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# A Gap Analysis of the Service Area of West Virginia's Trail Network

Good trail infrastructure supports the physical and economic health of communities. However, trails – and access to their benefits – are not always evenly distributed. Ensuring equitable access to infrastructure like trails, and the corresponding positive health and economic outcomes, is part of the growing consciousness of environmental justice and recreationally "underserved" communities. In view of this, this study examines the service area of West Virginia's trail network (both existing and proposed) using the ArcGIS Network Analyst tool. Results show that with a 10-mile service area, the proposed trails of 2,577 miles (or 65% increase in trail mileage) only increase the geographical extent of the service area by 8% and the demographic extent of the service area by 5%, reinforcing the existing regional trail disparities. This study helps recreation planners prioritize projects/resources and identify gaps.

Key words: Trail, Gap analysis, GIS, West Virginia

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**Introduction**

Good trail infrastructure supports the physical and economic health of communities

It is widely studied that nearby trails for walking and bicycling encourage exercise and physical activity (Brownson et al. 2000; Kaczynski, Potwarka, Smale, & Havitz, 2009; Saelens & Handy, 2008; Troped et al. 2001). Additionally, trails can serve as an engine for growth in the tourism and outdoor recreation industry, injecting new money into local businesses (Bowker, Bergstrom, & Gill, 2007; Busbee, 2001; Sallis & Spoon, 2015; Trail Town Program, 2016). Taken together, the physical and economic benefits of trails contribute to the overall quality of life for "trail towns." However, trails – and access to their benefits – are not always evenly distributed.

The concept of "underserved" communities involves various factors (socioeconomic, geographic, environmental, etc.) that contribute to an uneven and disadvantageous allocation of resources or the accessibility thereof. Underserved populations typically include minorities and/or the unemployed, poor, undereducated, young, and elderly (Moore, Diez Roux, Evenson, McGinn, & Brines, 2008; Taylor, Floyd, Whitt-Glover, & Brooks, 2007). Such communities are not confined to our inner cities; owing to a larger geographic distribution and a lower population, rural areas are even more likely to be considered underserved than their urban counterparts (Farrigan, 2017). Ensuring equitable access to infrastructure like trails, and the corresponding positive health and economic outcomes, is part of the growing consciousness of environmental justice and recreationally "underserved" communities (Cradock et al., 2009; Maroko, Maantay, Sohler, Grady, & Arno, 2009; Taylor et al., 2007). The Appalachian Regional Commission (ARC) has been keeping statistics on the region's county economic performance and annually updates a list of "distressed counties"— those in the bottom 10% of socioeconomic conditions related to income, poverty, and employment (Appalachian Regional Commission, 2018).

There are many initiatives that support trail development in West Virginia: Federal Highway Administration alternative transportation or recreation trail grants, the WVDOT State Trails Program, the National Park Service's Rivers, Trails, and Conservation Assistance (RTCA) Program, and a substantial number of local and community led efforts. However, state and federal assistance may not be getting to the places that need them most: the underserved communities that face hurdles raising the capital needed to jumpstart trail projects. From 1992- 2004 West Virginia was one of three lowest state recipients of federal funding for trail projects (Cradock et al., 2009). Cradock et al. (2009) noted that "bicycle and pedestrian projects were less likely to have been implemented in counties characterized by persistent poverty and lower educational attainment" (p. S61). This statistic is borne out in the distribution of WV's RTCA projects; of West Virginia's 12 most distressed counties, five have not received National Park Service recreation assistance (Appalachian Regional Commission, 2018).

In 2002, West Virginia completed a State Trail Plan with cooperation of federal, state, citizen, and academic organizations to guide future trail planning and implementation (WV Trail Plan Committee, 2002). Fifteen years later, progress has been limited. Given the naturally constrained resources available to public and private entities, a thorough analysis of the existing trail network and then the proposed trail network would certainly be beneficial in prioritizing future work and efforts, particularly with emphasis on expanding access and benefit to traditionally underserved communities. Since trail accessibility is found to be positively related to the frequency of use and the level of physical and recreational activities, which, in turn, contribute to the promotion/improvement of public health (National Recreation and Park Association, 2019), questions then arise: "Do economically distressed counties in West Virginia have less access to trails" and if yes, "To what extent the underserved communities are affected by proposed trails?" or in other words, "Do proposed trails increase the trail accessibility for these underserved communities?" To answer these questions, this study aims to: 1) measure the accessibility level of the existing trails; 2) measure the accessibility level of proposed trails; and 3) compare the trail service area before and after the proposed trails so that the trail service gap, if any, can be determined.

**Literature review**

Any analysis of a trail network has a few immediate problems. The first is defining "access." To quantify access, the simplest GIS analysis of parks and forests often uses calculations of distance from boundaries or centroids. Furthermore, these simple spatial analyses also often use Euclidean or "as the crow flies" straight-line distance. However, centroids or boundaries aren't how people interact with recreational infrastructure. Users are most often walking and driving to designated trailheads, access points, or intersections. Therefore, these simple analytical methods are being phased out as computer power improves and recreation managers and planners recognize that travel to parks or trails occurs within the constraints of the existing transportation system. Until personal transport drones are commonplace, visitors will continue to travel to definitive features like trailheads via a public road network. Scientific consensus suggests that any new recreation access models should reflect this reality and use network distances (Kaczynski, Powarka, & Saelens, 2008; Kim & Nicholls, 2016; Maroko et al., 2009; Nicholls, 2001). For example, Kim and Nicholls (2016) used network analysis in their study examining the influence of distance measurements on recreation access assessments, indicating that "several previous studies have indicated the preferability of using network-based rather than Euclidean (straight-line) distance" (p.128).

Another network analysis problem involves picking an appropriate distance to define what it means to be "local." Many studies have reviewed recreational access as it relates to walking distances, up to about 1 mile (Kim & Nicholls 2016, Maroko et al., 2009). However, pedestrian and public transportation infrastructure is significantly limited in a rural state like

West Virginia and it could be assumed that most people drive to access recreation (Federal Highway Administration, 2016). Studies that identify driving distances to trail access are few; a number of recreational studies from Australia suggest that driving between 6-20 miles is reasonable (Kim & Nicholls, 2016). As another rural state, Indiana could serve as a domestic example for the West Virginia State Trails Plan. Indiana has a goal of providing trail access within 15 minutes to every resident (Institute for Parks and Public Lands, 2017), which was chosen as the service area standard for this analysis. It should be noted that to have a network of trails within 15 minutes of every home, school, and workplace is also a goal set by American Trails (American Trails, 2018).

The final consideration in network analysis is devising metrics that accurately represent the desired population-park or trail relationship. Common methodologies include the “container” approach, kernel density, minimum distance, average distance, travel cost, the “covering” or service area, and population weighted or gravity models (Kim & Nicholls, 2016; Maroko et al., 2009; Zhang, Lu, & Holt, 2011). The subtle differences in methodologies (measuring population-to-park or park-to-population) can greatly influence the analytical approach and final product. As computer power increases there has been a trend toward more complex models (gravity, travel cost, service area) over simpler models (container, minimum distance) to better simulate human behavior. The container approach was ruled out because residents of one county are free to drive to access points across the border in another.

With a dispersed, low population density, identifying focal points for any population-to-park metrics (e.g. minimum distance, travel cost, etc.) is difficult for West Virginia; many residents do not live in designated towns. Kim and Nicholls (2016) used centroids of census block groups to calculate minimum distance to the nearest recreation access. However, West Virginia has nearly 67,000 census block groups, a number that would severely tax computer resources. Therefore, the park-to-population method of covering or service area was determined to be the best fit for this analysis of West Virginia's trail network. The service area method uses network distances to compute the coverage of each "facility" as the point of origin, in this case a trail access point (Kim & Nicholls, 2016). Cumulatively, the service area of all trail access points will provide a binary "covered or not covered" outcome for the whole state, and with fewer access points (1,400) than census block groups, provide faster computing times. This approach would be sufficient for a first look at access at a statewide scale; easily highlighting the gaping holes in the service area without trail access and readily identifying possible recreationally underserved areas.

## Methodology

A street network was obtained for West Virginia and the surrounding region from ESRI Streetmaps North America 2012. GIS shapefiles for existing trails and the 2002 State Trail Plan proposed trail network were obtained from the West Virginia GIS Tech Center (http://wvgis.wvu.edu). These trails provide opportunities for both locals and visitors to bike, walk, boat, or drive (for a detailed description of trail types and uses, please refer to West Virginia Trail Inventory: https://www.mapwv.gov/trails/).

The proposed trail network was edited to include the Cheat River Rail Trail, a project with significant momentum that was initiated after 2002. The existing trails database included an additional shapefile for "points of interest" associated with the trails, including the location of 824 parking areas. These existing parking areas formed the core of the access points for the trail network.

The parking points were supplemented with additional points obtained by calculating the points of intersection between the street network and the existing/proposed trail files. This provided reference for potential or informal access points not included in the original dataset.

113 of these modeled access points were added to the existing parking points, bringing the total of existing trails access points to 937. The additional points were primarily created for isolated trail features that did not have parking access indicated in the original “points of interest” file.

The proposed trails had no information on potential trailheads or parking, so all potential access points were modeled from the intersections between the street network and proposed trail files. In particular, access points were selected where trails passed through or near towns, at all end points, and at key intersections between other proposed trails, existing trails, or significant streets. A total of 460 new access points was chosen for the proposed trail network. Many proposed trails could share access with existing trails. For the proposed trail service area, the 460 access points were added to the 937 points for the existing trail system to simulate the entirety of the future service area.

Using the trail access points as “facilities”, the ArcGIS Network Analyst tool was used to calculate the service area distance for each access point. The network was not able to compute drive time; therefore to approximate the aforementioned “Indiana standard” of a 15-minute drive time, 10 miles was used as the service area threshold (e.g. 15 minutes on roads with a hypothetical average of 40 mph between common rural speed limits from 25 to 55mph). Finally, Population information was obtained from 2010 TIGER Census block groups (https://www.census.gov/geo/maps-data/data/tiger-line.html).

**Results**

With a 10-mile service area, the 3,939 miles and 937 access points of West Virginia’s existing trail network cover 43% of the state’s total land area, 45% of the state’s populated land area, and 73% of the state’s population (Figure 1). With a 10-mile service area, the 6,516 miles and 1,397 access points of West Virginia’s existing plus proposed trail network would cover 51% of the state's total land area (+8%), 53% of the state's populated land area (+8%), and 78% of the state's population (+5%) (Figure 2).

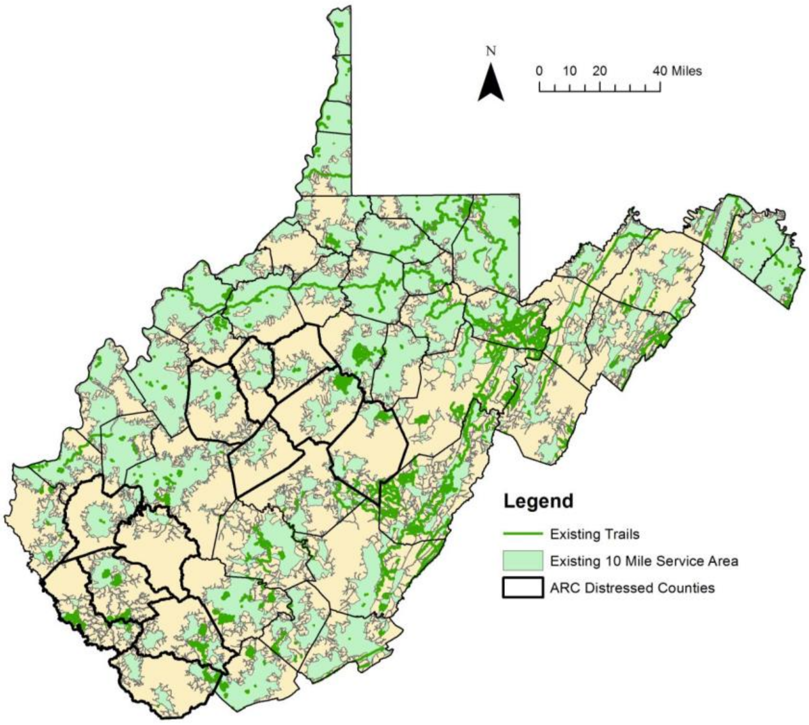


**Figure 1. Current 10-mile Service Area of WV's Existing Trail Access Points**

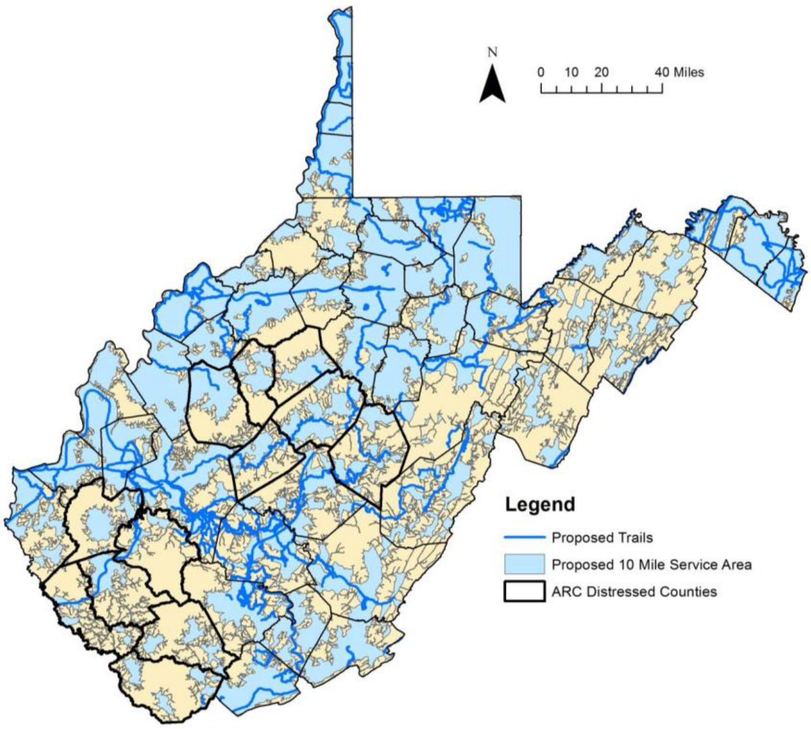


**Figure 2. Ten-mile Service Area of WV's Existing/Proposed Trail Access Points**

The 2,577 miles of proposed trails represent an increase in WV's total trail miles of 65%. However, 1,631 of the proposed trail miles (63% of all proposed miles) are within the existing 10-mile service area, leading to a proportionally much smaller increase in overall service area. The 65% increase in trail mileage only increases the geographical extent of the service area by 8% and the demographic extent of the service area by 5% (Figure 3).

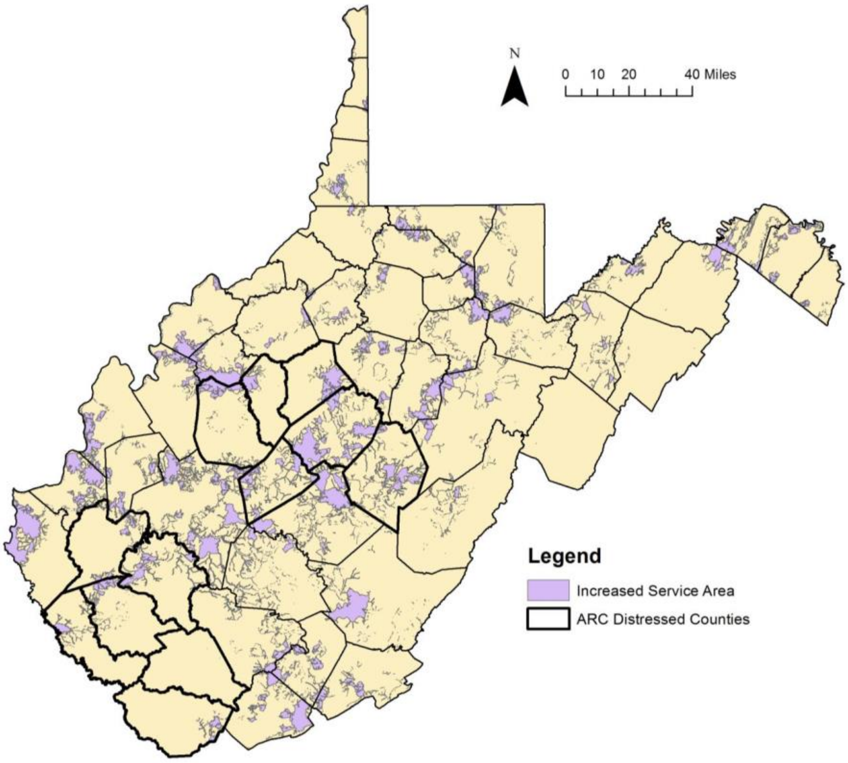


**Figure 3. Increased Service Area Based Upon Proposed Trails and Access Points**

At the county level, the percent of population within the existing 10-mile service area ranges from 11% to 97% with a mean of 61%. When including the proposed trails, the access range improves from 18% to 97% with a mean of 67%. Proposed changes on the individual county level range from 0% (10 counties) to a 33% increase in population covered within the 10-mile service area, with a mean of a 7% increase. However, it is apparent that many of the proposed trails overlap with regions that are already within the existing 10-mile service area (Figure 4), with a general lack of trail access continuing in southern and central West Virginia, where are also the most likely to contain underserved populations and/or designation as a "distressed county" by ARC. The specific metrics for the 12 distressed counties are presented in Table 1. As shown, the percent of population within the existing 10-mile service area for the 12 counties ranges from 11% to 61% with an average of 32%. In contrast, development of the proposed trails would improve accessibility from 18% to 69%, with an average of 44%, an increase of 12% over existing trails.

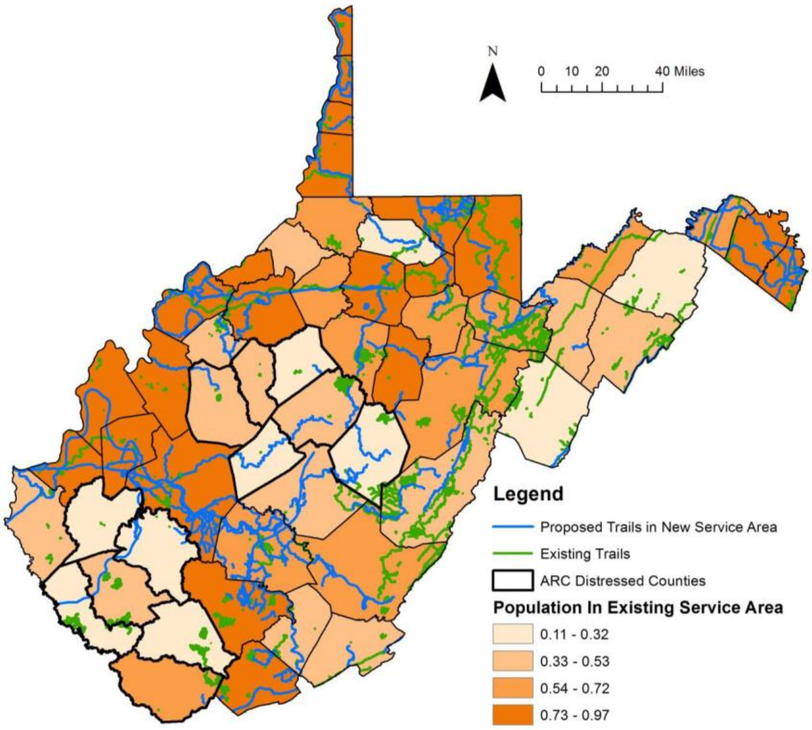


**Figure 4**. **Comparison of the Existing/Proposed Trail Miles and County Service Area**

**Table 1. A Breakdown of West Virginia's 12 ARC Distressed Counties with Their Current and Proposed 10-mile Trail Access Service Area***

| County | 2010 Census Population | % Pop in Current Trail Service Area | Rank from bottom | % Pop in Proposed Trail Service Area | Rank from bottom |
|---|---|---|---|---|---|
| **Braxton** | 14523 | 42% | 15 | 62% | 22 |
| **Boone** | 24629 | 11% | 1 | 30% | 7 |
| **Calhoun** | 7627 | 39% | 13 | 42% | 10 |
| **Clay** | 9386 | 19% | 3 | 35% | 8 |
| **Gilmer** | 8693 | 21% | 4 | 54% | 17 |
| **Lincoln** | 21720 | 14% | 2 | 18% | 1 |
| **Logan** | 36743 | 53% | 23 | 59% | 20 |
| **McDowell** | 22113 | 61% | 26 | 69% | 28 |
| **Mingo** | 26839 | 25% | 5 | 26% | 3 |
| **Roane** | 14926 | 45% | 17 | 52% | 16 |
| **Webster** | 9154 | 32% | 10 | 52% | 14 |
| **Wyoming** | 23796 | 26% | 7 | 26% | 2 |
| **Average** | | 32% | | 44% | |

*Note.* Ranking relative to all 55 West Virginia counties, lower ranks are worse.

**Discussion**

Based on current trail infrastructure, two fifths of West Virginia's counties don't have recreational trail access for half of their population, with the most socioeconomically disadvantaged areas among the hardest hit. The link between trail infrastructure and socioeconomic conditions has been made (Cradock et al., 2009) yet determining the nature of the correlation (or causation) is less certain. Does a lack of trail access perpetuate negative health outcomes and limited economic growth or does poor socioeconomic conditions preclude the construction of trail access? The answer is likely both to some degree and certainly includes a cumulative and feedback-loop effect.

The 2,577 miles of proposed trails represent an increase in the state's total trail miles of 65%. However, 1,631 of the proposed trail miles (63% of all proposed miles) are within the existing 10-mile service area. If a future goal of West Virginia is to provide reasonable trail access to all residents, like Indiana's goal of 100% of the population within 15 minutes of a trail, the current WV State Trail Plan is not optimized to do so. Increases in total trail mileage are not matched by equal increases in population or populated area coverage. This suggests that areas already served by trail infrastructure are getting more of the proposed miles, reinforcing regional trail disparities.

Local and city resources should absolutely continue to be allocated and prioritized for their own trail and recreation projects. However, where state or federal dollars are concerned, improving the quality of recreational access (more choice, more miles, or more connectivity) for communities within the current service area should possibly take a backseat to providing basic infrastructure and more coverage in traditionally underserved communities. It is worth noting that 12 distressed counties are ranked bottom seven with existing trails. Even the accessibility has a 12% increase after factoring the proposed trails into the accessibility estimation, still five counties are ranked bottom (Table 1). Overall, none of the 12 counties is ranked above the middle (the best ranking is bottom 26) with the existing trails, while only one county is ranked bottom 28, slightly above the middle ranking. This convincingly indicates that additional trails proposed after 2002 do not help too much to reduce the trail accessibility gap that has already existed in the 12 distressed counties.

The authors acknowledge the complexity of diminishing returns and the expense of providing trail access to a rural population dispersed in a geographically challenging state, but there should be a commitment from state and federal governments to assist underserved communities with basic services – including recreational trail access – in order to provide improved health, economic, and quality of life outcomes. This study was rooted in a desire to help recreation and tourism planners prioritize projects and resources and identify gaps.

Toward that end, some of the proposed trails that provide the most access increases in the ARC distressed counties include the Elk River Rail Trail (110mi), Webster Springs to Bergoo Rail Trail (11mi), Upper Elk Trail (21mi), Little Kanawha Rail Trail (18mi), Mountain Rivers Trail (20mi), the Spencer to Ravenswood Rail Trail (31mi), Rt 119 Bikeway (64mi), Tri Rivers to Rockhouse Trail (10mi), Anawalt Rail Trail (10mi), and the Fairmont to Moundsville Rail Trail (62mi). These trails represent only 14% of the total proposed mileage but would have the largest impact on the ARC distressed counties and counties in the bottom quartile of current trail access.

One of the biggest limitations to new trail development is the lack of public land and access in central and southern West Virginia. Owing to historical timber or mineral interests much of the land is privately held. There are a few parcels of public land located within the gaps in the existing trail service area that could be used to increase recreational access, however, much of the public lands in the service area gaps are Wildlife Management Areas (WMA), which are traditionally used for hunting and game habitats. Innovative solutions will be needed to maximize the potential of WMAs to contribute to other outdoor recreation pursuits. WMAs that are well positioned to provide increased recreation access and opportunity include "The Jug" in Tyler County (which currently has zero existing or proposed trail miles) and many of the lake WMAs in central and southern West Virginia: Elk, Burnsville, RD Bailey, Laurel, East Lynn. Other WMAs in service area gaps include Morris Creek, Wallback, Tug Fork, and Tomblin.

This analysis of West Virginia's existing and proposed trail system does have some limitations. There is likely some error in the trail network, including the completeness of both existing and proposed trail datasets, as well as in the manual selection of additional access points. Errors in the selection of additional access points are more probable in the Hatfield-McCoy and American Discovery Trail networks owing to their proximity (and occasional use) of the actual road network (resulting in too many intersections). Finally, there is some doubt as to the pedestrian use of motorized trails, particularly in the Hatfield-McCoy network of southern West Virginia. Pedestrians are legally permitted, but the shared-motorized environment is likely not conducive to walking and physical activity.

The "population within service area" figures in this study are more conservative than those in the methodology used by Kim and Nicholls (2016). They considered a census block group "served" if the centroid fell within the service area. This study used "entirely within" as the requirement for census blocks so that the population could be more confidently added to the "served" total.

As previously discussed, this analysis did not look at the "quality" of trails access. Beyond a bare minimum of access to a trail, there are lots of potential to understand choices among trails, the miles of trail available, or other trailside features or amenities related to user behavior and overall quality of life. Additionally, the service area of 10 miles used in this study represents driving length distances, which suggests the socioeconomic wherewithal to afford transportation. West Virginia's trail service area coverage decreases markedly below a

10-mile service area, with less than 10% of the state's population within a mile of a trail. More comprehensive research at the state and county scale could help planners better accommodate alternative transportation to trail access points, particularly in underserved communities.

Despite the aforementioned limitations, this study does make a contribution to the literature on the trail accessibility. First, much of research only focuses on accessibility issues related to a single trail or several trails, while few, if any, have examined trail accessibility at the state level. Thus, this study sets an example. Second, this study tested both population-to-park approach and park-to-population approach of accessibility estimation, finding the latter is better and suitable for West Virginia with a dispersed, low population density. This may inspire the use of this method for future studies that may be carried out in other states of the United States or beyond.

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