GPS in Household Travel Surveys: A Range of Options

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Household Travel Surveys (HTS)

- Conducted at regional and statewide level on stratified sample of population to collect basic travel and socio-demographic information
- Resulting dataset is used as input to travel demand model
- Early surveys were conducted using mail-out / mail-back surveys with travel information recorded on travel diaries
- Next generation of HTS were conducted by telephone interviews
- Within past decade, new technologies added to survey toolkit:
  - Web surveys (taken via desktop or laptop PC)
  - GPS logging devices (to passively capture travel details)
  - Smartphone apps (for survey entry or for GPS data logging)

- This presentation will focus on uses of GPS in household travel surveys
Since the Beginning...

- **GPS subsample dual method (diary and GPS)**
  - 2000-2005, diaries for persons, GPS for vehicles (California Statewide, St Louis, and Kansas City – 1 day, Washington DC and Baltimore – 2 or 4 days)
  - Starting with Chicago HTS in 2006, person-based GPS added for multi-modal travel (7 day vehicle and 7 day wearable)
  - 2007 - 2011 person-based GPS (Indianapolis - 1 day and Massachusetts Statewide – 2 or 4 days)

- **Primary purpose – trip rate correction factors**
More Recently...

- **GPS subsample dual method (diary and GPS)**
  - 2010-2012 both options, vehicle and person, used for different purposes / reasons / populations (Denver, Atlanta, California Statewide – 7 day vehicle, 3 or 4 day wearable)
  - 100% GPS and diary sample (Oakland/San Francisco Bay Area – 3100 households, 3 days wearable)

- **Secondary uses of GPS datasets include analyses of mode choice, route choice, congestion and travel times, active transport**
Along the Way...

- GPS-based **prompted recall** subset in diary survey for trip rate correction factors (10% sample NYC metro – 1880 GPS households – 2 or 4 days GPS, followed by CATI or CASI 1 day PR, 2010-2011)

- GPS-based **prompted recall** used for 100% GPS survey (Jerusalem, 8800 households – 1 day CAPI, 2010-2011)

- 100% GPS survey with 30% GPS **prompted recall** subset for imputation algorithm validation/calibration (Cleveland, 4250 households – 3 or 4 days GPS, followed by CATI or CASI 1 day PR, 2012-2013)
## NYC Regional Travel Survey (NY-NJ-CT)

### Persons

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<th>GPS</th>
<th>Diary</th>
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### Households

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![Report Your Travel](image)
Jerusalem 100% GPS Travel Habits Survey
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Cleveland GPS Household Travel Survey: Pretest and Pilot Study Design

Pretest (September 2011)
- 5 task force or staff participant households in PR subsample to test materials, methods, questionnaires

Pilot (October – November 2011)
- 150 hh recruited (original goals: 50 PR, 100 GPS only)
- All persons of age 13 – 75 provided with wearable GPS data logger for three days (four days if first day is Friday)
- 75+ only hh created new category: Log only
- Incentives offered, tailored to level of burden
## Cleveland Pilot Study Results

<table>
<thead>
<tr>
<th>Phase</th>
<th>% CATI</th>
<th>% WEB</th>
<th>Total Recruits</th>
<th>Total Retrieved / Completed</th>
<th>% CM</th>
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</thead>
<tbody>
<tr>
<td>Recruitment (all)</td>
<td>57%</td>
<td>43%</td>
<td>150</td>
<td>102</td>
<td>68%</td>
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<tr>
<td>Retrieval (PR Only)</td>
<td>53%</td>
<td>47%</td>
<td>41</td>
<td>30</td>
<td>73%</td>
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<td>71%</td>
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<td>NA</td>
<td>15</td>
<td>5</td>
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</tbody>
</table>

- High use of web recruitment and of web retrieval (PR households)
- The retrieval rate for GPS only and GPS+PR households exceeded expected rates by a few percentage points
- Log only households did not mail back completed logs as expected
Cleveland Main Survey Overview

- 4,250 Complete Households
  - 2,575 Households GPS-only (no travel retrieval)
  - 1,250 Households GPS-based Prompted Recall (PR)
  - 425 Households Log only (75+ households)
- 12-month data collection period starting on Feb 15, 2012
- Travel details for GPS-only sample to be derived/imputed
Extensions for Vehicle Activity

- Vehicle GPS and Onboard Diagnostic (OBD) sensors (California Statewide Travel Survey – 1300 households, 2012-2013)
  - GPS device measures all vehicle trips (second-by-second traces with instantaneous speed and heading)
  - OBD device measures engine activity (mass air flow, engine speed, engine load, throttle position – 5 second frequencies)
  - Combined metrics can be used for fuel consumption and emissions modeling
  - 500 households from alternative fuel vehicle sample
Sample GPS and OBD Data

- **Engine Speed**
- **Throttle Position**
- **Vehicle Speed**
- **Operating Mode**
Extensions for Physical Activity

- Wearable GPS and/or accelerometers (activity monitors) for measuring travel and physical activity (Atlanta – 500 households 2001-2002, Nashville – 600 households, 2012)
  - GPS devices measure all modes of travel (second-by-second)
  - Accelerometers measure physical activity intensity
  - Both devices in tandem identify where/how physical activity occurs
Nashville Walk-Bus-Walk Trip
Trends over the Past Decade

- Increasing size of GPS subsamples
  - Primary purpose: trip rate correction factors for diary participants
- Longer deployment durations and longer study durations
- Expansion from dual method to GPS only method
  - There is still value in dual methods for some agencies
- Although wearable devices are commonplace, doesn’t necessarily mean that they are only solution
  - Vehicle approach appropriate for certain goals and has lower burden
- Agencies see value of GPS data beyond correction factors
- GPS loggers used in tandem with other sensors to meet additional data needs
The Future

- Multi-modal surveys (web, phone, mail, GPS)
  - “Different strokes for different folks”
- GPS only surveys (with or without prompted recall)
  - Standalone GPS data loggers
  - Smartphone data logging apps
- Data mining of large-scale consumer datasets
  - GPS data from personal navigation devices, smartphones
  - Other transactional data (e.g., credit cards, farecards)
Acknowledgements

- This presentation covers some of the GPS studies conducted by GeoStats over the past 12 years.
- The travel surveys, of which these GPS components were a part, were led by numerous firms, including PTV NuStats, Parson Brinckerhoff, GeoStats, and Westat.
- Sponsoring clients for these travel surveys include Caltrans, Massachusetts DOT, Ohio DOT; and MPO’s from St Louis, Kansas City, Washington DC, Baltimore, Chicago, Indianapolis, Denver, Atlanta, Oakland/Bay Area, Los Angeles, New York City, North Jersey, Jerusalem (Israel), Cleveland, and Nashville.
Thanks!

For more information:
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