DEPARTMENT OF TRANSPORTATION

Minnesota's Walking and Bicycling Data Collection Report Update

Annual Data from 2014 to 2019

2/22/2021

February 2021

Dear People of Minnesota,

The Minnesota Department of Transportation (MnDOT), Office of Transit and Active Transportation (OTAT) is pleased to share the first update to *Minnesota's Walking and Bicycling Data Collection Report*. This publication adds two years of annual data to the previous 2014-2017 report and is a result of extensive analysis thanks to 9 years of commitment to counting pedestrians and bicyclists and collaborating with local and regional groups. This statewide effort would not be possible without our partners at MnDOT, Minnesota Department of Natural Resources, Minnesota Department of Public Health, University of Minnesota Twin Cities, several tribal nations, the Parks and Trails Council of Minnesota, counties, cities, and others throughout Minnesota. OTAT wants to thank everyone who took the time to test methodologies, collect data, share technical expertise, and provide guidance critical to the development of this report and MnDOT's larger non-motorized data collection program.

People in Minnesota bike and walk year-round because they may be too young to drive, it's their only reliable mode of transportation, to improve their health, or to reduce pollution cause by other modes of transportation. Consistent with MnDOT's values in equity and accessibility, the pedestrian and bicyclist data program collects and provides information crucial for informing data-driven decisions that assess progress of MnDOT's goals, but that also facilitate the connection of people and places to maximize the health of people, the environment and our economy.

The success of bicycling and walking in Minnesota depends on the coordination of many partners. MnDOT will continue to consult with state and local stakeholders in the development and implementation of this nationally renowned statewide non-motorized data collection program to ensure Minnesota has a multimodal network that works for everyone.

Sincerely,

Victoria Nill Digitally signed by Victoria Nill
Date: 2021.03.10 05:39:15 -06'00'

Tori Nill

Director for the Office of Transit and Active Transportation

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The Minnesota Pedestrian and Bicyclist Data Program is made possible thanks to several partnerships and collaborations between the Minnesota departments of transportation, natural resources, and public health, the University of Minnesota Twin Cities, Hennepin County and the Parks and Trails Council of Minnesota. We also thank our Tribal Nation representatives, and local and regional partners that have provided critical insight for identifying installation locations and needs for non-motorized data. Their support and progressive involvement in this program is and will continue to be critical for improving not only the original scope of this program, but also in establishing methods for sharing and using data.

Contents

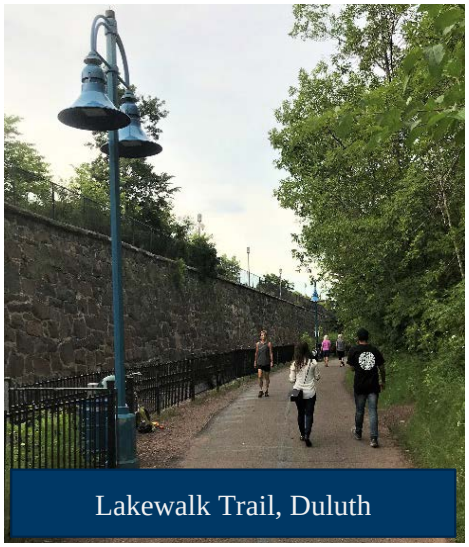
Overview

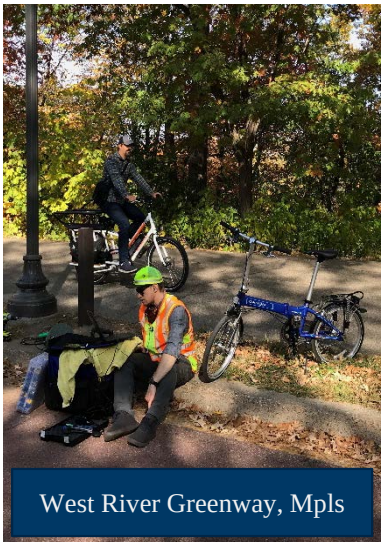
This report, produced by MnDOT's Office of Transit and Active Transportation (OTAT), is an update to the 2014-2017 Minnesota's Walking and Bicycling Data Collection Report adding annual data from 2018 to 2019. The data is derived from 29 permanent counter locations in 2018 and 27 permanent counter locations in 2019, along with 16 automated people counters distributed across Minnesota in eight portable counting kits. The counters and associated data are managed by the Pedestrian and Bicyclist Data Program within OTAT which provides information to decision makers regarding all facets of transportation plans, projects, funding and policies.

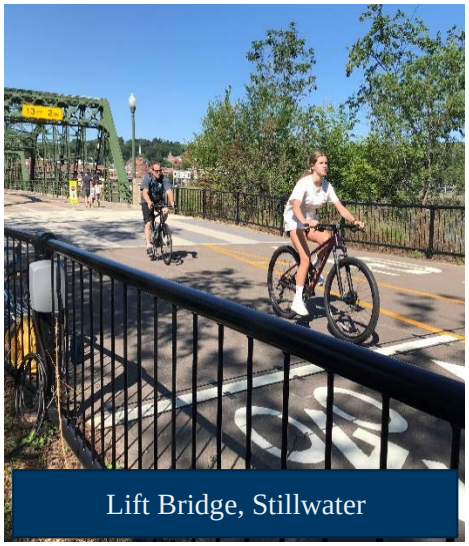
The data collected with these advanced automated technologies continue to prove beneficial in tracking comprehensive issues and approaches related to safety, health, project prioritization and maintenance of pedestrian and bicycle infrastructure throughout Minnesota. Furthermore, this data allows MnDOT and its' partners to better inform state, regional and local planning and engineering initiatives as well as assess important transportation policies and programs such as Complete Streets and Toward Zero Deaths. Counting people walking and bicycling also supports the advancement of goals and objectives identified in the Statewide Bicycle System Plan and Statewide Pedestrian System Plan.

Using six complete years of pedestrian and bicyclist data from many sites, MnDOT can better understand expected active transportation travel patterns, how behaviors change during extraordinary events (i.e. the Governor's COVID-19 executive orders), and how people volumes differ across facility types such as roads and trails. This report not only gives an overview of bicyclist and pedestrian trends but also provides a breakdown of key patterns captured within the last two years.

Figure 1: Left: Permanent bicyclist and pedestrian installation. Center: permanent counter maintenance. Right: Portable bicyclist and pedestrian installation.


Lakewalk Trail, Duluth


West River Greenway, Mpls


Lift Bridge, Stillwater

Methodology

Data Collection

The Pedestrian and Bicyclist Data Program operates two data collection methods - permanent sites used for continuous records and portable counters used for supplemental and mobile short duration records. Data is collected at 15-minute intervals, 24 hours a day and includes directional data in order to understand and visualize traffic patterns.

Some permanent sites and all portable count kits include a pyro (passive infrared (IR)) sensor that counts the number of people by sensing body temperature. Bicyclists are detected by portable counters when they create air compressions by rolling over two rubber pneumatic tubes. Bicyclists are counted by permanent counters when they pass over inductive loops, or wires embedded in pavement, and disrupt a continuous electromagnetic current.

Both the portable counter kits and the permanent count locations are capable of distinguishing between bicyclists and pedestrians when these technologies are paired together, as recommended in the Federal Highway Administration's Traffic Monitoring Guide. An IR sensor cannot discern mode of travel by itself - it must be combined with a second technology that counts the number of bicyclists and used in tandem. The equation below is commonly used to calculate total pedestrians at each count location and throughout the active transportation field.

$$Total\ IR\ Counts - Bicycle\ Counts\ from\ Tubes\ or\ Inductive\ Loops = Pedestrian\ Count$$

Counting Sites

Table 1: Number of counter installations and data collected each year from 2013-2019

Year	Counters Installed	Sites Added	Bicyclists Counted	Pedestrians Counted	Total People Counted
2013	4	2	0	0	0
2014	5	4	40,618	0	40,618
2015	6	4	542,769	513,987	1,056,756
2016	11	9	929,779	625,016	1,632,879*
2017	3	3	1,317,270	802,340	2,187,406*
2018	0	0	1,382,154	730,276	2,182,586*
2019	-2	-1	1,235,002	602,059	1,882,859*
Grand Total	**27**	**21**	**5,447,592**	**3,273,678**	**8,983,104**

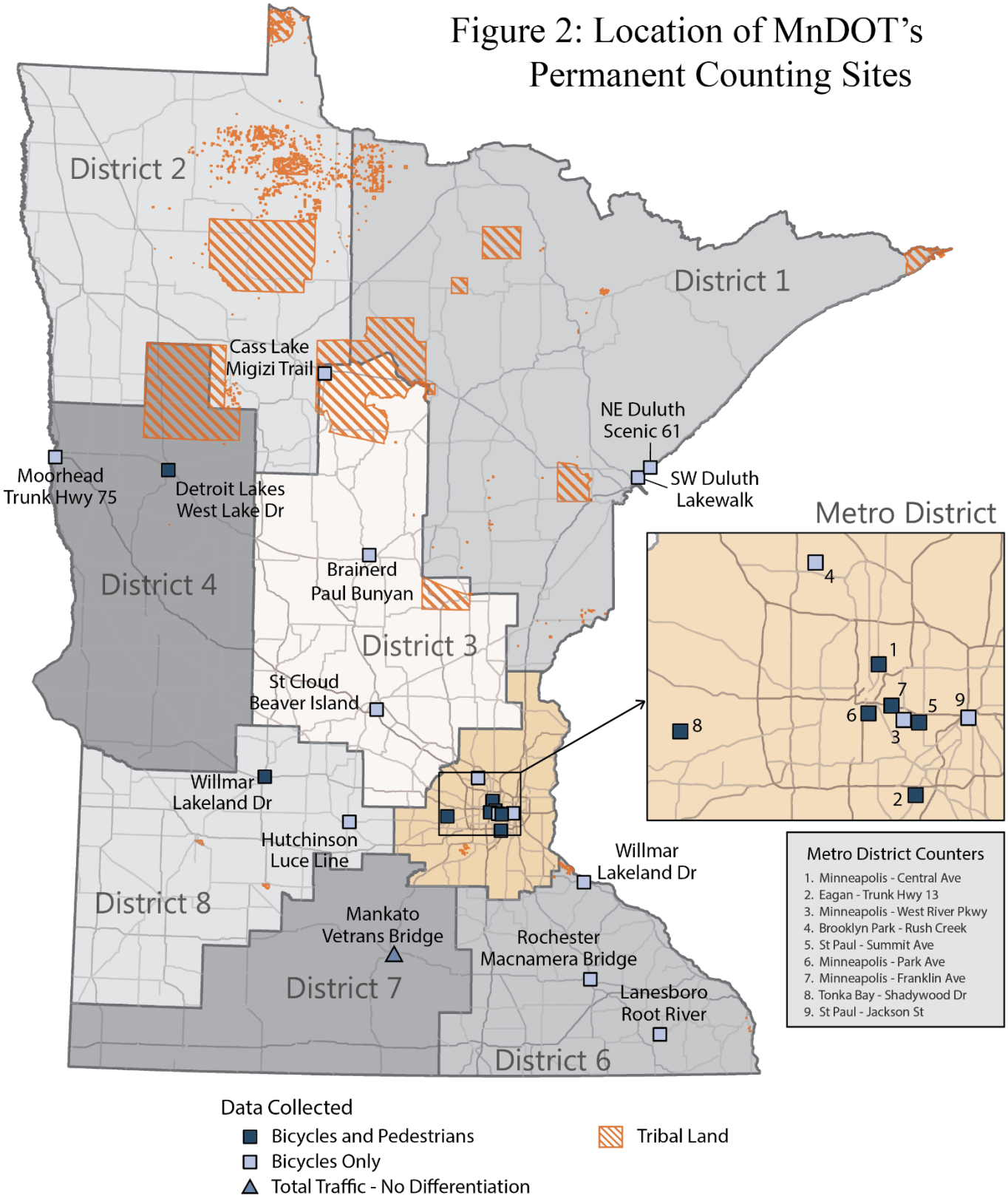
**Totals include counts from Veterans Memorial Bridge in Mankato, the only site where traffic isn't categorized by mode*

By April 2017, all eight of MnDOT's administrative districts were represented in the network of 29 permanent counters at 22 locations on six different facility types, both on- and off-road. Table 1 shows the total number of people counted per year at these sites, while showing number of installations and removals for comparison. Eight counters are currently installed in the metro area with the remaining scattered across the state, as visualized in Figure 2. The discrepancy between number of counters and sites is due to the placement of two counters at some sites – one on either side of a road. Four districts have at least one on-road site and one off-road shared path counted daily. MnDOT plans to grow its presence of permanent counters throughout the state, as detailed in the "Next Steps" section of the report.

Data Cleaning

Raw data from the counters are examined by MnDOT staff to identify any erratic or missing data. When irregularities are found, the data are run through a statistical model in 'R Studio' and cleaned up. Some key steps in this process include removing outliers and identifying historic trends to replace periods of erratic counts. These alterations calculate both in- and out- directions separately for pedestrian and bicycling counts through use of historic directional records from that site. The process takes a holistic approach by addressing any possible travel inhibitions such as weather or closures, ensuring the most accurate output. Details of this process are outlined in Appendix A and further explained in the 2014-2017 Report.

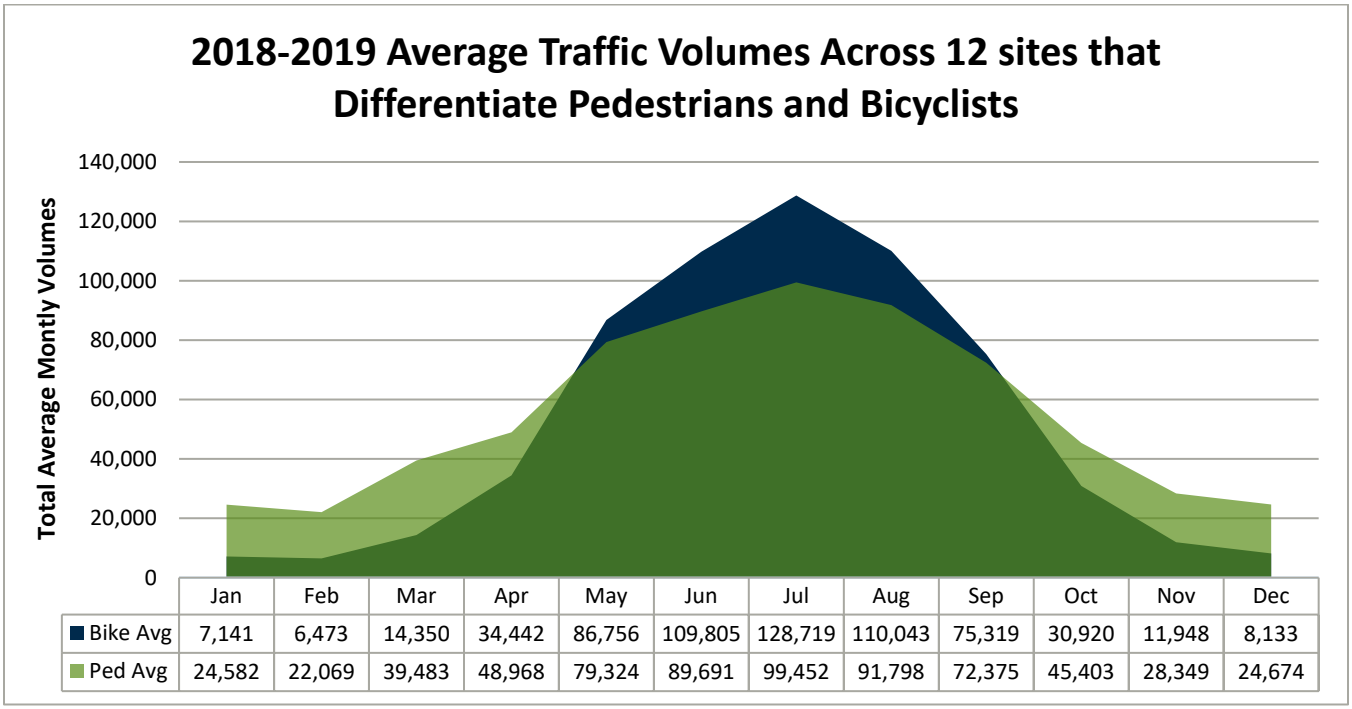
Permanent Sites



2018-2019 Findings

Historically, people volumes have peaked in July, which remained constant throughout 2018 and 2019 (Figure 3): more people walked than biked in the cooler months but that flipped between May and September (Appendix C, Appendix D). This switch in mode dominance is more pronounced in 2018-2019 than years prior. The gap between peak bicyclist and pedestrian counts is larger due to higher July bicycle ridership. The 2014-2017 report showed higher pedestrian than bicyclist counts from August through the year's end. In 2018 and 2019, however, cycling counts remained higher throughout August, extending bicycle dominance by a month.

Figure 3: Average monthly traffic volumes across the 12 permanent sites that differentiate pedestrian and bicycle traffic



MnDOT has permanent counters located on a variety of bicycle facilities including separated paths and shoulders, increasing understanding of traffic patterns by infrastructure design. Mode of active transportation type collected at each site is dependent on the facility type it's installed on (Table 2), in addition to the equipment used. There are 12 sites with pyro (IR) counters and inductive loops (permanent bicycle counters) that count both pedestrians and bicyclists.

Table 2: Active transportation collection type by facility

Type of Count Collected	Facility Type Collected On
Pedestrian & Bicyclist Separately	Shared-Use Path, Sidewalk
Bicyclist Only	Buffered Bicycle Lane, Protected Bicycle Lane, Bicycle Lane, Shoulder
Total People	Shared-Use Path

2018-2019 Permanent Site Changes

Between 2018 and 2019, Duluth's Lakewalk Trail, home to one of the three most popular sites in the count program prior to 2018, underwent construction due to a destructive storm that carried large waves from Lake Superior onshore, severely damaging the lakeside trail. This kept the site from reaching its usual peak in July and counts remained low throughout the season (Appendix B). Total traffic reduced by almost 50 percent, falling from 302,000 in 2018 to 158,000 in 2019 (Table 3). The Levee Trail in Redwing also experienced flooding, resulting in a decrease of over 55,000 travelers in 2018 to 15,000 in 2019. Detrimental storms have become increasingly frequent along the shores of Lake Superior in Duluth in 2018 and 2019, causing closures for flooding that ultimately required closures for reconstruction. Similarly, construction began at the Levee Trail in January of 2019 and growing occurrences of excessive flooding from the neighboring Mississippi River kept the trail closed beyond September. This was not the only weather change that impacted active transportation across Minnesota.

Table 3: Total people counted at all sites from 2018-2019

Site	2018	2019	Grand Total	% Bike	% Ped
Duluth | Lakewalk Trail	301,750	158,674	**460,425**	22%	78%
Duluth | Scenic 61	16,903	15,539	**32,442**	Bicycle Only	
Cass Lake | Migizi Trail	12,067	9,525	**21,592**	36%	64%
Brainerd | Paul Bunyan Trail	32,606	30,943	**63,549**	56%	44%
St Cloud | Beaver Island Trail	49,985	47,505	**97,491**	48%	52%
Detroit Lakes | W Lake Drive	28,525	23,098	**51,622**	Bicycle Only	
Moorhead | TH75 Trail	40,799	33,286	**74,086**	52%	48%
Lanesboro | Root River Trail	75,965	76,801	**152,766**	77%	23%
Red Wing | Levee Trail	54,266	15,954	**70,220**	19%	81%
Rochester | Macnamara Bridge	75,894	77,832	**153,726**	52%	48%
Mankato | Veterans Mem. Bridge	70,156	61,814	**131,970**	No Differentiation	
Hutchinson | Luce Line Trail	30,556	27,459	**58,015**	52%	48%
Willmar | Lakeland Drive	2,443	3,119	**5,562**	Bicycle Only	
Brooklyn Park | Rush Creek Trail	102,979	93,198	**196,177**	69%	31%
Eagan | Trunk Hwy 13	16,008	-	**16,008**	Bicycle Only	
Minneapolis | Central Ave	20,465	20,780	**41,245**	Bicycle Only	
Minneapolis | Franklin Tower	259,062	258,569	**517,632**	Bicycle Only	
Minneapolis | Park Ave. Northbound	101,410	89,701	**191,111**	Bicycle Only	
Minneapolis | West River Greenway	452,881	472,366	**925,247**	63%	37%
Orono | Shadywood Dr.	29,122	30,108	**59,230**	Bicycle Only	
St Paul | Jackson St	162,864	144,275	**307,139**	18%	82%
St Paul | Summit Ave (all loops)	245,880	208,328	**454,208**	Bicycle Only	
Grand Total	**2,182,586**	**1,898,876**	**4,081,462**	**66%**	**34%**

All permanent sites had consistent seasonal average temperature decreases and most endured increased precipitation from 2018 to 2019, bolstering one likely explanation of the total count decrease in pedestrian and bicyclist volumes over these two years, seen in Table 3. All but three sites (Lakewalk Trail, Scenic 61 and Veterans Memorial Bridge) saw increased levels of precipitation. Seven locations had over a 30 percent increase, meaning an additional 20 inches of precipitation in peak-use months at the Trunk Highway 75 Trail in Moorhead. Further, every site saw a yearly average temperature drop of at least one degree. These changes in weather conditions correlate with fewer people walking and biking in 2018 and 2019 compared to previous years.

In addition to loss of traffic at Lakewalk and Levee Trails, the Trunk Highway 13 permanent counters in Eagan were removed in the beginning of 2019 after five years of counting bicyclists on a highway shoulder. The site was removed due to the completion of a separated trail alongside the highway that diverted significant levels of traffic away from the counters. Furthermore, as one of the first sites installed, the equipment endured years of ground freezing and thawing and expected wear and tear, suggesting the system either be up for replacement or removal. Prior to its uninstallation, the counters collected an annual average of 15,748 counts over six years and registered a roughly 1,700 count increase throughout the years it was installed. In 2018, the Trunk Highway 13 site logged an average of 43 bicyclists a day. Paired with the negative traffic impact of construction at Lakewalk Trail and Levee Trail, total 2019 people counts took a significant hit but walking and biking appeared to remain stable.

Site Highlights

In 2017, the three sites with highest traffic counts were West River Greenway Trail, Lakewalk Trail and Summit Avenue Bike Lanes. Combined, these three sites made up 50 percent of traffic volumes collected in the program. Despite weather hindering use, Lakewalk Trail remained in the top three busiest sites in 2018, counting an average of 2,057 daily users in July. By 2019, the Lakewalk Trail fell from the top three sites, leaving West River Greenway with highest volumes at an average of 2,269 daily users in July, followed by Franklin Avenue and Summit Avenue.

Across the program's 22 sites, many high-volume days stand out. By looking at historical data, site attributes, weather and other information, we can begin to infer which counts may be outliers and which may just be exceptional, as detailed in Table 4. Between 2018 and 2019, the highest 29 counts all occurred at Minneapolis' West River Greenway, with May 26th, 2019 topping the chart at 4,356 people counted between 6:00 am and 10:00 pm. That's about 272 people per hour! While there was no specific event to draw such crowds, it was a warm Sunday of Memorial Day weekend. Many other sites shared this experience, including Root River Trail, Rush Creek Trail, Macnamera Bridge, Shadywood Dr, W Lake Drive and TH75 trail, who recorded high counts Memorial Day weekend as well. Duluth's Lakewalk Trail recorded its second highest daily volume on July 5th, 2018 when city's popular "Fourth Fest" was postponed to this date, leading to counts of 3,328 people. In 2015, a record 3,875 people were registered during "Fourth Fest". Another notable day fell on the yearly St Paul Classic bike ride in

September whose route includes passing the counters on Summit Avenue. In 2018, the site counted three times its historical average daily count in September.

Table 4: Potential causes for exceptionally high records by site and date, including the volume's percent increase from the site's non-winter average daily total

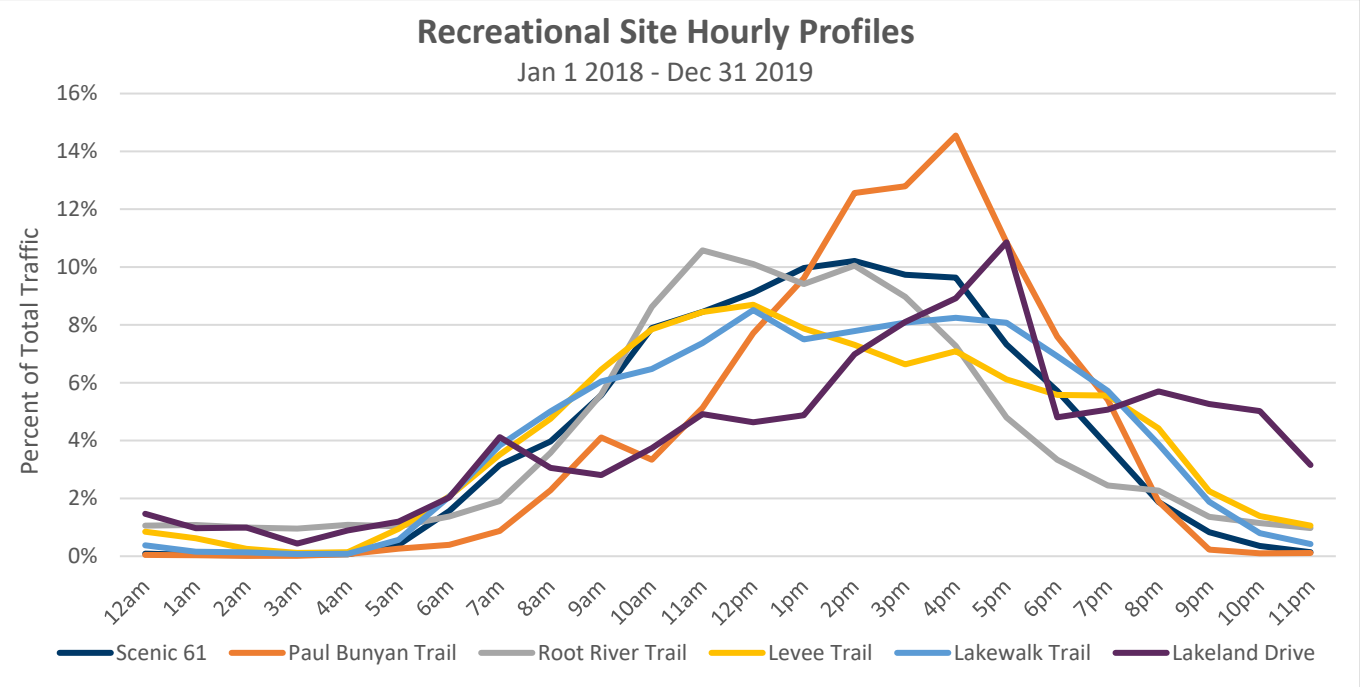
Site	Date	(Avg) Volume	Likely Cause for Counts	x ADT
Levee Trail	August 4-5, 2019	1,194	River City Days Car and Truck Show	22.5x
Scenic 61	August 26, 2018	481	Superior Man Marathon	8.2x
Central Ave	May 18-20, 2018	171	Art-A-Whirl Festival	7.3x
Paul Bunyan Trail	August 24, 2019	713	Paul's Bacon Ride	6.4x
Lakewalk Trail	July 5, 2018	3,328	Fourth of July Festival	5.5x
Root River Trail	September 1, 2019	1,547	Taste of the Trail	5.1x
Central Ave	August 5, 2018	341	Open Streets	4.5x
Veterans Mem. Bridge	July 28, 2018	844	Blues on Belgrade	3.9x
Scenic 61	September 1, 2018	176	Pride Block Party	3.0x
Macnamera Bridge	July 5-7, 2018	759	Fourth of July Weekend	2.6x
Summit Ave	May 16, 2018	1,475	Alan Grahn Memorial Bicycle Ride	2.4x
Veterans Mem. Bridge	October 6, 2019	407	Mankato River Ramble	1.9x
Jackson St	May 16, 2018	806	Alan Grahn Memorial Bicycle Ride	1.7x
Summit Ave	September 8, 2019	1,227	St Paul Classic Bike Ride	1.7x

Permanent Site Use Analysis

Based on hourly and day-of-week travel patterns, much of the bicyclist and pedestrian traffic detected at MnDOT's permanent sites is considered "Recreational" (Miranda-Moreno et al). However, traffic at some sites fall under other classifications including Mixed-Recreational, Utilitarian and Mixed-Utilitarian. Classifications are based on research focused on bicyclist trends, but this analysis extends these findings to include pedestrian traffic. While MnDOT strives to provide a safe network for each trip, regardless of transportation type, these classifications are useful for grouping similar sites together and creating extrapolation factors to better estimate and predict active transportation volumes.

Figure 4 visualizes average hourly data from a select group of the 20 counters representing the 16 sites classified as recreational. These counters are primarily distinguished by a single peak in an hourly profile across a single day, often from midday through late afternoon.

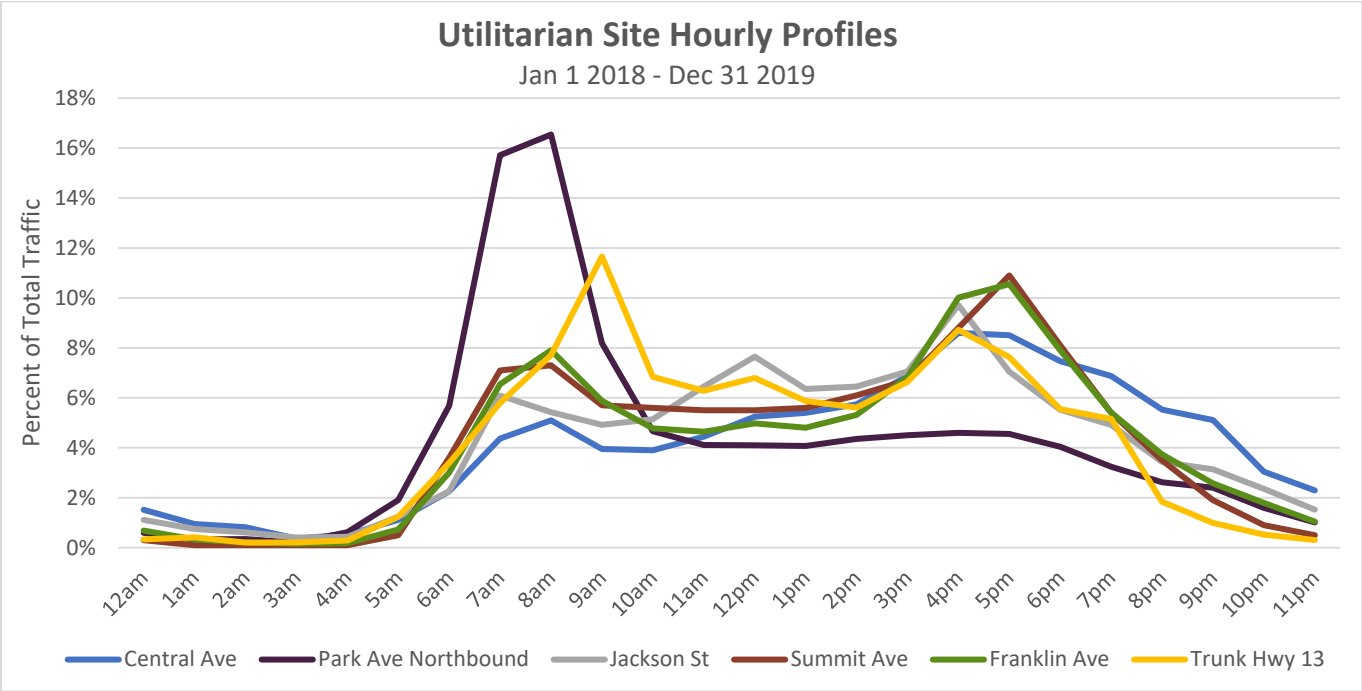
Figure 4: Area chart of hourly profiles for a representative group of recreational counters



Six of the permanent sites experience opposite trends to those of the recreational use counters. Central Avenue, Park Avenue, Jackson Street, Summit Avenue, Franklin Tower and Trunk Highway 13 see a stark morning peak followed by a second peak in the late afternoon/evening (Figure 5). These high-traffic times coincide with the beginning and end of the workday, suggesting primary use by commuters. These utilitarian and mixed-utilitarian sites are located within the Twin Cities Metro Area. Moreover, those living within half a mile of the above (graphed) utilitarian sites have over twice as many residents without access to a vehicle within their home compared to those living in areas surrounding recreational

counters and 3.24 percent of residents near utilitarian sites also commute by bike, according to the 2017 American Community Survey.

Figure 5: Area chart of hourly profiles for all utility counters



Sites and counters become further categorized as utilitarian and mixed-utilitarian or recreational and mixed-recreational when dissecting weekend versus weekday traffic. Recreational sites have an increase in traffic volumes during the weekend while Utilitarian sites have a decrease in traffic during the weekend, signifying majority of use as commuter traffic.

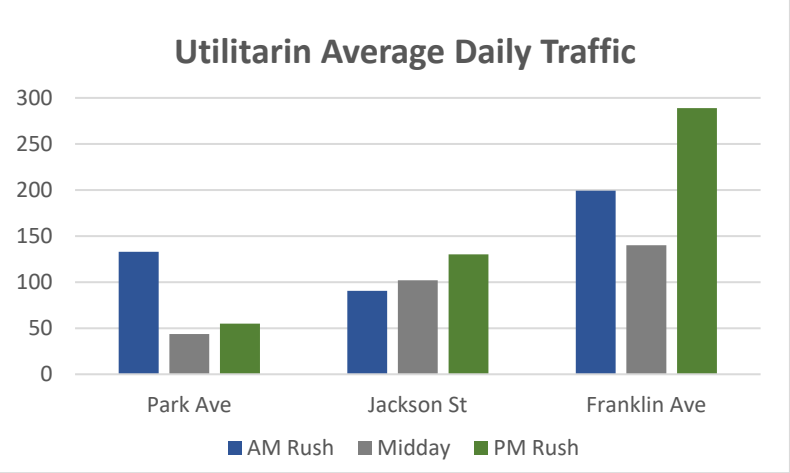
Park Avenue, Jackson Street, Franklin Tower and Central Avenue sites align most closely with the utilitarian label due to their weekday versus weekend ridership. At Park Avenue, 16 percent of weekly traffic occurs on each weekday, compared to 9 percent seen on Saturday and Sunday (Table 5). Jackson Street and Franklin Tower see comparable trends where weekend volumes decrease about 4 percent. The gap between weekday and weekend days begin to close at Central Avenue but is still large enough to qualify the counter as utilitarian in use.

Table 5: Average Weekday/Weekend Percent of Total Traffic for Utilitarian Counters

Site	Weekday	Weekend
Park Ave.	16.39%	9.03%
Jackson St	15.47%	11.32%
Franklin Tower	15.44%	11.35%
Central Ave	14.44%	13.90%
Summit Ave	13.92%	15.20%
Trunk Hwy 13	13.64%	15.90%

Figure 6 shows average daily totals at three utilitarian counters with highest daily counts, broken into the AM Rush between 6:00 and 10:00am, midday (11:00-2:00) and the PM Rush between 3:00 and 6:00pm. The graphic visualizes the variety of changing daily traffic

Figure 6: Graph of 2018-2019 average total counts in the morning, midday and the evening



flows that can still be classified as commuter sites. The Park Avenue site is a bicycle counter located on a three lane, one-way road leading into downtown Minneapolis. Because of its one-way designation, Park Ave only carries morning commuters towards the city's central business district, leaving the afternoon return peak to nearby routes not consistently monitored by our program. For this reason, Park Ave does not have the characteristic AM and PM peak most utilitarian sites experience. The Jackson Street site is home to a bicyclist and pedestrian counter in downtown St Paul, where many residents work. It's midday counts continue to rise as it is close to offices and restaurants that people frequent during their lunch breaks.

Utilitarian sites see similar AM and PM trends but fail to share the majority weekday use seen at Park Avenue and Jackson Street. Summit Avenue and Trunk Highway 13 sites have similar traffic patterns throughout each week but show increased traffic on weekends, putting them in in the mixed-utilitarian category (Table 5). These active transportation patterns, especially at sites where traffic drops nearly 50% on the weekend, prove bicyclist infrastructure is used for more than leisure and recreation. Motor vehicle traffic follows similar hourly patterns at many of these sites, demonstrating the importance of safe active transportation infrastructure on roads designed or used for commuting.

Table 6 shows how much of the total traffic passes by specific recreationally classified counters on weekdays versus weekends. Based on volumes alone, four of the 16 counters (TH75 Trail, Migizi Trail, Lakeland Drive and Beaver Island Trail) are designated as mixed-recreational due to higher weekday traffic. Land use analysis further supports this classification as three of the four mixed-recreational sites are in downtown areas near large business parks and employment centers. Traffic patterns at these sites show slight peaks in morning traffic followed by large afternoon/evening spikes suggesting probable active transportation commuting.

Table 6: Average Weekday/Weekend Percent of Total Traffic for Select Recreational Counters (2018-2019)

Site	Weekday	Weekend
Shadywood Dr.	11.56%	21.11%
Scenic 61	12.47%	18.84%
Levee Trail	13.06%	17.34%
West River Greenway	13.86%	15.36%
Beaver Island Trail	14.42%	13.95%
Lakeland Drive	14.61%	13.49%
Migizi Trail	15.91%	10.23%
TH75 Trail	16.04%	9.90%

The remaining 12 sites boast heaviest daily use on Saturdays and Sundays with regular peaks in volume during midday, which are clear indicators

of recreational use as noted in Figure 4's hourly trends. Most of these 12 sites, except for Shadywood Drive and Scenic 61, are along shared-use paths which often attract recreational users. These two exceptions are on a bike lane and shoulder, respectively, but their rural/suburban locations suggest limited alternative route options. At Shadywood Drive, average daily weekend traffic is nearly 10% higher than weekdays, whereas average traffic varies less than 1% across weekdays and weekends on Beaver Island Trail. Most counters in MnDOT's program are classified as recreational, but this may change as more permanent counters are installed on a more diverse and evenly distributed group of facility types.

All six utilitarian sites are located on a bike lane, shoulder or sidewalk while most recreational sites are on separated paths, suggesting that facility types may play a role in the kind of traffic they carry. Only three of 16 recreational sites are not situated on shared use paths, one being Shadywood Drive, which has the strongest recreational classification. While its facility type seems atypical, its classification is further supported by its location on a narrow roadway surrounded by a large body of water and single-family homes. As the only through-road in its vicinity, the Shadywood Drive bike lanes are the only connection to surrounding networks. Similarly, Duluth's Scenic Highway 61 site is on a highway shoulder along a designated US Bike Route 41 and an All-American Scenic Drive that carries primarily recreational riders and slower vehicle traffic between Lake Superior and the newer and faster MN-61 highway.

Direction of traffic influences the order of land uses you encounter which can impact site classifications. For example, when counters at the Central Avenue site are independently classified, the southbound site is utilitarian, and the northbound site is mixed-recreational. Central Avenue Southbound experiences morning and afternoon rush-hour peaks while the Central Avenue Northbound counter, directly across the street, has a lone afternoon peak. Likewise, more daily bicyclists travel Southwest bound at the Franklin Avenue site than Northeast bound, and they see varying daily traffic patterns. When data is combined to draw trends from the site, the AM and PM peaks become more defined, but it retains the higher counts around 4:00-5:00 PM. This suggests many people that bicycle by this site on their way home in the early evening perhaps use another mode of transportation or route in the morning.

Portable Sites

A large amount of data collected in this program stems from the portable counter lending program. Eight portable counting kits, equipped with both pedestrian and bicyclist counters, are hosted in each of MnDOT's eight districts and borrowed by local partners (Figure 7). These short duration site counters are offered for free in hopes of expanding MnDOT's coverage of active transportation facilities throughout Minnesota. To reserve portable counters and learn about deployment recommendations, use the MnDOT bicycle and pedestrian traffic counting website to contact your equipment host and find out how to reserve a counter.

Figure 7: Equipment in each of the eight MnDOT counting kits

In 2018 and 2019, counters across the state were loaned out a total of 45 times with use in seven of the eight districts (Table 7). Installations in 2018 surpassed those in in 2017, and 2019 installs outnumbered those in 2015 and 2016 combined. District 7, in the south-central region of the state, utilized the borrowing program the most, deploying 10 times in 2018 and 6 times in 2019 Community Health related services reported the most use, boasting over 30% of the installations in the district. However, while District 1 (Northeast Minnesota) had a lower number of installations, counters remained in the field longer, resulting in more total days counted. Throughout 2018 and 2019, District 7 counted 167 days of pyro data and District 1 counted 330 days of pyro data. District 7's install count is a significant change from the single installation it completed in 2017 where it collected 45 days of data. A decrease in installation numbers in 2019 urges the program to increase awareness of the opportunity to borrow portable counters, as is detailed in the "Next Steps" section.

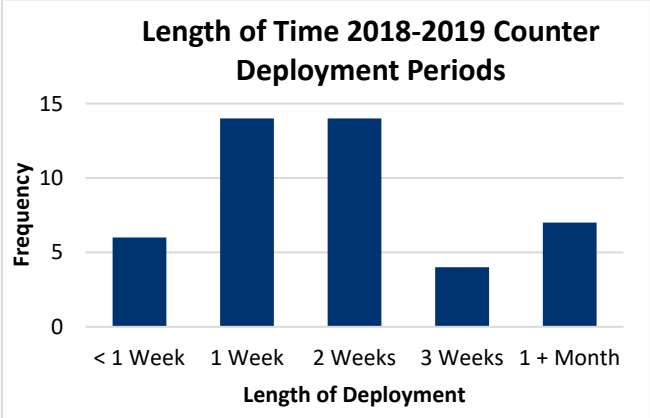
Table 7: Number of counter installations per district

Year	D1	D2	D3	D4	Metro	D6	D7	D8	Total
2016	8	0	0	5	0	0	0	0	**13**
2017	5	3	4	5	0	1	1	2	**21**
2018	5	0	2	1	3	5	10	1	**27**
2019	8	0	1	0	3	0	6	0	**18**
Total	**26**	**3**	**7**	**11**	**6**	**6**	**17**	**3**	**79**

In 2016, there were fewer installations, but each was deployed for extended periods of time. Since then, counts have been getting shorter, allowing for more frequency and diversity of count location.

Figure 8 displays a breakdown of deployment lengths for borrowed kits throughout the state. The longest installation was over 4 months in Carlton, Minnesota for 140 days to collect project related data for a Paved Trails Economic Impact Assessment study.

Figure 8: Individual portable counter installation lengths of the 45 deployments in 2018 and 2019



Count kits may be borrowed for a multitude of reasons, ranging from project development to trail network use analysis. In 2018, 16 of the 27 counts were taken to gather baseline data. Of those 16, four were listed as collecting baseline data for planning efforts, or for specific projects. Additionally, eight deployments were used to gather data in connection to another local project. In 2019, 12 installations occurred for planning or project related purposes. A number of these were connected to construction projects, but three were deployed to analyze pedestrian and bicyclist traffic during local events and inform a regional plan.

Next Steps

While MnDOT's Pedestrian and Bicyclist Data Program is nationally renowned, MnDOT will continue to improve data collection, encourage portable counter use, improve data storage and share data more routinely. According to borrower feedback, technical difficulties, counter installation and data retrieval make using the portable equipment challenging. To reduce this barrier, the program has plans to improve quality and frequency of in-person and virtual trainings to demonstrate installation procedures and answer questions. By widely offering these trainings to local, regional and state partners, the program aims to improve awareness of the equipment and increase the number of deployments across Minnesota to address many data needs. Such trainings may result in new or stronger relationships between equipment hosts and their borrowers and provide the program with better feedback and evaluation (i.e. more or different data collection resources are needed in a specific district(s)).

In order to expand geographic coverage, diversify site classifications, and better distinguish trends over time and across sites, MnDOT plans to nearly double the network of permanent automated people counters in the next five years. This expansion will also assist MnDOT in better understanding performance measures, provide insight into risk exposure for safety analyses, develop better extrapolation factors, track progress related to goals and objectives and inform policies and plans.

To improve storage and maintenance of the program's data, MnDOT, in consultation with many partners, has begun building a central data repository where agencies and organizations across Minnesota can archive, share and access standardized bicyclist and pedestrian traffic data.

Limitations

While the program aims to collect typical walking and bicycling traffic information in Minnesota, MnDOT understands current counting methods and locations may not capture truly inclusive data. Many regions of the state and specific populations are undoubtedly underrepresented in this report's findings, driving conscious future decisions to better represent Minnesota's vast population. Moreover, the program is aware of data that is not collected such as documentation of actual trip purpose and reason for choosing to pass through a site. For example, a counter may be located on a thoroughfare that is frequented by people moving quickly through an area, but seldom used by locals. This pushes MnDOT to move beyond raw counts and work to create estimates for where people are likely traveling based on system networks. Working to understand active transportation based on a site's location within a larger system will aide in recognizing travel patterns and how various trail and infrastructure systems connect the state. Once installed, the additional permanent people counters and strategically placed portable counters will help provide a more holistic and accurate image of state-wide network trends.

Appendix A

Data Quality Management

1. Export all daily total traffic volumes from permanent sites with a full year's worth of data from EcoCounter's Eco-Visio platform
    a. If "Ped_In" numbers are erratic:
        i. Find a range of historical days in EcoVisio where the "In" and "Out" direction volumes are well aligned and calculate the ratio of Ped_In to Ped_Out
        ii. Multiply each daily Ped_Out using the following formula:

$$Ratio\_PedIn = \left(\frac{Ped\_Out}{Ped\_Out\ Ratio}\right) - Ped\_Out$$

        iii. Calculate the range of the Raw_PedIn to the new Ratio_PedIn created in step ii
        iv. Chose the New_PedIn by using the formula:
        New_PedIn = IF(AND(Range_PedIn >= 5, Range_PedIn <= 5), Raw_PedIn, Ratio_PedIn)
        v. Sum the New_PedIn and raw number for Ped_Out into a new total ped number
        vi. Copy and paste into the 2019 associated site data file
    b. If "Ped_In" numbers are normal, leave untouched
2. Automate removal of outliers
    a. Flag days for manual review if their "IN" and "OUT" directions differ by more than 500
    b. Eliminate runs of zeros more than one week long
    c. Fit a hierarchical logistic model predicating the likelihood of zero traffic based on the following predictors: Month, Weekend/Weekday, with Site as a random effect. Days in which a site has less than a .04% predicted probability of having zero traffic and reports zero traffic are designated as outliers.
    d. Eliminate outliers with daily totals greater than 12 times the mean absolute deviation from the median and greater than 100
3. Include all calendar days in outlier output file, even those with an identified issue, making it easier to manually review and populate with separately calculated estimates based on modal and directional proportions
4. For sites with many days of missing data for one mode or direction, multiply the other mode by historical proportion between the two
    a. For a site with two counters counting separate directions
        i. Download daily data for the site from EcoVisio
        ii. Develop ratios between the two travel directions for day-of-week and month-of-year
        iii. Apply to missing or erratic travel direction
        iv. Sum directions to create a "New Total" for each day and round result to nearest integer
        v. Put "New Total" into outlier file for corresponding dates
    b. For a site counting separate modes
        i. Download daily data for the site from EcoVisio

        ii. Develop ratios between the two modes for day-of-week and month-of-year
        iii. Apply to missing or erratic mode
        iv. Sum directions to create a "New Total" for each day, rounding result to nearest integer
        v. Put "New Total" into outlier file for corresponding dates
    c. Run "New Total" through outlier detection and imputation process
5. Ensure all "total volumes" are integers so they are all used for the imputation process
6. Standardize the daily traffic totals at each permanent site, using mean and standard deviation to calculate z-scores for each day in the sample
7. Use the mean of the z-scores from all locations for each day as the summary statistic for statewide traffic on any specific day
8. For each site, create a linear regression model based on Gobster, Sachdeva, and Lindsey (2017) (article attached). Predictive variables include: average statewide traffic (calculated in step 4), weekday and weekend (dummy variable, where 1 = weekend), daily high temperature and daily precipitation. Retrieve weather variables from the National Oceanic and Atmospheric Administration (NOAA) at https://www.ncdc.noaa.gov/data-access/land-based-station-data
    a. Note that weather data came from stations that had the most days of data nearest each of the reference sites. MSP was chosen as the weather station for the metro (Minneapolis, Orno, Eagan, St Paul & Brooklyn Park) because there were no missing days of data
    b. Note that sites with a missing day of weather, regardless of their geographic location, were assigned the day's weather from MSP. This simplified the process and made it uniform across all sites since weather data is complete at MSP
9. Use the respective regression model to estimate daily traffic for missing days at each location

Day-of-Year Factors

Much like motor vehicle traffic, collection of active transportation data necessitates standardization of adjustment factors. In order to best understand the trends and details of non-motorized transportation, annual average daily pedestrian and bicyclist traffic estimates are based on short-duration portable counts comparing the ratio of day-of-year traffic to total annual traffic. This method, widely understood to be the most accurate approach, is calculated at all MnDOT permanent sites where traffic is monitored 365 days a year. Using day-of-year factors is the preferred approach for non-motorized traffic due to its ability to account for factors such as weather, nearby events, or other local impacts on pedestrian and bicycle traffic. This helps to avoid overgeneralization and provide more accurate data adjustments for 365 days of unique conditions.

Margin of Error:

Automated people counters tend to undercount traffic, especially in high volume locations, resulting in conservative estimates. One major factor causing undercounting is occlusion error, where two or more people pass a sensor simultaneously. In this situation, the counter only detects the person nearest to the sensor, failing to count others. Some of our partners have adjusted their counts to account for this error, but MnDOT has chosen not to. This, in turn, means statewide pedestrian and bicycle counts are likely conservative counts.

Appendix B

Site	2014	2015	% Chg	2016	% Chg	2017	% Chg	2018	% Chg	2019	% Chg	Grand Total
Duluth | Lakewalk Trail	291,124	397,143	36.4%	419,991	5.8%	394,291	-6.1%	301,750	-23.5%	158,674	-47.4%	**1,962,974**
Duluth | Scenic 61	15,202	15,344	0.9%	14,511	-5.4%	12,060	-16.9%	16,903	40.2%	15,539	-8.1%	**89,560**
Cass Lake | Migizi Trail				7,867		7,609	-3.3%	12,067	58.6%	9,525	-21.1%	**37,068**
Brainerd | Paul Bunyan Trail				33,065		30,496	-7.8%	32,606	6.9%	30,943	-5.1%	**127,110**
St Cloud | Beaver Island Trail				59,945		54,816	-8.6%	49,985	-8.8%	47,505	-5.0%	**212,252**
Detroit Lakes | W Lake Drive						18,972		28,525	50.3%	23,098	-19.0%	**70,595**
Moorhead | Trunk Hwy 75 Trail				43,917		41,968	-4.4%	40,799	-2.8%	33,286	-18.4%	**159,971**
Lanesboro | Root River Trail				99,013		86,904	-12.2%	75,965	-12.6%	76,801	1.1%	**338,684**
Red Wing | Levee Trail						64,141		54,266	-15.4%	15,954	-70.6%	**134,361**
Rochester | Macnamara Bridge	66,313	102,826	55.1%	133,293	29.6%	65,453	-50.9%	75,894	16.0%	77,832	2.6%	**521,611**
Mankato | Veterans Mem. Bridge						67,796		70,156	3.5%	61,814	-11.9%	**199,766**
Hutchinson | Luce Line Trail						29,622		30,556	3.2%	27,459	-10.1%	**87,637**
Willmar | Lakeland Drive				2,519		2,408	-4.4%	2,443	1.4%	3,119	27.6%	**10,490**
Brooklyn Park | Rush Creek Trail		106,551		111,347	4.5%	106,199	-4.6%	102,979	-3.0%	93,198	-9.5%	**520,274**
Eagan | Trunk Hwy 13	14,978	15,726	5.0%	15,386	-2.2%	16,647	8.2%	16,008	-3.8%			**78,745**
Minneapolis | Central Ave	25,640	27,771	8.3%	28,336	2.0%	23,475	-17.2%	20,465	-12.8%	20,780	1.5%	**146,468**
Minneapolis | Franklin Tower				276,087		268,758	-2.7%	259,062	-3.6%	258,569	-0.2%	**1,062,477**
Minneapolis | Park Ave		99,492		101,317	1.8%	93,844	-7.4%	101,410	8.1%	89,701	-11.5%	**485,764**
Minneapolis | West River Greenway	399,630	497,935	24.6%	503,019	1.0%	549,897	9.3%	452,881	-17.6%	472,366	4.3%	**2,875,727**
Orono | Shadywood Dr				33,497		33,219	-0.8%	29,122	-12.3%	30,108	3.4%	**125,946**
St Paul | Jackson St				147,525		151,923	3.0%	162,864	7.2%	144,275	-11.4%	**606,587**
St Paul | Summit Ave		278,310		277,618	-0.2%	273,549	-1.5%	245,880	-10.1%	208,328	-15.3%	**1,283,685**
Grand Total	**812,887**	**1,541,098**		**2,308,254**		**2,394,049**		**2,182,586**		**1,898,876**		**11,137,750**

Appendix C

Pedestrian Counting Sites	2018-2019 Annual Pedestrians	AADP	Jan ADP	Winter ADP	July ADP	Non-Winter ADP
Duluth | Lakewalk Trail	133,061	365	20	75	736	508
Cass Lake | Migizi Trail	5,675	16	3	5	47	21
Brainerd | Paul Bunyan Trail	14,030	38	17	26	80	45
St Cloud | Beaver Island Trail	25,551	70	39	36	102	87
Moorhead | Trunk Hwy 75 Trail	16,017	44	26	31	61	50
Lanesboro | Root River Trail	17,191	47	5	13	73	64
Red Wing | Levee Trail	13,597	37	30	23	41	45
Rochester | Macnamera Bridge	36,443	100	28	40	134	129
Hutchinson | Luce Line Trail	11,854	32	6	23	51	37
Brooklyn Park | Rush Creek Trail	29,580	81	19	37	114	103
Minneapolis | West River Greenway	179,578	492	247	267	727	604
St Paul | Jackson Street	119,482	327	224	231	448	375

AADP: Average Annual Daily Pedestrians
January ADP: Average daily pedestrians in the month of January, typically representational of lowest yearly counts
Winter ADP: Average daily pedestrians over winter months (December – March)
July ADP: Average daily pedestrians in the month of July, typically representational of highest yearly counts
Non-Winter ADP: Average daily pedestrians over all non-winter months (April – November)

Appendix D

Bicyclist Counting Sites	2018-2019 Annual Bicyclists	AADB	Jan ADB	Winter ADB	July ADB	Non-Winter ADB
Duluth | Lakewalk Trail	25,613	70	11	21	89	95
Duluth | Scenic 61	15,539	43	7	10	131	59
Cass Lake | Migizi Trail	3,850	11	1	2	29	15
Brainerd | Paul Bunyan Trail	16,913	46	6	5	121	67
St Cloud | Beaver Island Trail	21,954	60	9	11	153	85
Detroit Lakes | W Lake Drive	23,098	63	56	53	108	68
Moorhead | Trunk Hwy 75 Trail	17,269	47	7	9	110	67
Lanesboro | Root River Trail	59,610	163	1	4	440	242
Red Wing | Levee Trail	2,357	6	3	4	1	8
Rochester | Macnamara Bridge	41,389	113	14	18	249	161
Hutchinson | Luce Line Trail	15,605	43	7	7	99	60
Willmar | Lakeland Drive	3,119	9	1	2	15	12
Brooklyn Park | Rush Creek Trail	63,618	174	7	15	466	253
Minneapolis | Central Ave	20,780	57	14	21	118	75
Minneapolis | Franklin Tower	258,569	708	196	206	1,256	958
Minneapolis | Park Ave	89,701	246	145	122	393	307
Minneapolis | West River Greenway	292,788	802	172	179	1,754	1,111
Orono | Shadywood Dr	30,108	82	22	22	187	112
St Paul | Jackson St	24,793	68	17	20	150	92
St Paul | Summit Ave	208,328	571	315	281	895	715

AADB: Average Annual Daily Bicyclists
January ADB: Average daily bicyclists in the month of January, typically representational of lowest yearly counts
Winter ADB: Average daily bicyclists over winter months (December – March)
July ADB: Average daily bicyclists in the month of July, typically representational of highest yearly counts
Non-Winter ADB: Average daily bicyclists over all non-winter months (April – November)