PARKS AS A HEALTH TREATMENT: MEASURING THE DOSAGE

Layton, Robby
North Carolina State University/Design Concepts CLA, Inc./GP RED

1 ABSTRACT

Recent research confirms that parks are correlated with healthy lifestyles, and doctors are now prescribing them as treatment for a variety of ailments. The purpose of this study was to explore using validated metrics linking parks to public health goals in an index to assess the relative potential for a given site or collection of sites to produce positive public health outcomes.Health benefits are associated with exposure to and behavior within parks and greenspace. For this study the GRASP®Active Index was developed to indicate the relative potential of a given site to encourage greater use and/or physical activity. The index could be considered a measure of the relative "strength" of the park as a form of health treatment. The index combines an evaluation of park components (features that visitors go to a park to use, such as courts, fields, playgrounds, and picnic facilities) and other characteristics such as the availability of shade, seating, and drinking water, collected using the GRASP®-IT direct-observation audit tool with evidence from the literature incorporating Active Energy Expenditure (AEE) ratings system to generate an overall score for each park. The scores for individual parks can be aggregated to produce performance measurements for a collection of sites or locations, such as a park agency, planning district, or other jurisdiction. The resulting index was used to demonstrate its practicality as a way to compare the relative potential for physical activity generation between parks and to measure relative access to physical activity opportunities across a geographic area.

1.1 Keywords

Parks, Greenspace, Public Health, Landscape Performance

2 INTRODUCTION

Public parks, (including trails, greenways, and other greenspace locations generically referred to as parks), are a special kind of landscape that is a relatively new phenomenon in human history. They emerged as part of a larger reform movement during the 19th century to improve the lives of urban dwellers during the Industrial Revolution, becoming policy elements by which governments promote the well-being of citizens. Parks have taken on renewed importance recently in response to public health threats brought about by modern lifestyles. Doctors have even begun to prescribe visits to parks as a form of treatment for a variety of ills (Root, 2017).

Advances in medicine have mitigated many infectious and congenital diseases, but depleted physical activity brought about by technology has resulted in an increase in chronic diseases related to behavior, including obesity, Type 2 diabetes, and others (e.g., Bedimo-Rung, Mowen & Cohen, 2005; Kaplan, 1995; Sallis, Floyd, Rodreguez & Saelens, 2012). A social ecological model posits that modifying the environment with parks and other forms of greenspace can influence behaviors, including physical activity (Sallis et al., 2012). In fact, recent studies place parks among environmental variables with the most convincing relationship to physical activity (Bauman, et al., 2012), linking the availability of greenspace to potentially lower risk of obesity and other diseases.

The focus on parks as a way to encourage and facilitate physical activity has brought with it research on other dimensions of health that might be associated with both active and passive use of parks and greenspace, including psychological, social, ecological, and economic well-being (Sallis & Spoon, 2015). A large body of evidence now confirms the relationship between the availabilty of parks and individual behaviors that promote better health. This makes the provision of parks a matter of public welfare and environmental justice. Because all parks are not the same, it is necessary to be able to measure the differences between them to assure that they are administered effectively and equitably. This paper presents a metric that measures the relative potential for individual park features to encourage and facilitate increased use and physical activity—behaviors that are associated with better health. The measures for individual features can be aggregated to produce a measure for an entire park or system of parks, and to identify gaps or inequities in the availability of parks across geographies and/or populations.

2.1 Park Measurements

The study of correlations between the physical environment and health outcomes requires effective measurements of the environment (Giles-Corti et al., 2005; Saelens et al., 2006). Common metrics for parks include total park land, number of park locations, distance to a park, and measurements of the features within a park (quantity, type, size, location, quality, etc.). Among these, features seem to be emerging as particularly important (McCormack et al.,2010). Typical attributes recorded for park features in the past have been mainly limited to type and quantity of each. New evidence suggests that more information on the quality and functionality of park features should be included in park evaluations. Kaczynski et al. (2016) found an average park quality index for parks within one mile of an individual's residence to be significantly associated with park use. They also found a significant correlation with park use for the number of parks within one mile. An earlier summary of existing research published by Active Living Research (ALR) in 2010 concluded similarly that having more parks within a community is associated with higher physical activity. However, while ALR cited evidence that park proximity and having more park acreage is associated with higher levels of park use and physical activity--particularly among youth--Kaczynski et al. found that distance to the nearest park and the amount of park space within one mile were not significantly correlated with park use.

While quantitative metrics such as these have long been used in research and policy for parks services, the role of qualitative measurements of such attributes as aesthetics, condition and safety is an emerging aspect of greenspace research. ALR's (Active Living Research, 2010) conclusion that park aesthetics, condition and safety may be associated with park visitation and physical activity levels within parks is supported by Kaczynski et al.'s (2016) finding that park quality is an important aspect of park use. More specifically, enhanced park quality was preferred over the provision of new facilities in a study of minority populations in Houston, Texas (Smiley et al., 2015).

Thus, evidence from the literature points to park features and park quality as significant attributes of individual parks that are associated with visits to greenspace and physical activity, suggesting that a metric which incorporates both the number of features within a park and overall site quality could be useful in assessing the park's contribution towards public health. The incorporation of park acreage into the metric may also be useful, though less definitive. While total park acreage within a community has been identified as having a potential effect on physical activity (Cohen et al., 2010), the fact that more parks and larger ones imply a greater number of features may play a role in that effect (Giles-Corti et al., 2005).

2.2 Park Features and Physical Activity

The contribution of individual features (also referred to as components) towards park visits and physical activity varies. Cohen et al. (2010) found that gymnasiums and baseball fields were the busiest areas, while areas most frequently used were dog parks, walking paths, water features, and multipurpose fields. The ALR study (Active Living Research, 2010) indicated that within parks, people tend to be more physically active on trails, at playgrounds and at sports facilities. Recognizing this variation Floyd et al. (2015) developed a set of energy expenditure ratings associated with typical components found in parks. The ratings reflect the energy expended above and beyond the sedentary rate for each component, coded into categories of low, medium, and high. This results in a relative value for each feature in terms of its effectiveness at generating physical activity within the population.

2.3 Auditing Park Characteristics

Given the need to measure the variables described above from one place to the next, a number of audit tools have been developed to assess outdoor environments such as parks, trails, and streets. These tools rely primarily on direct observation. Direct observation is considered to be a reliable and valid method for collecting such data, but it is not the only one available. Remote sensing, crowd-sourcing, and use of secondary data are other methods that are growing in popularity among researchers. Most of the observational tools are intended to be used by trained observers, although new tools, such as eCPAT are being developed for use by citizens, youth, and other constituencies (BEACH Lab, 2016). Combined with research findings, such tools can be used to identify metrics and indicators correlated with health outcomes.

No single audit tool is perfect for all applications. Each has its strengths and weaknesses. Some are shorter and take less time to complete, while others are longer and provide greater detail. Some capture general data on a wide range of features, and others capture more data on fewer features. Testing has found some tools to be more reliable on certain features than others, although direct observation tools have been found reliable on most items (Bird et al., 2015; Joseph & Maddock, 2016). In general, reliability is highest for objective items that rate presence and number of features. Reliability tends to be lower for subjective items and those that may change over a relatively short timeframe.

3 METHODS

The intent of this study was to develop and evaluate a prototype—referred to as GRASP®*Active*--for an empirically derived index that could be used to evaluate the potential for a specific site (park, trail, location, etc.) to encourage use and stimulate physical activity. This would allow researchers and planners to compare one park to another or evaluate alternative proposals for a single park in terms of the most advantagous public health outcomes. It could also be used to measure variations in the availablity of public health resources across populations and geographic areas to address environmental justice considerations.

A review of the literature was conducted to identify variables with strong evidence of correlation with public health goals, and which could be measured with available audit tools. Park features and park quality were identified as significant correlates of park use and physical activity, so the metric was organized around individual park components, and overall park quality was used as a weighting factor to modify the value of components. A functionality rating for each component and an energy expenditure rating associated with that component type were also used to modify each component's overall value.

3.1 Sources of Data

Secondary data obtained from an inventory of parks in Cary, North Carolina conducted by the Principal Investigator (P.I.) in 2011 as part of a citywide parks and recreation master plan were used as measurements of park characteristics for this study. The inventory was conducted with the GRASP®-IT audit tool developed by the P.I. and others for use in the parks and recreation management field. The GRASP®-IT tool has been used on more than a hundred parks and recreation plans across the United States over a period of seventeen years, and has been applied in studies related to social equity, environmental justice, and public health (GP RED, 2013; Arlington Heights Park District, 2018). The instrument is designed to be used by trained observers and has been tested and found to have moderate overall reliability (exact agreement = 65% on all items, kappa = 0.42).

The tool rates 86 items, which are grouped into two categories: *components* and *modifiers.* Components are defined as those things that individuals visit a park to use--such as fields, courts, picnic facilities, and playgrounds, as well as paths, natural areas, open lawns, and other items related to passive use. A total of 71 unique components that may be present within a park have been defined in the tool. In addition to labeling and counting the components witin a given park, each individual component is scored on its functionality—defined as the capacity to fulfill expectations for its intended purpose at its specific location. Scores of 1 (below expectations), 2 (meets expectations), or 3 (exceeds expectations) are assigned by the auditor to each component present in a specific location.

Modifiers are comfort and convenience amenities that support or enhance the overall experience of visiting the park, including such things as the availability of restrooms, drinking water, shade, seating and overall comfort, convenience, and scenic quality. A total of 15 items are assessed as modifiers in the tool. Each type of modifier present at the park is evaluated on its overall capacity to meet expectations for that park using the same rating scale as described above for components. For example, if the amount of shade present at the park meets expectations for shade at that park (based on local norms for similar parks), the modifier *shade* is given a value of *2* for the park. If not, it is given a value of *1*. If shade exceeds expectations, a value of 3 is assigned for the shade modifier. Scores for 14 of the modifiers are summed to derive a total value for the park, which is then recoded into a modifier factor for the park site of low (1.1), moderate (1.2), or high (1.3). The 15th modifier is a rating of the overall "feel" of the park based on its design and ambience, including the sense of comfort and safety as well as the scenic value of the site itself and its sourrounding context, scored as low (1), moderate (2), or high (3). This is referred to as the park's D&A factor.

A rating for the potential of each type of component to promote physical activity was derived from a study published by NCSU Cooperative Extension (Floyd, et al., 2015). The NCSU study provides a listing of the total energy expenditure over and above the sedentary rate (referred to as AEE), and a recoding of this into three categories of high (coded 1), moderate (coded 2), and low (coded 3) for all individuals present within an activity zone associated with each of 40 facility types. The AEE ratings were reverse coded for the purposes of this study into Low = 1, Moderate = 2, and High = 3. The facility types were matched with the components in the GRASP®-IT tool and the reverse-coded AEE rating was assigned to each GRASP®-IT component. For components that could not be matched with a facility type from the NCSU study, additional research of the literature was conducted to estimate the AEE value based on published studies of energy expenditures associated with various activites and the expert opinion of the investigators.

3.2 Calculating the Index

Data from the 2011 inventory were used to populate the variables of an algorithm and generate a numerical score for each of Cary's 32 parks. Components present within the park were the basic unit of analysis. For each component that was present in a park, its functional score was multiplied by the reverse-coded AEE rating for that component type and by the recoded modifier value for the park, then by the design and ambience factor (D&A). The results for all components were then summed to provide a total component park score (CPS) for the park, as shown in Figure 1.

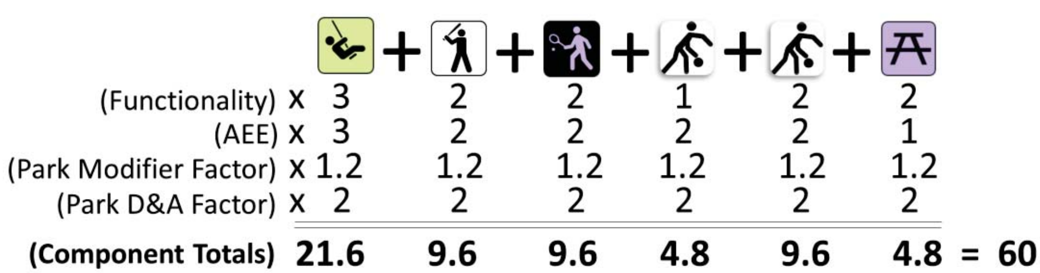

Figure 1. Illustrated formula for computing the total component score for a hypothetical park with six components (2018). Functionality and Active Energy Expenditure (AEE) ratings vary by component. Site has a park modifier factor of 1.2, and a Design and Ambience (D&A) factor of 2. Diagram by the author.

Given the inconclusive evidence in the literature for a relationship between the acreage of parks land available and park use or physical activity, further analysis was performed to determine whether to include park acreage in the index. Evidence in the literature suggests that the influence of park size on park visitation and usage may be related to the tendency for larger parks to have more features and that it is the features rather than the park size that affect park use (Giles-Corti et al., 2005). Thus, including park size in the metric could unintentionally be double-counting the influence of park features. To investigate this, the statistical relationship between park size and the total number of components was analyzed in SPSS 23. Results showed that the number of components in a park was positively correlated with the number of acres with a correlation of r = .600 (R^2 = .360; *P < .01).* While this is evidence of correlation, it does not account for all of the variation in the number of components. It also does not take into account the fact that larger parks might tend to have higher modifier values, so a separate correlation analysis was performed for park size and modifier values, yielding a non-significant correlation of r = .264 (R^2 = .070; *P = .072).* Finally, a correlation analysis was run on park size and the total component value for all parks, resulting in r = .548 (R^2 = .300; *P = .001).*

While the statistical analyses showed some correlation between park size and park features, there was enough variation left unexplained in the values for Cary's parks to warrant including park size in the metric. Therefore, the total component park score (CPS) for each park was multiplied by the size of the park in acres to arrive at a final index value for each park. The resulting scores cover an immense range of values. Transforming numbers that extend from very small to very large into logarithmic values is a useful way to make them easier to comprehend. The values were converted to base 10 (Log 10) logarithmic values in SPSS. Descriptive statistics for the results are shown in Table 1.

Table 1. Descriptive statistics for parks in Cary, NC.

	N	Range	Minimum	Maximum	Mean	Std. deviation
Number of components	32	41	1	42	11.06	9.94
AEE total for all components	32	42.00	1.00	43.00	15.25	10.63
Modifier factor	32	5.60	2.20	7.80	5.59	1.75
Size in acres	32	274.26	0.63	274.89	50.99	74.66
Component park score	32	1,625.80	4.40	1,630.20	279.36	347.12
Total park score	32	289,455.69	3.48	289,549.17	24,763.24	57,767.92
Log 10 of total park score	32	4.92	0.54	5.46	3.29	1.30

3.3 Analyzing the Index

A multiple linear regression analysis was run in SPSS to determine the relative effects of the main variables (total AEE, modifier factors, and park acreage) in predicting the Log10 Score of a park (Table 2).

Table 2. Linear regression results for variables in the GRASP®*Active* Index

	B	Std. Error	Beta	Sig.
AEE Total	0.077	0.015	0.629	0.000
Modifier Value	0.195	0.066	0.263	0.006
Size in Acres	0.003	0.002	0.172	0.149

Results show that the three variables together account for about 80% of the variation in Log10 scores for parks in Cary (R^2 = .822; Adjusted R^2 = .80; *P = .000).* Total AEE accounts for the largest portion of the variance in the Log10 Score (R^2 = .395; *P = .000*) with the park's modifier value next (R^2 = .069; *P = .006*), and park size as the least important and non-significant contributor of the three ($R^2 = .030$; $P = .149$). Given the empirical nature of the AEE variable and evidence from other sources supporting the contributions to physical activity from park features, it seems appropriate for AEE to be weighted more heavily in the equation than park quality and park size.

While the algorithm for the index is rooted in evidence from the literature, there is no clear basis for what the ideal value should be for any given park. One way to approach this is to look at the distribution of values among Cary's parks. The histogram in Figure 2 shows clustering around the Log10 values of 1.5 and 3.75. A look at the specific parks around the two clusters shows that the lower value tends to be made up of small parks that the Town of Cary classifies as "Mini Parks" and one classified as "Neighborhood Park", but which was rated low in the original inventory and considered by Cary parks staff at that time to be an under-performing park. The higher cluster is made up of locations classified as "Neighborhood Parks", which contain more features and are intended to serve a larger area. At the highest end of the scale are large parks that Cary classifies as "Community" and "Metro" parks and venue-type locations classified by Cary as "Special Use Facilities" that have concentrations of sports fields and active-use features.

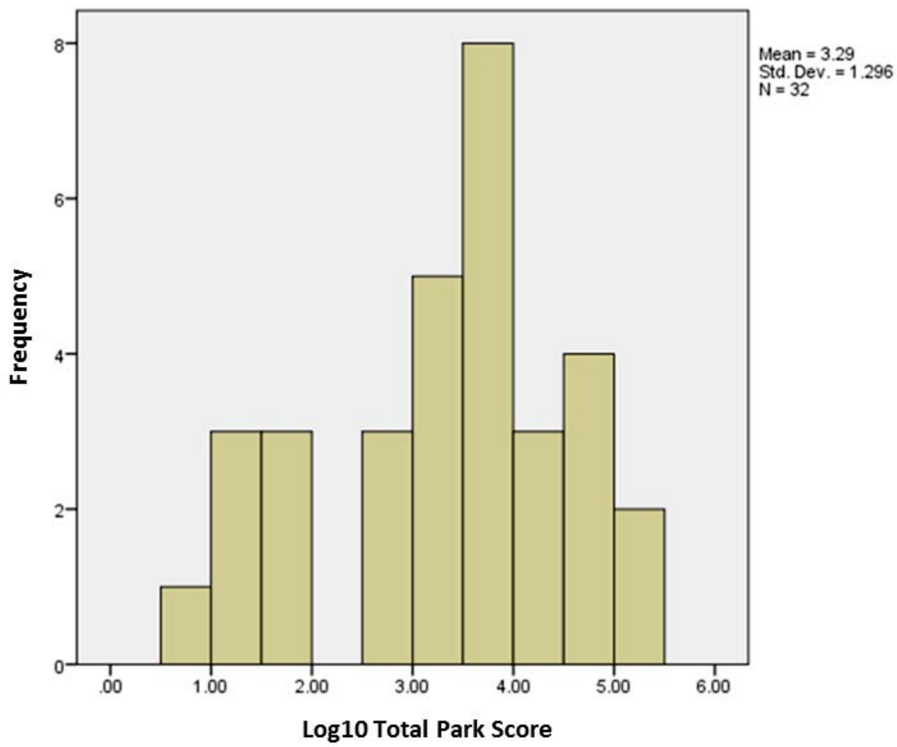

Figure 2. Histogram for Log10 Total Park Scores for parks in Cary, NC (2018). Produced by the author with SPSS 23.

4 APPLICATIONS

The index provides a way to measure and assign a value to an individual park which indicates its relative potential to encourage and support public health goals. Further research is recommended to determine what the ideal score for any given park should be, but the metric does allow for comparisons to be made between different parks and an ordered ranking of them to be produced. For example, a group of parks can be distributed into categories of low, medium, and high (i.e., top third, middle third, lowest third). Such rankings can be used to set policies and priorities for which parks to improve and which ones to maintian in their current state, and to set performance standards for proposed new parks.

The two cluster points identified in Figure 2 could be used as benchmarks against which parks could be measured, with small parks benchmarked against the 1.5 Log10 value and larger ones against the 3.75 value. Policies might be adopted which target those as values to be used in prioritizing.

4.1 Performance at the System Scale: Aggregated Measures for a Specific Geographical Area

To test the index for use in planning at the park system level, the values for Cary's parks were used to measure Level of Service (LOS) values across the city using ArcMap 10.1. The first step in the process was to enter the values for each park parcel into the attribute table of the park locations layer. The parcels were then buffered with a ½ mile Euclidian buffer, and a recoded Log10 score of 1 (low), 2 (moderate) or 3 (high) was was assigned to the corresponding buffer. The recoded Log10 values were used in order to simplify the results, but the full Log10 values, or the total park scores could be used to create a more intricate map with greater subtlety between values.

The buffers were combined to create a map displaying the composite values that result when the buffers are overlain on one another (Figure 3). The yellow background on the map indicates the geographic

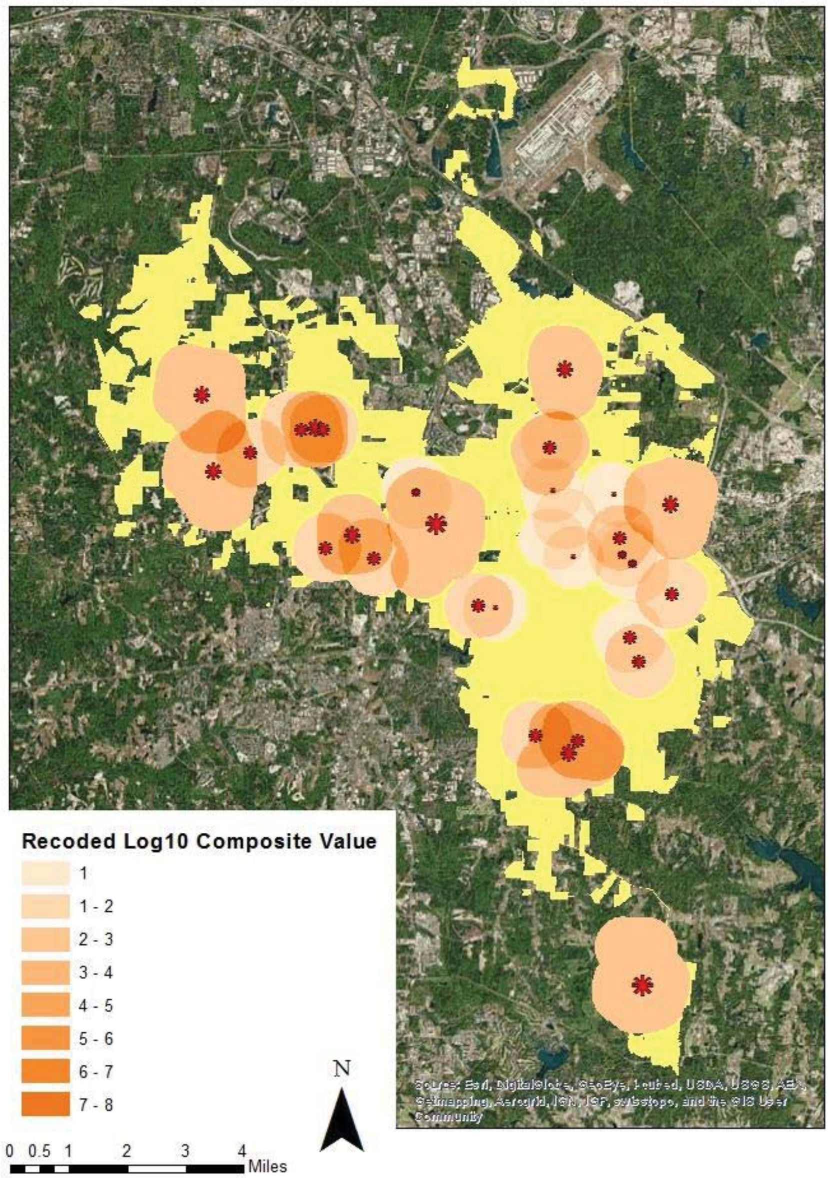

Figure 3. Composite values map of recoded Log 10 values (2018). Produced by the author with ArcMap 10.1.

corporate extents of Cary at the time the data were collected. The shades on the map represent composite values for recoded Log10 from all parks whose buffer overlays a given location. Total values range from zero (no shading) to 8. Additional performance measures for the entire system of parks can be extracted from the GIS using this information. For example, 30.30 square miles of Cary's total land mass of 55.60 square miles (55%) fall within a buffer, meaning that anyone living within that area can be considered to have walkable access to parks with features that support some degree of healthy activity. Figure 4 shows areas with value at or above the median recoded Log10 score of 2.

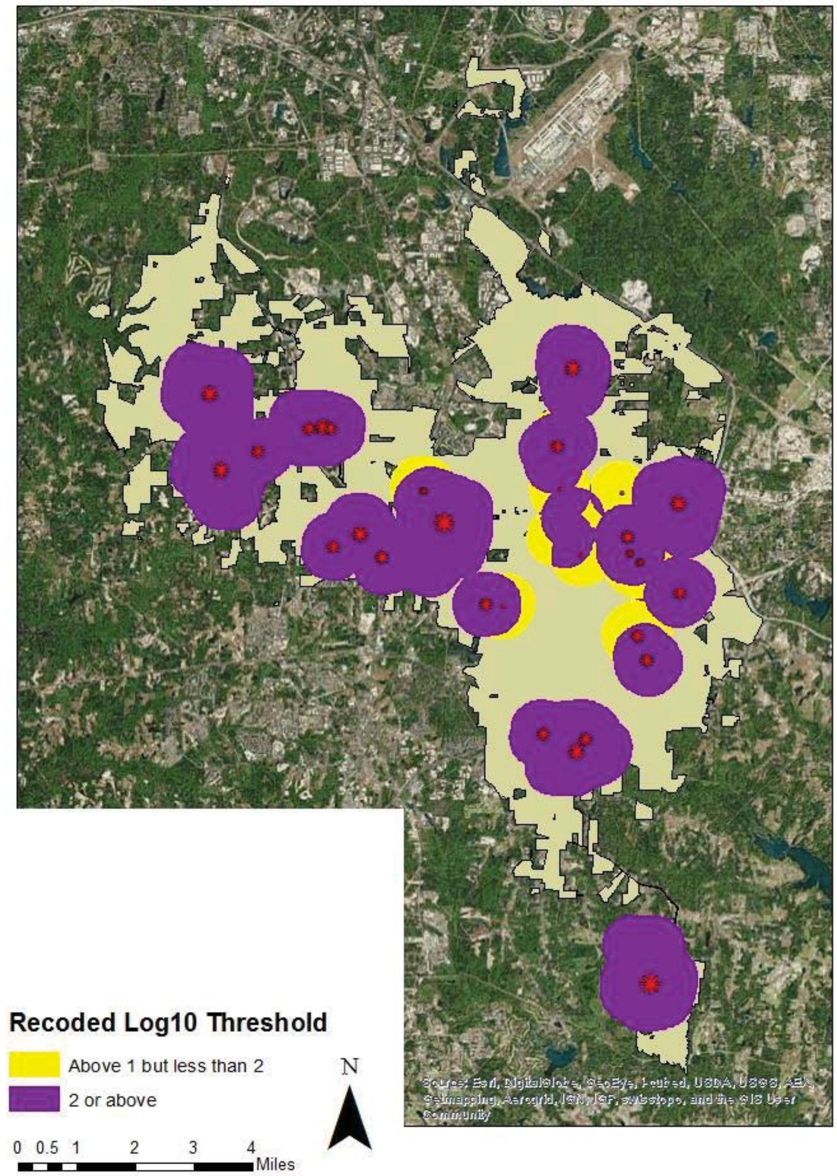

Figure 4. Threshold map with recoded Log 10 values for parks in Cary, NC (2018). Produced by the author with ArcMap 10.1.

A wide variety of possible performance metrics are available once scores have been assigned to parcels and imported into the GIS. For example, census data can be imported to compare the demographics of residents within different parts of the community with the level of service offered by parks to assure equitable access.

5 DISCUSSION AND CONCLUSIONS

The study showed that data from park inventories can be combined with empirical measures from the literature to generate an index that can be used to analyze individual parks and systems of parks for their potential to stimulate use and physical activity within a subject community. Feasibility of obtaining data with the GRASP®-IT audit tool has been demonstrated by its use within the parks and recreation field to prepare inventories of parks for over 100 master plans. However, the overall reliability of the tool may be a limitation for its application in some research studies. Using other audit tools or improving the GRASP®-IT tool could improve the reliability of the GRASP®*Active* index. However, one aspect of the GRASP®-IT tool that differentiates it from others is that it incorporates subjective measures of the quality of park features in addition to their objective presence or absence. Quality may be an important variable in the propensity of a park to attract users and encourage activity. One solution is to develop and test reliable measures of quality for parks.

Another limitation of the study is that it did not test the validity of the results or establish a scale against which they should be interpreted. The scores for Cary's parks were not confirmed against a gold standard to determine if they accurately reflect the differences between parks, nor was a range of scores established for what constitutes a desired, acceptable, high, medium, or low value for a given park or location within a community.

Finally, while the index demonstrated here is intended to reflect the relative potential for a park to encourage physical activity and is therefore strongly influenced by the AEE ratings, it also incorporates variables that are associated with increased use of parks, both passive and active. This suggests that high GRASP®*Active* values may indicate a higher potential for the park to contribute to other health outcomes that are associated with simply being exposed to a park, such as stress reduction. Further studies may allow for the development of a more complex and comprehensive index that incorporates multiple variables into a ranking of a park's potential to affect a broader public health outcome. Conversely, focused indices may be developed that target a park's potential to address specific health issues, such as recovery from stress, emotional disorders, and social interaction.

6 REFERENCES

Active Living Research (2010). Parks, playgrounds and active living. *Research Synthesis,* February, 2010. 1-15.

Arlington Heights Park District (2018). *Arlington Heights selected as a "beta site" for the Healthy Communities Surveillance and Management Project.* Web 29 September 2018.

Bauman, A.E., Reis, R.S., Sallis, J.F., Wells, J.C., Loos, R.J.F., Martin, B.W. (2012). Correlates of physical activity: why are some people physically active and others not? *Lancet 2012* (380) 258-271. Published online 18 July, 2012.

BEACH Lab (Built Environment and Community Health Laboratory) (2015). *Electronic Community Park Audit Tool (eCPAT) Project.* Web. 3 April 2015.

Bedimo-Rung, A.L., Mowen, A.J., & Cohen, D.A. (2005). The significance of parks to physical activity and public health: A conceptual model. *American Journal of Preventive Medicine, 28(S2),* 159-168.

Bird, M.E., Geetanjali, D.D., van Hulst, A., Kestens, Y., & Barnett, T.A. (2015). A reliability assessment of a direct-observation park evaluation tool: the Parks, activity and recreation among kids (PARK) tool. *BMC Public Health, (15:906),* 1-11.

Cohen, D.A., Marsh, T., Williamson, S., Derose, K.P., Martinez, H., Setodji, C., McKenzie, T. (2010). Parks and physical activity: Why are some parks used more than others? *Preventive Medicine* (50). S9-S12.

Floyd, M., Suau, L.J., Layton, R., Maddock, J.E., Bitsura-Meszaros, K. (2015). *Cost analysis for improving park facilities to promote park-based physical activity.* North Carolina Cooperative Extension.

Giles-Corti, B., Broomhall, M.H., Knuiman, M., Collins, C., Douglas, K., Ng, K., Lange, A., & Donovan, R.J. (2005). Increasing walking: How important is distance to, attractiveness, and size of public open space? *American Journal of Preventive Medicine, 28(2S2),* 169-176.

GP RED (2013), *South Bend Parks and Recreation healthy communities surveillance and management toolkit beta site project summary report for year 3 – 2013.* GP RED. Available at: http://www.gpred.org/wp-content/uploads/2014/10/South-Bend-HCRG-Year-Three-Report.pdf.

Joseph, R.P., & Maddock, J.E. (2016). Comparative analysis of fine observational audit tools to assess the physical environment of parks for physical activity, 2016. *Preventing Chronic Disease 13(E166),* 1-8.

Kaplan, S. (1995). The restorative benefits of nature: Toward an integrative framework. *Journal of Environmental Psychology, 15*(3), 169-182.

Kaczynski, A.T., Schipperijn, J., Hipp, J.A., Besenji, G.M., Stanis, S.A.W., Morgan, H.S., Wilcox, S. (2016). ParkIndex: Development of a standardized metric of park access for research and planning. *Preventive Medicine.*

McCormack, G.R., Rock, M., Toohey, A.M., Hignell, D. (2010). Characteristics of urban parks associated with park use and physical activity: a review of qualitative research. Health and Place (16). 712-726.

Root, T. (2017). Doctors are prescribing park visits to boost patient health. *National Geographic.* Retrieved from: https://news.nationalgeographic.com/2017/06/parks-prescribes-doctors-health-environment/.

Sallis, J.F., Floyd, M.F., Rodriguez, D.A., & Saelens, B.E. (2012). Role of built environments in physical activity, obesity, and cardiovascular diseases. *Circulation, 125*, 729-737.

Sallis, J.F., & Spoon, C. (2015) *Making the case for designing active cities* (Technical Report). Active Living Research. Revised version: February 2015.

Saelens, B.E., Frank, L.D., Auffrey, C., Whitaker, R.C., Burdette, H.L., & Colabianchi, N. (2006). Measuring physical environments of parks and playgrounds: EARPS instrument development and inter-rater reliability. *Journal of Physical Activity & Health, 3*(1), S190-S207.

Smiley, K.T., Sharma, T., Steinberg, A., Hodges-Copple, S., Jacobson, E., & Matveeva, L. (2015). More inclusive parks planning: Park quality and preferences for park access and amenities. *Environmental Justice (9)* 1. 1-7.