As the Crow Flies:

Comparing Radial and Network Analysis of Park Service Areas

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ABSTRACT

Objective:
Examine the difference in service area estimates and population served using radial and network analysis.

Background:
The prevalence of obesity in the United States is of great concern to public health officials. Physical activity, particularly the encouragement of walking, is strongly recommended by the 2008 Federal Physical Activity Guidelines for Americans. Studies have shown that the ability to walk to a site in less than 10 minutes contributes to frequency of use, and that public parks are important for the promotion of physical activity both as a destination and as an activity setting. The methods used to calculate access to sites affect our understanding of service and planning decisions. Service area estimates can be established using either radial analysis which includes all land within a specified distance regardless of barriers or travel route, or network analysis which follows actual travel paths.

Methods:
This study of the City of Atlanta park system established service or catchment areas for each park and then for the city as a whole. Four catchment areas were established for each site and the city using radial analysis and network analysis for ¼- and ½-mile distances. Study sites were all city parks that contained at least one amenity such as a park bench, trail, playground, picnic shelter, or recreation center. To establish catchment areas using radial analysis, buffers were created around park boundaries. Establishing catchment areas using network analysis required more steps; all entry points were identified, service area polygons were created by connecting end points established by the specified travel distances along the street network, and then overlapping polygons were merged. Because the catchment areas for individual park sites could overlap, the analysis for the city as a whole required that individual park catchment areas be merged. The estimated population within each catchment area was based upon the portion of the United States 2000 census blocks falling within each area.

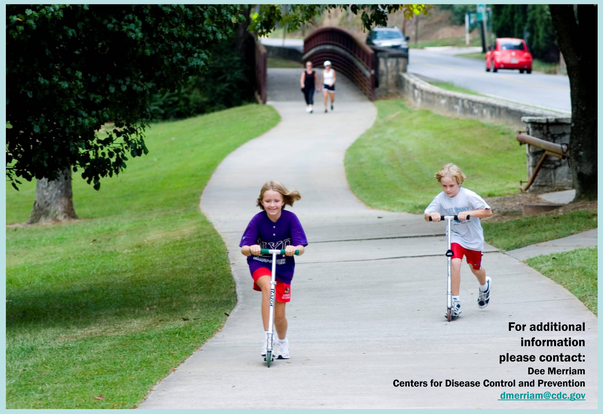
Results:
Out of 345 sites in the park system inventory only 154 sites met the threshold criteria of having some reason for people to got there, such as a bench or a trail. Catchment areas were mapped for sites meeting the study threshold criteria. In all cases the radial analysis resulted in a larger estimate of service. The citywide catchment acreage for the ¼-mile travel distance resulted in a radial analysis service area estimate 59.7% larger than the area estimated using network analysis (29,138 acres versus 11,778 acres). The ½-mile analysis resulted in a 44.3% difference (56,385 acres versus 31,380 acres).

The difference in the estimated population served by specific parks ranged from a low of 18.2% to a high of 99.5% for the ¼-mile travel distance, and from 16% to 93.5% for the ½-mile travel distance. Citywide the ¼-mile difference was 52.2% and the ½-mile difference was 35.5%. The least-accessible parks had limited entrances and street connectivity.

Conclusions:
Network analysis provides a more accurate estimate of park access than radial analysis and adds valuable insights for planners at both the system and site scales. At the system level the more precise maps provide a clearer representation of gaps in park distribution. At the site level the graphics created for each park illustrate where strategic acquisitions or street development could expand pedestrian park access. The graphic representations can also be used to illustrate the impact of additional entrances and how they expand access from adjacent neighborhoods.

Entrance location and route choice have a significant impact on site access. Single entrances, particularly in areas with disconnected street patterns, reduce pedestrian access to a site. The number of accessible sides of a park, number of entrances, and the characteristics of the street network are directly related to the size of the park catchment area and, subsequently, access to a park. A street pattern that links to a park with smaller blocks and a dense pattern of intersections increases the ratio of the network to radial catchment area.

This analysis may apply to any situation where pedestrian access is important.



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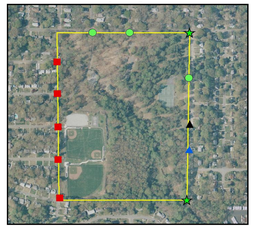
This study was commissioned by the City of Atlanta under the direction of Dee Merriam and conducted by Tony Giarrusso for the Georgia Institute of Technology Center for Geographic Information Systems.

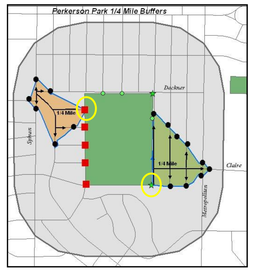
METHODS

- Studied 154 parks in the City of Atlanta, Georgia. (Out of 345 sites in the park system inventory only 154 sites met the threshold criteria of having some reason for people to got there, such as a bench or a trail.)
- Selected all parks that had at least one amenity; this could be as simple as a trail or a bench.
- Parks in the study ranged from .042 acre to 250 acres. (33 of the study sites were under 1 acre.)



Entrance Typology:

- **All** - Primarily automobile but can serve pedestrians and maintenance vehicles
- **Pedestrian** - Serves only pedestrians – no motorized vehicle access
- **Maintenance** - Maintenance entrance only – usually gated
- **Pedestrian/Maintenance** - Maintenance entrance but pedestrian access is possible (no gates)
- **Potential Pedestrian** - No definitive entrance but terrain permits access



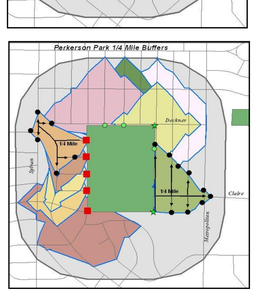
Create Park Service Areas for Each Entrance:

Network Service Areas

- Beginning at each entrance potentially usable by pedestrians; measure along the street network ending at the specified distance
- Black dots represent these end points
- One service area per entrance is created (blue outlines) by connecting end points

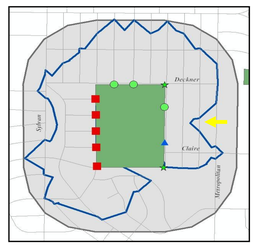
Radial Service Areas

- Black line and grey area represent the radial service area. The radial service areas were created by measuring the specified distance outward from the park boundary.



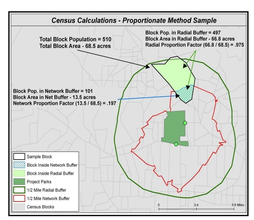
Create a Merged Park Service Area:

- Merge overlapping service areas



Park Service Areas:
Blue line represents the network service area
Dips occur where two service areas meet

This process was repeated for each of the four catchment areas: ¼- and ½-mile radial and network areas.



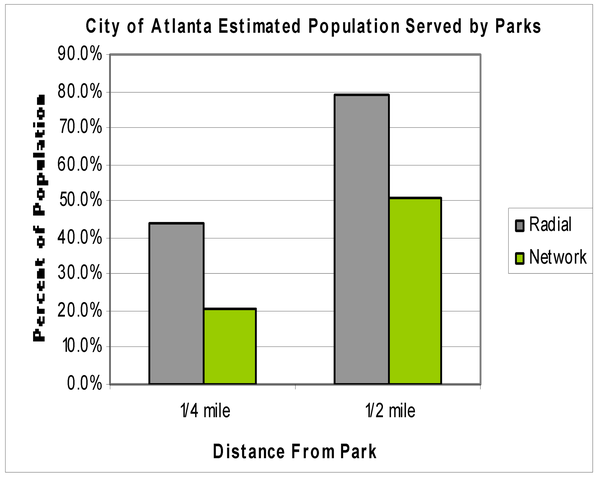
Proportional Estimate of Population:
Census tracts did not correspond with identified service areas, so the percent of a census tract falling within the park service area was calculated and used to assign population.

Note: This method assumes uniform distribution of population across the census block and may result in either an underestimate or overestimate.

Create Merged Polygons for the City as a Whole:
Some of the identified park catchment areas overlapped. To eliminate double counting the same populations, all park service areas were merged to create four citywide polygons: One each for the ¼- and ½-mile radial service areas, then for the ¼- and ½-mile network service areas.

RESULTS: City as a Whole

- Estimates of Atlanta's population served by parks were substantially higher using radial analysis than network analysis.
- Out of the 345 sites in the Atlanta's park inventory 154 sites met the study criteria of having at least one amenity.



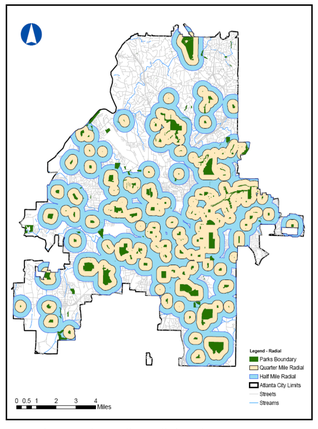
City of Atlanta Total Estimated Population Served by Parks Using Radial and Network Analysis
(2000 Census Total City of Atlanta Population Estimate 416,474)

¼- mile	Population Estimate	Percent Population Served*
Radial	181,950	43.7%
Network	86,883	20.9%
Difference	95,067	
Percent difference (radial-net)/radial: 52.2%		

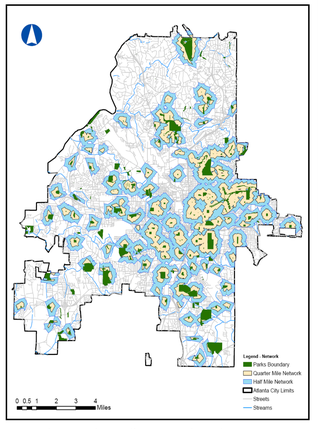
½- mile	Population Estimate	Percent Population Served*
Radial	327,869	78.7%
Network	211,375	50.8%
Difference	116,494	
Percent difference (radial-net)/radial: 35.5%		

Geospatial Analysis:

- Network analysis reveals much larger un-served areas of Atlanta than is evident using radial analysis.
- The size of park service areas appears to be determined more by the characteristics of nearby street patterns and the distribution of park entrances than upon park size.
- The ¼-mile network service area covers 14% of the Atlanta's total area.
- The ½-mile network service area covers 37% of the Atlanta's total area.



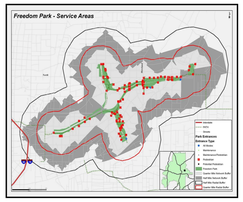
Map of ¼- and ½-mile radial estimates of park service areas.



Map of ¼- and ½-mile network estimates of park service areas.

RESULTS: Selected Parks

- Smallest percent difference, radial-network)/network population was 20%.
- Largest percent difference, (radial-network)/network, was 19,000%.



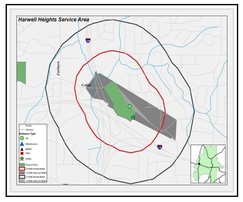
Freedom Park

Freedom Park serves the largest population calculated by both radial and network analysis. It illustrates a long linear park with many entrances serving traditional neighborhoods with a connecting grid street pattern.

Freedom Park - 188.6 acres

¼-mile	Population Estimate	Percent difference* (r-n) / r
Radial	10,524	
Network	6,851	
Difference	3,673	34.9%

½-mile	Population Estimate	Percent difference * (r-n) / r
Radial	22,743	
Network	16,106	
Difference	6,637	29.2%



Harwell Heights Park

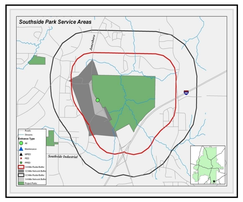
Harwell Heights Park serves the smallest population estimated by network analysis. It illustrates a site with limited entrances serving a neighborhood with a disconnected street pattern.

This site also shows the effect of a barrier; note how the interstate blocks access.

Harwell Heights Park – 23.4 acres

¼-mile	Population Estimate	Percent difference* (r-n) / r
Radial	582	
Network	3	
Difference	579	99.4%

½-mile	Population Estimate	Percent difference* (r-n) / r
Radial	2,397	
Network	361	
Difference	2,241	93.5%



Southside Park

Southside Park is Atlanta's largest park. It illustrates the opportunities that become apparent with this type of analysis.

The park currently fronts undeveloped land to the north and east. Park access can be increased by encouraging future developments to create roads fronting the park.

Southside Park – 211.4 acres

¼-mile	Population Estimate	Percent difference* (r-n) / r
Radial	1,130	
Network	37	
Difference	1,093	96.7%

½-mile	Population Estimate	Percent difference* (r-n) / r
Radial	3,368	
Network	361	
Difference	3,007	89.3%

LIMITATIONS

Both radial analysis and network analysis have limitations. In both types of analysis, population within census blocks is assumed to be uniformly distributed, which is seldom true. Radial analysis assumes straight line access to the park and does not recognize barriers. Network analysis is subject to overestimates resulting from identified entrances that are not useable or streets lacking pedestrian infrastructure. Network analysis could also underestimate access due to missed entrances and travel routes.

CONCLUSIONS

Although the difference varied depending on entry points and street pattern, in all cases the radial analysis overstated service. The magnitude of the overestimation was significant and could skew understanding of service provision. This is particularly significant for populations with limited access to automobiles: children, the poor, and the elderly. Studies that examine correlations between proximity to parks and walking may find stronger relationships using the more precise network analysis method.

Nov 2010