Minnesota Department of Transportation

Assessing the Economic Impact and Health Benefits of Bicycling in Minnesota

Task 5 Report
Collecting, reviewing, and summarizing existing estimates of bicycling infrastructure use

June 2015

Introduction

Assessing the Economic Impact and Health Benefits of Bicycling in Minnesota is a research study funded by the Minnesota Department of Transportation (MnDOT) to quantify to the extent possible in monetary terms the economic impact and health benefits of bicycling in Minnesota. In addition to information about the manufacturing, wholesale, and retail bicycling-related industries in the state, researchers need estimates of the number of bicyclists, as well as how often, how far, and where they ride, to achieve this objective. Not all of this information exists, and the available information about bicycle use in Minnesota never has been collected and integrated in a common database.

Task 5 of this research involves collecting, reviewing, and summarizing existing estimates of bicycling infrastructure use in Minnesota. The goal of Task 5 is to provide a comprehensive estimate of the magnitude of bicycling in the state. The principal deliverable is a technical memorandum that describes available information about bicycle use in Minnesota and estimates the range of bicycle use and traffic on different types of facilities. This DRAFT Task 5 Technical Memorandum describes the approach and methods used to assemble information about bicycling, and the results of analyses, including numbers of bicycle trips and BMT in counties throughout Minnesota.

Approach

Researchers and practitioners who work to understand, evaluate, or plan for bicycling generally work with two types of data:

- Survey data, specifically self-reports of frequency and duration of bicycling and other bicycling-related behaviors; and
- Counts of bicyclists on transportation facilities.

These two types of data are complementary, and both are required to understand bicycling from economic and health perspectives.

Survey data and self-reports of bicycle-related behaviors, which sometimes are referred to by economists and others as stated preference data, are needed to understand how many people within a population bicycle, how often they bicycle, how far they bicycle, why they bicycle, whether they wear helmets when they bicycle, and other behaviors needed to plan public infrastructure and programs. Samples of populations are required to obtain this information because it typically is too costly to conduct censuses of entire populations.

Sources of error in sample surveys that ask questions about behaviors include errors in self-reports, sample selection, and random error. Errors in self-reports occur when respondents provide inaccurate responses because their memories fail them or when they minimize negative behaviors or exaggerate positive behaviors (e.g., say they exercise more frequently than they actually do). While good surveys control for these sources of error, they are present to some degree in virtually all surveys.

Sample selection bias is a problem where people who are interested in a topic are more likely to "self-select" to participate in a survey, thereby reducing the sample's representativeness of the population. The potential for this problem is greater in special purpose surveys (e.g., MnDOTs Omnibus Survey or the Metropolitan Council's survey of use of parks and trails). Good methodologies can minimize this type of error, but it is likely present to some degree in some of the survey data summarized here. Random error occurs simply by chance, that is, results of well-designed sample surveys sometimes may yield results that are not representative of a general population simply by chance. All three sources of error are limitations that are useful to keep in mind in interpretation of results, but they do not preclude use of data for the purposes of this report, which include providing estimates of the amount of bicycling in Minnesota.

Counts of bicyclists on public infrastructure are useful for understanding where and when people bicycle, but they cannot be used to determine how many people in a population bicycle, how far they go when they ride, how often they ride, why they ride, or anything else specific to an individual cyclist's behaviors. Counts are most useful for transportation and recreation planners and engineers who want to understand spatial and temporal patterns in bicycling and improve system operations and optimize investments in facilities. Counts can be used to help project demand for new facilities or evaluation past investments. When used with self-reports of behavior and other socio-demographic information about cyclists, analysts can develop models of bicycling that include route-choice. For purposes of this report, counts are used mainly to provide perspective on the estimates of bicycling derived from integrating self-reports of cycling behaviors from sample surveys. Among other purposes, illustrating levels of use of particular facilities is helpful for understanding how demand for different types of infrastructure varies.

Methods

Consistent with the approach summarized above, the methods used in Task 5 to estimate bicycle use in Minnesota involved collection of both data from surveys of bicycle use and counts of bicycles on facilities. Data from surveys were used to estimate the magnitude of bicycling in Minnesota; counts from facilities are used to illustrate temporal and spatial patterns in use of bicycle facilities.

The two basic steps in completion of this task were:

- Literature review and data collection, and
- Data analysis and estimation.

No original data collection was planned in the original scope of work or undertaken for this task.

<u>Literature Review and Data Collection</u>

As noted, Task 5 involved collection of both sample survey data and counts of bicyclists on facilities. We identified previous and ongoing federal, state, and local efforts to collect quantitative measures about levels, frequency, or patterns of bicycling in Minnesota. We collected published reports, downloaded available data from public websites, and obtained copies of other datasets related to bicycling. Sources of information and types of data collected from them are presented in Table 1.

These data collection efforts focused on quantitative data for use in developing order-of-magnitude estimates of bicycling in Minnesota, informing economic analyses, and assessing health benefits. Published reports and documentation for datasets were reviewed to understand limitations of datasets and uncertainty associated with particular estimates. All data were imported into and analyzed using Excel ©.

Table 1. Sources and types of information collected about bicycling in Minnesota.	
Agency	**Data Collected**
U.S. Bureau of the Census, American Community Survey	• Commuting bicycle mode share, by county (Journey to work question)
MnDOT, Minnesota Bicycle and Pedestrian Counting Initiative	• Counts of bicycles in Minnesota cities and towns • MnDOT Omnibus Survey • Various published reports and datasets
Minnesota Department of Natural Resources (MDNR)	• Published estimates of trail use on selected DNR trails
Minnesota Department of Health (MDH)	• Counts of bicycles in Minnesota cities and towns (in cooperation with MnDOT)
Metropolitan Council (Council)	• 2010-11 Travel Behavior Inventory
Minneapolis Department of Public Works (MDPW)	• Counts of bicycles on Minneapolis streets and trails (2007-2013)
Minneapolis Park and Recreation Board (MPRB)	• Counts of mixed-mode trail traffic (i.e., undifferentiated bicyclists and pedestrian traffic) in Minneapolis
Transit for Livable Communities.	• Various published reports

Data Analysis and Estimation of Bicycling

After reviewing data available from the agencies listed in Table 1, we determined the best approach to estimating the number of bicycle trips and bicycle miles traveled (BMT) in Minnesota would be to begin with estimates of bicycle commuting mode share published annually by the U.S. Bureau of the Census for all counties in Minnesota and use the results from the Metropolitan Council's Travel Behavior Inventory (TBI) to augment them and develop estimates of bicycling for all purposes in Minnesota. Data from the MnDOT Omnibus Survey and counts of bicyclists on facilities across the state are used mainly to provide perspective on these estimates, assist with interpretation of them, and illustrate how bicycling varies temporally and spatially on different types of facilities.

The logic for beginning with the Census estimates and using data and inferences from the Metropolitan Council's TBI data to augment and extrapolate is as follows:

- The American Community Survey (ACS) is administered annually on a rolling basis throughout the year by the U.S. Bureau of the Census in every county in every state. The ACS does not ask individuals how many bicycle trips they make, but it does ask individuals how they generally get to work. Estimates of bicycle commuting mode share from the journey to work question in the ACS are the most consistent estimates of bicycling for the entire state, and these estimates have been used historically as performance indicators by FHWA, MnDOT, the Alliance for Biking and Walking, and other organizations. However, these estimates do not include bicycling commuting trips made by individuals who generally commute by other modes (i.e., they do not include part-time bicycle commuters), and they do not include bicycling trips made for other purposes such as shopping, recreation, or fitness. The ACS estimates of mode share, while valid given the wording of the question asked, therefore are incomplete measures of bicycling.
- The Metropolitan Council conducted its TBI for the Twin Cities Metropolitan Area (TCMA) between December 2010 and April 2012. The TBI included 30,284 individuals in 14,055 households, each of whom was asked to complete a 24-hour travel diary in which they recorded the origin, destination, and purpose of each trip.

Data from the TBI provide the most complete estimates of bicycle trips taken for commuting and some other purposes within a part of Minnesota. The TBI includes only 16 Minnesota counties, but these counties account for the majority of population of Minnesota. Because the TBI data can be analyzed for different geographies (i.e., cities, suburban counties around Minneapolis and St. Paul, and the ring or exurban counties that surround the suburban counties), they provide insight into geographic variation in bicycling. For example, bicycling commuter mode share is much lower in the ring counties than in Minneapolis and St. Paul. If it is assumed that bicycling patterns in the ring counties are roughly characteristic of patterns in greater Minnesota, then assumptions based on data from the TBI can be used to produce estimates of bicycling for all purposes in greater Minnesota. This assumption greatly simplifies variations in patterns that certainly exist across the state, but given the lack of better information and the limitations of relying solely on the ACS estimates, this approach is necessary to account for bicycle trips for different purposes throughout the state. The bicycle commuter share in the TBI is measured as the ratio of people whose home-based work trip(s) were made by bicycle to all individuals who made one or more home-based work trips. TBI responses are weighted using household expansion factors developed by the Metropolitan Council to represent the 19-county metropolitan region.

Although the TBI data include bicycle trips for some purposes in addition to commuting, the TBI also is an incomplete accounting of trips of all purposes, especially multipurpose trips for recreation and fitness. The TBI data are unlikely to include all recreation trips partly because the TBI was not administered on weekends when bicycle trips disproportionately occur. In addition, because many bicycle trips begin and end at the same destination, respondents may not record the trips as "travel." For example, if an individual drove to a lake in Minneapolis, rented a Nice Ride bicycle, and returned the bicycle to the same station, the trip may not be recorded. Similarly, if an individual drove to the North Shore and bicycled on the Gitchee Gami Trail, the trip may not be recorded. The methods used in this analysis likely do not account for all of these types of trips and therefore are conservative estimates of bicycling activity. Data collected in other tasks of this project that include participation in destination trail events may provide insight into the relative importance of this limitation.

Because both the ACS and the TBI were administered on a rolling basis through the year, answers with respect to bicycling are believed to reflect the seasonality known to be associated with patterns of bicycling in locations with temperate climates such as Minnesota.

Estimation of Annual Bicycle Trips in Minnesota

Estimation of the number of bicycle trips taken annually in Minnesota involved:

1. Adjusting county estimates of bicycle commuting from the ACS to account for the fact that people defined as bicycle commuters likely do not always bicycle to work;
2. Augmenting estimates of commuting trips made by bicycle with estimates of non-commuting trips by bicycle.

Both adjustments to ACS estimates were made using data from the Metropolitan Council's TBI, which includes estimates of total trips made by individuals by all modes for different purposes. The specific steps in estimating total number of bicycle trips in Minnesota were:

1. Extracted variables from the Census ACS: Population (B01003), Number of workers (B08301), Number of bike commuters (B08301) for the state and for each county. The number of workers was adjusted to exclude people who work from home.

2. Calculated bicycle mode share by county (number of bicycle commuters / number of workers).
3. Aggregated county estimates to different geographies to match geographies used in TBI analyses:
    a. Minneapolis
    b. St. Paul
    c. Hennepin County minus Minneapolis
    d. Ramsey County minus St. Paul
    e. Suburban 5 counties (Anoka, Carver, Dakota, Scott, Washington)
    f. MN-Ring 9 counties (Chisago, Goodhue, Isanti, Le Sueur, McLeod, Rice, Sherburne, Sibley, Wright; Wisconsin ring counties in TBI were excluded)
    g. Other 71 MN counties from ACS, using TBI values from MN-Ring 9 counties
    h. Entire state (calculated as sum of aforementioned geographies)
4. Estimated ratio of TBI bicycle commuting mode share to ACS commuting mode share for different geographies (to understand general magnitude of underestimation of bicycle commuting in ACS data).
5. Used TBI bicycle commuting mode share for the 9 ring (i.e., exurban) counties to adjust ACS commuting mode estimates for 71 counties in greater Minnesota.
6. Estimated total number of bicycling trips in each county by multiplying adjusted number of bicycle commuters times 2 (for return trip home) x 235 (the number of work days in a year after accounting for holidays, vacation, sick, and personal days).
7. Accounted for non-bicycling commuter trips made by bicycle commuters to account for the fact that many people classified by the ACS as bicycle commuters may not bicycle every day. The minimum number of days to be classified as a bicycle commuter would be three (of five); therefore the number of trips was multiplied by 60% to obtain a lower, conservative range estimate.
8. Used ratio of non-commute bicycle trips to commute bicycle trips from TBI to calculate non-work bicycle trips for TBI geographies and for greater Minnesota (using ratios from ring counties to adjust greater Minnesota counties), further adjusted by assuming non-work trips may be made on 260 weekdays throughout the year.
9. Added estimated commuting and non-commuting bicycling trips in each county to obtain estimates of total bicycle trips made in each county during work week (because the TBI provides estimates for trips only on weekdays).
10. Scaled up the estimated number weekday commute and non-commute trips to account for weekend trips.
11. Aggregated estimates of county bicycle trips to obtain estimates of bicycle trips statewide.

As noted, the range of final estimates is believed to be conservative because it assumes that weekend trips are proportional to weekday trips and because some types of recreational trips are unlikely to be recorded in the TBI. Data from counts of bicyclists on facilities throughout Minnesota indicate that weekend traffic often is higher. Because these estimates do not assume higher levels of non-commuting bicycling on weekends, they are likely to underestimate trips made for recreation, exercise, and non-commuting utilitarian purposes.

Estimation of Annual Bicycle Miles Traveled (BMT) in Minnesota

Estimation of miles traveled annually by bicyclists in Minnesota requires information about the length of trips taken by bicyclists. The TBI provides the best data available in Minnesota about the lengths of trips taken by bicycle for different purposes. To estimate miles traveled, we calculated the mean and median trip distances separately for commuting trips and trips taken for all other purposes. However, because outliers (e.g., a few cyclists with very long commutes) can influence mean values, we used median values for all estimates of miles traveled. Median values are not influenced by outliers and produce more stable estimates of a typical length.

To estimate BMT, we multiplied the median trip length for commute and non-commute bicycle trips times the number of trips taken during the year for each of the TBI geographies and for counties in greater Minnesota. Median trip lengths for trips in ring counties were used to estimate miles traveled for counties in greater Minnesota because it is assumed that travel patterns in these exurban counties are similar to those in counties in greater Minnesota.

Results

Number of Bicycle Trips and Bicycle Miles Traveled in Minnesota

Estimates of the total number of bicycle trips and annual BMT in the state of Minnesota and selected sub-geographies are presented in Table 2. For the state as a whole, depending on whether it is assumed that regular bicycle commuters bicycle three or five days per week, the number of bicycle trips is between 87 and 96 million annually. A key assumption in this estimate is that the ratio of non-commuting to commuting trips in counties in greater Minnesota is similar to the ratio for the ring counties surrounding the suburban counties in the Twin Cities metropolitan area. Similarly, assuming that the median lengths of trips taken for commuting and non-commuting bicycle trips in the ring counties and counties in greater Minnesota are similar, the number of miles traveled annually by bicyclists in Minnesota may range from 165 million to 198 million. Because recreational trips may be longer than commuter trips on average, the proportionate underestimate of BMT (relative to number of trips) is likely greater.

Table 2. Estimates of the range of bicycle trips and BMT in Minnesota.

Statewide	Population age 5+	Trips - Low Estimate	Trips - High Estimate	Miles - Low Estimate	Miles - High Estimate
Core Cities	627,861	31,568,455	36,717,945	64,330,319	81,782,345
Suburban Metro	2,066,735	28,487,560	31,072,908	47,997,399	62,780,683
Ring County Metro	462,678	5,439,864	5,684,446	10,608,246	10,704,518
Greater MN	1,839,126	21,579,517	22,522,578	42,150,122	42,521,326
7-County TCMA	2,694,596	60,056,015	67,790,852	112,327,718	144,563,029
Statewide Total	**4,996,400**	**87,075,396**	**95,997,876**	**165,086,086**	**197,788,872**
Statewide Average	**56,139**	**978,375**	**1,078,628**	**1,854,900**	**2,222,347**

The TCMA accounts for 69%- 72% of the total number of trips and miles traveled in the State even though it makes up only 54% of the state's population. This outcome is because the frequency of bicycling is much higher in the Twin Cities, particularly in Minneapolis. Minneapolis accounts for 29% of the number of trips taken annually and approximately 31% of the miles traveled annually.

Tables 3-6 include estimates for each county in Minnesota and the cities of Minneapolis and St. Paul. The estimates range widely from counties where there are only a few bicycle commuters to Hennepin and Ramsey Counties where there are both larger populations and higher numbers of bicycle commuters.

Figure 1 illustrates variation in summertime bicycle commuting mode share in the TCMA over time. Similar to the statistical summary in Table 2, Figure 1 shows that summertime bicycle commuting rates are much higher in Minneapolis and St. Paul. Variation across geographies is lower in winter when fewer people commute. Figure 2 shows variation in the estimated number of bicycle trips taken by county in Minnesota.

Table 3. Estimates of bicycle trips and BMT in Minneapolis and St. Paul					
Core Cities	**Population 5+**	**Trips - Low Estimate**	**Trips - High Estimate**	**Miles - Low Estimate**	**Miles - High Estimate**
City of Minneapolis	361,874	25,120,781	29,389,925	50,105,346	63,105,824
City of St. Paul	265,987	6,447,674	7,328,020	14,224,973	18,676,521
Total	**627,861**	**31,568,455**	**36,717,945**	**64,330,319**	**81,782,345**
Average	**313,930**	**15,784,227**	**18,358,972**	**32,165,160**	**40,891,173**

Table 4. Estimates of bicycle trips and BMT in suburban counties.					
Suburban Metro	**Population**	**Trips - Low Estimate**	**Trips - High Estimate**	**Miles - Low Estimate**	**Miles - High Estimate**
Anoka	311,981	3,303,916	3,388,075	4,004,239	5,145,339
Carver	86,276	912,415	934,850	1,090,281	1,394,469
Dakota	374,949	3,973,355	4,076,234	4,847,694	6,242,617
Hennepin minus Minneapolis	731,488	9,767,335	11,312,405	21,973,659	30,818,831
Ramsey minus St. Paul	213,644	6,842,766	7,580,781	11,634,160	13,473,946
Scott	122,285	1,295,396	1,328,641	1,574,744	2,025,501
Washington	226,112	2,392,377	2,451,922	2,872,621	3,679,980
Total	**2,066,735**	**28,487,560**	**31,072,908**	**47,997,399**	**62,780,683**
Average	**295,248**	**4,069,651**	**4,438,987**	**6,856,771**	**8,968,669**

Table 5. Estimates of bicycle trips and BMT in ring counties.					
Ring County Metro	**Population**	**Trips - Low Estimate**	**Trips - High Estimate**	**Miles - Low Estimate**	**Miles - High Estimate**
Chisago	50,631	593,619	619,276	1,160,200	1,170,299
Goodhue	43,391	510,355	533,421	994,940	1,004,019
Isanti	35,451	415,749	433,785	812,393	819,493
Le Sueur	25,954	305,949	320,203	595,381	600,992
McLeod	34,033	400,905	419,409	780,604	787,887
Rice	60,645	709,548	739,286	1,389,101	1,400,807
Sherburne	82,614	972,585	1,017,098	1,894,669	1,912,190
Sibley	14,162	166,231	173,536	324,587	327,463
Wright	115,798	1,364,923	1,428,431	2,656,370	2,681,368
Total	**462,678**	**5,439,864**	**5,684,446**	**10,608,246**	**10,704,518**
Average	**51,409**	**604,429**	**631,605**	**1,178,694**	**1,189,391**

Table 6. Estimates of bicycle trips and BMT in Greater MN Counties					
Greater MN	**Population**	**Trips - Low Estimate**	**Trips - High Estimate**	**Miles - Low Estimate**	**Miles - High Estimate**
Aitkin	15,311	177,301	183,588	349,973	352,447
Becker	30,635	358,398	373,399	701,697	707,601
Beltrami	41,644	486,367	506,208	953,537	961,346
Benton	35,966	423,418	442,802	824,835	832,465
Big Stone	4,923	57,276	59,479	112,627	113,494
Blue Earth	60,763	719,578	755,145	1,395,199	1,409,198
Brown	24,104	283,594	296,463	552,739	557,804
Carlton	33,274	388,912	404,965	762,000	768,319
Cass	26,804	311,175	322,696	613,005	617,540
Chippewa	11,499	135,136	141,174	263,621	265,998
Clay	55,642	656,905	688,118	1,276,824	1,289,110
Clearwater	8,132	94,300	97,727	185,928	187,277
Cook	4,972	58,424	61,034	113,978	115,005
Cottonwood	10,970	128,296	133,639	251,254	253,357
Crow Wing	58,789	685,628	712,987	1,345,720	1,356,489
Dodge	18,728	220,756	231,034	429,611	433,657
Douglas	34,197	401,696	419,527	783,920	790,938
Faribault	13,636	159,645	166,398	312,385	315,043
Fillmore	19,493	228,515	238,376	446,662	450,544
Freeborn	29,261	343,402	358,449	670,651	676,573
Grant	5,625	65,982	68,856	128,902	130,033
Houston	17,894	210,605	220,212	410,351	414,133
Hubbard	19,193	223,296	231,865	439,128	442,502
Itasca	42,777	497,626	516,692	978,698	986,202
Jackson	9,657	113,434	118,464	221,382	223,362
Kanabec	15,263	177,863	184,875	349,318	352,078
Kandiyohi	39,391	463,935	485,292	903,469	911,875
Kittson	4,283	49,997	52,018	98,068	98,863
Koochiching	12,588	146,534	152,206	288,047	290,280
Lac qui Parle	6,796	79,380	82,623	155,613	156,890
Lake	10,230	119,685	124,701	234,313	236,287
Lake of the Woods	3,790	44,472	46,416	86,864	87,629
Lincoln	5,503	64,509	67,291	126,092	127,188
Lyon	23,878	282,031	295,512	547,982	553,288
Mahnomen	4,938	57,398	59,565	112,967	113,820
Marshall	8,915	104,511	109,020	204,284	206,059
Martin	19,540	229,236	239,228	447,821	451,754

Table 6. Estimates of bicycle trips and BMT in Greater MN Counties					
Greater MN	**Population**	**Trips - Low Estimate**	**Trips - High Estimate**	**Miles - Low Estimate**	**Miles - High Estimate**
Meeker	21,643	253,619	264,499	495,893	500,175
Mille Lacs	24,164	282,316	293,898	553,326	557,885
Morrison	30,932	362,484	378,038	708,740	714,863
Mower	36,387	426,774	445,318	833,862	841,161
Murray	8,147	95,403	99,457	186,635	188,231
Nicollet	30,812	363,886	381,251	707,099	713,934
Nobles	19,771	232,391	242,801	453,279	457,377
Norman	6,368	74,277	77,247	145,773	146,942
Olmsted	135,400	1,599,475	1,676,068	3,107,412	3,137,560
Otter Tail	54,099	632,824	659,264	1,239,103	1,249,510
Pennington	13,111	154,705	162,003	300,835	303,708
Pine	27,800	323,526	336,004	636,083	640,995
Pipestone	8,864	103,914	108,398	203,112	204,877
Polk	29,473	346,163	361,501	675,614	681,651
Pope	10,332	121,060	126,241	236,736	238,775
Red Lake	3,821	44,946	46,977	87,622	88,422
Redwood	14,922	174,423	181,632	341,723	344,561
Renville	14,569	170,696	178,000	333,803	336,678
Rock	8,987	105,508	110,159	205,984	207,814
Roseau	14,605	172,452	180,663	335,152	338,384
St. Louis	189,710	2,218,569	2,310,913	4,344,959	4,381,307
Stearns	141,386	1,665,024	1,741,568	3,242,743	3,272,872
Steele	33,920	399,686	418,205	778,054	785,343
Stevens	9,149	107,273	111,910	209,658	211,483
Swift	9,126	107,015	111,647	209,135	210,959
Todd	23,042	269,031	279,955	527,570	531,870
Traverse	3,339	39,034	40,653	76,462	77,099
Wabasha	20,321	239,038	249,860	465,959	470,219
Wadena	12,863	149,256	154,736	294,144	296,301
Waseca	17,903	210,274	219,591	410,397	414,064
Watonwan	10,413	122,511	128,068	238,785	240,972
Wilkin	6,201	72,751	75,923	142,118	143,366
Winona	48,864	576,515	603,680	1,121,143	1,131,836
Yellow Medicine	9,676	113,485	118,411	221,747	223,686
Total	**1,839,126**	**21,579,517**	**22,522,578**	**42,150,122**	**42,521,326**
Average	**25,903**	**303,937**	**317,219**	**593,664**	**598,892**

FIGURE 1 Summer mode shares by geography of trip origin.

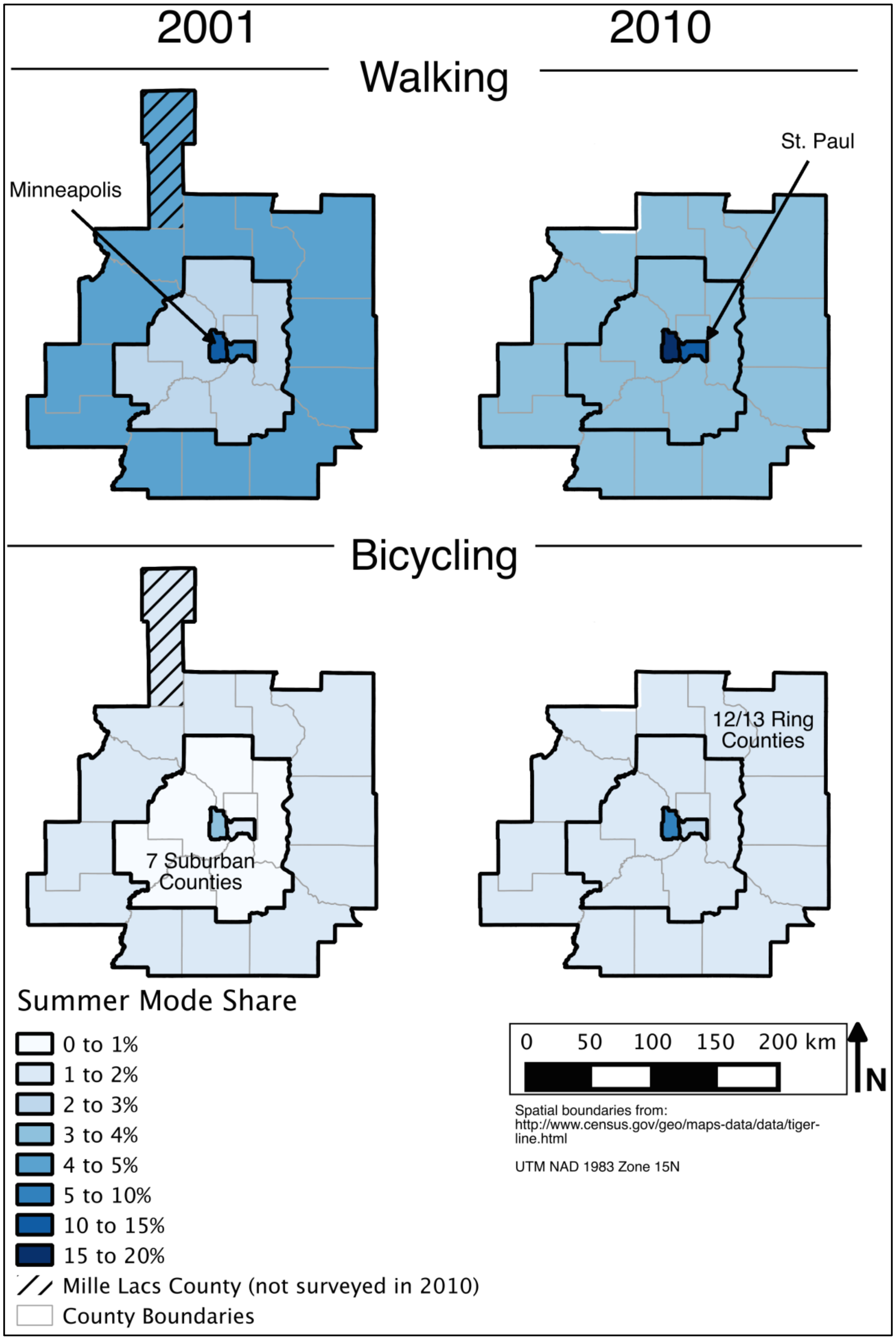
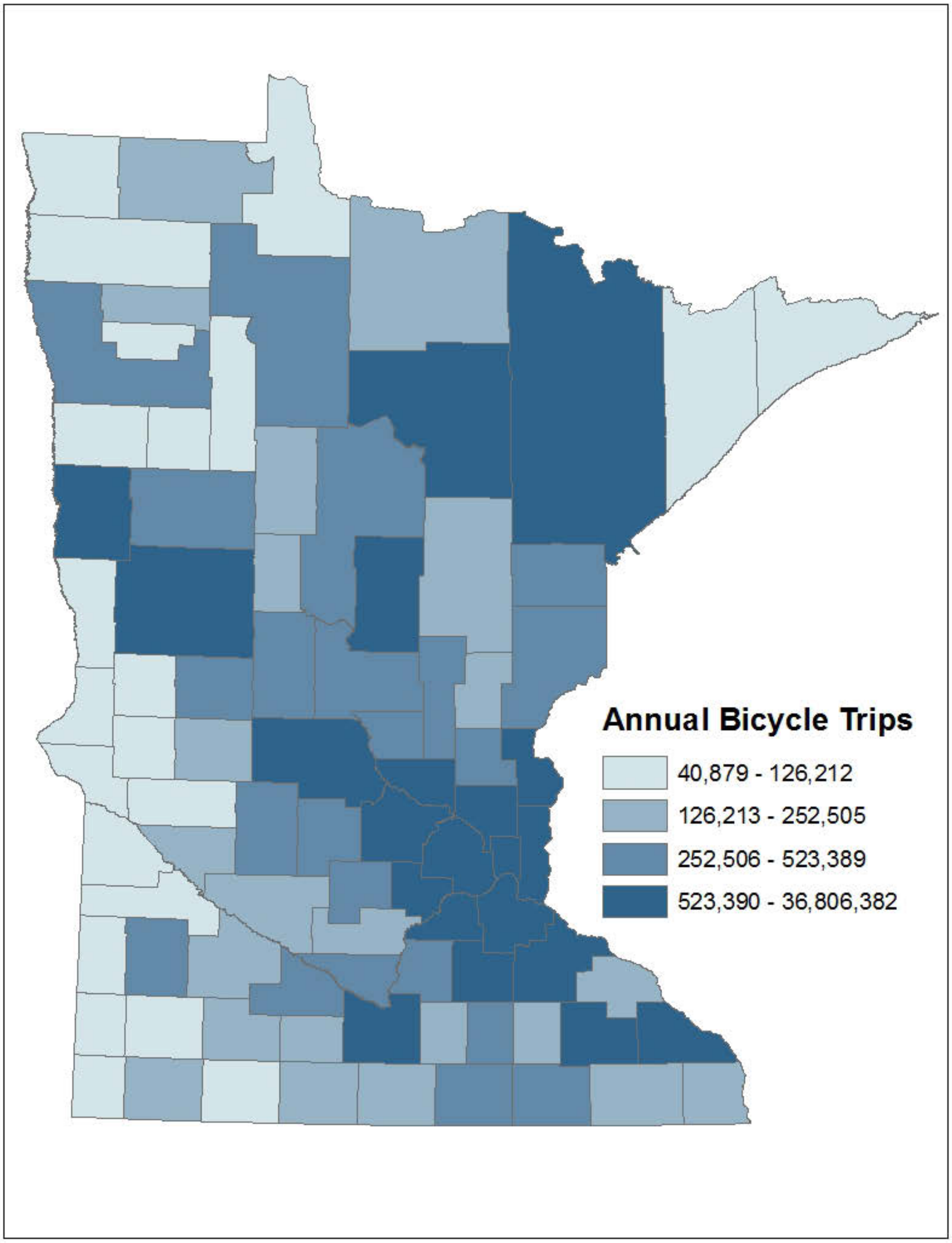


FIGURE 2. Estimated number of annual bicycle trips in Minnesota counties (Tables 3-6).



The MnDOT Omnibus 2013 Public Opinion Survey: Estimates of Bicycling Frequency

Another useful source of information about bicycling by residents of Minnesota is the annual Omnibus Public Opinion Survey conducted by MnDOT with support from The Improve Group and Dieringer Research Group. The 2013 Omnibus Survey, which includes questions people's opinions of all modes of transportation in Minnesota, asks people about frequency of bicycling, perceptions of safety, and other factors that affect their propensity to bicycle. The survey is administered annually to a random sample that is representative of the adult population in Minnesota. In 2013, Minnesota's population was approximately 5.42 million; the population of adults 18 and over was approximately 4.14 million.

In 2013, 619 (55%) of the 1,127 respondents to the survey said they had bicycled at least once between April and October, the highest percentage since 2008. The 55% who said they had cycled participated at different rates (Table 7):

- 11% said they had cycled only once;
- 45% said they cycled once per month or a few times a season;
- 38% said they cycled at least once a week; and
- 7% said they cycled every day.

The percentage of frequent riders – cyclists who said they ride at least once a week or daily – varied little across the state, from 24% in the metro counties to 26% in Greater Minnesota.

These responses can be used to provide a ballpark estimate of the number of bicycle trips made annually by adults in Minnesota. The approach involves multiplying the number of individuals in each response category by an estimate of the ride count during the cycling season (i.e., April – October) for that category, and then summing across all response categories. This approach yields an estimate of 123.9 million trips annually, an estimate which is approximately 23% higher than the top end of the range of estimates developed using the Census data and TBI results. The fact that similar estimates are derived using different sources of data and methods is evidence of, that the estimates are the right order-of-magnitude. From a methodological perspective, given potential sources of error in the two approaches, it is not surprising the estimate developed from the Omnibus Survey is higher. The Omnibus survey is more likely to include all recreational trips, which could explain part of the difference. In addition, questions like those in the Omnibus Survey, which ask people to report their frequency of engaging in a desirable behavior, are more likely to exhibit a "yea-saying" bias—or overestimation of that behavior—than are diaries in which people record specific behaviors. These two potential sources of difference for the ACS/TBI estimates (i.e., inclusion of more recreational and fitness trips and increased potential for over-estimation) likely offset each other somewhat. Regardless, the results from the Omnibus Survey are informative and provide perspective on the number of bicycling trips taken annually in Minnesota.

The Omnibus Survey also included questions about safety and other factors that potentially affect an individual's propensity to cycle. Approximately 85% of respondents said Minnesota was somewhat safe or very safe for bicycling, a percentage that has remained constant for three years after rising from 70% in 2008. Among respondents who believe Minnesota is not safe for cycling, the three most significant concerns are distracted drivers (71%), roadway shoulders that are not wide enough (64%), and aggressive driving (53%). Other concerns mentioned by at least 50% of those individuals concerned about safety were: not enough physical barriers between cars and bicycles, drivers not following the laws, and not enough dedicated bike lanes. Respondents from Metro counties (88%) were more likely than respondents from counties in Greater Minnesota (81%) to rate bicycling as somewhat or very safe. Perceptions of safety were positively correlated with frequency of riding.

With respect to commuting, 75% and 76% of respondents in the Metro Counties and in Greater Minnesota, respectively, said work was “too far” to bicycle. The similarity in percentages of respondents from the Metro Counties and Greater Minnesota who identify as frequent cyclists provides support for using the TBI results from the TCMA to augment estimates of commuting frequency in greater Minnesota.

Table 7. Estimated bicycle trips in Minnesota: 2013 (adapted from MnDOT 2013).

Reported Riding Frequency (April – October)	Percentage of Respondents in Frequency Category	Estimated Adult Population in Frequency Category*	Estimated Rides During Cycling Season	Estimated Rides
One Time	11%	451,722	1	451,722
Once / Month	45%	1,882,173	7	13,175,212
Once / Week	38%	1,581,025	29	45,849,736
Every Day	7%	301,148	214	64,445,607
Total	100%		—	123,922,276

*Estimated Minnesota adult population in 2013: 4,142,454

Use of Bicycle Infrastructure in Minnesota

Estimates of the use of bicycle infrastructure complement estimates of the numbers of trips made and BMT, and illustrate variations in use of different types of facilities. The examples presented here are taken from studies, reports, and publications by the agencies listed in Table 1. The most important source of data about bicycle traffic on roads and trails in Minnesota is a recent DRAFT report, “The Minnesota Bicycle and Pedestrian Counting Initiative: Implementation Study,” which currently is under review by MnDOT (Lindsey et al., 2015). This DRAFT report summarizes automated bicycle counts that have been completed in Minnesota since 2013. Most of the estimates are from bicycle counts taken in Minneapolis and the Twin Cities Metropolitan Area, although some estimates are available for greater Minnesota. The results include bicycle counts from permanent sites established in Duluth, Eagan, and Minneapolis and short-duration counts taken in Bemidji, Grand Marais, Hennepin County, and Minneapolis.

Bicycle Traffic Volumes at Permanent, Automated Monitoring Sites in Minnesota

Table 8 summarizes bicycle traffic counts taken at permanent monitoring locations on roads in Duluth, Eagan, and Minneapolis and on trails in Duluth, Minneapolis, and Rochester. These counts were obtained from inductive loop sensors in roads and on road shoulders that distinguish bicycles from cars (or, in the case of trails, inductive loop sensors integrated with infrared sensors). The sensors were deployed as part of MnDOT’s Minnesota Bicycle and Pedestrian Counting Initiative (Lindsey et al. 2015). Pedestrian traffic volumes also are reported for multiuse trails to illustrate the ranges of mode share that occur on trails. The results show significant variation across monitoring locations, with higher bicycle traffic counts on multiuse trails in urban areas than on urban roads, and higher bicycle traffic on urban roads than rural trails or roads.

Table 8. Bicycle traffic at permanent monitoring locations in Minnesota (Lindsey et al. 2015)					
Location	**Mode / Direction**	**Period Analyzed**	**Average Daily Traffic During Period**	**Maximum Monthly Average Daily Traffic**	**Day of Week with Highest Volume**
Street/ Road Locations					
Duluth: Scenic 61	Bikes #1	7/1/2014 – 4/30/2015	21	73 (July)	Sat.
	Bikes #2	7/1/2014 – 4/30/2015	18	67 (July)	Sun.
Eagan: Trunk Highway 13	Bikes #1	5/1/2014 – 4/30/2015	23	52 (July)	Sat.
	Bikes #2	5/1/2014 – 4/30/2015	21	43 (July)	Tues.
Minneapolis: Central Avenue	Bikes #1 NB	5/1/2014 – 4/30/2015	37	61 (July)	Sat.
	Bikes #2 SB	5/1/2014 – 4/30/2015	58	67 (July)	Wed.
Trail Locations					
Duluth: Lake Walk	Bikes	7/1/2014 – 4/30/2015	137	454 (August)	Sat.
	Peds	7/1/2014 – 4/30/2015	752	1,762 (July)	Sat.
Minneapolis: W. River Parkway	Bikes	7/1/2014 – 4/30/2015	765	1,854 (July)	Sun.
	Peds	7/1/2014 – 4/30/2015	380	586 (August)	Sat.
Rochester: McNamara Bridge Trail	Bikes	6/1/2014 – 4/30/2015	128	307 (July)	Sun.
	Peds	6/1/2014 – 4/30/2015	71	149 (June)	Sat.

Bicycle Traffic Volumes at Short-duration, Automated Monitoring Sites in Minnesota

As part of the Minnesota Bicycle and Pedestrian Counting Initiative, MnDOT also has completed or collaborated in short-duration bicycle counts for periods of 2 to more than 10 days using pneumatic tubes and other types of sensors at locations in Bemidji (Table 9), Grand Marais (Figures 3 and 4), and Hennepin County/Minneapolis (Tables 10, 11, and 12). Similar to the traffic counts from the permanent monitoring sites, the bicycle volumes counted at the short-duration sites show substantial variation, with higher volumes in urban areas on trails and high-class functional roadways (e.g., arterials, collectors), and lower volumes on residential streets or trails in suburban and more rural areas. Bicycle traffic volumes at some locations were more than 1,000 per day, while the volumes at some locations were in the single digits. These differences reflect spatial differences in population density, land use, access to destination and other factors. These results overall reinforce results from the ACS, TBI, and Omnibus surveys that indicate bicycling volumes are higher in more urban areas.

Table 9. Bicycle traffic volumes at short duration monitoring sites in Bemidji.					
Location	Type of Sensor	Complete Days of Monitoring	Mean Daily Traffic	Mean Weekday Traffic	Mean Weekend Day Traffic
Lake Bemidji Trail	Chambers Radio Beam (bikes & peds)	19	55	56	54
Claussen Avenue					
• Northbound	MetroCount pneumatic tube	19	7	8	6
• Southbound			6	6	6
• Total			13	14	12
First Avenue (westbound)	MetroCount pneumatic tube	3			

Figure 3 Bicycle traffic at short duration monitoring locations in Grand Marais (Moving Matters, 2014).

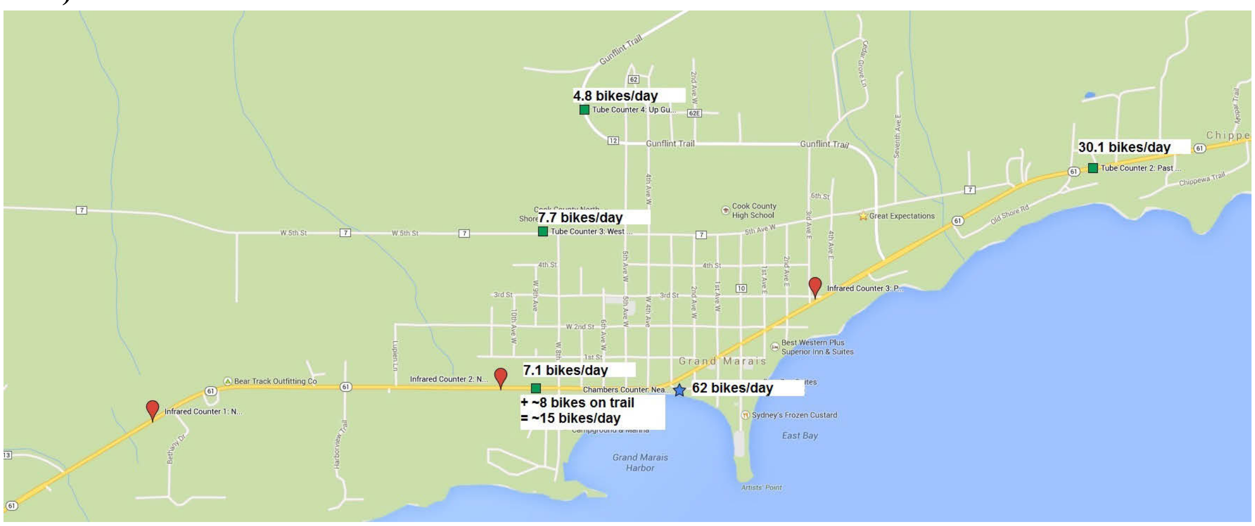


Figure 4. Bicycle and pedestrian traffic on Wisconsin Avenue, south sidewalk, Grand Marais (Moving Matters 2014).

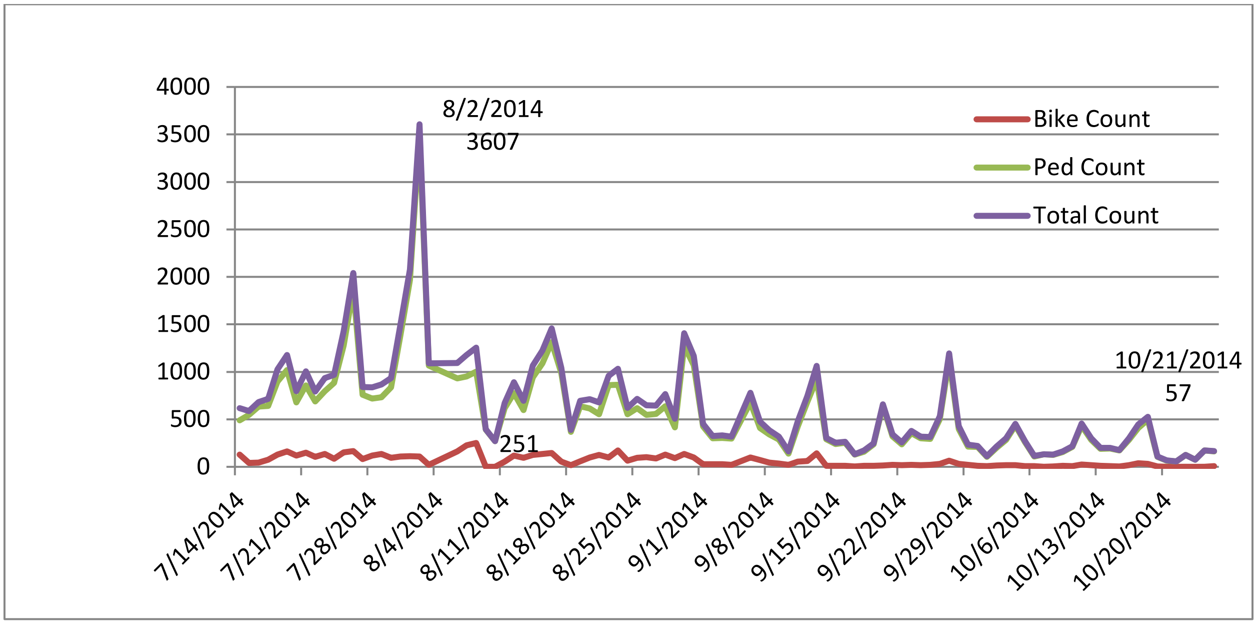


Table 10. Bicycle monitoring activity in Hennepin County 2013-14 (Lindsey et al., 2015).							
Year	Locations	Road Sites	Trail Sites	Number of Sites Reported	Mean Monitoring Days / Sites Reported	Minimum Monitoring Days for Sites Reported	Maximum Monitoring Days for Sites Reported
2013	11	7	4	9*	9 .7	6	14
2014	12	9	3	10**	5.2	3	8
Total	23	16	7	19	7.8	3	14

*Data from 2 of the 7 road sites are not reported because installation problems resulted in collection one or fewer days of data.
**Data from two sites not reported.

Table 10. Bicycle traffic volumes on roads at short-duration monitoring sites in Hennepin County 2013-14 (Lindsey et al. 2015)											
		Mean Daily Bike Traffic		Mean Weekday Bike Traffic		Mean Weekend Daily Bike Traffic		Hourly Traffic Patterns (factor group)			
Year (sites)	Device: classification algorithm	Min	Max	Min	Max	Min	Max	Commuter	Mixed	Multi-purpose	Not enough data to classify
2013 (5)	MetroCount: ARX	11	162	12	175	9	123	2	3	0	0
	Metrocount: BOCO	40	191	45	202	27	156	2	3	0	0
2014 (4)	MetroCount: ARX	9	407	13	407	0	262	0	2	0	2
	MetroCount: BOCO	10	372	15	379	0	357	0	2	0	2
2014 (8)	TimeMark	15	1,070	21	1,659	4	482	2	5	0	1

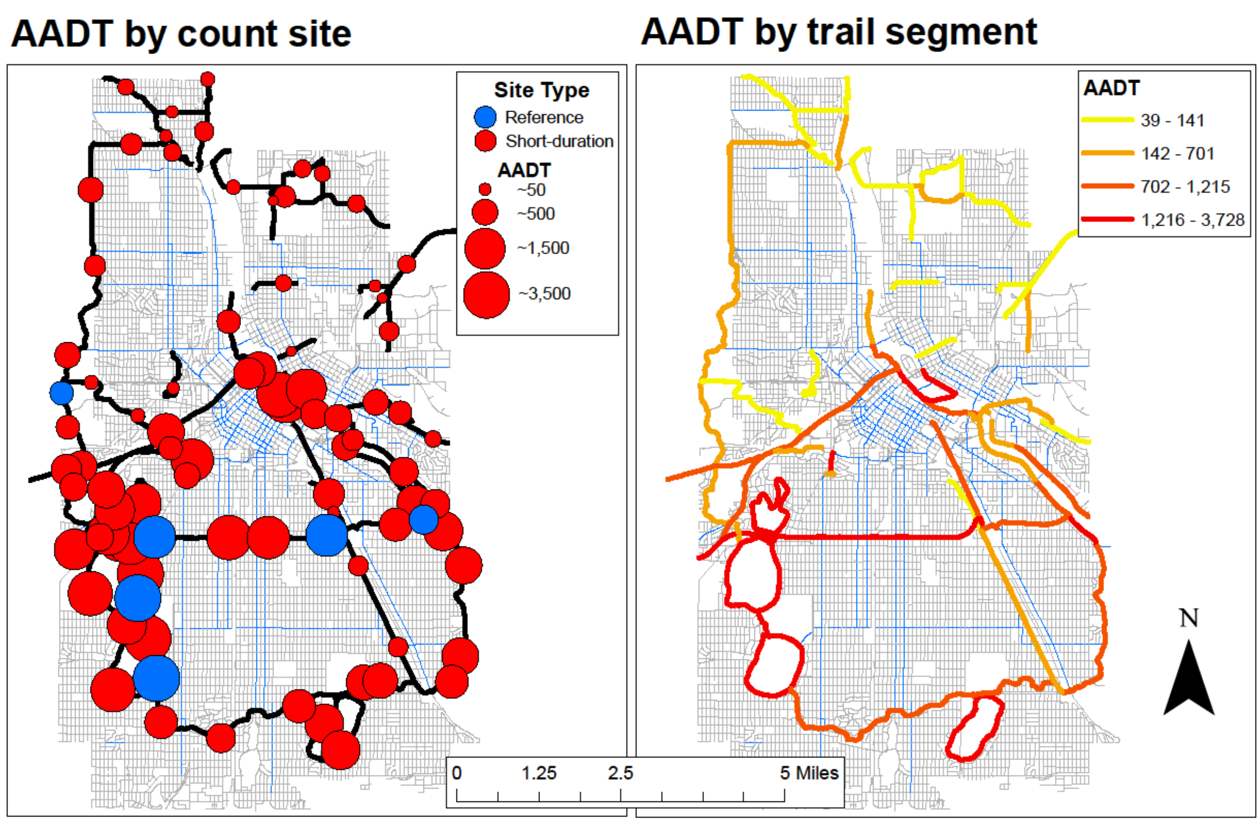
Table 11. Bicycle traffic volumes on multiuse trails at short-duration monitoring sites in Hennepin County 2013-14 (Lindsey et al. 2015)											
		Mean Daily Bike Traffic		Mean Weekday Bike Traffic		Mean Weekend Daily Bike Traffic		Hourly Traffic Patterns (factor group)			
Year (sites)	Device: classification algorithm	Min	Max	Min	Max	Min	Max	Commuter	Mixed	Multi-purpose	Not enough data to classify
2013 (4)	MetroCount: ARX	<1	263	<1	323	<1	162	1	1	1	1
	Metrocount: BOCO	<1	287	<1	344	<1	192	1	1	1	1
		M.G. Cedar	M.G Hen-nepin		M.G Hen-nepin	M.G. Cedar	M.G Hen-nepin				
2014 (2)	MetroCount: ARX	1,700	1,701	1,673	1,683	1,756	1,747	0	2	0	0
	MetroCount: BOCO	1,981	2,170	1,790	2,036	2,361	2,506	0	2	0	0
	TimeMark	1,409	1,703	1,271	1,691	1,683	1,733	0	2	0	0

Annual Average Daily Trail Traffic and Trail Miles Traveled in Minneapolis

Traffic analysts at MnDOT produce two common performance indicators – annual average daily traffic and vehicle miles traveled – from traffic counts taken at permanent and short-duration sites for motorized vehicles. The data do not exist to develop comparable measures for bicycles, but the principles of traffic data analysis potentially can be applied to bicycle traffic monitoring to obtain estimates of BMT.

However, researchers at the University of Minnesota, in collaboration with the Minneapolis Park and Recreation Board and the Minneapolis Department of Public Works, have monitored trail traffic with infrared counters on each of the 80 miles of trail within Minneapolis. Using standard engineering procedures outlined in the FHWA's *Traffic Monitoring Guide*, the researchers have estimated annual average daily trail traffic (AADTT) and trail miles travelled (TMT) for each trail segment and the network as a whole. These estimates of AADTT and TMT are for mixed-mode traffic – bicyclists and pedestrians combined – because the infrared monitors do not differentiate between types of trail users. Because of this limitation, these estimates cannot be interpreted solely as bicycle counts, but they illustrate both that trail use can be substantial and that intensity of use varies considerably across individual segments in the system. For individual segments on the network, estimates of AADTT range from as low as 40 to more than 3,700, and for the network as a whole, the estimate of TMT is approximately 28 million miles. The variation in trail use in Minneapolis is illustrated in Figure 5.

Figure 5. 2013 AADTT by Trail Segment in Minneapolis (Lindsey, Hankey, and Marshall 2014).



Implications for Policy and Planning

These analyses present the first-ever estimates of the total number of bicycle trips and bicycle miles traveled annually in Minnesota. These estimates also illustrate variation in bicycle traffic across the state in urban and rural areas and on different types of facilities.

The estimates of bicycle trips based on the ACS and TBI data are conservative because they likely undercount bicycle trips made for purposes of recreation and fitness. The estimates of trips from the MnDOT Omnibus survey, which are higher, likely include more recreational trips but potentially have other limitations, including the possibility that people may have overstated their frequency of cycling. Even if the totals are underestimates, the analyses show that Minnesota residents take tens of millions of bicycle trips annually and travel millions of miles by bicycle. These estimates can be used to inform other studies, including health impact assessments and other studies that require estimates of physical activity to assess health benefits. Other tasks being undertaken as part of this research project, particularly new analyses of bicycle-related events and destination trail use, may yield insights into the levels of recreational bicycling that are not fully included in these estimates.

The estimates of bicycle traffic at selected locations on roads and trails across Minnesota also illustrate that levels of bicycling activity in particular locations, especially on urban trails and urban roads near important commercial or recreational destinations, can be substantial. The spatial variation in counts is consistent with the variation observed in survey results.

MnDOT's Draft Bicycle Systemwide Plan includes recommendations for a statewide bicycle traffic monitoring program and use of bicycle traffic counts to inform the development of performance indicators. The procedures used to develop these estimates are relatively straightforward and could be replicated periodically as new results from the ACS or the MnDOT Omnibus survey become available. Further exploration of innovative ways to use these and related results to inform transportation policy and planning seems warranted.

Literature Cited

Lindsey, G., Petesch, M., and Hankey, S., (2015, forthcoming). "The Minnesota Bicycle and Pedestrian Counting Initiative: Implementation Study, DRAFT Final Report." Minnesota Department of Transportation, Research Services Section, St. Paul, MN.

Lindsey, G. Hankey, S., Wang, X., and Chen J. (2013). "The Minnesota Bicycle and Pedestrian Counting Initiative: Methodologies for Non-motorized Traffic Monitoring, Final Report." Minnesota Department of Transportation, Research Services Section, St. Paul, MN.

Lindsey, G., Hankey, S., and Marshal, J. (2015). "New Performance Measures for Urban Trails." Association of Collegiate Schools of Planning, Philadelphia PA, Nov. 2014.

Moving Matters (2014). HIA Draft Assessment: Highway 61 Corridor Project (powerpoint presentation), Sawtooth Mountain Clinic, Grand Marais, MN (December 16).

Metropolitan Council. 2013 (October). "Travel Behavior. The 2010 MSP Regional Travel Behavior Inventory (TBI) Report. Home Interview Summary. A Summary of Resident Travel in the Twin Cities Region." St. Paul, Minnesota.

Schoner, J., Lindsey, G., and Levinson, D. (2015). "Task 7. Biking and Walking Over Time." Prepared for Metropolitan Council, St. Paul MN. University of Minnesota, Minneapolis MN>

Schoner, J. and Lindsey, G. (2015). “Differences Between Walking and Bicycling Over Time: Implications for Performance Management.” *Transportation Research Record. Journal of the Transportation Research Board*, forthcoming.

Schoner, J., Lindsey, G., and Levinson, D. (2015). “Nice Ride Minnesota Program Evaluation. Minneapolis-St. Paul Bike Share System.” Prepared for Center for Prevention at Blue Cross and Blue Shield of Minnesota, Eagan MN. University of Minnesota, Minneapolis.

US Census Bureau. (n.d.). Place of Work and Journey to Work. Retrieved March 5, 2015, from http://www.census.gov/acs/www/about_the_survey/place_of_work_journey_to_work_questions/