A GPS Data Processing Method For Truck Activity Analysis

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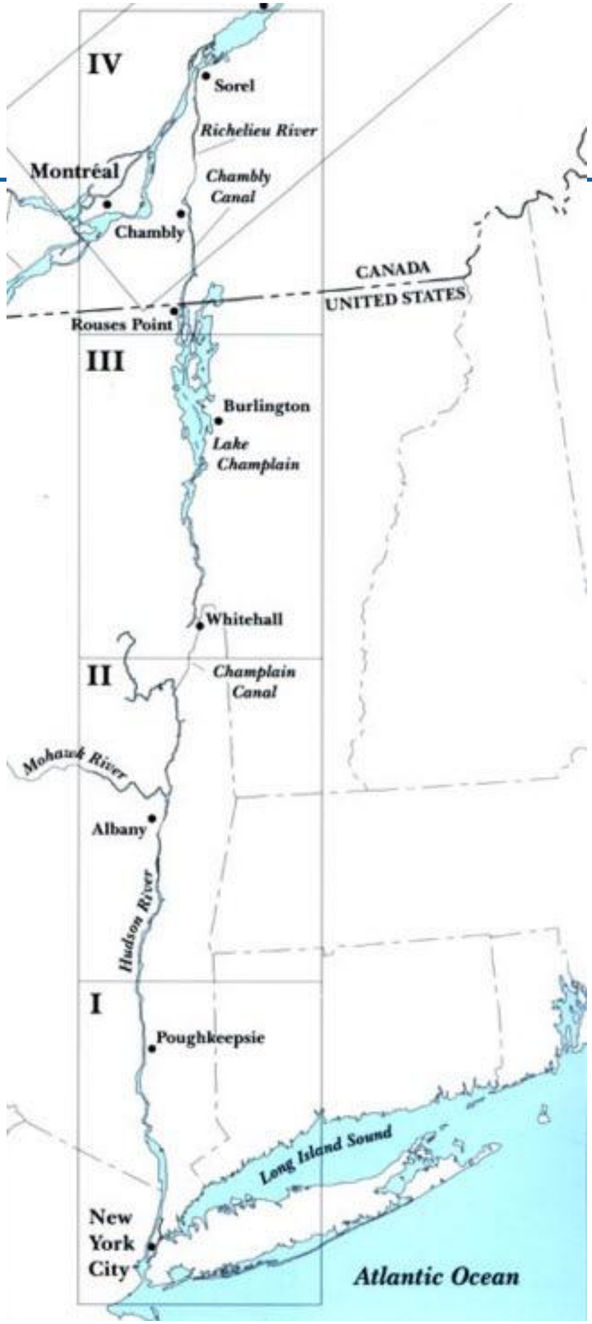
The Importance of Truck Activities to the Region

- Truck activities and regional economic conditions
- Impacts of truck activities
- Data challenges for analyzing truck activities:
  - consistency
  - coverage, and
  - timeliness



Hudson River Crossing Location

- Transportation challenges posed by the Hudson River
  - from the south end of Staten Island to the US/Canadian border

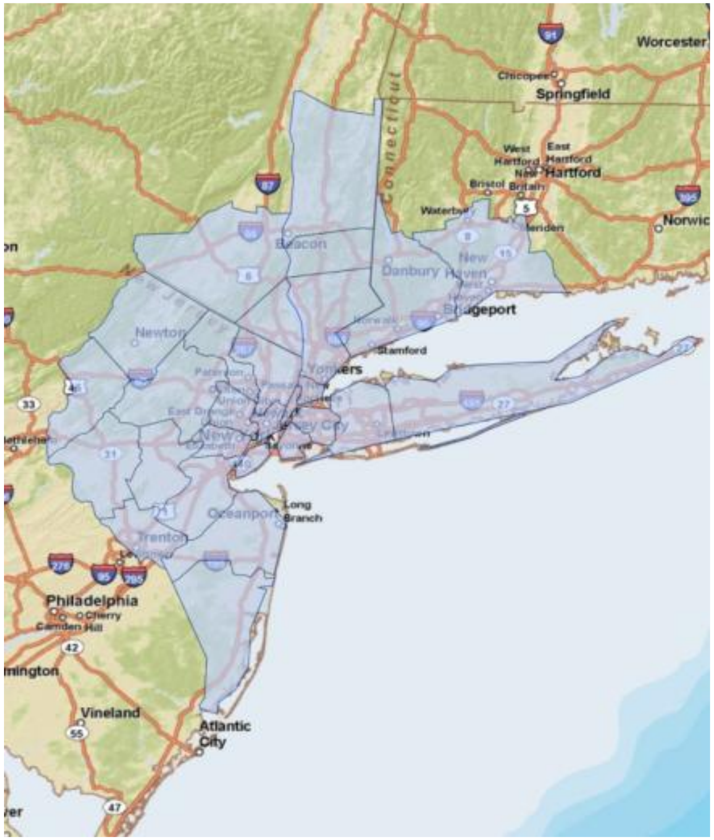
- The complexity of the transportation network in NY/NJ metro region leads to
  - computational burden
  - errors of spatial mismatches
  - assignment confusion

Truck GPS Data Sample Selection Method

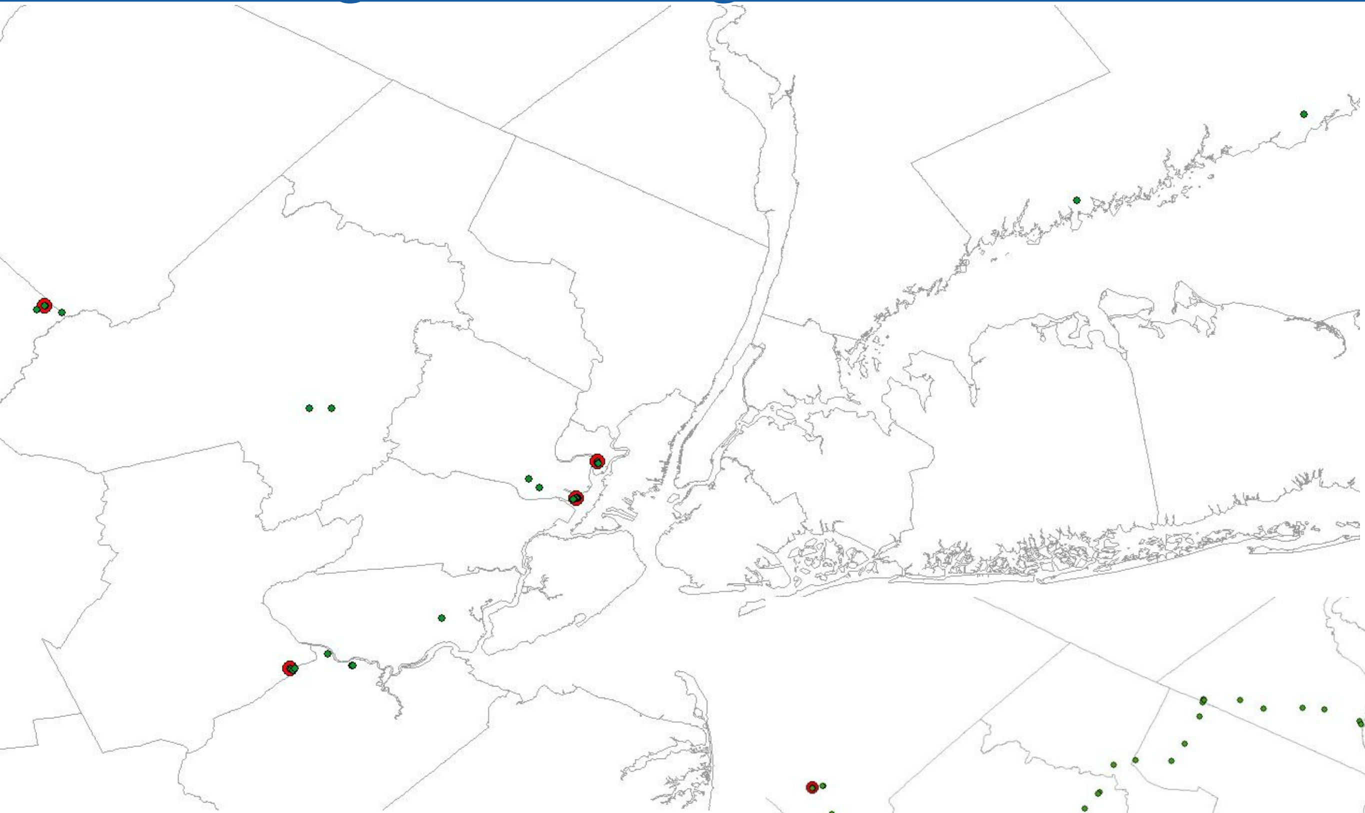
Data source:
American Transportation Research Institute (ATRI)

- The trucks selected were those appeared in the 28-county NY/NJ Metro region during the sample selection week. The movements of these selected trucks were traced backward/forward for one week.

- Each data entry (or record) is a position read
  - unique truck ID
  - time/date stamp
  - location: latitude, longitude, county, state, country



Challenges of Using GPS Data



- Differentiate between moving and stationary data records

- Irregular and low GPS data reporting frequency

Derive Hudson Crossing Location from GPS Data

Frequency distribution of time intervals between the GPS sighting points before/after crossing the Hudson

Time Interval (minute)	**2009**	**2011**	**2012**	**2013**	**2014**
15 or less	37.3%	64.6%	94.8%	97.5%	97.5%
61-75	39.9%	17.6%	0.3%	0.1%	0.1%
Other	22.8%	17.8%	4.9%	2.4%	2.4%

- Routing choice of river crossing is largely driven by
  - the last stop before the crossing & the first stop after the crossing
  - travel costs

GPS Data Processing Method

- Data structure

  - truck ID
  - current timestamp
  - current location
  - previous timestamp
  - distance travelled from the previous sighting read
  - the time elapsed since the previous sighting read
  - the space mean speed between the current and the previous sighting reads

- Step 1: Motion status detection — determine whether or not the truck is in motion or at stationary at any given time
  - motion/stationary status indicator

- Step 2: Stop identification — differentiate intentional stops from un-intentional stops

- Step 3: Crossing location identification & estimation — determine the crossing locations for a crossing event

Motion Status Detection

- Develop a rule-based algorithm to set the value of motion/stationary status indicator
  - motion/stationary status indicator

- Critical values used for setting the indicator
  - distance travelled between the current and previous sighting points
  - space mean speed between the current and previous sighting points

- The most influential factors in setting the critical values
  - GPS data reporting frequency
  - characteristics of the road network and traffic conditions
  - GPS signal blockage

- Fix false moving status and false short trips
  - calculate the continuous time and the number of reads the truck remained in the same status (either move or stationary)
  - move/stationary_duration
  - move/stationary_counts

Validity Check for Motion Detection Results

- Aggregate analysis for verifying the motion detection results – stationary time vs. time in motion

- Hours of Service Regulations used as a reference point:
  - drive for a maximum of 11 hours, and work for a maximum of 14 hours in a day, before having to take 10 hours off duty or in the sleeper
  - work no more than 70 hours in an 8 day period, before taking a 34-hour reset

- Service cycle length = 8 days * 24 hours/day + 34 hours = 226 hours
- Total number of hours on the move when on duty per service cycle = 70 * (11/14) = 55 hours
- The percentage of time spent on the move per service cycle: 24 ~ 31%

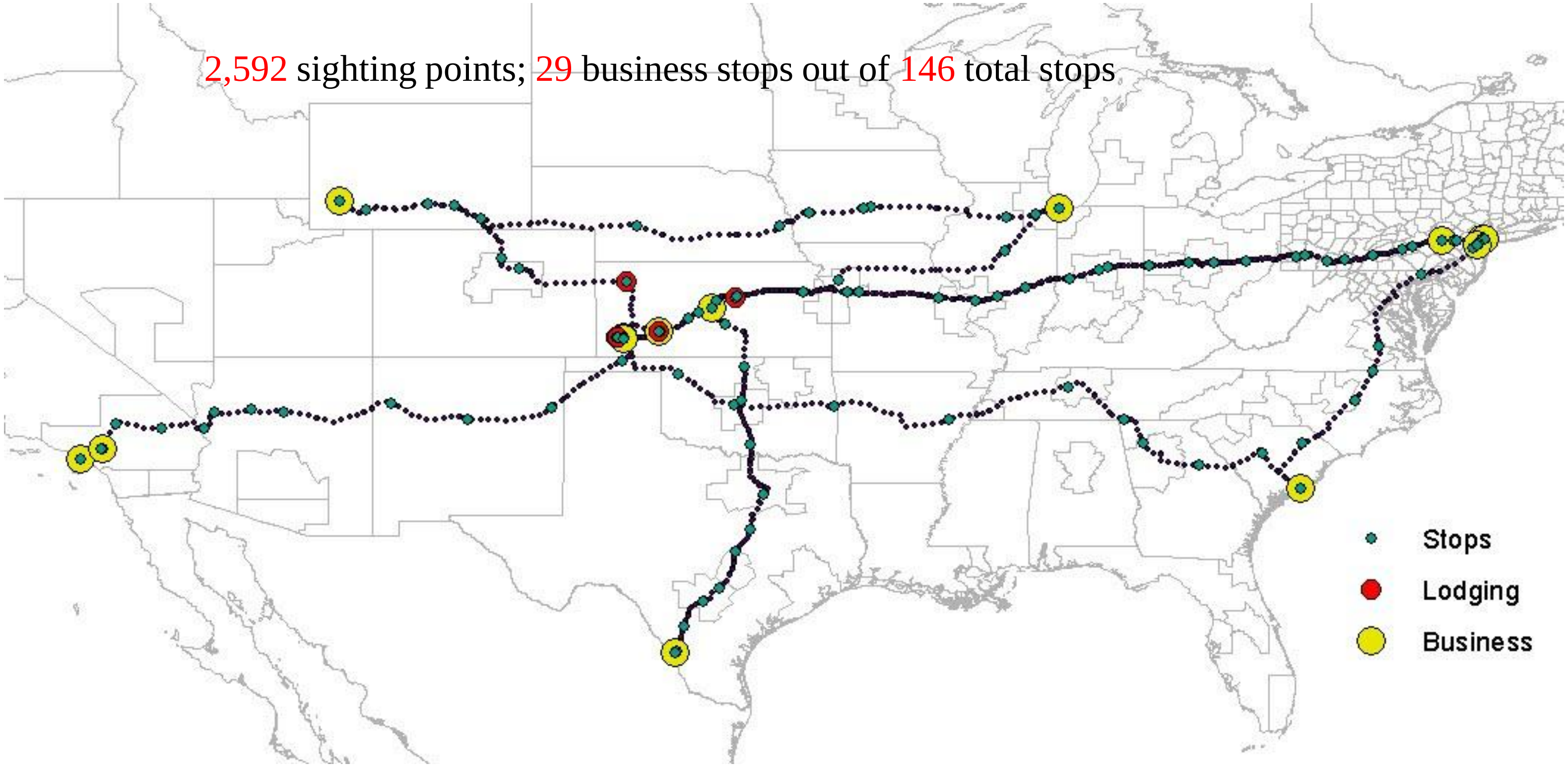
Results:

- Calculate the accumulated time spent on the move and in stationary in the dataset
- The percentage of time spent on the move was 25.5% in 2014

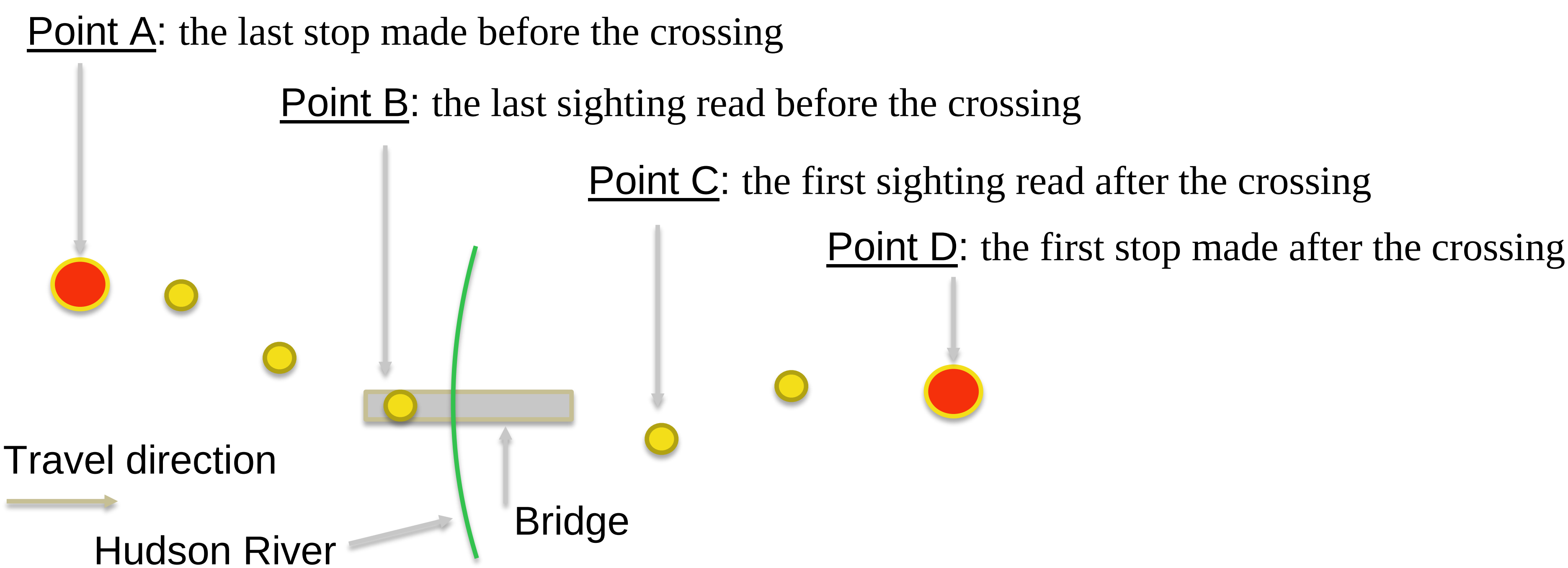
Stop Identification

- Stops
  - intentional stops
  - un-intentional stops

- A stop duration threshold is usually used for differentiating intentional vs. un-intentional stops
  - 10 minutes threshold

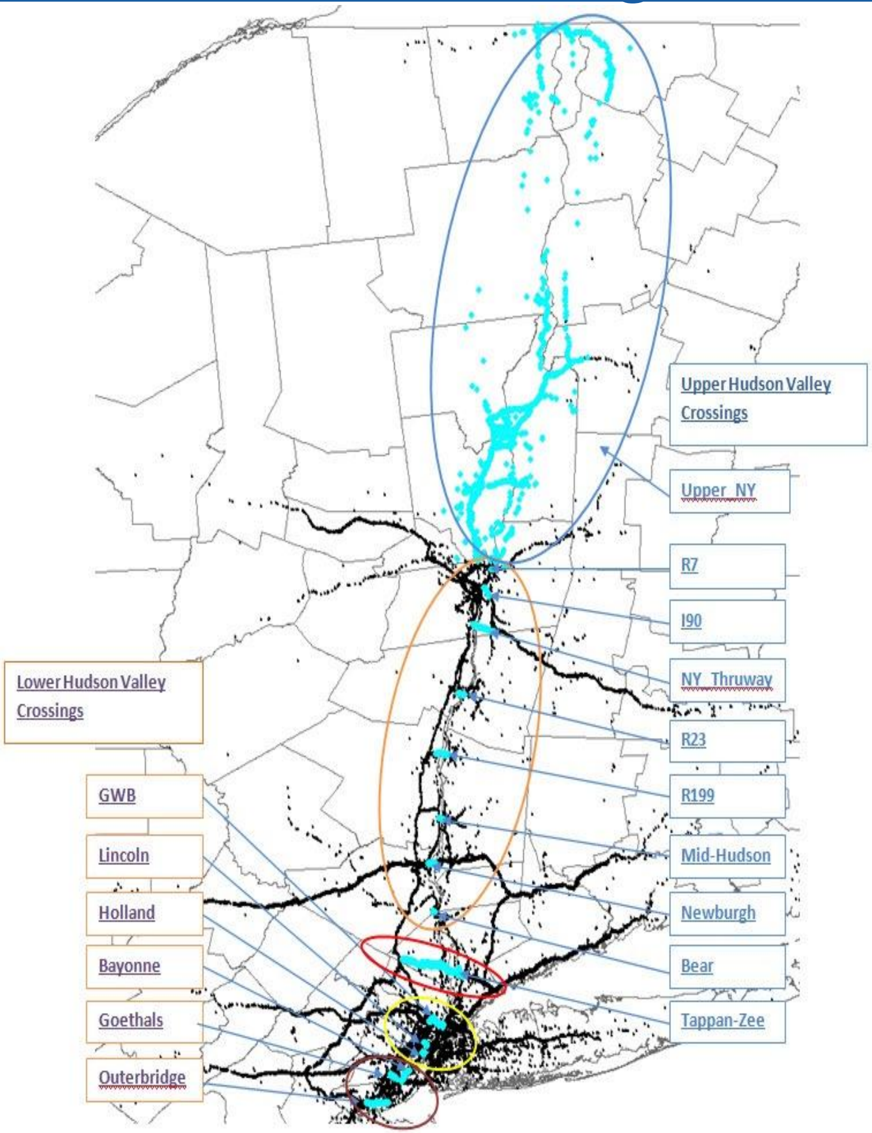


The Critical Data Records for a Crossing Event



- Four configurations for before/after crossing OD pairs:
  - B to C
  - B to D
  - A to C
  - A to D

Hudson Crossing Location Estimation

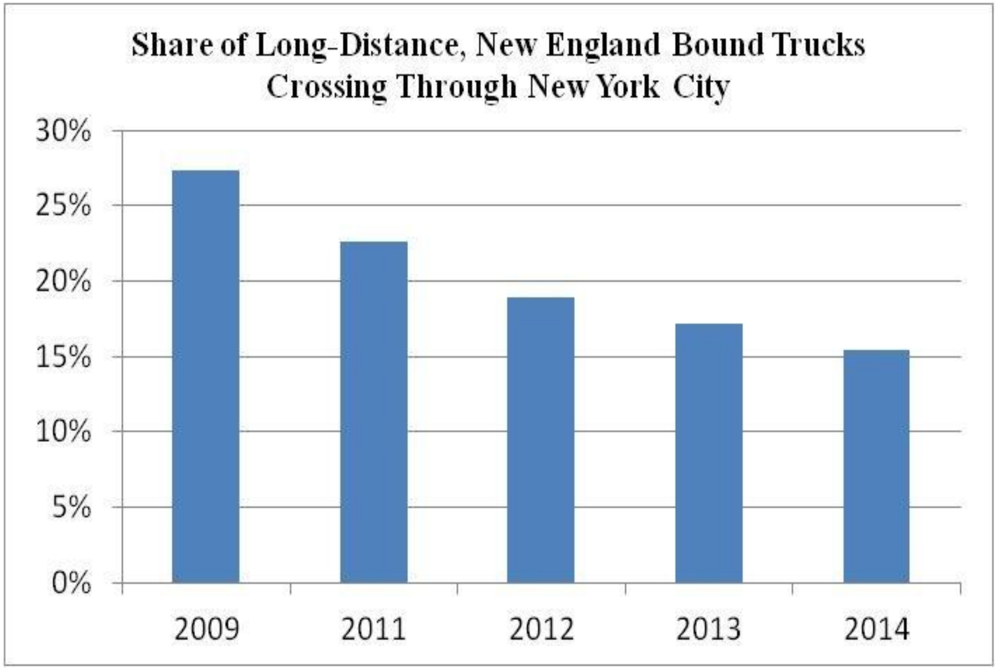


- Build OD market share lookup table based on the observed crossing events
- OD market share lookup table provided for each before/after crossing OD pair, the percentage of trucks using each available crossing facility
  1. George Washington Bridge, Lincoln Tunnel and Holland Tunnel
  2. Staten Island Bridges
  3. Tappan-Zee
  4. Mid-Hudson bridges
  5. Upper NY area
- Estimate the crossing locations for the un-determined crossing events using the OD market share lookup table
  - Assign a crossing location to each un-determined crossing events

Year	Observed	Estimated	Un-determined
2014	79.52%	20.30%	0.17%
2013	81.22%	18.68%	0.10%
2012	77.55%	21.76%	0.68%
2011	54.68%	44.99%	0.33%
2009	36.46%	63.06%	0.48%

An Application of Hudson Crossing Estimation

- Study the changes in truck routing and travel patterns
  - Calculate the share of facility usages by the trucks serving different market segments
    - e.g. long distance market vs. local market
  - Calculate the percentage of trucks using each crossing group by direction (i.e., eastbound and westbound) at different years
  - Analyze the trend of the long-distance, New England bound trucks crossing through New York City



Conclusions and Future Research

- The truck GPS data after being appropriately processed, has the potential to provide much more detailed, consistent and comprehensive information about truck behavior

- The value of this data source will increase as better quality GPS data collected from more trucks become available at lower cost.

- Cordon/border crossing analysis

- Real Origin/Destination demand that related to core-business activities