# Second Day Response Rates: Implications for CMAP's Travel Tracker Survey

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## Introduction

Why would MPOs implement 2-day travel surveys in the first place, given the strong likelihood that respondent fatigue may bias the results?

It is well established there is significant day-to-day variation in individual travel:

- major travel activities at the tour level,
- stop making (number of stops and duration of stop activity),
- adjustments to departure (and arrival time),
- mode shifts
- and route choice (although this is rarely asked in surveys, it would be available from GPS sources supplementing a travel diary survey)

Some researchers are convinced that 2-day surveys offer the best trade off for additional statistical insights at a lower cost than surveying twice as many household members, particularly in an era when survey recruitment is becoming increasingly difficult (Pas 1986).

The recently completed (2008) Travel Tracker household survey conducted for the Chicago Metropolitan Agency for Planning (CMAP) did include a considerable number of 2-day surveys. While the initial goal was for half of the households to be included in the 2-day "panel," in the final results approximately 45% of the households were asked about their travel activities over 2 days, with the remaining 55% being the of the more traditional one day travel diary type of survey.

One of the open questions about multi-day surveying is whether the respondent fatigue is such an issue that the resulting degradation in the data outweighs the advantage of instituting 2-day surveys in the first place. However, we already know that individuals' travel patterns are nearly always different from one day to the next, so simply a different travel pattern (even if resulting in less travel) does not guarantee that this difference is solely due to respondent fatigue.

This project first looks at how one might isolate specific surveys (or portions of surveys) that appear to be unreliable due to respondent fatigue. Next it considers various approaches towards solving the respondent fatigue issue (and reclaiming a portion of data for analysis purposes) and how this might vary between traditional 4-step models and activity-based models. Finally, it looks at how these issues impact CMAP's Travel Tracker survey.

Measuring Fatigue

There are few hard and fast rules regarding how to know with certainty if a respondent is suffering from fatigue. Provided the survey has been completed, it is possible (and indeed plausible) that stop activities are increasingly omitted the longer the survey takes to complete. However, as long as the final tour returns to the home location, there may be no smoking gun.

Nonetheless, there are markers that might raise flags or minimize concern. In the Travel Tracker, the respondent actually indicates whether the data is being read off hard copies of a travel diary or reported from memory.

- Hypothesis #1 is that respondents reading from travel diaries will suffer less fatigue.

Another issue is that NuStats was open to interviewing each adult household member, though in practice, one respondent usually took responsibility for the entire household.

- Hypothesis #2 is that respondent fatigue will increase as the number of household members increase, although this only applies if the main respondent is reporting for all of them.

If the total travel declines for the second day (either in terms of total number of activities or time accounted for) this suggests there might be a problem, though in isolation, this is probably not sufficient to claim respondent fatigue set in.

Another quality check would be to compare travel activity on a day-by-day basis, specifically looking at the 2$^{nd}$ day data in comparison to the 1-day data set. So for instance, if the second day was a Tuesday, then to look at travel rates based on Tuesday 1-day surveys. Again, this is largely indicative but it could be useful in conjunction with other warning flags.

As far as the content of the surveys, we might expect that respondents will recall the work tours (or simply report that this activity was the same as the previous day) but will not report all stop activities or potentially would omit maintenance or leisure activities on the second day.

- The related hypothesis (#3) is that respondent fatigue will decrease the number of recorded stops on mandatory tours on the second day, as well as reduce the non-mandatory tour rates on the second day.

In the results section, we will look at how CMAP's Travel Tracker data stacks up when these suggested tests are implemented.

Correcting for Respondent Fatigue

- Depending on the severity of the problem, there are a variety of options:
- Discarding the entire record (for respondents who prove to be particularly unreliable and/or are missing a great many data items);
- Discarding the second day information and treating the first day as if it were one-day data;
- Reweighting either the second day or both days to discount this information in general tabulations (note that these weights might vary depending on the attribute of interest – tour rates vs. stop making);
- Adjusting the existing data with respect to VMT or activity duration;
- Synthesizing missing information.

Under most conditions, travel modelers do not adjust information from travel surveys, although limited adjustments may take place in the course of geocoding for example. It is more accepted that questionable data is reweighted or discarded. One issue worth considering is that because 4-step modeling is more segmented, it is more straight-forward to use portions of a travel record. For instance, if the work trip (or tour) information seems accurate but the home-based other trip (or tour) information seems suspect, then in tradition 4-step modeling, the record could be used for generating work trip rates for example, while the home-based other data could be discarded or discounted heavily via weighting. Depending on how strict the activity-based modeling system is with respect to accounting for an entire day's worth of activities, there may be no choice but to discard the entire day's worth of information. For example, a model that is not substantially more than a tour-based rather than trip- based model could incorporate mandatory travel information without respect to the other travel. For more advanced models that take as their basis the inter-relationships between individual tours, namely that all tours should be considered as part of a daily travel pattern and are modeled at this level, this omitted data would be extremely problematic. At the most extreme end of the spectrum, some models look at the schedules of all travelers within the household in order to predict joint travel -- and leisure travel is scheduled after all other individual and joint mandatory and maintenance tasks have been modeled. These types of models require rejecting the entire household if any household member's travel is substantially impacted by respondent fatigue, even if the remaining household members' travel is reported accurately. For these advanced models, the key is identifying questionable data and filtering it out to improve the quality of the remaining data. As the inter-relationships of these models are relaxed, more techniques may be employed to "salvage" data that appears to be impacted by respondent fatigue.

Preliminary Results from Chicago Travel Tracker Survey

The results in all subsequent tables are based on unweighted data. All weekend and holiday travel was excluded. In practice, this means that for 2-Day surveys, the entire household is omitted if either day fell on a weekend (Sunday-Monday or Friday-Saturday), since comparing across weekday and weekend travel was not relevant to gauge whether respondent fatigue was an issue with the Chicago Travel Tracker Survey.

**Table 1. Non Traveling Households by Survey Type**

| | 1-Day Survey | 2-Day Survey | | | |
|---|---|---|---|---|---|
| | Day One | Both Days | Day One | Day Two | Either Days |
| **No Trip HHs** | 222 | 92 | 177 | 244 | 329 |
| **No Trip HHs (Percent)** | 2.8% | 2.7% | 5.1% | 7.1% | 9.6% |
| **Total Households** | 7874 | 3440 | 3440 | 3440 | 3440 |

Households which reported travel during regular weekdays. Diaries from weekends and holidays are excluded

**Table 2. Household Level Non-Response in 2-Day Survey**

| No response on either days | |
|---|---|
| Households Reported Trips only in the First day | 152 |
| Households Reported Trips only in the Second day | 85 |
| No response on Both Days | 92 |

Households which reported travel during regular weekdays. Diaries from weekends and holidays are excluded

**Table 3. Household Level Trip Reporting across the Days of the 2-Day Survey**

| Responded to both Days | |
|---|---|
| Households Reported Fewer Trips in the Second day | 1,349 |
| Households Reported More Trips in the Second day | 1,122 |
| Households Reported Same Number of Trips in the Second day | 640 |
| Total | 3,111 |

Households which reported travel during regular weekdays. Diaries from weekends and holidays are excluded

**Table 4. Household Level Trip Rates by Survey Type and Day of the Survey**

| Analysis Variable : hhtrips | | | | | |
|---|---|---|---|---|---|
| **Survey Type** | **Day Number** | **N Obs** | **Sum** | **Mean** | **Std Dev** |
| 1-Day | 1 | 7,652 | 69,996 | 9.147 | 6.933 |
| 2-Day | 1 | 3,263 | 28,857 | 8.844 | 6.713 |
| 2-Day | 2 | 3,196 | 27,567 | 8.625 | 6.666 |

Households which reported travel during regular weekdays. Diaries from weekends and holidays are excluded

The household-level results reported in Tables 2 through 4 are consistent with the hypothesis that respondent fatigue impacts the second day of a two-day survey, but are not sufficient to declare that respondent fatigue was an issue.

**Table 5. Non Traveling Respondents by Survey Type**

| | 1-Day | 2-Day | | | |
|---|---|---|---|---|---|
| | Day One | Both Days | Day One | Day Two | Either Days |
| No Trip Person | 1777 | 519 | 874 | 1064 | 1419 |
| No Trip Persons (Percent) | 10.0% | 6.8% | 11.4% | 13.9% | 18.5% |
| Total Persons | 17810 | 7652 | 7652 | 7652 | 7652 |

Persons which reported travel during regular weekdays. Diaries from weekends and holidays are excluded

**Table 6. Person Level Non-Response in 2-Day Survey**

| **No response on either day** | |
|---|---|
| Persons Reported Trips only in the First day | 545 |
| Persons Reported Trips only in the Second day | 355 |
| No response on Both Days | 519 |

Persons which reported travel during regular weekdays. Diaries from weekends and holidays are excluded

**Table 7. Person Level Trip Reporting across the Days of the 2-Day Survey**

| Responded to both Days | |
|---|---|
| Persons Reported Fewer Trips in the Second day | 2175 |
| Persons Reported More Trips in the Second day | 1991 |
| Persons Reported Same Number of Trips in the Second day | 2067 |
| Total | 6233 |

Persons which reported travel during regular weekdays. Diaries from weekends and holidays are excluded

**Table 8. Person Level Trip Rates by Survey Type and Day of the Survey**

| Analysis Variable : pertrips | | | | | |
|---|---|---|---|---|---|
| **Survey Type** | **Day Number** | **N Obs** | **Sum** | **Mean** | **Std Dev** |
| 1-Day | 1 | 16,033 | 69,996 | 4.366 | 2.602 |
| 2-Day | 1 | 6,778 | 28,857 | 4.257 | 2.510 |
| 2-Day | 2 | 6,588 | 27,567 | 4.184 | 2.444 |

Persons which reported travel during regular weekdays. Diaries from weekends and holidays are excluded

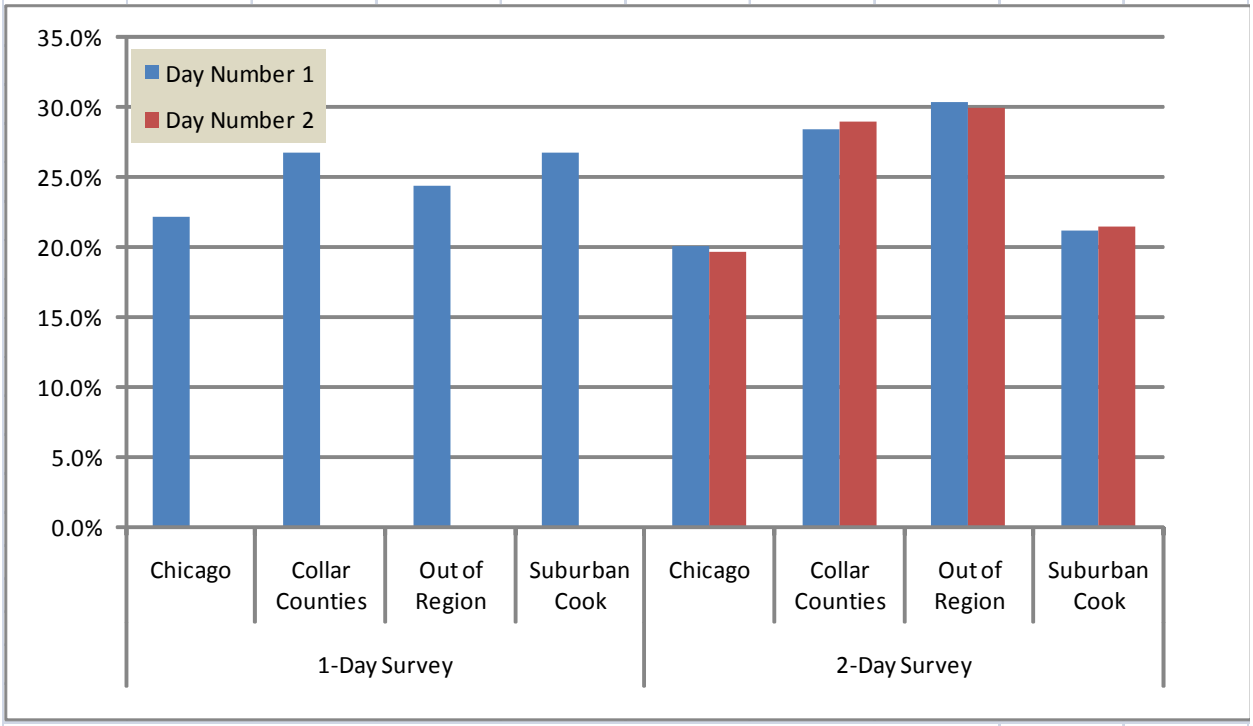
The individual-level results reported in Tables 6 through 8 are consistent with the hypothesis that respondent fatigue impacts the second day of a two-day survey, but are not sufficient to declare that respondent fatigue was an issue.

**Table 9. Distribution of Number of Reported Trips by Region, Survey Type and Day of the Survey**

| | | Day Number | | | Day Number | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | Totals | 1 | 2 | Sum |
| 1-Day Survey | Chicago | 15,485 | | 15,485 | 22.1% | | 22.1% |
| | Collar Counties | 18,714 | | 18,714 | 26.7% | | 26.7% |
| | Out of Region | 17,053 | | 17,053 | 24.4% | | 24.4% |
| | Suburban Cook | 18,717 | | 18,717 | 26.8% | | 26.8% |
| | Total | 69,969 | | 69,969 | 100.0% | | 100.0% |
| 2-Day Survey | Chicago | 5,788 | 5,430 | 11,218 | 20.1% | 19.7% | 19.9% |
| | Collar Counties | 8,206 | 7,982 | 16,188 | 28.4% | 29.0% | 28.7% |
| | Out of Region | 8,757 | 8,234 | 16,991 | 30.4% | 29.9% | 30.1% |
| | Suburban Cook | 6,098 | 5,915 | 12,013 | 21.1% | 21.5% | 21.3% |
| | All | 28,849 | 27,561 | 56,410 | 100.0% | 100.0% | 100.0% |
| All | | 98,818 | 27,561 | 126,379 | | | |

Trips reported from regular weekday diaries. Diaries from weekends and holidays are excluded

**Figure 1. Distribution of Number of Reported Trips by Region, Survey Type and Day of the Survey**



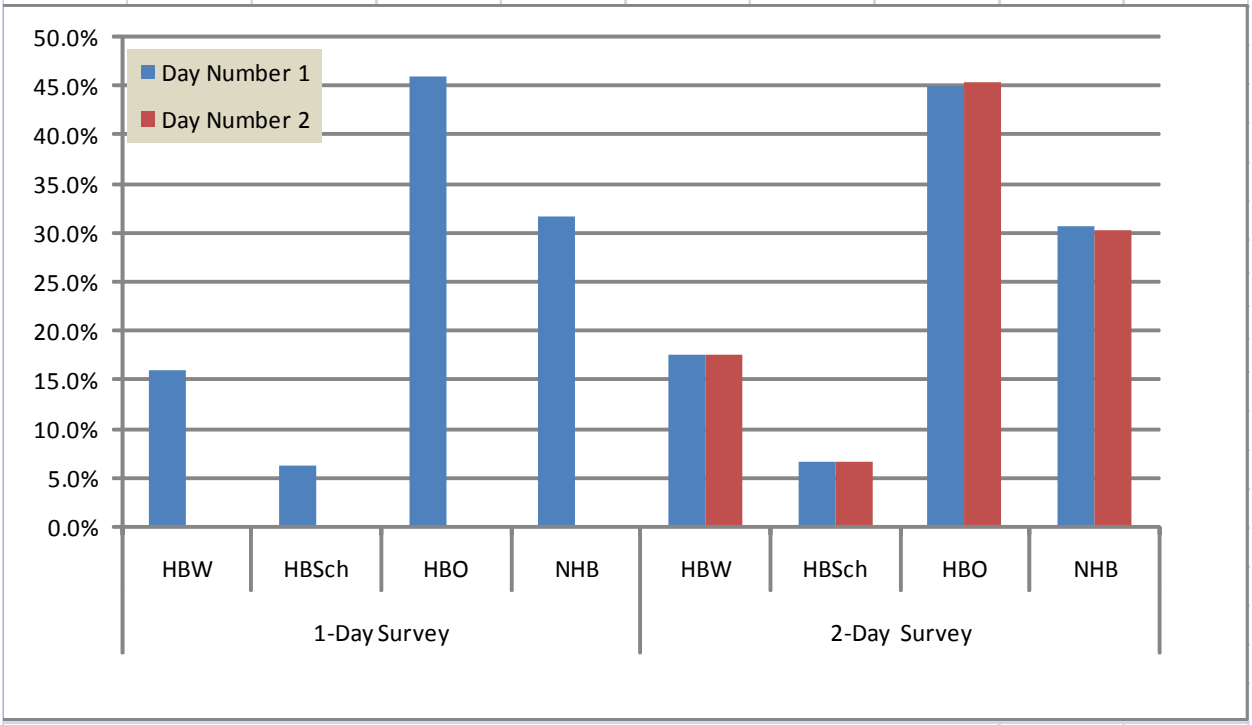

Trips reported from regular w eekday diaries. Diaries from w eekends and holidays are excluded

**Table 10. Distribution of Number of Reported Trips by Purpose, Survey Type and Day of the Survey**

| | | Day Number | | | Day Number | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | Totals | 1 | 2 | Sum |
| 1-Day Survey | HBW | 11,202 | | 11,202 | 16.0% | | 16.0% |
| | HBSch | 4,427 | | 4,427 | 6.3% | | 6.3% |
| | HBO | 32,212 | | 32,212 | 46.0% | | 46.0% |
| | NHB | 22,155 | | 22,155 | 31.7% | | 31.7% |
| | Total | 69,996 | | 69,996 | 100.0% | | 100.0% |
| 2-Day Survey | HBW | 5,052 | 4,834 | 9,886 | 17.5% | 17.5% | 17.5% |
| | HBSch | 1,951 | 1,839 | 3,790 | 6.8% | 6.7% | 6.7% |
| | HBO | 12,980 | 12,524 | 25,504 | 45.0% | 45.4% | 45.2% |
| | NHB | 8,874 | 8,370 | 17,244 | 30.8% | 30.4% | 30.6% |
| | Total | 28,857 | 27,567 | 56,424 | 100.0% | 100.0% | 100.0% |
| All | | 98,853 | 27,567 | 126,420 | | | |

Trips reported from regular w eekday diaries. Diaries from w eekends and holidays are excluded

**Figure 2. Distribution of Number of Reported Trips by Purpose, Survey Type and Day of the Survey**




Trips reported from regular weekday diaries. Diaries from weekends and holidays are excluded

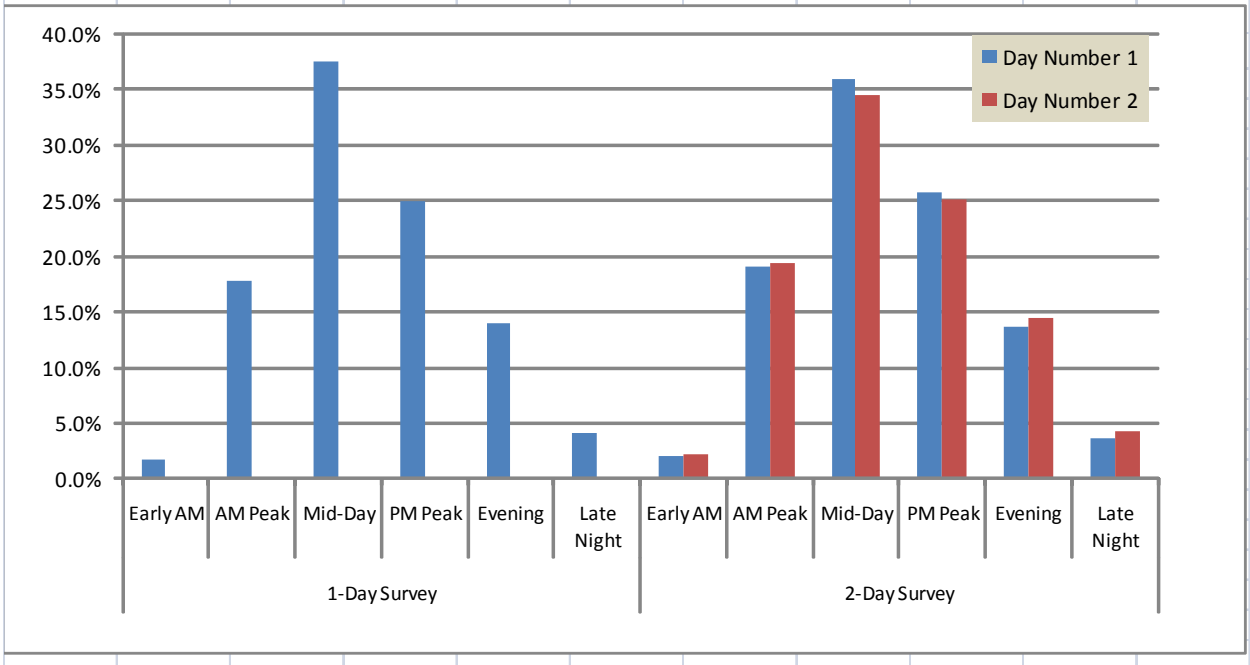
Table 10 and Figure 2 represent travel activities as reported in trips rather than tours. Future work will extend this analysis by converting the trips into tours. The results suggest that Hypothesis #3 is correct. Mandatory travel (Home-based work and home-based school trips) seems to be occurring at the same rates across both days of the Two-Day records. Home based other trips are slightly more prevalent on the second day and non-home-based travel is down, suggesting that fewer stops are reported on the second day of travel.

**Table 11. Distribution of Number of Reported Trips by Time of Day, Survey Type and Day of the Survey**

| | | Day Number | | | Day Number | | |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | Sum | 1 | 2 | Sum |
| 1-Day Survey | Early AM | 1,240 | | 1,240 | 1.8% | | 1.8% |
| | AM Peak | 12,418 | | 12,418 | 17.7% | | 17.7% |
| | Mid-Day | 26,232 | | 26,232 | 37.5% | | 37.5% |
| | PM Peak | 17,424 | | 17,424 | 24.9% | | 24.9% |
| | Evening | 9,820 | | 9,820 | 14.0% | | 14.0% |
| | Late Night | 2,862 | | 2,862 | 4.1% | | 4.1% |
| | Total | 69,996 | | 69,996 | 100.0% | | 100.0% |
| 2-Day Survey | Early AM | 577 | 591 | 1,168 | 2.0% | 2.1% | 2.1% |
| | AM Peak | 5,507 | 5,358 | 10,865 | 19.1% | 19.4% | 19.3% |
| | Mid-Day | 10,362 | 9,523 | 19,885 | 35.9% | 34.5% | 35.2% |
| | PM Peak | 7,410 | 6,934 | 14,344 | 25.7% | 25.2% | 25.4% |
| | Evening | 3,947 | 3,979 | 7,926 | 13.7% | 14.4% | 14.0% |
| | Late Night | 1,054 | 1,182 | 2,236 | 3.7% | 4.3% | 4.0% |
| | Total | 28,857 | 27,567 | 56,424 | 100.0% | 100.0% | 100.0% |
| All | | 98,853 | 27,567 | 126,420 | | | |

Trips reported from regular w eekday diaries. Diaries from w eekends and holidays are excluded

**Figure 3. Distribution of Number of Reported Trips by Time of Day, Survey Type and Day of the Survey**




Trips reported from regular w eekday diaries. Diaries from w eekends and holidays are excluded

Discussion and Preliminary Conclusions

The general finding is that less travel is reported on the second day of travel. More specifically, mandatory travel seems to be just as prevalent on the first as on second day of travel but stop making is not taking place (or at least is not being recorded) at the same rate. Less stop making is observed on the 2nd day of the survey, which is consistent with Hypothesis #3.

The next steps include pushing further into data analysis of the Travel Tracker, specifically looking at the variation by household size and the use of previously recorded travel diaries versus respondent recall. The analysis of trip rates will be repeated at the tour-level. If, as seems likely, respondent fatigue is prevalent in the Travel Tracker survey, we will undertake an analysis to identify routines that would allow specific records to be flagged. The treatment of these records will depend upon the severity of the respondent fatigue, as well as the intended use of the Travel Tracker data. As identified in the paper, a number of options are available to the modeler, ranging from eliminating suspect data, reweighting data or even synthesizing missing data. However, our general belief is that the more advanced the structure of the desired model, the fewer the options available to the modeler.

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