Transit Deserts in Durham, North Carolina and Opportunities for Increased Transit Service

Prepared for: GoDurham and the Center for Advanced Hindsight

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Introduction

Since the early 20th Century, the automobile has served as America’s preferred transportation mode and for decades, state, local, and federal policymakers have crafted policies to accommodate and even incentivize car ownership. But some communities, particularly minorities and people of color, have not always felt the benefits of the automobile or the interstate highway system. In their book about the U.S. highway system, Rose and Mohl (1979) write that “rebuilding of the central city in many cases came at the expense of African American communities in the inner cities, whose neighborhoods—not just housing but churches, schools, business districts, even entire urban renewal areas—were demolished in the process of Interstate construction.” Bus systems are an important resource for many communities, especially those where many cannot afford to buy an automobile. And while the Biden administration recently made the case for $85 billion in spending on the country’s transit system in the American Jobs Plan, the U.S. transit system has historically received a fraction of the support from federal officials that the highway system has.

Today, observers credit Urban Renewal and the creation of the Durham Freeway with effectively uprooting 4,000 families from Durham’s minority communities like the Hayti neighborhood. And while this history is not new to local residents, local advocacy groups like Bike Durham have stressed that any conversation around the county’s contemporary transportation system – be it automobiles, transit, bicycle and pedestrian, or rideshare services – must acknowledge that Durham’s transportation system was designed with little regard for the well-being of its minority population.

Today, the automobile remains the leading transportation mode in Durham County. Just over 85 percent of locals commuted to work via car, truck, or van in the county, according to
2018 American Community Survey data, and over 77 percent drove alone. Comparatively, just
3.3 percent of residents used public transportation to get to work and only 3 percent walked.\(^7\)
And while public transportation represents a relatively small segment of Durham’s overall
transportation network, a 2019 GoDurham passenger survey found that 65 percent of riders were
African American, 6 percent were Hispanic, 7 percent were Asian, and 16 percent were White,
meaning that service changes are likely to have an outsized impact on minority groups.\(^8\)

At the same time, the debate over the future of Durham’s transportation system is alive
and well today. Notably, a proposed light rail project between Durham and Chapel Hill lost
momentum in 2019 after Duke University withdrew support.\(^9\) In the Fall of 2020, Bike Durham
alongside other local advocacy organizations kickstarted a Transit Equity Campaign to ensure
that minorities and low-income communities have a seat at the table throughout the development
of Durham County’s Transit Plan.\(^10\)

In recent years, GoDurham has unveiled programs to provide increased bus access to
vulnerable populations. In 2018, for example, GoTriangle launched the Youth GoPass, which
gave teenagers (13-18) the ability to ride the service free of charge.\(^11\) And in 2019, the agency
created a similar program for seniors 65 and above.\(^12\)

For this project, I developed a transit equity index on behalf of GoDurham, the local
transit agency in Durham county, and used it to identify transit deserts. In this study, the transit
equity index is a tool used to measure the quantity (or supply) of transit service across the county
and helps identify what census tracts may benefit from greater service. GoDurham manages 24
transit routes across the county and as recently as 2016 supported more than 5.9 million
riders.\(^13\)\(^14\) I used the transit equity index to answer the following question: **Are there “transit
deserts” in Durham County and what should GoDurham do to provide better service to**
those areas in the future? A transit desert is a region where there are relatively high levels of transit need – whether because of limited car ownership, sizeable elderly populations, high poverty, or some other factor – but a dearth of transit service.\textsuperscript{15} While the term “desert” implies there is no service, for the purposes of this study, I define a transit desert as a census tract where there is very little transit service relative to other census tracts. Since Covid-19 upended transit ridership across the country in the last year, local agencies have had to consider how to adjust service to best meet passengers’ needs. This study provides an opportunity to identify gaps in service coverage, which may help inform future transit planning efforts at GoDurham as ridership begins to return to normal levels in the months ahead.

In this study, I examine two time periods, February 2019 and February 2020, to measure the impact service changes that took effect in late January 2020 had on transit access in Durham County. This work focused mostly on GoDurham routes but also included some GoTriangle routes that travel through Durham.\textsuperscript{1} In my analysis, I used the following variables: (1) the number of bus stops located in each census tract, (2) average weekly bus ridership within each census tract, and (3) the number of bus trips that serve each individual census tract each week.

The map in Figure 1 below illustrates the location of GoDurham and GoTriangle bus stops in Durham County in February 2020. Census tracts are labeled by their assigned number. The dark blue regions indicate census tracts where high percentages of households do not have access to a vehicle.

\footnotesize{\textsuperscript{1} In 2010, Triangle Transit formally partnered with the Durham Area Transit Authority to assist with daily operations. In 2015, the two bus services were officially renamed GoTriangle and GoDurham, respectively. For more information, see: “About & History” \url{https://godurhamtransit.org/about}}
Figure 1. Durham census tracts and bus stops (February 2020).
Methods

For this project, I devised a Transit Index to measure and quantify overall supply of transit service in Durham, North Carolina during February 2019 and February 2020. The index is a summation of total bus stops per census tract, average weekly ridership per census tract, and the number of bus trips that serve each census tract in a given week. Each census tract receives an individual Transit Index Value. I then employed the CDC’s Social Vulnerability Index to identify census tracts in Durham where a large portion of the population does not own a vehicle. With this information, I could then identify tracts with high demand but limited supply of transit.

In this analysis, Transit Index Values range from 0 (no service) to just over 6,604 (high service) in 2020. That same year, the mean value was 2,328.4, and the median value was 2,386.7. Census tracts were considered to have either “moderately low” or “low” supply when their overall Transit Index Value was less than 1,981.25. Census tracts were considered to have high demand when the percentage of households without access to a vehicle was higher than 10.5 percent, which was determined by the CDC’s Social Vulnerability Index. I do not consider tracts to have high transit demand when the percentage of households without access to a vehicle is less than 10.5 percent. Census tracts had to have high demand and either “moderately low” or “low” supply to be considered a transit desert.

As I mentioned, I draw a distinction in this analysis between census tracts with “low” and “moderately low” Transit Index Values because sometimes census tracts’ Index Values varied widely. Therefore, census tracts with Index Values below 1,981.25 were considered to have “moderately low” service while census tracts with Index Values below 990.62 were considered to have “low” service. In this paper, census tracts are said to have characteristics of transit
deserts, so long as they have high transit demand and either “moderately low” or “low” transit supply.

Results/Key Takeaways

The purpose of this study was to identify whether Durham residents, particularly those with limited or no access to personal vehicles, have adequate transit service in the census tracts where they live. This analysis finds that:

- **Six census tracts have characteristics of transit deserts.** They include: census tract 17.08, 17.11, 18.02, 3.01, 3.02, and 9. All tracts with characteristics of transit deserts have some transit supply. The map in Figure 2 below illustrates the location of each census tract in Durham and the level of transit supply within each census tract.

- **Among the six census tracts with characteristics of transit deserts, four have “moderately low” service and two have “low” service.** For example, tracts 17.08 and 3.01 have low service while 17.11, 18.02, 3.02, and 9 have “moderately low” service. These classifications were necessary because the level of need between census tracts varied widely; tracts with “low” service are considered most in need of more transit options.

- **Some high demand census tracts are well served by the current transit system.** Census tract 23 has an Index Value of 4,348.7, a relatively high score. The same is true of census tract 15.02, which has an Index Value of 5,780.5.

- **Some census tracts with high transit demand lost service when GoTriangle implemented service changes in 2020.** For example, census tract 3.01, which is a historically African American neighborhood, witnessed a dramatic drop in its Transit Index Value from 1,282.6 in 2019 to 677.4 in 2020. Additionally, census tract 10.02, where 24.7 percent of households do not have access to a vehicle, witnessed a drop in its Transit Index Value from 7,032.8 to 5,444.7. This loss of service was due to a decline in the number of bus stops in that census tract, a fall in its average weekly ridership, and a drop in the number of bus trips that serve the tract.

- **A handful of census tracts have no transit service, but they also have low demand for it.** Census tracts 18.08, 16.04, 19, 20.20, and 21 do not have any bus stops located within their boundaries. However, these tracts are located in areas where the percentage of households without a vehicle are very low (less than 3 percent).
Figure 2. A map of Durham County that illustrates each census tract’s Transit Index Value in February 2020. Tracts with the highest service are shaded in dark green.
Landscape Analysis/Literature Review

Transit equity is a central theme in transportation policy conversations both in and outside the academic literature. Litman (2006) classifies equity as “the fairness with which impacts (benefits and costs) are distributed”.16 Equity is codified in U.S. government funding protocols as well. In fact, the Federal Transit Administration (FTA) mandates that transit agencies that serve communities with more than 200,000 people and that receive federal funding demonstrate that planned schedule and route changes will not have an outsized adverse effect on marginalized groups.17

Two types of equity are featured prominently in the transit literature: vertical and horizontal equity. Litman describes horizontal equity as “the distribution of impacts between individuals and groups considered equal in ability and need”, compared to vertical equity which is “the distribution of impacts between individuals and groups that differ in transportation ability and need”.18 For this report, I focus on vertical equity because I’m interested in examining how transit service is allocated across different areas of the county and across different demographic groups.

Another term related to equity is “transit-richness”. Wang and Woo (2017) define transit-rich neighborhoods as those “within a one-half mile radius of a transit station”.19 In other words, transit-richness is determined based on proximity to transit services. Pollack, et al. (2010) examined whether there was a noticeable impact on transit usage in forty-two “newly transit-rich neighborhoods” (TRNs) from 1990 to 2000 in places where new rail transit facilities had been built. The authors found that in roughly two-in-five of the TRNs, “public transit use for commuting actually declined relative to the change in transit use in the metro area once the new station opened”.20 These findings suggest that proximity to transit does not necessarily lead to
higher usage or ridership. Pollack, et al. argue that in some instances, other factors may be at play such as rising home prices, which may “drive out lower income families who are more likely to use public transit”.21

There are many ways to measure transit equity. Delbosc and Currie (2011) detail their employment of a Gini coefficient – a tool commonly used to calculate income inequality – to assess “the distribution of public transport supply across population and employment in Melbourne, Australia.” 22 23 Ultimately, the authors conclude that a substantial portion of the city’s residents (70 percent) share less than a fifth (19 percent) of transit service in the city.24 Similarly, Cao et al. (2018) utilized a transit-oriented Gini coefficient to examine transit accessibility in Guangzhou, China.25 While I did not use a Gini coefficient in my analysis, these studies are notable in part because they underscore how research tools that have historically been applied in one area of study can be repurposed and applied in other contexts.

One way to estimate the areas in a region that are underserved by transit is to identify the places where desire for transit outstrips the quantity available. Allen (2018) refers to these regions as transit deserts, which she argues, “… exist where there is a demand for public transportation but little, inefficient, or none exists.”26 Jiao and Dillivan (2013) offer a way to quantify areas within a community where transit supply falls short of meeting demand, which they also refer to as “transit deserts”. The authors borrowed a formula from the U.S. Department of Transportation to approximate transit demand (which in the study is referred to as “transit-dependent populations”) by census block in four U.S. cities. They then estimated transit supply using four variables, including: the amount of bus and rail stops per Census block, frequency of bus and rail arrivals per Census block, total routes per Census block, and bike path and sidewalk distance.27 Jiao and Cai (2020) use a similar approach to examine transit deserts in four Chinese cities, including
Beijing, Shanghai, Wuhan, and Chengdu. The authors conclude that “most of these cities have a high concentration of transit desert areas in the central urban areas.” I used some of the same variables in my analysis described previously in this paragraph.

Pedestrians are typically willing to travel between a quarter and a half mile to access transit, according to the Federal Highway Administration. An examination of recent research underscores potential barriers, including proximity, some communities face that prevents them from benefiting from transit as well as the important role public transit can play in connecting people to health services and employment. Kotval-K (2017) sought to measure senior citizens’ proximity to bus stops in Lansing and East Lansing, Michigan. The author concluded that “a relatively large amount of blocks with high density older adult residents are not included within the 183-metre buffer area” which indicates that many seniors would have to travel more than that distance to access a bus. The author noted, however, that a larger share of this demographic is located within 305 meters or 402 meters of a bus stop. Additionally, Transit Land, an open-source website that focuses on collecting and creating maps and visualizations using GTFS data, now offers a tool on its site that allows visitors to view census demographic data through the lens of residents’ proximity to specific bus stops and transit lines. While I did not measure how far Durham residents live from transit stops in my analysis, studies like this one are of interest because they raise important questions about proximity and access that are critical to any discussion of transit deserts. For the purposes of my research, I assumed that if a bus stop is within the boundaries of a census tract, it is accessible to the residents of that census tract.

Kotval-K et al. (2020) also analyzed the connection between transit services targeted at people over 65 and access to “preventative healthcare services” in Michigan. In qualitative interviews that were part of the study, the author cites a range of challenges in using transit to
connect seniors to healthcare services, including lack of awareness of transit services, hurdles in making a reservation, and “[t]he sheer size alone of the older adult population that needs to be served”.32

Holzer and Wissoker (2001) analyzed survey data from businesses in four U.S. cities about employing women participating in welfare. They found that struggling to find transportation was one of the key factors (along with childcare and health issues) leading to absenteeism. Notably, the authors also mention that businesses based in the suburbs or stationed far from transit systems “experience greater difficulties with such absenteeism than those located in the central cities or nearer to transit”.33 The implication, therefore, is that proximity to transit is not just a concern for employees that rely on it, but employers as well.

However, the impact of transit access on employment is not always clear. Blumenberg and Pierce (2014) used data collected during the Department of Housing and Urban Development’s Moving to Opportunity program to consider whether having a car or public transit as transportation options had a meaningful impact on job prospects. Not surprisingly, the study finds that having an automobile as a transportation option was “strongly correlated with finding employment and being employed at baseline and interim.”34 At the same time, living near transit does not have a meaningful impact in helping people get a new job, according to the authors. But it does “greatly raise the probability of having consistent employment.”35

The literature also indicates that access to transit does not always lead to positive employment outcomes. Sanchez et al. (2004) explored the impact “access to public transit and regional employment” can have on Temporary Assistance for Needy Families (TANF) participants based in Atlanta, Baltimore, Dallas, Denver, Milwaukee, and Portland, OR. The study ultimately concluded that program participants “with relatively higher levels of transit and
regional employment access were not more likely to find employment and leave public assistance compared with other TANF recipients.”36 This finding suggests that transit is not a panacea and improved access to transit cannot on its own lift people out of poverty. Instead, transit is one of many tools that policymakers can employ to assist vulnerable populations.

Smart and Klein (2018) applied the Panel Study of Income Dynamics, a “nationally representative panel data set”, to shine a light on transportation’s impact (including automobiles and transit) on income between 1999 and 2015. The authors argue that for people who use transit that do not already own a car, greater employment access can lead to as much as six percent higher wages.37 At the same time, transit does not appear to result in any income benefits for people who already own an automobile. Additionally, the study indicates that having transit as a transportation option does not impact “the likelihood of being employed”.38 Studies like this one highlight the fact that transit’s impact is not consistent across society. And while for some communities, transit can serve as a lifeline and means of ascent, for others, it has little noticeable effect.

Transit Indices

Quality of service can be measured in many different ways. It can be the number of bus stops in a specific region, the on-time performance of a specific bus route, the state of bus stop amenities, or even how far the average rider lives from a transit stop. Regardless of the metric, quality of service is a way to measure how well a transit agency is serving its customers. If we know how well a transit agency is serving riders, we can pinpoint where there are shortcomings in service and ultimately propose solutions to fill those gaps. In my analysis, the quality of service is measured by the quantity, or level of supply, of transit service.
Recent reports from GoTriangle provide some indication of the ways the agency is already measuring how well it is serving its riders. For example, GoTriangle’s FY2018 Annual Bus Service Performance Report focused on three factors, including: daily boardings, boardings per revenue hour,² and on-time performance.³⁹

There are other ways to measure whether or not a system is meeting riders’ needs. For example, the city of Oakland, California developed an *Equity Indicators Report*, which is a tool to help “better understand the impacts of race, measure inequities, and track changes in the disparities for different groups over time.” The index contains three indicators within the Transportation and Infrastructure topic, including: access to a car, bus frequency, and curb ramps.⁴⁰

The USC Equity Research Institute and PolicyLink developed the National Equity Atlas, which measures how equitable cities and states are across the country using a range of topics, including demographics, economic vitality, readiness, and economic benefits. The Atlas identifies equitable communities as places “where all residents — regardless of their race, nativity, gender, or zip code — are fully able to participate in the community’s economic vitality, contribute to its readiness for the future, and connect to its assets and resources.” The Atlas estimates that as recently as 2017, 13 percent of minority households in Durham did not have a vehicle compared to 4 percent of White households. That same year, the Atlas reports that the average commute to a job took 24 minutes for minority groups compared to 21 minutes for White residents.⁴¹

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² GoTriangle defines this indicator as “how cost-effective is this service compared to others?”
Smart Growth America developed a Pedestrian Danger Index to identify the states and metropolitan statistical areas that pose the greatest risk to pedestrians. North Carolina is the 13th “most dangerous state” for those commuting by foot, according to the index. The index value is quantified by dividing total pedestrian fatalities by the local population, multiplying by one hundred thousand and then dividing the result by the percentage of people that commute by foot to their job.42

In 2019, the Port Authority of Allegheny County (PAAC), which serves the area in and around Pittsburgh, Pennsylvania, released a revised “Equity Index of Mobility Need” to pinpoint communities that have the highest need for transit service in the region. The PAAC collected Census block group and tract data about specific marginalized communities, such as those with disabilities, households that do not own a vehicle, and households with people 65 and older, among others. To quantify where people without a vehicle live in the area, PAAC used census data from the 2016 American Community Survey to identify the proportion of households within census tracts that fit this description. From there, the authors assigned every census block a grade between 0 and 1, which was later used to generate an equity score.43

Additionally, the Centers for Disease Control maintains the Social Vulnerability Index, which aims to aid officials in determining “communities that will most likely need support before, during, and after a hazardous event.” The CDC’s index relies on data from the American Community Survey (2014-2018) to gauge how vulnerable communities across the country are. It uses data at the census tract level and allows researchers to compare census tracts within states based on their level of vulnerability. The index “ranks the tracts on 15 social factors”, including: below poverty, unemployed, income, no high school diploma, aged 65+, aged 17 or younger,
older than 5 with a disability, single-parent households, minority, speaks English “less than well”, multi-unit structures, mobile homes, crowding, no vehicle, and group quarters.44

The indexes described in this section underscore a range of variables that can help researchers and policymakers identify where there might be high-levels of need in a community. There is no single cause of poverty or inequity and, therefore, no single indicator or variable can tell the full story. In the next few pages, I will provide more detail on my index and outline my approach to identifying transit deserts in Durham.

Methodology

Transit Index Value. I created an index to estimate available “supply” of transit services in Durham County in February 2019 and February 2020. Each census tract has an individual Transit Index Value, which is an estimate of total transit supply in that tract. I measured transit supply by summing: (1) the total number of bus stops per census tract, (2) the total number of average weekly bus riders per census tract, and (3) the total number of bus trips that serve each census tract each week. To determine whether a census tract is a transit desert, I identified tracts where overall transit supply was low but demand (which was determined by the CDC’s social vulnerability index) was high.

Bus Stops. For this project, I downloaded General Transit Feed Specification (GTFS) data from the OpenMobilityData website, which houses historical transit feed data for GoDurham and GoTriangle along with many other transit agencies.45 The GTFS data provides bus stop location information (including latitude, longitude, stop name, etc.). Since GoDurham and GoTriangle share bus stops on some routes, I removed duplicate bus stops (identified by stop_code) so that I could avoid double counting bus stops in each census tract. I later created a
Pivot Table to calculate the number of bus stops in each individual census tract across the county.

**Average Daily Ridership.** I also incorporated average daily ridership figures (at the individual bus stop level) for February 2019 and February 2020 into my analysis, which GoTriangle’s data scientist shared with me. Daily ridership figures at the individual stop level could not be obtained. To estimate average weekly ridership for each bus stop in February 2019 and 2020, I multiplied the average daily boardings for the average weekday (“Wkdy On”) by five, and then added the average daily boardings for Saturday and Sunday (“Sat On” and “Sun On”) to the result. I then built a Pivot Table in Excel to calculate the average total weekly ridership in each census tract across the county by adding average weekly ridership at each bus stop in each census tract. Note that these figures reflect average weekday, Saturday, and Sunday ridership for GoDurham and GoTriangle bus service before the outbreak of COVID-19 in the United States. Since this data was collected, average boardings may have changed due to changes in commuting habits.

**Bus Trips Per Census Tract.** To calculate how many bus trips serve each census tract during a given week, I used a method that GoTriangle’s data scientist shared with me that involved combining various GTFS text files in Excel from February 2019 and February 2020 and creating Pivot Tables to analyze the information. To view the steps, see Appendix A.

**CDC’s Social Vulnerability Index.** A key piece of my analysis was the CDC’s Social Vulnerability Index, which compares the relative vulnerability of individual census tracts within U.S. states and nationwide. The index compares census tracts using 15 indicators of vulnerability, including poverty and age. For this analysis, I focused on the variable “percentage of households with no vehicle available estimate” (EP_NOVEH) because it illustrates areas
across the county where access to transit may be most needed. This variable serves as a proxy for transit demand in this analysis.

**QGIS.** I relied on QGIS, an open-source geographic information system software, to plot and visualize the location of Durham’s bus stops. I then created a joined layer in QGIS, which allowed me to identify in which census tract each bus stop was located and export that information into an excel spreadsheet. From there, I could calculate the total number of bus stops as well as total average weekly ridership within each census tract.

**Criteria for a Transit Desert.** To be considered a census tract with characteristics of a transit desert, the percentage of households without access to a vehicle had to be higher than 10.5 percent, and it had to have a Transit Index Value of less than 1,981.25. These thresholds were determined by calculating 30 percent of the highest CDC’s SVI value in Durham County (which was 35 percent) as well as calculating 30 percent of the highest Transit Index Value in 2020, which was 6,604.16. This index ensured that those tracts identified as having characteristics of transit deserts were areas where more than one in ten households did not have access to a vehicle and transit supply for the tract was no more than 30 percent of the most heavily resourced census tract in terms of transit supply.

As I mentioned previously, there are two categories of low transit service: “moderately low” service which is any census tract whose Transit Index Value is below 1,981.25 and “low” service which is any census tract whose Transit Index Value is below 990.62.

1. **Results**

In this section, I outline the key findings from the analysis, including determining: (1) which census tracts in February 2020 have some characteristics of a transit desert; and (2) which
census tracts witnessed a positive or negative impact to their Index Value after GoTriangle implemented service changes in 2020.

Transit Deserts

According to the Transit Index Values, there are six census tracts in Durham County that fall into the category of “transit desert”, including census tracts 17.08, 17.11, 18.02, 3.01, 3.02, and 9. The maps in Figures 3 and 4 below depict images of Durham County moving from north to south. Each tract is labeled by its census tract number. As the color key illustrates, the darkest shaded tracts (in green) indicate a higher Transit Index Value and therefore greater transit supply in those areas.
Figure 3. An aerial view of Durham County census tracts, major freeways, interstates, lakes, and rivers.
Fig. 4. An aerial view of central and north Durham, including key neighborhoods, landmarks, and roads.

There are a handful of census tracts that have relatively low transit supply despite sizeable demand. In census tract 17.08, for example, roughly 13.5 percent of households do not have access to a vehicle, but the tract has only seven bus stops, an average weekly ridership of just over 512, and only 250 bus trips serve the tract each week, resulting in a combined Transit

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3 The data for the roads, highways, rivers, and lakes in Figures 3 and 4 were provided by Duke Library's Center for Data and Visualization Sciences.
Index Value of 769.4. Census tract 17.11 has more transit supply than tract 17.08; it’s Index Value lies at 1,823.7, not far below the transit desert threshold. As a tract where 13.8 percent of households do not have access to a vehicle, its transit supply is substantially greater than tract 17.08. According to this analysis, tract 17.11 is home to 22 bus stops, supports an average weekly ridership of 1,200.7 travelers, and more than 600 bus trips serve the tract each week. While tract 17.11 may be considered a transit desert according to this analysis, there are significant differences in terms of the amount of transit supply between tract 17.11 and 17.08; the former has “moderately low” service while the ladder has “low” service.

Table 1. Six census tracts in Durham County fall into the category of “transit desert” in February 2020.

<table>
<thead>
<tr>
<th>Census Tract</th>
<th>Percentage of Households w/o Access to Vehicle</th>
<th>Total Bus Stops</th>
<th>Average Weekly Ridership</th>
<th>Total Bus Trips</th>
<th>Transit Index Value</th>
<th>Level of Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.08</td>
<td>13.5</td>
<td>7</td>
<td>512.4</td>
<td>250</td>
<td>769.4</td>
<td>Low</td>
</tr>
<tr>
<td>17.11</td>
<td>13.8</td>
<td>22</td>
<td>1200.7</td>
<td>601</td>
<td>1,823.7</td>
<td>Moderately Low</td>
</tr>
<tr>
<td>18.02</td>
<td>11.8</td>
<td>32</td>
<td>857.6</td>
<td>677</td>
<td>1,566.6</td>
<td>Moderately Low</td>
</tr>
<tr>
<td>3.01</td>
<td>17.7</td>
<td>6</td>
<td>263.4</td>
<td>408</td>
<td>677.4</td>
<td>Low</td>
</tr>
<tr>
<td>3.02</td>
<td>13</td>
<td>12</td>
<td>958.0</td>
<td>408</td>
<td>1,378.0</td>
<td>Moderately Low</td>
</tr>
<tr>
<td>9</td>
<td>20.9</td>
<td>15</td>
<td>693.9</td>
<td>827</td>
<td>1,535.9</td>
<td>Moderately Low</td>
</tr>
</tbody>
</table>

Census tract 17.08 and 17.11 are also notable because of their location. Both census tracts are situated north of the Durham freeway and some distance from the popular attractions located
downtown such as the Durham Bull’s Baseball Stadium and American Tobacco Historic District. This finding is a reminder of the significant need for transit for communities outside the main downtown area. While there is undoubtedly a high-level of transit demand near Durham’s commercial downtown, there is evidence of some unmet transportation need beyond the city’s central business district.

Census tract 18.02 has an Index Value of 1,566.6 and a little less than 12 percent of households in that area do not have access to a vehicle. The analysis indicates that tract 18.02 contains 32 bus stops, supports roughly 857 riders on average each week, and 677 bus trips serve the tract throughout the week. Given the large number of bus stops in the tract and relatively high need for transportation support, one might expect average weekly ridership to be higher. Census tract 10.02, which is adjacent to tract 18.02, contains 33 bus stops, so it is possible that some residents of census tract 18.02 prefer to catch a bus in the neighboring census tract.

Census tracts 3.01 and 3.02 also fall under the transit desert category, according to this analysis, which is surprising given those tracts’ proximity to Durham’s downtown. Census tract 3.01 is home to Walltown, a historically African American Durham neighborhood as well as Northgate Shopping Mall. The social vulnerability index estimates 17.7 percent of households in tract 3.01 do not have access to a vehicle. According to this analysis, the tract has six bus stops, an average weekly ridership of 263.4, and it is served by 408 bus trips each week, resulting in a low Transit Index Value of 677.4. Given the high percentage of households without access to a vehicle and Walltown’s position as a historically African American neighborhood, it is surprising that it does not have more transit service. However, a relatively recent news report underscored how gentrification has begun to impact home prices in Walltown. As the demographics of the neighborhood have started to change, it is possible GoDurham has shifted
some of that service elsewhere. Similarly, 13 percent of households in census tract 3.02 do not have access to a vehicle, and the tract contains 12 bus stops, an average weekly ridership of 958, and it is served by 408 bus trips each week, resulting in an Index Value of roughly 1,378.

In census tract 9, almost 21 percent of households do not have access to a vehicle but its overall transit supply is moderately low. According to the analysis, tract 9 contains 15 bus stops, supports roughly 693 riders on average each week, and it is served by 827 bus trips each week, which results in an Index value of 1,535.9. Despite the tract’s proximity to downtown Durham and large percentage of transportation vulnerable households, the tract still has a moderately low supply of transit service compared to other areas.

Notably, there are several census tracts where a sizeable percentage of households do not have access to a vehicle but there is already a significant amount of transit supply. For example, the social vulnerability index indicates that 22.1 percent of households in census tract 23 do not have access to a vehicle, but the Transit Index Value associated with that track is 4,348.7 – a relatively high score. The same is true of census tract 15.02 where 20.1 percent of households do not own a vehicle, but the tract has an Index Value of 5,780.5. Census tract 10.02 is another tract with high demand for transportation services – 24.7 percent of households do not have a vehicle – but whose overall transit supply is high with an Index Value of 5,444.7. These findings are important because they suggest that some high-need tracts are well served by the existing system.

Census tracts 9801 and 15.03 were excluded from this analysis because the CDC’s SVI did not include an estimate for those tracts on the percentage of households that did not have a vehicle. Census tract 7 was also excluded from this analysis because it has a substantially larger number of riders that get on a bus at the stops in that tract compared to other census tracts and a
significant number of bus trips that serve that tract each week compared to other census tracts.

This is due to the fact that census tract 7 is home to Durham Station, which buses will leave from and return to regularly throughout the day, which inflates the index score.

Each blue dot in the scatter plots in Figure 5 below represents a census tract in Durham County. Each census tract is plotted using its Transit Index Value and the CDC’s estimate of households without access to a vehicle.

**Figure 5**

A snapshot of the Transit Index Values for each census tract in Durham in February 2019.
Six census tracts in February 2020 fell under the category of transit desert due to high demand and low supply.

Impact of 2020 Service Changes

As I mentioned previously, GoDurham implemented service changes to the system in late January 2020. In this analysis, I examined whether there was a notable change in transit Index Values between 2019 and 2020, which may be attributed to these service adjustments. In my analysis, I focus on census tracts where residents appear to have limited access to personal vehicles but still saw a steep decline in their overall Transit Index Value between 2019 and 2020.

Table 2. Examples of census tracts that lost service between 2019 and 2020.

<table>
<thead>
<tr>
<th>Census Tract</th>
<th>Transit Index Value 2019</th>
<th>Transit Index Value 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.01</td>
<td>1,282.6</td>
<td>677.4</td>
</tr>
<tr>
<td>3.02</td>
<td>1,846.8</td>
<td>1,378</td>
</tr>
<tr>
<td>5</td>
<td>3,875.3</td>
<td>2,746</td>
</tr>
<tr>
<td>10.02</td>
<td>7,032.8</td>
<td>5,444.7</td>
</tr>
</tbody>
</table>
Census tract 3.01, which is a historically African American neighborhood, witnessed a dramatic drop in its Transit Index Value from 1,282.6 in 2019 to 677.4 in 2020. The sudden drop in the Transit Index Value appears to have been due to a loss of 8 bus stops, a drop in average weekly ridership from 466.6 in 2019 to 263.4 in 2020, and a decline in the number of bus trips serving the tract each week from 802 in 2019 to 408 in 2020. Given that 17.7 percent of households in the tract do not have access to a vehicle, this drop in service is a concern and may be worth investigating further.

Census tract 3.02 also witnessed its Transit Index Value fall. It dropped from 1,846.8 in 2019 to 1,378 in 2020. The decline can be attributed to a loss of three bus stops, a drop in average weekly ridership from 1,223.8 in 2019 to 958 in 2020, and a fall in the number of total bus trips serving the tract from 608 in 2019 to 408 in 2020. Thirteen percent of households in tract 3.02 do not have access to a vehicle so this drop in service may have unintentionally impacted residents there.

In census tract 18.02, another area previously identified as having “moderately low” transit service, the Transit Index Value fell from 1,744.1 in 2019 to 1,566.6 in 2020. This decline appears to have been the result of a drop in average weekly ridership, which tumbled from 1,072.1 in 2019 to 857.6 in 2020. Notably, the number of bus trips serving the tract increased between 2019 and 2020 from 640 to 677.
A similar story is at play in census tract 5 where just over 21 percent of households do not have access to a vehicle. From 2019 to 2020, this tract observed a decline in its Transit Index Value from 3,875.3 to 2,746. This decline was due in large part to a loss of four bus stops between 2019 and 2020, a drop in average weekly ridership from 1,871.3 in 2019 to 1,291 in 2020, and a fall in the number of bus trips serving the tract each week from 1,982 in 2019 to 1,437 in 2020.

Census tract 10.02 where 24.7 percent of households do not have access to a vehicle witnessed a drop in its Index Value from 7,032.8 to 5,444.7. This drop was due to a few factors, including: a decline in the number of bus stops in that census tract from 37 in 2019 to 33 in 2020, a decline in its average weekly ridership from 5,960.8 in 2019 to 4,571.7 in 2020, and a drop in the number of bus trips that serve that tract throughout the week from 1,035 in 2019 to 840 in 2020. Census tract 15.01 is another area that saw a steep drop in its Index Value between the two time periods. In 2019, this tract, where 20.6 percent of households do not have access to a vehicle, had an Index Value of 6,491.2, but this figure fell to 4,127.1 by 2020. This drop in the Index Value can be attributed largely to a sizeable drop in its average weekly ridership (falling from 4,132.2 in 2019 to 2,541.1 in 2020) and a significant drop in the number of bus trips that serve the tract each week (2,335 in 2019 and 1,563 in 2020).

Some tracts with even higher percentages of households where no vehicle was available witnessed significant losses in transit service between 2019 and 2020. For example, census tract 14 where in 31.7 percent of households no vehicle is available, it saw its Index Value fall from 3,354.3 in 2019 to 2,687.6 in 2020. This drop in the index score can be attributed almost exclusively to a drop in average weekly ridership from 2,528.3 in 2019 to 1,862.6 in 2020. While this analysis does not identify the specific reasons that may have led to this decline, such a sharp
decrease in average weekly ridership is worth exploring further. A similar pattern emerged between 2019 and 2020 for census tract 11 where in 35 percent of households there is no vehicle available. The tracts Index Value fell from 5,746.9 to 4,695.6 in 2020, which according to the analysis occurred largely because of a drop in the average weekly ridership from 3,710.9 to 2,815.6 in 2020. Notably, these two tracts are adjacent to one another, extend north and south of the Durham Freeway, and are near the American Tobacco Historic District, one of the economic centers of the county. While both tracts maintained relatively high Transit Index Values despite the drop in ridership between 2019 and 2020, the cause of this decline is worth investigating further.

Some census tracts witnessed a slight decline in their overall Index Value but the reasons for that decline are not totally clear. For example, census tract 17.09 (where 22.8 percent of households do not have a vehicle available) saw its Index Value fall from 2,670 in 2019 to 2,496.3 in 2020, a relatively small decline in service. After examining the results, it appears the tract actually saw an increase in the number of bus stops between 2019 and 2020, rising from 45 to 48, and the number of bus trips that service the tract each week only fell from 628 to 627, a minor difference. However, average weekly ridership actually fell from 1,997 to 1,821.3. Census tract 10.01 also lost some service, including three bus stops. Its average weekly ridership dropped from 2,004.9 to 1,627.3, while the number of bus trips serving the tract barely rose from 1,235 to 1,239.

There are also census tracts that gained service after the service changes took effect, according to the index. For example, census tract 15.02’s Index Value increased from 5,078.7 to 5,780.5. Even though the tract lost two bus stops, its average weekly ridership jumped from 3,282.7 to 3,892.5 and the number of bus trips serving the tract each week rose from 1,761 to
1,855, which boosted its Index Value. Census tracts 13.01, 13.03, 13.04, 17.08, and 17.11 also saw a rise in their Transit Index Values, however, the gains to those tracts’ overall quantity of service were marginal.

Low Supply, Low Demand

Using 2020 GoDurham and GoTriangle GTFS data, I identified five census tracts where there are no bus stops, including: tracts 18.08, 16.04, 19, 20.20, and 21. However, these tracts are not considered transit deserts because they are located in areas of the county, according to the CDC’s social vulnerability index, where the percentage of households without a vehicle are very low (less than 3 percent). Unsurprisingly, these tracts lie geographically on the outer edges of Durham county.

Discussion/Recommendations

The following includes recommendations for GoDurham and the Center for Advanced Hindsight based on the key findings from this analysis. However, these recommendations are intended to inform the ongoing discussion surrounding Durham’s Transit Plan, and I hope local government officials, policymakers, and advocates can also use this research to support their ongoing work and initiatives aimed at better understanding local transit needs and expanding service for vulnerable communities.

1. **Broaden research lens to include other vulnerability indicators.** I used only a single variable from the CDC’s social vulnerability index – the estimated percentage of households with no vehicle available – to identify census tracts in need of transportation support. But the CDC’s index includes information on poverty, language barriers, education along with many other indicators that could reveal additional findings that may
confirm or complicate this analysis. Future researchers examining transit access in Durham should explore how these results change depending on the lens used to measure demand.

2. **Increase service to census tracts with characteristics of transit deserts in Durham.** I identified a handful of census tracts with high demand for transportation services but limited supply, including census tracts 17.08, 17.11, 18.02, 3.01, 3.02, and 9. As the city of Durham begins to finalize its Transit Plan later this summer, it should ensure that these census tracts receive new bus stops (where appropriate) and more frequent service throughout the week.

3. **Expand partnerships with Lyft and Uber.** GoDurham established a partnership with Lyft to help transport passengers home as well as to a few other destinations from specific bus stops in East Durham. The program, known as East Durham Connect, offers subsidies to riders to help cover the cost of the Lyft ride. The service appears to run at least partially through census tract 18.02 along Holloway St., which notably was one of the tracts identified previously in this analysis as having “moderately low” service. GoDurham should consider expanding the program in census tracts further north where there may be additional demand for bus service like census tracts 3.01, 3.02, 17.08, and 17.11.

4. **Target future transportation studies and programs in census tracts with greatest transit need.** While this research does not identify any transit vulnerable census tracts in Durham without any access to transit service, there are some areas where service is limited. In the future, researchers and program evaluators could use the findings from this

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4 GoTriangle has a similar partnership, known as RTP Connect, with Lyft and Uber. Read more about it at “What is RTP Connect”? 
report to tailor the focus of their studies and analyses, whether it’s through resident surveys, pilot programs, or focus groups. For example, census tract 3.01 appears to have lost transit service in recent years. This tract encompasses the Walltown neighborhood, a historically African American neighborhood, in Durham. Future researchers should explore how transit habits and needs have changed in Walltown in recent years to determine whether transit service should be restored there.

5. **Opportunities to improve the methodology.** There are several ways future researchers could adjust and improve my methodology in the future. 1) In this analysis, I assume that a bus stop is accessible to a resident if she/he lives in the census tract where the bus stop is located. But some researchers have developed methodologies to measure how far away vulnerable communities live from bus stops. Future research should take into account this important feature because it will provide a clearer and more granular picture of the populations in Durham most in need. 2) My methodology does not consider how the total population size within each census tract influences the Transit Index Value in each census tract. Presumably, the higher the population of the tract, the more transit supply the tract would need to adequately serve those residents. Dividing the Transit Index Value by the total population of the census tract would allow researchers to observe whether each census tract’s Transit Index Value is low or high relative to how many people actually reside in that tract or neighborhood. 3) Finally, the Index Values in this analysis are comprised of a combination of transit variables, including location of bus stops, ridership, and bus trips. In future analyses, researchers should consider designing the methodology so that each variable is weighted equally when quantifying overall index scores.
APPENDIX A

To quantify the number of bus stops that serve each census tract in a week, I used the following formula, which Matthew Frazier, GoTriangle’s Data Specialist, shared with me. For clarity, the instructions have been adapted from an email correspondence.

1. Generate a joined layer in QGIS so that it shows which bus stops are housed in each individual census tract (by stop_id).
2. Upload the stop_times, stops, trips, and routes text files into an Excel workbook. They should be in separate tabs. Additionally, upload the joined layer created in step 1 into the same workbook.
3. Create a copy of the stop_times tab in the workbook and label it “census stop_times”.
4. In the “census stop_times” tab, insert a column and title it “census_tract”. Create a formula in Excel using Index/Match so that the census tract aligns with the appropriate stop_id.
5. Select “Data” and then select “Remove Duplicates”. Make sure only “trip_id” and “census_tract” are selected.
6. Create a new blank tab and paste the “trip_id” and “census_tract” columns into it. Label the new tab “census trips”.
7. Once again, use the Index/Match formula to align the “route_id” and “service_id” with the “trip_id”. You can then use the Index/Match formula to align the “calendar” text file with the “service_id” column. This will allow you to view the weekly bus schedule.
8. Use the information in the “census trips” tab to create a pivot table.
   https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/
12 “For those 65 or older, it’s now free to explore, travel, ride all over the Triangle.” GoTriangle. August 14, 2019. https://gotriangle.org/news/those-65-or-older
21 Ibid, 24.

24 Ibid, 1255.


29 “Chapter 4: Actions to Increase the Safety of Pedestrians Accessing Transit”. Federal Highway Administration. 

