Bicycling in Bloomington:

Establishing a Baseline of Use and Determining Trends in Ridership

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Planning Department
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Acknowledgements:
This report could not have been produced without the contributions of the volunteers who spent many hours counting bicyclists at intersections throughout the city. Special thanks to those who contributed to the data collection efforts referenced in this report.

Introduction

Bicycling has received increased attention from the City of Bloomington. After receiving recognition as a Bicycle Friendly Community by the League of American Bicyclists (LAB) in 2003 and then increasing its distinction from Bronze to Silver level in 2010, the Bloomington City Council formed the Platinum Biking Task Force to increase the bicycle friendliness of Bloomington to the LAB Platinum level (currently the highest distinction offered by LAB) by the year 2016.

Bloomington will achieve Platinum status by increasing its rating in each of the LAB's "Five Es" of education, encouragement, engineering, evaluation, and enforcement. In order to address each of these criteria for bicycle friendliness, the City must research and document the volume and patterns of bicycle use as well as the characteristics of bicyclists. The "Evaluation" criterion, the "E" most applicable to this report, is the cornerstone of good planning; knowing the strengths and weaknesses of the bicycling community in Bloomington will allow bicycle advocates to pursue education, encouragement, engineering, and enforcement opportunities where they will have the greatest impacts.

This report serves as an initial attempt to quantify the level of bicycle activity in Bloomington. Providing an initial baseline of use will allow the City of Bloomington to determine whether the level of bicycle use has increased, to discover gaps in bicycle infrastructure, and to investigate facilities that may not be considered safe. In order to generate the baseline of bicycle use, this report relies on collected data from observations at intersections and of bicycle parking facilities.

Section one contains estimates of bicycle activity based on one-hour counts of cyclists crossing different intersections throughout downtown Bloomington and the IU campus area. It attempts to answer the study question, "What is the baseline of bicycle activity in downtown Bloomington?"

Section two attempts to demonstrate a bicycle ridership trend from observations of bicycle parking in downtown Bloomington. Section two addresses the study question, "Has bicycle ridership changed in the past year?"

Section One: Intersection Counts of Bicycle Activity

Estimating Bicycle Activity in Five Scenarios

This section of the report seeks to determine the City of Bloomington's current level of bicycle activity by estimating the daily number of intersection crossings by cyclists throughout the study area. These counts are then extrapolated to daily values using five different methods. Bicycle activity differs from ridership in that activity describes the number of bicycles in use at a discrete location and time. Bicycle ridership reflects the number of regular bicycle riders in the community. Activity depends in part on ridership but also on the distance and frequency of each rider's trips. A single cyclist might be counted more than once during an activity count. Providing some estimate of baseline activity will help City staff determine trends in bicycle activity over time and patterns of activity across locations. This section of the report is also meant to assist the City in refining its data collection and analysis methods.

The level of bicycle activity in a given community is difficult to determine. Surveys which differentiate among transportation modes are reliable to the extent that those surveyed represent the population, and many cities have determined that actual count data is more reliable than the anecdotal or hypothetical data collected through surveys. Generally, cities collect data and then use a variety of different methods to generate estimates of overall bicycle activity in the community.

Assumptions:

Because this study lacks 24-hour data across several locations, it will make the following assumptions to generate estimates:

Assumption #1

This study is based on counts that have been conducted between 8:00 AM and 7:00 PM; this period captures a portion (approximately 70-75% by most estimates) of weekday bicycle activity.

- Traffic studies suggest that 75% of trips occur between the hours of 7:00 AM and 7:00 PM for motor vehicles and 6:30 AM and 6:30 PM for other modes[1]
- Other studies of bicycle and pedestrian activity have assumed that 95-97% of trips occur between the hours of 6:00 AM and 10:00 PM[2]

Assumption #2

This report supposes that bicycle traffic across different locations within the study area follows a similar daily trend or pattern of use and that a single daily use profile applies to all intersections.

- Because there are few observations for each location, it is difficult to determine whether use profiles across locations are consistent. For the purpose of this analysis, we suppose that daily use of the network follows a similar distribution across all intersections.
- The report also assumes that weekday use and weekend use share a similar use profile, though this may not be the case. The majority of data collection occurred on weekdays.
- Also, the count data were collected in spring and fall, so the activity profile may not apply to winter and summer as readily, especially if the university generates a good deal of bicycle activity.

1. Minneapolis Bicycle & Pedestrian Count Report (2009); Robert Seyfried, Northwestern University Center for Public Safety. The point that bicycle traffic and motor vehicle traffic share similar trip patterns may be contested.
2. The National Bicycle and Pedestrian Documentation Project (2009).

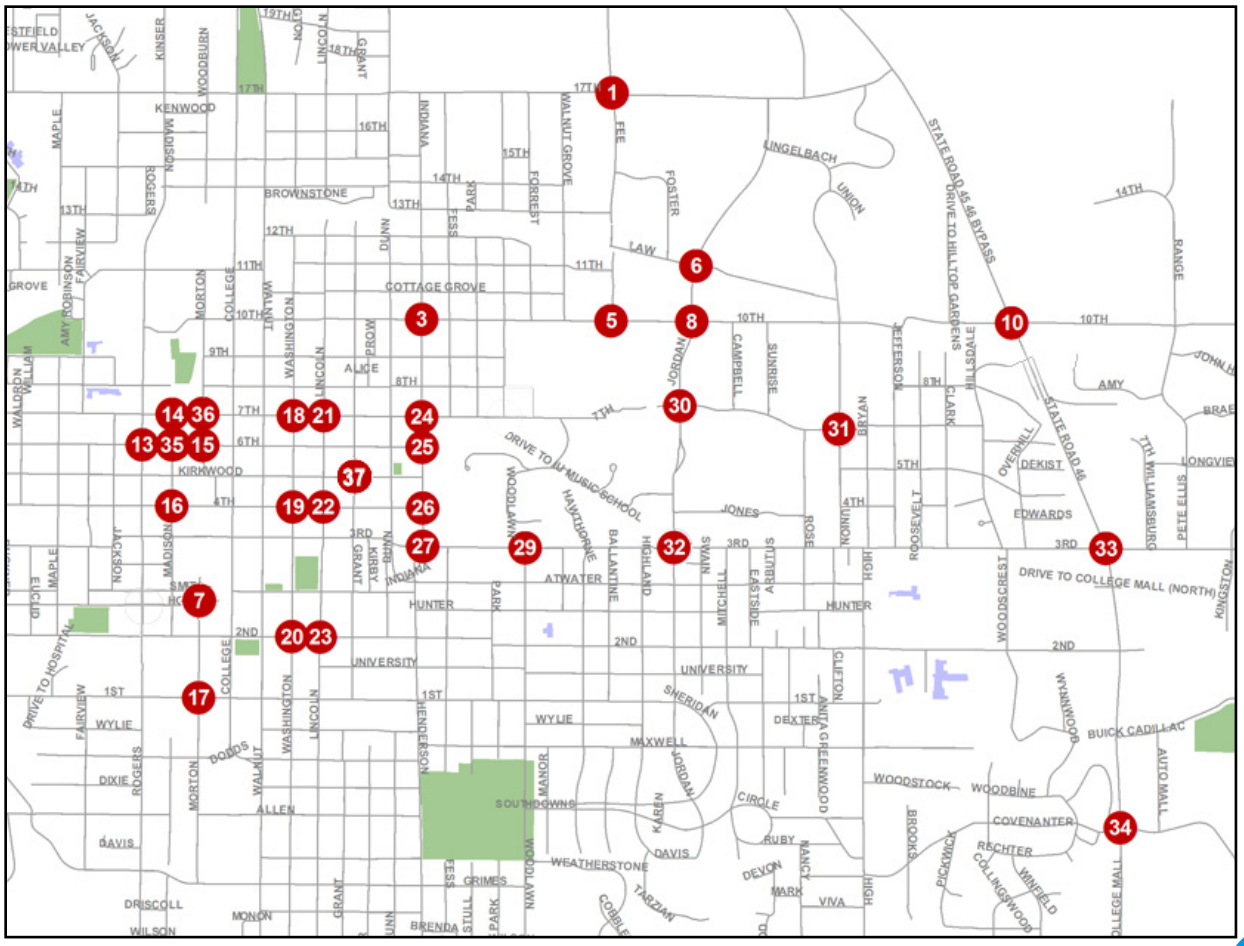
Methodology for Section One:

During designated weeks in the spring and fall of 2010, City staff and volunteers recorded hourly counts of the number of times bicyclists passed through an intersection of the study area. The study area consisted of 31 different intersections in the downtown and Indiana University (IU) campus area of the City of Bloomington (Figure 1). City staff chose this study area for its high expected bicycle activity level given the following criteria: proximity to destinations such as IU, high mixture of land uses, and the extent of bicycle accommodations. Volunteers recorded each cyclist's gender and the direction of entry into the intersection in 15-minute increments. The total number of one-hour observations is 181. No automated counts were taken for this study.

Section one of the report extrapolates the hourly data provided by the 2010 hourly bicycle counts to estimate the total daily bicycle activity at all intersections of the study area. By projecting daily bicycle activity estimates in five different scenarios, this report aims to determine the most suitable and consistent method of estimation. Additionally, the raw count data collected by staff and volunteers are available in Appendix A.

Figure 1: Intersections in the Section One Study Area

Numbers in red circles are intersection ID codes.



Scenarios:

This study estimates daily bicycle activity according to five scenarios. Other scenarios are possible and will vary in accuracy depending on how closely they resemble the actual distribution of daily bicycle activity. Also, as indicated in the section on assumptions, these estimates are intended to capture weekday activity. For a detailed account of the methods used to calculate estimates, see Appendix B.

Scenario #1: Flat Use

The mean number of cyclists on the road does not vary by hour throughout the day.

- For this scenario there is no peak use time.
- Hourly counts follow a uniform distribution from 8:00 AM to 7:00 PM, as demonstrated in Table 1.
- This is the least likely scenario since bicycle activity likely varies over the course of the day due to commuting patterns and activity around Indiana University. It likely inflates the daily rider activity estimate when the data comes from a relatively low use time (early morning in a location which is not a morning commute route). Also, it would conversely deflate daily bicycle activity estimates for data corresponding to relatively high use times.

Scenario #2: Two Peak Times

The mean number of cyclists on the road varies according to daily commutes, as determined by the Minneapolis Bicycle Master Plan.

- Peak times occur from 7:30 to 10:00 AM and from 4:00 to 7:00 PM
- Activity is low outside peak use hours (with exception of a slight midday rise)
- Hourly percentages of total daily bicycle activity are listed in Table 2.

Table 1. Scenario 1 Percentage of Daily Bicycle Activity by Hour

Hour	Percentage of Daily Activity
8:00 – 9:00	6.5
9:00 – 10:00	6.5
10:00 – 11:00	6.5
11:00 – 12:00	6.5
12:00 – 13:00	6.5
13:00 – 14:00	6.5
14:00 – 15:00	6.5
15:00 – 16:00	6.5
16:00 – 17:00	6.5
17:00 – 18:00	6.5
18:00 – 19:00	6.5
Total	**71.5%***

Table 2. Scenario 2 Percentage of Daily Bicycle Activity by Hour

Hour	Percentage of Daily Activity
8:00 – 9:00	7.7
9:00 – 10:00	5.5
10:00 – 11:00	3.8
11:00 – 12:00	4
12:00 – 13:00	4.1
13:00 – 14:00	4.7
14:00 – 15:00	5.3
15:00 – 16:00	6.5
16:00 – 17:00	9.5
17:00 – 18:00	10.5
18:00 – 19:00	9.5 est.
Total	**71.1%**

* Totals should be between approximately 70 and 75% of daily activity, as designated by Assumption 1. Scenario 3 has a slightly different set of assumptions.

Scenario #3: National Bicycle and Pedestrian Documentation Project (NBPDP) Method

The mean number of cyclists on the road varies by hour according to standards set by the National Bicycle and Pedestrian Documentation Project. Hourly percentages of bicycle activity according to this standard are displayed in Table 3.

- Note that the total percentage of bicycle activity for the data collection period comprises 77% of expected daily count, as opposed to the 70-75% benchmark for other scenarios.
- The advantage of this method of estimating bicycle activity is that several other areas use it, so it can be used as a standard of comparison. The disadvantage of this method is that it does not necessarily describe unique local use patterns, so resulting estimates could be inaccurate. For example, the national estimation method may not account for the unique effect of Indiana University on non-motorized travel patterns.

Scenario #4: Single-Peak Normalized Distribution

The mean number of cyclists on the road varies by hour according to a normal distribution centered on the midday peak between 1:00 and 2:00 PM (See Table 4).

- Due to the number of cyclists on and around Indiana University campus, the daily peak in bicycle ridership may coincide with the period of greatest activity on the IU campus.[3] Based on the median count by hour in Figure 2, this peak likely occurs in the middle of the day.

Table 3. Scenario 3 Percentage of Daily Bicycle Activity by Hour

Hour	Percentage of Daily Activity
8:00 – 9:00	4
9:00 – 10:00	5
10:00 – 11:00	6
11:00 – 12:00	7
12:00 – 13:00	9
13:00 – 14:00	9
14:00 – 15:00	8
15:00 – 16:00	8
16:00 – 17:00	7
17:00 – 18:00	7
18:00 – 19:00	7
Total	**77%**

Table 4. Scenario 4 Percentage of Daily Bicycle Activity by Hour

Hour	Percentage of Daily Activity
8:00 – 9:00	4.8
9:00 – 10:00	5.7
10:00 – 11:00	6.5
11:00 – 12:00	7.1
12:00 – 13:00	7.5
13:00 – 14:00	7.7
14:00 – 15:00	7.5
15:00 – 16:00	7.1
16:00 – 17:00	6.5
17:00 – 18:00	5.7
18:00 – 19:00	4.8
Total	**70.9%**

3. The one-peak profile with highest use in the middle of the day concurs with a study of Boulder, CO (Schneider et al, for Federal Highway Administration, 2005).

Scenario #5: Distribution Inferred from Observations

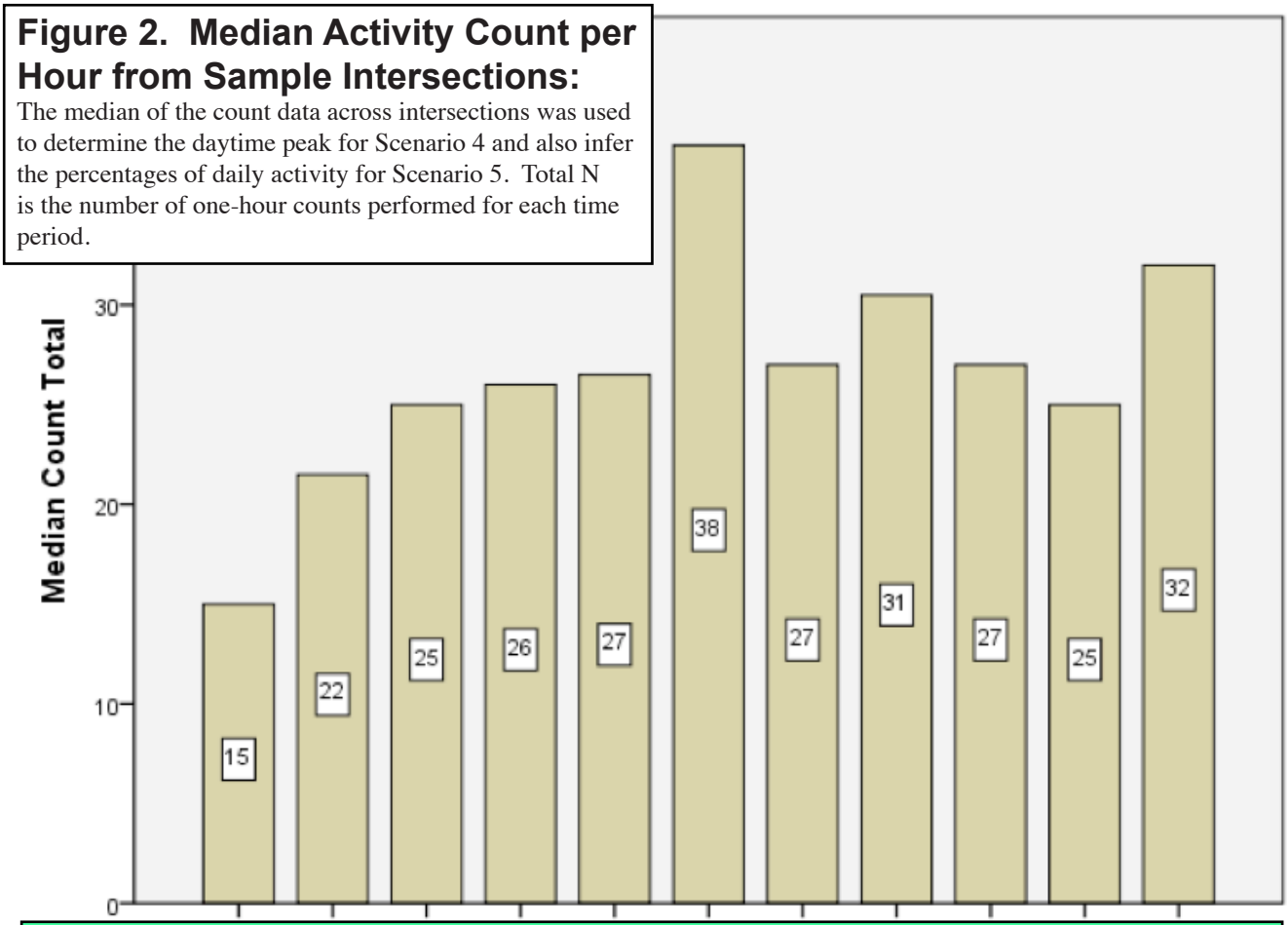
The mean number of cyclists on the road varies by hour according to the data collected (See Table 5).

- This method uses the actual data collected to infer how to weight the counts based on the hour of data collection. The median count per hour across intersections was taken from all study area intersections and used to determine the hourly percentage of bicycle activity in the study area. These medians are listed in Figure 2.

Table 5. Scenario 5 Percentage of Daily Bicycle Activity by Hour

Hour	Percentage of Daily Activity
8:00 – 9:00	3.6
9:00 – 10:00	5.3
10:00 – 11:00	6.0
11:00 – 12:00	6.3
12:00 – 13:00	6.5
13:00 – 14:00	9.2
14:00 – 15:00	6.5
15:00 – 16:00	7.5
16:00 – 17:00	6.5
17:00 – 18:00	6.0
18:00 – 19:00	7.7
Total	**71%***

Figure 2. Median Activity Count per Hour from Sample Intersections:
The median of the count data across intersections was used to determine the daytime peak for Scenario 4 and also infer the percentages of daily activity for Scenario 5. Total N is the number of one-hour counts performed for each time period.



Start time	8:00	9:00	10:00	11:00	12:00	1:00	2:00	3:00	4:00	5:00	6:00
Total N	**8**	**24**	**34**	**24**	**10**	**8**	**9**	**15**	**23**	**17**	**9**

* Total in Scenario 5 may not appear to sum correctly due to rounding.

Section One Results:

Each of the five scenarios produced different estimates for activity at each intersection per day (24-hours). Based on the results in Table 6, Scenarios 3 and 4 give the most conservative estimates of daily activity; Scenarios 1 and 5 predict similar levels of daily activity; Scenario 2 projects the highest level of daily activity.

Table 6: Estimates of the Number of Times Bicyclists Passed through a Study Area Intersection per 24-hour Day, Based on Five Scenarios

	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	No Peak	**Two Peaks**	**NBPDP Case**	**One Peak**	**Inferred**
Mean	610	761	575	604	625
Median	464	462	443	459	471
High	3,435	5,415	2,671	2,952	3,416
Low	31	53	33	31	33

The medians from the estimates are probably more reliable because the means are influenced more by disproportionately high values from the relatively few high-activity intersections.

Because we are assessing bicycle activity across several locations, the per intersection means and medians do not tell us exactly how many trips are taken or how many riders there are; what these do tell us is that, by the most conservative counts, the typical intersection experiences between an estimated **440 and 575** crossings by cyclists daily. Applied across the study area, the most conservative estimate projects that cyclists cross the 31 intersections of the study area between **13,640 and 17,825** times daily (within a 24-hour period).

The highest activity intersections in the study area may experience a daily volume of up to 2,600 crossings (in the most conservative estimate), and some intersections may have as few as 30 crossings per day. When compared with motor vehicle traffic counts, bicycle traffic at 7th Street and Jordan Avenue makes up between 10 and 15% of daily on-street traffic, while at 6th Street and Madison Street, bicycles make up between 5 and 10% of daily on-street traffic. At locations such as 10th Street and the SR 45/46 Bypass, bicycles account for less than 0.5% of daily traffic.

Table 7 displays the mean daily estimates for each of the five scenarios for each intersection in the study area, and Figure 3 demonstrates mean daily estimates from Scenario 3 (because it provides the most conservative estimates) and distribution of use across intersections in the study area.

Further study could expand on these findings. An in-depth spatial analysis that identifies corridors of travel could potentially minimize double counting and give a more accurate representation the number of commuter trips by bicycle. Once a spatial analysis determines activity patterns along different routes, future counts could take place at strategic locations, such as one-way street pairs and at discrete locations with bicycle accommodations. The recommendations which follow address these possibilities.

Section One Study Area, for Reference with Table 7

Numbers in red circles are intersection ID codes.

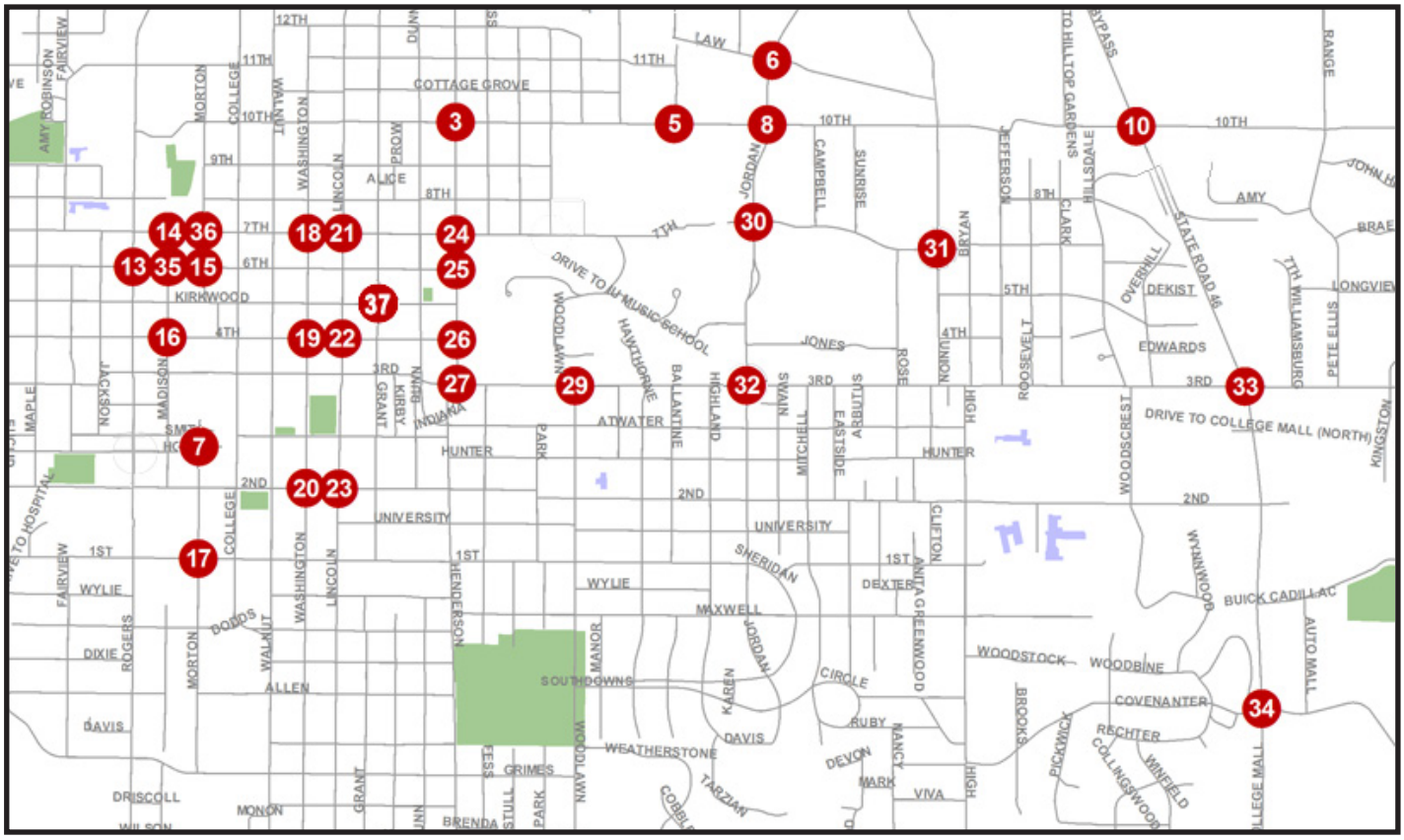
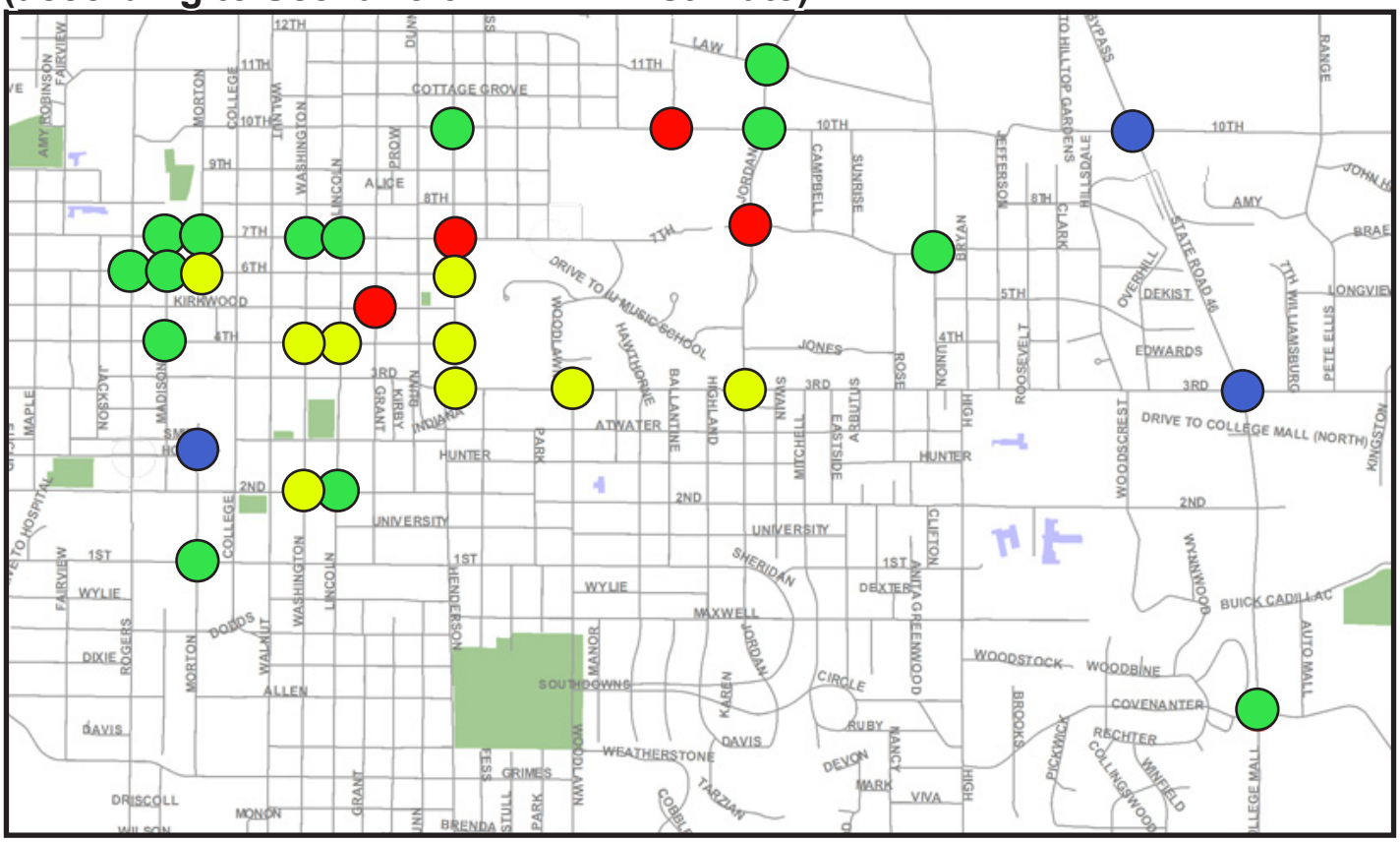


Table 7: Results of Scenario Applications

Location	W-E Street	N-S Street	# of Observations	1. No Peak: Mean 24-hour Estimate	2. Two Peaks: Mean 24-hour Estimate	3. NBPDP: Mean 24-hour Estimate	4. One Peak: Mean 24-hour Estimate	5. Inferred from Data: Mean 24-hour Estimate
1	17th	Fee	2	209	134	193	254	204
3	10th	Indiana	2	232	239	333	284	341
5	10th	Fee	18	889	1319	873	859	945
6	Law	Jordan	2	147	134	228	190	246
7	Howe	Morton	2	70	90	87	77	83
8	10th	Jordan	10	616	473	548	635	600
10	10th	SR 45/46	2	54	74	61	56	62
13	6th	Rogers	4	313	316	325	331	338
14	7th	Madison	2	147	95	136	157	152
15	6th	Morton	12	648	574	593	699	645
16	4th	Madison	10	277	409	312	285	311
17	1st	Morton	8	383	407	378	381	388
18	7th	Washington	2	155	169	213	183	211
19	4th	Washington	6	575	682	607	631	615
20	2nd	Washington	9	471	446	403	480	452
21	7th	Lincoln	4	263	302	228	273	262
22	4th	Lincoln	6	614	790	651	647	651
23	2nd	Lincoln	14	364	387	364	370	370
24	7th	Indiana	10	1044	1603	922	952	1045
25	6th	Indiana	5	526	669	450	482	513
26	4th	Indiana	11	796	1128	779	760	834
27	3rd	Indiana	5	483	603	428	451	472
29	3rd	Woodlawn	3	562	690	588	568	586
30	7th	Jordan	7	2265	3151	1875	2047	2219
31	7th	Union	1	263	447	283	262	283
32	3rd	Jordan	4	433	618	501	454	516
33	3rd	SR 45/46	1	77	132	83	77	83
34	Covenanter	College Mall	1	155	189	125	133	154
35	6th	Madison	11	405	436	371	439	390
36	7th	Morton	3	284	209	256	278	276
37	Kirkwood	Grant	4	1064	1086	1007	1088	1109

Figure 3: Study Area Intersections: Mean Daily Use Estimate (according to Scenario 3: NBPDP Estimate)



Estimated number of bicycles passing through intersection in 24 hours

- < 100
- 101 - 400
- 401 - 800
- > 801

Recommendations from Section One:

1. Continue to allocate staff to bicycle counting. In order to determine trends in use, future regular standardized counts would give a basis for comparison. Seasonal or year-round counts take weather, weekday vs. weekend use, and seasonal variation into consideration. Coordinating volunteers and limiting the counts to fewer strategically determined intersections will maximize the effectiveness of staff and volunteer time.

2. Choose a method for extrapolating hourly count data. Of the five scenarios, the NBPDP methodology provided the most conservative estimate of bicycle activity. The NBPDP estimate is also readily comparable to data from other localities which use the same estimation method. The most accurate estimation method, and that which requires more resources, would be to determine the hourly proportion of activity through longer observations of intersections in Bloomington to provide estimates that fit the daily use profile of the community.

3. Consider investing in more sophisticated counting equipment. At present, it is impossible to determine an accurate use profile for the bicycle network nor accurate counts over a 24-hour period. With equipment to count cycling activity for a continuous 24 hours in a location (and can be moved from one location to another), we might develop more accurate spatial and temporal use profiles, which would in turn improve our estimates of activity. It would also facilitate data collection, and data would not be biased by volunteer preference or availability. The cities of Madison, WI, and Minneapolis, MN, for example, have invested in loop detectors to record count data from several locations over extended periods and have determined trends in ridership based on this data.[4] Other cities have used time-lapse video recording and active infrared systems.[5]

4. Conduct a spatial analysis of bicycle activity density across intersections. Determining corridors of activity will allow the city to focus on fewer locations and measure different metrics, e.g. bicycle trips. Ideally one count location would correspond to each common segment of bicycle travel to reduce the potential for double counting.[6] Many cities have performed these counts at travel bottlenecks such as bridges, tunnels, and multi-use paths.[7]

5. Expand the study area, particularly to the west and south. Current count locations have focused on the IU campus area, but data collection should eventually incorporate the downtown area and areas which lack significant bicycle infrastructure improvements. As data collection methods improve, and as more data are accumulated, it will be possible to expand the study area. Possible study intersections include those near Bloomington Hospital, near the B-Line Trail and trails south of downtown (such as the Clear Creek Trail and Jackson Creek Trail), and in the Near West Side, McDoel Gardens, and Bryan Park neighborhoods. Monitoring bicycle activity in these areas may demonstrate whether the current bicycle infrastructure meets the demand.

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4. City of Madison, WI 2009 Traffic Volume Report; also in City of Minneapolis Report on Bicycle Counts for the Midtown Greenway, 2009
5. Pedestrian and Bicycle Data Collection in the United States, 2005, by US Department of Transportation and the Pedestrian and Bicycling Information Center
6. Fehr & Peers, Transportation Consultants, use a model that incorporates GIS and regression analysis to model bicycle transportation demand ("GIS Based Bicycle and Pedestrian Modeling Demand Forecasting Techniques," 2010 Webinar). Potential GIS data for such an analysis include destinations, demographic data, land-use mix, street network, and bicycle infrastructure.
7. City of Portland, OR 2008 Bicycle Counts; case studies of other cities in Pedestrian and Bicycle Data Collection in the United States, 2005.

Section Two: Bicycle Parking Counts
Estimating Bicycle Ridership with Bicycle Parking

This section of the report seeks to identify the baseline of and trends in bicycle ridership in the City of Bloomington. Bicycle ridership is defined as the number of regular bicyclists in a community. By gauging changes and predicting trends in bicycle ridership, the City can plan to address any changes in demand for bicycle facilities.

In counting the number of bicycles parked in the study area, we hope to identify changes in the demand for bicycle parking over the course of one year. As the intersection counts in Section One of this report help estimate bicycle activity, bicycle parking serves as a means of estimating ridership. Demand for bicycle parking should increase as the number of active riders (that is, ridership) increases.

Assumptions:

Assumption #1

This section assumes that each bicycle parked in the study area has a distinct, regular rider. Considerations for this assumption include the following:

- Derelict bicycles: Although those collecting data attempted to recognize abandoned bicycles by whether they were rideable or had not moved since the last count, it is still possible that some of the bicycles counted were derelict bicycles.
- Shared bicycles: In contrast, the study does not take into account that bicycles could be shared by more than one rider.
- Infrequent riders: Determining what constitutes normal bicycle use is difficult. Some bicycle owners may ride less frequently than others. The study area consists of a commercial corridor rather than a residential area, so the study assumes that bicycle owners are using the bicycle racks for temporary parking rather than long-term storage.

Assumption #2

Although the analysis attempts to control for weather and temperature, the analysis assumes that total bicycle parking was not significantly impacted by other factors, such as minor infrastructure changes and fluctuations in parking based on time of day or day of week.

- Construction along West Kirkwood Avenue resulted in street closure for several months in 2010, and at the completion of the project several new racks for bicycle parking were installed.
- All parked bicycles, regardless of whether they were parked on City-installed bicycle racks, were counted in the data collected for the analysis.
- A potential limitation of this analysis is that staff did not collect data during the same time period for each observation. However, the counts seem well distributed across morning and afternoon hours.
- Also, this analysis only utilizes data collected during weekdays. For comparing trends in facility use, this should not limit the analysis. To determine whether infrastructure provision is adequate, future studies might incorporate data collected on weekends as well.

Methodology for Section Two:

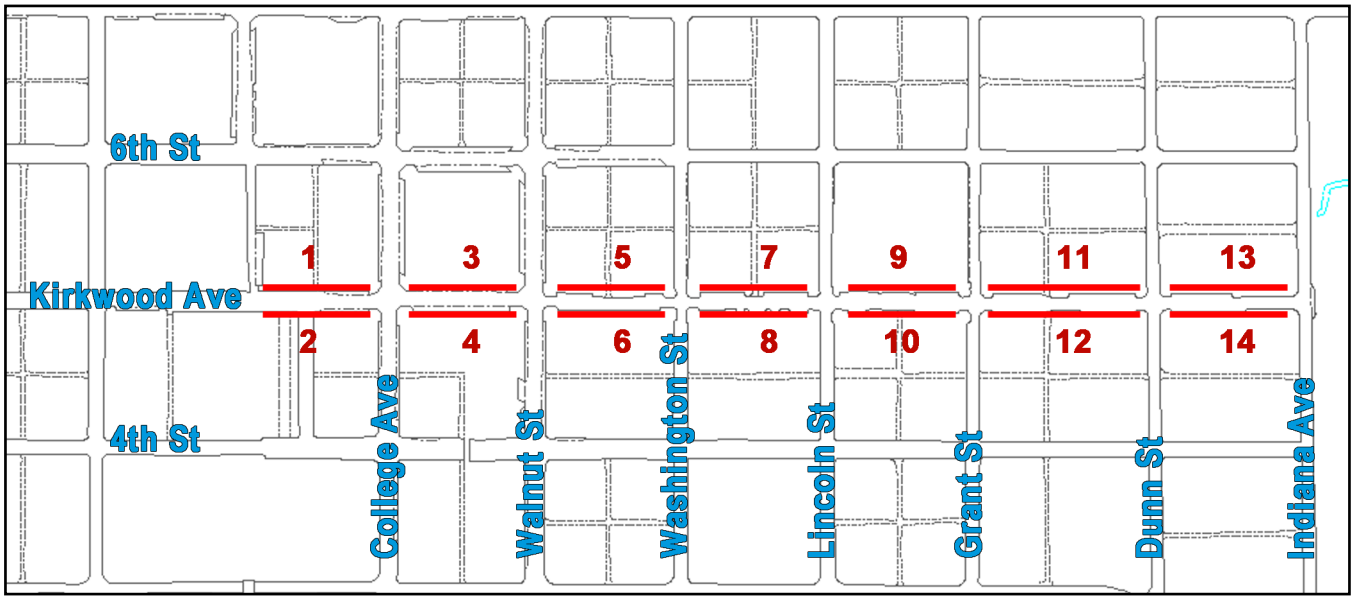
From spring of 2009 through fall 2010, City staff recorded counts of the number of bicycles parked on the north and south sides of each linear city block in the study area (Figure 4 below) between 10:00 AM and 5:00 PM. Planning Department staff chose this study area for its high volume of bicycle activity and for the high number of secure bicycle parking spaces. Staff conducted 40 counts of the 16 linear blocks in the study area. Staff recorded both the number of bicycles parked in spaces next to designated bicycle racks and the number of bicycles parked against walls, buildings, trees, trash containers, fences, etc., from street edge to building facade, for each block.

Because weather impacts cyclists' decision to ride, this study adjusts the data to control for the impact of precipitation and temperature. By normalizing the data to the same riding conditions, we provide a basis for comparison over time. The study then identifies the trend of the adjusted count data with regression analysis to determine whether ridership appears to have increased, decreased, or remained constant.

The raw count data collected by staff are available in Appendix C. A technical supplement of the statistical analysis and its application to adjusting for differences in temperature and weather conditions is available in Appendix D.

Figure 4: Linear Blocks in the Section Two Study Area

Numbers in red are block ID codes



Section Two Results:

1.) The number of bicycles parked in the study area, and thus the number of active riders in Bloomington, seems to be increasing.

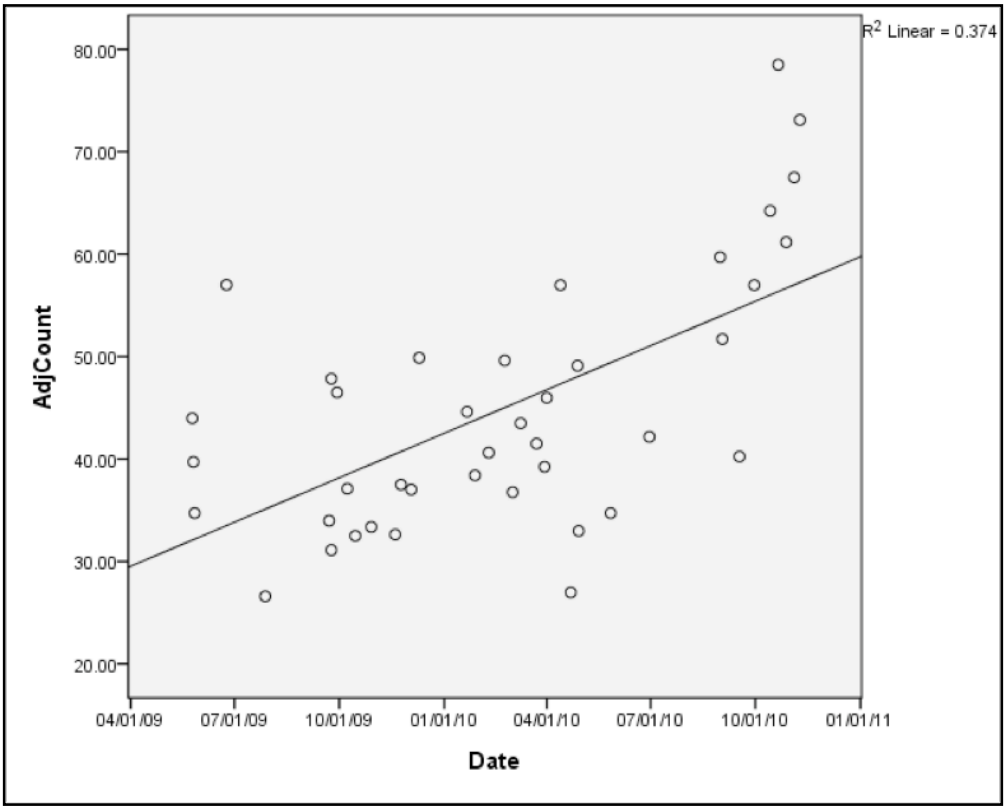
The second set of observations (from 3/2/2010 to 11/9/2010) had a mean number of parked bicycles significantly greater than the first set of observations (from 5/25/2009 to 2/23/2010). When adjusting for temperature and weather (Adjusted Count), the second set of observations remained significantly greater than the first set of observations. Table 8 shows the relationship between the raw and adjusted count means for the two sets of observations. Additionally, the trend in the data portrays a statistically significant increase in bicycle parking demand over the course of the study period (Figure 5). For further information on the statistical analysis, see Appendix D.

Table 8: Mean Bicycle Count Totals and Adjusted Count Totals for the Two Periods of Observations, each period N = 20 data collection observations

	Period 1 Mean (Observations 1-20)	Period 2 Mean (Observations 21-40)	Significant Increase?	p value*
Count	27.10	43.65	Yes	<0.001
Adjusted Count	39.73	50.15	Yes	0.007

*p values are a measure of statistical significance. A value of less than 0.05 indicates that there is a statistically significant difference between the two means.

Figure 5: Adjusted Bicycle Parking Count by Date of Count



Results, Continued:

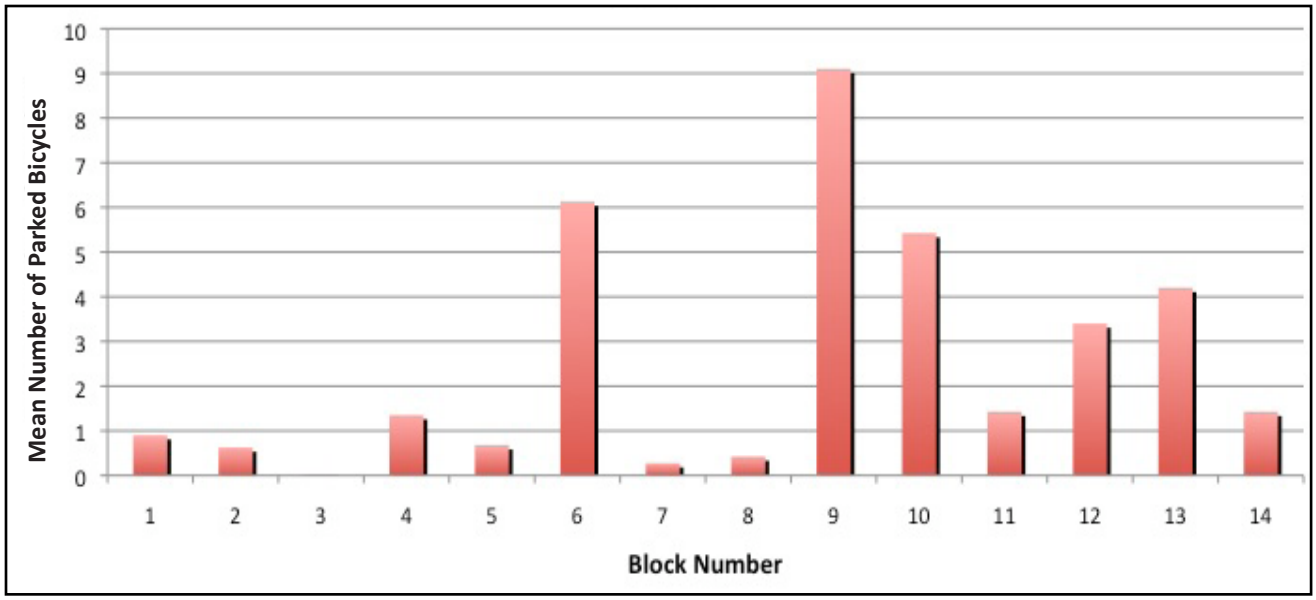
2.) Certain blocks in the study area appear to attract consistently higher numbers of riders. The higher mean number of parked bicycles along particular blocks may result from the current capacity of bicycle parking facilities at those locations. Where there are more bicycle racks, there seem to be more bicycles parked. This information might provide good targets for increasing bicycle parking infrastructure.
The mean number of bicycles counted along each block segment, over the entire study period, are displayed in Figure 6.

Bicycle corral on Grant Street south of Kirkwood Avenue. Future counts should consider these types of facilities.

Particularly high count means exist in the following locations:

- Between Walnut Street and Washington Street, on the south side of Kirkwood Avenue
- Between Lincoln Street and Grant Street, on the north side of Kirkwood Avenue
- Between Lincoln Street and Grant Street, on the south side of Kirkwood Avenue
- Between Dunn Street and Indiana Avenue, on the north side of Kirkwood Avenue

Figure 6: Mean Number of Bicycles Parked in Each Linear Block of the Study Area (N = 40 observations for each block)



Recommendations from Section Two:

1. Continue to allocate staff time to bicycle parking counts. Similar to the logic for continuing intersection activity counts, bicycle parking counts across several seasons can serve as valuable indicators of changes in demand for bicycle facilities. The more data we accumulate over time, the better we can see trends in bicycle activity and ridership. Volunteers could contribute by monitoring bicycle facility use as well. In cities such as Boulder, CO, and Portland, OR, volunteers have counted the number of bicycles parked at bicycle racks and in bicycle corrals in their neighborhoods over an extended period of time.[8]

2. Expand the study area. Although the City has increased the study area beyond the six-block area described in this report, the bicycle parking count should evaluate all commercial areas, both within and outside the downtown area, in which the City has installed bicycle parking facilities.

3. Evaluate different facilities separately. Evaluating the use of covered bicycle parking facilities, bicycle parking in parking garages, and on-street bicycle parking facilities (or bicycle corrals) could prove valuable in determining the degree to which the provision of those facilities should or should not be continued or expanded.

4. Evaluate bicycle parking counts relative to parking capacity. Comparing the number of bicycles parked in a given area relative to the number of bicycle parking spots could be a valuable method to determine whether bicycle parking infrastructure is sufficient.

5. Consider using a traditional survey to determine bicyclists' habits and patterns. Although conducting a survey of bicyclists may be difficult, an in-person, mail, or internet survey may help establish patterns of use, barriers to riding, characteristics of regular riders, and common travel corridors and destinations. Collaboration with IU in the design and implementation of the survey will likely improve response rate. The survey would be a good complement to other data collection techniques.

Conclusion

By investing time and resources into bicycle counting, the City of Bloomington has begun to identify trends in bicycle activity and to evaluate the use of bicycle infrastructure. Continuing to refine and standardize the methods of data collection and analysis will improve the quality of the evaluation.

With data collected by staff and volunteers in years to come, Bloomington will be able to gauge longer term trends in bicycle activity and ridership. In evaluating these trends, the City, in collaboration with local bicycle organizations, advocates, and members of the public, will be better able to respond to changing infrastructure and service requirements.

Careful evaluation of bicycle use and ridership trends puts Bloomington on the road to Platinum.

8. Portland Bureau of Transportation organizes voluntary summer counts of bicycles in corrals, while the 2009 Downtown Boulder Bicycle Count includes bicycle parking data collected by volunteers.

Appendix A: Bicycle Activity Count Data (N = 181)

Location ID	Date of Count	Start Time (24:00)	N-S Street	W-E Street	Count Total
1	4/28/10	17	Fee	17th	16
1	4/28/10	18	Fee	17th	11
3	4/13/10	8	Indiana	10th	13
3	4/13/10	9	Indiana	10th	17
5	4/27/10	8	Fee	10th	17
5	4/27/10	9	Fee	10th	7
5	4/27/10	10	Fee	10th	13
5	4/27/10	11	Fee	10th	8
5	4/29/10	16	Fee	10th	33
5	9/28/10	9	Fee	10th	68
5	9/28/10	10	Fee	10th	77
5	9/28/10	16	Fee	10th	71
5	9/29/10	10	Fee	10th	121
5	9/29/10	11	Fee	10th	100
5	9/30/10	12	Fee	10th	95
5	10/2/10	8	Fee	10th	15
5	10/2/10	9	Fee	10th	11
5	10/5/10	11	Fee	10th	58
5	10/5/10	12	Fee	10th	104
5	10/5/10	13	Fee	10th	37
5	10/6/10	10	Fee	10th	89
5	10/6/10	11	Fee	10th	91
6	4/20/10	8	Jordan	Law	15
6	4/20/10	9	Jordan	Law	4
7	4/29/10	9	Morton	Howe	7
7	4/29/10	10	Morton	Howe	2
8	4/16/10	16	Jordan	10th	73
8	4/16/10	17	Jordan	10th	88
8	4/24/10	15	Jordan	10th	31
8	4/27/10	15	Jordan	10th	41
8	4/27/10	16	Jordan	10th	36
8	4/27/10	18	Jordan	10th	31
8	4/28/10	14	Jordan	10th	22
8	4/28/10	15	Jordan	10th	23
8	4/28/10	16	Jordan	10th	32

Location ID	Date of Count	Start Time (24:00)	N-S Street	W-E Street	Count Total
8	4/28/10	17	Jordan	10th	21
10	4/28/10	9	SR45/46	10th	4
10	4/28/10	11	SR45/46	10th	3
13	4/20/10	16	Rogers	6th	27
13	4/20/10	17	Rogers	6th	18
13	4/21/10	9	Rogers	6th	17
13	4/21/10	10	Rogers	6th	19
14	4/27/10	16	Madison	7th	9
14	4/27/10	17	Madison	7th	10
15	4/22/10	11	Morton	6th	17
15	4/28/10	15	Morton	6th	29
15	4/28/10	16	Morton	6th	23
15	9/28/10	12	Morton	6th	42
15	9/28/10	13	Morton	6th	57
15	9/29/10	8	Morton	6th	17
15	9/29/10	9	Morton	6th	19
15	9/30/10	16	Morton	6th	42
15	9/30/10	17	Morton	6th	42
15	10/6/10	17	Morton	6th	68
15	10/6/10	17	Morton	6th	68
15	10/6/10	18	Morton	6th	79
16	4/22/10	9	Madison	4th	16
16	4/22/10	10	Madison	4th	6
16	9/28/10	9	Madison	4th	34
16	9/28/10	10	Madison	4th	17
16	9/30/10	9	Madison	4th	20
16	9/30/10	10	Madison	4th	13
16	10/5/10	10	Madison	4th	15
16	10/5/10	11	Madison	4th	25
16	10/6/10	10	Madison	4th	19
16	10/6/10	11	Madison	4th	14
17	4/15/10	9	Morton	1st	13
17	4/15/10	10	Morton	1st	15
17	4/29/10	15	Morton	1st	28
17	4/29/10	16	Morton	1st	27

Appendix A (cont.): Bicycle Activity Count Data (N = 181)

Location ID	Date of Count	Start Time (24:00)	N-S Street	W-E Street	Count Total
17	10/6/10	15	Morton	1st	30
17	10/6/10	16	Morton	1st	38
17	10/7/10	9	Morton	1st	23
17	10/7/10	10	Morton	1st	24
18	4/15/10	8	Washington	7th	5
18	4/15/10	9	Washington	7th	15
19	4/6/10	11	Washington	4th	26
19	4/9/10	10	Washington	4th	34
19	4/28/10	17	Washington	4th	47
19	4/28/10	18	Washington	4th	33
19	9/28/10	9	Washington	4th	53
19	9/28/10	10	Washington	4th	30
20	4/8/10	16	Washington	2nd	19
20	4/8/10	17	Washington	2nd	24
20	4/28/10	14	Washington	2nd	49
20	10/5/10	13	Washington	2nd	12
20	10/5/10	14	Washington	2nd	24
20	10/6/10	17	Washington	2nd	53
20	10/6/10	18	Washington	2nd	43
20	10/7/10	13	Washington	2nd	20
20	10/7/10	14	Washington	2nd	30
21	4/20/10	11	Lincoln	7th	17
21	4/20/10	12	Lincoln	7th	19
21	4/28/10	17	Lincoln	7th	19
21	4/28/10	18	Lincoln	7th	13
22	4/6/10	10	Lincoln	4th	33
22	4/6/10	11	Lincoln	4th	38
22	4/27/10	16	Lincoln	4th	37
22	4/27/10	18	Lincoln	4th	28
22	10/6/10	9	Lincoln	4th	55
22	10/6/10	10	Lincoln	4th	47
23	4/8/10	16	Lincoln	2nd	14
23	4/8/10	17	Lincoln	2nd	12
23	4/21/10	9	Lincoln	2nd	32
23	4/21/10	10	Lincoln	2nd	19

Location ID	Date of Count	Start Time (24:00)	N-S Street	W-E Street	Count Total
23	4/24/10	16	Lincoln	2nd	21
23	4/27/10	15	Lincoln	2nd	18
23	4/28/10	13	Lincoln	2nd	52
23	4/28/10	15	Lincoln	2nd	18
23	4/28/10	16	Lincoln	2nd	21
23	4/28/10	16	Lincoln	2nd	19
23	4/28/10	17	Lincoln	2nd	25
23	9/28/10	9	Lincoln	2nd	33
23	9/28/10	10	Lincoln	2nd	15
23	9/30/10	9	Lincoln	2nd	30
24	4/29/10	9	Indiana	7th	26
24	4/29/10	10	Indiana	7th	34
24	9/28/10	10	Indiana	7th	75
24	9/28/10	11	Indiana	7th	58
24	9/29/10	10	Indiana	7th	54
24	9/29/10	11	Indiana	7th	88
24	9/30/10	12	Indiana	7th	94
24	9/30/10	13	Indiana	7th	70
24	9/30/10	14	Indiana	7th	83
24	10/7/10	12	Indiana	7th	93
25	4/15/10	11	Indiana	6th	38
25	4/15/10	12	Indiana	6th	32
25	4/28/10	15	Indiana	6th	44
25	4/28/10	16	Indiana	6th	32
25	10/7/10	11	Indiana	6th	24
26	4/14/10	8	Indiana	4th	22
26	4/14/10	9	Indiana	4th	55
26	4/14/10	10	Indiana	4th	31
26	4/27/10	10	Indiana	4th	59
26	4/27/10	11	Indiana	4th	92
26	10/5/10	13	Indiana	4th	39
26	10/5/10	14	Indiana	4th	66
26	10/7/10	10	Indiana	4th	55
26	10/7/10	11	Indiana	4th	50
26	10/7/10	14	Indiana	4th	55

Appendix A (cont.): Bicycle Activity Count Data (N = 181)

Location ID	Date of Count	Start Time (24:00)	N-S Street	W-E Street	Count Total
26	10/7/10	15	Indiana	4th	42
27	4/27/10	12	Indiana	3rd	21
27	10/6/10	10	Indiana	3rd	26
27	10/6/10	11	Indiana	3rd	31
27	10/6/10	15	Indiana	3rd	46
27	10/6/10	16	Indiana	3rd	32
29	4/28/10	9	Woodlawn	3rd	39
29	4/28/10	10	Woodlawn	3rd	26
29	10/6/10	15	Woodlawn	3rd	44
30	4/28/10	15	Jordan	7th	74
30	4/28/10	16	Jordan	7th	80
30	9/30/10	10	Jordan	7th	100
30	9/30/10	11	Jordan	7th	187
30	9/30/10	12	Jordan	7th	222
30	10/5/10	12	Jordan	7th	198
30	10/7/10	15	Jordan	7th	164
31	4/24/10	10	Jordan	3rd	17
32	4/13/10	10	Union	7th	34
32	4/13/10	11	Union	7th	34
32	10/5/10	8	Union	7th	14
32	10/5/10	9	Union	7th	30
33	4/28/10	10	SR45/46	3rd	5
34	4/24/10	14	College Mall	Covenanter	10
35	4/17/10	11	Madison	6th	36
35	9/29/10	17	Madison	6th	33
35	9/29/10	18	Madison	6th	43
35	9/30/10	10	Madison	6th	18
35	9/30/10	11	Madison	6th	11
35	10/2/10	10	Madison	6th	15
35	10/2/10	11	Madison	6th	13
35	10/6/10	13	Madison	6th	22
35	10/6/10	14	Madison	6th	24
35	10/6/10	17	Madison	6th	33
35	10/6/10	18	Madison	6th	40
36	4/27/10	15	Morton	7th	10
36	4/27/10	16	Morton	7th	21
36	10/6/10	16	Morton	7th	24
37	10/6/10	10	Grant	Kirkwood	41
37	10/6/10	11	Grant	Kirkwood	62
37	10/6/10	16	Grant	Kirkwood	78
37	10/6/10	17	Grant	Kirkwood	94

Appendix B: Calculation Methods for Section One Estimates

Step 1: Determine the Hourly Percentage of Daily Activity

For Scenario 1, given the assumption of approximately 70-75% of daily activity between the hours of 8:00 AM and 7:00 PM,

- 70% divided by 11 hours = 6.36%
- 75% divided by 11 hours = 6.81%

This study used a figure of 6.5% for hourly percentages.

For Scenarios 2 and 3, the hourly percentages of daily activity were given by the Minneapolis Bicycle Report and National Bicycle and Pedestrian Documentation Project, respectively.

For Scenario 4, hourly percentages were determined by a normal distribution centered at 1:30 PM with standard deviation of 5.2 hours to encompass approximately 70-75% of daily activity.

For Scenario 5, observed median hourly count values across all intersections of the study area divided by the sum of the medians to return a percentage of observed activity. This percentage was then divided by 0.71 (given the assumption that the study's observation period comprises 70-75% of daily activity) to yield a daily percentage of activity.

Step 2: Apply the Hourly Multiplier to the Raw Count Data

The hourly multiplier reflects the relationship between the hourly activity count and all bicycle activity at the intersection during a given day. The multiplier is calculated by dividing one by the hourly percentage of activity.

Multiplying the collected hourly activity count number recorded by staff and volunteers by the hourly multiplier for that one-hour period for each scenario yields each scenario's estimate of daily activity.

Appendix C: Bicycle Parking Count Totals (N = 40)

Date	Time	Temp. (°F)	Weather	Count	Adj. Count
5/25/09	15:00	70	pc	39	44
5/26/09	15:00	80	pc	37	40
5/27/09	15:00	80	pc	32	35
6/24/09	15:00	92	pc	57	57
7/28/09	15:00	85	pc	25	27
9/22/09	11:30	70	c	29	34
9/24/09	11:10	60	r	28	48
9/24/09	15:00	65	c	25	31
9/29/09	11:20	50	c	37	46
10/8/09	10:45	50	r	15	37
10/15/09	11:15	50	sun	23	32
10/29/09	11:15	55	sun	25	33
11/19/09	11:45	45	c	22	33
11/24/09	15:00	50	c	28	37
12/3/09	11:30	30	c	23	37
12/10/09	11:00	20	snow	21	50
1/21/10	11:30	30	r	18	45
1/28/10	15:15	15	c	21	38
2/9/10	10:00	30	snow	14	41
2/23/10	10:30	30	snow	23	50
3/2/10	11:30	40	sun	25	37
3/9/10	11:05	50	c	34	43
3/23/10	11:45	50	sun	32	41
3/30/10	11:20	60	sun	32	39
4/1/10	12:15	70	sun	41	46
4/13/10	12:30	70	sun	52	57
4/22/10	10:15	70	sun	22	27
4/28/10	16:30	65	sun	43	49
4/29/10	10:30	70	sun	28	33
5/27/10	16:15	80	c	32	35
6/30/10	15:30	78	sun	39	42
8/31/10	13:00	80	sun	57	60
9/2/10	15:20	80	pc	49	52
9/17/10	9:30	60	pc	33	40
9/30/10	13:15	70	sun	52	57
10/14/10	14:15	60	sun	57	64
10/21/10	12:00	50	sun	69	78
10/28/10	16:45	47	c	51	61
11/4/10	13:10	50	pc	58	67
11/9/10	12:15	65	sun	67	73

Appendix D: Statistical Analysis for Section Two

Step 1: Determine the impact of weather and temperature on the number of bicycles parked in the study area

Linear regression via ordinary least squares estimation reflected that precipitation and temperature variables demonstrated a marginally significant relationship to the number of bicycles counted.

Dependent Variable: Count ($R^2 = 0.27$, $F = 6.845$, $p = 0.003$)*				
Variable	**B value**	**Std. Error**	**t value**	**Significance**
Temperature	.226	.126	1.790	.082
Precipitation	-12.603	6.477	-1.946	.059

This regression suggests that a one-degree increase in temperature raises the total count number by 0.226 and that the presence of precipitation decreases the total count number by 12.603.

Step 2: Adjust the count data to reflect the impacts of weather and temperature

Using the parameter estimates from the table above, counts were adjusted to optimal bicycling conditions by normalizing the temperature to the highest temperature recorded in the data and adjusting for the presence of precipitation (indicated by a 1 for precipitation or 0 for no precipitation). With this adjustment, colder days and days with precipitation receive a higher adjusted count value. The equation for adjusting the data follows:

$$\text{adjusted count} = \text{count} + [0.226 * (92 - \text{temperature})] + [12.603 * (\text{precipitation})]$$

Step 3: Perform statistical tests on both unadjusted and adjusted data

a.) To determine whether the means of the first and second halves of the observations were significantly different, we employed a two-sample t test. Although we had fewer than 30 observations for each subsample, the data appeared to be relatively normally distributed. The test of the adjusted data employed a two-sample t test of samples with significantly different variances. The statistical information on page 14 reflects the significant difference between the two subsets of the data.

b.) Considering the data set as a whole, we regressed the adjusted count data on date of observation to determine whether there existed a significant trend. Statistical information on the adjusted count data follows, and an explanation of the results can be found on page 14.

Dependent Variable: Adjusted Count ($R^2 = 0.32$, $F = 17.884$, $p < 0.001$)*				
Variable	**B value**	**Std. Error**	**t value**	**Significance**
Date	5.915E-7	.000	4.229	< 0.001

* An R^2 value indicates the percentage of the variation in data captured by the line of fit in a linear regression (an R^2 of 0.27 = 27%). The *F* statistic and its associated p value indicate the statistical significance of the regression. The t statistic and its associated p value indicate the significance of each individual parameter in the regression equation. Significant p values are generally values less than 0.05.