelines and on-the-ground sites. These steps also served to demonstrate a simple method of assessing the context-sensitivity of targeted and city-wise civic spaces using SmartCode guidelines. Although the approach is not comprehensive, the results and methods outlined in this phase of the study represent a first step towards enhancing the suitability of urban public spaces that support a cohesive, coherent urban fabric with accessible amenities.

The third and final goal of this research was to empirically evaluate SmartCode civic space guidelines as applied to the City of Phoenix, highlighting the strengths and weaknesses of the approach while recommending place-specific alterations. Some results of this study bring into question the appropriateness of SmartCode civic space typologies in Phoenix and highlight areas for improvement. In some aspects the code is unnecessarily ridged, while in other ways the guidelines appear detrimentally ambiguous. For example, the limited number of civic space types is problematic. Phoenix contains a variety of park types that do not fit into SmartCode categories because of their size, landscaping type, and/or location. The value of forcing a diversity of parks into so few categories is unclear. Instead, it is recommended that the variety of civic space typologies are expanded to include spaces for different purposes and different landscaping types. In desert cities such as Phoenix, native desert landscape versus irrigated 'green' parks should be distinguished between. The code is also quite rigid in its size and landscaping specifications, which although they hold value in their attempt to keep the urban fabric appropriately close-knit in more urban zones, should be more flexible to account for local geography, politics, and preferences. While it is understood the code is meant to be calibrated, it should be noted in the text that the size and other specifications for civic spaces are flexible, and to what extent.

Another issue was that several terms in the design guidelines were undefined, leaving important definitions up to broad interpretation. In order to broaden the reach of SmartCode to non-planners, certain terms should be more clearly defined, including: 'unstructured recreation,' 'civic purposes,' 'commercial activities,' and 'formally' or 'naturalistically" disposed landscaping. Remarkably, although the process is touted as a 'sustainable' solution to urban planning, there is no mention of environmental or ecological considerations in the civic space guidelines. The lack of ecological considerations represents a significant deficiency. As such, purposes beyond unstructured recreation, civic, and commercial uses should be extended to include more 'ecocentric' benefits, such as the protection and promotion of ecological health, particularly in less developed rural and natural zones. In sum, this study proposes that the expansion of several elements, the clarification of certain terms, tightening of some guidelines, and loosening of others would greatly enhance the value of the civic space guidelines outlined in SmartCode.

Chapter 4

INTEGRATING ECOSYSTEM SERVICES INTO URBAN PARK PLANNING & DESIGN

BACKGROUND

Urban parks—including plazas, preserves, and other civic spaces—are key providers of a wide range of ecocentric and anthropocentric ecosystem services in cities (Bolund and Hunhammer 1999; Tratalos et al. 2007). Access to parks has been shown to enhance the physical, mental, and spiritual health and well-being of urban residents, leading to reduced rates of depression, obesity, and attention disorders (Sherer 2003; Chiesura 2004; Bedimo-Rung et al. 2005; Louv 2005). Vegetation in parks has been linked to enhanced air and water quality, microclimate cooling, flood mitigation, and reductions in energy use. Trees specifically remove carbon dioxide from the air, release oxygen, and filter suspended particles and storm water (Woudstra and Fieldhouse 2000; Sherer 2003). Civic spaces also provide economic benefits to communities by increasing property values and attracting tourism (Lutzenhiser and Netusil 2001; Nicholls and Crompton 2005; Harnik and Welle 2009). Although other urban open spaces (e.g. residential lawns, private parks) also deliver ecosystem services, civic spaces have the benefit of being publically owned, therefore their design can be coordinated on a larger scale and over longer periods of time without having to navigate the complex realm of private property ownership and rights.

Given the key role parks play in the provisioning of urban ecosystem services (Bolund and Hunhammer 1999) and evidence that urban form significantly impacts service provisioning (Tratalos et al. 2007), there is a growing consensus that ecosystem service considerations should be integrated into urban park planning, policy, and decision-making (Cadenasso and Pickett 2008; Lovell and Johnson 2009; Sander 2009; Schilling 2010). Yet the applicability of the ecosystem services model to cities is limited for several reasons that must be resolved before it can be effectively integrated into urban planning and design. First, because the model was originally designed for non-urban landscapes and principally by natural scientists, it has limited suitability to the built environment. Those studies that have explicitly studied ecosystem services in cities still focus on ecological processes *in* the city, rather than *of* the city (Collins et al. 2000). These approaches also fail to fully integrate the 'human' element of the model, including social need and the various attributes of the built environment (e.g. MA 2005). Proper assimilation of 'cultural services,' which represent more anthropocentric values, is therefore required (Kinzig 2009).

A second issue is that the ecosystem services model, as applied to urban parks in particular, lacks balanced contextual and spatial considerations. No distinction is made between the appropriate and potential benefits of a square in the urban core versus a wildlife preserve on the urban fringe. Certainly not all civic spaces in a city can, or should, be expected to provide all possible ecosystem services, and in many cases, tradeoffs must be made. Failure to consider the place-specific tradeoffs, impacts on urban form (e.g. contribution to sprawl), potential disservices, and the overall effectiveness of urban ecosystem services initiatives can lead to detrimental, rather than favorable outcomes. In an assessment of the sustainability of a greenway system Lindsey (2003) focused on six principles: harmony with nature, livable built environments, place-based economy, equity, polluters pay, and responsible regionalism. Findings revealed that some principles were prioritized over others and that enhancement of one principle often degraded another.

Likewise, research on two parks in Barcelona revealed that one of the parks successfully contributed to the social, political, and environmental dimensions of sustainability, while the other ignored all but the environmental dimension (Saurí et al. 2009). Parés and Saurí (2007) argue that urban open spaces with negative environmental impact may still be valuable if they fulfill social or political sustainability goals. Campbell (1996) attacks this quandary from the planning perspective, recognizing that it is not only unnecessary, but impossible to give equal balance to all the dimensions of sustainability in every situation. Urbanists argue that creating expansive greenway and park systems can disrupt the urban fabric, causing sprawling development patterns and reducing access to civic spaces (Kunstler 1996; Talen 2010). Kunstler (1996) questions the validity of emphasizing ecological functioning in cities, wondering if instead it is appropriate to have some places where social services take center stage. Such perspectives suggest that balanced approaches to urban planning that consider what ecosystem services should be emphasized, and *where*, are necessary for the maintenance of coherent, sustainable urban form.

Managing ecosystem service tradeoffs in arid regions is particularly challenging, understudied, and misunderstood. For example, studies of arid city urban tree programs concluded that some expected results (e.g. carbon sequestration, air quality) were at best relatively insignificant, and at worst negative (e.g. high water demand of trees, negative feedback from residents) (Pincetl 2010; Pataki et al. 2011). Further, urban park research tends to focus on the benefits of 'green' space (e.g. Maas et al. 2006; CABE Space 2010; Schilling 2010), even in arid cities though water requirements for widespread urban greening in these regions is often environmentally and economically impractical (Parés and Saurí 2007; Pataki et al. 2011). Jenerette et al. (2011: 2637) warns that,

> Increasing vegetation is one strategy for moderating regional climate changes in urban areas and simultaneously providing multiple ecosystem services. However, vegetation has economic, water, and social equity implications that vary dramatically across neighborhoods and need to be managed through informed environmental policies.

Further, civic space research in general ignores native desert urban parks, therefore the potential benefits of 'brown infrastructure' are grossly underappreciated and misunderstood and there are no design standards for protecting and enhancing its value. Surely the minimally disturbed native desert landscape of the 16,000-acre South Mountain Preserve in Phoenix has ecological value, and a hike to the top of Camelback Mountain can be physically and spiritually exhilarating.

The final limitation to the successful integration of ecosystem service considerations into civic space planning and design is the absence of accessible, balanced tools and standards for implementation (Tzoulas 2007; Sander 2009; Schilling 2010). Urban scholars have highlighted the need for a planning approach that synthesizes and balances the tradeoffs of multiple biophysical and socio-economic perspectives across multiple spatial scales (Sander 2009; Schilling 2010), and also details, "how different land uses can be configured for greater support of biodiversity and ecosystem services" (Colding 2007: 46). Further, it is argued that such a tool can only be effectively and efficiently mobilized by urban planners and designers (Gutman 2007). Duany and Talen (2002: 244) assert that what is needed to balance environmental goals and coherent, sustainable urban form is a complete "reworking of the tools of planning implementation" and new "regulatory devices that implement planning objectives" and integrate the goals of multiple stakeholders, including conservationists, architects, designers, landscape architects, and transportation planners.

Though the concept is far from new, the influential planning movement New Urbanism has recently reinvigorated a 'transect approach' to urban planning which may assist in the successful integration of ecosystem services into urban planning and design, particularly in the realm of urban parks. The concept of a transect has its roots in ecology. An example of an ecological transect is a wetland, wherein a perpetually wet zone eventually transitions into to a wet/dry zone, which gives way to dry land. Each zone contains a unique mix of plant, animal, and insect species specially adapted to the conditions of that location (Figure 4.1).

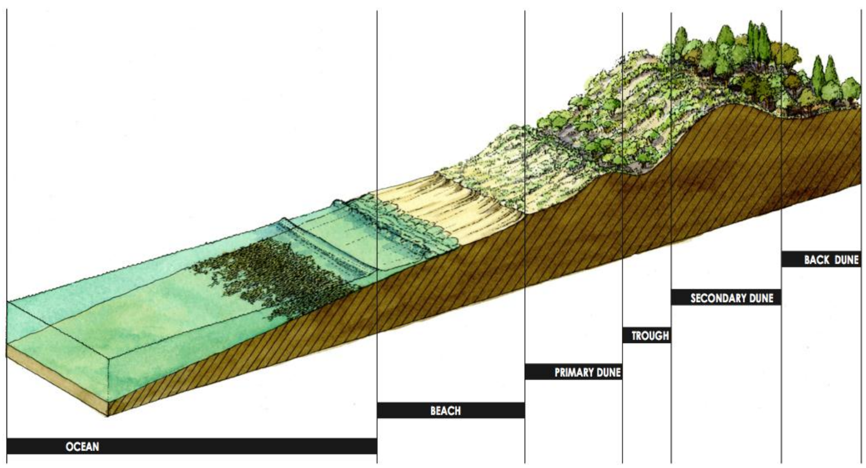


Figure 4.1 An ecological transect model (CATS 2013)

In the context of human settlements, transect planning seeks "the proper balance between human-made and natural environments" (Duany and Talen 2002: 247), by defining habitat types (i.e. transect zones) across a range of urban intensities from undisturbed wildlands to formally designed, dense urban centers. Each zone maintains a character of place by organizing specific urban elements in a way that is "true to locational character" (Duany and Talen 2002: 146). Transect planning is codified in the *SmartCode* manual, a multiscalar planning and regulatory tool designed to guide the development (and redevelopment) of more sustainable, context-sensitive human settlements (CATS 2013, *Codes*). Designed to be calibrated to local social and ecological conditions and preferences at multiple scales (building to region), SmartCode organizes the built environment into six transect zones (Figure 4.2): Preserve (T1), Reserve (T2), Sub-urban (T3), General Urban (T4), Urban Center (T5), and Urban Core (T6). The specific characteristics of the zones are outlined in Table 4.1. *Special Districts* (SD) are an exception to the guidelines. These zones consist of "areas with buildings that by their function, disposition, or configuration cannot, or should not, conform to one or more of the six normative Transect Zones" (SmartCode 2009: xi). Examples include university campuses, historic sites, and other places of natural or cultural significance.

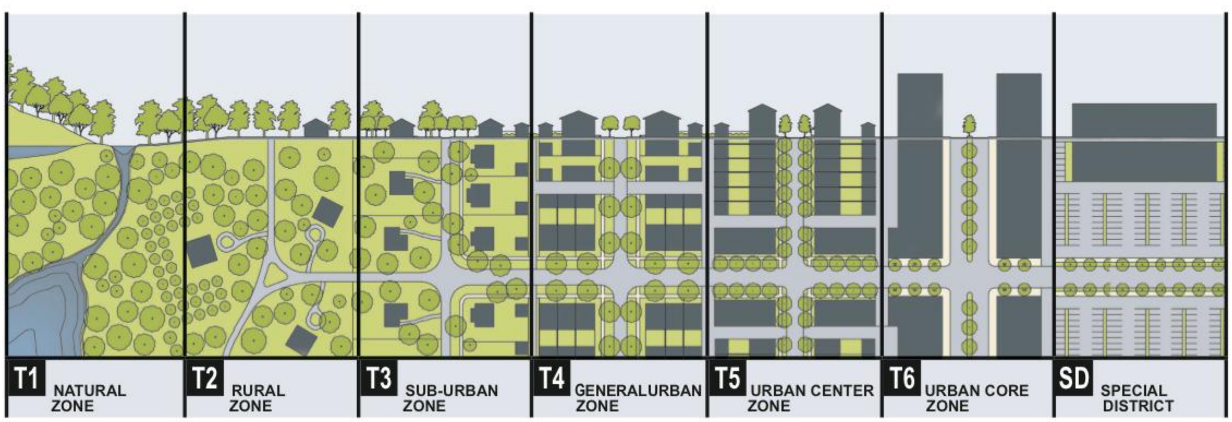


Figure 4.2 Transect zones in SmartCode (2009)

Table 4.1 Primary characteristics of each transect zone as outlined in SmartCode

	Overview	General Character
T1-Preserve (or natural)	Consists of lands approximating or reverting to a wilderness condition, including lands unsuitable for settlement due to topography, hydrology or vegetation.	Natural landscape with some agricultural use
T2- Reserve (or rural)	Consists of sparsely settled lands in open or cultivated states. These include woodland, agricultural land, grassland, and irrigable desert. Typical buildings are farmhouses, agricultural buildings, cabins, and villas.	Primarily agricultural with woodland & wetland and scattered buildings
T3- Sub-urban	Consists of low-density residential areas, adjacent to higher zones that some mixed use. Home occupations and outbuildings are allowed. Planting is naturalistic and setbacks are relatively deep. Blocks may be large and the roads irregular to accommodate natural conditions.	Lawns, and landscaped yards surrounding detached single-family houses; pedestrians occasionally
T4- General Urban	Consists of a mixed use but primarily residential urban fabric. It may have a wide range of building types: single, sideyard, and rowhouses. Setbacks and landscaping are variable. Streets with curbs and side-walks define medium-sized blocks.	Mix of houses, townhouses & small Apartment buildings, with scattered commercial activity; balance between landscape and buildings; presence of pedestrians
T5- Urban Center	Consists of higher density mixed-use buildings that accommodate retail, offices, rowhouses and apartments. It has a tight network of streets, with wide sidewalks, steady street tree planting and buildings set close to the sidewalks.	Shops mixed with Townhouses, larger Apartment houses, Offices, workplace, and Civic buildings; predominantly attached buildings; trees within the public right-of-way; substantial pedestrian activity
T6- Urban Core	Consists of the highest density and height, with the greatest variety of uses, and civic buildings of regional importance. It may have larger blocks; streets have steady street tree planting and buildings are set close to wide sidewalks. Typically only large towns and cities have an urban core Zone.	Medium to high-Density Mixed use buildings, entertainment, civic, and cultural uses. Attached buildings forming a continuous street wall; trees within the public right-of-way; highest pedestrian and transit activity

As applied to the planning of urban parks, transect theory would assert that a large nature reserve is more suited to a natural or rural landscape, while a small plaza is most suitably situated in a dense, built up urban core. By extension, such an approach allows for certain goals (or ecosystem services) to be prioritized in certain parks, balancing out the multiple goals across a region where they are most appropriate. Social and civic ecosystem services would be most aptly emphasized in more urban transect zones, while native biodiversity protection (which requires minimally-disturbed, native landscapes) would be emphasized in less developed rural areas and wildlands.

Given its unique qualities, the transect approach, as operationalized in SmartCode, reconciles many of the limitations that have hampered the successful integration of ecosystem services into planning, particularly in arid cities. As the approach recognizes the place-specific conditions and qualities of heterogeneous urban landscapes, it provides an integrative model of human and natural systems that allows for the incorporation of an array of ecosystem services across an urbanized region. The fact that SmartCode is open-source and already in use by planners also makes it a very accessible tool. In addition, the Code provides an organized structure for uniting both human and natural considerations as it is aligned with core ecological principles including diversity, evolution, adaptation, and gradients of habitats (Talen 2002; Talen 2009a). Finally, as the Code is customizable, the approach can also be well adapted to the special characteristics and needs of arid regions.

The incorporation of the ecosystem service model into the SmartCode protocol also presents an opportunity to improve the Code itself. A common critique of SmartCode and New Urbanist practice more broadly, is that such approaches are "too narrowly aligned with architectural sensibilities," and lack rigorous, scientifically based "ecological considerations"

(Krieger 2010: 1). With respect to civic space design, the Code is both simplistic and lacking clear ecological and environmental standards based on scientific, empirical research. The current typology dedicates a single page to civic space design, outlining five categories—parks, greens, squares, plazas, and playgrounds—accompanied by rudimentary guidelines specifying the size, use, and landscape type appropriate for each. Considering the increasingly widespread use of this document to guide planning and design—recently the complete rezoning of Miami, Florida (City of Miami Planning Department 2008)—the scant attention paid to the ecological characteristics of civic spaces highlights a critical gap, but also a unique opportunity to integrate the ecosystem services concept into a popular urban planning tool.

RESEARCH APPROACH

The aim of this research was to develop an immediately accessible and efficient tool and standards for integrating multiple ecosystem service considerations, across the spectrum of 'anthropocentric' to 'ecocentric' concerns, into urban park planning practice. To this end, the Urban Park Ecosystem Services (UPES) planning tool was created and tailored to the study area of Phoenix, Arizona.

In the development of the UPES, this study progressed through three principal phases. The first step involved the development of basic landscape and design guidelines for a suite of key arid region urban park ecosystem services and attaching them to specific landscape types across the urban-to-natural gradient. This phase was informed by a review of literature from multiple fields including urban planning, public health, geography, environmental justice, leisure science, urban and ecosystem ecology, landscape architecture, and climatology. The ecosystem services emphasized in the new tool included two traditionally anthropocentric benefits (i.e. social/civic and recreation), a more ecocentric value (biodiversity protection), and one directly beneficial to both human and non-human urban life (microclimate cooling). It is acknowledged that the suite of ecosystem services selected for this study are not necessarily the 'most' important, and certainly not the only important benefits of parks in arid regions. These particular services were chosen because they are essential park values that integrate both natural and social science ideologies and are well-studied—therefore amenable to transformation into design guidelines.

In the second phase, SmartCode civic space typologies and the existing park classification system in Phoenix were analyzed and compared. The strengths and weaknesses of each system as applied to civic space planning across the transect of an urbanized region were identified and discussed, informed by the aforementioned review of literature. The documents used in this analysis included the latest City of Phoenix General Plan (2002) and the SmartCode (2009) manual. SmartCode was used here as it represents a well-organized, cost-effective, and flexible planning code that can be easily adapted to local conditions and allows for the integration of multiple social and ecological (i.e. ecosystem service) considerations in park planning and design. Further, the fact that SmartCode is already in use and gaining favor with urban planners and designers was expected to facilitate the adoption of the new tool by urban planners and designers. The analysis of the current Phoenix Park classification system highlighted the unique, place-specific characteristics of an arid region urban park system. While not all arid city park systems are analogous, it is expected that the UPES can be tailored to other similar arid urbanized regions given minor adjustments.

Based on the findings of the previous steps and related literature, the final step of this study involved augmenting SmartCode with ecosystem service considerations tailored specifically to arid urban ecosystems in the development of the UPES. Here, design guidelines for the four ecosystem services were attached to appropriate civic space types, emphasizing the range of ecocentric to anthropocentric values as appropriate to their context. Specific determinations were based on which type of landscape could most effectively and efficiently provide each service, as well as where (across the urban-to-natural gradient) each service was most essential.

It is important to note that given the range of possible interpretations and geographic variations, the final design specifications are not meant to be rigidly followed, but should be coupled with site-specific natural, social science, planning, and design expertise. As such, this research does not represent an end, but a start to the systematic integration of multidisciplinary science into park planning and design aimed at advancing the multiple dimensions of sustainability in arid regions.

RESULTS & DISCUSSION

Design for Enhanced Urban Park Ecosystem Services across the Transect

The first component of this study involved an in-depth review of literature related to ecosystem service provisioning of urban landscapes, and the development of general criteria for the enhancement of a range of ecosystem services in different civic space types. While there are a number of other critical urban park ecosystem services that could be integrated into these standards, this study focused on a suite of four benefits particularly critical to human and biological health and well-being in hot, arid cities: recreation, social/civic benefits, microclimate cooling, and biodiversity protection. The review drew primarily from the fields of urban planning, public health, geography, environmental justice, leisure science, urban and ecosystem ecology, landscape architecture, and climatology. Tailored to arid cities, the following section outlines the review findings and subsequent guidelines for civic space design in the most urban, most natural, and transitional zones. A central tenet of these guidelines is that the benefits of the park system should be maximized while maintaining a coherent urban form with a compact, walkable urban center, as well as a diversity of other human and non-human habitat types including suburban and natural zones. Also in alignment with transect theory, the guidelines emphasize native biodiversity in the natural and rural zones, and social benefits in the urban core, assuming the lowest of each in the suburban zones as illustrated by Figure 4.3 (from Duany 2002).

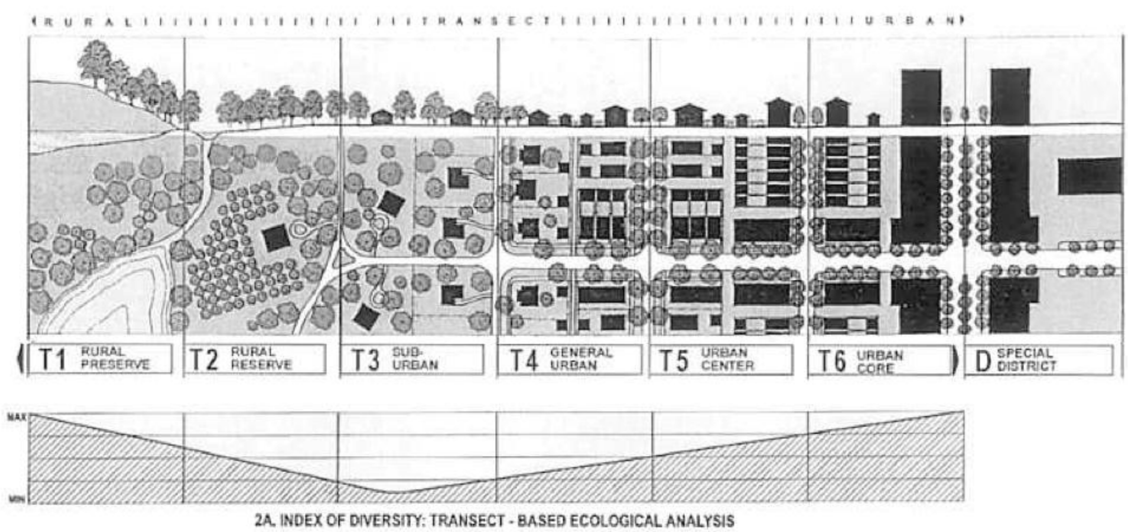


Figure 4.3 Excerpt taken from Duany (2002: 257). The bottom figure showing a “hypothetical level of diversity for each transect zone,” as related to the transect zones above.

Recreation

The ability to support physical activity represents a fundamental role of municipal parks. Access to parks is often correlated with increased levels of physical activity (Bedimo-Rung et al. 2005; Giles-Corti et al. 2005), which in turn promotes a physically and mentally healthy urban population (Orsega-Smith et al. 2004; Maller et al. 2005; Bedimo-Rung et al. 2005). Access to parks has repeatedly been linked to decreased rates of obesity (Kaczynski and Henderson 2007), which is a growing epidemic in the United States, particularly among minority and low-income populations (Ogden et al. 2006).

Research shows that the provisioning of recreation in urban parks is related to park size, accessibility, physical condition, safety, aesthetics, facilities, and the built environment. Larger parks have been linked to increased rates of physical activity in communities and proximity to parks has been shown to increase park use, as well as the frequency and level of physical exercise by urban residents (NRPA 2012). Giles-Corti et al. (2005) correlated access to public open spaces with increased physical activity, especially at more proximate, large, scenic parks. Studies have shown that adults and youth who lived close to parks (within a half mile) exercise two to five times more per week than other urban residents (Frank et al. 2007; Kaczynski and Henderson 2007). The level of physical activity engaged in by urban residents is also highly influenced by their ability to walk to a park (NRPA 2012). A common distance threshold used in parks literature is a quarter mile, meaning that ideally all city residents would be within a five-minute walk of some type of park (Thwaites et al. 2005; Boone et al. 2009).

The condition, safety, and aesthetics of park grounds and facilities also impact park use for recreational purposes. Studies show that the frequency of park use and overall activity levels are higher in safe, scenic parks with well-maintained facilities (Coen and Ross 2006; Cohen et al. 2006; NRPA 2012). Park safety can be said to encompass both perceived and actual safety. The condition of parks and surrounding areas, including the presence of graffiti, refuse, or other signs of vandalism, can impair perceived safety (Quebec en Forme 2011). Objective personal safety in parks is related to actual crime rates in parks and surrounding areas, both linked to reduced use of parks, which can subsequently cause more criminal activity (Crompton 2001; Bedimo-Rung et al. 2005). Park aesthetics can be defined as the "perceived attractiveness and appeal of the various design elements of a park" (Bedimo-Rung et al. 2005: 165). Certain aesthetic features are extremely influential in park use, including landscaping, topography, and the presences of art and water features. Some important design issues include the size of a park, its layout, landscaping, the balance between sun and shade, topography, ease of access, visual appeal, and other aesthetic features such as ponds or sculptures (Bedimo-Rung et al. 2005; Giles-Corti et al. 2005).

The specific amenities, facilities, and features of a park also play an important role in the use of parks for recreational purposes. Generally, more recreational facilities lead to increased levels of physical activity (Li et al. 2005; Rosenberger et al. 2005). The quality and condition of facilities are also a factor, wherein newer and/or better-maintained features often increase activity (Bedimo-Rung et al. 2005). Specific types of amenities are particularly influential in spurring physical activity, including trails, playgrounds, and sports complexes (Kaczynski et al. 2008; Flyod et al. 2008; NRPA 2012). In fact, parks with trails (paved or unpaved) and forested areas were found to increase physical activity levels sevenfold by Kaczynski et al. (2008). Features that support physical activity and longer park visits, such as bicycle racks and restrooms, further extend the use of parks (Kaczynski et al. 2008).

Vigorous levels of physical activity can also be encouraged by the presence of playgrounds and ball courts and fields (Floyd et al. 2008).

The built environment surrounding urban parks is a final predictor of park use for recreational purposes. The presence of low-density housing, single uses, and poor access limits park use. Particularly in zones of high urban intensity, access to parks and related recreational benefits can be amplified by boosting housing density around parks and increasing the diversity of surrounding land uses, particularly active uses. Other methods include creating a sense of enclosure around parks with landscaping and building frontages to make the space a "positive feature" of the landscape, creating a central focal point or feature, and constructing permeable perimeters that are pedestrian and bike friendly (Jacobs 1961; Talen 2010).

Recreation Across the Transect

The UPES prioritizes recreational provisioning along the transect where there are more people, while the specific types of facilities are related to what is most appropriate given the social and environmental context. Specifically, areas of higher population density are targeted because they have more people overall but also because these neighborhoods tend to have more lower-income populations, higher rates of obesity, and less access to private outdoor lawns (Mokdad et al. 2003; Papas et al. 2007). The appropriateness of specific recreational facilities is related to the built environment, wherein low-impact hiking trails may be more suited to large nature preserves, and playgrounds to small urban squares.

Civic spaces in the most urban transect zones of desert cities such as Phoenix can best support recreation by being within close proximity to residents, particularly in areas with high density housing and mixed land uses. These parks should be accessible by sidewalks, bicycle paths (and racks for parking), and public transportation. Such parks may support recreation by integrating playgrounds, ball courts, and other exercise equipment suitable to smaller spaces (e.g. exercise stations). The presence of water features (e.g. fountains, splash pads), drinking fountains, movable seating, shaded areas, food kiosks, and art can also aid in their utilization. The landscaping in the parks and the surrounding buildings should create a sense of enclosure and safety.

Civic spaces in the transitional zones between natural and urban areas can encourage recreational use by including larger water features such as ponds and lakes. These parks may include large athletic complexes, swimming pools, playgrounds, paths, trails, picnic tables, and artificial water bodies. Accessibility can be enhanced by integrating bike trails (and racks), sidewalks, and trails where appropriate.

Sparsely developed areas are best suited to larger, more scenic parks, though *Special District* parks supersede this rule. Landscaping in these parks should be naturally disposed. Such areas may support low-impact outdoor recreational activities such as hiking, biking, and horseback riding via trails. Portable restrooms, water pumps or fountains, and shaded picnic areas should be provided whenever possible.

Social/Civic Benefits

Jane Jacobs (1961) recounted some of the numerous non-consumptive reasons people visit parks beyond recreational use: to relax, read, work, show off, find love, meet other people intentionally (for an appointment) or spontaneously, retreat from the business of the city, connect with nature, entertain children, people watch, or just see what happens.

Public parks represent areas where residents can commune, socialize, and form social ties (Coley et al. 1997; Kuo et al. 1998). Parks are also "places were interpersonal and intergroup cooperation and conflict can be worked out in a safe and public forum" (Low et al. 2005: 3). While somewhat intangible, such social and civic uses are of tremendous importance (Boyd and Banzhaf 2006). In this way, public civic spaces facilitate and support the development of social capital, cultural diversity, equity, justice, and representative political participation (Ferris et al. 2001; Mitchell 2003; Sherer 2003; Parés and Saurí 2007; Seeland et al. 2009).

The ability of public spaces to successfully deliver social and civic benefits is largely a product of their accessibility, comfort, aesthetics, spatial distribution, and surrounding built environment. First, parks must be where people are; therefore surrounding areas should support high density housing, active and mixed land uses, and infrastructure for public transportation, biking, and walking. Also, particularly in urban centers, there must not be too many parks or too much park acreage, as excessive competition has a way of 'saturating' the market, often resulting in underutilized and degraded public spaces (Jacobs 1961; Harnik 2010; Talen 2010). Low et al. (2005) present six guidelines for management and promotion of cultural diversity in urban parks. Authors claim parks should represent the history of the local people, create access through proper transportation, be safe, facilitate a variety of uses for a variety of preferences, maintain facilities as well as scenic features, and communicate cultural meaning. Youth development can be facilitated in parks by offering activities and programs that encourage physical, social, intellectual, and emotional health. Such activities could include gardening programs, environmental education tours, and community sporting events (NRPA 2012).

Civic spaces are made comfortable and welcoming by providing seating (preferably movable) in both shaded and open areas, water (e.g. drinking fountains), and food (via farmer's markets, food trucks, kiosks, or nearby restaurants). Parents with children in particular will be concerned with these amenities as well as safe places for their children to play. Facilities should therefore be well-maintained, clean, and lit at night. Hardscapes, including paved areas, paths, benches, gazebos, and private nooks also enable park use for social purposes such as children playing games, couples having private conversations, and families enjoying picnics (Jacobs 1961; Harnik 2010).

After years of study, William Whyte (1980) and his team discovered seven key features that enable the use of small urban park and plazas for social and civic purposes. First, locating a site near a busy street corner can immediately enliven a space. Also important was providing a diversity of seating options including chairs, ledges, and steps in a variety of environmental contexts (i.e. shade, sun, wind). Whyte's research also discovered that trees, places to eat, and accessible water features both attracted people to parks and made them stay longer. Finally, to facilitate engagement between diverse park visitors, the element of *triangulation* was deemed essential. A piece of art, pleasant view, or unusual event could serve this function if it prompted two (or more) strangers to engage in conversation.

Social/Civic Benefits Across the Transect

Overall, the guidelines developed by this study concentrate social and civic park values in areas of higher urban intensity. These areas should support a sufficient, though not excessive number of smaller squares, plazas, and neighborhood parks that contain elements known to facilitate social interaction and civic engagement. Where appropriate, these sites may include a variety of seating options in sun and shade, public art, drinking fountains, food vendors, paved areas, gardens, paths, gazebos, and private corners. Further, such parks are best located at busy intersections that already support a vibrant street life. Surrounding land uses should include civic buildings (e.g. city hall, libraries, schools, government offices), and mixed commercial and residential parcels when possible. The need for proper infrastructure for public transportation, biking, and walking must also be underscored. Events that promote conservation, education, arts, and culture should be encouraged in small to moderately sized parks (i.e. squares, neighborhood and community parks, rather than preserves). To foster social interaction and inclusion, public art, performances, and other efforts that communicate cultural meaning and history should be integrated into all urban parks.

Microclimate Cooling

Particularly in arid cities, the cooling benefits of parks and open spaces represent one of the most valuable ecosystem services. Ecosystem services related to urban cooling also have a global impact, reducing global greenhouse gas emissions and regional energy use (Akbari 2002; Baker et al. 2002; Nowak and Heisler 2011). Studies of the Phoenix urban heat island (UHI) have determined that temperature difference between the most intensively built up areas can be up to 13°C higher than surrounding rural lands (Hawkins et al. 2004; Brazel et al. 2007). This heat island effect exacerbates already extreme risks to human health and comfort in hot, arid cities like Phoenix. Park landscapes with open areas, trees and other vegetation contribute to human health and comfort by providing protection from the sun's heat and ultraviolet rays. These areas also mitigate the heat risks posed by high temperatures and the urban heat island effect via evapotranspiration and the release of radiant heat (Yu and Hien 2006; Jenerette et al. 2011). The presence of water features in parks, such as pools and fountains, also provide cooling benefits to urban residents via evaporative cooling of the human body (Nowak and Heisler 2011).

The magnitude of cooling provided by urban landscapes is primarily related to patch size, landscaping, extent of vegetation, irrigation practices, and the availability of water. Park size is positively correlated with lower air temperatures relative to surrounding urbanized landscapes (Barradas 1991; Jauregui 1991). Spaces in the middle of large parks can be up to 13°F (7°C) cooler than adjacent areas. Larger parks also have a more significant impact on cooling outside their boundaries than smaller civic spaces, particularly if they support green vegetation (Nowak and Heisler 2011). The presence of trees and other vegetation also considerably increases the cooling benefits of parks (Kalnay and Cai 2003; Jenerette et al. 2007). Urban landscapes with a high percentage of tree coverage (via larger and or more trees), and trees that are tightly planted, have a more significant cooling benefit than areas with few, sparsely planted trees. This effect is especially pronounced during the hot afternoon hours (Spronken-Smith and Oke 1998; Nowak and Heisler 2011). Open grassy areas also contribute to cooler air temperatures both inside and around parks, especially in the morning hours around sunrise (Spronken-Smith and Oke 1998). Irrigation of urban vegetation, xeric or green, greatly enhances the cooling effects of park landscapes arid cities via evapotranspiration (Brazel et al. 2007; Pearlmutter et al. 2009; Shashua-Bar et al. 2009; Chow et al. 2010).

The cooling influence of parks is most significant during nighttime hours and the level of cooling provided by different park landscapes (trees vs. open grass) varies by time of day (Nowak and Heisler 2011). Daytime cooling is most dependent on shade and evapotranspiration, while nighttime temperatures are most impacted by the release of heat from impervious surfaces (e.g. pavement and buildings) (Oke et al. 1991; Spronken-Smith and Oke 1999; Nowak and Heisler 2011). As such, parks with trees and irrigated vegetation provide the most extreme cooling benefit during the afternoon hours, while grassy parks cool surrounding landscapes most efficiently in the morning and at night (Spronken-Smith and Oke 1998; Pearlmutter et al. 2009; Shashua-Bar et al. 2009). The integration of diverse landscape types in parks, including shaded areas with trees and open turf areas, results in the most beneficial configuration for 24-hour cooling. Finally, the presence of water features in parks, including fountains, ponds, lakes, pools, and splash pads, can enhance the heat relief provided by parks in arid regions via evapotranspiration of plants and evaporative cooling of the human body (Nowak and Heisler 2011).

Cooling Across the Transect

The need for microclimate cooling aimed at increased human health and comfort is most critical in neighborhoods with high population density, and the most extreme risks of heat stress due to the UHI effect caused by copious impervious cover. Larger parks in less developed areas can also be managed to provide cooling, but this should be accomplished with minimal disturbance. That is, although the planting of grass over the 16,000-acre South Mountain Park would enhance urban cooling, such practices are in conflict with water and biodiversity conservation. In an effort to balance the cooling benefits of urban parks without contributing to urban sprawl, this study suggests distinct methods for enhancing microclimate cooling in different civic space types. First, smaller parks in highly urban areas can most effectively provide cooling benefits by the presence of water features (e.g. ponds, pools, splash pads, fountains), irrigated vegetation, and large, tightly planted trees. Integrating a patch of open lawn in these smaller parks can also extend the cooling effects, particularly during the night.

Parks in the transitional zones may best provide cooling benefits by integrating ponds and lakes and landscaping that includes a mix of trees and large open grassy areas. Larger parks in more rural zones can provide cooling via large native open areas, but should also provide shaded areas in strategic areas for relief during hot days.

Biodiversity

The role of urban landscapes in the protection of biodiversity and conservation efforts overall is a controversial subject, and as such represents the most complex ecosystem service addressed in this study. To begin, there is no consensus among scholars, practitioners, and lay people regarding what type of outcome is desirable, that is what 'kind' of biodiversity is valuable (Marris 2009). Traditionally, the relationship between cities and wildlife protection has been antagonistic. Cities were considered a disturbance to, not protector of biodiversity and if there was any benefit of cities it was to keep people and development out of wildlands (Grimm et al. 2008). Given this perspective, any discussion of protecting biodiversity in cities is mute (Ibes 2011). Another perspective advocates that cities can play a role in biodiversity protection, but that only native species are 'valuable.' From this angle, non-native flora and fauna are undesirable, as such, there should be no effort to protect them (Marris 2009). From still another viewpoint, it is not the particular biological composition of a landscape that matters, but rather how that ecosystem is 'functioning' or what 'services' it is providing. Some urban scholars argue that there is value in 'novel' ecosystems, which contain unique biological communities (i.e. with respect to composition and abundances) due to human management (Hobbs et al. 2005; Marris 2009). From this perspective, the ecosystems of managed urban landscapes, including urban parks, have been irrevocably changed but efforts to restore these to their (previous) natural state may be both impractical and unachievable. Hobbs et al. (2006: 5) suggest such human and financial resources should rather be directed to preservation of existing natural areas, while accepting altered landscapes for "what they are and what benefits they provide." In fact, the benefits, or ecosystem services provided by novel ecosystems are extensive and include providing habitat for native and non-native species, water filtration, erosion control, recreation, and aesthetic values. Further, there is evidence that such landscapes are becoming more then norm than the exception, and for this reason alone should not be disregarded or unappreciated (Marris 2009).

Another matter is that 'biodiversity' is an often oversimplified and misunderstood concept. 'Species richness' refers to the variety of species, while 'species abundance' relates to the number of plant and animal species in a given area. 'Species evenness' is a measure of the distribution of different species in an area. If there were, for example, 250 species of birds in a park but only three types of insects, this would constitute poor evenness. When one speaks of biodiversity or 'species diversity,' this is a measure of both richness and abundance (Tuomisto 2010).

Despite these tensions and complications, there is evidence that urban open spaces do play a role in protecting biodiversity and ecological processes, functioning, and services within cities (Forsyth and Musacchio 2005), even in non-native, landscapes heavily altered by human activity (Marris 2009; Rosensweig 2003). In a survey of research on 'novel' ecosystems, Marris (2009) reported that some 'exotic' forest systems support more biodiversity than native forests and have higher rates of nutrient cycling and biomass. This new focus on 'ecosystem services' has, in fact, transformed perspectives on the biodiversity value of urban landscapes. "Ecosystem-service arguments are powerful enough to get some ecologists to abandon, or at least put to one side, their deep distrust of novel ecosystems," notes Marris (2009: 452).

Biodiversity in cities is controlled directly by humans through the planting of vegetation, and indirectly through the creation of habitat types (e.g. size, landscaping, vegetation) that attract particular biological communities (Faeth 2011). An urban park 'habitat' is a product of the community and structure of plants at the scale of the entire park, or a subsection. Park habitats and the biodiversity they support are related to their size, how fragmented or connected they are, the types and abundance of vegetation, irrigation practices, and the presence of water. Larger parks connected by greenways or other biological corridors support more plant and animal life than small fragmented, isolated landscapes (Faeth 2011). This is true because smaller parks generally provide fewer resources (i.e. food, water, and shelter) and isolated patches present a barrier to migration. In particular, bird and arthropod abundances are lower in smaller patches, while a set of many small parks with diverse landscape types can actually increase bird diversity in cities (Faeth and Kane 1978; Donnelly and Marzluff 2006). In general, minimally developed, larger landscapes and connected urban patches tend to better support biodiversity in cities, particularly native plant and animal life (Faeth 2011).

The local biological community in parks is also influenced by the composition and abundance of vegetation and presence of water features, therefore the protection of biodiversity in arid city parks must consider the value of both green and 'brown' infrastructure. Managed and irrigated 'green' parks in desert cities generally have higher productivity than the surrounding native desert (Imhoff et al. 2000; Kaye et al. 2005). Because of the increased availability of water, food, and habitat, the abundance and the richness of animal and insect species are often higher in green parks relative to native and rural desert landscapes (Faeth 2011). Increased vegetation in desert cities, particularly irrigated vegetation, also supports biodiversity year-round by buffering seasonal variations in food and water supplies (Pierotti and Annett 2001; Reichard et al. 2001), and by stabilizing the microclimate (Imhoff et al. 2000; Kaye et al. 2005). Increasing vegetation in parks can therefore serve to increase (primarily non-native) biodiversity in cities (McKinney 2008; Shochat et al. 2010). If the goal is to attract native species, the planting and protection of native plants is an effective approach (Faeth et al. 2005; Tallamy 2010). Also, existing undisturbed native desert landscapes should be protected from alterations (e.g. planting trees, grass) to maintain their integrity and the native biological communities they support. Conversion of native desert landscapes significantly alters the composition and functioning of these ecosystems (Marzluff et al. 2001; Chace and Walsh 2006), including productivity and carbon, water, and nitrogen balances (Kaye et al. 2005; Pataki et al. 2006; Gaston et al. 2010). Integrating water features in parks can also enhance patch biodiversity as it both provides a consistent water source and facilitates adaptation of certain species to arid urban ecosystems (Faeth et al. 2005; Shochat et al. 2006). Such water sources could include fountains, ponds, and lakes that are present water year-round.

Biodiversity Across the Transect

As discussed previously, there is no consensus regarding what kind of biodiversity can or should be provided by urban landscapes. Though an impediment to most urban ecological research, this controversy is, in fact, perfectly suited to the transect approach to civic space planning. This is because by its nature, the transect integrates multiple ecocentric and anthropocentric perspectives in their proper context. Faeth (2011: 77) notes that,

> The goal of conserving and reconstructing habitats within cities is often to minimize loss of species; however, for this to work, environments must be preserved and created where wildlife and humans can coexist. In urban environments, this usually involves the coexistence of native and nonnative species in the same environment.

Reflecting this sentiment, this study emphasizes the promotion of both native and non-native biodiversity, but prioritizes native biodiversity where appropriate and considering tradeoffs among other ecosystem services. For example, the large minimally-developed mountain preserves in Phoenix are the best suited to native biodiversity protection, while smaller neighborhood parks will be less focused on biodiversity protection overall, but may enhance non-native biodiversity via green vegetation needed for cooling and social benefits.

It is well established that the number, composition, and variety of species varies across the gradient of intensely urban to undeveloped wildlands. Understanding of these variations is informed largely by island biogeography theory (MacArthur and Wilson 1967) and intermediate disturbance hypothesis (Connell 1978; Faeth et al. 2011). Generally the diversity of species is lowest in built up, paved urban centers and areas that experience frequent or severe disturbances (Marzluff et al. 2001; McKinney 2008). Native biodiversity is generally highest in wildlands outside the city, though oftentimes the highest biodiversity in urbanized regions occurs in the intermediate or 'transitional' zones (McKinney 2008). While in temperate cities the opposite is often the case, frequently in desert cities there is lower richness but greater abundance of bird species (predominately non-native), in green spaces (Germaine et al. 1998; Green and Baker 2003). Broadly the guidelines in this research emphasize the protection of native biodiversity in preserves and other larger parks in the more rural and natural transect zones. Enhancement of non-native biodiversity is not a priority but may be a secondary benefit of smaller parks in areas of higher urban intensity. The planting of native trees and other vegetation is encouraged in all civic spaces when possible, provided reasonable human and financial resource needs.

Comparison of SmartCode & City of Phoenix Park Classification Systems

In the next phase of the study, SmartCode and the City of Phoenix park typologies were assessed and compared to direct the modification of SmartCode for arid cities by highlighting the strengths and weakness of each system and revealing opportunities for improvements (Table 4.2).

SmartCode

SmartCode defines urban civic space as outdoor areas dedicated for public use, and outlines five categories: parks, greens, squares, plazas, and playgrounds. The SmartCode Manual devotes one of its 58 pages to guidelines for these civic spaces. On this page each civic space is accompanied by a four to six sentence description outlining the appropriate use, spatial context, landscaping type, size, and transect zone for each civic space type. The exact descriptions from the SmartCode (2009: SC41) manual are as follows:

- *Park*: A natural preserve available for unstructured recreation. A park may be independent of surrounding building frontages. Its landscape shall consist of paths and trails, meadows, woodland and open shelters, all naturalistically disposed. Parks may be lineal, following the trajectories of natural corridors. The minimum size shall be 15 acres. Larger parks may be approved by warrant as districts in all zones.

- *Green*: An open space, available for unstructured recreation. A green may be spatially defined by landscaping rather than building frontages. Its landscape shall consist of lawn and trees, naturalistically disposed. The minimum size shall be 2 acres and the maximum shall be 15 acres.
- *Square*: An open space available for unstructured recreation and civic purposes. A square is spatially defined by building frontages. Its landscape shall consist of paths, lawns and trees, formally disposed. Squares shall be located at the intersection of important thoroughfares. The minimum size shall be 1 acre and the maximum shall be 5 acres.
- *Plaza*: An open space, available for civic purposes and commercial activities. A plaza shall be spatially defined by building frontages. Its landscape shall consist primarily of pavement. Trees are optional. Plazas shall be located at the intersection of important streets. The minimum size shall be 1 acre and the maximum shall be 2 acres.
- *Playground*: An open space designed and equipped for the recreation of children. A playground shall be fenced and may include an open shelter. Playgrounds shall be interspersed within residential areas and may be placed within a block. Playgrounds may be included within parks and greens. There shall be no minimum or maximum size.

The SmartCode civic space typology has the advantage of being well-organized and easy to integrate into planning designs across a range of urban-to-natural landscape types. However, the Code descriptions for the different civic spaces are found to be too vague, generic, and simplistic to be usefully applied in a large urban area, particularly in an arid ecosystem. The Code also does not address the intended ecological benefits of these spaces but rather focuses narrowly on civic and recreational benefits, negating the possibility of creating multi-functional civic spaces that support a variety of ecosystem services.

City of Phoenix

In its most recent General Plan (2002), the City of Phoenix classifies its parks into the following categories: mini parks, neighborhood parks, community parks, district parks, desert parks and mountain preserves, and special facilities. The General Plan offers a short description for the different types of parks, including their primary purpose, urban context, and service area. Excerpted from the City of Phoenix General Plan (2002: 283, 287, 294, 295, 314), descriptions for the various park types on Phoenix are as follows. (Note: there are no details on mini parks as descriptions for these spaces were not included in the General Plan or other official city documents (electronic or print)).

- *Neighborhood Parks*: Designed to serve an area within a radius of one-half mile or a population from 4,000 to 7,000 people; examples include Moon Valley, Verde, and Desert Star. These parks are within walking or bicycling distance of residences and are typically 15 acres in size. Local or collector streets typically border them. Most neighborhood parks include children's playground and picnic areas, open play turf areas, parking, lighted volleyball and basketball courts, and restroom facilities.
- *Community Parks*: Serve an area of one and one-half miles and a population of 20,000 to 50,000 people. These parks are typically 40 acres or larger, with active recreation improvements, and are located on collector or arterial streets. Organized team sports, leagues, and large-activity facilities are located in these parks. Most existing community parks include lighted basketball, volleyball, soccer and softball facilities; playgrounds; picnic areas; and restroom facilities. Pools, lighted tennis courts, and ramadas also may be included. Community parks have turf areas that are unprogrammed open spaces, which can be used for a variety of activities and events. Examples are Roadrunner, Circle K, and Falcon.
- *District Parks*: Draw from several communities and are 200 acres or larger, serving 100,000 to 200,000 people. They provide for active and passive recreation and serve a five-mile service radius. They may include specialized activities such as a golf course, festival area, or an amphitheater. In general, district parks are located on arterial streets, or in areas where the size and function will have minimum impact, i.e., commercial or industrial areas. They also serve the immediate local communities as neighborhood parks or community parks and contain these features: playgrounds and picnic areas, lighted basketball and volleyball courts, lighted racquetball courts, lighted softball and soccer facilities, restroom facilities, lighted tennis courts, and

picnic ramadas. District parks include Encanto, Paradise Valley Park, Desert West, and Cave Creek Recreation Area.

- *Mountain Preserves and Desert Parks*: These areas accommodate various recreational and outdoor activities - hiking, mountain bicycling, horseback riding, picnicking, outdoor education, bird watching, and biological field studies. Ecological principles included are: (1) hydrologic processes should be maintained, (2) connectivity of desert patches and corridors should be maintained, (3) patches should be as large as possible, (4) unique and interesting mosaics of landforms and vegetation types should be included in the preserve, (5) diverse mosaics should be integrated into the developed human environment, and (6) a preserve should be considered at multiple scales. Another preserve plan recommendation is to preserve lands above the 10 percent slope, including transition lands and washes in their undisturbed state (City of Phoenix General Plan 2002: 283, 287)
- *Special Facilities*: Fill an important role with the city's park system, as amenities that are unique in their purpose, design, and the needs they fulfill. Such sites/amenities range from historical sites to those providing very specialized services. Some of the facilities in this category include Pueblo Grande Museum, Patriots Park, Maryvale Stadium, Phoenix Municipal Stadium, Oakland Athletics' Training Complex, Heritage and Science Park, Shemer Art Center, Cancer Survivors' Park, Rio Salado and Tres Rios, Tovrea Castle with Carraro Cactus Gardens, the Irish Cultural Center, and the Japanese Teahouse Garden.

The benefit of the City's park typology is that it represents a variety of park types in an arid urban ecosystem and more explicitly outlines the benefits of these spaces as compared to the SmartCode system, however the system does have a number of shortcomings. First, the system lacks landscaping and other design guidelines for parks. Second, some of the categories overlap and are not mutually exclusive. For example, some 'neighborhood parks' are also labeled basin or desert parks. Also, with regards to size, there are gaps in the classification system such that there is no classification for parks between one and ten, 20 to 40, or 60 to 100 acres. Special facilities may be of any size, but these spaces have unique characteristics that the parks of intermediate sizes may not necessarily have.

Overall the size specifications are limiting. These issues represent areas for improvement of the classification system.

Overall, both the Phoenix and SmartCode park classification systems lack sufficient guidelines for enhancing microclimate cooling, biodiversity, social and civic benefits, and the recreational value of urban parks. Also, neither system explicitly communicates the significance of 'native' or 'brown' infrastructure in arid regions. More explicit guidelines for enhancing civic space ecosystem services across the transect would benefit both classification systems.

Table 4.2 Comparison of SmartCode and City of Phoenix park classification systems, including park type characteristics, ecosystem services emphasized, and recommended improvements.

	SmartCode Civic Space Typology				
Park Type	Playground	Plaza	Square	Green	Park
Size	Any size	½ - 2 acres	½ - 5 acres	½ - 8 acres	8+ acres
Primary Purpose	Children's recreation	Civic & commercial purposes	Unstructured recreation & civic purposes.	Unstructured recreation.	Unstructured recreation.
Location	In residential areas or in parks or greens.	Spatially defined by buildings & located at major intersections	Spatially defined by buildings & located at major intersections	Need not be spatially defined by building frontages, may be spatially defined by landscaping	May or may not be spatially defined by building frontages, may line natural corridors
Service Area	Not specified	Not specified	Not specified	Not specified	Not specified
Other Details	Should be fenced.	Open space consisting primarily of pavement; trees optional.	Open space consisting of paths, lawns, trees. Formally disposed.	Open space consisting of lawn & trees. Naturalistically disposed.	Natural preserve consisting of paths, tails, meadows, water bodies, woodlands, open shelters. Naturalistically disposed.
Ecosystem Services Emphasized	Recreation for children	Civic & economic	Recreation	Recreation	Recreation
Examples	n/a	n/a	n/a	n/a	n/a
Needed Improvements	More detail regarding design & landscaping.	Vague description, too generic to be useful in guiding park design	Difference between plaza & square is negligible, should be combined.	Does not consider benefit of 'brown'/ native open space	Very simplistic definition of a varied open space, needs to be expanded

Table 4.2 continued.

City of Phoenix Park Classification System

Park Type	Mini Park	Neighborhood Park	Community Park	District Park	Desert Parks & Mountain Preserve	Special facilities
Size	Not specified	10-20 acres	40-60 acres	100-200+ acres	7,000 + acres	Any size
Primary Purpose	Not specified	Active & passive recreation.	Active & passive recreation.	Active & passive recreation.	Ecological preservation* & recreation	Are unique in their purpose & design
Location	Not specified	Within walking/ biking distance of residences. Often bordered by local or collector streets.	On/near major streets.	On/near major streets &/or in commercial or industrial areas.	Not specified	Not specified
Service Area	Not specified	1/2 mile; 4,000 to 7,000 people	1-1 ½ mile radius; 20,000-50,000 people	5-mile radius; 100,000-200,000 people	City-wide	Not specified
Other Details	n/a	Most include playgrounds, picnic areas, open play turf areas, parking, volleyball/ basketball courts, restrooms.	May include turf & pavement, ball courts, playgrounds, picnic areas, restrooms, pools, tennis courts, ramadas.	May include golf courses, festival area, amphitheater, playgrounds, picnic areas, basketball/volleyball/tennis/ racquetball courts, softball/ soccer facilities, restrooms.	Facilities for hiking, mountain bicycling, horseback riding, picnicking, outdoor education, bird watching, & biological field studies.	Range from historical sites to those providing very specialized services.
Ecosystem Services Emphasized	Not specified	Recreation for general & children, relaxation	Recreation	Recreation, entertainment, economic activity, children's recreation	Recreation, habitat, water quality & provisioning, biodiversity, natural heritage protection	Varies. Historic/cultural preservation, water quality & provisioning, aesthetic
Examples	Eototo Mini Park	Moon Valley, Verde, & Desert Star	Washington Park, Roadrunner Park, Granada Park	Encanto Park, Desert West Park, Paradise Valley Park	Phoenix Mountains Preserve, Camelback Mountain, Squaw Peak, North Mountain.	Rio Salado, Tres Rios, Japanese Teahouse Garden.
Needed Improvements	Needs purpose & design guidelines	What is biking/walking distance? Does this consider presence of paths/safety of transportation?	How near streets? Needs more specific guidelines.	Large parks should include some native landscapes to expand ecosystem service provisioning. District & community parks are similar- should be combined	Should address level of disturbance more specifically & distinguish between desert & mountain parks. Also, not all parks should strive to maximize all benefits, prioritize.	This category holds much potential for integration into transect & with a spectrum of ecosystem services.

* Specifically to maintain hydrologic processes, desert patch and corridor connectivity; avoid land fragmentation; preserve unique and interesting landform mosaics and vegetation types and integrate these into the built environment; integrate diverse; preserve lands above 10% slope in undisturbed state (including transition lands and washes).

Urban Park Ecosystem Services (UPES) Tool and Standards

Based on the findings of the literature review and analysis of park classification systems, the final step in this research was the development of an integrated tool and standards for civic space planning and design, augmented with ecosystem service considerations (Table 4.3). Although the model was designed particularly for Phoenix's park system, slight modifications and local calibration can expand its applicability to other arid cities.

UPES reconfigured the civic space types from both systems. The new typology includes four categories not in the original SmartCode: *desert preserves, desert community parks, desert neighborhood parks,* and *greenways*. *Squares* and *plazas* were combined into a single category, as they were deemed quite similar. SC's *green* classification is now a *green neighborhood park*, and *park* is a *green community park*. With respect to the City of Phoenix parks classification system, *community* and *district* park categories became *green community parks* and *desert community parks*. *Mini parks* were renamed *squares/plazas* and *neighborhoods parks* were separated into *desert* and *green neighborhood parks*.

The UPES includes specific guidelines for enhancing recreation, social/civic benefits, cooling, and biodiversity in various civic spaces across the urban-to-natural gradient. The appropriate and expected magnitude (level) of provisioning for each service is also noted. There are also general guidelines with respect to the proper size, service area, primary landscaping type and orientation, and spatial context of each park type. These guidelines are approximate and should be considered recommendations, not hard and fast rules.

Table 4.3 Urban Park Ecosystem Services (UPES) planning tool and standards				
Civic Space Type	**Size (approx.)**	**Service Area**	**Primary Landscaping & Orientation**	**Spatial Context**
Desert Preserve	1000+ acres	City-wide	Native xeric, natural waterbodies	Independend of building frontages or formal landscaping. Surrounding areas mainly low-density residential, farms, & natural areas
Desert Community Park	20+ acres	1-5 mile radius; 20,000-200,000 people	Native xeric, naturally disposed, natural water bodies.	Located in low to moderate density residential and/or commercial areas. May be spatially defined by landscaping.
Green Community Park	20+ acres	1-5 mile radius; 20,000-200,000 people	Mix of native vegetation and non-native, irrigated, naturally disposed lawn and trees.	Located in low to moderate density residential and/or commercial areas. May be spatially defined by landscaping.
Desert Neighborhood Park	1-20 acres	1/2-mile; 4000-7000 people	Native desert	In densely populated areas easily accessible by walking/biking and public transportation.
Green Neighborhood Park	1-20 acres	1/2-mile; 4000-7000 people	Non-native, irrigated, naturally disposed lawn & trees.	In densely populated areas easily accessible by walking/biking and public transportation.
Square/Plaza	Up to five acres	1/4 mile	May be primarily pavement. Formally disposed mix of native xeric & non-native, irrigated vegetation. Trees optional.	At the intersection of impotant thouroughfaresa with sidewalks, bike/walk paths; surrounded by civic buildings & mixed commerical & residential land uses; spatially defined by building frontages.
Playground	Any size	1/4 mile	Primarily pavement or sand, little to no vegetation. Should be fenced and may include an open shelter.	In residential areas or within other park types.
Greenways & Basin Parks	Any size	City-wide	Water feature with native vegetation in riparian zones.	Along natural water bodies and corridors.
Special Districts	Any size	City-wide	Varied.	Varied.

Table 4.3 UPES, continued.				
Civic Space Type	Ecosystem Service Level of Provisioning and Details.			
	Recreation	Social/Civic	Cooling	Biodiversity
Desert Preserve	Low to moderate. May support low-impact outdoor recreational activities such as hiking, biking, & horseback riding via trails/paths. Portable restrooms, water pumps or fountains, & shaded picnic areas should be provided when possible	Low. Provisioning of social/civic benefits in these parks may be limited as the focus is on biodiversity protection, with some secondary recreation & cooling benefits.	Moderate to high. Cooling provided by maintaining minimally developed open spaces largely free of impervious surfaces and buildings. Shade should be provided via artificial structures and/or native vegetation. Drinking water should be provided.	High (native). Preservation of intact, minimally developed native desert patches will contribute most to native biodiversity protection.
Desert Community Park	Moderate to high. Structured & unstructured recreation. May include athletic complexes, pools, playgrounds, paths/trails, picnic facilities, & artificial water bodies. Accessibility enhanced via bike paths, racks, and sidewalks.	Moderate. Events that promote conservation, environmental education, art, youth development, and culture should be encouraged.	Moderate. Cooling provided by maintaining minimally developed open spaces largely free of impervious surfaces and buildings. Shade should be provided via artificial structures and/or native vegetation. Drinking water should be provided.	Moderate to high (native). Preservation of intact, minimally developed native desert patches will contribute most to native biodiversity protection. Native landscaping should be prioritized whenever possible.
Green Community Park	Moderate to high. Structured & unstructured recreation. May include athletic complexes, pools, playgrounds, paths/trails, picnic facilities, & artificial water bodies. Accessibility enhanced via bike paths, racks, and sidewalks.	Moderate. Events that promote conservation, environmental education, art, youth development, and culture should be encouraged.	High. Cooling benefit can be enhanced by providing a mix of irrigated open grassy areas as well as trees, flower, and other green vegetation. May included larger water bodies (e.g. ponds & lakes). Drinking water should be provided.	Moderate to high (mixed native & non-native). Irrigated green vegetation, including grass & trees, and year-round water features will enhance primarily exotic biodiversity.
Desert Neighborhood Park	Moderate to high. Structured & unstructured recreation. May include public art, playgrounds, ball fields/courts, skate areas, & water features (e.g. swimming, wading pools). Should provide picnic areas, drinking water, restrooms, seating, shaded areas, food (e.g. kiosks, trucks).	Moderate to high. May include a variety of seating options in sun & shade, public art, drinking fountains, food vendors, paved areas, gardens, paths, gazebos, & private corners. Events that promote conservation, education, arts, youth development, & culture should be encouraged.	Low to moderate. Cooling benefits should be enhanced by providing drinking water & shade structures. Drinking water should be provided.	Low to moderate (native). Xeric landscaping can protect moderate native biodiversity.

Table 4.3 UPES, continued.

Civic Space Type	Ecosystem Service Level of Provisioning and Details.			
	Recreation	Social/Civic	Cooling	Biodiversity
Green Neighborhood Park	Moderate to high. Structured & unstructured recreation. May include public art, playgrounds, ball fields/courts, skate areas, & water features (e.g. swimming, wading pools). Should provide picnic areas, drinking water, restrooms, seating, shaded areas, food (e.g. kiosks, trucks)	Moderate to high. May include a variety of seating options in sun & shade, public art, drinking fountains, food vendors, paved areas, gardens, paths, gazebos, & private corners. Events that promote conservation, education, arts, youth development, & culture should be encouraged.	Low to moderate. Cooling benefits should be enhanced by providing drinking water & shade structures. Drinking water should be provided.	Low to moderate (native). Xeric landscaping can protect some native biodiversity.
Square/Plaza	Low. Unstructured recreation, civic, & commercial. May include public art, playgrounds, exercise equipment, & water features suitable to smaller spaces (e.g. exercise stations, fountains, splash pads). Should provide picnic areas, drinking water, restrooms, seating, shade, food (kiosks/trucks).	High. May include a variety of seating options in sun and shade, public art, drinking fountains, food vendors, paved areas, gardens, paths, gazebos, & private nooks.	Low. Limited cooling benefit can be provided via irrigated vegetation, small water features (e.g. splash pads, fountains, small ponds), or tightly planted trees w/dense canopy. Drinking water should be provided.	Low. Limited biodiversity benefit can be gained via year-round water source, irrigated green vegetation, & trees. Native plantings may attract certain native species.
Playground	High. Unstructured children's recreation. May include public art, water features.	High. To encourage socialization playgrounds should contain play structures, seating (in sun & shade), and drinking water.	Low. Limited cooling benefit can be provided via irrigated vegetation, small water features (e.g. splash pads, fountains, small ponds), or tightly planted trees w/dense canopy. Drinking water should be provided.	Low. Limited biodiversity benefit can be gained via year-round water source, irrigated green vegetation, & trees. Native plantings may attract certain native species.
Greenways & Basin Parks	Varied. Paths/trails along the edges may be integrated to encourage physical activity.	Varied. May include elements of other park types that facilitate social/civic uses as appropriate.	Varied. Cooling benefit will depend on the consistency of the water supply and vegetative abundance.	Varied. Vegetation along banks may enhance wildlife habitat.
Special Districts	Low to high depending on specific site purposes and features. May integrate elements & features of other park types that facilitate recreational uses as appropriate.	Varied. May integrate elements and features of other park types that facilitate social/civic uses as appropriate.	Varied. May integrate elements and features of other park types that provide cooling benefits as appropriate.	Varied. May include elements and features of other park types that facilitate biodiversity protection as appropriate.

CONCLUSION

This research advocates a conceptualization of civic spaces as heterogeneous socio-ecological systems that support multiple and distinct functions and conditions which are heavily impacted by their socio-ecological-spatial context. Stemming from this understanding, this investigation seized the opportunity to contribute to urban planning and urban ecological theory and practice in arid regions by synthesizing two powerful and complimentary, but individually incomplete approaches to sustainable urbanism. By integrating ecosystem service considerations into SmartCode, the UPES capitalized upon the strengths of each approach, while minimizing their shortcomings.

Synthesizing thought and theory from a range of disciplines including urban planning, public health, geography, urban ecology, climatology, and landscape architecture, the product of this research is an immediately accessible tool for integrating multiple ecosystem service considerations into urban park planning practice. The Urban Park Ecosystem Services (UPES) planning tool represents a civic space typology for arid cities, complete with context-sensitive design guidelines for enhancing four key ecosystem services—recreation, social/civic benefits, cooling, and biodiversity—in each park category.

This research contributed to ecosystem service research and practice by providing a means of logically and systematically integrating ecosystem service considerations into urban planning and design. This study also injected ecosystem service planning with balanced contextual, spatial considerations necessary for the maintenance of coherent, sustainable urban form. By explicitly integrating 'brown' spaces, the UPES advanced an appreciation for the value and proper design of native, desert parks including the context-sensitive consideration of tradeoffs between urban 'greening' and water use. Because it is based on existing models and typologies, the UPES is familiar and therefore instantly accessible to designers, planners, and decision-makers looking to maximize urban ecosystem services across an urbanized region.

This study advanced urban planning thought and practice by improving upon the current SmartCode model for civic space planning and design. The UPES integrates detailed, scientifically-based ecological considerations into SmartCode as well as considerations of the tradeoffs, feedbacks, and potential synergies between the multiple benefits of urban civic spaces. The tool and standards also provide an arid region version of SmartCode that extends its applicability to these unique systems. Further, though tailored to arid cities, the UPES is flexible enough to allow for geographic customization based on local climate, preferences, and available human and natural resource.

The UPES represents a starting point and foundation for the integration of ecosystem service considerations into civic space planning and design. Given the innumerable potential park ecosystem services and their place-specific tradeoffs, the model was designed to be continuously adjusted, augmented, and improved upon according to local needs and preferences. As such, the addition of other considerations and calibration of the model to other cities embodies a prolific area for future research. Urbanists, conservationists, landscape architects, decision-makers, as well as park designers, planners, and advocates alike can utilize the findings and products of this research to inform public policy and planning aimed advancing sustainable urbanism in arid regions.

Chapter 5

CONCLUSION

The lack of substantive, multi-dimensional perspectives on civic space planning and design has undermined the potential role of urban parks in advancing urban sustainability goals. Responding to these deficiencies, this dissertation utilized mixed quantitative and qualitative methods and synthesized multiple social and natural science perspectives to inform the development of progressive civic space planning and design, theory, and public policy. Using Phoenix, Arizona as a case study, the analysis was tailored to arid cities, yet the products and findings are flexible enough to be geographically customized to the social, environmental, built, and public policy goals of other cities.

Theoretical, methodological, & empirical contributions

The theoretical, methodological, and empirical contributions of this research advance urban park discourse, scholarship, and practice—and more broadly, the fields of urban ecology, geography, and planning—in numerous ways. Specifically, moving beyond current simplistic classification schemes, this study promotes a fuller conceptualization of urban parks as complex human-environment systems that support multiple and distinct social and ecological functions and conditions that are themselves heavily impacted by their socio-spatial context. By exploring a transect planning approach to civic space planning and design, this work introduced a context-sensitive method for assessing and targeting improvements to a city park system, meanwhile highlighting the importance of socio-spatially contextualized planning and design of these areas. This research advances urban ecological and planning theory and practice by injecting ecosystem service planning with balanced, spatial considerations necessary for the maintenance of coherent, sustainable urban form. The resulting Urban Park Ecosystem Services (UPES) planning tool represents an immediately accessible instrument for integrating multiple ecosystem service considerations into urban park planning practice.

Using Phoenix as a case study, this study highlights the unique opportunities and challenges associated with desert city park planning and design, emphasizing the need to consider the value and unique needs of 'brown' spaces and water tradeoffs when developing 'green' parks in desert ecosystems. Findings also enhanced understanding of the current physical, ecological, social, built, and spatial characteristics of the Phoenix park system, and as such can inform the development and evaluation of plans and policy aimed at enhancing the sustainability of the city through urban park planning and design. This study has also provided an empirical test and evaluation of SmartCode civic space guidelines as applied to an arid city.

Advancing methodological approaches to urban park assessment, planning, and design this study emphasizes the importance of civic space planning across the urban to rural transect, and introduces a spatially informed statistical method for classifying an urban park system using a mix of social, environmental, and built criteria. As the approaches used to measure, assess, and represent parks in this research are thoroughly detailed, they can be customized and applied to park systems in other cities, representing an additional methodological contribution to the field.

Key Findings & Policy Implications

The findings and products of this dissertation can aid in the development and evaluation of public policy and park planning initiatives aimed at enhancing the social and ecological benefits of an urban park system and contributing to overall sustainable development, particularly in arid urban ecosystems. As such, this research is useful to a range of stakeholders including developers, city planners, park designers, policy-makers, residents, sustainability scientists, and park researchers across disciplines.

Results from this research suggest that targeted improvements to the urban park system in Phoenix can serve to steadily increase the contribution of these spaces to the social and ecological sustainability of the city. When planning park improvements, the installation of essential amenities such as restrooms and drinking fountains as well as playgrounds and paths/trails should be prioritized when possible and where appropriate. Playgrounds are particularly essential in dense, low-income neighborhoods with multi-family housing as these populations are less likely to have access to private outdoor space. Paths and trails have been shown to increase physical activity, and as such, represent a relatively low-cost solution to obesity mitigation. To extend access, new parks should be prioritized in neighborhoods without a park within the recommended distance threshold of one-fourth mile. Access can also be extended over time by rezoning parcels around civic spaces to encourage higher density, mixed and active use development. The exception to this rule is that landscapes around ecologically sensitive and culturally valuable desert preserves should remain undeveloped or minimally developed. Applying strategies that cause minimal ecological disturbance, public policy should strive to facilitate the use of these rich recreational and scenic sites by lower-income residents.

This analysis has demonstrated that the adoption of transect code in Phoenix would drastically transform the trajectory of growth in the region, directing it towards a more heterogeneous, compact, and potentially sustainable urban form. Results highlighted specific challenges and opportunities associated with this transition. Transect zoning emphasizes a range of habitats along a gradient of urban intensity from undeveloped natural areas to compact, densely populated, mixed-use urban centers. As demonstrated by this study, the sprawling, polycentric urban form of Phoenix—dominated by single-family homes, clusters of single land uses, and an abundance of underutilized land which disrupts the urban fabric—makes the adoption of this coding scheme challenging. Such urban morphological patterns are also significant because they reflect the homogeneity of human (and natural) habitats in Phoenix that appeal to a narrow range of needs and preferences. Yet because the city is so expansive and retains an abundance of potentially developable, centrally located underutilized land, transect code could expand the variety of habitat types without sacrificing the city's characteristic low-density developments or the region's expansive natural and culturally significant features, including several large, scenic mountain parks. Specifically, areas identified in this analysis as having more 'urban' qualities—i.e. relatively higher population density and commercial/industrial/active surrounding land uses, and smaller blocks—should be prioritized for intensification. Meanwhile areas coded as preserve and reserve should be protected from future development.

The macroanalysis and microanalysis of the Phoenix parks system conducted here revealed matches and mismatches between the city designations and the recommended civic space types following transect code standards as outlined in SmartCode. Though many parks lacked accordance, the majority matched SmartCode recommendations, yet more detailed field assessments of individual sites would be required to verify these observations. The microanalysis honed in on four specific parks to determine their context-sensitivity in more detail. Spatial analysis and observations of satellite imagery for the four microanalysis sites informed recommended alterations for enhancing the relationship between the parks and their corresponding social, spatial, and built context. This method can also be used by planners as a first step in field assessments for other parks in the region.

The present study also serves as an empirical test of the application of SmartCode to Phoenix's civic spaces. Recommended improvements include expanding the civic space typologies to include 'brown spaces' (i.e. native desert parks), more clearly defining ambiguous terms and standards (e.g. 'civic purposes', 'naturalistically disposed' landscaping), and integrating more scientifically-based ecological standards into the Code.

The Urban Park Ecosystem Services (UPES) planning tool and standards presentrf here was developed in response to the shortcomings of the City of Phoenix and SmartCode civic space typologies and guidelines. The tool reconfigures the civic space types from both systems. Some SmartCode park types are combined and four categories not in the original Code are added to reflect 'brown' spaces and basin parks. With respect to the City of Phoenix parks classification system, community and district park categories are changed to green community parks and desert community parks. Mini parks are retitled squares/plazas, and neighborhoods parks are separated into desert and green neighborhood parks. The UPES also provides guidelines for enhancing four key ecosystem services—recreation, social/civic benefits, cooling, and biodiversity—in context-appropriate civic space types. Standards are informed by an extensive review of scholarly literature from the fields of geography, public health, environmental justice, leisure science, urban and ecosystem ecology, landscape architecture, and climatology. Specifically, the guidelines detail the proper size, service area, primary landscaping type and orientation, and spatial context of each park type. The appropriate and expected magnitude (level) of provisioning for each service is also noted.

Future Research

This dissertation serves as a point of departure for other urban civic space research. The spatial and statistical method I used to assess the social, ecological, spatial, and built characteristics of parks and their neighborhoods can be applied to other cities to generate a more detailed and substantial understanding of other civic space systems. Subsequent comparisons between Phoenix and civic space networks in other cities may also prove insightful, shedding light on the role of these spaces in the quest for more sustainable urbanisms in other geographic, social, and political contexts. Using additional variables, the methods presented here can also be reapplied to Phoenix to further sharpen this expanded picture of urban parks in the region. Likewise, the methods used to rezone Phoenix and assess the context-sensitivity of parks in the region can be applied to other cities to both evaluate their current pattern of growth as well as the 'spatial logic' of their park system (Talen 2010).

If decision-makers in Phoenix wish to systematically and logically expand the range of natural and human habitats in the city, the rezoning process outlined in this dissertation can serve as a significant first step towards this goal. More refined transect coding, down to the neighborhood level, would then be needed to assure a proper mix of neighborhood types across the city (for subsequent steps see Criterion Planners 2005; Talen 2009b; and PURL 2011).

Future research and practice that extends this dissertation research should also include two critical, additional elements: field assessments and community involvement in the planning and decision-making process. Field assessments of individual parks may include surveys and interviews of residents, park users, and non-users to understand how and why they do or do not use existing amenities. Observational protocols like SOPARC (System for Observing Play and Recreation in Communities), developed by the Robert Wood Johnson Foundation's Active Living Research program, can also help illuminate the social functioning and use of parks. Collaborations with urban ecologists, landscape architects, biologists, and other biophysical experts may also aid in the optimization of socio-ecological dynamics in urban parks. Involving the community in park planning efforts via planning charrettes (NCI 2011), public meetings, and community outreach activities represents other essential complements to successful park planning.

Finally, the Urban Park Ecosystem Services (UPES) planning tool and standards developed in this dissertation represents a ripe area for future research. With the help of natural and social scientists, practitioners, and the wider public, this model can be continuously refined to incorporate more ecosystem services and altered to better reflect local preferences, priorities, geography, and other place-specific considerations.

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APPENDIX A

PHOENIX PARKS: CLUSTER MEMBERSHIP & DESIGNATED TRANSECT ZONES

Name	Civic Space Type	Size (acres)	Cluster (Park Type)	Miles to Center	T-zone
Desert Broom	Community	44.3	1	> 10	5
Buffalo Ridge	Desert Park	210.9	1	> 10	99
Deem Hills	Desert Park	1005.1	1	> 10	99
Lookout Mountain	Mtn Preserve	369.8	1	> 10	99
Dove Valley	Nbhd	4.8	1	> 10	3
Dynamite	Nbhd	18.5	1	> 10	2
Tramanto Park	Nbhd	12.2	1	> 10	3
North Mountain Shaw Butte	Mtn Preserve	1659.6	1	5.01 - 10	99
Piestewa Peak	Mtn Preserve	3588.7	1	5.01 - 10	99
South Mountain	Mtn Preserve	16289.5	1	5.01 - 10	99
Sereno	Community	37.7	2	> 10	3
Venturoso	Community	15.6	2	> 10	3
Conocido	Community	27.6	2	> 10	3
Vista Canyon	Community	25.2	2	> 10	3
Cactus	Community	31.6	2	> 10	4
Sonrisa	Nbhd	10.3	2	> 10	3
Altadena	Nbhd	5.9	2	> 10	4
Acacia	Nbhd	8.1	2	> 10	3
Sunburst Paradise	Nbhd	9.7	2	> 10	4
Acoma	Nbhd	10.3	2	> 10	3
Country Gables	Nbhd	4.3	2	> 10	4
Surrey	Nbhd	9.2	2	> 10	4
Werner's Field	Nbhd	11.0	2	> 10	2
Westown	Nbhd	4.4	2	> 10	4
Paradise Cove	Nbhd	17.0	2	> 10	3
Hermoso	Community	25.6	2	2.01 - 5	3
Cielito	Community	42.9	2	2.01 - 5	3
El Prado	Community	35.9	2	2.01 - 5	3
Sueno	Community	38.1	2	2.01 - 5	3
Ladmo	Mini	0.3	2	2.01 - 5	88
Smith	Nbhd	3.6	2	2.01 - 5	88
Colter	Nbhd	8.0	2	2.01 - 5	5
Nueve	Nbhd	9.8	2	2.01 - 5	3

Roesley	Nbhd	2.6	2	2.01 - 5	4
Monterey	Nbhd	8.8	2	0 - 2	5
Edison	Nbhd	4.8	2	0 - 2	5
Sun Ray	Community	17.6	2	5.01 - 10	3
Santa Maria	Community	27.0	2	5.01 - 10	3
El Oso	Community	32.4	2	5.01 - 10	3
Marivue	Community	33.5	2	5.01 - 10	3
La Pradera	Community	37.1	2	5.01 - 10	3
Royal Palm	Nbhd	27.3	2	5.01 - 10	3
West Plaza	Nbhd	4.5	2	5.01 - 10	3
Mariposa	Nbhd	18.4	2	5.01 - 10	4
Palma	Nbhd	7.8	2	5.01 - 10	3
Norton	Nbhd	7.7	2	5.01 - 10	3
Orme	Nbhd	4.2	2	5.01 - 10	4
Hoshoni	Nbhd	8.5	2	5.01 - 10	3
Nevitt	Nbhd	8.6	2	5.01 - 10	3
Laveen Village	Nbhd	13.1	2	5.01 - 10	3
Desert Star	Nbhd	12.3	2	5.01 - 10	3
Sunridge	Nbhd	17.0	2	5.01 - 10	4
Little Canyon	Nbhd	13.8	2	5.01 - 10	4
Ho-E	Mini	0.3	3	2.01 - 5	88
Kipok	Mini	0.5	3	2.01 - 5	88
Eototo	Mini	0.4	3	2.01 - 5	4
Aya	Mini	0.7	3	2.01 - 5	3
Lenang	Mini	0.2	3	2.01 - 5	4
Yunya	Mini	0.2	3	2.01 - 5	4
Toho Mini	Mini	0.2	3	2.01 - 5	3
Yapa	Mini	0.3	3	2.01 - 5	5
Peace Park	Mini	0.2	3	2.01 - 5	4
Ninos	Mini	0.6	3	0 - 2	88
Hu-O-Te	Mini	0.3	3	0 - 2	5
Sherman Parkway	Nbhd	3.8	3	0 - 2	2
Grovers	Basin	36.9	4	> 10	99
Quail Run	Basin	8.0	4	> 10	99
Roadrunner	Community	35.8	4	> 10	2
Paseo Highlands	Community	37.2	4	> 10	4
Desert Horizon	Community	36.4	4	> 10	3
Moon Valley	Community	27.9	4	> 10	3

Reach 11 District & Rec Area	Desert Park	1520.2	4	> 10	99
Pecos	District	65.4	4	> 10	88
Moonlight	Mini	1.7	4	> 10	2
Hyde	Mini	0.2	4	> 10	3
Cashman	Nbhd	10.2	4	> 10	4
Cholla Cove	Nbhd	7.1	4	> 10	3
Adobe Mountain	Nbhd	5.7	4	> 10	3
Margaret T. Hance	Community	32.7	4	0 - 2	6
Mercury Mine	Basin	4.1	4	5.01 - 10	99
Granada	Community	49.8	4	5.01 - 10	2
Desert Foothills	Community	45.6	4	5.01 - 10	2
Cave Creek Wash Recreation Area	District	254.5	4	5.01 - 10	2
Arcadia	Nbhd	8.7	4	5.01 - 10	3
Kachina	Nbhd	2.8	4	5.01 - 10	4
Western Star	Nbhd	9.1	4	5.01 - 10	3
Country Club Oval	Mini	1.3	5	2.01 - 5	4
Virginia	Mini	0.5	5	2.01 - 5	3
Longview	Nbhd	4.4	5	2.01 - 5	4
Herberger	Mini	2.2	5	5.01 - 10	2
Old Cross Cut Canal	Nbhd	24.6	5	5.01 - 10	99
Sunnyslope	Nbhd	4.1	5	5.01 - 10	5
Coyote	Basin	21.1	6	> 10	99
Indian Bend Wash & Park	Basin	31.8	6	> 10	99
Turtle Rock	Basin	23.3	6	> 10	99
Sweetwater	Community	19.6	6	> 10	3
Sandpiper	Nbhd	18.9	6	> 10	3
Kierland	Nbhd	8.3	6	> 10	3
Crossed Arrows	Nbhd	22.0	6	> 10	3
Palomino	Nbhd	11.1	6	> 10	4
Momo	Mini	0.8	6	2.01 - 5	5
Tawa	Mini	0.2	6	2.01 - 5	3
Desert Storm	Nbhd	4.6	6	2.01 - 5	88
Portland Parkway	Mini	1.3	6	0 - 2	6
Roosevelt	Mini	0.6	6	0 - 2	6
G.R. Herberger	Nbhd	7.0	6	5.01 - 10	2
Sumida	Nbhd	4.7	6	5.01 - 10	5

Alicia	Nbhd	7.3	6	5.01 - 10	3
Esteban	Community	60.7	7	2.01 - 5	1
Mong	Mini	0.3	7	2.01 - 5	3
Hilaria Rodriquez	Mini	0.5	7	2.01 - 5	6
Solano	Nbhd	9.6	7	2.01 - 5	6
Kuban Community	Nbhd	9.3	7	2.01 - 5	5
Rio Salado	Basin	652.4	7	0 - 2	99
Lewis	Mini	0.5	7	0 - 2	3
Matthew Hensen	Mini	1.4	7	0 - 2	88
Green Valley	Nbhd	4.9	7	0 - 2	88
Barrios Unidos	Nbhd	14.4	7	0 - 2	4
Townsend	Nbhd	1.6	7	0 - 2	5
Central	Nbhd	2.2	7	0 - 2	5
Nuestro	Nbhd	4.2	7	0 - 2	3
Coffelt Lamoreaux	Nbhd	2.2	7	0 - 2	2
Eastlake	Nbhd	8.9	7	0 - 2	6
Papago Dist Park	Desert Park	940.6	7	5.01 - 10	99
Paradise Valley	District	79.4	8	> 10	4
Telephone Pioneers of America	Nbhd	7.5	8	> 10	3
El Reposo	Community	22.7	8	2.01 - 5	88
Madison	Community	18.7	8	2.01 - 5	2
Falcon	Community	14.6	8	2.01 - 5	88
Steele Indian School	Community	72.5	8	2.01 - 5	6
Hayden	Community	16.4	8	2.01 - 5	4
Los Olivos	Community	24.5	8	2.01 - 5	5
Willow	Nbhd	2.2	8	2.01 - 5	3
Perry	Nbhd	8.4	8	2.01 - 5	6
Kids Street	Nbhd	2.2	8	2.01 - 5	5
Encanto	District	61.5	8	0 - 2	2
Grant	Nbhd	1.8	8	0 - 2	5
Alkire	Nbhd	4.6	8	0 - 2	4
University	Nbhd	8.3	8	0 - 2	88
Harmon	Nbhd	11.0	8	0 - 2	4
Coronado	Nbhd	10.4	8	0 - 2	3
Verde	Nbhd	3.9	8	0 - 2	6
Pierce	Community	18.8	8	5.01 - 10	88
Washington	Community	54.1	8	5.01 - 10	4
Cortez	Community	30.4	8	5.01 - 10	2

Maryvale	Community	14.0	8	5.01 - 10	3
Desert West	District	101.6	8	5.01 - 10	3
Holiday	Nbhd	4.5	8	5.01 - 10	2
Starlight	Nbhd	7.6	8	5.01 - 10	4
Trailside Point	Nbhd	15.0	8	5.01 - 10	2
Winifred Green	Nbhd	3.4	8	5.01 - 10	5
Deer Valley	Community	51.9	9	> 10	4
Mountain Vista	Community	43.4	9	> 10	3
Manzanita	Community	38.4	9	2.01 - 5	4
Playa Margarita	Nbhd	5.3	9	2.01 - 5	4
Lindo	Nbhd	21.3	9	2.01 - 5	3
Circle K	Community	31.7	9	5.01 - 10	3
Mountain View	Community	35.5	9	5.01 - 10	1
Cesar Chavez	District	181.6	9	5.01 - 10	1
Francisco Highland	Nbhd	9.9	9	5.01 - 10	3
Jackrabbit	Nbhd	17.8	9	5.01 - 10	3
Ma-Ha-Tuak	Nbhd	10.9	9	5.01 - 10	5
Camelback Mtn Echo Canyon	Desert Park	290.5	*	*	99
Casa de Montanes	Desert Park	35.3	*	*	99
Cave Buttes Rec Area	Desert Park	2797.0	*	*	99
Ludden Mountain	Desert Park	441.9	*	*	99
Pitcher Hill	Desert Park	33.4	*	*	99
Union Hills	Desert Park	490.8	*	*	99
Maryvale Tot Lot	Mini	0.5	*	*	3
Shadow Mountain	Mtn Preserve	175.8	*	*	99
Stoney Mountain	Mtn Preserve	1595.2	*	*	99
John F. & Mary P. Long Homeste	Nbhd	5.0	*	*	88
Christy Cove	Nbhd	8.3	*	*	4
Desert Willow	Nbhd	12.1	*	*	3
John W. Teets	Nbhd	15.6	*	*	3
Mountain View Community Center	Nbhd	11.9	*	*	4

* Not in final sample