DEPARTMENT OF TRANSPORTATION

Minnesota's Walking and Bicycling Data Collection Report

Annual Data from 2014 to 2017

August 2018

Office of Transit and Active Transportation (OTAT)

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Acknowledgements

The Minnesota Pedestrian and Bicyclist Counting Program is made possible thanks to several strategic 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 local partners in Regional Development Commissions, Metropolitan Planning Organizations, tribal nations, cities, and counties that have provided critical insight for identifying installation locations and needs for non-motorized data. Their support and progressive involvement of 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 in standard and accessible formats.

Contents

Overview

The Minnesota Pedestrian and Bicyclist Counting Program (The Program), coordinated and led by the Office of Transit and Active Transportation within the Minnesota Department of Transportation, was formed as a research project in 2013. The Program set out to address the shortcomings of using two-hour manual counts taken by community volunteer and use decades of MnDOT experience with motorized vehicle data to build a similar program for collecting, analyzing, validating, evaluating, and managing non-motorized traffic data. The result is a state-of-the-art pedestrian and bicycle data program, designed to fully integrate with motorized data and allow for volumes and travel patterns of people walking and bicycling on Minnesota’s entire network of roads and highways to be estimated in the future.

Just like MnDOT’s motor vehicle program, this one consists of two main components – 1) permanent “reference” sites and 2) portable counters used for supplemental short duration counts.

1) Permanent ‘Reference’ Sites

Sites were selected and counters were installed in consultation with MnDOT and representatives from local, regional, tribal and state agencies in each district. These sites help MnDOT:

- Track trends in bicycle and pedestrian traffic over time
- Provide insight into risk exposure for safety analyses
- Identify traffic patterns on various facility types among different land uses
- Create extrapolation factors that allow short-duration counts to be expanded to an annual traffic estimate
- Develop performance indicators to track progress relative to state and local goals and objectives

2) Portable Counters

In each MnDOT district there is one tube and one passive infrared counter available for local partners to use (for free) to collect their own data. This joint effort supplements the reference sites and provides broad geographic coverage. MnDOT recommends borrowers:

- Reserve the counters for a minimum of 9 days (one day for installation, seven days of collection and one day to take down and return the equipment)
- Conduct counts between April and October to avoid snow and plowing
- Use the counters to document variations in traffic volumes across facility types, changes in traffic before and after construction, testing innovative safety treatments, etc.

Figure 1: Example of permanent installation in Duluth and a portable counter installed in Battle Lake.

Duluth – Scenic 61 bicycle counter installation, 2014

Battle Lake – portable counter installation, 2017

To identify a wide range of permanent sites, the research team worked with local partners to find on-road (i.e. in a wide shoulder or bike lane) and off-road (state or local shared-use path or trail) locations where people were already walking and biking. As of April 2018, the network of reference sites spans all of MnDOT's eight administrative districts, consists of 29 permanent counters at 22 locations on six different facility types (Figure 1 and 2). There are more counters than sites because some sites have two counters - one counting traffic on one side of the road, and one counting traffic on the other.

MnDOT uses several technologies to tally the number of people walking and biking through an area, visualize changes in travel patterns across days and months, and begin to understand changes across seasons and years. Inductive loops (magnetic detectors embedded in pavement) and passive infrared (IR) sensors (body heat detectors) are used at the permanent sites, while rubber tube counters and IR sensors are used as portable counters. The data collected with these automated technologies, will be helpful for tracking broad issues and approaches related to safety, health, project prioritization and maintenance. This data will also allow 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 Minnesota Walks.

Figure 2: Different types of permanent installations (red dashed line indicates passive IR sensor and the yellow ovals identify inductive loops).

Passive infrared sensors are able to count people by detecting a change in environmental temperature (body heat) when a person passes by. However, they cannot tell the difference between a person riding a bike or walking. Inductive loops detect the metal or aluminum in bicycle wheels and therefore can only count people on bikes. Systems with both counting technologies are able to differentiate between modes:

Passive Infrared volume = Total People

Inductive Loop volume = Total Bikes

Passive Infrared volume - Inductive Loop volume = Total Pedestrians

Methodology

Realizing the limitations of two-hour manual counts (i.e. limited data, unable to understand day-of-week or time-of-day patterns, impacts of weather, etc.), a research team, led by MnDOT and the University of Minnesota Twin Cities, organized in 2013 with the goal of figuring out how to automate and expand the collection of walking and biking data so it is more useful for informing policies and plans.

First, the project team tested several types of automated equipment with partners across Minnesota to determine which were easy to install, provided simple and intuitive data analysis tools, and were reasonably priced. EcoCounter products were determined to be the best at the time, and make up the majority of the equipment MnDOT's uses in their two-pronged approach – 1) reference sites and 2) portable counters for supplemental short-duration counts. This approach mimics how motor vehicle data is collected across the state. This format will allow full integration with motorized data and in the future will let MnDOT estimate the volumes of people walking and bicycling on Minnesota's entire network of roadways.

After the equipment was purchased, the team worked with MnDOT's local partners to find the best installation locations. One of the program's goals was to install one counter on a road (i.e. in a wide shoulder or bike lane) and one off-road counter (i.e. on a state or local shared-use path or trail) in each of MnDOT's eight districts. However, the team also wanted sites where known non-motorized traffic occurred. This resulted in at least one on-road site and one off-road site in four of MnDOT's eight districts. The rest of the systems were all installed on off-road, shared-use paths. The data in this report is from 29 automated counters installed at 22 reference sites. Funding availability, signing contractual agreements, and weather impacted the installation timelines of the counters (see Table 1). As a result, the total number of days of data collected varies throughout the network. For example, only two sites (Eagan Trunk Highway 13, and Minneapolis Central Avenue) were in the ground collecting data for all of 2014. In 2015, an entire year of data was captured at six sites. To understand the effects of seasonality (difference in volume and travel patterns because of changes in weather and climate) only sites with at least seven months of data in each calendar year were included in Table 1 and the rest of the report. Since the 2013 counters were installed in November they are shown as having no data that year.

Table 1: Counters installed, counting sites created, and data collected each year from 2013-2017.

Year	Counters Installed	Sites Added	Complete Years of Data	Bicyclists Counted	Pedestrians Counted	Total People Counted
2013	4	2	0	0	0	0*
2014	5	4	4	40,618	0	40,618
2015	6	4	9	542,769	513,987	1,056,756
2016	11	9	15	929,779	625,016	1,632,879**
2017	3	3	26	1,317,270	802,340	2,187,406**
Grand Total	**29**	**22**	**54**	**2,830,436**	**1,941,343**	**4,917,660**

* Counter was installed in the fall of 2013 resulting in less than seven months of data, so total volumes are shown as zero.
** The total volume also includes total (non-differentiated) counts from two counters on Veterans Memorial Bridge in Mankato. Both counters use passive IR technology and are mounted above the path, counting people as they pass below.

Early every morning, each counter uploads its previous day's data through the cellular network to computer servers where it is stored. MnDOT staff then use the vendors' web-based application to explore the raw data across sites, travel mode types, and time periods (see Figure 14 on page 17). MnDOT also uses the website application to remotely check on counter functionality, so replacement parts may be promptly ordered and maintenance visits scheduled.

Unfortunately, even with these precautions in place, issues do arise (Figure 3). In 2017, many counting systems were found to have components facilitated corrosion that led to malfunction. As a result, these systems needed to be partially or totally replaced. Additional issues (i.e. loop wires cut by plows, stolen IR posts, equipment dug up and discarded during renovation of a business, etc.) caused counters to stop counting or report erroneous data. To fill in and replace these data gaps (about nine percent of total data collected in 2017) raw data from all the sites were downloaded from the interactive web-app and entered in an established non-motorized traffic model (described below). This model incorporates a statewide traffic index, daily maximum temperatures, daily precipitation and the day-of-week to predict estimates of traffic. Once imputed, the estimated daily totals and the total daily raw volumes are combined to create complete years of daily data.

Figure 3: Examples of environmental and equipment issues. Clockwise from top left – water infiltration, ant infestation, cracked cable housings, spider web with eggs.

Extrapolation Factors

The data is then used to generate extrapolation factors (percentages of the daily volume compared to the annual volume for a location) from the permanent site data that can be used to estimate annual traffic volumes from a short duration count of a week or month. The extrapolation factors were generated for each permanent count site using 'R' (a programming language and free statistical software) and the following process that incorporates national best practices:

1. Export all daily total traffic volumes from all permanent sites / reference bicycle and pedestrian counting sites with entire years of data.
2. Automate the removal of outliers.
    a. Eliminate runs of zeros more than one week.
    b. Eliminate daily totals greater than 12 times the mean absolute deviation from the median and also greater than 100.
    c. Fit a hierarchical logistic model predicting 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 3.5 percent predicted probability of having zero traffic and also reports zero traffic, are designated outliers.

3. Standardize the daily traffic totals at each permanent site, using mean and standard deviation to calculate Z-scores for each day in the sample.
4. Take the mean of the Z-scores across all locations for each day in the sample. Use this as the summary statistic for statewide traffic on any specific day.
5. Create a linear regression model for each site based on the study titled, "Up on The 606. Understanding the Use of a New Elevated Pedestrian and Bicycle Trail in Chicago, Illinois" by Gobster, Sachdeva, and Lindsey (2017). This model uses predictive variables including: average statewide traffic (calculated in Step 4), weekday and weekend (dummy variable, where 1 = weekend), daily high temperature, and daily precipitation. Weather variables can be retrieved from the National Oceanic and Atmospheric Administration.
    a. Use weather data from stations that have the most days of data nearest each of the reference sites. The Minneapolis – Saint Paul International Airport was chosen as the weather station for the Twin Cities Metro (Minneapolis, Orono, Eagan, Saint Paul and Brooklyn Park) because there were no missing days of data.
        i. For these factors, if the nearest weather station had some missing days of weather, regardless of its geographic location, data for those missing days was assigned from MSP. This simplified the process and made it uniform across all sites since MSP has a complete record of daily data from 2013 to the present.
6. Use the respective regression model (from Step 5) to estimate daily traffic for missing days at each location.
    a. Missing days were imputed only if the site had approximately seven or more months of data for the entire year. This duration was chosen because seven months of data should provide a reasonable indication of the sites' seasonality.

This process produces one set of 365 day-of-year factors for one year for each independent site. These factors are available for download on MnDOT's website. Creating DOY factors is the current best practice, but the process requires 365 days of data to be collected before the factors can be generated. Therefore, MnDOT is exploring more flexible, responsive and robust methods that are further described in the "Next Steps" section of this report.

Data Validation and Quality Control

MnDOT currently validates the data collected by the automated equipment by simultaneously conducting video and / or manual counts, as well as establishing statistical parameters when creating day-of-year factors. While validation and quality control of MnDOT's network of non-motorized counters is ongoing, the equipment vendor, EcoCounter, advertises accuracies of upwards to 95 percent depending on the type of counter, sensitivity of the settings, and the level of people traffic at a site (i.e. in heavily trafficked places, accuracy may be lower because multiple people walking or biking side-by-side may only be detected and counted as one person). Therefore, the numbers presented in this report are likely conservative.

Key Discoveries

Nearly 5 million people were counted since 2014

More than 4.9 million people bicycling and walking were counted at 22 reference sites (Figure 4) between January 2014 and December 2017. Average daily volumes per site in 2017 ranged from a low of seven people bicycling on Lakeland Drive in Willmar, to 1,507 total people per day on the West River Greenway in Minneapolis. Volumes vary across sites by time-of-day, day-of-week, and month of year.

The five busiest sites in 2017 saw 77 percent of the total traffic

At the Minneapolis West River Greenway location, more than one person was counted every minute of 2017 (Table 2). Modal splits varied widely between the busiest sites, ranging from 55 percent bicyclists and 45 percent pedestrians on the West River Greenway to 15 percent bicyclists and 85 percent pedestrians on Jackson Street in Saint Paul where many people take midday walks on during the workday. While the top five sites are in highly urban areas, several other suburban and rural locations rounded out the top 10. The Root River Trail in Lanesboro (86,904 people) attracts many weekend tourists. Veterans Memorial Bridge in Mankato (67,796 people) connects two communities, a university and bars and restaurants. And the Beaver Island Trail in Saint Cloud (54,816 people) is a well-traveled suburban shared-use-path that connects housing with jobs and is part of the Mississippi River Trail (US Bike Route 45).

Table 2: The five sites with the highest number of people counted in 2017.

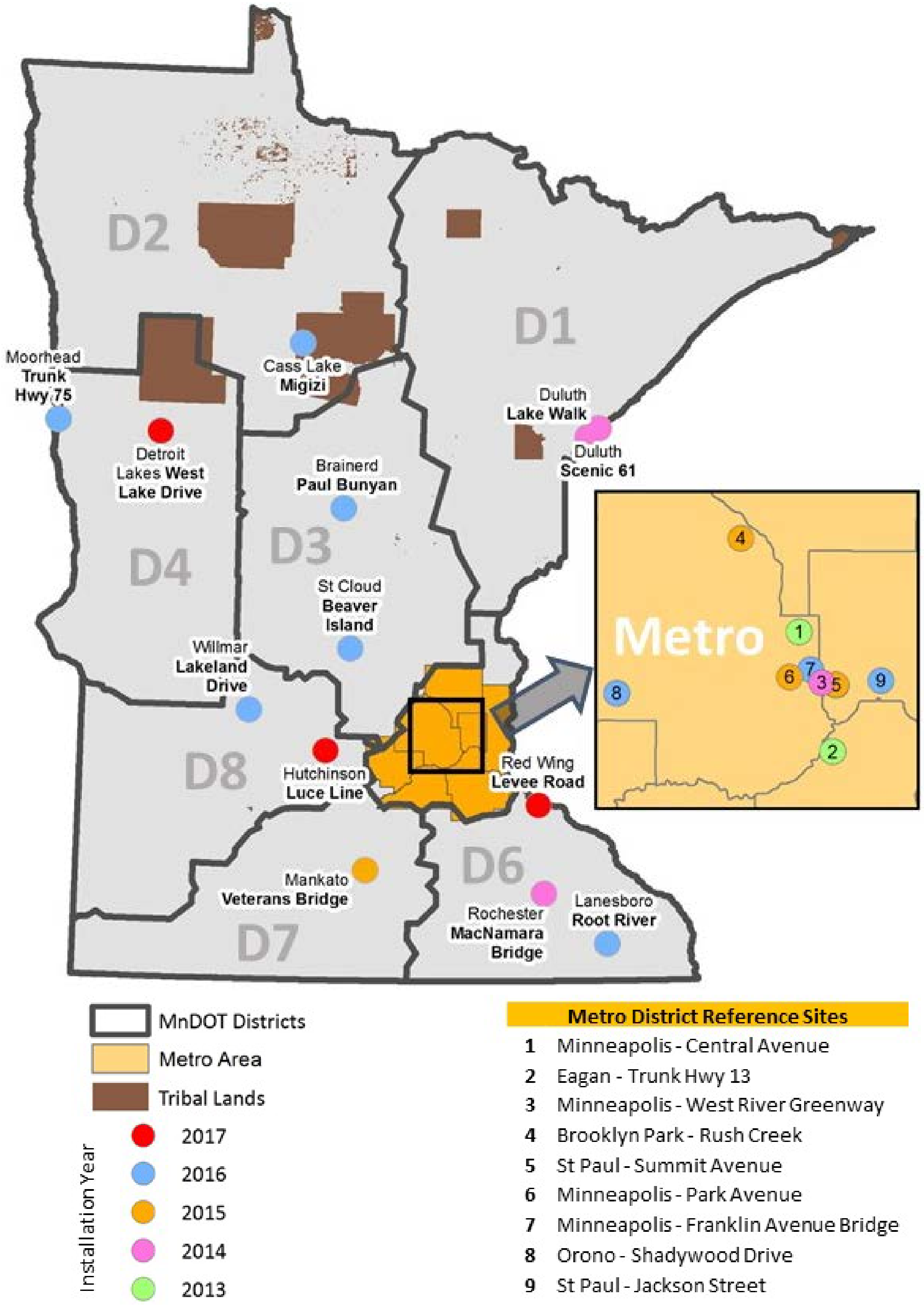
Reference Site	Bicyclists	Pedestrians	2017 Total
Minneapolis – West River Greenway Trail	299,924	249,973	549,897
Duluth – Lakewalk Trail	90,169	304,123	394,292
St Paul – Summit Ave Bike Lane	274,316	Not Counted	274,316
Minneapolis – Franklin Bridge Bike Lane	268,758	Not Counted	268,758
St Paul – Jackson St (Capitol City Bikeway)	23,524	128,399	151,923

25 Short Duration Counts Taken in 2017 by Local Partners

Local partners borrowed MnDOT's free portable counters 25 times in 2017 (up from 11 in 2016 during the first year of the program). Count durations ranged from six to 102 days and were conducted in every MnDOT district except the Metro where some local partners have their own equipment and established counting programs. These short counts were used to collect data for temporary project installations, Safe Routes to School programs, winter fat bike trail maintenance, new facility placement and usage, and verification that existing facilities are used (see pages 17-18).

Permanent ‘Reference’ Sites & Findings

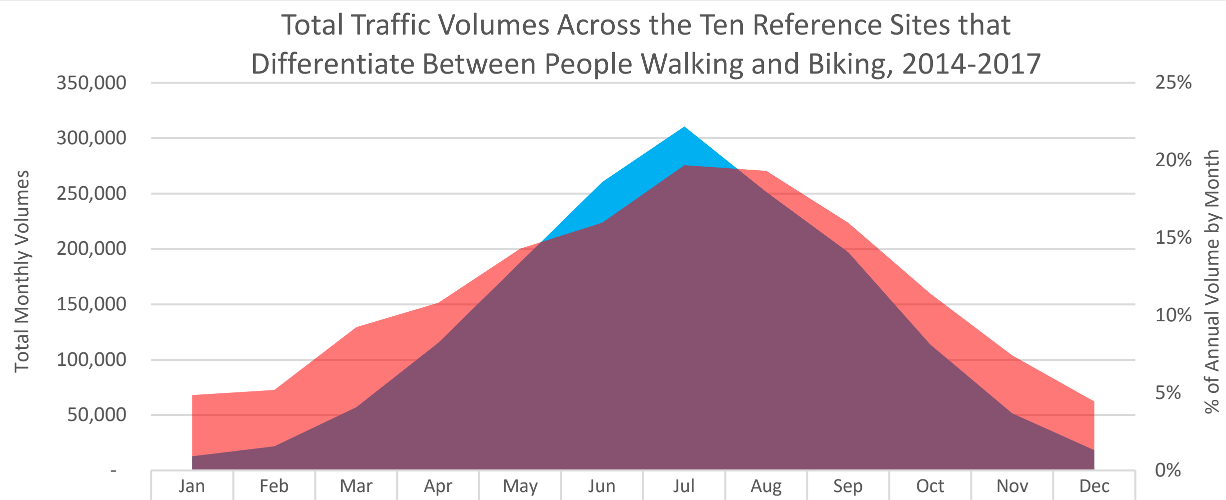
Figure 4: Since 2013, 29 permanent automated counters have been installed in Minnesota to collect walking and bicycling data. Equipment was installed at two reference sites in 2013, four sites in 2014, four in 2015, nine in 2016, and three in 2017 for a total of 22 total sites. There are more counters than sites because seven sites have two counters – each separately counting different directions of traffic.



All People Walking & Bicycling

In Minnesota, changes in precipitation and temperature influence when people choose or are able to bike and walk where they need to go. When looking at the data across the calendar year, a bell-shaped curve appears (Figure 5) indicating July volumes can be more than twice those in April or October (the months with average traffic), and that fewer people are walking in January and December. It also becomes clear that walking volumes are less variable throughout the year, but tend to be higher than bicycling volumes in the winter and vice versa in the summer.

Figure 5: Total traffic volumes across the ten reference sites that differentiate between people biking and walking.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bikes	12,720	21,869	57,158	115,102	187,710	260,325	310,628	251,381	197,075	113,799	51,578	18,444
Peds	68,153	72,734	129,298	151,249	200,299	223,710	275,639	270,486	223,811	159,713	103,999	62,252
% Bikes	1%	1%	4%	7%	12%	16%	19%	16%	12%	7%	3%	1%
% Peds	4%	4%	7%	8%	10%	12%	14%	14%	12%	8%	5%	3%

The information collected can vary by site depending on the type of installation and what sensors are used (Tables 3 & 4). Nine sites are on-road installations with inductive loops cut into the pavement and are only able to count people biking. Twelve of the 13 reference sites installed on shared-use paths (i.e. trails) include both a passive IR and inductive loop sensor allowing MnDOT to separately count people walking and biking. The site on Veterans Memorial Bridge in Mankato has two passive infrared sensors that detect body heat and can't differentiate walking versus biking resulting in a count of "total people."

Table 3: Reference counters by facility type.

Facility Type	Counters	Sites
Bicycle Lane	7	4
Buffered Bicycle Lane	1	1
Protected Bicycle Lane	2	1
Shared-Use Path	14	13
Shoulder	5	3
Grand Total	**29**	**22**

Table 4: Reference counters by mode counted.

Mode Counted	Counters	Sites
People Walking & Biking Separately	12	12
People Biking Only	15	9
Total People	2	1
Grand Total	**29**	**22**

Since most of the reference sites were installed in 2016 and have only one or two years of data, few annual trends can yet be observed (Table 5). Furthermore, ease of accessibility and changes in land use may play a part in funneling people towards or away from the reference sites overtime. Consequently, trends may not be evidently clear or particularly meaningful even after several additional years of collection.

*Table 5: Total people counted by year at each site that was installed prior to 2018. * These were installed in 2016 and collected less than at least seven months of data that year, so their numbers are not reflected in this report. ** The Duluth Scenic Highway 61, Eagan, and Rochester sites all had equipment issues in 2017 resulting in less than seven months of data being collected and were not included in this report.*

Reference Sites	2014	2015	2016	2017	Grand Total	% Bike	% Ped
Brainerd - Paul Bunyan Trail *	-	-	-	30,496	**30,496**	56%	44%
Brooklyn Park - Rush Creek Trail	-	-	111,347	105,685	**217,032**	68%	32%
Cass Lake - Migizi Trail *	-	-	-	7,609	**7,609**	48%	52%
Duluth - Lakewalk Trail	-	397,153	420,145	394,292	**1,211,590**	24%	76%
Duluth - Scenic Highway 61	-	15,345	14,511	**	**29,856**	Bicycles Only	
Eagan - Highway 13	14,978	15,726	15,386	**	**46,090**	Bicycles Only	
Lanesboro - Root River Trail *	-	-	-	86,904	**86,904**	77%	23%
Mankato - Veterans Memorial Brdg.	-	-	78,085	67,796	**145,881**	No Differentiation	
Minneapolis - Central Avenue	25,640	27,771	28,336	23,475	**105,223**	Bicycles Only	
Minneapolis - Franklin Avenue *	-	-	-	268,758	**268,758**	Bicycles Only	
Minneapolis - Park Avenue	-	-	101,317	93,844	**195,161**	Bicycles Only	
Minneapolis - West River Greenway	-	497,935	503,019	549,897	**1,550,851**	61%	39%
Moorhead - Highway 75 Trail *	-	-	-	41,968	**41,968**	55%	45%
Orono - Shadywood Drive *	-	-	-	33,219	**33,219**	Bicycles Only	
Rochester - MacNamara Bridge	-	102,826	83,116	**	**185,941**	26%	74%
St Cloud - Beaver Island Trail *	-	-	-	54,816	**54,816**	50%	50%
St Paul - Jackson Street *	-	-	-	151,923	**151,923**	15%	85%
St Paul - Summit Avenue	-	-	277,618	274,316	**551,934**	Bicycles Only	
Willmar - Lakeland Drive *	-	-	-	2,407	**2,407**	Bicycles Only	
Grand Total	**40,618**	**1,056,756**	**1,632,879**	**2,187,406**	**4,917,660**	**59%**	**41%**

Figure 6: Different types of permanent installations in Minnesota.

People Walking

More than 802,000 pedestrians were counted in 2017, resulting in an Annual Average Daily Pedestrian count of 2,198 pedestrians across nine reference sites. While sites in Duluth, Minneapolis, and Saint Paul recorded the most people walking, the difference between winter (December through March) and non-winter (April through November) volumes was greatest in Lanesboro (Table 6). On average, 54 pedestrians used the Root River Trail each day in 2017, but volumes by season varied significantly. For example, six times more people walk by the Root River site on an average non-winter day (75 people) compared to an average day in the winter (12 people). Regardless of site or season, this data shows that people walk year round. Further improvements in maintenance and network connections that make walking safer and more convenient could further increase the volumes throughout the year.

Table 6: 2017 average annual daily pedestrians and average daily pedestrians for winter (December through March) and non-winter (April through November) months.

Pedestrian Sites	Annual Peds	AADP	Jan ADP	Winter ADP	July ADP	Non-Winter ADP
Brainerd – Paul Bunyan Trail	13,568	37	15	15	64	48
Brooklyn Park – Rush Creek Trail	36,186	99	33	53	135	122
Cass Lake – Migizi Trail	3,956	11	4	6	20	13
Duluth – Lakewalk Trail	304,123	833	315	404	1,634	1,046
Lanesboro – Root River Trail	19,822	54	11	12	114	75
Minneapolis – West River Greenway	249,973	685	222	316	1,105	868
Moorhead – Highway 75 Trail	19,049	52	51	33	82	61
St Cloud – Beaver Island Trail	27,265	75	29	42	65	91
St Paul – Jackson St shared-use path	128,399	352	186	232	447	411
Grand Total	**802,340**	**2,198**	**867**	**1,113**	**3,665**	**2,736**

During Minnesota summers, roads and shared-use paths tend to be free of debris and obstacles. However, during winter, ice and snow can build up and narrow non-motorized facilities which may deter people from bicycling or shift them to walking, therefore contributing to a higher percentage of walkers in the winter (Figure 5). Figure 7 takes a closer look at this modal seasonality. It shows that at the four sites with at least two years of pedestrian data, the annual percentage of total people that walk in winter ranges from about 10 percent on the MacNamara Bridge in Rochester to roughly 20 percent on the West River Greenway shared-use path in Minneapolis.

Figure 7: Annual percentage of winter pedestrians (December through March) by year as shown in for the four sites with at least two years of data.

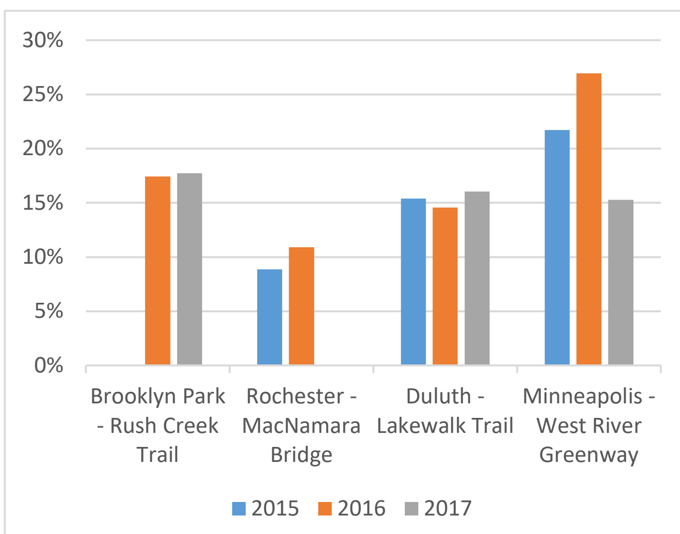
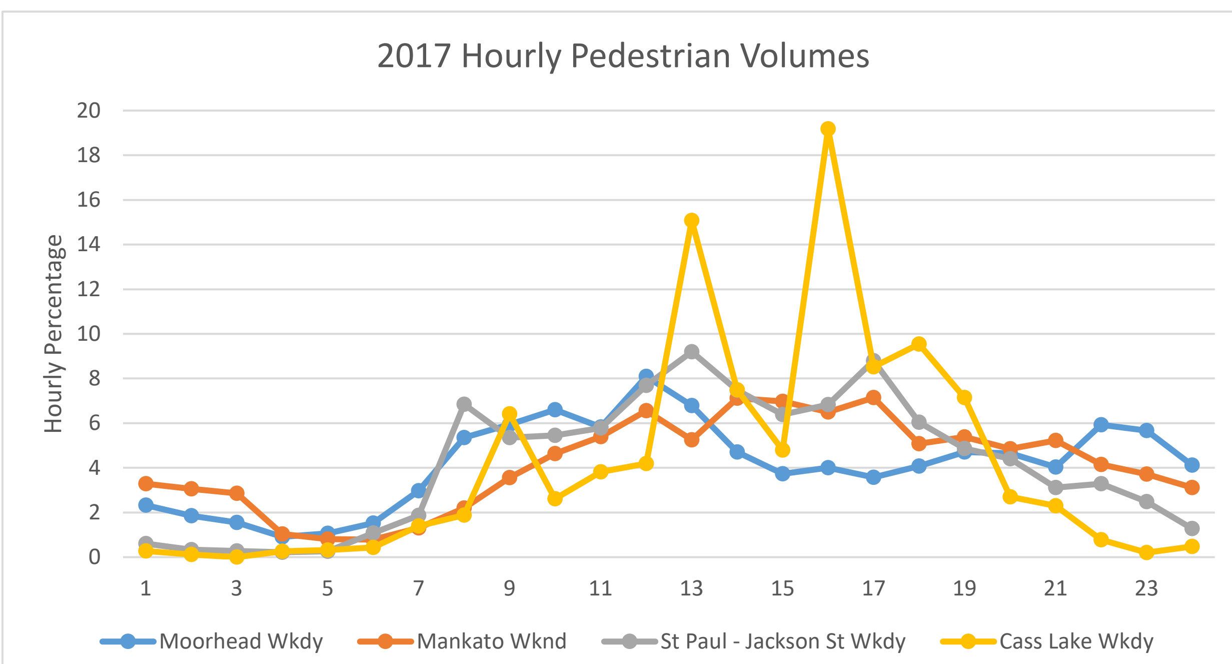


Figure 8: Examples of reference sites where people walking are counted.

The average number of pedestrians per hour varies widely from site to site. At the Jackson Street site in Saint Paul, pedestrians are most common during the workday with a peak around the noon hour when people may be walking for exercise, to get food or change work shifts (Figure 9). Weekday pedestrian traffic on the Migizi Trail in Cass Lake very closely resembles arrival and dismissal times for the middle school a quarter mile away. At both the Highway 75 trail in Moorhead (Figure 6) and the Veterans Memorial Bridge in Mankato (Figure 8) lots of people walk during evening hours (after 9 p.m.). This may be due to night life and bar close times, shift changes or because they are both near universities and daily schedules of students can vary widely.

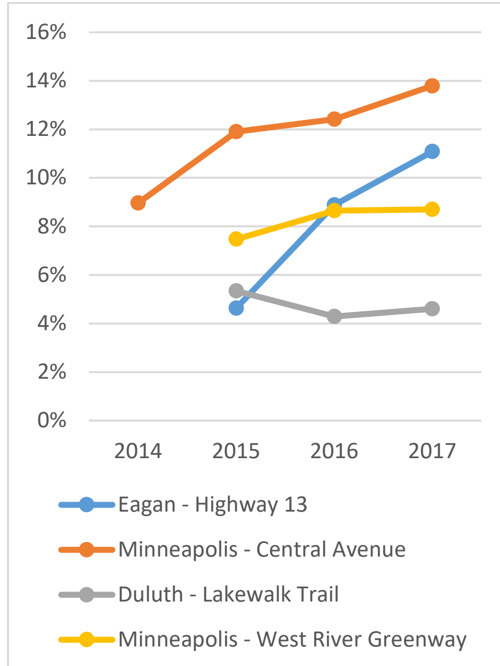
Figure 9: Percentage of people walking per hour by site and time period (Wkdy = weekday, Wknd = weekend).



People Bicycling

More than 1.3 million bicycle trips were counted at 15 reference sites in 2017, translating to 3,609 Average Annual Daily Bicyclists across the sites (Table 7). Like the busiest sites for people walking, the sites with the most people biking were in Minneapolis, Saint Paul and Duluth. Compared to pedestrian volumes, the change in the number of people bicycling during winter is more pronounced. For example, only one percent of total bike trips on the Root River Trail in Lanesboro were made during the winter, but nearly 18 percent of bike traffic on Summit Avenue in Saint Paul was in the winter – the highest winter bicycle share of any of the 2017 sites. Despite the lower numbers of winter bicyclists, winter riding continues to grow as a percentage of the overall annual bicyclists (Figure 10).

Figure 10: Percentage of winter riders by year for the four sites with at least three years of data.



The only real-time display tower in the state is installed on the west end of the Franklin Avenue Bridge in Minneapolis (Figure 12). Here, people can watch the number tick up as they ride over the inductive loops. They can also see a barometer displaying the total number of bikes that have passed by that year. The time and temperature are also displayed.

Table 7: Bicyclist volumes for the winter (December through March) and non-winter seasons of 2017.

Row Labels	Annual Bicyclists	AADB	Jan ADB	Winter ADB	July ADB	Non-Winter ADB
Brainerd - Paul Bunyan Trail	16,928	46	1	4	126	67
Brooklyn Park - Rush Creek Trail	69,499	190	9	37	476	266
Cass Lake - Migizi Trail	3,654	10	0	1	31	15
Duluth - Lakewalk Trail	90,169	247	21	34	734	353
Lanesboro - Root River Trail	67,083	184	3	4	577	273
Minneapolis - Central Avenue	23,475	64	18	27	109	83
Minneapolis - Franklin Ave Bridge	268,758	736	216	322	1,192	942
Minneapolis - Park Avenue	93,844	257	87	121	403	325
Minneapolis - West River Greenway	299,924	822	104	216	1,877	1,122
Moorhead - Highway 75 Trail	22,919	63	7	13	137	87
Orono - Shadywood Drive	33,219	91	4	15	223	129
St Cloud - Beaver Island Trail	27,551	75	10	18	174	104
St Paul - Jackson Street	23,524	64	8	17	130	88
St Paul - Summit Avenue	274,316	752	316	403	1,170	924
Willmar - Lakeland Drive	2,407	7	1	2	12	9
Grand Total	**1,317,270**	**3,609**	**805**	**1,233**	**7,371**	**4,787**

The number of people bicycling also changes by hour. On Park Avenue, a one-way street into downtown Minneapolis, the highest percentage of bicyclists is during the morning commute. But across the river, bicyclists travel in both directions on Saint Paul's Summit Avenue, creating clear morning and evening commute spikes (Figure 11). Weekend ridership on Beaver Island Trail in Saint Cloud and Rush Creek Trail in Brooklyn Park takes a more gradual smooth shape with peak traffic during the middle of the day.

Figure 11: Percentage of bicyclists per hour by site and time period (Wkdy = Weekday and Wknd = Weekend).

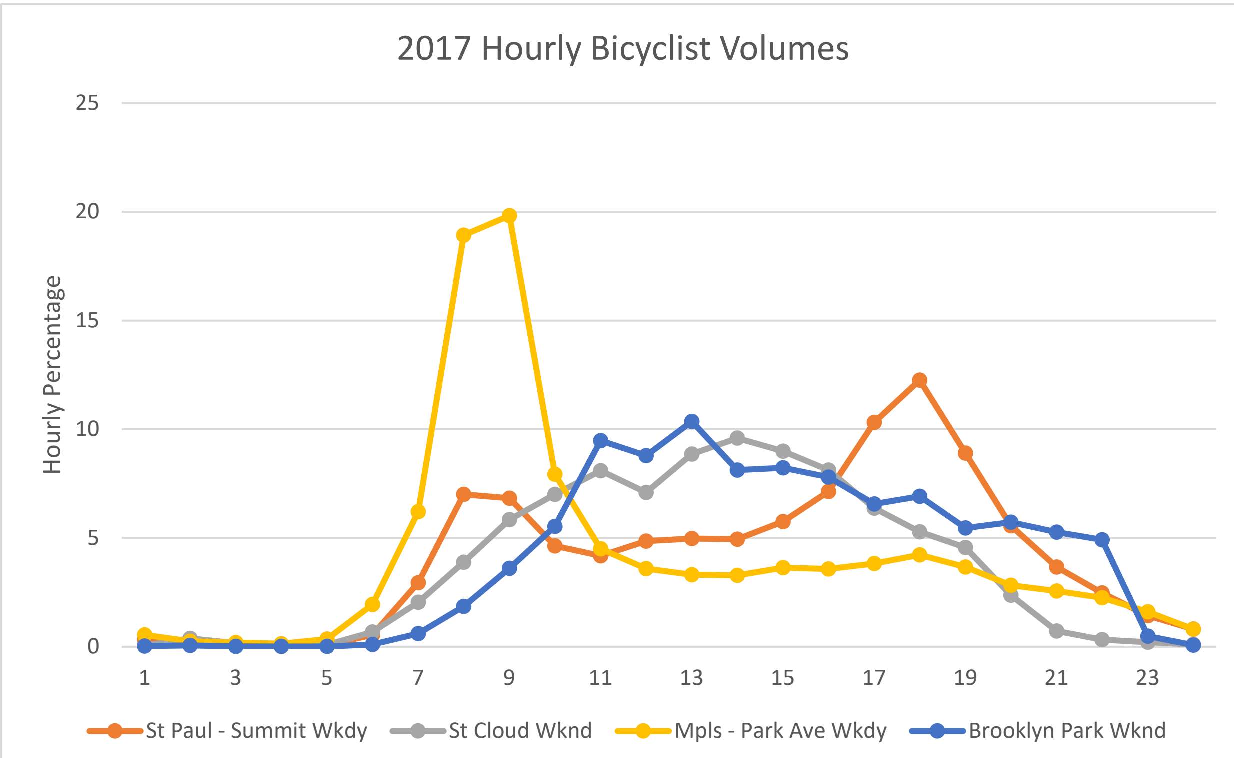


Figure 12: Examples of reference sites where people biking are counted.

Short Duration Sites (Portable Counters)

In cooperation with local jurisdictions throughout Minnesota, the Minnesota pedestrian and bicyclist count program also established MnDOT's short-duration automated bicycle and pedestrian counting efforts. Initially, that program used several types of technologies to count people and primarily inform on-going MnDOT research projects. With direction from the program team, MnDOT purchased 16 portable counters in 2015 and created eight counting kits (one for each MnDOT district) complete with two counters, a safety vest, hammer, road nails, tubes and installation instructions (Figures 13 and 15).

Figure 13: Equipment in each of the eight MnDOT counting kits.

The kits were distributed to host sites in each MnDOT district where they can be borrowed – free of charge – by local partners (Public Health, Parks Departments, non-profits, etc.). MnDOT recommends a minimum count period of nine days (one day for setup, seven complete days to collect data, and a day to take down and return). MnDOT provides annual training opportunities to teach both the hosts and borrowers how to use the equipment, navigate the data and use it to tell data-focused stories.

In 2017, MnDOT and its partners completed 25 short duration counts of at least six days. While most of the short duration locations have only been counted once, the geographic distribution is wide and the purposes are varied.

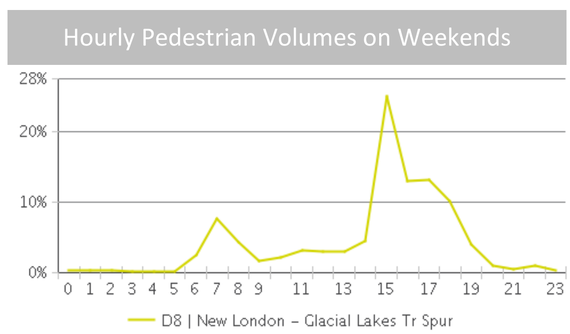
One of the locations counted was a local trail spur off the Glacial Lakes State Trail in the town of New London where the local trail network may connect to the Sibley State Park in the future (Figure 14). Both passive IR and tube counters were installed and collected 45 days of data in September and October 2017, capturing 2,636 pedestrians and 658 cyclists during that period. The data can be displayed in a lot of ways including by hour, day, week and month.

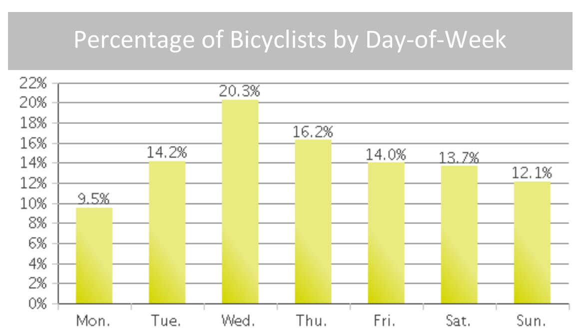
Of the MnDOT districts that provided complete installation location and duration information for each of their short duration counting sites, the portable counters were used to record 609 complete days of data in 2017 (Table 8). The

Figure 14: Several types of summarized data from a short duration site in New London.

Summary Data Table

Mode	Total Traffic	Daily Average	Busiest Day of the Week
Pedestrians	2636	59	Tuesday
Cyclists	658	15	Wednesday





Arrowhead Regional Development Commission in Duluth (MnDOT District 1) reported the most use with a total of 311 complete days of data collected using portable passive IR counters called "Pyros" (239 days) and portable tube counters (72 days). Overall, the Pyros were used more regularly than the tubes, but often both types of counters were installed at the same counting site to capture mode split (Pyro count – Tube count = Pedestrians and the Tube count = Bicyclists). There were no requests for using the portable counters in the Metro District in 2017 despite having a pair of them available. This may be due to many local partners having their own counting equipment and programs.

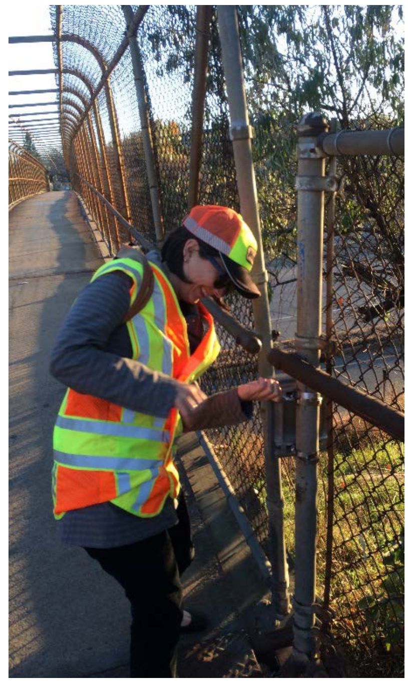
Table 8: The number of days of data collected by portable counter type in 2017 (D = district).

Counted Days	D1	D2	D3	D4	D6	D7	D8	Total
Pyro Days	239	6	-	49	19	-	45	**358**
Tube Days	72	6	32	32	19	45	45	**251**
Total	**311**	**12**	**32**	**81**	**38**	**45**	**90**	**609**

Table 9: Reasons for why borrowing parties collected short duration count data in 2017 (D = district).

Count Reason	D1	D2	D3	D4	D6	D7	D8	Total
Baseline Data	1	-	5	5	1	-	1	**13**
Before & After	-	-	-	1	-	-	-	**1**
Demonstration	1	-	-	-	-	-	-	**1**
Planning	5	-	-	1	-	-	1	**7**
Project Related	-	-	-	-	-	1	-	**1**
Equipment Test	-	-	-	-	-	-	1	**1**
Unknown	-	1	-	-	-	-	-	**1**
Total	**7**	**1**	**5**	**7**	**1**	**1**	**3**	**25**

Figure 15: Installation of a portable Pryo (passive IR) counter.



Borrowers of the equipment ranged widely and included regional development commissions, metropolitan planning organizations, the Minnesota Department of Natural Resources, cities and the Safe Routes to School program in Proctor, Minn. Reasons for counting were also quite varied with most of the installations collecting baseline information or data for planning purposes (Table 9).

Each MnDOT district has a main contact for borrowing counting equipment (Table 10).

Table 10: District contacts for borrowing portable bicycle and pedestrian counting equipment.

District	City	Contact	Phone	Email
1	Duluth	Charlie Moore	218-529-7553	cmoore@ardc.org
2	Bemidji	Darren Laesch	218-755-6554	darren.laesch@state.mn.us
3	St Cloud	Joseph Mueller	320-252-7568	mueller@stcloudapo.org
4	Fergus Falls	Wayne Hurley	218-739-2239	wayne@wcif.org
Metro	Roseville	Mackenzie Turner Bargen	651-234-7879	mackenzie.turnerbargen@state.mn.us
6	Rochester	Kurt Wayne	507-286-7680	kurt.wayne@state.mn.us
7	Mankato	Brett Paasch	507-304-6189	brett.paasch@state.mn.us
8	Willmar	Lindsey Bruer	320-214-6333	lindsey.bruer@state.mn.us

Next Steps

While MnDOT does not currently intend to expand its network of counters, it will continue to provide technical expertise to aid partners in collecting data throughout Minnesota, and apply knowledge gained to further research and improve biking and walking. To do that, the program is establishing a statewide taskforce, working collectively with partners to identify needs and limitations of non-motorized data in Minnesota, and exploring opportunities for future growth and collaboration.

Since many of the permanent counting stations were installed within the last three years, it is difficult to draw out meaningful trends, yet. However, as more data is collected, MnDOT will use it to better understand performance indicators, provide insight into risk exposure for safety analyses, develop better extrapolation factors, track progress related to goals and objectives and inform policies and plans. Local partners will likely use the data for many of the same reasons in addition to local evaluations of reconstruction projects (using before and after counts), planning maintenance activities or even pinpointing where a new facility would best serve users.

With more data, comes better predictive capabilities. With better predictive capabilities, the pedestrian and bicycle counting program aims to generate an average annual daily traffic interactive web map that will allow users to click on any road segment in Minnesota and see the expected volume of traffic broken down by mode – non-motorized and motorized – traveling along it. This level of information and detail will be helpful for the creation of future bike maps, identifying preferred non-motorized routes, and even calculating the health benefits of biking and walking.

Minnesota Pedestrian and Bicycle Data Taskforce

Minnesota is one of only a handful of states with a pedestrian and bicycle counting program, let alone an interagency collaboration with partners who are rapidly becoming interested and involved in non-motorized data collection and utilization. Due to the lack of peer examples and the need for building a robust non-motorized data management program, MnDOT organized a statewide taskforce in May 2018 to begin addressing common issues and developing best practices for a collaborative statewide model for data collection and management.

The taskforce is comprised of MnDOT, the Minnesota departments of health and natural resources, cities, counties, the University of Minnesota, a metropolitan planning organization, and out state partners among others. This group will help explore questions such as:

- How do we reduce or eliminate redundancy in data collection efforts?
- How should the data be managed? By whom? Where should it be housed?
- How do we ensure agencies are using the same data and telling the same data-driven stories in their reports?
- How do we support and sustain what we currently have? Especially in Greater Minnesota?

Improvements for Extrapolating Data

MnDOT's method for producing single site extrapolations factors is consistent with national best practices, but there is room for improvement. For example, the current practice to extrapolate data for a short duration count is to match the characteristics of that site with characteristics of a different site that has more data. Often characteristics such as surrounding land uses, facility type, nearby origins and destinations, and types of traffic patterns are used in the selection process. However, unknown characteristics may also affect a site's volumes and travel patterns (i.e. events or festivals, detours, winter maintenance, etc.) and are not accounted for in this methodology. Additionally, the current best practice only uses one year of data, whereas it's common for established motor vehicle monitoring programs to use three or more years of data. All this makes it difficult to choose the site with the best fitting factors.

For these reasons, MnDOT is exploring ways to eliminate the need for qualitative site comparisons and the guess work needed to apply factors, by generating one set of day-of-year extrapolation factors that combine data from all sites, all weather, and uses multiple years of data. This would further automate the generation and application of factors in a reliable and repeatable way. Using only one set of factors rather than choosing from 20 or more factors would also promote consistent data-driven story telling across all agencies and users of the data. MnDOT's preliminary attempts determined that one set of such factors has statistically shown to be a consistently good predictor when compared to same year single site factors.

Other Resources

The efforts of the Minnesota Pedestrian and Bicyclists Counting Program are further detailed in several other documents including:

- Hennepin County, Minnesota: Bike Count Report (2018)
- Parks and Trails Council: Minnesota State Trail User Count (2018)
- Minnesota's Bicycle and Pedestrian Data Collection Manual (2017)
- The Minnesota Bicycle and Pedestrian Counting Initiative: Institutionalizing Bicycle and Pedestrian Monitoring (2017)
- NCHRP Report 797: Guidebook on Pedestrian and Bicycle Volume Data Collection (2016)
- The Minnesota Bicycle and Pedestrian Counting Initiative: Implementation Study (2015)
- The Minnesota Bicycle and Pedestrian Counting Initiative: Methodologies for Non-Motorized Traffic Monitoring (2013)
- MnDOT's Bicycle and Pedestrian Traffic Counts Webpage