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MEMORANDUM

To: **Ross Patronsky**
From: Claire Bozic
Date: August 24, 2015
Re: Calculating Distribution of Counts by Month and MOVES Source Type from IDOT Continuous Count Station Classification Data (DRAFT)

Background

The MOVES Air Quality model requires a number of inputs that are not calculated using the results of the regional travel demand model. One of these inputs is an Excel workbook containing the monthly distribution of vehicle miles traveled by source type (vehicle class). There isn't a source of information which presents regional observed vehicle miles traveled by month. As a proxy for vehicle miles traveled, we used the Illinois Department of Transportation continuous count station data. Only the continuous count stations which provide vehicle class data were used.

Continuous Count Stations

The following table presents the locations of stations which were included in the data received from IDOT. Stations with Y in the drop category were dropped from the analysis because they either had questionable data quality or were missing too much data.

Nearest City	County	Location	Illinois Functional Class Description	Rural/ Urban	Restricted Access	Drop
Fox Lake	Lake	US 12 1.0 mile south of IL 134	Other Principal Arterial	Urban	no	
	Cook	IL 59 0.4 mile south of US 20	Other Principal Arterial	Urban	no	Y
Addison	DuPage	I 290	Interstate	Urban	yes	
Palos Park	Cook	IL 7 NE of West 131st St.	Minor Arterial	Urban	no	Y
Elk Grove Village	Cook	Devon Ave. west of Ridge Ave. and Mittel Blvd	Minor Arterial	Urban	no	
Rosemont	Cook	IL 72 (Higgins Rd.) West of I-294 overpass	Major Collector	Urban	no	
Northbrook	Cook	IL 43 (Waukegan Rd.) NW of Techny Dr.	Other Principal Arterial	Urban	no	
Wheeling	Cook	IL 68 (Dundee Rd.) East of Portwine Rd.	Other Principal Arterial	Urban	no	
Woodridge	DuPage	IL 53 0.02 mi south of 75th St.	Other Principal	Urban	no	Y

			Arterial			
West Chicago	DuPage	IL 64 0.9 mile west of IL 59	Other Principal Arterial	Urban	no	
Hinsdale	DuPage	IL 83 (Kingery Hwy) North of 55th Street overpass	Other Principal Arterial	Urban	yes	Y
Lake Zurich	Lake	IL 22 .14 mile W. of Quentin	Other Principal Arterial	Urban	no	
North Barrington	Lake	IL 59 (Hough Rd.) South of Cresthill Rd.	Other Principal Arterial	Urban	no	
Woodstock	McHenry	US 14 SE of Deep Cut Road	Other Principal Arterial	Rural	no	
Romeoville	Will	IL 53 (Independence Blvd.) North of Taylor Rd.	Other Principal Arterial	Urban	no	Y
Plainfield	Will	IL 126 ne of 143rd St.	Minor Arterial	Urban	no	
Elwood	Will	Arsenal / Manhattan Rd. West of S. Brandon Rd.	Other Principal Arterial	Urban	no	
Peotone	Will	I-57 North of MM 326 at Kennedy Rd. Stub -- South	Interstate	Rural	yes	
Beecher	Will	Peotone/Beecher Road west of Kedzie Ave.	Other Principal Arterial	Urban	no	Y
Joliet	Will	I 80 east of Cherry Hill Road	Interstate	Urban	yes	
Minooka	Will	I-80 NE of Shepley Rd Overpass	Interstate	Urban	yes	
Braidwood	Will	I-55 North of Reed Rd. Exit 233 -- North of MM 234	Interstate	Rural	yes	

Here are the numbers and types of station used in the analysis. There were originally 22 stations in the dataset. Six were dropped, which left sixteen in the dataset.

	Retained		
	Unrestricted	Restricted	Total
Rural	1	2	3
Urban	10	3	13
Total	11	5	16

	Dropped		
	Unrestricted	Restricted	Total
Rural	0	0	0
Urban	5	1	6
Total	5	1	6

Dataset Description

Datasets were obtained at two different times. The first dataset included only data from 2011. The data was presented by station, direction, and lane of travel. It included records representing hours 1 – 24. The second dataset covered the years 2012 – 2014. This dataset was aggregated by station without lane and direction of travel information but also included hourly records for each data of the time period. To make the two datasets compatible, the 2011 data was aggregated to the station level, eliminating the lane and direction information. The two datasets were then combined and used together for a total of four years of continuous count data with vehicle classes for sixteen stations.

Each record in the dataset represents one hour of one calendar day. Theoretically, for each station there are 24 records for each day of each year. Each record presents a vehicle count by 13 FHWA vehicle category classifications. IDOT's datasets also include class 14 "unknown" and class 15 "unclassified."

Assignment of FHWA Classes to MOVES Classes

The following table shows which continuous count station vehicle classes were assigned to each MOVES source type (vehicle) category. It was immediately clear that no FHWA class exists for MOVES category 54, motor home. That category was estimated using National Park Service RV camper statistics for 2013 and 2014 instead.

MOVES Vehicle Class	FHWA Vehicle Category
11 Motorcycle	Class 1 Motorcycles
21 Passenger car	Class 2 Passenger cars
31 Passenger trucks	Class 3 Four tire single unit
32 Light commercial truck	Class 5 Two Axle, six tire single unit
41 Intercity bus 42 Transit bus 43 School bus	Class 4 Buses
51 Refuse truck 52 Single unit short haul truck 53 Single unit long haul truck	Class 6 Three axle, single unit Class 7 Four or more axle, single unit
54 Motor home	Included in Class 5, with no way to identify them. Use National Park Service data
61 Combination short-haul truck 62 Combination long-haul truck	Class 8 Four or less axle, single trailer Class 9 Five axle tractor semi-trailer Class10 Six or more axle, single trailer Class 11 Five or less axle, multi trailer Class 12 Six axle, multi trailer Class 13 Seven or more axle, multi trailer

Method

1. Hourly data by station, month, and day of week were averaged to develop an average count by station, month, day of week (Sunday – Saturday), and hour of day.
2. The average hour was aggregated to a number representing an average count for each station by month and day of week for each of the vehicle classes. For example, Mondays in January, Tuesdays in January, etc.
3. The average weekdays for each station, by month, were multiplied by the average number of those days for each month, over the 2011 – 2014 period, resulting in an average month for each station.
4. The station average months were combined into a single total for each month. One expressway station which had not included any observations for the month of February was retained, and an estimate for February counts was calculated from the average of January and March counts.

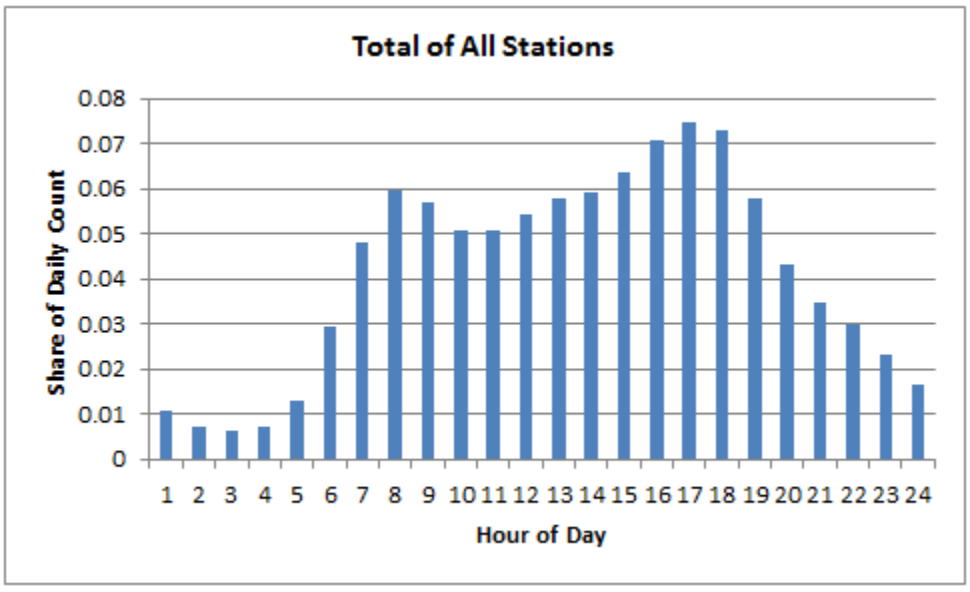
Average Number of Days per Month 2011 – 2014

These are the average numbers of each day of week for each month over the data period. For example, an average Sunday in January was calculated from the four years of data. It was then multiplied by 4.5 to represent the average number of Sundays in January for the dataset.

Average Number of Days per Month 2011-2014								
Month	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Total
January	4.5	4.5	4.5	4.5	4.5	4.25	4.25	31
February	4	4	4	4.25	4	4	4	28.25
March	4.5	4.25	4.25	4.25	4.5	4.5	4.75	31
April	4.25	4.5	4.5	4.25	4	4.25	4.25	30
May	4.25	4.25	4.5	4.5	4.75	4.5	4.25	31
June	4.5	4.25	4	4.25	4.25	4.25	4.5	30
July	4.5	4.5	4.75	4.5	4.25	4.25	4.25	31
August	4.25	4.25	4.25	4.5	4.5	4.75	4.5	31
September	4.5	4.5	4.25	4	4.25	4.25	4.25	30
October	4.25	4.5	4.5	4.75	4.5	4.25	4.25	31
November	4.25	4	4.25	4.25	4.25	4.5	4.5	30
December	4.5	4.75	4.5	4.25	4.25	4.25	4.5	31
Grand Total	52.25	52.25	52.25	52.25	52	52	52.25	365.25

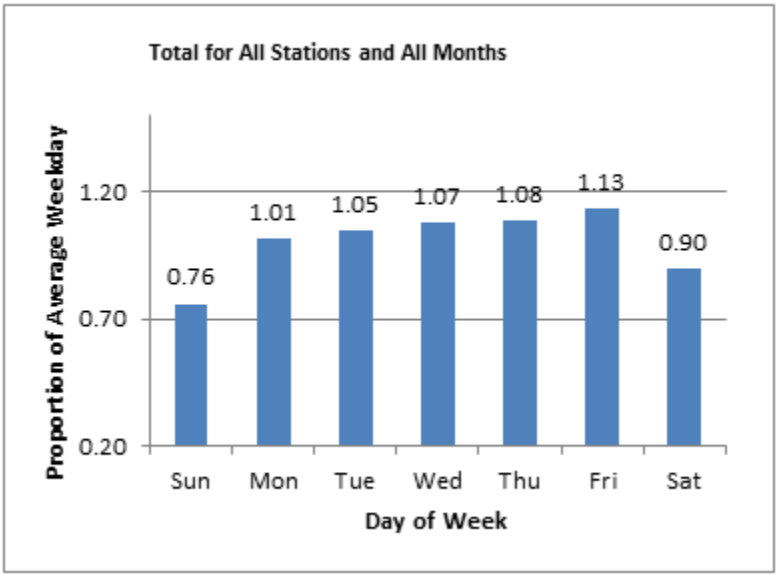
Average Hour by Station

A plot of each station's average hourly volume, summed for all the months and days, was produced to ensure that the distribution of hourly volumes looked reasonable. All of the station average hourly volumes were summed and presented in the following chart. The shape of the distribution for each station resembled the total for all stations, with some variation.



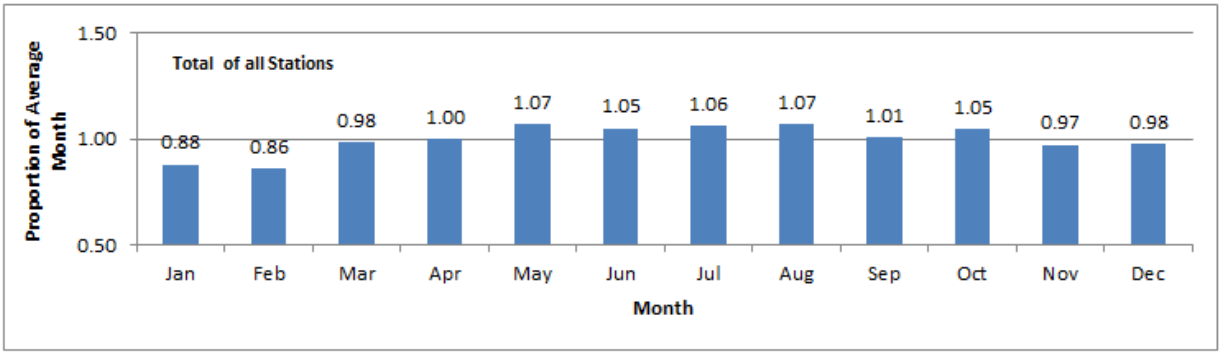
Average Day of Week

The average day of week, generated by aggregating the average hours of each weekday per month, was also calculated. This was undertaken to ensure the data processing was working correctly. Charts for each station were produced and reviewed. They resembled the following chart, which is a summary of all the total average day of week volumes for all stations.



Average Month

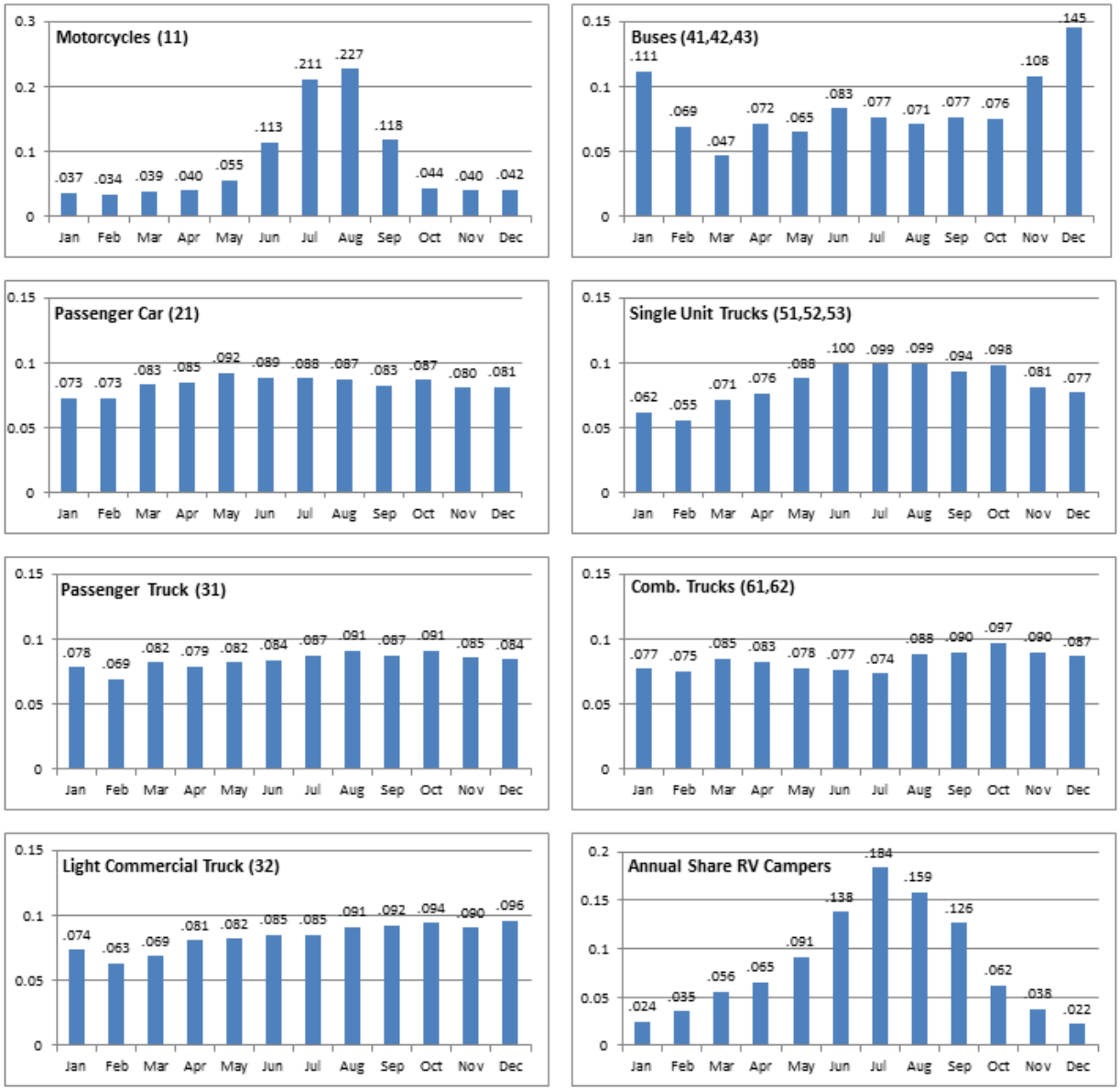
Charts of the distribution of monthly total volume were produced for each station and reviewed. The charts showed generally higher volumes in the warmer months and lower volumes in the winter months. All the stations were combined into the following chart, showing the relationship of the monthly volumes to an average month, for all stations.



MOVES Inputs

Once we were satisfied that the distribution of total volume by hour of day, day of week, and month of year looked reasonable, the same method was used to generate the class volume distributions needed by the MOVES model. These charts present the monthly distributions for

the MOVES vehicle classes. Note tha the RV campers chart presents data from the National Park Service and not the IDOT ATC system.



Source: Illinois Department of Transportation 2011 - 2014 continuous count station/ class data except mobile home.
Source: (RV/Mobile Home): National Park Service RV Camper Statistics 2013-2014

From these charts we determined that the bus distribution looks strange. Also, MOVES software requires school bus, public transit bus, and inter city bus distributions as inputs. The ATC system has a class for buses, but not the three types of buses. We decided to use different information to develop the bus distributions, which will be discussed in the next section.

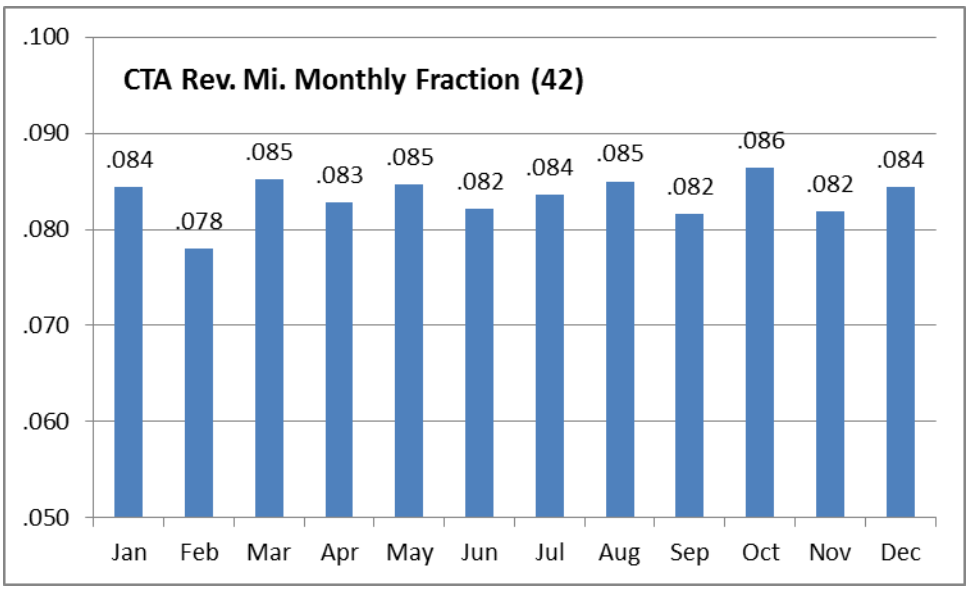
The motorcycle information also showed an unexpected distribution, with what appeared to be an unreasonably high peak in July and August. We believe that counts should be lower in the cold months and higher in the warm months, but this seemed too extreme. We looked at other data to try to determine if this was likely, and decided to use an alternative data source for the motorcycle distribuion instead.

Buses

As stated previously, the distribution of bus counts from the ATC system did not show an explainable pattern, and was not used. It is not possible for us to determine whether the counting equipment has difficulty identifying the difference between buses and some other class of vehicle, or if there are patterns in the bus data based on underlying conditions we are unaware of. In any case, bus traffic represents less than 1% of counted vehicles. Instead of using the ATC data for buses, other sources of information were consulted.

Transit Buses

CTA provided a summary of monthly revenue miles for buses for the years 2011 – 2014. Conversation with CTA staff indicated that they did not adjust bus revenue miles by month or season. The data supported this, with the monthly share looking similar to the month's share of days. This data was used for the MOVES input.

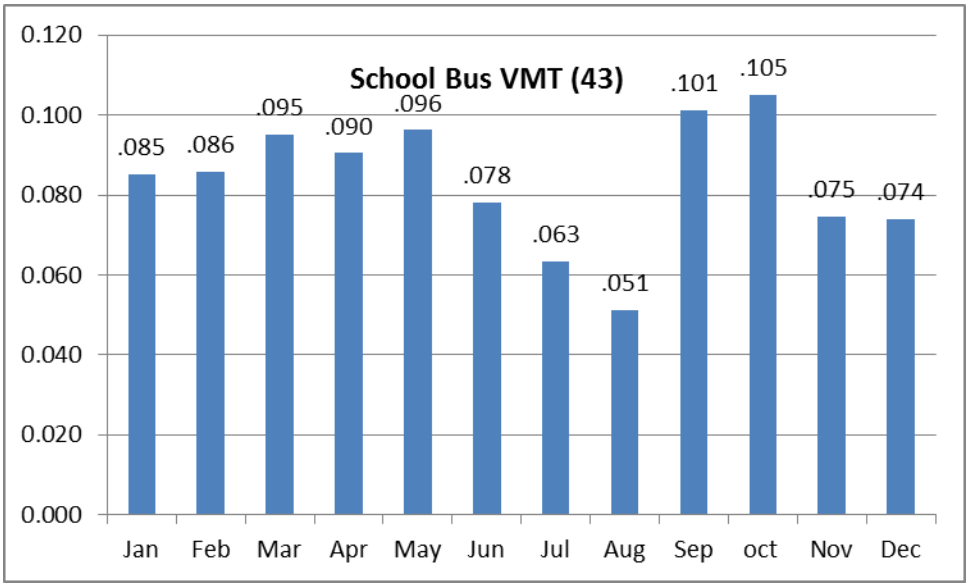


Interurban Buses

Data from DePaul University Chaddick Institute intercity bus research program, and from commercial bus providers was requested. Data on the monthly distribution of service was not available, so the same distribution as the public transit bus was used.

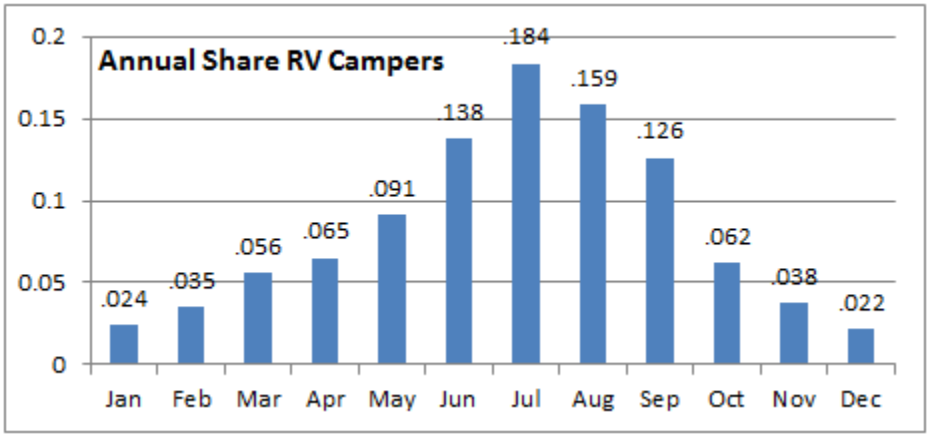
School Buses

For school buses, it seemed reasonable to assume that the amount of service provided reflects in-school days on the school calendar. The school 2014-2015 calendars for the biggest district in each county (Cook SD 99, DuPage CUSD 204, Kane SD U-46, Lake CUSD 60, McHenry Cons SD 158 and Will SD 202) were collected. Note that the biggest school district in Lake County is Waukegan District 60. That school had a long-lasting strike during the 2014-2015 school year. The original school schedule was still available online, and that was used rather than the calendar including changes caused by the strike. Summer program schedules and whether bus service is provided was also reviewed. This data was used for school bus vehicles.



Motor Homes

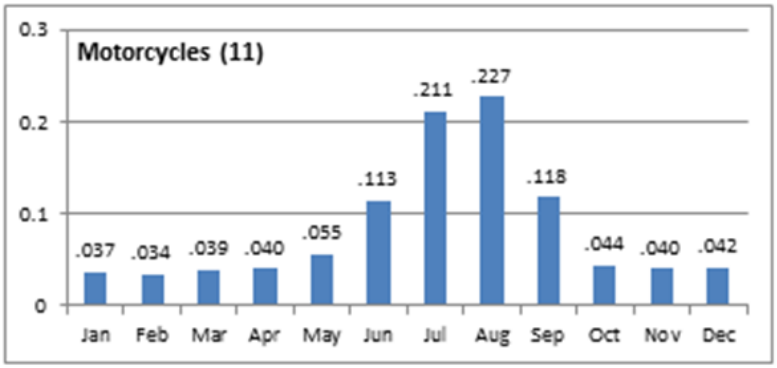
The IDOT counts include motor homes in class 5 vehicles, but there is no way to separate them from other class 5 vehicles. Since the motor home is generally a recreational vehicle (RV) we assumed that the travel characteristics are similar to RV's in general. The National Park Service keeps monthly and annual summaries of RV campers using the national park system. I collected these statistics for each month for the years 2013 and 2014, and calculated the monthly share of the total. It looked reasonable, with RV usage happening throughout the year but peaking in the summer months.



Motorcycles

As previously described, continuous count station classification data was analyzed. The resulting distribution of motorcycle counts by month is quite different from what we have used in the past, and we questioned whether this was a realistic distribution of values. We desired other sources of information to confirm the data generated from the count stations. The tollway

transaction data we have were not useful for this purpose because the tollway doesn't count motorcycle toll transactions differently from auto transactions.



This chart presents the vehicle counts derived from the IDOT ATC data. The data showed a significant peak in July and August.

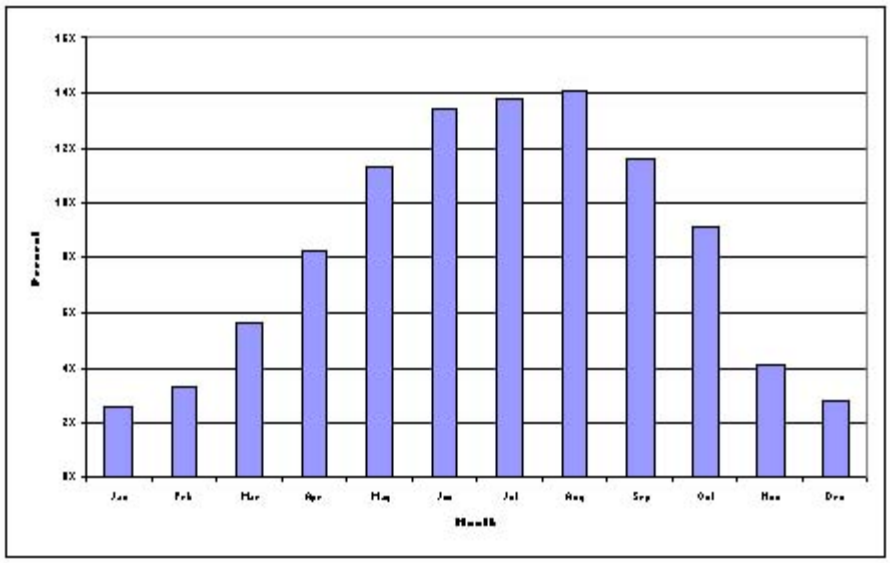
Detection Technology

Is it possible the ATC system does not count motorcycles very well? NCHRP Report 760 "Improving the Quality of Motorcycle Travel Data Collection" (2013) http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_760.pdf includes a table showing that inductive loops such as those used in the IDOT traffic count program are not highly accurate for counting motorcycles. Discussing this with IDOT data staff, we learned that motorcycles may not be heavy enough to be counted, or they may be driving at the edge of a lane. In addition, IDOT staff observed that two of the four winters covered by the data were especially cold and lengthy. This may have depressed the cold month readings, making the summer peak also appear higher than it normally would.

Other Data Sources

Another way to estimate the relative amount of motorcycle travel is to review crash statistics, since the number of crashes are linked to the amount of usage. The National Highway Traffic Safety Administration produced a report that included statistics about motorcycle fatalities by month. Figure 10 represents the **national** statistics of motorcycle fatalities by month from the report "Evaluation of the Repeal of Motorcycle Helmet Laws in Kentucky and Louisiana." (http://www.nhtsa.gov/people/injury/pedbimot/motorcycle/kentuky-la03/NatTrends.html, National Highway Traffic Safety Administration, October 2003)

Figure 10. Percent of Motorcyclists Killed by Month (Source: FARS)



Although it is difficult to see, the scale goes from 0% to 16% by two's. This chart reflects national trends. June, July, and August are the months with the highest fatalities, with each of their shares of annual fatalities being around 14%.

The report also says "The riding season is longer in states with more temperate climates. The 'southern tier' states CA, AZ, NM, TX, LA, MS, AL, FL and GA recorded about 17 percent of motorcyclist deaths in December, January and February, while the "northern tier" states WA, MT, ND, MN, WI, MI, OH, PA, NY, VT, NH, and ME recorded just over two percent of their fatalities during those months." This implies a significantly reduced amount of motorcycle use in the winter month, with a much higher share in the summer months.

Not to belabor the point, but from the Insurance Institute for Highway Safety national statistics:

http://www.iihs.org/iihs/topics/t/motorcycles/fatalityfacts/motorcycles/2013

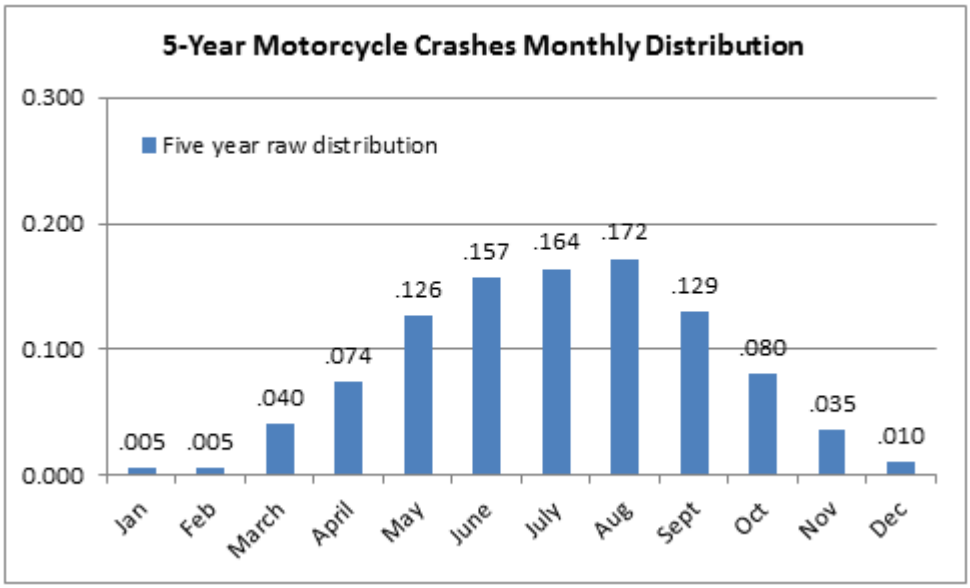
National 2013 Fatalities

Month	Deaths	%
January	148	3
February	121	3
March	271	6
April	369	8
May	464	11
June	534	12
July	530	12
August	630	14
September	557	13

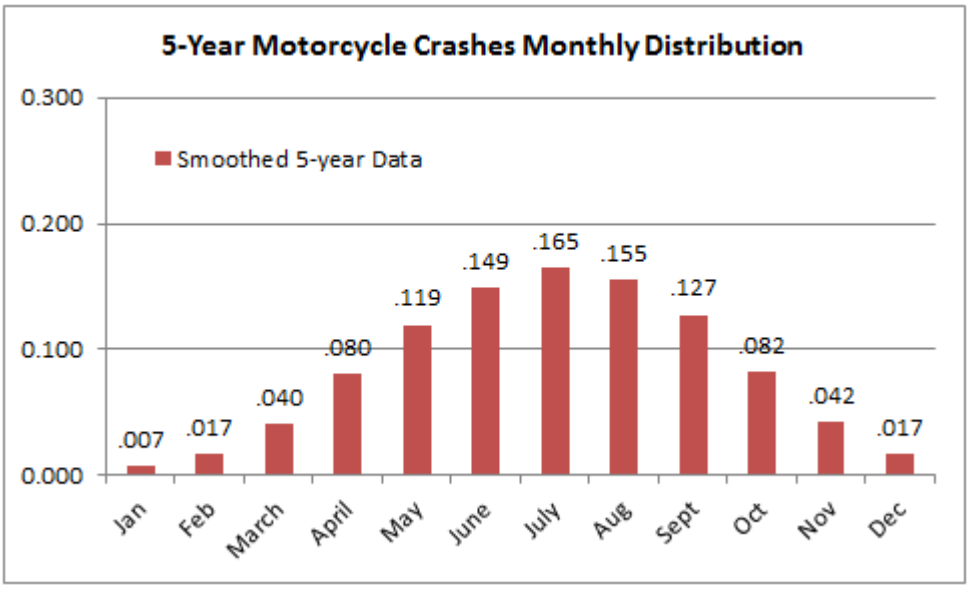
October	391	9
November	244	6
December	122	3
Total	4,381	100

None of the crash data shows the high peak of crashes in July and August that would seem to reflect the pattern in the IDOT ATC data. It seems likely that the ATC technology does not count motorcycles very well.

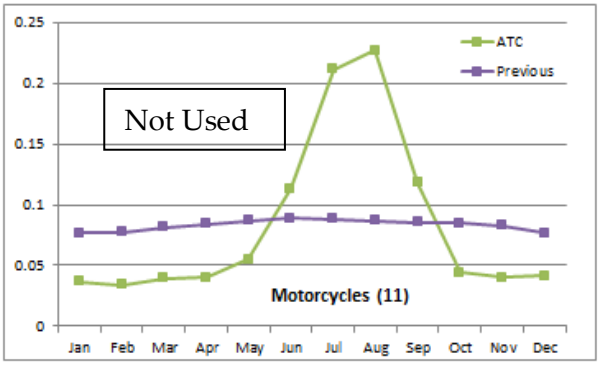
CMAP has good local information for motorcycle crashes from the Illinois Department of Transportation safety department. The following chart shows the distribution of five years of northeastern Illinois motorcycle crashes. The data includes crashes for seven counties and all severities. It does not show the same peak in crashes in July and August as I have calculated from the continuous count station data.

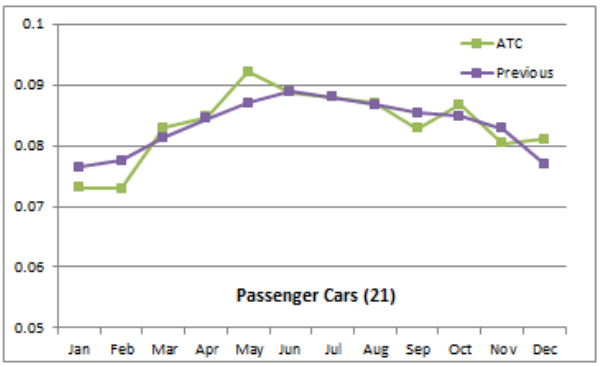


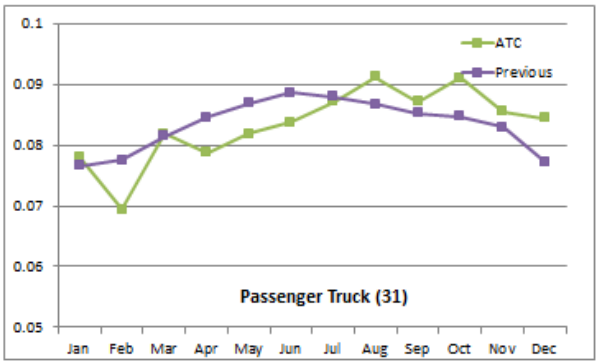
To attempt some adjustment for the likelihood that cold weather riders are more experience and safer than summer riders, I calculated a 3-month moving average to smooth the curve a little more. The effect was to reduce the summer peak a little and increase the winter percents. I think this approximates the monthly share of motorcycle VMT better, and can be used in the MOVES model instead of the ATC data.

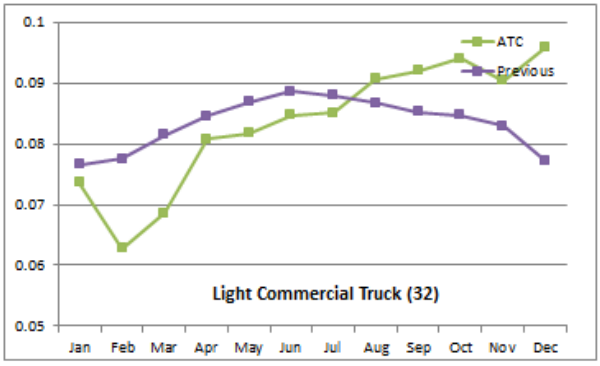

5-Year Motorcycle Crashes Monthly Distribution
0.300
0.200
0.100
0.000
Smoothed 5-year Data
.007
.017
.040
.080
.119
.149
.165
.155
.127
.082
.042
.017
Jan
Feb
March
April
May
June
July
Aug
Sept
Oct
Nov
Dec

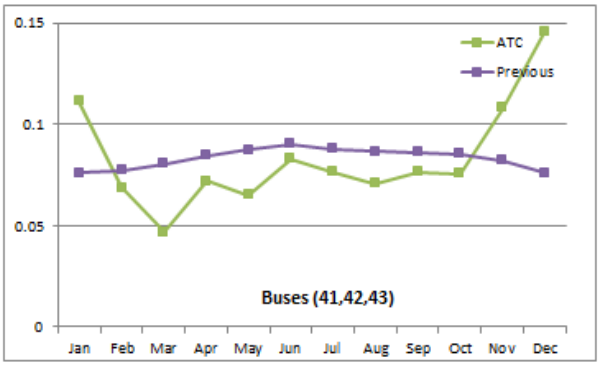
Comparison with Data Previously Used

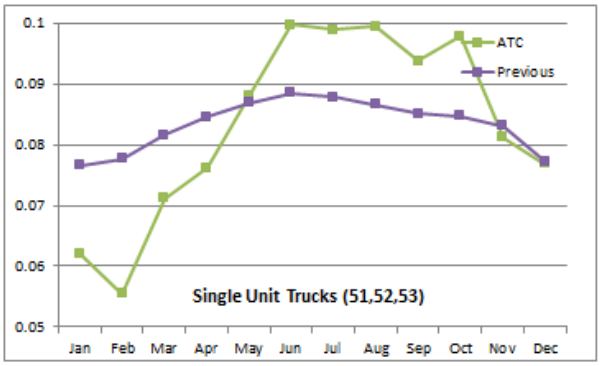


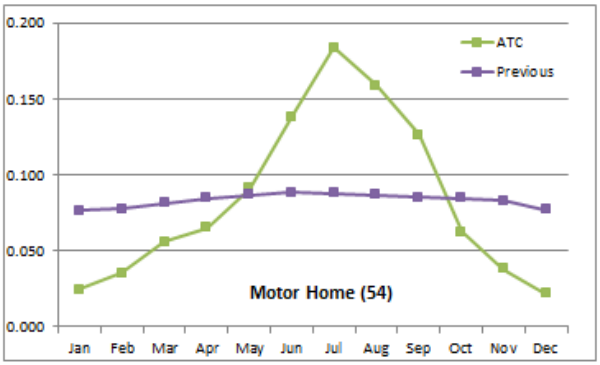


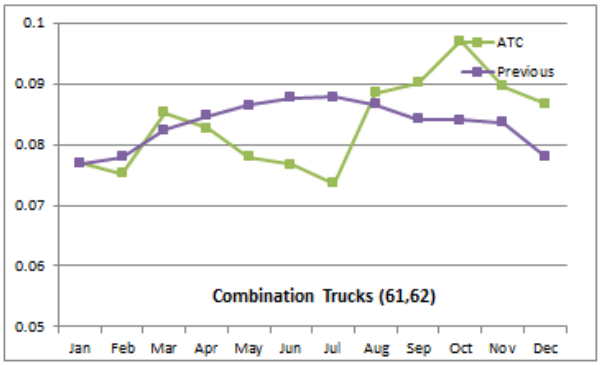












Note: motor home data is from the National Park Service, and the bus data shown here from ATC was not used. See following section for that.

Bus Data Used (from other sources)