Methodology

Advancing Cleveland's Active Transportation Agenda

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About BikeAble™

Rails-to-Trails Conservancy's (RTC's) BikeAble™ tool is a GIS-modeling platform that analyzes the bicycle connectivity of a community to determine the best low-stress routes for bicycling between a set of user-specified origins and destinations. Stress-tolerance parameters are unique to each study region and are used to define the connectivity between origins and destinations specific to the needs of the community. The tool can also compare current scenarios with future scenarios to evaluate the potential impact of investments in trails and bicycle infrastructure on community connectivity. It also allows for population-specific assessments to identify inequities in the current bicycle network as well as opportunities to improve equitable access to trails in the community.

Assigning Level of Traffic Stress

The chief deterrent to riding a bike—and bicycle connectivity in a community—is the high stress of riding without protection from the danger of fast and heavy automotive traffic, or "traffic stress." Some streets have low traffic stress, while others have higher stress. Treatments such as separated bike lanes can sometimes mitigate most of the traffic stress; but at other times, even where there is bicycle infrastructure, riding in streets can be very stressful. In an international survey assessing the use of cycling as a mode of transportation, countries with high levels of cycling had separated bicycle facilities along heavily traveled roads and at intersections, combined with traffic calming (for example, narrow roads or speed bumps) of most residential neighborhoods.[1]

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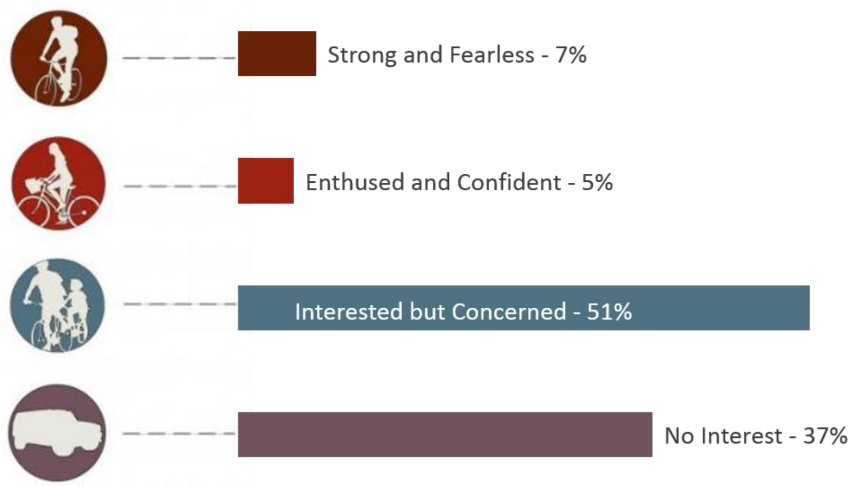
[1] John Pucher and Ralph Buehler. (2008). "Making Cycling Irresistible: Lessons from The Netherlands, Denmark and Germany." Transport Reviews, Vol. 28(4).

Various methods have been developed for rating the suitability of streets for bicycling; however, most of the methods have been limited in their effectiveness by factors such as burdensome data requirements, black-box formulas, inconsistencies, failure to account for the effects of intersections and the inability to gauge the positive effect of mitigating treatments such as protected bike lanes. The most effective method uses simple rules that rely on easily accessible data to classify streets into four traffic-stress levels.[2] The stress levels are linked to specific classifications of people based on their readiness to use a bike on a street network (Figure 1).[3]

Figure 1: The Four Types of Cyclists



BikeAble™ fully integrates level of traffic stress and calculates it as a function of the number of lanes and the speed limit of a route (Figure 2). The tool also evaluates the quality of bicycle facilities based on how likely a facility is to reduce stress. While bicycle facilities can reduce stress along a street, not all facilities reduce stress by the same amount. For example, a sharrow (a symbol of a bicycle with two chevrons above it, marked on a roadway to indicate that motor vehicles and bicycles are to share the lane) would reduce stress by very little, while a protected bike lane along the same street would reduce stress by a much greater amount (Figure 3).

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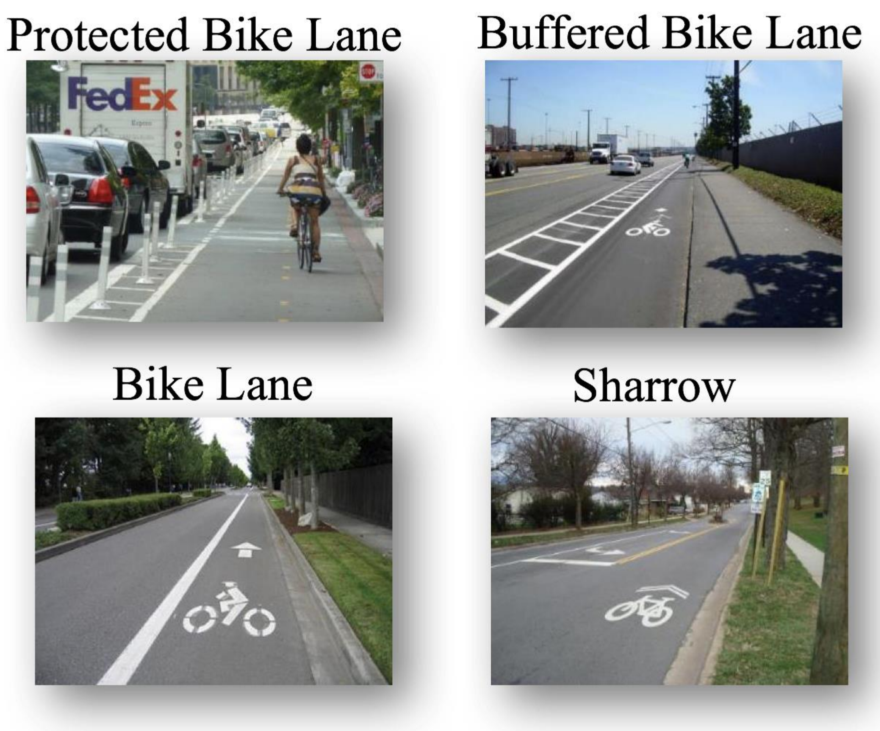
[2] Maaza C. Mekuria, Peter G. Furth, and Hillary Nixon. (2012). "Low-Stress Bicycling and Network Connectivity." Mineta Transportation Institute.

[3] Roger Geller. "Four Types of Transportation Cyclists." Portland Bureau of Transportation. https://www.portlandoregon.gov/transportation/article/158497.

Figure 2: Traffic Stress Factors

Figure 3: Bicycle Facilities



Other Factors Influencing Stress Assignment

- Intersections that require bicyclists to cross busy streets without signal protection are a significant factor for increasing traffic stress and a deterrent from using bicycles. BikeAble™ assigns stress to street segments based on the presence or absence of intersection accommodations such as traffic signals. For example, a traffic signal would reduce stress along adjacent streets.

- Barriers are areas within a bicycle network where people are unable to safely pass, requiring a bicyclist to find an alternate route or to ride out of the way to complete a trip. Barriers can include natural and manufactured features such as rivers, creeks, freeways, or interstates that are impassable by bike except with bridges or underpasses.

BikeAble™ Methodology

BikeAble™ applies the literature on level of traffic stress to better understand the needs of "interested but concerned cyclists" who represent a majority of the population.[4] These individuals are interested in cycling more frequently but are concerned about the safety of bicycle networks. They are mostly comfortable bicycling on low-speed local streets and off-street multiuse trails. Based on these cyclists' needs, BikeAble™ defines low-stress connectivity as accessibility to destinations using routes such as multiuse trails and bicycle facilities, and streets with speeds of 25 miles per hour or lower and two or fewer lanes. The tool generates a connectivity score for the geographic area studied that is a measure of low-stress connectivity between origins (residential parcels) and a "basket" of destinations within a search distance a cyclist is hypothetically willing to travel to reach the destination.

BikeAble™ studies are informed by the unique stress parameters of the geographic area being studied as well as five GIS data inputs, which are customized based on unique characteristics of the community:

1. Bicycle-trip origin points, defined as residential parcels
2. Selected destination points classified by type, which can include banks, grocery stores, pharmacies, post offices, etc.
3. Street network with roadway functional class (e.g., arterial versus residential), number of lanes, speed limit, bicycle facilities (if any) and trail network
4. Intersection points with traffic signals and other bicycle accommodations, such as medians
5. Digital elevation map

The study produces two key GIS outputs:

1. A connectivity score that indicates the percentage of residential parcels (or an equivalent measure) that can reach a predetermined (usually 60 percent) percentage of user-specified destinations
2. The flow of potential bicycle trips through the street and trail network from origins to destinations

BikeAble™ indicates that for an origin to be classified as "connected," it needs to meet the following criteria:

- It should be able to reach the target number of destination types within the search distance.
- The destinations should be accessible using low-stress routes within the search distance.

Neighborhood Inequality Analysis

To understand how low-stress bike connectivity relates to neighborhood inequality, the BikeAble™ tool is applied to examine the connectivity of a specific subset of origins within neighborhoods of inequality to desired destinations within 2 miles. A set of socioeconomic and demographic variables is chosen at the census block group level that together act as a measure of neighborhood inequality criteria, including:

- Concentration of the population living under the poverty line (30 percent or more)
- Concentration of the population unemployed (30 percent or more)
- Concentration of the population without a high school degree (20 percent or more)

[4] ibid

- Concentration of zero-car households (60 percent or less)
- Concentration of African-American population (75 percent African American)
- Concentration of Hispanic population (30 percent Hispanic)

The process of selecting origins use these six variables as defining factors of neighborhood inequality, as they align with equity and transportation disadvantage literature and are commonly used in transportation equity analysis.[5] There are multiple factors that could contribute to neighborhood inequality, such as age, gender, poverty level, income level, employment rate, level of education, car ownership rate, home ownership rate, disability status, segregation level and minority population (e.g., African-American, Hispanics, Asians, etc.)[6], in addition to other socioeconomic variables. In general, the higher the degree of each of these variables and the more number of variables that are concentrated in an area, the greater the neighborhood inequality tends to be.

To analyze the geographic distribution of these six variables, block groups received a "1" or a "0" for each variable, depending on whether or not the area met the neighborhood inequality criteria. If a block group scored a total of "3" or higher, it was included as a neighborhood experiencing inequality. Block groups that were spatial outliers were excluded. Block groups that were spatially encompassed by other block groups that scored a 3 or higher but did not meet three of the five variables were included due to their spatial correlation. This process helped visualize areas that have a clustering of the six defining variables of neighborhood inequality.

Applying BikeAble™ in the City of Cleveland

RTC is working to build the Industrial Heartland Trails Coalition—a trail network-building project that aims to create a world-class 1,500-miles-plus trail network that will stretch across 51 counties in four states—Pennsylvania, West Virginia, Ohio and New York—from the shores of Lake Erie to the confluence of the three rivers in Pittsburgh and on to the Ohio River and Appalachian foothills. Cleveland is an urban hub of the Industrial Heartland Trails Coalition's vision. RTC implemented BikeAble™ in Cleveland to better understand the current connectivity of the city, how neighborhood inequality might affect connectivity and how specific investments in trails and bike infrastructure could improve access to opportunities and connect people to places in the city.

Table 1 shows the stress tolerance parameters used for this study in Cleveland. The basket list and targets used for this study (Table 2) are representative of the types of destinations available in the city. The basket of destinations was determined from previous BikeAble™ analyses and in collaboration with partners. Public high schools, and select transit stops (RTA Rail and RTA BRT) were used as destination points in other sub-scenarios.

Table 1: Parameters used to define bicycling/walking stress tolerance for Cleveland

Comfortable speed limit (mph)	25
Comfortable number of lanes	2

[5] Todd Litman (2002). Evaluating Transportation Equity. World Transport Policy & Practice, Volume 8 (2), pp. 50-65.
[6] Sandra Rosenbloom and Alan Altshuler. (1997). Equity Issues in Urban Transportation. Policy Studies Journal, pp. 29-39.

Maximum travel distance (miles)	2

Table 2: Basket of Destinations

Destinations	Desired Number
Amusement and Recreation	3
ATM	1
Bank	2
Beauty Salon and Barber Shop	2
Cafes and Bakeries	1
Child Care	2
Clothing and Accessory Store	2
Colleges and University	1
Convenience Store	1
Courier and Postal Service	1
Drinking Place	5
Eating Place	10
Electronic Store	1
Elementary and Secondary Schools	2
General Retail Store	2
Hardware Stores	1
Health Care Provider	2
Hospital and Clinics	1
Library	1
Movie Theater	1
Office and Home Furnishings Store	1
Public Park	2
Pharmacy	1
Physical Fitness Facility	1
Small Grocery Store	2
Supermarket	1

Cleveland Neighborhood Inequality Analysis

Using a detailed inventory of Cleveland's existing and future bike infrastructure and basket of destinations, RTC applied the BikeAble™ tool to discover the level of connectivity via low stress bike routes—based on the actual street network. An emphasis was placed on low-stress routes—those with speeds lower than 25 miles per hour (mph) and no more than two lanes. Measuring connectivity using the street network instead of straight-line (Euclidean) distance is important because it enables the identification of barriers, including bridges, tunnels and high-stress routes—streets with speeds more than 25 mph and more than two lanes—that make it difficult for people to access destinations via a low-stress route, even if they live nearby.

In order to effectively compare study outcomes between all residents in Cleveland and those living in neighborhoods experiencing inequality, parcel-level data was selected from the block groups that met the neighborhood inequality criteria. Using the same unit of analysis (parcels) allowed comparison between the connectivity scores for all residents and for the specific neighborhoods experiencing inequality.

Local Partner Collaboration

Throughout this project, RTC communicated and collaborated with local Cleveland partners, particularly Bike Cleveland, whose mission is to "creating a region that is sustainable, connected, healthy, and vibrant by promoting bicycling and advocating for safe and equitable transportation for all." Collaboration focused on determining the parameters and variables for this analysis. Partners helped vet the input data and the analysis results to ensure the inputs were sound and the results were clear. More specifically, partners helped refine which socioeconomic and demographic characteristics should be included in the analysis that best characterized neighborhood inequality in the City of Cleveland. They also helped vet the street, bicycle facility and trail network for accuracy and appropriate traffic stress level.

Data Sources

RTC compiled and utilized a myriad of data sources for this analysis. Data files and sources are listed below.

Data	Source
Street Network	Open Street Map/Cleveland Centerline Street Data
Trail Facilities	Rails-to-Trails Conservancy/ Northeast Ohio Areawide Coordinating Agency (NOACA)
Bicycle Facilities	NOACA
Residential Parcels	Cleveland Data Portal, City of Cleveland
Block Group Equity Variables	U.S. Census/TigerLine, ESRI Business Analyst
Traffic Signals	Open Street Map
Transit Stations	Greater Cleveland Regional Transit Authority (RTA)
Public High Schools	City of Cleveland
Key Destinations	ESRI Business Analyst