Temporal and Spatial Variation in Non-Motorized Traffic in Minneapolis

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Thanks to:

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Tony Hull, Transit for Livable Communities

Issue

- Transportation managers lack data about use of bicycle and pedestrian facilities.
  - Quality of data is “poor;” priority for data is “high” (BTS 2000)
- Federal, state, & local governments and nonprofits spending billions on new facilities.
- Need information & tools to plan, manage, evaluate, and optimize investments in facilities.

Which pedestrian would you rather be?

Capstone Objectives

- Assemble, analyze, and describe existing cycling and pedestrian counts in Minneapolis.
- Develop a regression model to estimate bicycle and pedestrian infrastructure use based on the count data provided by the clients.
- Develop recommendations for count protocol and future count locations.

http://www.ci.minneapolis.mn.us/bicycles/VolunteerforBicycleCounts.asp

Approach

Assemble and clean data (e.g., match locations and counts; map locations)

↓

Compute descriptive statistics (e.g., counts by facility type, presence of bus line)

↓

Compute scaling factors for extrapolating counts (e.g., time of day, day of week)

↓

Estimate 12-hour daily counts from short counts

↓

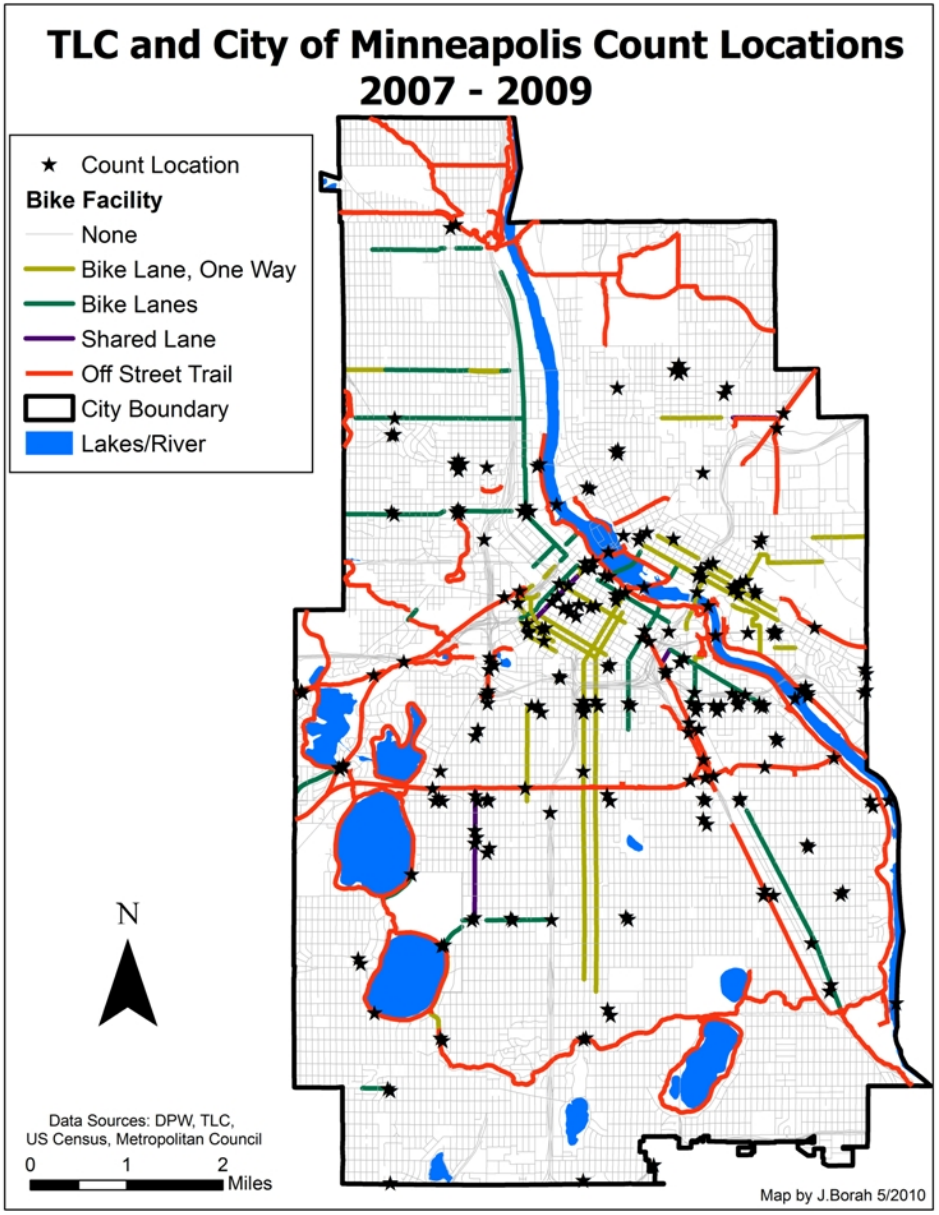
Model pedestrian and cycling traffic

↓

Assess need for validation of observation methods

Summary of Data

Non-motorized Traffic Counts in Minneapolis, Minnesota		
Method of observation	Manual	Magnetic Loop Detector
Traffic observed	Cyclist - separate Pedestrian - separate	Cyclist - separate
Locations in Minneapolis	On and off-street bike facilities and no bike facilities (n=240)	Midtown Greenway (n=3)
Period of observation	2007-2009	2007-2009
Number of observations	458	± 2,500
Length of observations	12-hour (n=43) 2-hour peak period (n=352) Other	24 hours
Limitations	Human error	Never validated


TLC and City of Minneapolis Count Locations
2007 - 2009
Count Location
Bike Facility
None
Bike Lane, One Way
Bike Lanes
Shared Lane
Off Street Trail
City Boundary
Lakes/River
N
Data Sources: DPW, TLC,
US Census, Metropolitan Council
0
1
2
Miles
Map by J.Borah 5/2010

Data and Methods: Location Attributes

Type of Street / Facility	Daily Auto Traffic Volume	Number of count locations	% all count locations	% of count location type with bike facilities
Principal Arterial	15,000 - 100,000	3	1%	0%
A-Minor	5,000 - 30,000	79	33%	16%
B-Minor	5,000 - 30,000	36	15%	44%
Collector	1,000 - 15,000	49	20%	20%
Local	< 1,000	44	18%	18%
Off-street trail	0	29	12%	100 %
All facilities	0-100,000	240	100%	31%

COUNT DATA BY COUNT LOCATION CHARACTERISTICS

12-Hour Bike Traffic Volumes

(Actual observations (6:30 a.m. – 6:30 p.m.; n=43))

	Off-Street (Trails)	On-Street Bike Lane	Shared Lane	None	All
Number of 12 hour observations	**6**	**10**	**1**	**26**	**43**
Maximum traffic volume	1,005	1,157	71	901	1,157
Mean traffic volume	**584***	**625***	**71**	**215**	**358**
Median traffic volume	642	541	71	202	247
Minimum traffic volume	229	240	71	13	13
Average hourly traffic volume	49	52	6	18	30

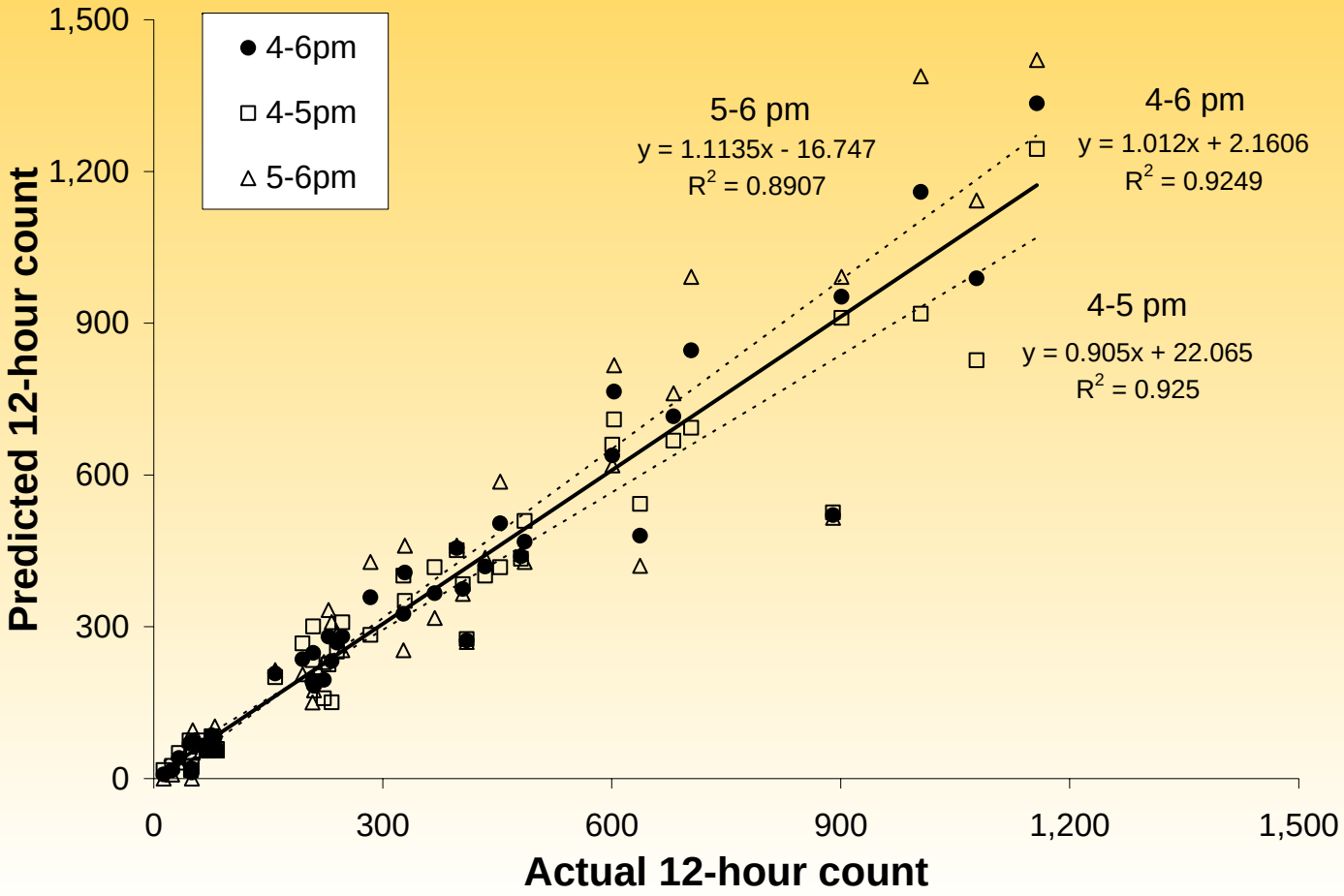
Hourly Scaling Factors for Estimating 12-Hour Volumes

Time period	Bicycle			Pedestrian		
	Percent of 12-hour count	Scale factor	R^2	Percent of 12-hour count	Scale factor	R^2
7-8am	7.5%	13.2	0.88	6.9%	14.5	0.91
8-9am	9.3%	10.7	0.90	5.3%	18.7	0.96
9-10am	7.8%	12.9	0.89	6.1%	16.4	0.97
10-11am	6.4%	15.6	0.89	5.9%	16.8	0.96
11-noon	5.9%	16.9	0.87	9.2%	10.9	0.99
noon-1pm	5.2%	19.1	0.77	9.7%	10.3	0.99
1-2pm	7.2%	14.0	0.88	8.7%	11.5	0.99
2-3pm	7.5%	13.3	0.84	8.8%	11.4	0.98
3-4pm	9.3%	10.8	0.90	7.8%	12.8	0.98
4-5pm	**12.0%**	**8.4**	**0.93**	10.4%	9.6	0.97
5-6pm	12.6%	7.9	0.89	**12.3%**	**8.2**	**0.996**

Example:

Multiplying 4-5 pm traffic by 8.4 yields 12-hour traffic volume.

Estimated vs. Actual 12-Hour Volumes



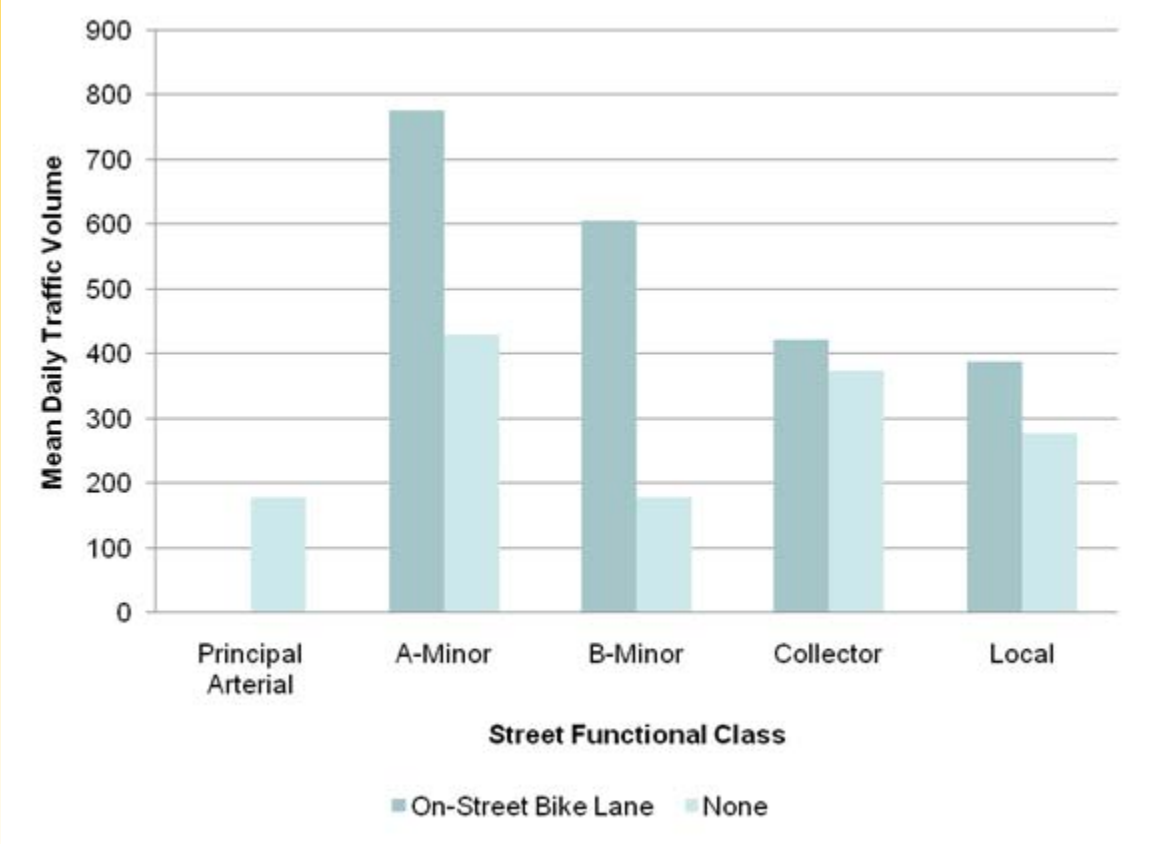
12-Hour Bike Traffic Volumes

(Actual & Estimated observations (6:30 a.m. – 6:30 p.m.; n=458)

	Off-Street (Trails)	On-Street Bike Lane	Shared Lane	None	All
Number of 12 hour observations	**100**	**81**	**5**	**272**	**458**
Maximum traffic volume	6,701	3,138	964	3,394	6,701
Mean traffic volume	**837***	**566***	**450***	**362**	**502**
Median traffic volume	770	301	395	220	269
Minimum traffic volume	20	41	71	0	0
Average hourly traffic volume	70	47	38	30	42

Mean Bike Traffic Volumes by Street & Facility Type

(Actual & Estimated 12-hour observations (6:30 a.m. – 6:30 p.m.; n=458)



Pedestrian Traffic Volumes by Street Type

(Actual & Estimated 12-hour observations (6:30 a.m. – 6:30 p.m.; n=453)

	Principal Arterial	A-Minor	B-Minor	Collector	Local	All Streets	Trails
Observations	**6**	**160**	**72**	**58**	**63**	**359**	**94**
Maximum volume	150	18,153	6,230	13,424	1,476	18,153	14,779
Mean volume	**87**	**1,005**	**939**	**1,447**	**355**	**934**	**440**
Median volume	86	674	315	461	230	443	114
Minimum volume	36	0	43	4	0	0	0
Average hourly volume	7	84	78	121	30	78	37

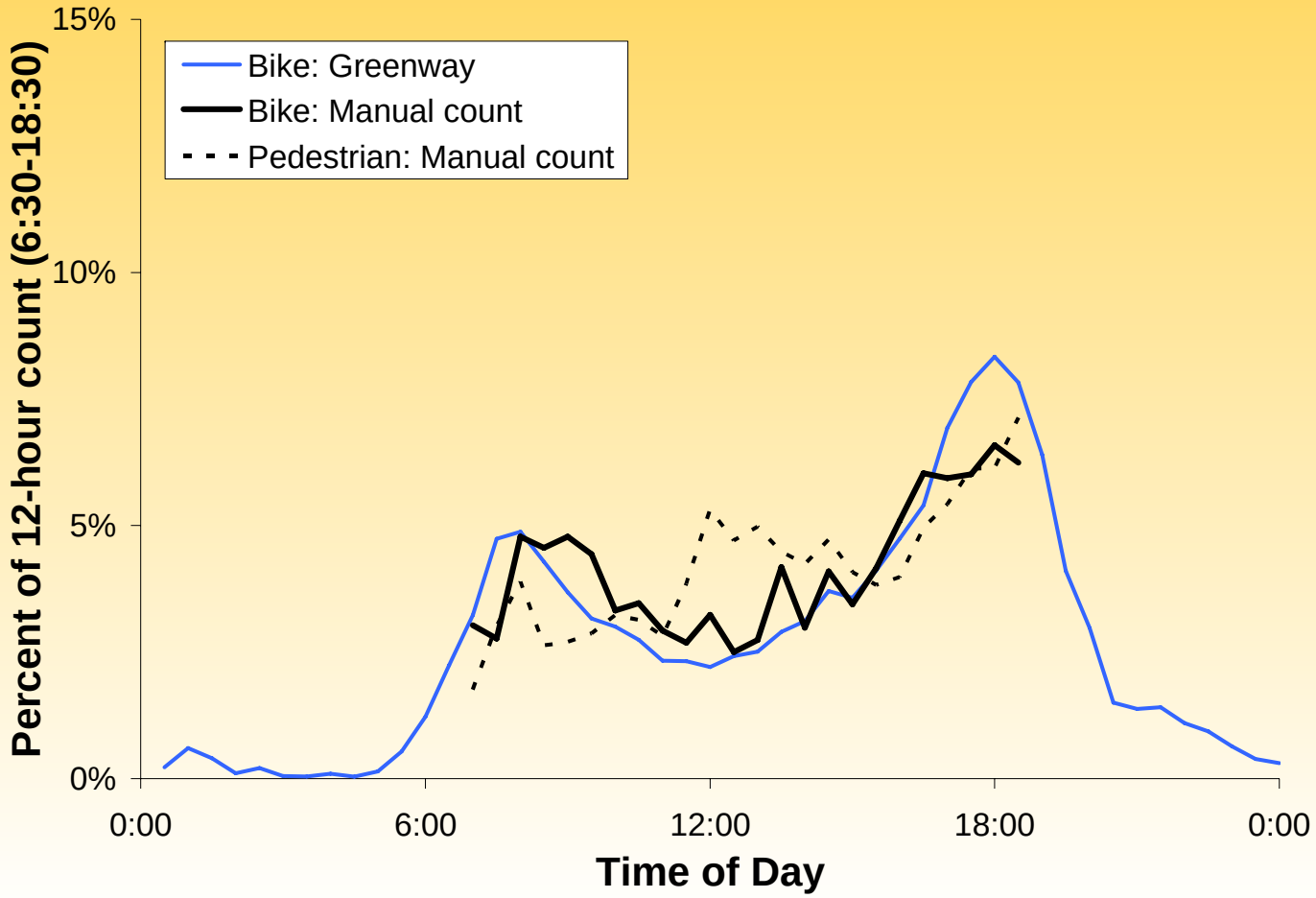
Pedestrian Volumes, Bus Lines, & Trails

(Actual & Estimated 12-hour observations (6:30 a.m. – 6:30 p.m.; n=453)

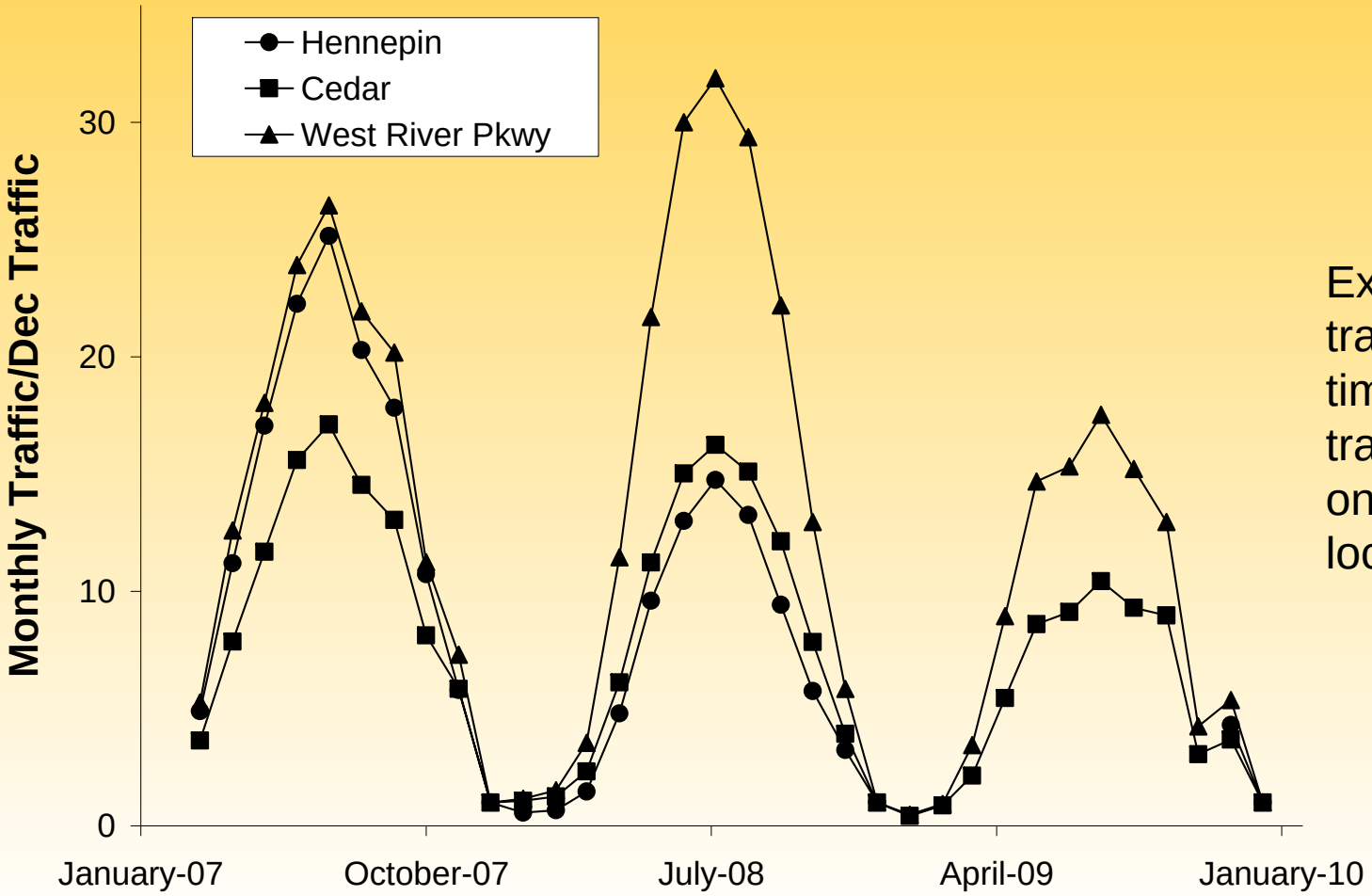
	On Bus Route	None	Trails
Observations	**265**	**94**	**94**
Maximum volume	18,153	8,492	14,779
Mean volume	**1,071***	**547**	**440**
Median volume	552	230	114
Minimum volume	0	0	0
Average hourly volume	89	46	37

HOURLY AND SEASONAL PATTERNS

Variation in Hourly Bicycle and Pedestrian Traffic

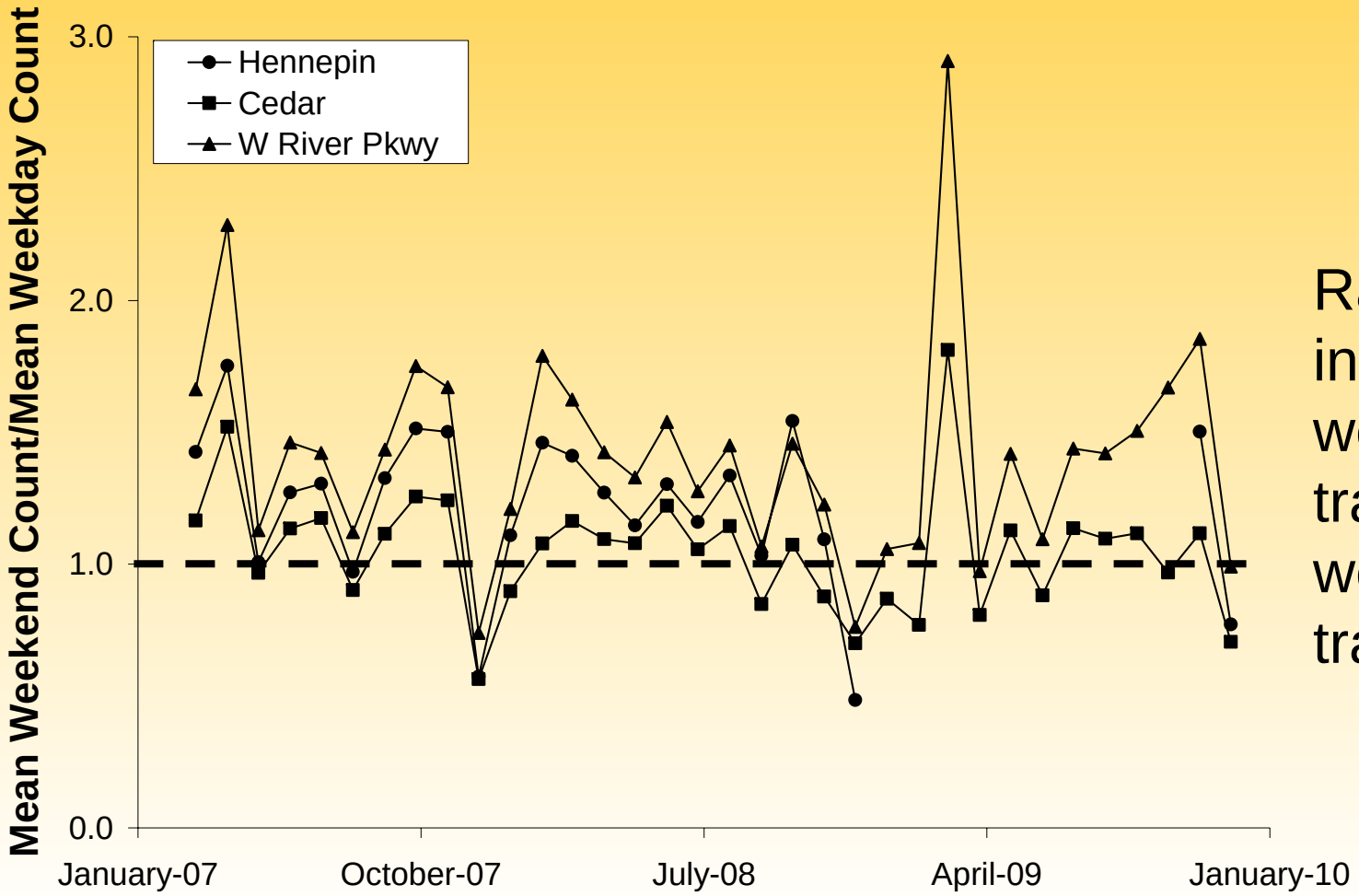


Monthly Scaling Factors (Relative to December)



Example: July traffic is 10 to 30 times December traffic depending on year and location

Weekend-Weekday Greenway Bicycle Ratios

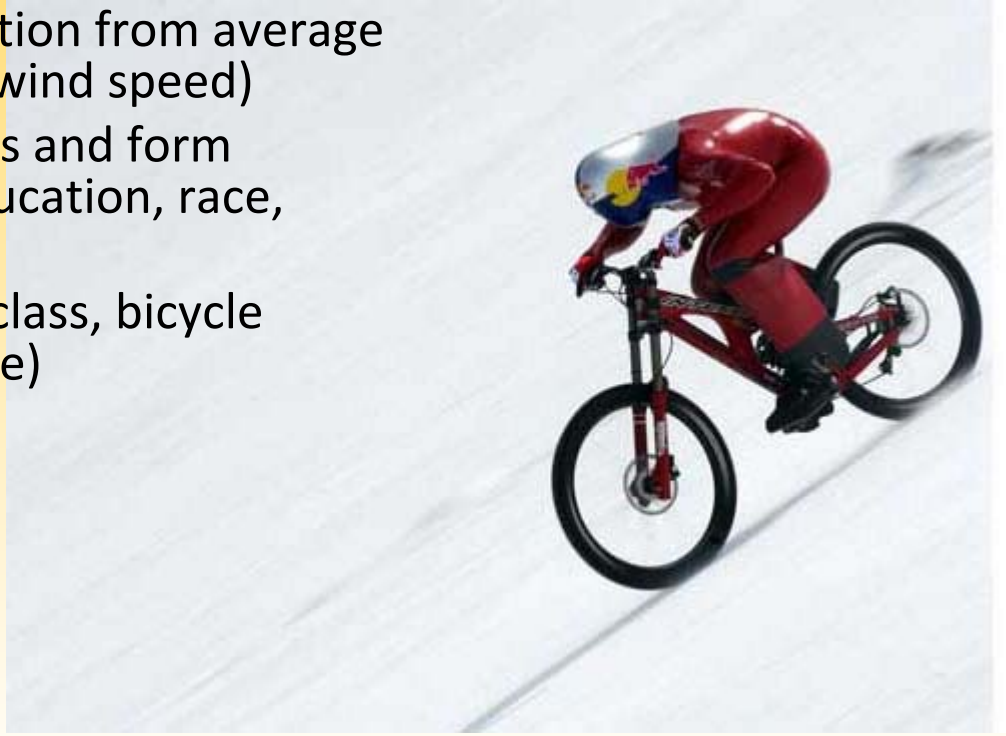


Ratios > 1 indicate mean weekend traffic > mean weekday traffic

REGRESSION MODEL

Explaining Variation in Counts

- 12-hour bicycle and pedestrian estimates as a function of:
  - Climate (temperature, deviation from average temperature, precipitation, wind speed)
  - Neighborhood characteristics and form (population age, income, education, race, density, land use mix)
  - Facility infrastructure (road class, bicycle facility, presence of bus route)
- Adjusted R^2
  - Bicycle model = 0.237
  - Pedestrian model = 0.269



Regression Model Results

Climate Variable	Effect on Bicycles	Effect on Pedestrians
Maximum daily temperature	+	+
Deviation from average temperature	Not significant	Not significant
Precipitation (any)	- -	Not significant
Wind speed (average)	Not significant	Not significant

Significant at 10% level if applicable

Model Results, cont.

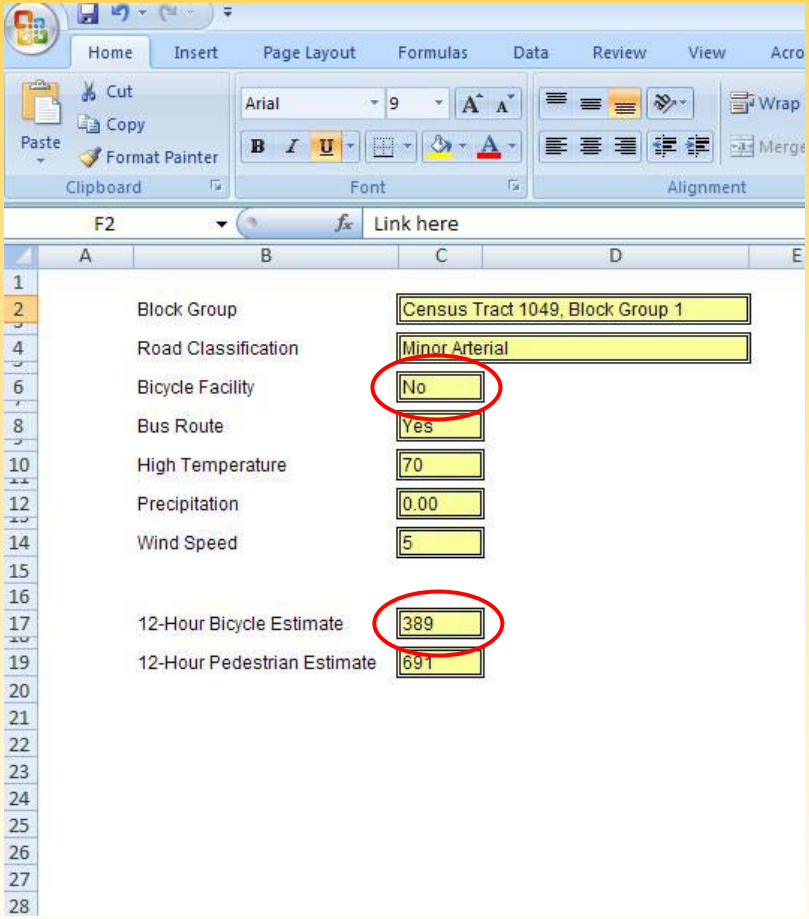
Neighborhood Variable*	Effect on Bicycles	Effect on Pedestrians
% Population > 65, < 5	+	Not significant
Median household income	-	-
% Population with college degree	+	+
% Black population	-	-
% Other race	Not significant	Not significant
Population density	Not significant	Not significant
Land use mix	++	+++

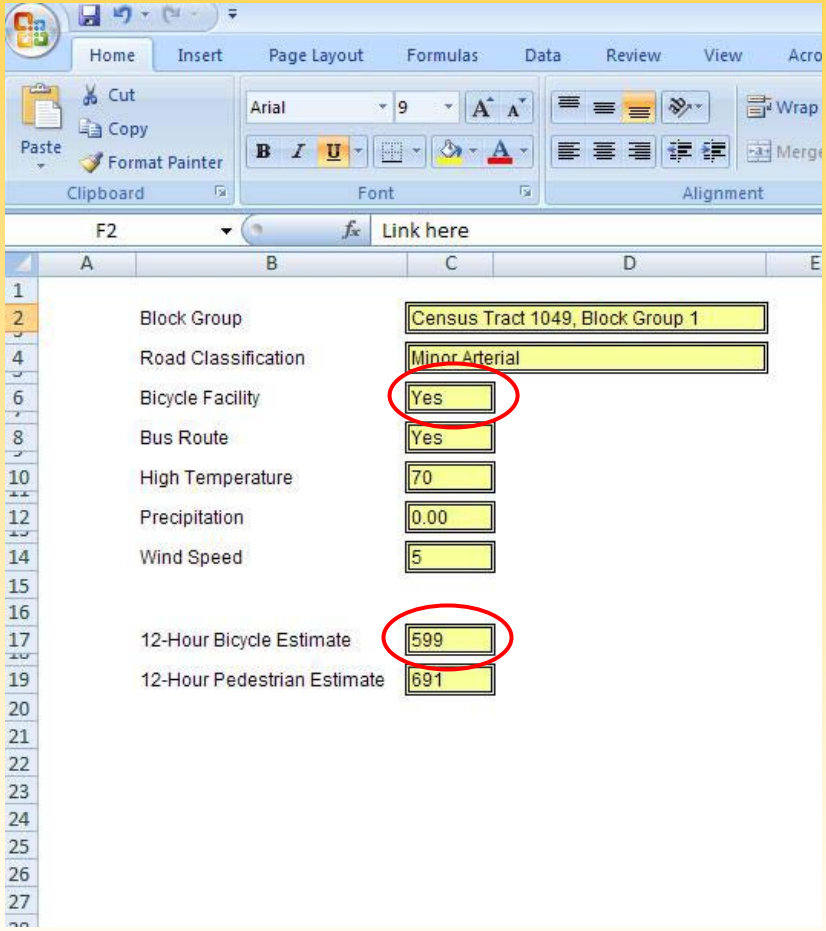
*Estimated for Census block group where counting location falls
Significant at 10% level, if applicable

Model Results, cont.

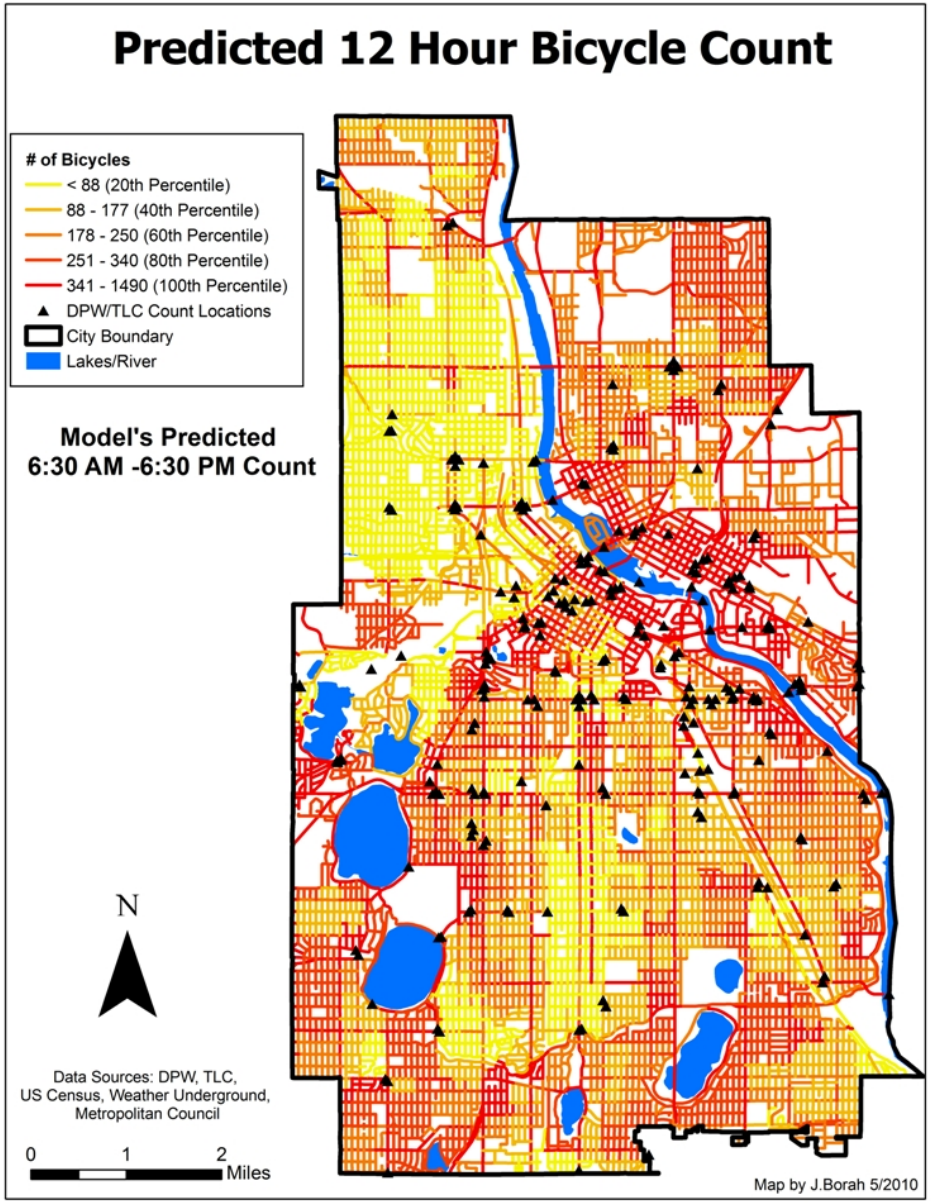
Road Infrastructure Variable	Effect on Bicycles (relative to local street, no bike facility)
Principal arterial with bike facility	No counts
Minor arterial with bike facility	++
Collector with bike facility	Not significant
Local with bike facility	Not significant
Principal arterial, no facility	Not significant
Minor arterial, no facility	++
Collector, no facility	Not significant
Off-street bike facility	+++
Presence of bus line	Not significant
Local, no facility	(base case)
Significant at 10% level, if applicable	

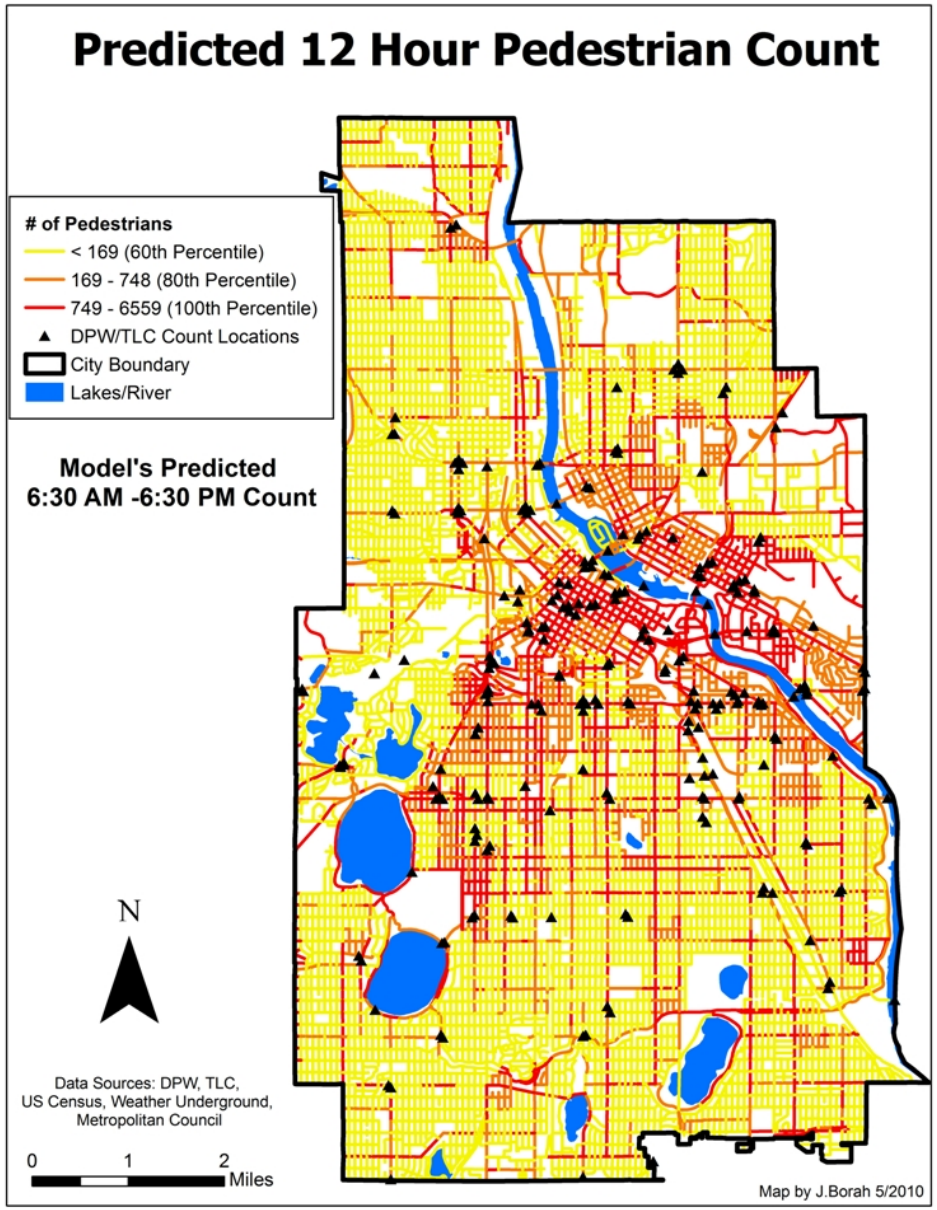
Count Estimator Tool



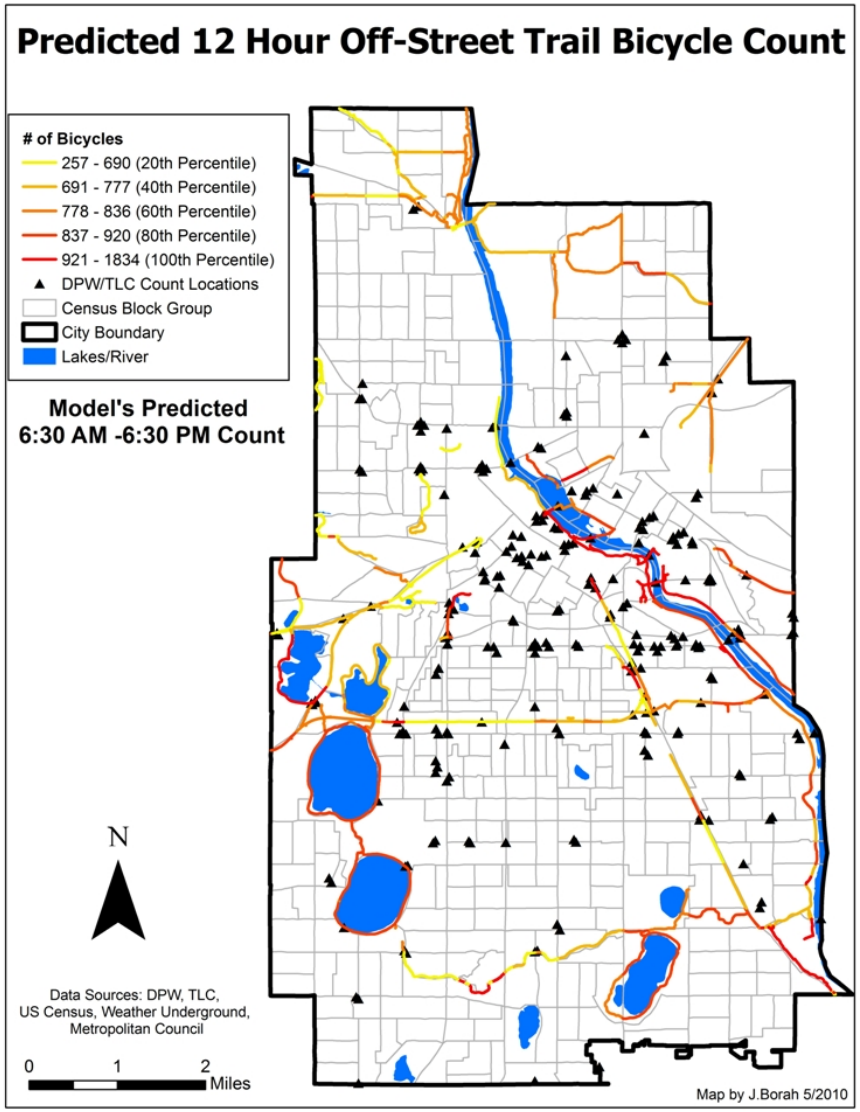


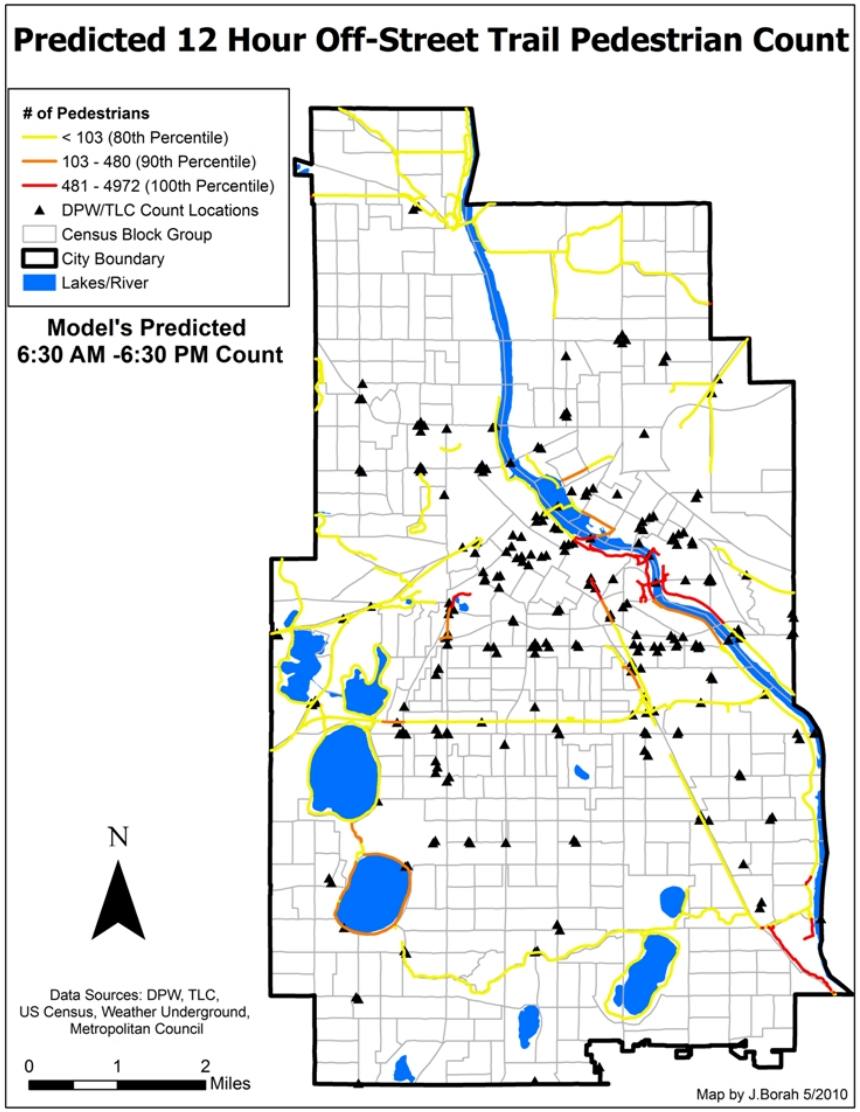
PREDICTIVE MAPS


Predicted 12 Hour Bicycle Count
# of Bicycles
< 88 (20th Percentile)
88 - 177 (40th Percentile)
178 - 250 (60th Percentile)
251 - 340 (80th Percentile)
341 - 1490 (100th Percentile)
DPW/TLC Count Locations
City Boundary
Lakes/River
Model's Predicted
6:30 AM -6:30 PM Count
N
Data Sources: DPW, TLC,
US Census, Weather Underground,
Metropolitan Council
0
1
2
Miles
Map by J.Borah 5/2010


Predicted 12 Hour Pedestrian Count
# of Pedestrians
< 169 (60th Percentile)
169 - 748 (80th Percentile)
749 - 6559 (100th Percentile)
DPW/TLC Count Locations
City Boundary
Lakes/River
Model's Predicted
6:30 AM -6:30 PM Count
N
Data Sources: DPW, TLC,
US Census, Weather Underground,
Metropolitan Council
0
1
2
Miles
Map by J.Borah 5/2010

Off-Street Trail Maps





RECOMMENDATIONS

Recommendations for Future Counts

- Validation of count methods
- Standardized count protocol
- Full day counts as feasible
- Fill in data gaps

Data Gap Analysis

Have count locations been evenly selected throughout the City?

- Spatially?
- Sociodemographically?

	City	Model Variable	Count Location Block Groups	
Minimum	0.0000	**LUMix**	0.0004	*Minimum*
Maximum	4.9820		4.9820	*Maximum*
Median	0.0219		0.0366	*Median*
Mean	0.0775		0.1731	*Mean*
Standard Deviation	0.3323		0.6070	*Standard Deviation*
Minimum	0.14	**BlackPct (%)**	0.48	*Minimum*
Maximum	73.13		73.13	*Maximum*
Median	9.46		9.24	*Median*
Mean	17.00		15.88	*Mean*
Standard Deviation	17.78		17.35	*Standard Deviation*
Minimum	1.62	**CollegePct (%)**	1.62	*Minimum*
Maximum	91.35		88.79	*Maximum*
Median	39.48		45.56	*Median*
Mean	41.83		44.67	*Mean*
Standard Deviation	21.41		22.05	*Standard Deviation*
Minimum	1.94	**OtherPct (%)**	3.14	*Minimum*
Maximum	85.03		46.27	*Maximum*
Median	12.57		12.06	*Median*
Mean	16.03		15.70	*Mean*
Standard Deviation	11.50		10.71	*Standard Deviation*
Minimum	0.03	**YngOldPct (%)**	0.03	*Minimum*
Maximum	55.09		36.21	*Maximum*
Median	15.72		14.53	*Median*
Mean	15.91		14.06	*Mean*
Standard Deviation	6.85		6.98	*Standard Deviation*
Minimum	10.50	**MedIncThd ($)**	10.50	*Minimum*
Maximum	176.25		126.74	*Maximum*
Median	39.42		34.50	*Median*
Mean	43.33		38.32	*Mean*
Standard Deviation	22.16		20.89	*Standard Deviation*
Minimum	0.54	**PopDens (per acre)**	0.54	*Minimum*
Maximum	58.22		58.22	*Maximum*
Median	12.63		12.17	*Median*
Mean	14.83		14.93	*Mean*
Standard Deviation	8.78		10.38	*Standard Deviation*

Conclusions

- Bicycle volumes greatest on off-street facilities > on-street facilities > no facility
- Pedestrian volumes greater on roads with bus lines, effect of road classification unclear
- Peak hour bicycle and pedestrian volumes highly correlated with 12-hour volumes
- Bicycles and pedestrians can be modeled using weather, neighborhood characteristics and built environment variables

Thank you.

Questions?

Supplemental Slides

Data and Methods: Road and Bike Infrastructure Characteristics

- *Type of bike facility*: Minneapolis DPW
  - One-way bike lane
  - Two-way bike lane
  - Shared lane
  - Off-street trail
- *Street/road classification*: Metropolitan Council
  - Principal Arterial
  - A-Minor arterial
  - B-Minor arterial
  - Major Collector
  - Local
- *Bus lines*: Metro Transit

Data and Methods: Location Attributes

- 240 locations (manual counts, bikes and pedestrians)
  - 100% of pedestrian count locations on sidewalks or trails
  - 68% of bike count locations on streets with no bike facility
  - 32% of bike count locations on bike facilities
    - 18% are on-street facilities (i.e., bike lanes or shared traffic lanes)
    - 14% are off-street facilities (e.g., trail)
  - 61% of bike and pedestrian count locations served by bus lines
  - Number of repeat observations at locations varies