Understanding the Travel Behaviour of the Rural Elderly

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1. Introduction

A number of trends related to elderly drivers, when considered in concert, serve to identify a building crisis particularly for those who live in rural areas. It is well documented that because of the 'Baby Boom' cohort, not only are the numbers of elderly on the rise, but the proportion of North American's population over 65 years of age will dramatically increase over the next two decades. These demographic shifts, coupled with exceedingly high accident rates among this age group, have elevated the pressure for jurisdictions to consider more proactive re-licensing practices for seniors.

The issues are particularly problematic for those seniors living in rural areas as they typically have limited transportation alternatives other than driving their own automobiles. In fact, research has shown that the rural elderly tend to retain their driver's license longer than their urban counterparts, yielding accident rates that are the highest among any age group (Hildebrand and Myrick, 2001). It is a crucial first step to develop a better understanding of the travel behaviour of this group so that the most appropriate proactive strategies can be pursued.

Traditionally, travel behaviour was documented through the use of either written trip diaries or personal interviews to collect trip-by-trip data over a two to three-day period. These techniques rely on the participant to either mentally recall or manually record trip-making, often resulting in under-reporting as trips (particularly short ones) are often forgotten or omitted. A further difficulty is that traditional travel surveys only provide limited dimensions of exposure to the risk of an

accident; typically expressed simply in terms of kilometres of travel coupled with end origin and destinations. Distances traveled by road class, traffic volume, operating speeds, time of day, and specific route choice are all important variables not usually captured through conventional analyses.

Over the past few years, there have been significant advances in travel data collection methods, particularly with the proliferation of Global Positioning System (GPS) technology. New compact GPS units, combined with more comprehensive Geographic Information Systems (GIS), allow for convenient presentation and analysis of GPS-collected travel information. GPS and GIS resources have been shown to complement the traditional survey methods currently employed by researchers. With improved accuracy and functionality, GPS and GIS have the ability to accurately quantify the older driver travel habits and ensure the survey captures a complete record of trip-making behaviour. These detailed travel data can form the basis of a valuable planning tool for the formation of public policy and the development of alternative public transportation services.

This paper synthesizes the results of a study that was undertaken that had two broad goals established to address some of the previously noted issues.

- To develop and test a GPS-based methodology for data collection, presentation, and analysis of automobile trip data with minimal involvement/disruption of participants;

- To collect precise and comprehensive travel data on older drivers (65 years and older) in New Brunswick for the purposes of comparing urban and rural travel patterns.

Geographically, the study was limited to the census subdivisions of the New Brunswick counties of York, Sunbury, and Queens. Participants for the study were composed of solicited volunteers 65 years of age and older. Although the study was conducted using a 'convenience' sample, efforts were made to include participants representing equally both sexes, all elderly age cohorts, and both

urban and rural areas. Automobile travel habits of the participants were tracked throughout a minimum two-day period. The survey time period was extended beyond 48 hours when scheduling and equipment permitted.

2. Background

Given the prevalence of reduced driving abilities among the elderly, there has been much discussion in the literature regarding mandatory relicensing, or the introduction of driving restrictions. Policies vary widely by jurisdiction ranging from automatic renewal to required medical checks, road or written tests, to automatic revocation at an age threshold (Deschenes, 2004). There are many differing opinions regarding an appropriate strategy. For example, Lange and McKnight (1996) suggest that retesting be confined to an older age group and initiated when doctors, police, or family provide evidence of the driver's decline in ability. The loss of an elderly person's license has substantial implications for them and their dependents particularly in areas where public transit services cannot counter the convenience of the private automobile (Taylor, et al. 2001). The rural elderly suffer a larger drop in absolute mobility when driving is no longer possible, because public and private services are limited or absent in rural areas (Rosenbloom, 1988).

Carp (1988) associates the well-being of an elderly person with the satisfaction of two categories of needs: those activities that precipitate independent living, and needs that give positive quality of life or "higher-order" needs. He defines "higher-order" needs (such as social interaction, usefulness, recreation, and religious experience) as not being essential for living, but are necessary for the well being of the person. Other studies have referred to these dichotomies as mandatory and discretionary activities or needs. A 1978 travel diary study of able-bodied elderly in Lawrence, MA showed that 38.1 % of all vehicle trips related to the satisfaction of higher order needs, which was less than the 61.9% of trips for essential needs, but significant nevertheless (Slavin and Jacobson, 1985).

Both necessity and "higher-order" needs can be difficult to satisfy if the person does not own a private vehicle. An elderly person in a rural area is further restricted where the automobile is often the sole means of personal transportation. When an older person ceases driving, it is usually the "higher-order" needs trips that are most adversely affected. A study of focus groups of those over 70 years of age in Maine and Florida found that older people who ceased driving concentrated their trips on life maintenance activities, often at the expense of recreational trips (Burkhardt, 1999).

The rural elderly are particularly dependent on the private automobile. A 1996 survey by Stamatiadis et al. (1996) of 155 people in rural Kentucky found that the automobile accounted for a total of 83.2% of all trips being taken as either a driver or passenger. In the Lawrence study, 66% of all trips were taken in an automobile, with 58.4% of those trips as a driver and 35.6% as an automobile passenger (Slavin and Jacobson, 1985). Hildebrand and Myrick (2001) found that the rural elderly retain their licenses longer than their urban counterparts presumably because often no alternative to the private automobile exists. Consequently, accident rates were found to be much higher for the rural elderly.

The travel behaviour of an elderly person as described in several recent studies can be generalized in the following manner: a typical elderly person has independence and social needs that require mobility, and the most prevalent means of mobility is the private automobile. It becomes more likely that as a person ages, they will suffer effects that reduce physical and cognitive abilities, making the use of the private automobile difficult or dangerous. Consequently, one would need to switch travel modes to maintain mobility, or compromise independence and social needs. The rural elderly are especially prone to losing mobility because rural mobility is secured predominately with the private automobile.

The current study was conceived based on the need for more detailed research on the travel behaviour of elderly drivers, and the successful application of GPS and GIS to recent travel surveys. The mapping of traveled routes collected by GPS onto a GIS base map has been shown

to aid in prompted recall, and GPS as a travel diary has been shown to reduce respondent burden. It has been discussed that self-reported methods can result in missed trips and trip link rounding, therefore GPS promises a more complete description of vehicular trip-making.

The most prevalent elderly driver research investigates elderly driver accident characteristics, yet the "measures of exposure" have been limited to average kilometres traveled. GPS will provide added dimensions to exposure, in terms of kilometres of travel on different speed, class, and volume of roads, and different times of the day for travel. In addition, trip purposes can be determined from prompted recall interviews, providing better understanding of vehicle use for life maintenance and higher order needs.

3. Methodology

To satisfy the first study goal, several tests were undertaken to identify the best practices for the administration of a GPS travel diary survey based on the target population. These tests identified: the GPS receiver to be used, means of power supply, installation and configuration practices, and data presentation methods. The study was structured to allow for some variance in terms of equipment location, post-test interview approach, test period timing, and test duration, all of which were monitored and best practices identified. The specified constants for the data collection included: trackpoint sampling frequency, power supply methods, base mapping, and geographic location.

In anticipation of a GPS study of older drivers, several assumptions were made. The first was that many of the potential participants would be unfamiliar with the technology and require some orientation with the equipment. The second was that based on this unfamiliarity, the use of active data collection as defined by Wolf et al. (2001) would be burdensome to the participants. The third assumption was that most participants might not be comfortable permitting the GPS unit to be powered by the vehicle battery, particularly during the colder survey months. The fourth assumption was that many potential participants would treat this study with some skepticism and regard it

as an evaluation of their driving capabilities rather than an analysis of travel characteristics. Based on these initial assumptions, test methods were developed to address these potential concerns, with hopes of maximizing participation.

There are two major manufacturers that produce off-the-shelf GPS units: Garmin and Magellan. After preliminary tests with the GPS V and the Etrex Legend models, it was found that both unit types were suitable for the data collection needs. The Etrex Legend from Garmin is smaller and less expensive than the GPS V, yet has similar features necessary for this study. It can record 10,000 data location points, and its point sampling rate can be manually altered (thereby extending the sample period). It has a one second continuous update rate, a GPS accuracy of < 15 metres (3-5 m with differential corrections), a velocity accuracy of 0.05 m/s steady state, and can operate from temperatures of -15ºC to 70ºC (Garmin, 2002). This unit also costs half the price of a GPS V, approximately $300 CDN. The GPS V's built-in road maps and trip navigation is the major difference between the two units. Functionally, these extras were unnecessary for the study.

In order to maximize trackpoint memory, while achieving data precision, an "automatic" interval setting, with "medium" resolution was used. Points were sampled at 15-20 second intervals while the vehicle was in motion, and at a higher rate when the vehicle was making a complex maneuver, such as making a sharp turn. Few or zero points were sampled while the vehicle was stationary. Three initial tests were conducted with this setting on the GPS units, and it proved precise enough to determine trip starts, routing, and trip ends from the collected data.

ESRI's ArcView GIS 3.3 was chosen primarily because of researcher familiarity and the availability of appropriate base maps in ESRI format.

A study criterion required participant GPS data collection durations for at least 48 hours, with 72 hours being preferable. The most convenient power supply for this purpose is the vehicle's battery,

however, some vehicles do not provide outlet power when the ignition is in the 'off' position. Because of this, an external 12V power pack was utilized for the study.

Following the collection of the GPS data, an interview (either telephone or in person) was arranged where the subject could participate in stated-adaptation surveys and add critical information regarding each trip link, such as purpose or the presence of passengers. However, before the interviewer could undertake this step, it was necessary to transform the data from raw numerical information to graphical geographic representations of the trips.

Points tracing the vehicle's travel paths were delineated on the GIS base mapping using a graduated colour legend to represent varying travel speeds (organized in 20 km/h intervals, from 0 – 120 km/h). This made it easier to identify stops due to traffic control devices or short drop-off trips.

To satisfy the study's second primary goal (i.e., to develop a comparison of elderly rural and urban travel behaviours), the collected data were reviewed and compared to information from traditional travel diaries, or survey studies of older drivers. This ensured that the information collected through this study offered an improvement on existing travel data. Some of the key findings are presented in the following section.

4. Study Findings

A total of 39 elderly subjects participated in the pilot study. Data collection varied from two to four days depending on equipment availability and scheduling. Data collected for two participants were excluded from analysis because of extreme travel circumstances. For example, it was discovered that one subject was a part-time door-to-door salesperson. The net result was that 43 person-days of travel data were collected for the rural elderly, while 45 person-days were gathered describing urban seniors. Because of this sampling method, noted differences between urban and rural elderly drivers in this study cannot be expressed with statistical significance. However, general

trends and averages are discussed, along with marked differences noted between the two groups. Urban and rural participant data were normalized by expressing travel per participant-day, so that general comparisons could be made. This information provides valuable insight into senior travel behaviour not identified by written trip diaries, and aims to demonstrate the applicability of the data collection on a larger scale.

Most of the participants were between the ages of 65 and 75 years of age. Of the three women younger than 65 years, all were 64 years old and the spouses of older male participants. Six rural and five urban seniors over the age of 75 participated. The results are summarized in Table 1.

Table 1: Distribution of Participants

	Rural		**Urban**	
Age	Male	Female	Male	Female
< 65	0	2	0	1
65-75	8	4	8	4
>75	3	4	5	0

4.1 Trip Characteristics

This section presents an analysis of the collected data, and employs various descriptive terms. For clarity, these terms are defined below:

- **Trip (or round trip)**: Travel characterized by participants leaving their Home, performing a task or series of tasks, then returning Home. A trip is composed of a series of trip links.

- **Trip link (or link):** The one-way path connecting an origin and destination. A trip is composed of a minimum of two trip links: Home (origin) to Desired Location (destination), and Desired Location (origin) to Home (destination).

- **Trip chain**: Refers to a minimum of two trip links in series, where sequential trip link destinations are not Home, but another Desired Location.

4.1.1 Trip Frequency

When trip frequencies were analyzed, it was found that urban seniors engaged in, on average, 2.1 trips per day, while rural seniors performed 1.7 trips per day. As the data in Figure 1 show, there is a fair degree of variability in the survey data.

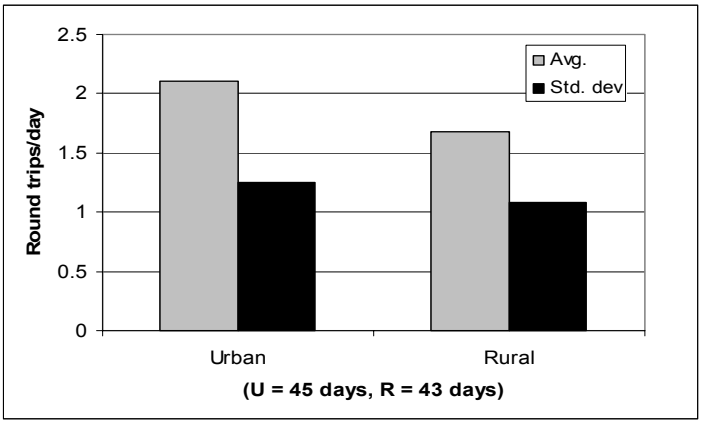

Figure 1: Average Number of Round Trips per Day

4.1.2 Trip Chaining

Trip frequency cannot be considered in isolation of the number of stops or activities included in each link. Trip links refer to the one-way path connecting the nodes of an origin and destination. A chain refers to sequential trip links. Consequently, a round-trip with one destination would consist of two trip links, one being to the destination, and the other the return segment. Figure 2 contrasts the

number of links per trip for both rural and urban seniors. The frequency of simple two-link trips for urban seniors was 1.68 times higher than for rural seniors, and remained generally higher for three and two-link trips. Conversely, rural seniors had a higher proportion of trips with five or more links. When compared with the data presented in Figure 1 that show rural seniors perform fewer round trips per day, it is not surprising to find that they chain more activities together during each trip. This is most likely because they live further away from their desired destinations.

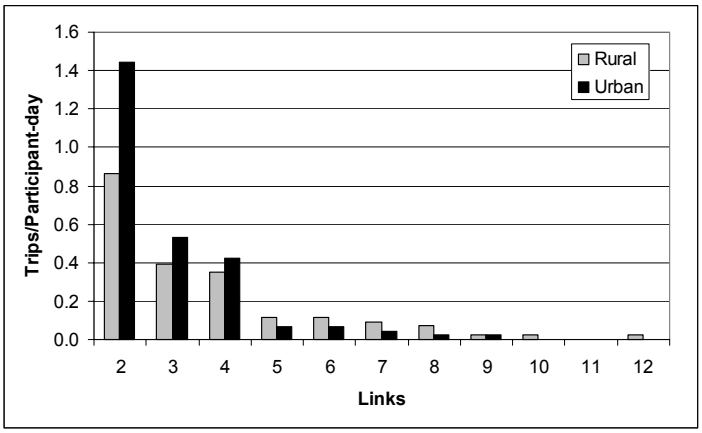

Figure 2: Frequency of links per trip

4.1.3 Trip link length

Urban seniors had a higher frequency of trip link lengths less than 10 km (1.87 times the rate of rural seniors); however, rural seniors had 1.86 times the urban rate of trips less than 1 km. This frequency of shorter trip links by rural seniors may suggest that they use their vehicles for tasks that urban seniors would complete by other modes or that they are more likely to string together multiple stops in a single trip where those in urban areas would use multiple trips. Figure 3 shows that very few of the urban seniors drove further than 10 km in a

trip link. Rural seniors experienced high rates of trip links greater than 20 km, accounting for almost one-fifth of all of their trip links. As most rural participants lived greater than 20 km away from urban centres in the study area, this was not unexpected.

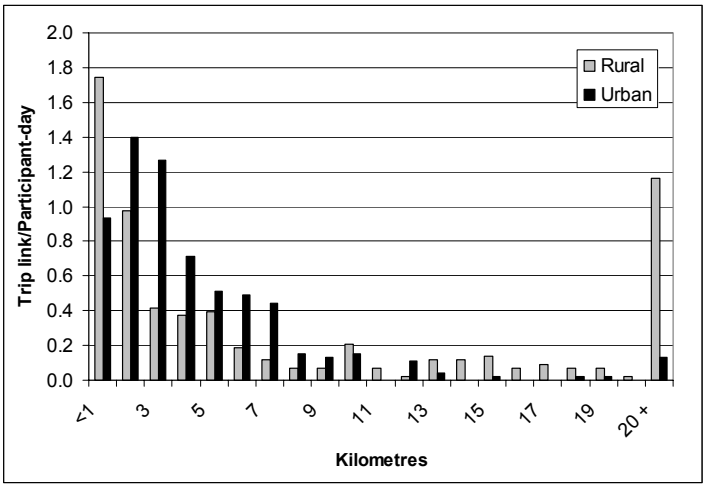

Figure 3: Trip Link Lengths

4.1.4 Trip Start Times

There are several similarities in trip link start frequency patterns between rural and urban seniors, as the data show in Figure 4. In contrast with younger age groups, there are very few trip links started prior to 8:30-9:00 am, and frequency patterns follow similar patterns through much of the day. A major difference observed is the higher trip link start frequencies for rural seniors versus urban seniors from 10:00 am to 1:00 pm and 6:30 to 7:30pm. These data suggest that overall rural seniors in this study performed their trips approximately one to two hours prior to those of the urban seniors. Finally, it is important to note that trip-making is much more curtailed after 7:30 pm among the rural elderly. This is consistent with difficulties the

aged have with vision after dark and the predominately non-illuminated conditions in rural areas.

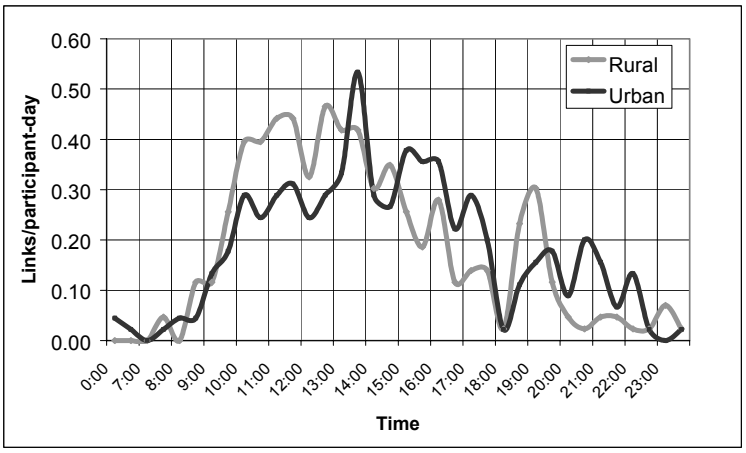

Figure 4: Rural and Urban Trip Link Starts

4.1.6 Passenger Trips

Rural seniors traveled with one or more passengers during 39% of their trips, compared to 24% of the urban seniors. For the rural senior, 6% of all trips involved two or more passengers compared to only 2% of trips among the urban elderly. These trends are important because it has been shown that some seniors tend to compensate for diminished capabilities through the use of 'co-piloting'. The findings may also reflect a reliance among seniors to travel with friends or family when they discontinue driving.

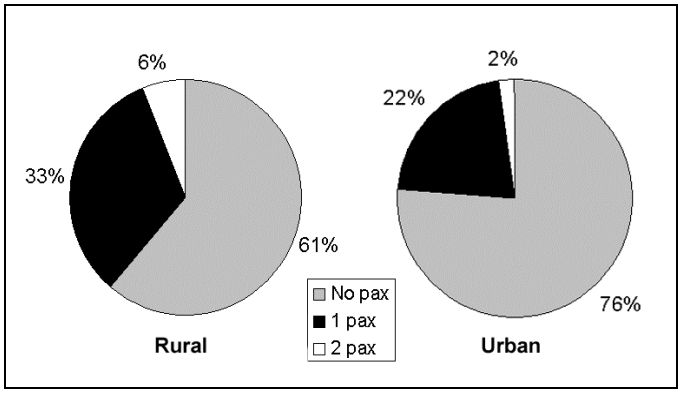

Figure 5: Proportion of Elderly Trips with Passengers

4.1.7 Trip Purpose

Trip purposes were garnered from the interview that followed the GPS survey. Various responses to trip purpose were recorded, and then assigned into two broader categories consistent with Carp (1988), and further subdivided based on frequency of participant responses:

Life Maintenance – trips associated with maintaining life including:

- Shopping (groceries, convenience, hardware, etc)
- Personal errands (mailing a letter, banking)
- Vehicle errands (fueling up, vehicle maintenance)
- Work
- Medical related (visiting a doctor, buying prescriptions)

Higher order - trips associated with well-being including:

- Social trip (visiting, recreation, pleasure drives)
- Pick up/drop off (shuttling trips)
- Dining out
- Lending vehicle
- Errands for others
- Volunteer work
- Church/educational

Excluding return trips, life maintenance and higher order needs trips were split nearly evenly for both rural and urban seniors. The most frequent life maintenance trip for both groups was shopping, followed by personal errands, as depicted in Figure 6. Urban seniors had a higher frequency of shopping trips; however, this may be due to their proximity to shopping venues and lessened propensity to chain activities together. Rural seniors had a higher incidence of personal and vehicle errands. As rural seniors were shown to drive further than their urban counterparts, trips for fuel were more common. Urban seniors had a higher incidence of medical related trips.

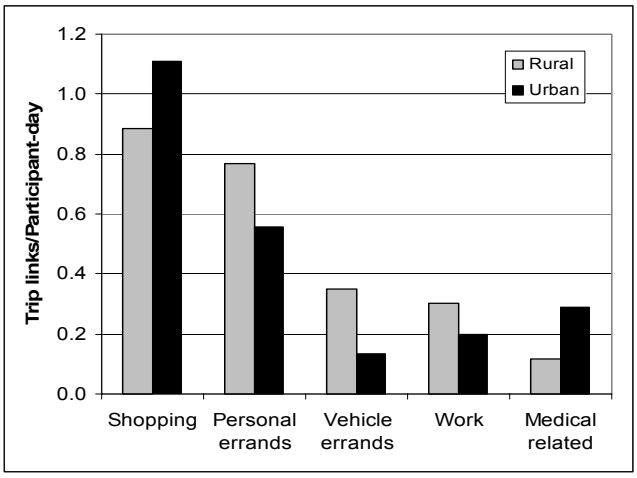

Figure 6: Frequency of 'Life Maintenance' Trips

The most frequent higher order trips were social-related, as shown in Figure 7. Interestingly, rural seniors performed 1.56 times as many social trips as their urban counterparts. The second most frequent trip-making for both groups was passenger pick-up/drop offs. There was a slightly higher incidence of dining out for rural seniors. The less frequent trips included loaning of their vehicle, running errands for others, volunteer work, and church/educational. It is likely that the number of church-related trips would be more frequent if the sample had not concentrated mainly on weekdays.

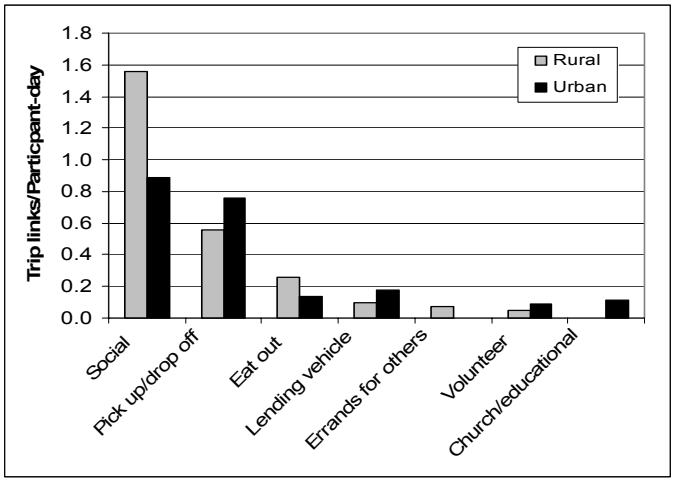

Figure 7: Frequency of 'Higher Order' Trips

4.2 Measures of Exposure

The data presented in Table 2 summarize study findings regarding variables that can be used to describe exposure including total daily travel time, daily distance traveled, and average link speed. It is clear that for those seniors living in rural areas, their travel needs result in increased exposure regardless of the metric used. Although the results are not presented in this paper, an increased level of detail is possible where other factors such as road class, speed limit, time of day (and corresponding traffic volumes), number of intersections (by control type), etc. can be detailed for each respondent using the GIS base mapping in combination with the GPS data. These kinds of variables are extremely important when one evaluates accident involvement rates by comparing to other age cohorts.

Table 2: Summary of Elderly Driver Exposure Estimates

	Rural	Urban
Daily Travel Time	1:05 hours	0:43 hours
Daily Distance Traveled	63 km	24 km
Average Link Speed	45 km/h	30 km/h

5. Discussion

The methods employed in this survey were very time consuming. Although installation of the unit and orientation with participants usually took just a few minutes, interviewer transit times were much longer when engaging rural participants. Post survey data processing was the most time consuming task, taking two hours on average per participant. Nevertheless, the richness of the data collected provides an opportunity for policy-makers to explore the impact of alternative transportation services. Furthermore, a much more valid comparison of accident involvement can now be made given added dimensions of driver exposure.

Although the results are not presented in this paper, elderly subjects were asked to explain how they might alter their trip-making in light of different hypothetical restrictions on their driving licenses (e.g., no night driving, no driving on high speed roads, license revoked, etc.). The ability to review plots of their recent trip-making with a GIS interface proved very valuable with both recall and strategizing adaptations. Anecdotally, the majority of participants were not concerned if under one scenario they were not permitted to drive at night; however, nearly every participant, both urban and rural, would consider themselves severely affected if they could not drive at all. Urban seniors were able to identify alternate means of transportation they could take, such as the bus or taxi, but rural seniors indicated they would need to rely more on family members or even relocate to an urban area.

List of References

Burkhardt, J. 1999. Mobility changes: their nature, effects, and meaning for elders who reduce or cease driving. Transportation Research Record 1671, TRB, National Research Council, Washington D.C.

Carp, F. 1988. Significance of mobility for the well being of the elderly. Transportation in an Aging Society, vol. 2. Transportation Research Board Special Report 218. TRB, National Research Council, Washington D.C.

Deschenes, S,, 2004. Development of a Driver's Retesting Policy for New Brunswick. Master's Thesis. University of New Brunswick, Fredericton, NB.

Garmin, 2002. Etrex Legend – Owner's manual and reference guide. Garmin International, Kansas USA pp 52

Hildebrand, E.D. and B.E. Myrick, 2001. Accident involvement of rural elderly drivers, Proceedings of the Canadian Multidisciplinary Road Safety Conference XII, London, ON.

Lange, J. and A. McKnight, 1996. Age-based road test policy evaluation. Transportation Research Record no. 1550. TRB, National Research Council, Washington D.C. pp 81-87

Rosenbloom, S. 1988. The mobility needs of the elderly. Transportation in an Aging Society, Volume 2. Transportation Research Board Special Report 218. TRB, National Research Council, Washington D.C.

Slavin, H. and J. Jacobson, 1985. A travel diary analysis of the mobility of the elderly and transportation handicapped. U.S. Dept of Transportation, Research and Special Programs Administration. Cambridge, MA, USA.

Stamatiadis, N., T. Leinback, J. Watkins, 1996. Travel among non-urban elderly. Transportation Quarterly, Vol 50, No. 3.

Taylor, B. and S. Tripodes, 2001. The effects of driving cessation of the elderly with dementia and their caregivers. Accident Analysis and Prevention #33 pp 519-528. Elsevier Science Ltd. [Online]

Wolf, J., R. Guensler, and W. Bachman, 2001. Elimination of the travel diary. Transportation Research Record no. 1768, TRB, National Research Council, Washington D.C.