Parks suitability index, developing a landscape metric for analyzing settlement patterns in the context of rapidly urbanizing area, central Florida, USA

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1.Introduction

In this research study, we discuss the definition and development of a Park Suitability Index (PSI), a park-level urban landscape metric, that can be used to assess landscape conditions, park function and form, as well as other relevant attributes for understanding the quality of particular parks within a given urban context. Although the particular types of activities or amenities may vary across parks in different contexts, the overarching functions and values associated with urban parks may show similar patterns. Our pilot study focuses on the Orlando Metropolitan Region, an area known globally for its theme parks and other tourism features (e.g. Universal Studios, Walt Disneyworld, SeaWorld, etc.). As such, this region is particularly interesting for also studying the importance and functions of local urban parks, because so much of the recreational infrastructure is designed for tourism and not open to communities.

We compared the unique and overlapping attributes from 12 Orlando parks to develop a preliminary PSI, which was then used to explore the possible interrelationship between park characteristics and urbanization patterns. By analyzing historical land use change and urbanizing processes, we also speculate how park distribution and size have been influenced by settlement patterns in Orlando at both the individual and multi-park levels. In addition, each park was described according to its primary features, such as recreational amenities, walkability, proximity to settlements and other variables. The final scoring PSI demonstrated the spatial distribution and physical features of parks that have been pri-marily influenced by the rapid process of urbanization in this region.

1.1 Site selection and study context

At the broader regional scale, the Orlando Metropolitan Region covers 862,720 acres and includes both Orange and Seminole Counties. Within this region, there are a total of 621 community and neighborhood parks which make up 27,721 acres of public land. Not including state or private parks, the ratio of community and neighborhood level public park-land to other land use types in the region is 3.2%. According to our previous historical land use change study in Orlando (MURTHA et. al. 2019), over the course of a half century of urbanizing processes, most parks in the Orlando metropolitan region are located in urban core areas. Zooming into the city scale, currently 196 parks are situated within 5 miles from the Orlando urban center and constitute 32% of public parks in the region as a whole. However, these parks only occupy 8.6% of the total parkland area, based on calculations from dataset at Florida Geography Data Library (FGDL 2019). In addition, within 5 miles of the urban center, 11.6% of the total land cover is defined as residential and includes three main household (HHD) categories: low-density unit (LDU), medium-density units (MDU), and high-density unit (HDU) (FGDL 2019). Given the high number of parks within 5 miles of the urban center and our interest in comparing park distribution and settlement patterns, we chose to select our initial study sample of parks from those located within this 5-mile radius. These parks are notably all influenced by long-term urbanizing processes and high-density settlement patterns. All pilot study sites were located to the north of the urban center and were intentionally selected along a gradient of different acreage, func-tions, typologies, amenities, and social and ecological conditions (Figure 1).

We assessed publicly available data from the FGDL and other official online park resources in order to compile park-level attributes along out PSI themes for the 12 sampled sites. After ranking the most frequent amenities from the sample parks, the most common amenity identified was access to lakeshore, followed by the presence of walking trails, bike trails, and finally picnic facilities. About the low frequency amenities, some of these features actually highlight the unique aspects of particular types of parks. Such unique features include a wide range of amenities, for example: interpretive signs or infrastructure, municipal administration (e.g. museums, theaters, etc.), bird watching spots, golf courses, and bike trails.

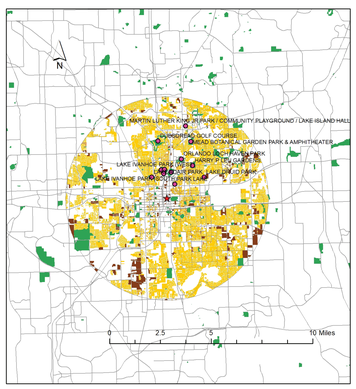


Fig 1: Locations of sample parks

Photos: current features & amentities

2. Materials and Methods

In order to explore landscape metrics and evaluate individual grades across parks, we calculated the PSI score for the sample parks based on the following variables: DC, MAP, MCP, UH, AH, GN, PA, TC, TRL, PLG, PCF, NAP, NEP, and WA (see Table 1). Park loca-tions, attribute data, and land use/land cover (LULC) were obtained from Florida Geogra-phy Data Library (FGDL 2019), along with additional information from Orange and Semi-nole Counties. Sample areas were drawn around the Orlando Metropolitan Area. Since this work is part of a broader Geodesign project focused on Orlando and greater Central Flori-da, the map formats are based on the standards established by the International Geode-sign Collaboration. In addition, a site visit was made by the lead author to Orlando in January 2020 to investigate several parks firsthand.

First step: we evaluate the PSI on sample parks. These PSI measurements are subject to the methodologies under which each variable was calculated. To assess the efficacy and interpretation of each variable within the PSI, we started with a small subset of variables upon which we anticipate expanding in future studies. We filtered the data and used the network analyst tool in ArcMap in order to measure the proximity of households and parks along several dimensions. In addition, each map in this paper visualizes the range of serviced households at particular thresholds away from each park, thereby conveying additional information about the relationship between park and residence locations.

Second step: we evaluated the form and distribution of parks through the lens of PSI, especially in measuring the proximity and walkability for individual parks and compare these results to other variables about park functions and amenities. Finally, we discuss the relationship between sprawl or settlement patterns and PSI scores across the geography of Orlando.

2.1 Outline of multi-park analysis and PSI development

Table 1: Park suitability index components (compiled after APPARICIO, 2008, NICHOLLS 2001; WOLCH et al. 2005, BROWNING & LEE 2017, MIYAKEL et al. 2010, MCGARIGAL 1995). Shaded boxes indicate multi-park variables, while unshaded boxes represent individual park-level variables.

Themes	Acronym	Park Suitability Index
1. Proximity	DC	Distance to the closest household.
Multi-park proximity variables	MAP	The mean distance to all parks.
	MAP1	The mean distance in 0-400m for all parks.
	MAP2	The mean distance in 400-800m for all parks.
	MAP3	The mean distance in 800-2000m for all parks.
	MCP	The mean distances in ranges of 0-400m, 400-800m, and 800-2000m proximate to parks.
2. Walkability	UH	The numbers of household units within 2000m walkable distance.
	AH	The acreage of households within 2000m walkable distance.
3. Connectivity	GN	The ratio of greenness.
	PA	The acreage of individual park
	TC	Tree coverage
4. Amenities	TRL	Walking trails (Y/N)
	BT	Biking trail (Y/N)
	PLG	Playgrounds (Y/N)
	PCF	Picnic facilities (Y/N)
5. Typology	NAP	Nature parks (Y/N)
	NEP	Neighbourhood parks (Y/N)
	WA	Water access (Y/N)

3 Results and Discussion

We used the PSI to assess the typology, functions, and structures of sampled parks, which are evaluated across different land use categories. Here, we describe the results related to 1) the description of sample parks; 2) the distribution of PSI; and 3) what PSI tells us about urban sprawl patterns observed in prior studies (MURTHA et al 2019).

3.1 Description of sample parks

Table 2: Multi-park proximity measurements

HHD Categories	MAP	MCP1	MCP2	MCP3	MCP4
LDU	649	372	486	604	882
MDU	443	347	491	600	836
HDU	514	310	484	647	859

To evaluate how parks are influenced by urbanization, the proximity of sample parks to various housing density areas (LDU, MDU, HDU) are listed in Table 2. Several proximity metrics are calculated, as described in the PSI overview section above. According to the multi-park level proximity analysis, the MDU type residential areas are on average closer to parks (443m) compared to either LDU (649m) or HDU (514m) residential areas. Using the traditional buffering methods, we also examined the residential patterns for households within 2000m walking distance to the sample parks (Table 3). For each park and residen-tial density type, the distance to the nearest household was calculated. These park-level distances were then averaged across all 12 sample parks to yield the average distance from the parks to the closest residential units. Without considering the road networks, residents who live in the LDU were the least distance (183m) on average to parks, MDU were in the middle (359m), while the HDU had the furthest distance away from parks (493m).

3.2 The distribution of PSI for individual parks

Table 3: Direct measures of variables within Park Suitability Index

Parks	PA(acre)	DC(m)	Proximate to HHD	AH(m)	UH
Harry P Leu gardens	42.305	198	LDU	304	1480
Gaston Edwards Park	43.508	320	LDU	303	1384
Lake Druid Park	19.704	229	LDU	208	1019
Orlando Loch Haven Park	41.184	268	LDU	283	1452
Park Lake	11.751	117	LDU	377	1857
Lake Adair Park	28.244	154	LDU	247	983
Lake Ivanhoe Park (S)	40.625	265	MDU	134	531
Lake Ivanhoe Park (W)	22.423	413	LDU	94	256
Martin Luther King Jr Park	25.172	148	LDU	274	1332
Mead Botanical Garden Park	45.398	213	LDU	220	1038
Dubsdread Golf Course	124.206	340	LDU	251	1102
Lake Ivanhoe Park (N& NW)	22.382	183	LDU	134	581

PSI also reveals the performance of individual parks. From the PSI assessments conveyed in Table 3, it can be seen that although Park Lake has the smallest acreage of 11.751 acres, it actually was the shortest distance to the nearest household of all the parks (117m) and served the greatest number of residential units (within the 2000m threshold). On the con-trary, Lake Ivanhoe Park (West) was larger, at 22.423 acres, but has the furthest near dis-tance of all the parks and serviced the least number of household units. Despite these differences in accessibility and size, from a typology and feature perspective, these two parks share the common features of being nature parks and providing lake access.

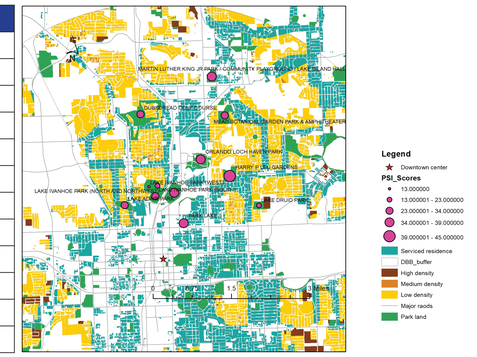
Our preliminary assessment of the PSI involved directly ranking parks relative to one another based on their respective scores for each variable measured. Future efforts will improve limitations arising from this calculation method, but for this pilot, we relied on direct ranking. Individually, PSI scores enable the assessment of performance across the sample parks in a manner that can be easily listed and offer pathways to identifying the major differences across parks. However, as variables differ by multiple hidden dimensions, the scoring process requires a follow-up study for discussing the methods of proportioning in variables.

3.3 PSI vs. Urban sprawl

Table 4: PSI and settlement patterns

Park	Type	Sprawl dist. miles	PSI
Harry P Leu gar-dens	Nature park/Gar-dens	2.5	1
Gaston Edwards Park	Nature park/Boat ramp	1.5	3
Lake Druid Park	Neighbourhood park/Open space	2.5	10
Orlando Loch Haven Park	Neighbourhood park/Cultural park	2.5	4
Park Lake	Nature park/Water access	1	2
Lake Adair Park	Nature park/Water access	1.5	7
Lake Ivanhoe Park (S)	Nature park/Water access	1.5	8
Lake Ivanhoe Park (W)	Nature park/Water access	1.5	11
Martin Luther King Jr Park	Neighbourhood park/Mixed-use	4	4
Mead Botanical Garden Park	Nature park	3.5	5
Dubsdread Golf Course	Neighbourhood park/Golf course	3	6
Lake Ivanhoe Park (N&NW)	Nature park/Water access	1.5	9

Fig.2: PSI and settlement patterns



Comparing PSI scores to urban sprawl patterns (Figure 2 & Table 4), three parks that are 1.5 miles away from the urban center (Lake Ivanhoe Park (West), Lake Ivanhoe (North and North West), and Lake Ivanhoe (South)) all had relatively lower PSI scores, with Lake Ivanhoe Park (West) having the lowest PSI score overall. By contrast, Harry P Leu Gardens, which has the highest PSI score, is lo-cat-ed even further from the urban core, 2.5 miles distant. Within the 1.5 miles radius of the urban center, the remaining PSI ranks vary considerably. Moving further from the urban center, at the 2.5-mile radius scale, there are also no clear patterns in park rank based on current PSI indicators. This does not necessarily indicate that there is no relationship between sprawl and park-level attributes, however, it does suggest a potential limitation in our current evaluative metrics.

In addition to assessing overall park suitability as it relates to distance from urban cores, it is also critical to consider the relationship between park location and park function. The farthest park, Park Lake is the smallest park with water access, while the closest park, Martin Luther King Jr. Park, is similarly a smaller park although it can be classified as a mixed recreation park with multiple ameni-ties catering to community needs. Although these two parks are similar in size, the park furthest from the urban core has only one notable park feature while the closest park has multiple functions. This suggests a possible relationship between park location and diversity of park functions.

In our previous work, we assessed historical land use change, urbanization patterns, and park distribution in Orlando over 40 years in order to evaluate variables for inclusion in the PSI metric (MURTHA et. al. 2019), here we expand upon this analysis. Investigating the spatial distribution of PSI variables – namely, park functions – reveals a complex pattern. For instance, Florida's largest rose garden – Harry P Leu gardens – not only services the nearby settlements within the urban core, but also has several important and unique functions including maintaining a historical home and delivering educational pro-grams. In addition, Harry P Leu gardens services a high number of households despite being further from the urban core, while two other sampled parks – Lake Druid Park and Orlando Loch Haven Park – conversely were closer to the urban core but serviced the least number of households out of all sampled parks.

Major References

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