Truck GPS Data for Freight Performance Measurement, Modeling, and Planning

presented to
Florida Model Task Force, Freight Committee

presented by
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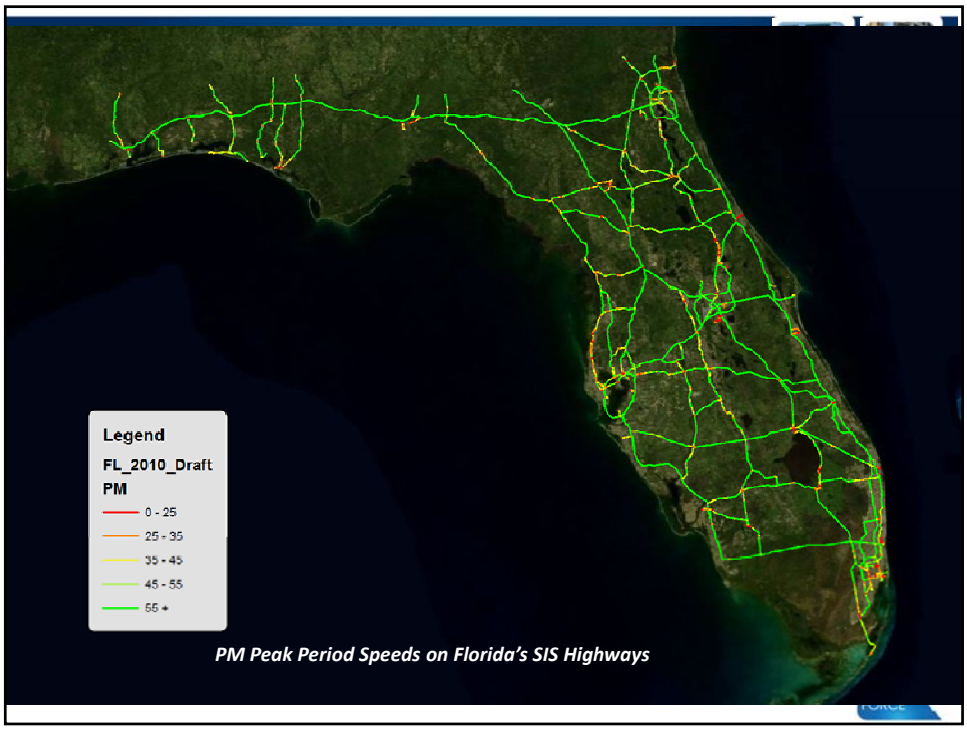
Project Objectives

- Project Objectives
  - Investigate the use of ATRI-FPM data for freight performance measurement and planning in Florida.
  - Use the data for the following applications
    - Derive freight performance measures (speeds) for Florida's highways
    - Algorithms for converting the GPS data into a database of truck trips
    - Understand truck travel characteristics in Florida
    - Derive tuck-trip OD tables for the Florida Statewide Model
  - Other
    - Assess the data – its coverage of freight truck traffic in Florida
    - Exploratory analysis of the use of data for different applications
      - Analysis of truck flows from Ports
      - Analysis of truck travel time skims
      - Analysis of truck route patterns

Freight Performance Measurement

- Average speeds on Florida's Strategic Intermodal System (SIS) highways
  - ATRI data used to measure average truck speeds on the entire SIS network
  - Speeds measured for different time-of-day periods for each 1-mile segment on the SIS network (half-mile segments in urban regions)
    - AM peak
    - PM peak
    - Mid day
    - Off peak
    - Daily average
  - Speeds measured based on 3 months of data in year 2010



PM Peak Period Speeds on Florida's SIS Highways

Convert Raw GPS Data into Truck Trips

- Two types of algorithms for two types of raw data
  - Algorithm for data with spot speeds
  - Algorithm for data without spot speeds
- The algorithms were refined based on a variety of validations
  - Comparison of trip outputs with manual tracking of trucks on Google Earth
  - Checking the validity of trip end locations in Google Earth
  - Discussions with ATRI and FDOT

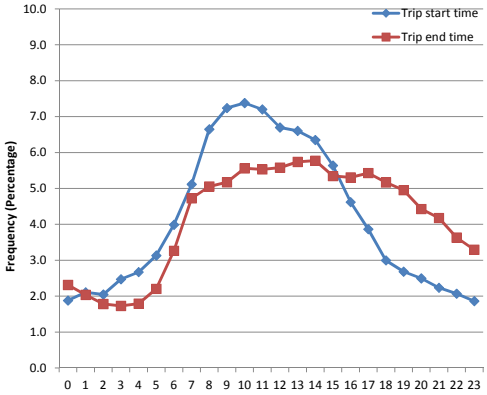
Trips Extracted From 4 Weeks of GPS Data

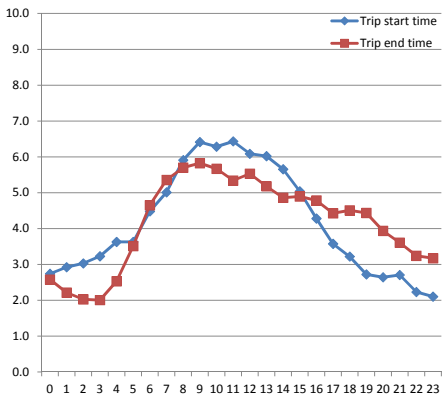
Duration	# raw GPS records	# trucks in the data	# trips extracted that start/end in FL
1 week in March 2010	5.39 Million	18,428	83,065
1 week in April 2010	4.21 Million	23,134	79,048
1 week in May 2010	4.88 Million	21,366	78,786
1 week in June 2010	5.08 Million	16,955	77,720

Characteristics of Truck Trips Derived from 4 Weeks of ATRI Data: Time-of-day, Trip Length, Trip Duration

Time-of-day Profile: I-E & E-I Trips for Florida

Weekdays



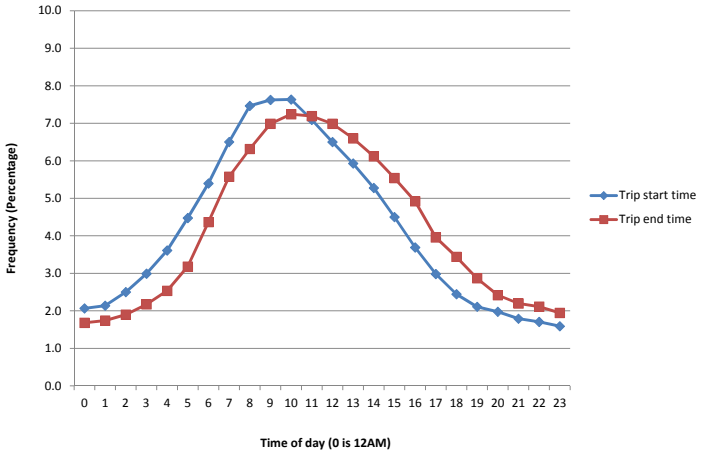


I-E trips: Start in Florida & end outside Florida, E-I trips: Start outside Florida & end in Florida

Time-of-day Profile of Trips Derived from 4 weeks of ATRI Data
(one week in each of the following months: March, April, May, June 2010)

Time-of-day Profile: Trips within Florida (I-I Trips)

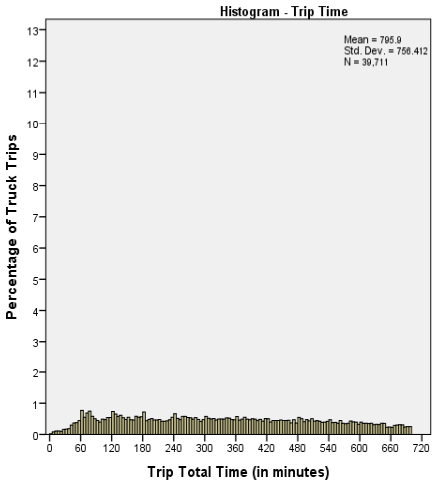
Weekdays

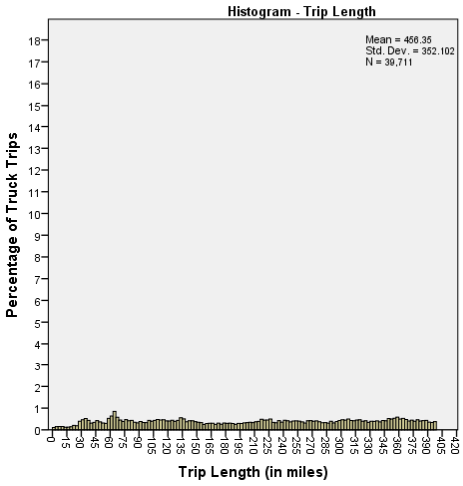


Time-of-day Profile of Trips Derived from 4 weeks of ATRI Data (one week in each of the following months: March, April, May, June 2010)

Trip Duration & Length Distribution: I-E & E-I Trips

Weekdays

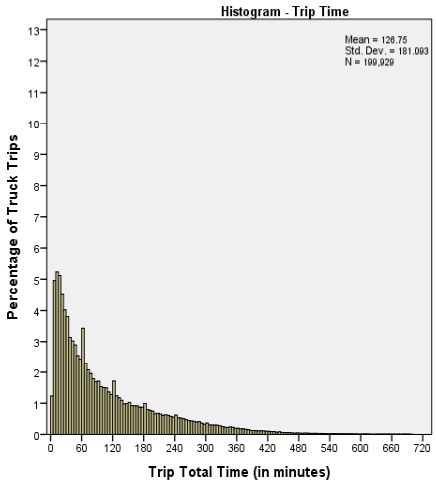


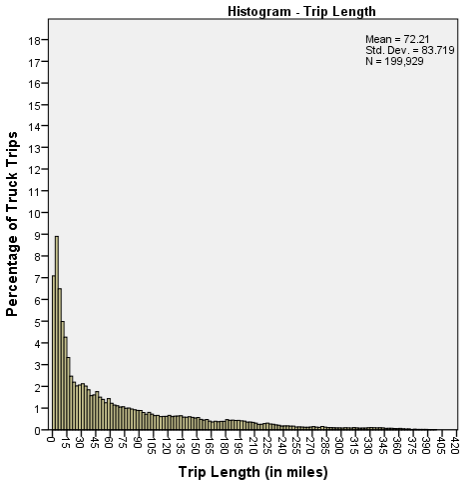


Trip Duration and Trip Length Histogram of Trips Derived from 4 weeks of ATRI Data (one week in each of March, April, May, and June 2010)

Trip Duration & Length Distribution: Trips within FL

Weekdays





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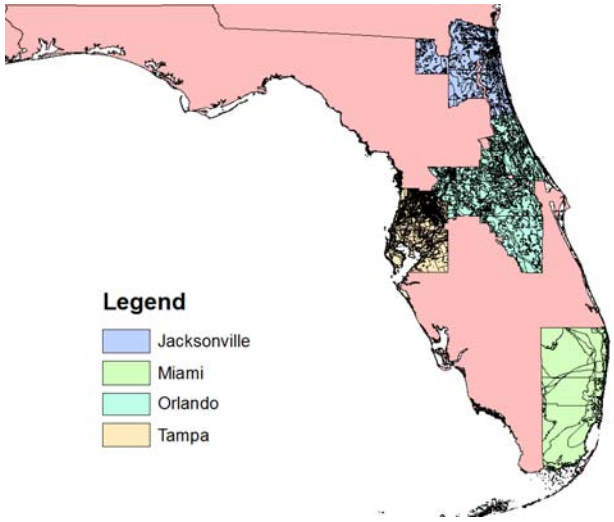


Florida FAF Zones

Jacksonville FAF-zone
- Baker, Clay, Duval, Nassau, St. Johns

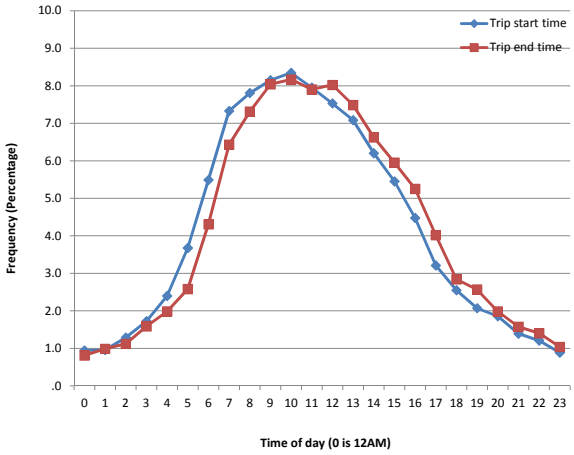
Miami FAF-zone
- Broward, Miami-Dade, Palm Beach

Orlando FAF-zone
- Flagler, Lake, Orange, Sumter, Osceola, Seminole, Volusia

Tampa FAF-zone
- Hernando, Hillsborough, Pasco, Pinellas

Time-of-day Profile: Trips within Jacksonville FAF-Zone

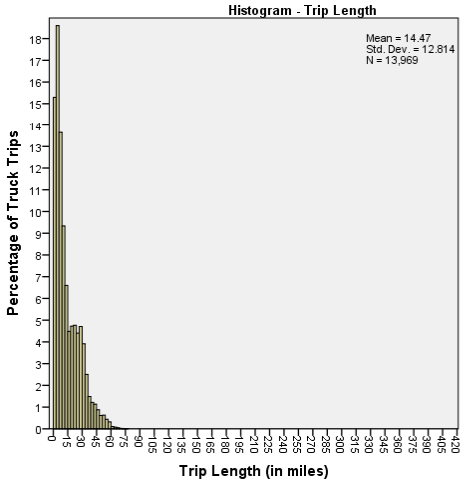
Weekdays



Time-of-day Profile of Trips Derived from 4 weeks of ATRI Data (one week in each of the following months: March, April, May, June 2010)

Trip Length Distribution: Trips within Tampa FAF-Zone

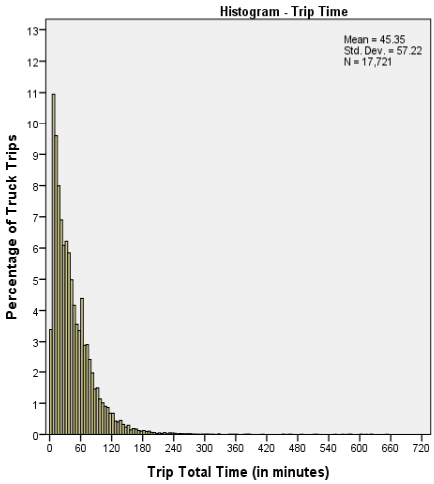
Weekdays



Trip Length Distribution of Trips Derived from 4 weeks of ATRI Data (one week in each of the following months: March, April, May, June 2010)

Trip Duration Distribution: Trips within Orlando FAF-Zone

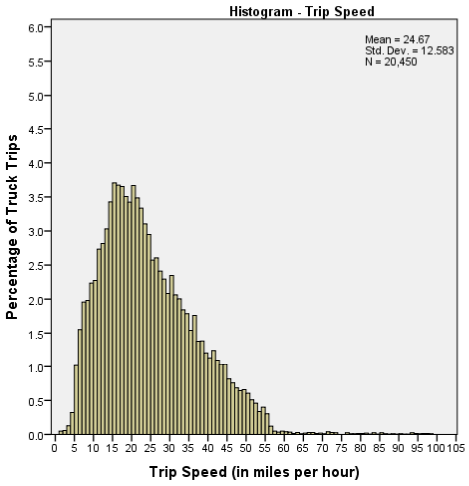
Weekdays



Trip Duration Histogram of Trips Derived from 4 weeks of ATRI Data (one week in each of the following months: March, April, May, June 2010)

Trip Speed Distribution: Trips within Miami FAF-Zone

Weekdays



Trip Speed Histogram of Trips Derived from 4 weeks of ATRI Data (one week in each of the following months: March, April, May, June 2010)

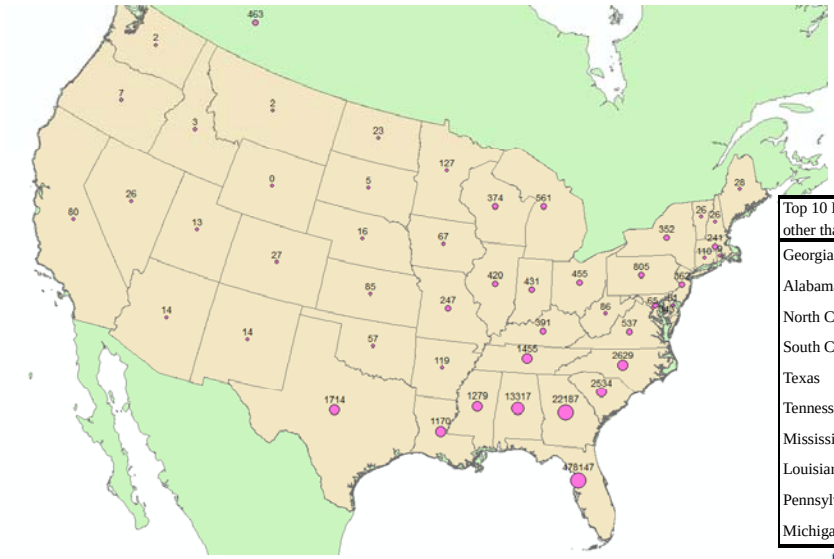
Trips Extracted From 4 Months of GPS Data

	# raw GPS records		# trucks in the data		# trips extracted that start/end in FL	
Month	spot speed data	no-spot speed data	spot speed data	no-spot speed data	spot speed data	no-spot speed data
March 2010	13.3 M	25.7 M	7.5K	54.2K	145K	195K
April 2010	12.9 M	22.8 M	7.6K	51.1K	145K	175K
May 2010	13.3 M		7.5K		146K	
June 2010	13.7 M		7.7K		149K	

Legend:
M = Millions
K = Thousands

Truck OD Patterns Extracted from 4 Months of ATRI Data with Spot Speeds (March, April, May, June 2010)

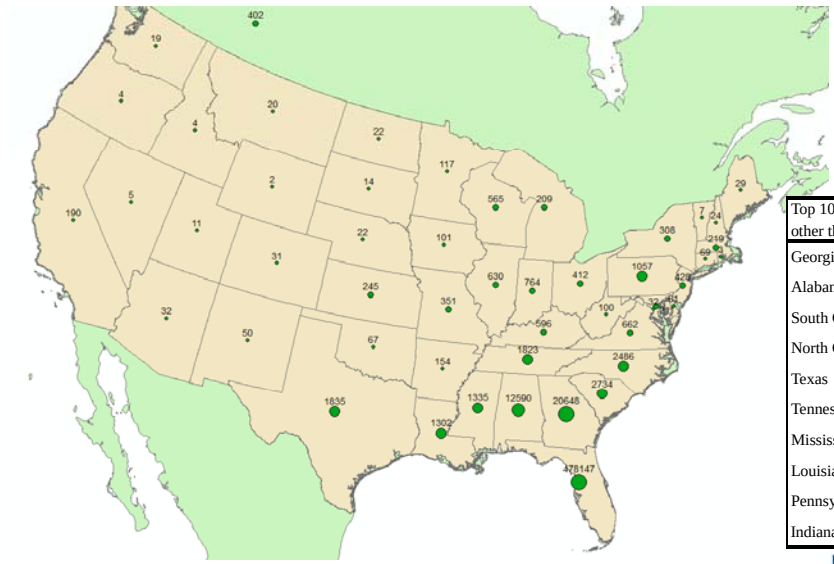
Destinations of Trips Starting in FL (where are trips going to?)



Top 10 Destinations other than FL
Georgia
Alabama
North Carolina
South Carolina
Texas
Tennessee
Mississippi
Louisiana
Pennsylvania
Michigan

Total number of trips starting in FL: 531502

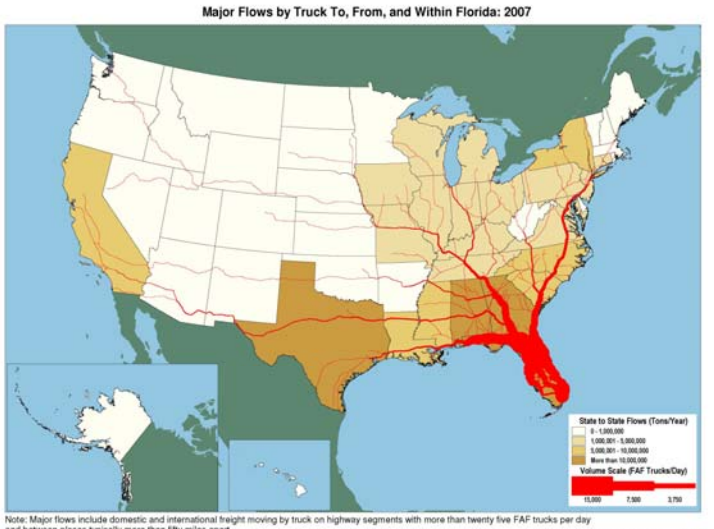
Origins of Trips Ending in FL (where are trips coming from?)



Top 10 Origins other than FL
Georgia
Alabama
South Carolina
North Carolina
Texas
Tennessee
Mississippi
Louisiana
Pennsylvania
Indiana

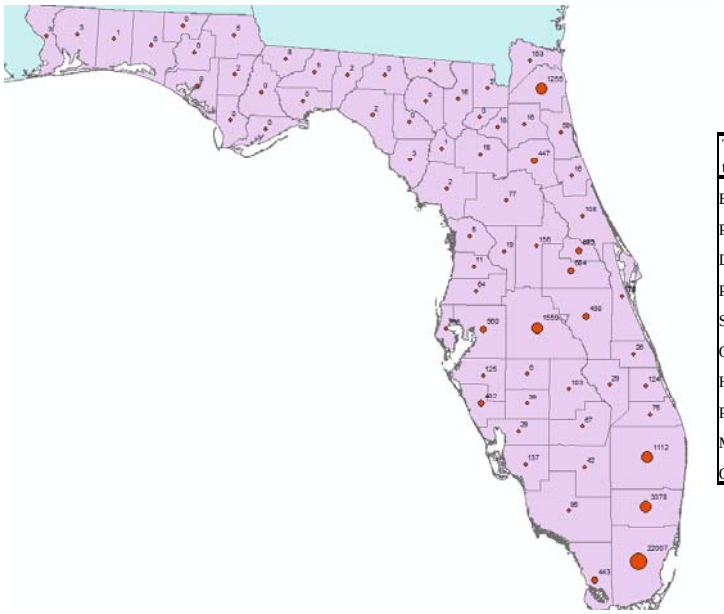
Total number of trips ending in FL: 531149

Truck Flows to, From, and within Florida



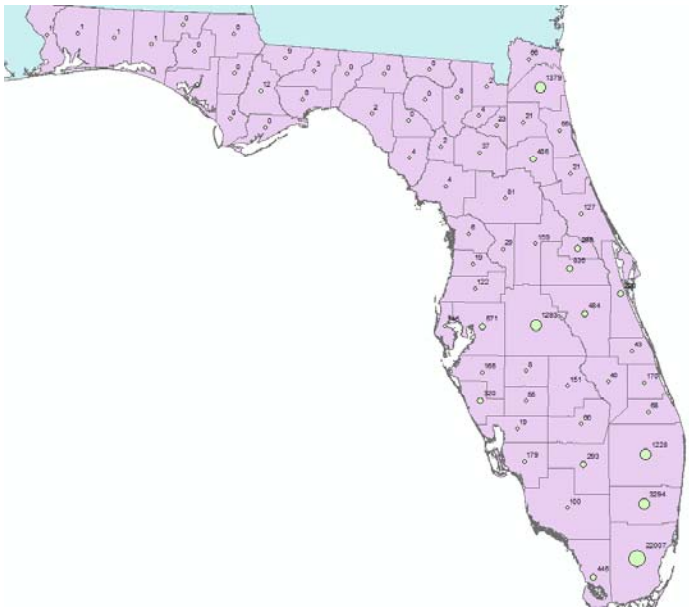
Note: Major flows include domestic and international freight moving by truck on highway segments with more than twenty five FAF trucks per day and between places typically more than fifty miles apart.
Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, version 3.1.2, 2011.

Origins of Trips Ending in Miami-Dade county (where are trips coming from?)



Top 10 Origins other than Miami-Dade
BROWARD
POLK
DUVAL
PALM BEACH
SEMINOLE
ORANGE
HILLSBOROUGH
PUTNAM
MONROE
OSCEOLA

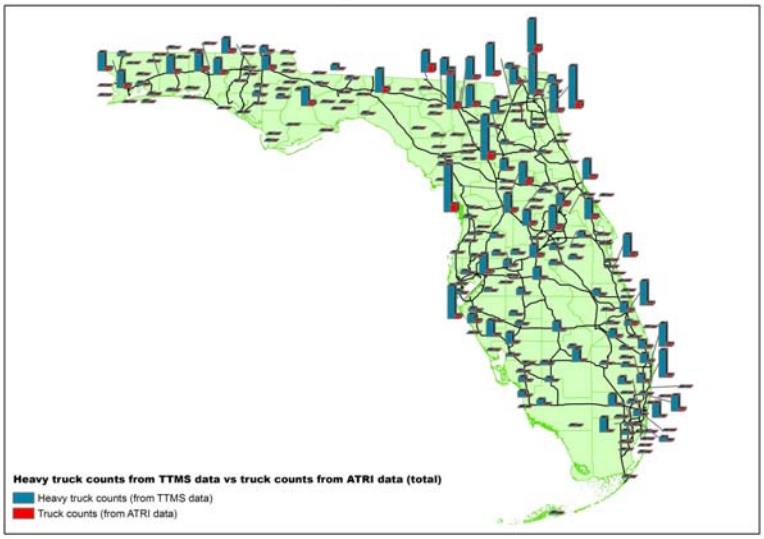
Destinations of Trips Starting in Miami-Dade County (where are trips going to?)



Top 10 Destinations other than Miami-Dade
BROWARD
DUVAL
POLK
PALM BEACH
ORANGE
HILLSBOROUGH
OSCEOLA
MONROE
PUTNAM
SARASOTA

How Much Freight-Truck Traffic in Florida is Covered by the ATRI Data?

Heavy truck (class 9 - 13) counts from TTMS data vs truck counts from ATRI data
May 9-15, 2010



Next Steps

- Ongoing work involves updating previous analysis with additional data (i.e., data without spot speeds)
- Next steps in the project
  - The OD patterns developed are from a **sample** of trips (large sample).

    Need to arrive at the **population** of truck flows
  - Perform OD matrix estimation to…

    "Inflate" the **sample** OD table to a **population** OD table…

    such that, when loaded onto the network, the resulting flows match reasonably with the observed truck traffic flows in the state
  - Travel time skims
    - Measure peak and off-peak travel times for several OD pairs for validating the FL statewide model under development
- Way forward
  - Short-term predictive analysis tool for conducting scenario analysis

Thank you

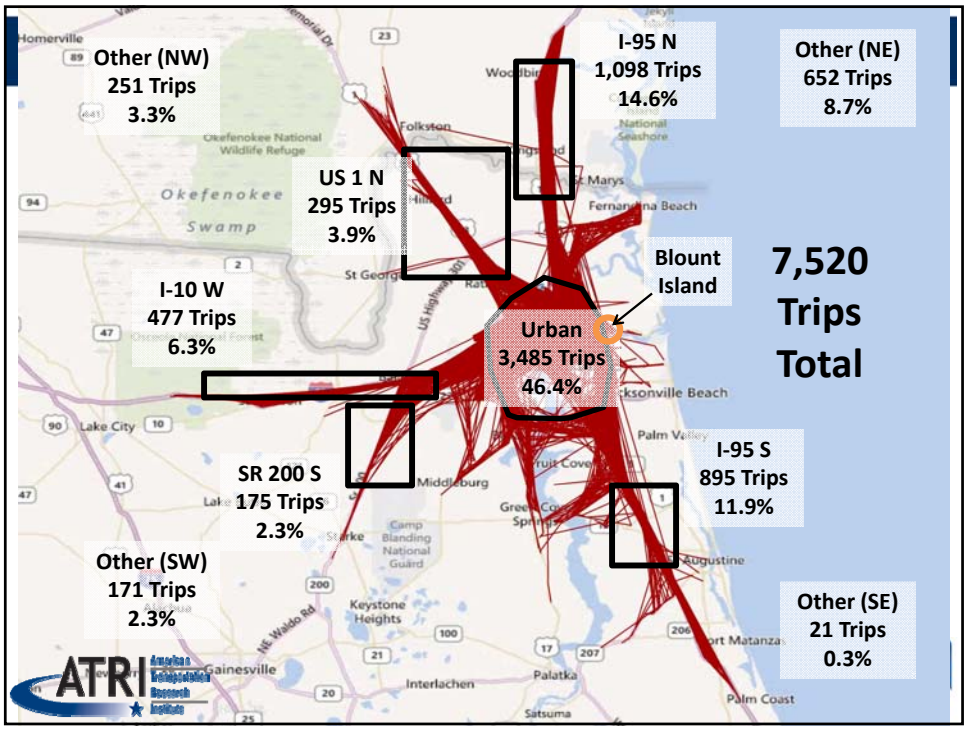
Questions and Discussion

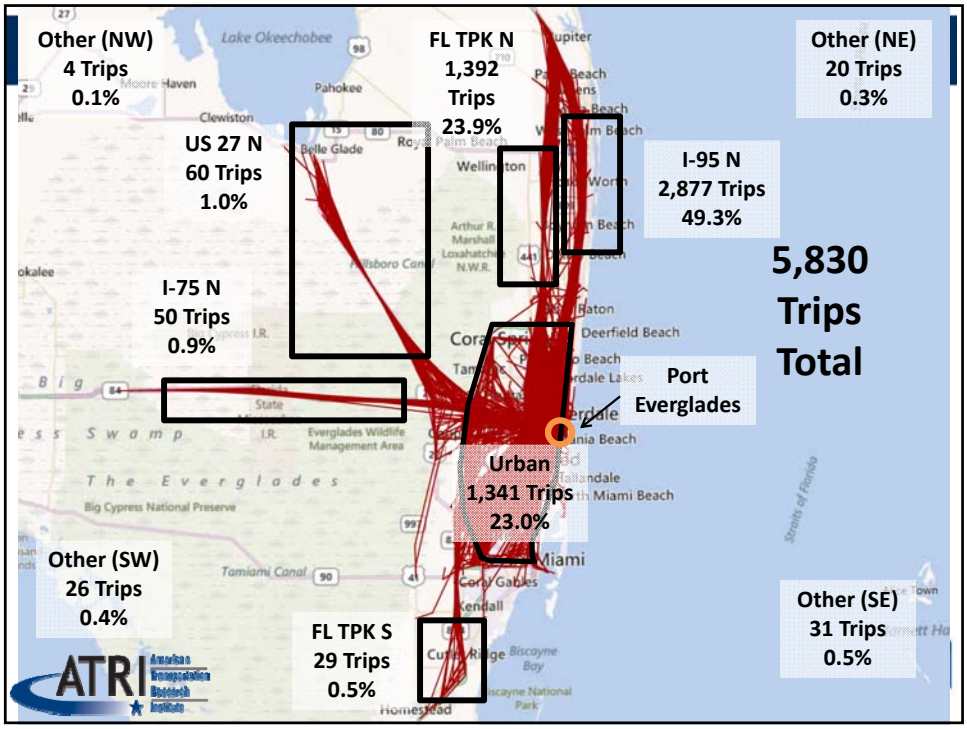
How Much Freight-Truck Traffic in Florida is Covered by the ATRI Data?

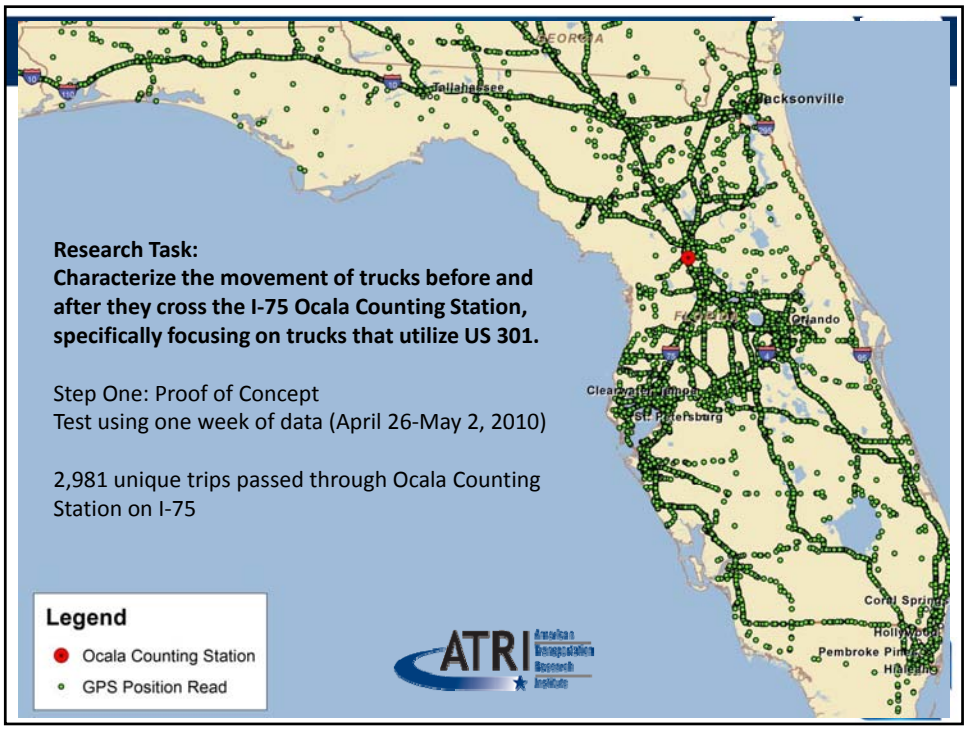
- Aggregate percentage coverage by facility type

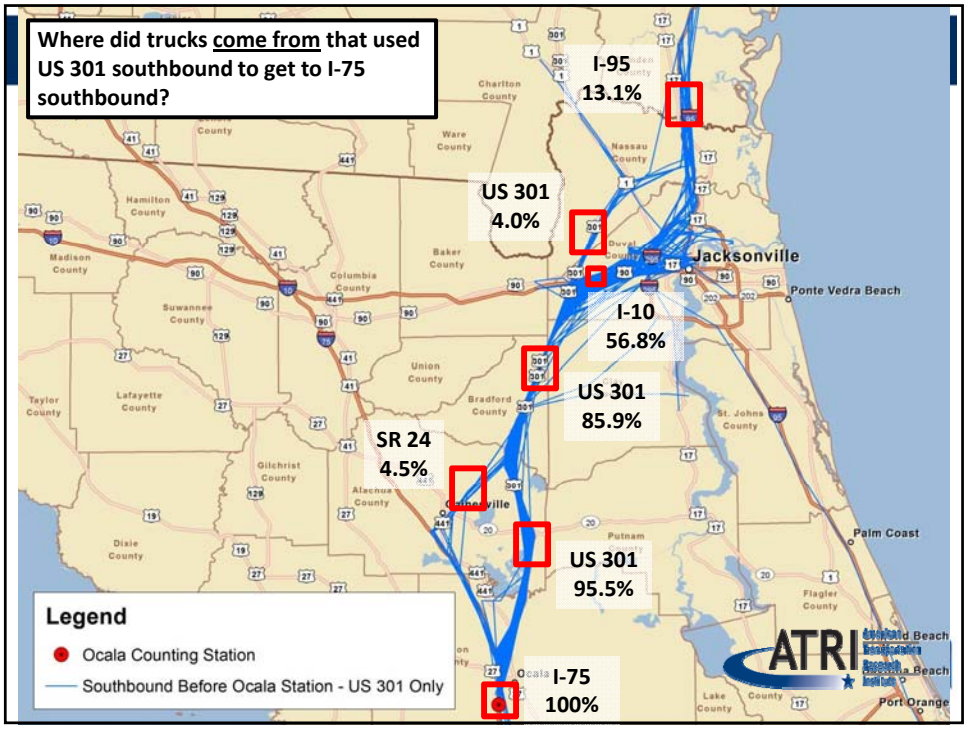
Facility Type	No. of count stations	ATRI truck counts	TTMS truck counts for Class 8-13	TTMS truck counts for Class 9-13	% coverage assuming ATRI data comprises trucks of class 8-13	% coverage assuming ATRI data comprises trucks of class 9-13
Freeways & Expressways (1)	29	111,608	1,063,765	869,684	10.5%	12.8%
Divided Arterials (2)	64	30,472	333,791	205,534	9.1%	14.8%
Undivided Arterials (3)	52	6,969	101,066	53,987	6.9%	12.9%
Collectors (4)	8	5,127	42,164	32,704	12.2%	15.7%
Toll Facilities (9)	7	9,291	80,493	60,012	11.5%	15.5%
Total	160	163,467	1,621,279	1,221,921	**10.1%**	**13.4%**

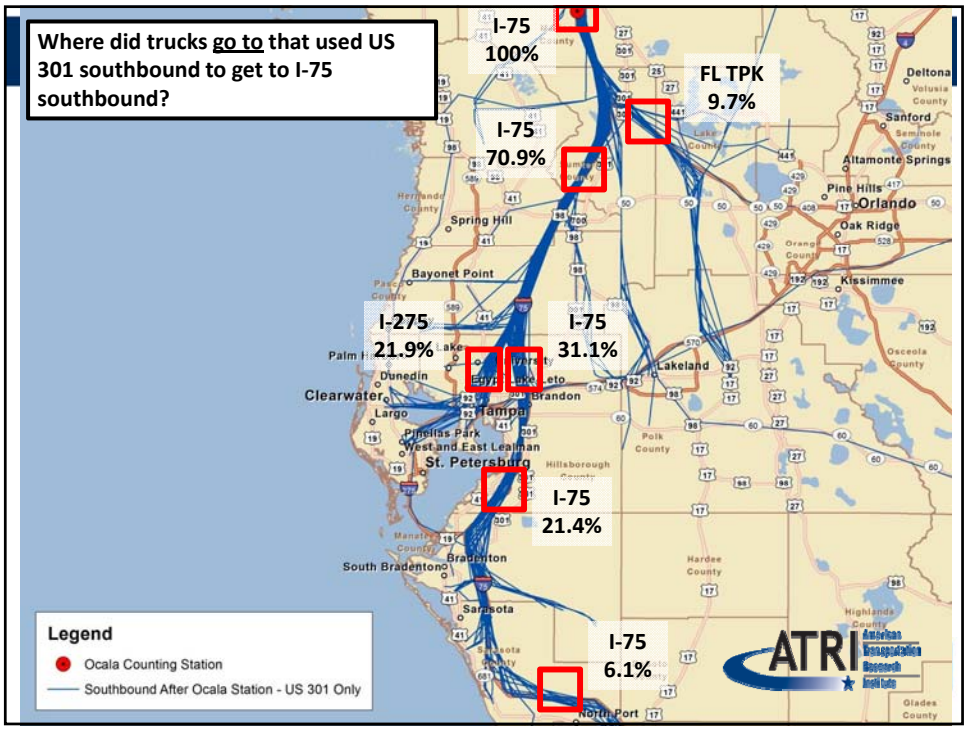
- Summary
  - ATRI data shows about **13%** coverage of the truck traffic in Florida, if we assume the data comprises class 9-13 trucks



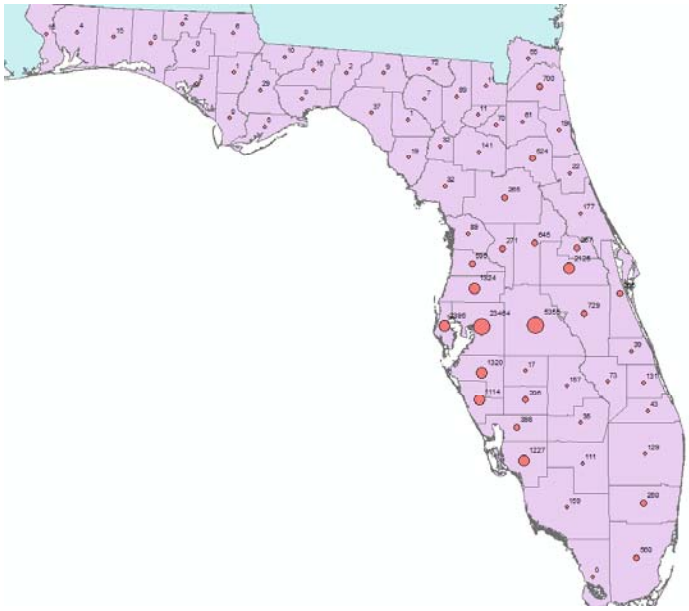

Other (NW)
4 Trips
0.1%
FL TPK N
1,392
Trips
23.9%
Other (NE)
20 Trips
0.3%
US 27 N
60 Trips
1.0%
I-95 N
2,877 Trips
49.3%
5,830
Trips
Total
I-75 N
50 Trips
0.9%
Port
Everglades
Urban
1,341 Trips
23.0%
Other (SW)
26 Trips
0.4%
FL TPK S
29 Trips
0.5%
Other (SE)
31 Trips
0.5%
ATRI


Research Task:
Characterize the movement of trucks before and after they cross the I-75 Ocala Counting Station, specifically focusing on trucks that utilize US 301.
Step One: Proof of Concept
Test using one week of data (April 26-May 2, 2010)
2,981 unique trips passed through Ocala Counting Station on I-75
Legend
Ocala Counting Station
GPS Position Read
ATRI


Where did trucks come from that used US 301 southbound to get to I-75 southbound?
I-95
13.1%
US 301
4.0%
I-10
56.8%
US 301
85.9%
SR 24
4.5%
US 301
95.5%
I-75
100%
Jacksonville
Ponte Vedra Beach
Palm Coast
Legend
Ocala Counting Station
Southbound Before Ocala Station - US 301 Only

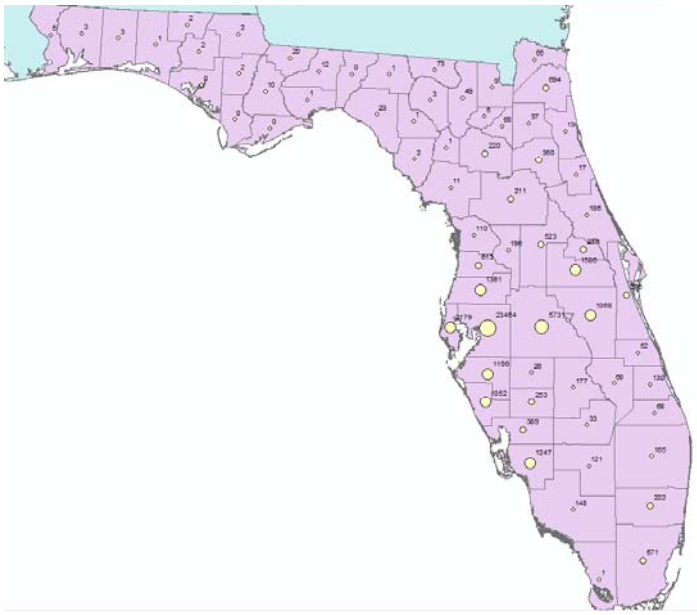

Where did trucks go to that used US 301 southbound to get to I-75 southbound?
I-75
100%
FL TPK
9.7%
I-75
70.9%
I-275
21.9%
I-75
31.1%
I-75
21.4%
I-75
6.1%
Orlando
Tampa
St. Petersburg
Clearwater
Lakeland
Kissimmee
Legend
Ocala Counting Station
Southbound After Ocala Station - US 301 Only

Destinations of Trips Starting in Hillsborough County
(where are trips going to?)



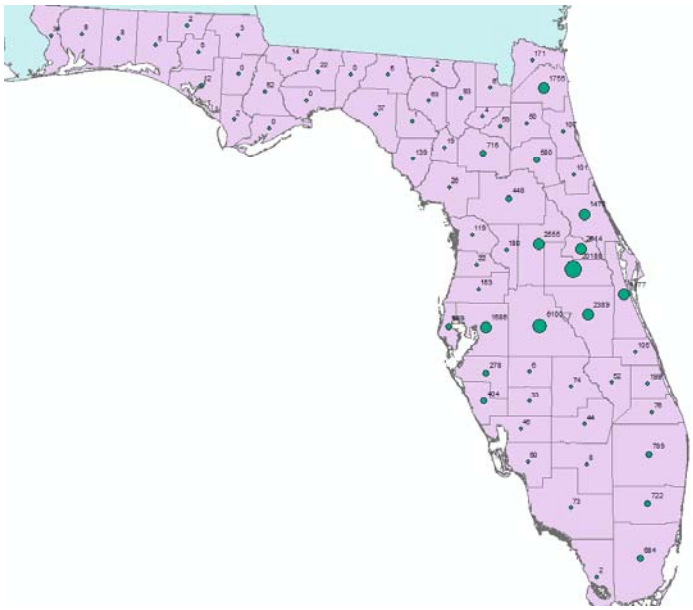
Top 10 Destinations other than Hillsborough
POLK
PINELLAS
ORANGE
PASCO
MANATEE
LEE
SARASOTA
OSCEOLA
DUVAL
LAKE

Origins of Trips Ending in Hillsborough county
(where are trips coming from?)



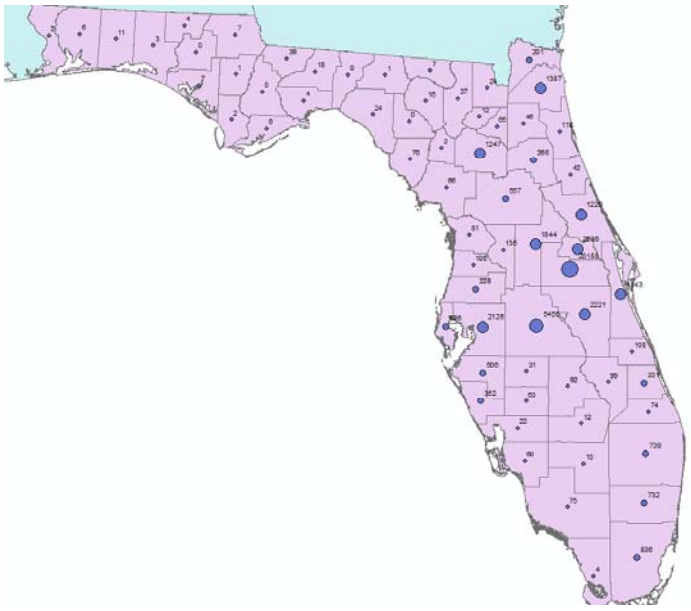
Top 10 Origins other than Hillsborough
POLK
PINELLAS
ORANGE
PASCO
LEE
MANATEE
OSCEOLA
SARASOTA
DUVAL
HERNANDO

Destinations of Trips Starting in Orange County
(where are trips going to?)



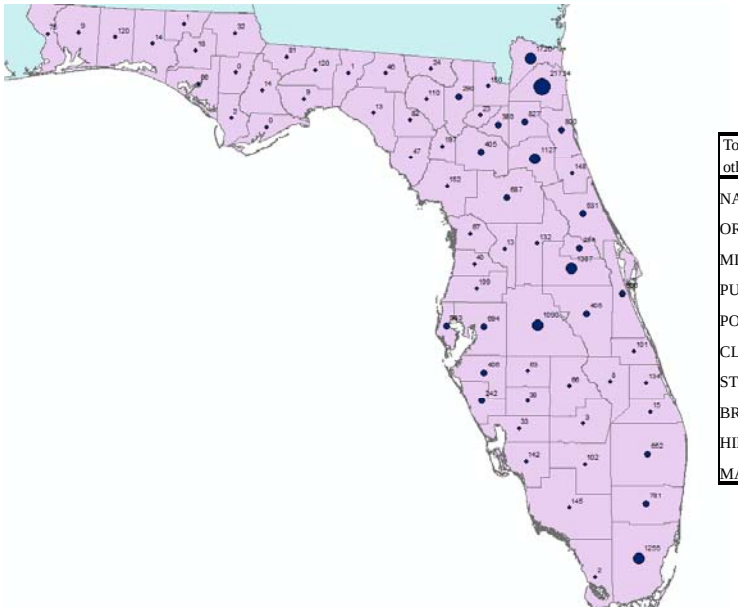
Top 10 Destinations other than Orange county
POLK
SEMINOLE
LAKE
OSCEOLA
DUVAL
HILLSBOROUGH
VOLUSIA
BREVARD
PALM BEACH
BROWARD

Origins of Trips Ending in Orange county
(where are trips coming from?)



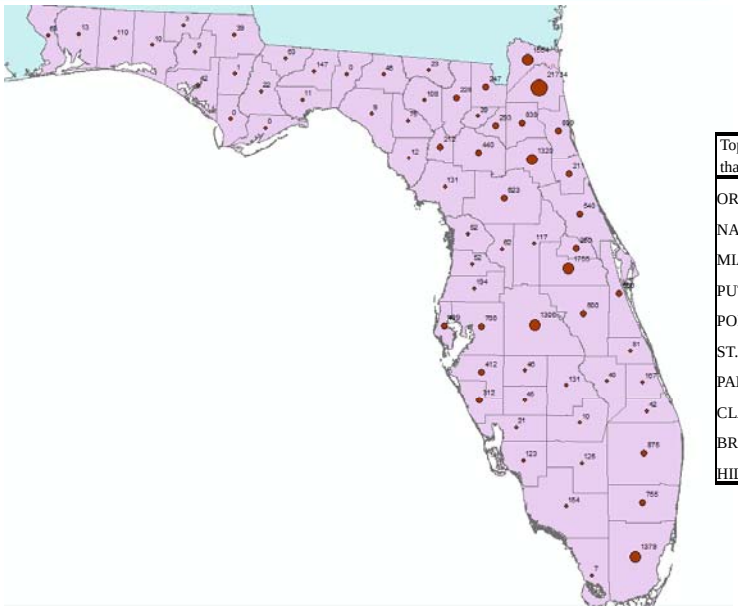
Top 10 Origins other than Orange county
POLK
SEMINOLE
OSCEOLA
HILLSBOROUGH
LAKE
DUVAL
ALACHUA
VOLUSIA
BREVARD
MIAMI-DADE

Destinations of Trips Starting in Duval County
(where are trips going to?)



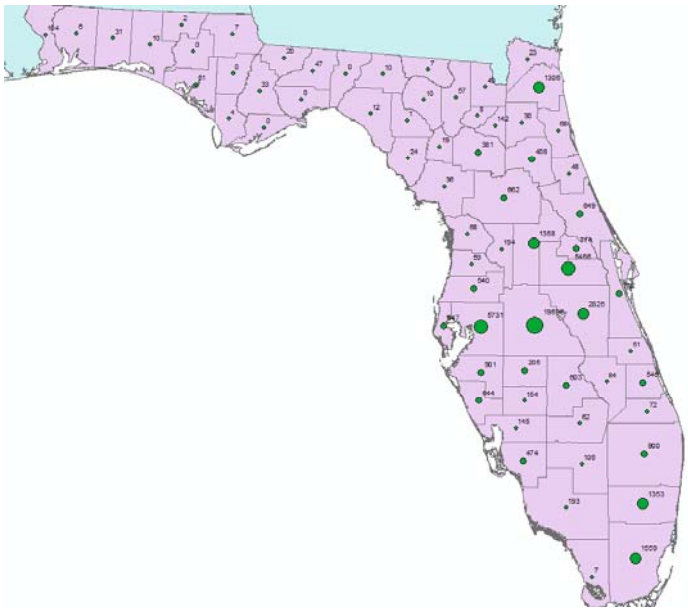
Top 10 Destinations other than Duval
NASSAU
ORANGE
MIAMI-DADE
PUTNAM
POLK
CLAY
ST. JOHNS
BROWARD
HILLSBOROUGH
MARION

Origins of Trips Ending in Duval county
(where are trips coming from?)



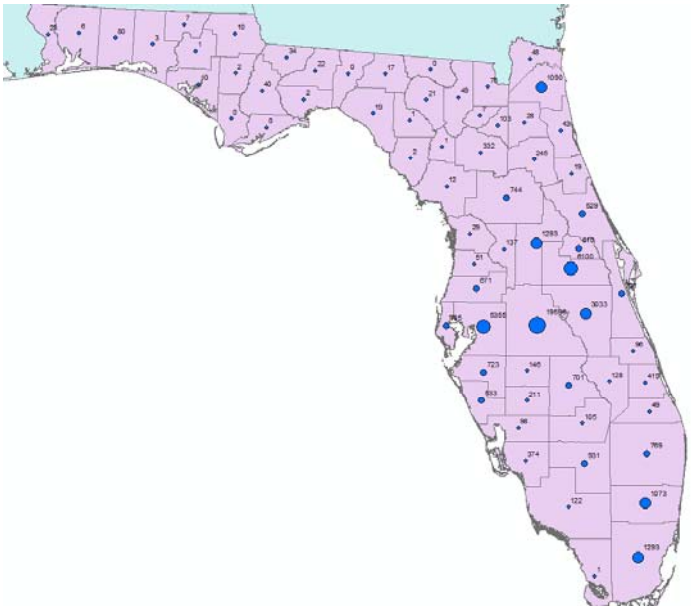
Top 10 Origins other than Duval
ORANGE
NASSAU
MIAMI-DADE
PUTNAM
POLK
ST. JOHNS
PALM BEACH
CLAY
BROWARD
HILLSBOROUGH

Destinations of Trips Starting in Polk County
(where are trips going to?)



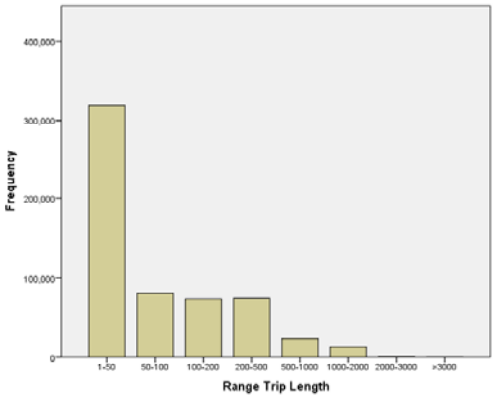
Top 10 Destinations other than Polk
HILLSBOROUGH
ORANGE
OSCEOLA
MIAMI-DADE
LAKE
BROWARD
DUVAL
MANATEE
PALM BEACH
PINELLAS

Origins of Trips Ending in Polk county
(where are trips coming from?)



Top 10 Origins other than Polk
ORANGE
HILLSBOROUGH
OSCEOLA
MIAMI-DADE
LAKE
DUVAL
BROWARD
HENDRY
PINELLAS
PALM BEACH

Trip Length Distribution
(trips starting and/or ending in Florida)



Trip Length (miles)	Frequency	Percent
< 50	319171	54.6
50-100	80469	13.8
100-200	73542	12.6
200-500	74262	12.7
500-1000	23544	4.0
1000-2000	12754	2.2
2000-3000	556	0.1
> 3000	206	0.04
Total	**584504**	**100**