

**AN EXAMINATION OF BICYCLE COUNTS AND SPEEDS ASSOCIATED
WITH THE INSTALLATION OF BIKE LANES
IN ST. PETERSBURG, FLORIDA**



**William W. Hunter
Senior Research Scientist**

**Raghavan Srinivasan
Senior Transportation Research Engineer**

**Carol A. Martell
Senior Applications Specialist**

**FDOT Contract BA784
Final Report**

**University of North Carolina
Highway Safety Research Center**

September 2009

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the State of Florida Department of Transportation.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle An Examination of Bicycle Counts and Speeds Associated with the Installation of Bike Lanes in St. Petersburg, Florida		5. Report Date September 2009	6. Performing Organization Code
7. Author(s) William W. Hunter, Raghavan Srinivasan, and Carol A. Martell		8. Performing Organization Report No.	
9. Performing Organization Name and Address Highway Safety Research Center University of North Carolina CB# 3430, 730 MLK Blvd. Chapel Hill, NC 27599-3430		10. Work Unit No. (TRAVIS)	11. Contract or Grant No. BA784
12. Sponsoring Agency Name and Address Florida Department of Transportation 605 Suwannee Street, MS-30 Tallahassee, FL 32399		13. Type of Report and Period Covered Final Report 10/1/05-10/31/09	
		14. Sponsoring Agency Code	
15. Supplementary Notes			
16. Abstract It is assumed that installation of bicycle facilities will result in an increase in the number of bicyclists. However, it is rare that any kinds of before and after counts are performed and reported in the literature. This report focuses on the before-after change in the amount of bicycle riding associated with the installation of bicycle lanes along two corridors, 31 st and 37 th streets in St. Petersburg, Florida, with low levels of bicycling. For all data collection locations, model results showed a 17.1% increase in the bicycles per day after installation of the bike lanes (from 9.06 to 10.49 bicycles per day using the raw count data). When 31 st and 37 th streets were examined separately, 31 st Street experienced almost no change in counts (10.43 to 10.22 bicycles per day using the raw count data). This 3% reduction was not statistically significant. After bicycle lanes were introduced, 37 th Street experienced a statistically significant 42% increase in counts, although the change in the raw counts from before to after was only 7.59 to 10.74 bicycles per day. Bicycle average speeds were approximately 11-12 mph before and after the bike lane installation. This study shows that the addition of bicycle lanes alone on a street will not guarantee an immediate increase in bicycle volume. Other factors, including adjacent land use, convenient origins and destinations, and connectivity of a bicycle lane to other bicycle facilities within the street system are just as, or perhaps more critical, in terms of encouraging bicycling.			
17. Key Word bike lane, counts		18. Distribution Statement No restrictions	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 37	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Acknowledgements

The research was funded by the Florida Department of Transportation (Contract BA784), and the contract manager was Dennis Scott. From the City of St. Petersburg, Mike Frederick, Manager of Neighborhood Transportation; Cheryl Stacks, Bicycle and Pedestrian Coordinator; and Melody Stone, Traffic Engineering Assistant, were extremely helpful in all stages of the project.

EXECUTIVE SUMMARY

This report focuses on the before-after change in the amount of bicycle riding associated with the installation of bicycle lanes along two corridors in St. Petersburg, Florida, with low levels of bicycling. The corridors are 31st and 37th streets and run in a north and south direction. Tube counters with vehicle classification software were used to gather the data. The study methodology was to collect count data before and after placement of the bike lanes on the two corridors. To try to account for any seasonality, before and after counts were taken in the following manner:

31st Street before bike lanes – Winter 2005, Spring 2006, Fall 2006

31st Street after bike lanes – Summer 2007, Spring 2008, Fall 2008

37th Street before bike lanes – Winter 2005, Fall 2006, Spring 2007

37th Street after bike lanes – Fall 2007, Summer 2008, Winter 2009

For all sites and days on both corridors, and with the wrong way riders removed from the data, model results showed a 17% increase in the number of bicyclists per day after installation of the bike lanes (from 9.06 to 10.49 bicycles per day using the raw count data). When 31st and 37th streets were examined separately, 31st Street experienced almost no change in counts (10.43 to 10.22 bicycles per day using the raw count data). This reduction was not statistically significant. After bicycle lanes were introduced, 37th Street experienced a statistically significant 42% increase in counts, although the change in the raw counts from before to after was only 7.59 to 10.74 bicycles per day.

There was at least one outlier in the 31st Street data. The site near 5th Avenue N in the southbound direction experienced a dramatic reduction in bicycles per day from 31.06 to 7.89 following the implementation of bicycle lanes. If this site is removed from the analysis, then the overall rate for 31st Street in the before period will be 9.32 (instead of 10.43) and will be 10.36 (instead of 10.22) in the after period, indicating that bicycles per day would have slightly increased on 31st Street. Even with considerable discussion with local staff, it could not be determined why before counts at this location were large.

Bicycle speed data were also available from the counters and for most data collection locations were near the overall average speeds of 11-12 mph for the two streets. Examining all sites and days of the week, the ratio of average speed in the after period compared to the before showed a 0.9% increase in speed (not statistically significant at the 0.05 level). Similarly, there was a 1.3% increase in speed during weekdays during the after period (statistically significant at the 0.05 level). When 31st and 37th streets were examined separately, the average speed of bicycles on 31st Street essentially increased 2.7% (statistically significant at the 0.05 level), and the average speed of bicycles on 37th Street decreased 1.6% (not statistically significant at the 0.05 level). These average speed changes are considered too small for practical significance.

This project allowed a before-after examination of bicycle counts and speeds associated with the installation of bike lanes on streets with low levels of bicycling. The average bicycle speeds were quite similar from before to after bike lane installation. Although

actual counts increased only by a small number, it is interesting to ponder why counts increased on 37th Street and remained relatively constant on 31st Street. An examination of available motor vehicle traffic volume and speed data from before to after bike lanes shows general decreases in traffic volume and speed on both 31st and 37th Streets. This analysis does not account for changes in bicycle travel due to trends in population and demography and for changes (temporary or permanent) that may have occurred due to increase in the price of gasoline in 2008.

It is clear that the two corridors are somewhat different. The land use of 37th Street is almost entirely residential with only a few commercial establishments. The street is relatively quiet and could be considered a neighborhood collector. The land use of 31st Street is mainly commercial and more of a citywide collector that moves traffic to arterials. In addition, 31st Street has more convenience stores, shops, and shopping centers, as well as more motor vehicle traffic. One would expect that cyclists would view 37th Street as a safer street to bicycle, and perhaps that is the main reason that the number of bicycles per day increased.

As mandated by its bicycle master plan, St. Petersburg is attempting to place bike lanes on all collector and arterial streets. Some 95 miles have been completed to date with another 10-12 expected in the next year. Both 31st and 37th streets were wide enough to be able to install bike lanes with a road diet philosophy and provided north-south connections. This study shows that the addition of bicycle lanes alone on a street will not guarantee an immediate increase in bicycle volume. Other factors, including adjacent land use, convenient origins and destinations, and connectivity of a bicycle lane to other bicycle facilities within the street system are just as, or perhaps more critical, in terms of encouraging bicycling. Over time, as a bicycle-friendly system becomes more widespread and better connected, routes such as those evaluated in this study will likely see increases in bicycle volumes. The results of this effort emphasize the importance of consideration of all of these factors when making prioritization decisions about which bicycle routes/facilities to build, especially if the goal is to achieve immediate gains in mode shift.

TABLE OF CONTENTS	
EXECUTIVE SUMMARY	v
INTRODUCTION	1
LITERATURE	1
SITE SELECTION AND PHASING	3
DATA COLLECTION	7
ANLYSIS AND RESULTS	9
SUMMARY AND DISCCUSSION	20
REFERENCES	22
APPENDIX A – SUPPLEMENTAL TABLES	25

LIST OF FIGURES

Figure 1. View of 31 st and 37 th Street bike lane corridors.	4
Figure 2. 37 th Street and 5 th Avenue South.	6
Figure 3. 31 st Street and 5 th Avenue South.	6
Figure 4. 31 st Street and 22 nd Avenue South.	7
Figure 5. MetroCount counter.	8
Figure 6. Typical installation of counter and tubes after bike lane installation.	9
Figure 7. Speed histograms for 31 st and 37 th streets before and after the installation of bikes.	18

LIST OF TABLES

Table 1. Profile information.	5
Table 2. Number of bicycles at each site before and after the installation of bicycle lanes.	10
Table 3. Number of bicycles at each site before and after the installation of bicycle lanes with wrong-way bicyclists included.	12
Table 4. Percentage of wrong way riding at each data collection location.	13
Table 5. Number of bicycles by day of week.	14
Table 6. Negative binomial regression models for the number of bicycles per day at all sites.	16
Table 7. Average speed for each site before and after bicycle lanes.	17
Table 8. Log-linear model for average speed at all sites.	20

INTRODUCTION

It is assumed that the installation of bicycle facilities will result in an increase in the number of bicyclists. However, it is rare that any kinds of before and after counts are performed and reported in the literature. The objective of the study was to determine the before-after change in the amount of bicycle riding associated with the installation of bicycle lanes along two corridors in St. Petersburg, Florida, with low levels of bicycling. The corridors are 31st and 37th streets and run in a north and south direction. The study methodology was to collect count data before and after placement of the bike lanes on the two corridors. Tube counters with vehicle classification software were used to gather the before and after bicycle counts.

This study came about as part of a contract between the University of North Carolina Highway Safety Research Center (HSRC) and the Florida Department of Transportation (FDOT). The contract provides funding to evaluate bicycling improvements in the State of Florida.

LITERATURE

The literature pertaining to amount of bicycle riding associated with the installation of bike lanes or other bike facilities is quite variable. Many communities are developing bicycle (and pedestrian) master plans, and thus have interest in developing an estimate of the potential of the number of riders who would be attracted to bike facilities if installed. As an example, Mandel-Ricci et al. (1) note the commitment by New York City to install 240 miles of bike lanes over a four-year period, along with other activities, to try to reduce the number of bicyclist fatalities and serious injuries. The Chicago Metropolitan Agency for Planning is developing GO TO 2040, a long range regional plan for northeastern Illinois which includes the Chicago area (see www.goto2040.org) (2). The ongoing planning assumes that providing more bicycle facilities increases the amount of bicycling (see bicycling strategy article) (3). The city is seeking to add an additional 150 miles of bike lanes by 2015 to the more than 100 miles of bike lanes currently in place (see www.bike2015plan.org) (4).

Bike lanes are often a factor in bicycle level of service (LOS) models. Landis et al. (5) developed a statistically calibrated LOS model using input from bicyclists riding in urban traffic conditions. The striping of bicycle lanes and pavement surface conditions were important factors in the model. Harkey et al. (6) developed the Bicycle Compatibility Index for street segments. This LOS model shows the presence of a bicycle lane to reduce the index amount by about one full point, thereby showing an improved comfort level for the bicyclist. Dowling et al. developed level of service models from the point of view of motor vehicle drivers, transit passengers, bicycle riders, and pedestrians through video laboratories and onboard transit surveys (7). The models can be used to test the impact of converting a motor vehicle through lane to a bicycle lane.

Several studies support the notion that bicyclists place a high value on facilities. Davis and Wicklatz found that bike facilities are used far more than normal streets (8). Studies from Aultman-Hall and Hall (9) and Tilahun et al. (10) indicate that bicyclists are willing to travel longer distances or times to be able to use facilities. Titze et al. used a telephone survey of 1,000 people in Graz, Austria to conclude that bike lane connectivity is an important factor in the choice of bicycling for transport among adults in the city (11). Moudon et al. (12) used a telephone survey to generate data about bicycling behavior from 608 randomly selected respondents in the urbanized sections of King County, Washington. Of most relevance to this review was the section pertaining to perceived environmental correlates of bicycling. The perception of the availability of both bicycle lanes and trails was positively associated with the likelihood of bicycling. However, the study also found that on-street variables such as bicycle lanes, traffic speed and volume, number of lanes, topography, and street block size were not as influential to bicycling as personal factors. The urbanized King County area has more bicycle facilities than many areas in the U.S.; however, the lack of more miles of *connected* bike lanes is a factor in the decision to bicycle. A random telephone survey of adults in the Portland, Oregon area by Dill and Voros (13) reinforces these findings. Cervero and Duncan (14) examined the San Francisco urban environment and its effect on bicycling. They concluded that control variables such as demographic characteristics of the trip makers, as well as factors such as topography, darkness, and rainfall, had stronger influence than built environment factors such as block size and gridiron streets. Pucher and Buehler (15) note that a “more extensive cycling infrastructure,” as well as a number of other factors, relate to why Canadians bicycle more than Americans. Bonham and Suh (16) examine intra-urban factors in bicycling for the journey-to-work in Adelaide and Melbourne, Australia, although the concentration is on socio-economic and demographic characteristics. Follow-on research will focus more on the urban environment, cycling context, culture of travel, and local government policies and programs.

In an attempt to study the relationship between bicycle facilities and amount of bicycle commuting, Nelson and Allen (17) used cross-sectional data from 18 U.S. cities to model the percentage of commuters using bicycles to get to work. Factors in the model included miles of bicycle pathways (or those that separate bicyclists from motorists, including both grade-separated and designated travel lanes) per 100,000 residents, whether a city has flat or very unproblematic terrain, number of days per year in which rain exceeds one-tenth of an inch, mean high temperature, and the percentage of college students residing in each city. After removing the terrain and temperature variables from the model, the result indicated that each mile of bikeway per 100,000 residents is associated with a 0.0069 % increase in commuters using bicycle facilities. The authors were careful to point out that the results represent statistical associations and not cause-and-effect.

Dill and Carr (18) furthered the research by Nelson and Allen by using a larger sample of cities, not focusing the cities on college towns, and using data from the Bureau of the Census 2000 Supplemental Survey. Data were obtained for 43 cities and included information on Class I and Class II facilities, average state spending per capita on pedestrian and bicycling improvements, price of gasoline, and others. Correlations showed that the percentage of people commuting by bicycle was significantly associated

with bicycle infrastructure and gasoline price variables, and that the most significant correlation was with the number of Class II bike lanes per square mile. Regression models were developed with various combinations of independent variables. The best model showed that the miles of Class II bike lanes per square mile was the most significant variable. Further results from the model indicated that for “typical U.S. cities with a population of more than 250,000, each additional mile of Class II bike lanes per square mile is associated with a roughly one percentage point increase in the share of workers commuting by bicycle.” It is noted that increasing the bike lane mileage by one mile per square mile would be about four times the current average of 0.31 miles per square mile. Concurrently, an increase of one percentage point in the share of workers commuting by bicycle would more than double the average share for many of the 43 cities examined.

Barnes and Thompson (19) examined bicycle commute mode shares between 1990 and 2000 in the Minneapolis-St. Paul area in an attempt to determine the impact of new on-street bike lanes and off-street bicycle paths. The same locations were examined before and after the facilities were built. Bicycle mode share did increase significantly for all individual facilities studied. Improvement in bicycle accommodations on bridges also appeared to be associated with an increase in bicycle trips across the Mississippi River to Central City. Most of the new facilities were built in downtown Minneapolis and near the University of Minnesota, and these areas showed large increases in bicycle mode share. In comparison, downtown St. Paul, which received few facility improvements, showed a slight decrease in bicycle mode share.

A recent study by Dill (20) used GPS devices to collect bicycle travel behavior from a convenience sample of 166 cyclists who ride regularly in the Portland, Oregon area. The majority of the bicycling was utilitarian, with a median trip length of 2.8 miles and an average trip speed of 10.8 mph. Bicycle facilities were shown to be important, with about half of the recorded miles of travel occurring on streets with bike lanes, paths, or bike boulevards, as compared to these facilities accounting for about 8% of the current network. Travel on streets with bike lanes followed the same pattern, indicating their importance to route choice.

SITE SELECTION AND PHASING

The City of St. Petersburg is located about halfway down the western side of Florida and lies between Tampa Bay and the Gulf of Mexico. The population is approximately 250,000. Within the City government, the Neighborhood Transportation Department is involved in the planning and implementation of bicycle facilities. As part of the improvements recommended in their bicycle master plan (21), the department planned to install bike lanes along 31st and 37th streets, two north-south corridors running on the east and west sides of US 19 (Figure 1). For 37th Street the profile was 2-lanes both before and after the bike lanes over approximately 4.6 miles. For 31st Street the before and after profile was variable (see Table 1 below) over approximately 6.2 miles, although the vast majority of the street was 2-lanes after the bike lane was installed. In terms of motor

vehicle traffic volume, 31st Street carries about 4,000 vehicles per day in a 24-hour period and 37th Street about 1,800 vehicles per day.

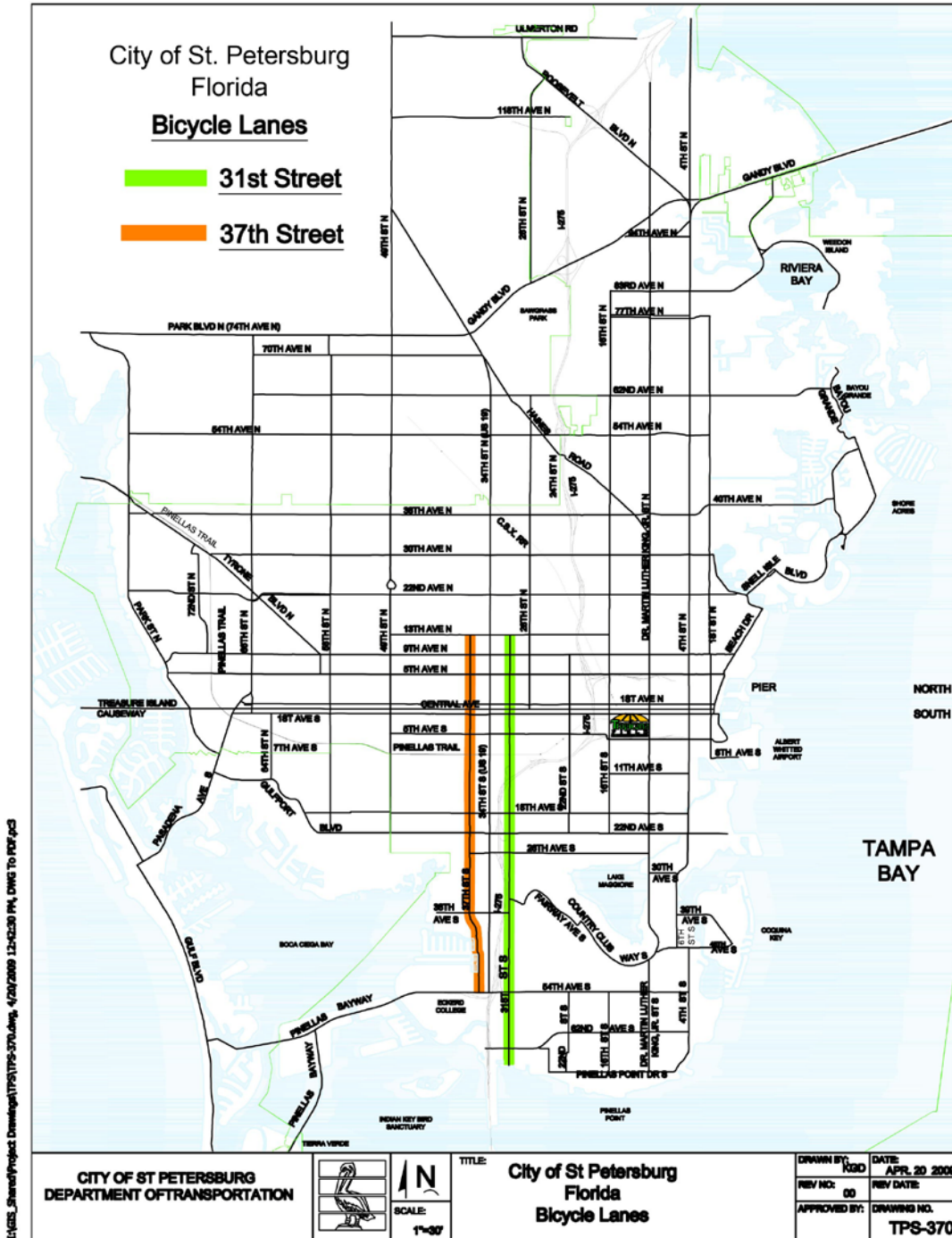


Figure 1. View of 31st and 37th Street bike lane corridors.

Table 1. 31st Street profile information.

From	To	Before Profile	After Profile	Length (ft)
Pinellas Point Drive	54th Avenue S	4-lanes divided	4-lanes divided	3,665
54th Avenue S	26th Avenue S	2-lanes undivided	2-lanes undivided	14,753
26th Avenue S	21st Avenue S	4-lanes divided	3-lanes undivided (2 S/B & 1 N/B)	1,650
21st Avenue S	Melrose Avenue S	2-lanes undivided	2-lanes undivided	2,800
Melrose Avenue S	Fairfield Avenue S	4-lanes divided	4-lanes divided	2,300
Fairfield Avenue S	Central Avenue	4-lanes divided	2-lanes undivided	2,650
Central Avenue	13th Avenue N	2-lanes undivided	2-lanes undivided	4,900

A typical view of 37th Street South near an intersection after the installation of bike lanes is shown in Figure 2. A typical view of a two-lane section of 31st Street South after the installation of bike lanes is shown in Figure 3. A typical view of a four-lane section of 31st Street South after the installation of bike lanes is shown in Figure 4. Bike lane installation was complete on 31st Street during the first week of August 2007. Bike lane installation was complete on 37th Street during the first week of September 2007.



Figure 2. 37th Street and 5th Avenue South.



Figure 3. 31st Street and 5th Avenue South.



Figure 4. 31st Street and 22nd Avenue South.

DATA COLLECTION

The study methodology was to collect count data before and after placement of the bike lanes on the two corridors. To try to account for any seasonality, before and after counts were taken in the following manner:

31st Street before bike lanes – Winter 2005, Spring 2006, Fall 2006

31st Street after bike lanes – Summer 2007, Spring 2008, Fall 2008

37th Street before bike lanes – Winter 2005, Fall 2006, Spring 2007

37th Street after bike lanes – Fall 2007, Summer 2008, Winter 2009

The schedule was somewhat irregular because field staff from Neighborhood Transportation had to perform the counts at various locations. In addition, the bike lanes were installed on slightly different schedules. The counters generally were in place for one week at a location and then moved; however, at times the counters stayed in place for a longer period due to schedule disruption. All of the available data count data were used, with the main dependent variable being the number of bicycles per day. Days without a full 24-hour period were excluded.

The counts were taken with MetroCount 5600 series counters (Figure 5) purchased by Neighborhood Transportation (see www.metrocount.com for more details). The cost was

approximately \$900 per counter. With this system, two rubber pneumatic tube axle sensors are used to record each axle of a passing vehicle. Adaptive auto-ranging axle sensors (or “air switches”) will detect a variety of vehicles, from bicycles to heavy vehicles, without any user-adjustment. Counters are retrieved, data extracted and then later processed with MetroCount software. Besides simple counts, the software allows classification of vehicles. Wheelbase was used as a determinant of a bicycle, and based on discussions with numerous bicycling specialists and researchers, speeds were restricted to equal to or less than 22 mph for the analyses in this paper.



Figure 5. MetroCount counter.

To perform the counts, two counters were used at each intersection, and the tubes were set approximately 100-200 feet downstream from selected signalized intersections. The placement was chosen to avoid side streets and alleys. A template was used to set the tubes 39 inches apart. The counters generally stayed in place for at least one week and were then moved to another location. Along 31st Street the counters were set up near 10 intersections, and along 37th Street near nine intersections. In the before period, the tubes would cover about one-fourth of the traffic lane; thus, it is possible some bicycles were missed. In the after period, the tubes covered the entire bike lane; thus, bicycles outside of the bike lane would be missed. Figure 6 shows the placement in the field to obtain counts after the bike lanes were installed.



Figure 6. Typical installation of counter and tubes after bike lane installation.

ANALYSIS AND RESULTS

Bicycle Counts

The intent of this section is to determine whether the installation of bicycle lanes may lead to change in the number of bicycles that may use this facility. The dependent variable in this analysis was the number of bicycles per day riding with traffic at a particular location. Bicycles traveling against traffic or wrong way, were removed from the analysis involving statistical modeling. Data were collected near 10 intersections in both directions on 31st Street and 9 intersections in both directions on 37th Street for a total 38 locations before and after the installation of bicycle lanes. For this analysis, only those days where bicycle counts were recorded for the whole day (i.e., 24 hours) were included, and the maximum bicycle speed was set to be equal to or less than 22 mph.

Table 2 shows the counts of bicycles, number of days, and counts per day for each site before and after the implementation of bicycle lanes. The data collection locations are ordered from north to south. Note that these are low levels of bicycling – less than 10 bicycles per day in many locations. On 37th Street every site experienced an increase in the bicycle counts per day following the implementation of bicycle lanes. However, on

Table 2. Number of bicycles at each site before and after the installation of bicycle lanes.

31st Street	AFTER			BEFORE		
	Counts	Days	Counts per day	Counts	Days	Counts per day
31st N/of 5th Ave N - NB	123	21	5.86	95	18	5.28
31st S/of 5th Ave N - SB	213	27	7.89	559	18	31.06
31st N/of 1st Ave N - NB	204	23	8.87	145	18	8.06
31st S/of 1st Ave N - SB	316	25	12.64	225	18	12.50
31st N/of Central Ave - NB	54	25	2.16	107	18	5.94
31st S/of Central Ave - SB	374	25	14.96	204	19	10.74
31st N/of 1st Ave S - NB	258	26	9.92	106	18	5.89
31st S/of 1st Ave S - SB	673	26	25.88	309	18	17.17
31st N/of 5th Ave S - NB	317	26	12.19	96	16	6.00
31st S/of 5th Ave S - SB	396	26	15.23	250	18	13.89
31st N/of 18th Ave S - NB	226	26	8.69	184	18	10.22
31st S/of 18th Ave S - SB	180	26	6.92	95	18	5.28
31st N/of 22nd Ave S - NB	212	16	13.25	242	17	14.24
31st S/of 22nd Ave S - SB	150	24	6.25	106	18	5.89
31st N/of 26th Ave S - NB	125	21	5.95	146	12	12.17
31st S/of 26th Ave S - SB	72	22	3.27	105	18	5.83
31st N/of 54th Ave S - NB	352	23	15.30	285	18	15.83
31st S/of 54th Ave S - SB	221	22	10.05	117	18	6.50
31st N/of Pinellas Pt - NB	258	23	11.22	174	18	9.67
31st S/of Pinellas Pt - SB	142	23	6.17	123	18	6.83
37th Street						
37th N/of 9th Ave N - NB	234	27	8.67	152	20	7.60
37th S/of 9th Ave N - SB	302	27	11.19	129	20	6.45
37th N/of 5th Ave N - NB	349	27	12.93	144	18	8.00
37th S/of 5th Ave N - SB	404	27	14.96	94	15	6.27
37th N/of 1st Ave N - NB	250	28	8.93	131	18	7.28
37th S/of 1st Ave N - SB	254	27	9.41	155	18	8.61
37th N/of Central Ave - NB	182	27	6.74	44	18	2.44
37th S/of Central Ave - SB	237	27	8.78	93	18	5.17
37th N/of 1st Ave S - NB	232	27	8.59	145	18	8.06
37th S/of 1st Ave S - SB	264	27	9.78	132	18	7.33
37th Ave N/of 5th Ave S - NB	344	28	12.29	117	18	6.50
37th Ave S/of 5th Ave S - SB	371	28	13.25	204	18	11.33
37th N/of 15th Ave S - NB	327	23	14.22	235	18	13.06
37th S/of 15th Ave S - SB	329	28	11.75	181	18	10.06
37th N/of 18th Ave S - NB	277	28	9.89	137	18	7.61
37th S/of 18th Ave S - SB	351	28	12.54	175	19	9.21
37th N/of 22nd Ave S - NB	176	22	8.00	118	20	5.90
37th S/of 22nd Ave S - SB	317	28	11.32	112	19	5.89
31st Street	4866	476	10.22	3673	352	10.43
37th Street	5200	484	10.74	2498	329	7.59
All	10066	960	10.49	6171	681	9.06

31st Street, some sites experienced an increase, while others experienced a reduction in bicycles per day. For unknown reasons, one site on 31st Street (near 5th Avenue N - SB) experienced a dramatic reduction in bicycles per day from 31.06 to 7.89 following the implementation of bicycle lanes. Even with considerable discussion with local staff, it could not be determined why before counts at this location were (apparently) large. Overall, the counts per day decreased from 10.43 to 10.22 (a 2% decrease) after bike lanes on 31st Street, and the counts per day increased from 7.59 to 10.74 (a 42% increase) after bike lanes on 37th Street. If the site near 5th Avenue N – SB were removed from the raw counts, 31st Street would experience an overall before to after change from 9.32 to 10.36 bicycles per day (an 11% increase).

By way of comparison, Table 3 shows the bicycle count data with the *wrong way riders included*. The trends are much the same as in Table 2. Overall, the counts per day increased from 14.32 to 14.39 (a 0.5% increase) after bike lanes on 31st Street, and the counts per day increased from 9.78 to 13.20 (a 35% increase) after bike lanes on 37th Street. The location of 31st S/of 1st Ave S – SB had some of the largest counts per day. The count per day was 46.42 after bike lanes compared to 30.56 before when wrong way riders were included. Without wrong way riders the counts were 25.88 after and 17.17 before at this location.

Table 4 shows the percentage of wrong way riders at all data collection locations. At first glance the percentages seem high. However, the number of bicycles per day is relatively small, and a few bicyclists riding wrong way would lead to a relatively high percentage. A special camera study was conducted at two locations to ascertain the percentage of wrong way riders, and the results were in agreement with the outcomes from the counters. For 31st Street overall, 27% rode wrong way before bike lanes and 29% after. For 37th Street overall, 22% rode wrong way before bike lanes and 19% after.

Table 3. Number of bicycles at each site before and after the installation of bicycle lanes with wrong-way bicyclists included.

	AFTER			BEFORE		
	Counts	Days	Counts per Day	Counts	Days	Counts per Day
31st Street						
31st N/of 5th Ave N - NB	140	21	6.67	109	18	6.06
31st S/of 5th Ave N - SB	252	27	9.33	585	18	32.50
31st N/of 1st Ave N - NB	281	23	12.22	203	18	11.28
31st S/of 1st Ave N - SB	477	25	19.08	312	18	17.33
31st N/of Central Ave - NB	87	25	3.48	126	18	7.00
31st S/of Central Ave - SB	604	25	24.16	308	19	16.21
31st N/of 1st Ave S - NB	359	26	13.81	155	18	8.61
31st S/of 1st Ave S - SB	1207	26	46.42	550	18	30.56
31st N/of 5th Ave S - NB	429	26	16.50	160	16	10.00
31st S/of 5th Ave S - SB	680	26	26.15	525	18	29.17
31st N/of 18th Ave S - NB	290	26	11.15	272	18	15.11
31st S/of 18th Ave S - SB	242	26	9.31	135	18	7.50
31st N/of 22nd Ave S - NB	312	16	19.50	385	17	22.65
31st S/of 22nd Ave S - SB	188	24	7.83	135	18	7.50
31st N/of 26th Ave S - NB	147	21	7.00	189	12	15.75
31st S/of 26th Ave S - SB	80	22	3.64	136	18	7.56
31st N/of 54th Ave S - NB	375	23	16.30	289	18	16.06
31st S/of 54th Ave S - SB	244	22	11.09	133	18	7.39
31st N/of Pinellas Pt - NB	267	23	11.61	179	18	9.94
31st S/of Pinellas Pt - SB	188	23	8.17	155	18	8.61
37th Street						
37th N/of 9th Ave N - NB	248	27	9.19	168	20	8.40
37th S/of 9th Ave N - SB	368	27	13.63	183	20	9.15
37th N/of 5th Ave N - NB	394	27	14.59	170	18	9.44
37th S/of 5th Ave N - SB	552	27	20.44	121	15	8.07
37th N/of 1st Ave N - NB	325	28	11.61	167	18	9.28
37th S/of 1st Ave N - SB	282	27	10.44	176	18	9.78
37th N/of Central Ave - NB	211	27	7.81	54	18	3.00
37th S/of Central Ave - SB	274	27	10.15	108	18	6.00
37th N/of 1st Ave S - NB	297	27	11.00	184	18	10.22
37th S/of 1st Ave S - SB	310	27	11.48	163	18	9.06
37th Ave N/of 5th Ave S - NB	368	28	13.14	130	18	7.22
37th Ave S/of 5th Ave S - SB	467	28	16.68	287	18	15.94
37th N/of 15th Ave S - NB	427	23	18.57	308	18	17.11
37th S/of 15th Ave S - SB	430	28	15.36	236	18	13.11
37th N/of 18th Ave S - NB	352	28	12.57	217	18	12.06
37th S/of 18th Ave S - SB	505	28	18.04	221	19	11.63
37th N/of 22nd Ave S - NB	210	22	9.55	203	20	10.15
37th S/of 22nd Ave S - SB	369	28	13.18	120	19	6.32
31st Street	6849	476	14.39	5041	352	14.32
37th Street	6389	484	13.20	3216	329	9.78
All	13238	960	13.79	8257	681	12.12

Table 4. Percentage of wrong way riding at each data collection location.

	AFTER	BEFORE
	% of wrong way riders	% of wrong way riders
31st Street		
31st N/of 5th Ave N - NB	12.14%	12.84%
31st S/of 5th Ave N - SB	15.48%	4.44%
31st N/of 1st Ave N - NB	27.40%	28.57%
31st S/of 1st Ave N - SB	33.75%	27.88%
31st N/of Central Ave - NB	37.93%	15.08%
31st S/of Central Ave - SB	38.08%	33.77%
31st N/of 1st Ave S - NB	28.13%	31.61%
31st S/of 1st Ave S - SB	44.24%	43.82%
31st N/of 5th Ave S - NB	26.11%	40.00%
31st S/of 5th Ave S - SB	41.76%	52.38%
31st N/of 18th Ave S - NB	22.07%	32.35%
31st S/of 18th Ave S - SB	25.62%	29.63%
31st N/of 22nd Ave S - NB	32.05%	37.14%
31st S/of 22nd Ave S - SB	20.21%	21.48%
31st N/of 26th Ave S - NB	14.97%	22.75%
31st S/of 26th Ave S - SB	10.00%	22.79%
31st N/of 54th Ave S - NB	6.13%	1.38%
31st S/of 54th Ave S - SB	9.43%	12.03%
31st N/of Pinellas Pt - NB	3.37%	2.79%
31st S/of Pinellas Pt - SB	24.47%	20.65%
37th Street		
37th N/of 9th Ave N - NB	5.65%	9.52%
37th S/of 9th Ave N - SB	17.93%	29.51%
37th N/of 5th Ave N - NB	11.42%	15.29%
37th S/of 5th Ave N - SB	26.81%	22.31%
37th N/of 1st Ave N - NB	23.08%	21.56%
37th S/of 1st Ave N - SB	9.93%	11.93%
37th N/of Central Ave - NB	13.74%	18.52%
37th S/of Central Ave - SB	13.50%	13.89%
37th N/of 1st Ave S - NB	21.89%	21.20%
37th S/of 1st Ave S - SB	14.84%	19.02%
37th Ave N/of 5th Ave S - NB	6.52%	10.00%
37th Ave S/of 5th Ave S - SB	20.56%	28.92%
37th N/of 15th Ave S - NB	23.42%	23.70%
37th S/of 15th Ave S - SB	23.49%	23.31%
37th N/of 18th Ave S - NB	21.31%	36.87%
37th S/of 18th Ave S - SB	30.50%	20.81%
37th N/of 22nd Ave S - NB	16.19%	41.87%
37th S/of 22nd Ave S - SB	14.09%	6.67%
31st Street	28.95%	27.14%
37th Street	18.61%	22.33%
All	23.96%	25.26%

Table 5 shows the number of bicycles by day of week, with wrong way riders removed, for each corridor before and after the implementation of bicycle lanes. Except for the after period on 31st Street, Tuesday, Wednesday, and Thursday had the highest bicycle traffic (in terms of bicycles per day). On 31st Street, Sundays had the least number of bicycles, whereas on 37th Street, Fridays had the least number of bicycles.

Table 5. Number of bicycles by day of week.

Day of Week	31st Street						37th Street					
	After			Before			After			Before		
	Counts	Days	Counts per day	Counts	Days	Counts per day	Counts	Days	Counts per day	Counts	Days	Counts per day
Sunday	614	80	7.68	495	58	8.53	915	87	10.52	441	54	8.17
Monday	854	79	10.81	421	40	10.53	828	80	10.35	368	53	6.94
Tuesday	668	55	12.15	508	44	11.55	810	74	10.95	307	37	8.30
Wednesday	614	57	10.77	673	59	11.41	642	54	11.89	381	45	8.47
Thursday	731	68	10.75	461	40	11.53	696	59	11.80	363	44	8.25
Friday	603	57	10.58	519	52	9.98	472	49	9.63	267	42	6.36
Saturday	782	80	9.78	596	59	10.10	837	81	10.33	371	54	6.87

Additional before-after count data by period of the year are shown in the appendix in Tables A1-A4. The wrong way riders have been removed. The counts per day by period are relatively flat for 31st Street and show moderate growth for 37th Street. In the modeling analyses that follow, the wrong way riders are not included.

Modeling Approach and Results for Count Data

Bicycle counts are an example of data that assume only non-negative integers. There are many ways to model count data including the most popular Poisson and negative binomial regression (22). Poisson regression restricts the mean and variance of the distribution to be the same, whereas the negative binomial regression allows the variance to exceed the mean. When the variance is higher than the mean, the data are considered overdispersed, and this can happen sometimes with counts of events that are relatively rare, such as bicycle counts.

In the most common negative binomial regression that was adopted in this study, the relationship between the dependent variable and the predictors (independent variables) is log-linear. In other words, the relationship can be expressed as follows:

$$Y = \exp(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_n X_n)$$

where Y is the dependent variable, X's are the independent variables, and β 's are coefficients to be estimated. For this analysis, one of the independent variables is an indicator variable to indicate whether the data were collected before or after the installation of bicycles. This indicator variable was coded as 1 for the after condition and

zero for the before condition. If the coefficient of this variable is positive, that is an indication that counts increased in the after period.

The analysis recognizes that multiple counts were collected at the same site, indicating that there may be serial correlation between the error terms among the observations. Many methods have been proposed to address this correlation, including fixed and random effects models (see (22) for further discussion). A random effects model is typically used if individual sites can be assumed to have been randomly selected from a population of sites. Since that is not an appropriate assumption in this case, the fixed effects model was selected for use. With this approach, the site number is introduced as a categorical variable in the model. The model also included day of week as a categorical variable.

Table 6 shows the results and selected goodness-of-fit (GOF) statistics for different conditions: all sites and all days, all sites during weekdays, for 31st Street, and then for 37th Street. Only the coefficient for the before-after variable is shown (coefficients for day of week and individual sites are not shown for brevity). The GOF statistics shown are overdispersion parameter, and the deviance and the Pearson chi-square values (divided by the degrees of freedom (df)). For a given dataset, the lower the value of the overdispersion parameter, the better the model. Both the deviance (divided by df) and the Pearson chi square (divided by df) are quite close to 1.0 for all the models, indicating a good fit. The p value of the coefficient of Before_After is lower than 0.05 for three of the models: all sites and all days, all sites on weekdays, and 37th Street, indicating that changes in the bicycle counts following the installation of bicycle lanes were statistically significant at the 0.05 level for these three models. In these tables, the $\exp(\text{coefficient of Before_After})$ represents the ratio of the predicted number of counts in the after period to the predicted to the number of counts in the before period. For example, the coefficient for Before_After is 0.1582 in the model that was estimated with all sites and all days. This implies that the ratio of after counts to before counts is 1.1714 ($\exp(0.1582)$), implying a 17.1% increase in counts. Similarly, during weekdays there was an 18% increase in bicycle counts during the after period. However, when 31st and 37th streets were examined separately, 31st Street experienced almost no change in counts (3% reduction that was not statistically significant), whereas 37th Street experienced a statistically significant 41.9% increase in counts after bicycle lanes were introduced. Even though statistically significant, the 37th Street increase amounts to a change from only 7.6 to 10.7 bicycles per day in the raw count data from before to after.

Table 6. Negative binomial regression models for the number of bicycles per day at all sites.

	All Sites and All Days			All Sites during Weekdays		
	Estimate	Std Error	p-value	Estimate	Std Error	p-value
Constant	2.3637	0.0798	<0.0001	2.3653	0.0916	<0.0001
Before_After (After = 1; Before = 0)	0.1582	0.0265	<0.0001	0.1659	0.0308	<0.0001
Observations (days)	1641			1088		
<i>GOF statistics</i>						
Overdispersion parameter	0.1595			0.1333		
Deviance/df	1.1537			1.1570		
Pearson chi-square/df	1.0065			1.0230		
	31st Street			37th Street		
	Estimate	Std Error	p-value	Estimate	Std Error	p-value
Constant	1.8328	0.1059	<0.0001	2.2363	0.0741	<0.0001
Before_After (After = 1; Before = 0)	-0.0313	0.0404	0.4381	0.3500	0.0329	<0.0001
Observations (days)	828			813		
<i>GOF statistics</i>						
Overdispersion parameter	0.2040			0.0905		
Deviance/df	1.1698			1.1502		
Pearson chi-square/df	0.9936			1.0538		

Bicycle Speed

The intent of this section is to examine whether the installation of bicycle lanes could lead to changes in the average speed of bicycles. The speeds of bicycles could be extracted from the data collected previously at the total of 38 locations on 31st and 37th streets before and after the installation of bicycle lanes. For this analysis, only those days where bicycle counts were recorded for the whole day (i.e., 24 hours) were included, and wrong way riders were removed. In an attempt to model free flow conditions, only those speed observations where the headway of the bicycle (to the vehicle in front) was at least 3.0 seconds were included in the analysis, and the maximum bicycle speed was equal to or less than 22 mph.

Table 7 shows the average speed at each data collection site, by street, and overall before and after implementation of bicycle lanes. Most of the average speeds at individual data collection locations are near the overall average speeds of 11-12 mph for 31st and 37th streets. Some sites experienced an increase in average bicycle speed following the installation of bicycles whereas others experienced a decrease in average speed.

Table 7. Average speed for each site before and after bicycle lanes.

	AFTER	BEFORE
31st Street	Average Speed (mph)	Average Speed (mph)
31st N/of 5th Ave N - NB	11.54	10.96
31st S/of 5th Ave N - SB	11.76	12.47
31st N/of 1st Ave N - NB	10.72	11.50
31st S/of 1st Ave N - SB	11.42	11.83
31st N/of Central Ave - NB	11.93	12.89
31st S/of Central Ave - SB	10.57	11.22
31st N/of 1st Ave S - NB	10.08	10.50
31st S/of 1st Ave S - SB	10.97	10.35
31st N/of 5th Ave S - NB	12.24	11.84
31st S/of 5th Ave S - SB	10.42	9.56
31st N/of 18th Ave S - NB	12.04	11.71
31st S/of 18th Ave S - SB	13.22	13.62
31st N/of 22nd Ave S - NB	10.61	9.05
31st S/of 22nd Ave S - SB	14.54	13.88
31st N/of 26th Ave S - NB	11.47	9.72
31st S/of 26th Ave S - SB	15.21	11.73
31st N/of 54th Ave S - NB	15.70	16.01
31st S/of 54th Ave S - SB	14.28	14.25
31st N/of Pinellas Pt - NB	15.96	16.25
31st S/of Pinellas Pt - SB	10.10	10.27
37th Street		
37th N/of 9th Ave N - NB	10.32	10.81
37th S/of 9th Ave N - SB	10.45	10.36
37th N/of 5th Ave N - NB	11.26	11.52
37th S/of 5th Ave N - SB	10.39	10.64
37th N/of 1st Ave N - NB	11.42	11.24
37th S/of 1st Ave N - SB	10.28	10.68
37th N/of Central Ave - NB	11.61	13.41
37th S/of Central Ave - SB	12.43	10.99
37th N/of 1st Ave S - NB	10.52	10.50
37th S/of 1st Ave S - SB	13.11	12.36
37th Ave N/of 5th Ave S - NB	11.26	11.65
37th Ave S/of 5th Ave S - SB	12.03	12.48
37th N/of 15th Ave S - NB	10.58	10.35
37th S/of 15th Ave S - SB	11.90	12.01
37th N/of 18th Ave S - NB	11.18	10.68
37th S/of 18th Ave S - SB	13.61	13.34
37th N/of 22nd Ave S - NB	11.44	11.77
37th S/of 22nd Ave S - SB	13.48	16.03
31st Street	12.21	11.92
37th Street	11.53	11.64
All	11.82	11.82

Modeling Approach and Results for Speed Data

The intent was to model average speed. The distribution of speed was found to be right skewed (also called positive skew). Figure 7 shows the histogram of speed for 31st and 37th streets before and after the introduction of bicycle lanes. The top two histograms are for the after condition and the bottom histograms are for the before condition. The histograms on the left are for 31st Street and on the right are for 37th Street.

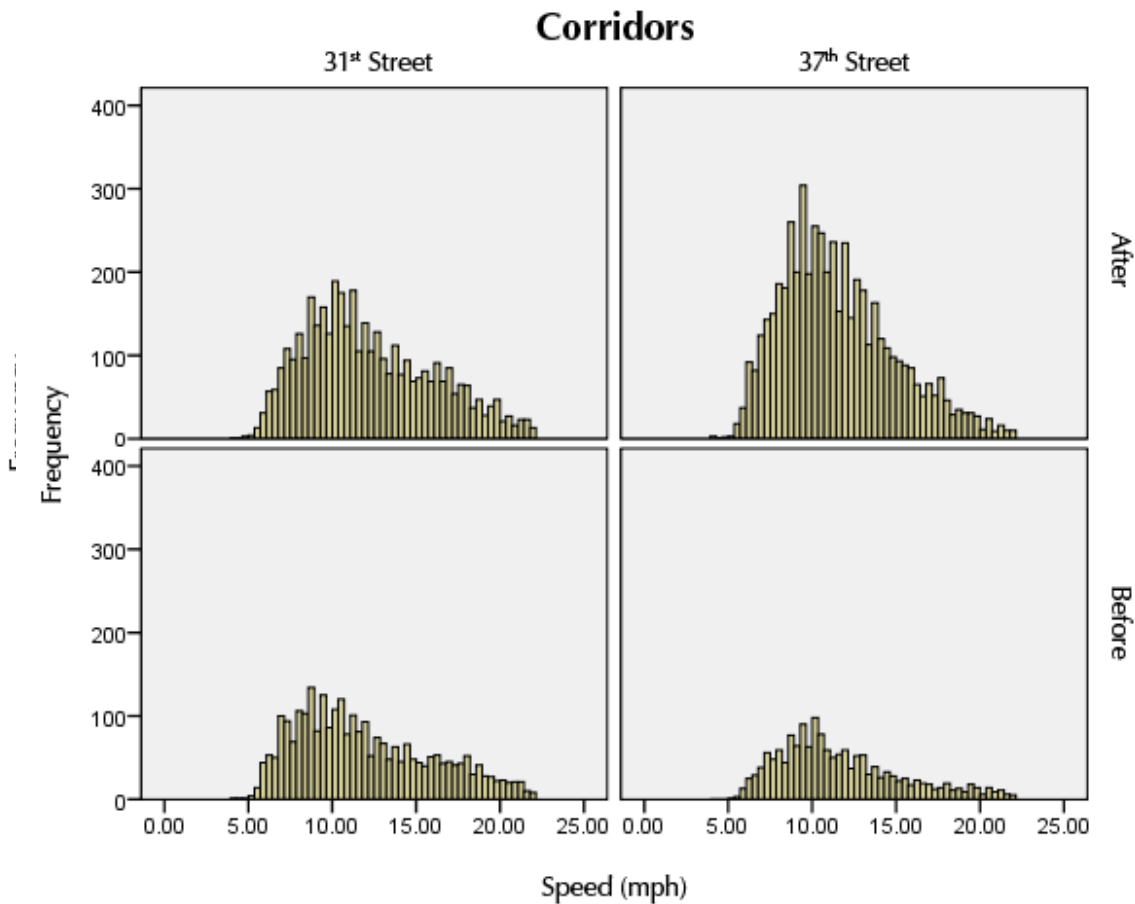


Figure 7. Speed histograms for 31st and 37th streets before and after the installation of bike lanes.

Two sets of models were estimated to further investigate the effect of skew. In the first set of models, a linear regression model was estimated with speed as the dependent variable. In the other set of models, a linear regression model was estimated with the natural logarithm of speed as the dependent variable. To determine which set of models to use, standard P-P and Q-Q plots (24) were used to assess the normality of the residuals

from these models. These plots showed that the second set of models (with natural log of speed as the dependent variable) were slightly better, and are discussed below.

If Y is the speed of bicycle, then

$$\log_e Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots \beta_n X_n$$

where $\log_e Y$ is the natural logarithm of Y, X's are the independent variables, and β 's are coefficients to be estimated.

This relationship can be rewritten as follows

$$Y = \exp(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots \beta_n X_n)$$

For this analysis, one of the independent variables is an indicator variable to indicate whether the data were collected before or after the installation of bicycle lanes. This indicator variable was coded as 1 for the after condition and zero for the before condition. If the coefficient of this variable is positive, that is an indication that speed increased in the after period; and if the coefficient is negative, that is an indication that speed decreased in the after period.

The analysis recognizes that multiple speed observations were collected at the same site indicating that there may be serial correlation between the error terms among these observations. As discussed earlier, many methods have been proposed to address this correlation including fixed and random effects models. In this study, the fixed effects model was selected for use. With this approach, the site number is introduced as a categorical variable in the model. In addition, the model also included day of week and month of year as categorical variables.

Table 8 shows the results and selected GOF statistics for different conditions: all sites and all days, all sites during weekdays, for 31st Street, and then for 37th Street. Only the coefficient for the before-after variable is shown (coefficients for day of week, individual sites, and month of year are not shown for brevity). The GOF statistics shown are the R-square and F values (along with the appropriate degrees of freedom). The F statistics indicate that the models are reasonable. The R-square values are between 0.10 and 0.26, which are quite reasonable for disaggregate data of this nature. The p value of the coefficient of Before_After is lower than 0.05 for two of the models: weekdays and 31st street. In these tables, the exp (coefficient of Before_After) represents the ratio of the predicted average speed in the after period to the predicted average speed in the before period. For example, the coefficient for Before_After is 0.0093 in the model that was estimated with all sites and all days. This implies that the ratio of average speed in the after period to the average speed in the before period is 1.009 ($\exp(0.0093)$), implying a 0.9% increase in speed (this increase was not statistically significant at the 0.05 level). Similarly, during weekdays there was a 1.3% increase in speed during the after period. However, when 31st and 37th streets were examined separately, 31st Street essentially

experienced a 2.7% increase in speed (statistically significant at the 0.05 level), whereas 37th Street experienced a 1.6% reduction (not statistically significant at the 0.05 level). These average speed changes are considered too small for practical significance.

Table 8. Log-linear model for average speed at all sites.

	All Sites and All Days			All Sites during Weekdays		
	Estimate	Std Error	p-value	Estimate	Std Error	p-value
Constant	2.4687	0.0156	<0.0001	2.4717	0.0158	<0.0001
Before_After (After = 1; Before = 0)	0.0093	0.0063	0.1394	0.0130	0.0065	0.0460
Observations	13565			12750		
<i>GOF statistics</i>						
R-square	0.1932			0.1882		
F value (DFM, DFE)	58.81 (55, 13509)		<0.0001	55.53 (53, 12696)		<0.0001
	31st Street			37th Street		
	Estimate	Std Error	p-value	Estimate	Std Error	p-value
Constant	2.2692	0.0281	<0.0001	2.4699	0.0168	<0.0001
Before_After (After = 1; Before = 0)	0.0266	0.0098	0.0065	-0.0163	0.0142	0.2503
Observations	6696			6869		
<i>GOF statistics</i>						
R-square	0.2683			0.1031		
F value (DFM, DFE)	67.82 (36, 6659)		<0.0001	22.44 (35, 6833)		<0.0001

SUMMARY AND DISCUSSION

The data collected in this project allowed an examination of bicycle counts and speeds on two corridors with relatively low levels of bicycling. For all sites and days on both corridors, and with the wrong way riders removed from the data, model results showed a 17% increase in the number of bicyclists per day after installation of the bike lanes (from 9.06 to 10.49 bicycles per day using the raw count data). When 31st and 37th streets were examined separately, 31st Street experienced almost no change in counts (10.43 to 10.22 bicycles per day using the raw count data). This reduction was not statistically significant. After bicycle lanes were introduced, 37th Street experienced a statistically significant 42% increase in counts, although the change in the raw counts from before to after was only 7.59 to 10.74 bicycles per day.

There was at least one outlier in the 31st Street data. The site near 5th Avenue N in the southbound direction experienced a dramatic reduction in bicycles per day from 31.06 to 7.89 following the implementation of bicycle lanes. Reasons for this change could not be determined. If this site is removed from the analysis, then the overall rate for 31st Street in the before period will be 9.32 (instead of 10.43) and will be 10.36 (instead of 10.22) in

the after period, indicating that bicycles per day would have slightly increased on 31st Street.

Bicycle speed data were also available from the counters and for most data collection locations were near the overall average speeds of 11-12 mph for the two streets. Examining all sites and days of the week, the ratio of average speed in the after period compared to the before showed a 0.9% increase in speed (not statistically significant at the 0.05 level). Similarly, there was a 1.3% increase in speed during weekdays during the after period (statistically significant at the 0.05 level). When 31st and 37th streets were examined separately, the average speed of bicycles on 31st Street essentially increased 2.7% (statistically significant at the 0.05 level), and the average speed of bicycles on 37th Street decreased 1.6% (not statistically significant at the 0.05 level). These average speed changes are considered too small for practical significance.

In conclusion, this project allowed a before-after examination of bicycle counts and speeds associated with the installation of bike lanes on streets with low levels of bicycling. The average bicycle speeds were quite similar from before to after bike lane installation. Although actual counts increased only by a small number, it is interesting to ponder why counts increased on 37th Street and remained relatively constant on 31st Street. An examination of available motor vehicle traffic volume and speed data from before to after bike lanes shows general decreases in traffic volume and speed on both 31st and 37th Streets. This analysis does not account for changes in bicycle travel due to trends in population and demography and for changes (temporary or permanent) that may have occurred due to increase in the price of gasoline in 2008.

It is clear that the two corridors are somewhat different. The land use for 37th Street is almost entirely residential with only a few commercial establishments. The street is relatively quiet and could be considered a neighborhood collector. The land use for 31st Street is mainly commercial and more of a citywide collector that moves traffic to arterials. In addition, 31st Street has more convenience stores, shops, and shopping centers, as well as more motor vehicle traffic. One would expect that cyclists would view 37th Street as a safer street to bicycle, and perhaps that is the main reason that the number of bicycles per day increased.

As mandated by its bicycle master plan, St. Petersburg is attempting to place bike lanes on all collector and arterial streets. Some 95 miles have been completed to date with another 10-12 expected in the next year. Both 31st and 37th Streets were wide enough to be able to install bike lanes with a road diet philosophy and provided north-south connections. This study shows that the addition of bicycle lanes alone on a street will not guarantee an immediate increase in bicycle volume. Other factors, including adjacent land use, convenient origins and destinations, and connectivity of a bicycle lane to other bicycle facilities within the street system are just as, or perhaps more critical, in terms of encouraging bicycling. Over time, as a bicycle-friendly system becomes more widespread and better connected, routes such as those evaluated in this study will likely see increases in bicycle volumes. The results of this effort emphasize the importance of consideration of all of these factors when making prioritization decisions about which bicycle

routes/facilities to build, especially if the goal is to achieve immediate gains in mode shift.

REFERENCES

- (2003). *CityTrails bicycle pedestrian master plan*. City of St. Petersburg, Florida.
- Aultman-Hall, L. and Hall, F. (1998). Research design insights from a survey of urban bicycle commuters. *Transportation Research Record No. 1636*, 21-28.
- Barnes, G.R., and Thompson, K.B. (2006). *Longitudinal analysis of effect of bicycle facilities on commute mode share*. Paper presented at the 87th Annual Meeting of the Transportation Research Board, Washington, DC. (Paper #06-2365).
- Bonham, J. and Suh, J. (2008). Pedalling the city: intra-urban differences in cycling for the journey-to-work. *Road and Transport Research*, 17, 4, 25-40.
- Cervero, R. and Duncan, M. (2003). Walking, bicycling, and urban landscapes: evidence from the San Francisco Bay area. *American Journal of Public Health* 93, 1478–1483.
- Chicago Metropolitan Agency for Planning. *Bicycling strategy report*. <http://www.goto2040.org/ideazone/forum.aspx?id=662#5652>. Accessed March 25, 2009.
- Chicago Metropolitan Agency for Planning. “GO TO 2040.” <http://www.goto2040.org>. Accessed March 24, 2009.
- City of Chicago. “Bike 2015 Plan.” <http://bike2015plan.org>. Accessed March 24, 2009.
- Davis, G. and Wicklatz, T. (2001). *Sample-based estimation of bicycle miles of travel (BMT)*. (Report 2001-23). Minneapolis, MN: Minnesota Department of Transportation.
- Dill, J. (2009). Bicycling for transportation and health: the role of infrastructure. *Journal of Public Health Policy*, 30, S95-S110.
- Dill, J. and Carr, T. (2003). Bicycle commuting and facilities in major U.S. cities: if you build them, commuters will use them. *Transportation Research Record No. 1828*, 116-123.
- Dill, J. and Voros, K. (2007). Factors affecting bicycling demand: initial survey findings from the Portland, Oregon, region. *Transportation Research Record No. 2031*, 9-17.
- Dowling, R., Flannery, A., Landis, B., Petritsch, T., Roupail, N., and Ryus, P. (2008). Multimodal level of service for urban streets. *Transportation Research Record No. 2071*, 1-7.

- Harkey, D.L., Reinfurt, D.W., Knuiman, M., Stewart, J.R., and Sorton, A. (1998). *Development of the bicycle compatibility index: a level of service concept*. (Report No. FHWA-RD-98-072). Washington, DC: Federal Highway Administration.
- Hausman, J., B. Hall, and Z. Griliches. (1984). Economic models for count data with an application to the patents-r&d relationship, *Econometrica* 52, 909-938.
- Landis, B. W., Vattikuti, V. R., Brannick, M. T. (1997). Real-time human perceptions: toward a bicycle level of service. *Transportation Research Record No. 1578*, 119-126.
- Mandel-Ricci, J., Stayton, C., Nicaj, L., Assefa, S., Woloch, D., Jeffrey, K., McCarthy, P., Budnick, N. (2008). A multiagency effort to reduce bicyclist fatalities and serious injuries in New York City. *Public Health Reports*, 123, 652-654.
- Mannering, F. (1998.). Modeling driver decision making: a review of methodological alternatives. Chapter 7 of *Human Factors in Intelligent Transportation Systems* (Ed. by W. Barfield and T. Dingus), Mahwah, NJ: Lawrence Erlbaum Associates.
- Moudon, A.V., Lee, C., Cheadle, A.D., Collier, C.W., Johnson, D., Schmid, T.L., and Weather, R.D. (2005). Cycling and the built environment, a US perspective. *Transportation Research Part D: Transport and Environment*, 10, 3, 245-261.
- Nelson, A.C., and Allen, D. (1997). If you build them, commuters will use them: association between bicycle facilities and bicycle commuting. *Transportation Research Record No. 1578*, pp.79-83.
- Neter, J., Wasserman, W., Kutner, M.H. (1990). *Applied Linear Statistical Models*. (3rd Edition). Homewood, IL: Irwin.
- Pucher, J., and Buehler, R. (2006). Why Canadians cycle more than Americans: A comparative analysis of bicycling trends and policies. *Transport Policy*, 13, 3, 265-279.
- Tilahun, N.Y., Levinson, D.M., and Krizek, K.J. (2007). Trails, lanes, or traffic: Valuing bicycle facilities with an adaptive stated preference survey. *Transportation Research Part A: Policy and Practice*, 41, 287-301.
- Titze, S., Stronegger, W. J., Janschitz, S., Oja, P. (2008). Association of built-environment, social-environment and personal factors with bicycling as a mode of transportation among Austrian city dwellers. *Preventive Medicine*, 47, 3, 252-259, ISSN 0091-7435, DOI: 10.1016/j.ypmed.2008.02.019.

APPENDIX A
SUPPLEMENTAL TABLES

Table A1. Number of bicycles on 31st Street at each site by period before the installation of bicycle lanes.

BEFORE BIKE LANES

31 st Street	2005; 10-26 to 11-20			2006; 04-04 to 05-04			2006; 08-25 to 10-09		
	Counts	Days	Counts per Day	Counts	Days	Counts per Day	Counts	Days	Counts per Day
31st N/of 5th Ave N - NB	26	6	4.33	44	6	7.33	25	6	4.17
31st S/of 5th Ave N - SB	201	6	33.50	186	6	31.00	172	6	28.67
31st N/of 1st Ave N - NB	67	6	11.17	50	6	8.33	28	6	4.67
31st S/of 1st Ave N - SB	78	6	13.00	60	6	10.00	87	6	14.50
31st N/of Central Ave – NB	29	6	4.83	46	6	7.67	32	6	5.33
31st S/of Central Ave – SB	91	7	13.00	65	6	10.83	48	6	8.00
31st N/of 1st Ave S - NB	24	6	4.00	43	6	7.17	39	6	6.50
31st S/of 1st Ave S - SB	96	6	16.00	112	6	18.67	101	6	16.83
31st N/of 5th Ave S - NB	60	6	10.00	26	5	5.20	10	5	2.00
31st S/of 5th Ave S - SB	110	6	18.33	65	6	10.83	75	6	12.50
31st N/of 18th Ave S – NB	52	6	8.67	61	6	10.17	71	6	11.83
31st S/of 18th Ave S - SB	34	6	5.67	32	6	5.33	29	6	4.83
31st N/of 22nd Ave S – NB	75	6	12.50	92	6	15.33	75	5	15.00
31st S/of 22nd Ave S - SB	51	6	8.50	30	6	5.00	25	6	4.17
31st N/of 26th Ave S – NB	77	6	12.83	69	6	11.50	.	.	.
31st S/of 26th Ave S - SB	26	6	4.33	10	6	1.67	69	6	11.50
31st N/of 54th Ave S – NB	91	6	15.17	94	6	15.67	100	6	16.67
31st S/of 54th Ave S - SB	54	6	9.00	57	6	9.50	6	6	1.00
31st N/of Pinellas Pt - NB	.	.	.	69	6	11.50	100	6	16.67
31st S/of Pinellas Pt - SB	.	.	.	48	6	8.00	43	6	7.17
31st Street Overall	1242	109	11.39	1259	119	10.58	1135	112	10.13

Table A2. Number of bicycles on 31st Street at each site by period after the installation of bicycle lanes.

AFTER BIKE LANES

31 st Street	2007; 08-07 to 09-27			2008; 02-23 to 05-19			11-01-2008 to 01-20-2009		
	Counts	Days	Counts per Day	Counts	Days	Counts per Day	Counts	Days	Counts per Day
31st N/of 5th Ave N - NB	.	.	.	53	10	5.30	70	11	6.36
31st S/of 5th Ave N - SB	28	6	4.67	80	10	8.00	105	11	9.55
31st N/of 1st Ave N - NB	2	5	0.40	23	7	3.29	179	11	16.27
31st S/of 1st Ave N - SB	79	7	11.29	93	7	13.29	144	11	13.09
31st N/of Central Ave - NB	4	7	0.57	26	7	3.71	24	11	2.18
31st S/of Central Ave - SB	94	7	13.43	88	7	12.57	192	11	17.45
31st N/of 1st Ave S - NB	77	7	11.00	71	7	10.14	110	12	9.17
31st S/of 1st Ave S - SB	162	7	23.14	203	7	29.00	308	12	25.67
31st N/of 5th Ave S - NB	96	6	16.00	104	8	13.00	117	12	9.75
31st S/of 5th Ave S - SB	118	6	19.67	132	8	16.50	146	12	12.17
31st N/of 18th Ave S - NB	59	6	9.83	66	8	8.25	101	12	8.42
31st S/of 18th Ave S - SB	45	6	7.50	50	8	6.25	85	12	7.08
31st N/of 22nd Ave S - NB	85	6	14.17	.	.	.	127	10	12.70
31st S/of 22nd Ave S - SB	62	6	10.33	41	8	5.13	47	10	4.70
31st N/of 26th Ave S - NB	22	5	4.40	57	6	9.50	46	10	4.60
31st S/of 26th Ave S - SB	21	6	3.50	26	6	4.33	25	10	2.50
31st N/of 54th Ave S - NB	134	7	19.14	87	6	14.50	131	10	13.10
31st S/of 54th Ave S - SB	68	6	11.33	67	6	11.17	86	10	8.60
31st N/of Pinellas Pt - NB	68	6	11.33	71	6	11.83	119	11	10.82
31st S/of Pinellas Pt - SB	26	6	4.33	43	6	7.17	73	11	6.64
31st Street Overall	1250	118	10.59	1381	138	10.01	2235	220	10.16

Table A3. Number of bicycles on 37th Street at each site by period before the installation of bicycle lanes.

BEFORE BIKE LANES

37th Street	2005; 11-23 to 12-26			2006; 10-04 to 11-28			2007; 03-21 to 06-06		
	Counts	Days	Counts per Day	Counts	Days	Counts per Day	Counts	Days	Counts per Day
37th N/of 9th Ave N - NB	47	6	7.83	49	7	7.00	56	7	8.00
37th S/of 9th Ave N - SB	35	6	5.83	57	7	8.14	37	7	5.29
37th N/of 5th Ave N - NB	43	6	7.17	55	6	9.17	46	6	7.67
37th S/of 5th Ave N - SB	28	6	4.67	24	3	8.00	42	6	7.00
37th N/of 1st Ave N - NB	45	6	7.50	46	6	7.67	40	6	6.67
37th S/of 1st Ave N - SB	40	6	6.67	52	6	8.67	63	6	10.50
37th N/of Central Ave - NB	20	6	3.33	6	6	1.00	18	6	3.00
37th S/of Central Ave - SB	20	6	3.33	33	6	5.50	40	6	6.67
37th N/of 1st Ave S - NB	44	6	7.33	64	6	10.67	37	6	6.17
37th S/of 1st Ave S - SB	38	6	6.33	56	6	9.33	38	6	6.33
37th Ave N/of 5th Ave S – NB	46	6	7.67	21	6	3.50	50	6	8.33
37th Ave S/of 5th Ave S – SB	55	6	9.17	62	6	10.33	87	6	14.50
37th N/of 15th Ave S - NB	88	6	14.67	100	6	16.67	47	6	7.83
37th S/of 15th Ave S - SB	58	6	9.67	74	6	12.33	49	6	8.17
37th N/of 18th Ave S - NB	55	6	9.17	57	6	9.50	25	6	4.17
37th S/of 18th Ave S - SB	69	6	11.50	61	7	8.71	45	6	7.50
37th N/of 22nd Ave S - NB	46	7	6.57	60	7	8.57	12	6	2.00
37th S/of 22nd Ave S - SB	41	7	5.86	65	7	9.29	6	5	1.20
37th Street Overall	818	110	7.44	942	110	8.56	738	109	6.77

Table A4. Number of bicycles on 37th Street at each site by period after the installation of bicycle lanes.

AFTER BIKE LANES

37 th Street	2007; 09-22 to 11-06			2008; 05-10 to 08-26			2009; 01-10 to 03-15		
	Counts	Days	Counts per Day	Counts	Days	Counts per Day	Counts	Days	Counts per Day
37th N/of 9th Ave N - NB	33	6	5.50	103	10	10.30	98	11	8.91
37th S/of 9th Ave N - SB	67	6	11.17	124	10	12.40	111	11	10.09
37th N/of 5th Ave N - NB	86	6	14.33	163	10	16.30	100	11	9.09
37th S/of 5th Ave N - SB	91	6	15.17	162	10	16.20	151	11	13.73
37th N/of 1st Ave N - NB	65	8	8.13	117	11	10.64	68	9	7.56
37th S/of 1st Ave N - SB	75	7	10.71	121	11	11.00	58	9	6.44
37th N/of Central Ave - NB	44	7	6.29	87	11	7.91	51	9	5.67
37th S/of Central Ave - SB	71	7	10.14	154	11	14.00	12	9	1.33
37th N/of 1st Ave S - NB	61	7	8.71	99	11	9.00	72	9	8.00
37th S/of 1st Ave S - SB	77	7	11.00	129	11	11.73	58	9	6.44
37th Ave N/of 5th Ave S - NB	123	9	13.67	109	8	13.63	112	11	10.18
37th Ave S/of 5th Ave S - SB	131	9	14.56	109	8	13.63	131	11	11.91
37th N/of 15th Ave S - NB	88	8	11.00	161	8	20.13	78	7	11.14
37th S/of 15th Ave S - SB	140	9	15.56	89	8	11.13	100	11	9.09
37th N/of 18th Ave S - NB	90	9	10.00	71	8	8.88	116	11	10.55
37th S/of 18th Ave S - SB	127	9	14.11	101	8	12.63	123	11	11.18
37th N/of 22nd Ave S - NB	42	8	5.25	47	5	9.40	87	9	9.67
37th S/of 22nd Ave S - SB	82	8	10.25	139	11	12.64	96	9	10.67
37th Street Overall	1493	136	10.98	2085	170	12.26	1622	178	9.11