

CMAP



GO TO 2040

UPDATE APPENDIX

Indicator Methodology



16. Appendix C: Access to Transit Documentation

In anticipation of the GO TO 2040 plan update, CMAP staff developed a new method of measuring transit accessibility as a means of determining the percentage of regional population and jobs with access to transit, one of the plan's indicators for measuring the progress of plan implementation. This document describes the methodology used to develop this measure and presents analysis results.

16.1 Measure Description

The transit accessibility metric included in GO TO 2040 is derived from a simple spatial analysis that relies on fixed buffers around bus stops and train stations (one-quarter mile and one-half mile, respectively) to define the accessible area. The land area ratio of buffered area divided by total area is then applied to the total population and jobs values for each Trip Generation zone (commonly referred to as subzones) to determine the final "accessible" values. This metric ostensibly measures the number of people who live and work within walking distance of fixed-route transit service, based on the underlying assumption that both population and jobs are uniformly distributed within the subzones. While this spatial buffering offers an easily-understood "back-of-the-envelope" estimate of transit access, mere proximity to transit is too simplistic a way to measure accessibility. Further, it says nothing about the transit service itself or about the variations in level of service offered throughout the region.

To measure the percentage of population and jobs in the region with access to transit as a means of tracking plan implementation progress, a new metric was developed – the Access to Transit Index. For a specific area, this index is intended to measure the relative level of access residents have to the transit system regardless of mode. The intent of this new index is to provide a more complete measure of how residents view access to transit by including multiple factors that contribute to one's perception of transit accessibility, while maintaining a metric that is still easily comprehended. The new index value is calculated from four component factors:

- Weekly frequency of transit service.
- Activities that can be reached via a single direct transit route.
- Proximity to a transit stop or station measured over the network.
- Pedestrian friendliness of the surrounding area.

The Access to Transit Index is a uniform measure of transit level of service available during an average week. It permits the tracking of changes in transit level of service over time and presents the results in an intuitive fashion. It also offers a universal comparison of the different service levels offered across the region. The inherent loss of some of the nuances in localized service is balanced against the ability of the index to provide a relatively simple way to compare transit service over a large area over time. This index also adheres to a number of tenets CMAP staff used in developing a revised set of performance measures for the GO TO 2040 plan update:

principally that the indicator use actual observed data rather than modeled values, that it is widely comprehensible and that the data are updated with sufficient frequency for the index to serve as a reasonable benchmark for measuring progress.

The index is not intended to measure the connectivity of the transit system as a whole, or the access to the region that the transit system provides. The index is not intended to reflect the actual transit service conditions one may encounter on a specific transit trip. It is also not intended as a means to evaluate the performance of the various transit operators nor is it a suitable tool for such an evaluation.

16.2 Data Description

Transit service for the region is analyzed using information provided in General Transit Feed Specification (GTFS) files. These are files developed and distributed by the transit operators themselves and use a standard format to provide route and schedule information to automated trip planning applications such as Google Transit. This measure analyzes transit data for the four major operators in the region: the Chicago Transit Authority, Metra, Pace and the Northern Indiana Commuter Transportation District. This metric analyzes fixed-route transit service only – meaning service along a prescribed route that operates on a fixed schedule. It does not include demand-responsive transit service or paratransit. The analysis also excludes seasonal and event-specific transit service that does not operate throughout the entire year. Examples of this type of service include express buses serving events at locations such as the United Center, Soldier Field, Wrigley Field, U.S. Cellular Field and Toyota Park, among others.




For this analysis, transit service attributes are summed at the subzone-level geography for the seven-county region. Subzones are quarter-section sized geographies that CMAP uses for household and employment forecasting; generally they are ½ mile by ½ mile square throughout the region. Subzones in the Chicago Central Business District (CBD) are generally ¼ mile by ¼ mile square due to the densities of activities and the street network in that area. For the transit accessibility analysis, buffers around the subzones were used to identify a reasonable transit service area. This was done to reflect that fact that transit stops located within a close distance of the subzone boundaries may be an acceptable choice to residents of the subzone. Due to their small size and the density of transit stops available, subzones in the CBD were buffered by a distance of 0.1 miles (equivalent to one Chicago city block). All other subzones were buffered by a distance of 0.25 miles, representing a distance that could be traversed by walking within a five-minute period, assuming a pace of three miles per hour.

Consolidation of bus stops into generalized locations

This analysis uses generalized bus stop locations representing composite levels of transit service. The GTFS files include information on the spatial location of every bus stop in the region, thus stops serving the opposite direction runs of the same bus route are physically located on different sides of the same street. Therefore, when service frequency values are attached to bus stops, it represents half of the service provided by the route because it only measures one direction. In order to place all stops (regardless of mode) on equal footing, a

method was employed to consolidate each pair of single-direction stops on every bus route into one physical location that represents the combined service of both directions. The underlying concept is that a passenger would perceive the bus stop pair as a single destination, regardless of which side of the street the stop was on. This concept was taken to the next level at intersections, where all stops at an intersection were consolidated into one location, based on the notion that travelers view an intersection containing multiple stops as one general location. During the stop consolidation process, the data integrity of each individual stop is maintained so that the individual attributes can be aggregated to the composite stop location and that the composite stop can be linked back to each of the individual stops that it represents. Figure 1 illustrates the process used to create generalized bus stop locations at an intersection.

Figure 1. Bus Stop Consolidation Process

<p>The intersection of Ashland Avenue and 74th Street is serviced by two CTA bus routes: Route 9 which runs north-south on Ashland, and Route 75 which runs east-west on 74th. Each route has two stops located at the intersection: the blue triangles designate the stops for Route 9 and the red triangles identify the stops for Route 75.</p>	
<p>The initial round of processing collapses the directional stops of each specific bus route into one location that represents the intersection, as denoted by the blue and red squares to the right.</p>	
<p>A final round of processing combines all bus stops associated with this intersection into one location, as represented by the purple circle in the graphic to the right. The data integrity of all of the individual stops is maintained so that the composite stop location can be linked to each of the individual stops that it represents.</p>	

The consolidated stops are used throughout the analysis process.

Access to Transit Components

Data files representing 2010 transit service were analyzed to develop a base year Access to Transit Index, consistent with the year GO TO 2040 was adopted. This information is presented in the body of this Indicators Appendix along with the description of this measure. Each of the four component factors was measured individually at the subzone level and an index value was assigned to each subzone. The overall accessibility index value is the average of the four factor

indices that were assigned to the subzone. The remainder of this section discusses the four component factors of the overall index.

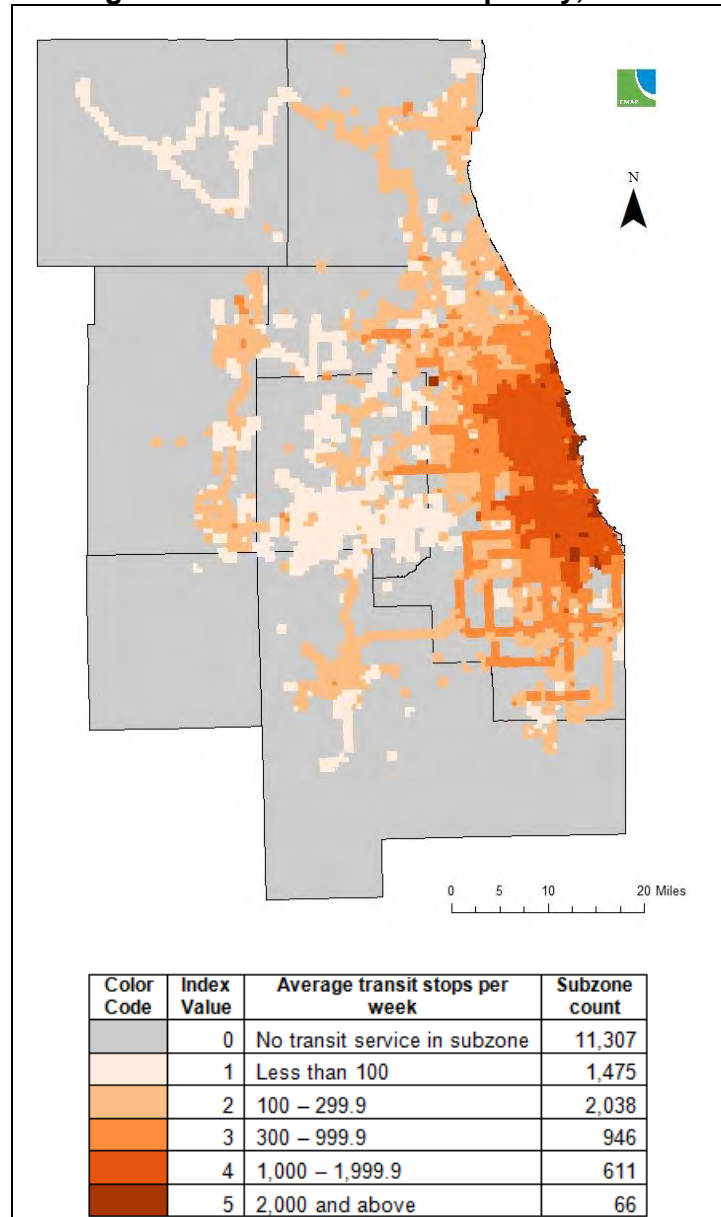
Average weekly transit service frequency

The transit service frequency component of the index measures the average number of times a stop in the buffered subzone area is visited by a fixed-route transit service vehicle during one week. The service frequency at the consolidated stop locations is the aggregate total of the service frequencies of the individual stops that comprise it.

Figure 2 shows the transit service frequency component of the overall index. The analysis methodology places all subzones without transit into Category 0, so that credit for this measure is only given if transit service is offered in the subzone. The subzones with transit service are categorized based upon actual service levels using the following categories developed by the Regional Transportation Authority based on the types of services that are operated in the Chicago region and Chapter 5 Section 2 of the [Transit Capacity and Quality of Service Manual \(TCQSM\) 3rd Edition](#):

- Category 1: Less than 100 stops per week – At the stop level, this generally represents infrequent commuter services in which passengers must consult transit schedules and adapt significantly to them. This service is operationally feasible in low density areas. Examples of this type of service include Pace routes 709 and 806.

Figure 2. Transit Service Frequency, 2010



Source: Chicago Metropolitan Agency for Planning analysis.

- Category 2: 100 to 299.9 stops per week – At the stop level, this generally represents moderately frequent commuter services in which passengers must consult transit schedules and adapt somewhat to them. This service is operationally feasible in low

density areas. Examples of this type of service include Pace route 330 and Metra's Rock Island District service.

- Category 3: 300 to 999.9 stops per week – At the stop level, this generally represents frequent commuter services in which passengers will likely consult transit schedule and adapt somewhat. This service is operationally feasible in low-to-moderate density areas. Examples of this type of service include Metra's Burlington Northern service and CTA route 84.
- Category 4: 1000 to 1999.9 stops per week – At the stop level, this generally represents relatively frequent urban service where it is not necessary to consult schedules due to the brief wait time for the next vehicle. This service is operationally feasible in moderately dense areas. Examples of this type of service include the CTA Orange Line and CTA route 9.
- Category 5: At least 2000 stops per week – At the stop level, this generally represents frequent urban service where passengers can wait without a schedule. This service is operationally feasible in high-density corridors.

Activities that can be reached via a single direct transit route

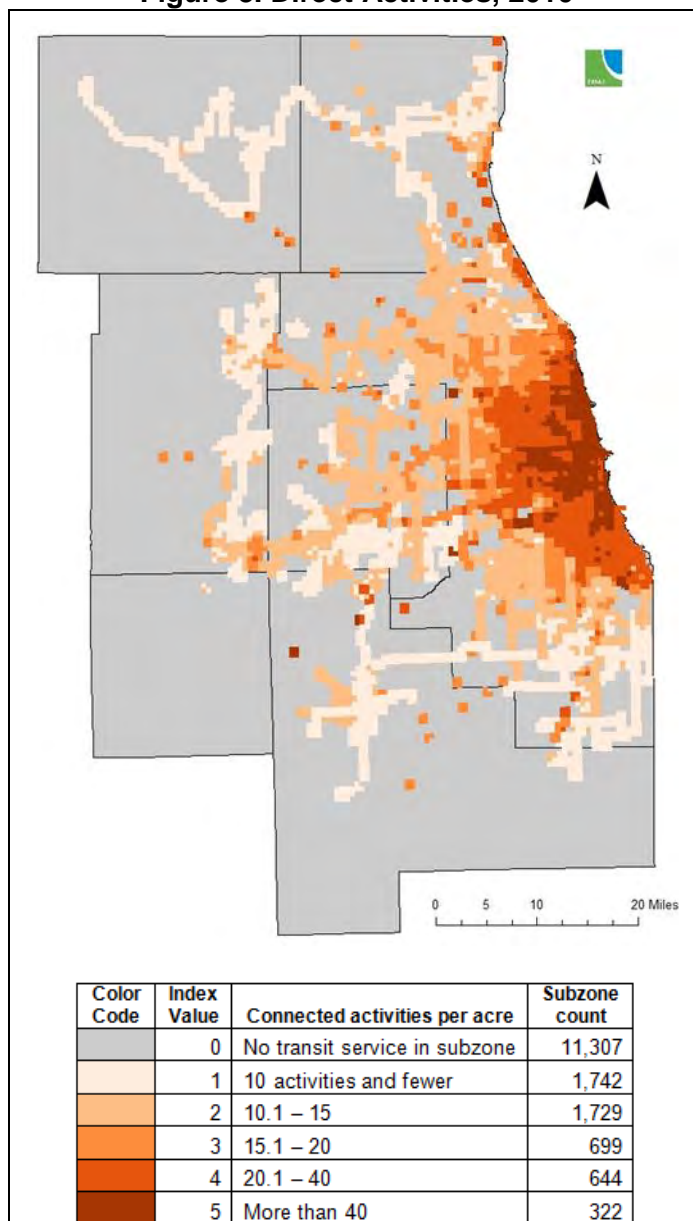
This component measures the relative value to individuals that transit service provides, measured in terms of the activities that can be reached from a subzone, using a single direct transit route. The assumption is that individuals deem a transit trip that reaches a destination without using a transfer as more accessible than one that does use a transfer. Activities are defined as the sum of the number of people residing in a subzone and the number of jobs located in a subzone. Reachable activities are calculated for each subzone by first finding all other subzones that can be reached from the buffered origin subzone using a single direct transit route. For each origin subzone, the reachable activities value is the activity density; i.e., the total activities that can be reached in the destination subzones divided by the total area of the destination subzones. The result is reported as direct activities per acre. This calculation is limited to only those destinations within the 7-county region. Figure 3 shows the direct activities index.

As with transit service frequency, all subzones without transit service are classified as Category 0. The remaining subzones are assigned to five categories of activity density, which were developed based on the ranges of densities derived from the U.S. Census Bureau's Public Use Microdata Areas.

Average proximity to transit

The proximity to transit measures the average distance one would need to travel to reach a transit stop, regardless of the mode of travel. This value is measured differently depending on whether or not the subzone being analyzed has transit service. For subzones containing transit stops, the measurement for each stop is the average network-based distance one must travel to reach that stop without encountering a closer stop. To calculate this value, a catchment area is created for each stop which represents all locations that are closer to that particular stop than to any other stop. An average distance is assigned to the stop based on the shortest distances to all

Figure 3. Direct Activities, 2010



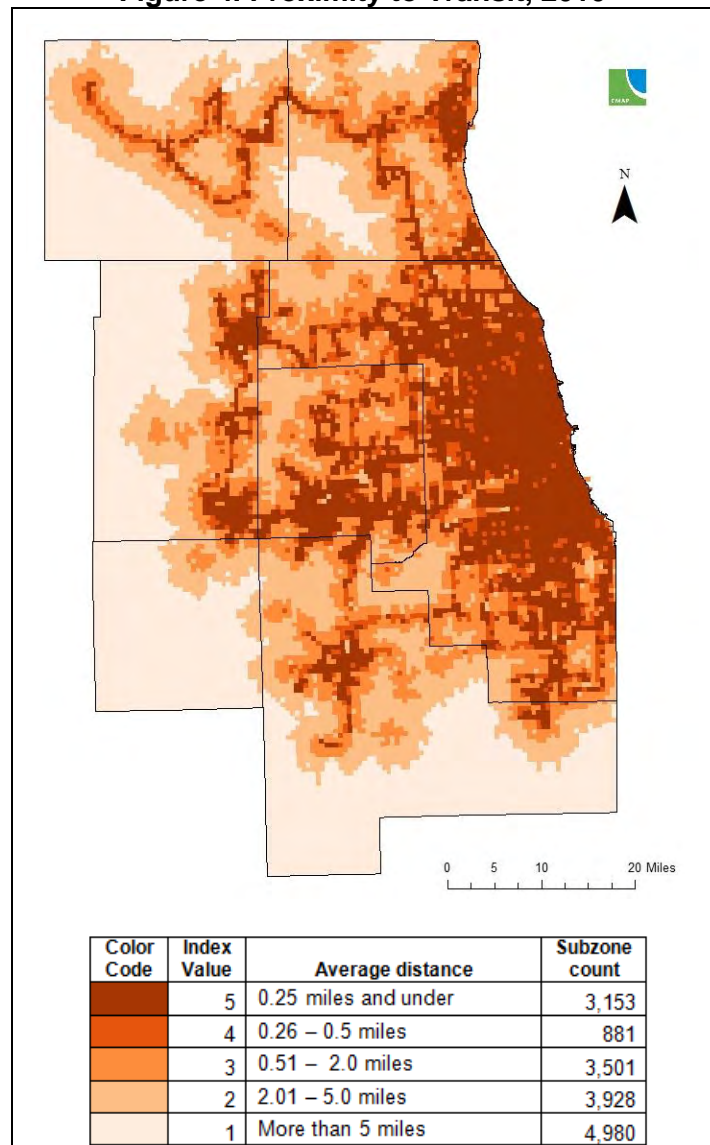
Source: Chicago Metropolitan Agency for Planning analysis.

locations within the catchment area. Finally, the stop distances are weighted by the stop's service frequency to calculate the overall subzone proximity value.

For subzones that do not contain transit stops, the measurement is simply the shortest network distance from the subzone centroid to the five nearest transit stops. A threshold value derived from the network-based distance to the closest stop is used to limit the selection of the remaining stops to ensure the group has comparable proximity to the centroid. For all subzones where the minimum distance to the closest stop is less than one mile, the remaining stops selected cannot be more than double that distance from the centroid. For the remaining subzones, the transit stops selected cannot be more than one mile farther away from the centroid than the closest stop. The proximity value for these subzones is the average of the distances to the relevant nearest stops, weighted by the stop service frequency. Subzones that only contain transit stops in their buffered area (not the core subzone) are analyzed using the same method as for subzones without transit service.

The distance values are grouped into categories based on the ranges of values shown in Figure 4. The two highest value categories represent the areas with the greatest likelihood of potential walk trips to access transit: one category with a high degree of potential walk trips to access transit (up to 0.25 miles) and a category with a somewhat lesser likelihood of potential walk trips (between 0.26 miles and 0.5 miles). As the index values decline, the presumption is the number of non-motorized trips used to access transit service will also decline.

Figure 4. Proximity to Transit, 2010



Source: Chicago Metropolitan Agency for Planning analysis.

Pedestrian environment

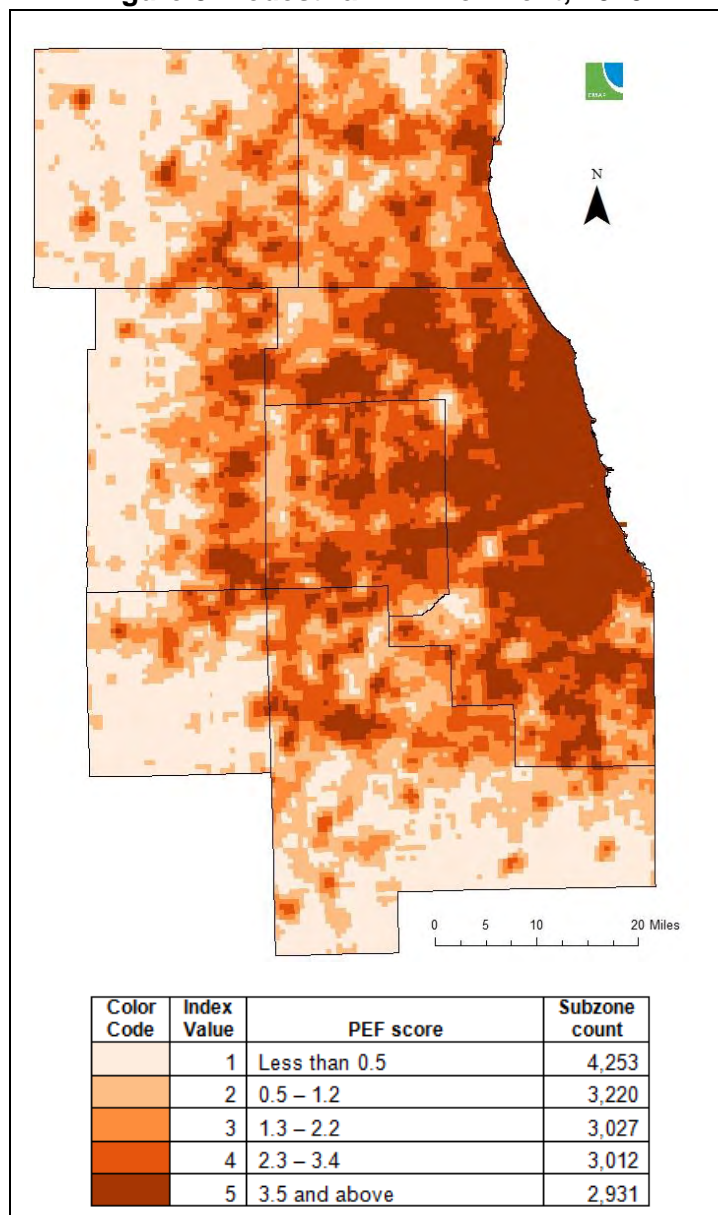
The Pedestrian Environment Factor (PEF) is a measure of walkable street density that is used in CMAP's Trip Generation model. It serves as a proxy for the "pedestrian-friendliness" of an area. An "all-streets" network is used to perform the PEF calculation, which reports values in terms of centerline miles of roadway per subzone. Street segments identified as being unsuitable for walking are excluded from the calculation. Subzones are assigned index values based on their PEF score, as shown in Figure 5. The PEF values are used to separate the subzones into five equal-sized categories. Values for the PEF are rounded to one decimal place; this is done so that the precision of the measure is not overstated as it is only a proxy for pedestrian-friendliness.

Sensitivity to Service Changes

An important measure of whether or not the Access to Transit Index provides meaningful information is the extent to which it can reflect localized changes in transit service. To test the index's responsiveness, CMAP staff analyzed data reflecting 2013 transit service and compared the results to the 2010 base year data. This comparison is shown in Figure 6.

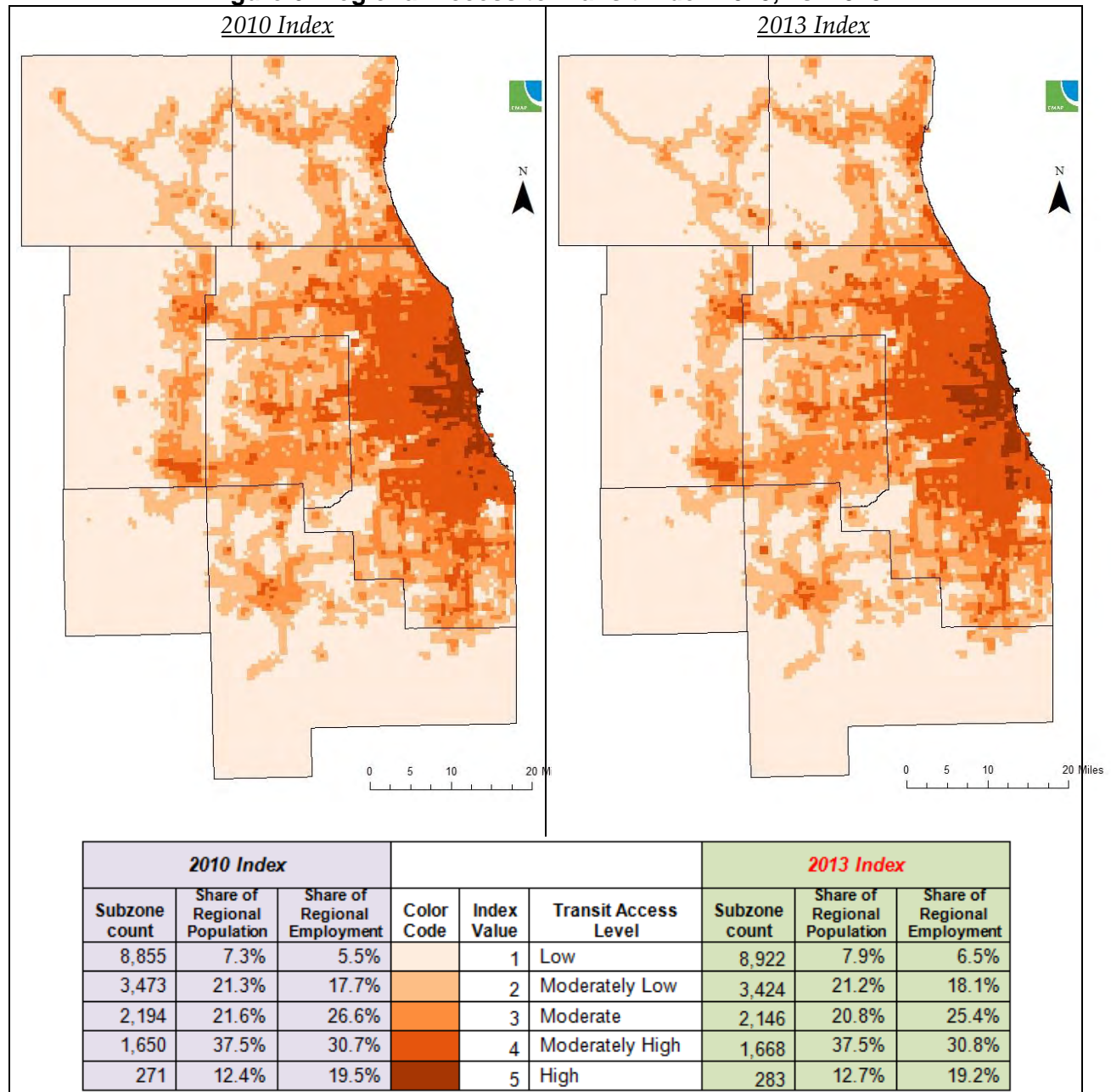
The table in Figure 6 presents a comparison of the regional population and jobs in each of the accessibility categories. The 2013 values for employment and households are CMAP estimates based on the expected growth in the region through the year 2040. The transit service data are from 2013 GTFS files. The data show that 71.5% of the regional population had at least moderate access to transit in 2010; in 2013 that value declined slightly to 71.0%. Similarly, 76.8% of regional jobs had at least moderate access to transit in 2010, with that value inching down to 75.4% in 2013.

Figure 5. Pedestrian Environment, 2010



Source: Chicago Metropolitan Agency for Planning analysis.

Figure 6. Regional Access to Transit Index 2010, vs. 2013



Source: Chicago Metropolitan Agency for Planning analysis.

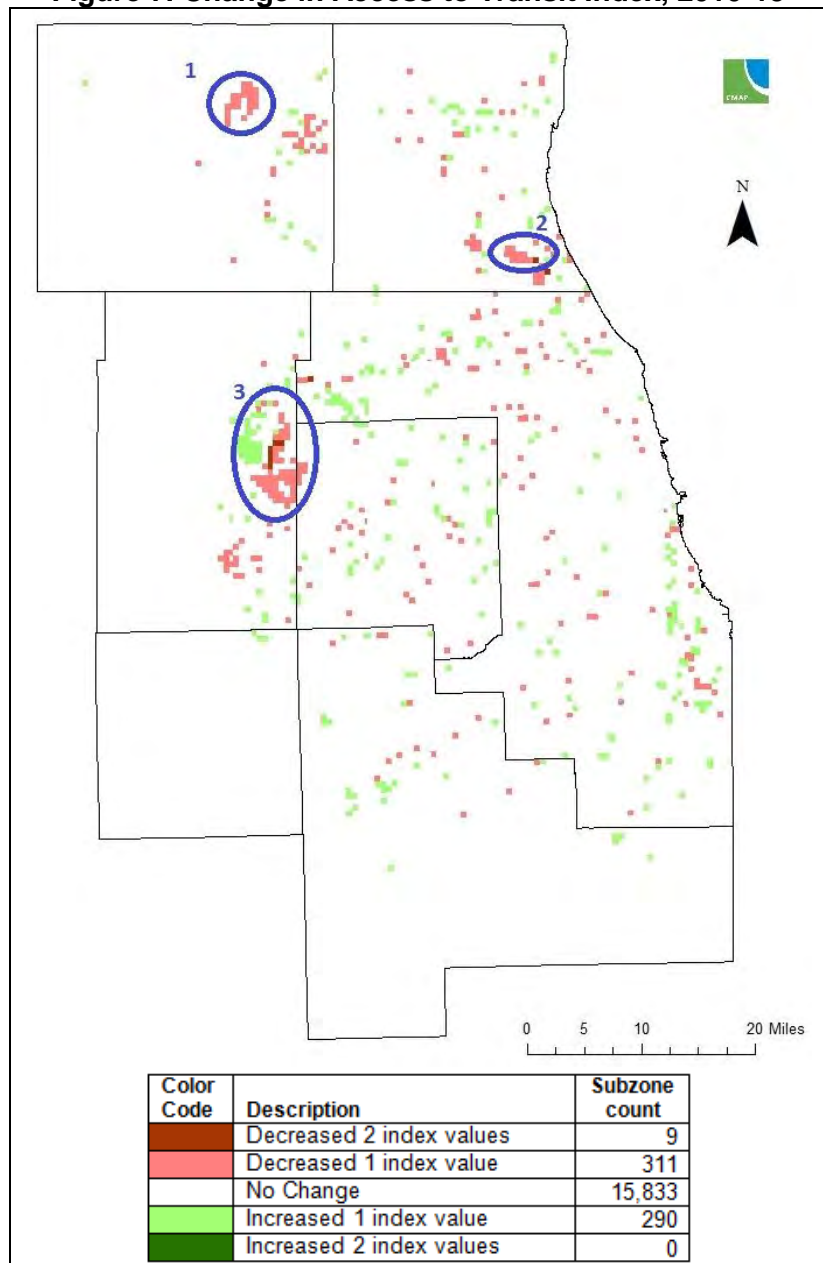
While at first glance the two maps shown in Figure 6 appear to be the same, they do contain subtle differences. To clearly illustrate those differences, Figure 7 presents the change in overall index values from 2010 to 2013. Following are brief descriptions of what occurred to cause the change in index values for three specific locations:

Location 1: This area in McHenry County shows a decrease in transit accessibility between 2010 and 2013. This change is due to a re-routing of Pace route 807. In 2010, this route traveled on IL 120, then made a loop to the north into Wonder Lake before continuing on IL 120. Effective December 2012, the loop into Wonder Lake was discontinued on the route. As this was the only transit route serving this area, the index reflects the loss of transit service in the immediate area.

Location 2: This area in southeastern Lake County also shows a decrease in transit accessibility between 2010 and 2013. This is explained by the elimination of [Shuttle Bug route 622](#), due to the withdrawal of corporate subsidies to support the service. Again, this was the only transit service provided in the affected subzones. Note that this service had an average weekday ridership of only 47 passengers in 2011.

Location 3: This area in eastern Kane County highlights a number of subzones that saw an improvement in their accessibility score, next to an equally large number that experienced a decline. This pattern of change is due to the shifting of Pace route 801 to the west. In 2010, this route traveled north-south on IL 25. By 2013, this route was using Randall Road instead.

Figure 7. Change in Access to Transit Index, 2010-13



Source: Chicago Metropolitan Agency for Planning analysis.

This brief analysis illustrates that the Access to Transit Index is sensitive enough to capture localized changes in transit service over time. As one would expect, in areas saturated with transit service, the impact of changes to a specific route are muted in the index. Conversely, transit service changes in areas with limited service available show a more significant impact.