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DIRECT OBSERVATION OF SAFETY BELT USE IN MICHIGAN: FALL 2004

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16. Abstract

A direct observation survey of safety belt use in Michigan was conducted in the fall of 2004. In this study, 13,874 occupants traveling in four vehicle types (passenger cars, sport-utility vehicles, vans/minivans, and pickup trucks) were surveyed between September 2 and 20, 2004. Belt use was estimated for all commercial/noncommercial vehicle types combined (the statewide safety belt use rate) and separately for each vehicle type. The current survey was designed to provide data for comparison with surveys conducted in previous years, as well as to provide follow-up data for comparison with the baseline survey conducted in August 2004. Within and across each vehicle type, belt use by age, sex, road type, day of week, time of day, and seating position were calculated. Statewide belt use was 90.5 percent. This rate represents the highest level of statewide safety belt use ever observed in Michigan. Further, this level of belt use makes Michigan only the fifth state in the country to obtain a statewide rate of 90 percent or higher. When compared with the baseline survey, a statically significant increase in overall belt use is noted. Safety belt use was 91.3 percent for passenger cars, 92.3 percent for sport-utility vehicles, 91.3 percent for vans/minivans, and 85.3 percent for pickup trucks. For all vehicle types combined, belt use was higher for females than for males, and about the same for drivers and passengers. In general, belt use was the highest during the morning commute and about the same throughout the rest of the day. Belt use did not vary systematically by day of week. Belt use was lowest among 16-to-29 year olds, and about the same for the 30-to-59 and 60-and-older age groups. Survey results suggest that the implementation of primary enforcement along with other enforcement and public information and education efforts have been effective in maintaining and continuing to increase safety belt use in Michigan.

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INTRODUCTION

In September 1999, the belt use rate in Michigan was 70.1 percent (Eby, Vivoda, & Fordyce, 1999). While this rate was slightly higher than the average of 67 percent for the U.S. (National Highway Traffic Safety Administration, NHTSA, 2000), it was still far below the level desired by traffic safety professionals in the state. Shortly after the study in 1999 was conducted, the enforcement provision of Michigan's safety belt law was changed from secondary to primary (standard) enforcement, resulting in a net increase of more than 10 percentage points. This type of legislative change became popular following the success observed in California when that state made the first uninterrupted change from secondary to primary enforcement in 1993. In the months following the change in the California law, the belt use of motorists increased from 58 percent to 76 percent (Ulmer, Preusser, Preusser, & Cosgrove, 1995). Since that legislative change, the observed belt use rates of California motor vehicle occupants have been among the highest in the country. In 2001, California became the first state to reach the 90 percent level of safety belt use (California Office of Traffic Safety, COTS, 2003). Traffic safety programs implemented in California continue to serve as a model for other states. For example, a recent change in that state tripled the fine associated with a safety belt violation, and increased the cost of failing to properly restrain a child under the age of 16, to $350 per violation (COTS, 2004). This type of commitment to traffic safety has enabled California to continue to increase and maintain the statewide belt use rate at or above the 90 percent level.

In 2003, there were only four states in the entire country that had attained a statewide safety belt use rate at or above the 90 percent level: California, Hawaii, Oregon, and Washington. To reach this level of belt use, these states have generally followed the model recommended by NHTSA and implemented in California. All four states allow for primary enforcement of the safety belt law; and, all of these states make traffic safety a priority. For example, safety belt media and enforcement campaigns, such as *Click It or Ticket* (CIOT), are utilized to continue to increase and maintain belt use. High-visibility police enforcement of the safety belt law is paired with these media messages to get the word out about zero-tolerance enforcement. Additionally, innovative enforcement and media messages are implemented whenever possible. For example, for the duration of a

CIOT campaign conducted in Hawaii during 2002, safety belt fines were increased from $45 to $67 statewide (Kim, Kinjo, & Yamamura, 2002). This change made the point clear that there would be zero tolerance for noncompliance during the campaign. Another example is found in the Pacific Northwest. A selective traffic enforcement program (STEP) called the *Three Flags Campaign* has been successful by bringing together hundreds of law enforcement agencies in Oregon, Washington, and British Columbia for a two week "blitz" of safety belt enforcement (Oregon Department of Transportation, ODOT, 2004). It is important to recognize that although these states have reached the 90 percent belt use level, they continue to implement aggressive safety belt programs like those previously described. It is acknowledged that even with such a high rate of statewide belt use, about 10 percent of the motoring public within these states continue to travel unbelted. These non-users represent a significant number of people; in California alone, the remaining nine percent is equal to more than three million people (COTS, 2004).

While reaching 90 percent belt use is noteworthy, it is not enough just to reach that level as a one time accomplishment. It is important that belt use campaigns and mobilizations continue to be implemented so that progress is not lost. As mentioned earlier, California reached the 90 percent belt use mark in 2001. Since that time, annual statewide belt use surveys have revealed use rates of 91 percent for each consecutive year (Glassbrenner, 2004). It was in 2002 that Hawaii (90 percent) and Washington (93 percent) achieved belt use rates at or above the 90 percent level. Both of these states were able to not only maintain, but increase their rates to 92 and 95 percent respectively, in 2003 (Glassbrenner, 2004). Finally, in 2003, the statewide belt use rate in Oregon was observed at 90 percent; this rate represented an achievement of one of that state's traffic safety goals. For the two years prior to this accomplishment, belt use in Oregon was observed just under the 90 percent level, at 88 percent (Glassbrenner, 2004).

A similar goal of 90 percent belt use has been set for Michigan in 2004 (Michigan Office of Highway Safety Planning, OHSP, 2004). To accomplish this goal, OHSP has implemented several safety belt mobilizations over the past year. These efforts have been centered around holidays (Thanksgiving, Memorial Day, and Labor Day) and have included several new components. Media messages focusing on low belt use groups were aired on television and radio. Additional police enforcement was conducted along with the implementation of safety belt enforcement zones. A new tag line of *Buckle Up or Pay Up* was also added to the CIOT slogan to make it clear that the police would be enforcing the law, and a substantial monetary loss would result if motorists failed to buckle up. These programs have been successful over the past year, but belt use in Michigan was not quite to the 90 percent level. Safety belt use has risen from 84.8 percent in September 2003, to 88.3 percent in August 2004 (Eby & Vivoda, 2004).

The purpose of the current survey is to continue to track the changes in belt use that have occurred since the first mandatory safety belt use law was implemented in Michigan. Additionally, this survey will assess efforts, including safety belt mobilizations, designed to increase safety belt use statewide. This survey wave was timed to coincide with the safety belt mobilization centered around Labor Day 2004. A previous survey wave, conducted in August 2004, provided baseline data for comparison before the mobilization began. The current study represents the thirty-eighth wave in a series of statewide direct observation surveys conducted in Michigan since 1984. This survey will identify overall changes in safety belt use, along with belt use changes within specific demographic groups in Michigan.

METHODS

Sample Design

The sample design for the present survey was closely based upon the one used by Streff, Eby, Molnar, Joksch, and Wallace (1993). While the entire sampling procedure is presented in the previous report, it is repeated here for completeness, with modifications noted.

The goal of this sample design was to select observation sites that accurately represent front-outboard vehicle occupants in eligible commercial and noncommercial vehicles (i.e., passenger cars, vans/minivans, sport-utility vehicles, and pickup trucks) in Michigan, while following federal guidelines for safety belt survey design (NHTSA, 1992, 1998). An ideal sample minimizes total survey error while providing sites that can be surveyed efficiently and economically. To achieve this goal, the following sampling procedure was used.

To reduce the costs associated with direct observation of remote sites, NHTSA guidelines allow states to omit from their sample space the lowest population counties, provided these counties collectively account for 15 percent or less of the state's total population. Therefore, all 83 Michigan counties were rank ordered by population (U.S. Bureau of the Census, 1992), and the low population counties were eliminated from the sample space. This step reduced the sample space to 28 counties. In order to account for shifts in the population of Michigan counties (U.S. Bureau of the Census, 2003), three additional counties were added to the present design bringing the total number of counties in the sample space to 31.

The original counties were then separated into four strata. The strata were constructed by obtaining historical belt use rates and vehicle miles of travel (VMT) for each county. Historical belt use rates were determined by averaging results from three previous University of Michigan Transportation Research Institute (UMTRI) surveys (Wagenaar & Molnar, 1989; Wagenaar, Molnar, & Businski, 1987b, 1988). Since no historical data were available for six of the counties, belt use rates for these counties were estimated using multiple regression based on per capita income and education for the other 22 counties (r^2 = .56; U.S. Bureau of the Census, 1992).[1] These factors have been shown previously to correlate positively with belt use (e.g., Wagenaar, Molnar, & Businski, 1987a). Wayne County was chosen as a separate stratum because of its disproportionately high VMT, and because we wanted to ensure that observation sites were selected within this county. Three other strata were constructed by rank ordering each county by historical belt use rates and then adjusting the stratum boundaries until the total VMT was roughly equal within each stratum. The stratum boundaries were high belt use (stratum 1), medium belt use (stratum 2), low belt use (stratum 3), and Wayne County. The additional counties for the present survey became part of stratum 3 and all sites in this stratum were re-selected and rescheduled following the procedures described below. The counties comprising each stratum can be found in Table 1.

Table 1: Listing of Michigan Counties by Stratum

Stratum Number	Counties
1	Ingham, Kalamazoo, Oakland, Washtenaw
2	Allegan, Bay, Eaton, Grand Traverse, Jackson, Kent, Livingston, Macomb, Midland, Ottawa
3	Berrien, Calhoun, Clinton, Genesee, Ionia, Isabella, Lapeer, Lenawee, Marquette, Monroe, Muskegon, Saginaw, Shiawassee, St. Clair, St. Joseph, Van Buren
4	Wayne

To achieve the NHTSA required precision of less than 5 percent relative error, the minimum number of observation sites for the survey (N = 56) was determined based on within- and between-county variances from previous belt use surveys and on an estimated 50 vehicles per observation period in the current survey. This minimum number was then increased (N = 168) to get an adequate representation of belt use for each day of the week and for all daylight hours.

[1] Education was defined as the proportion of population in the county over 25 years of age with a professional or graduate degree.

Because total VMT within each stratum was roughly equal, observation sites were evenly divided among the strata (42 each). In addition, since an estimated 23 percent of all traffic in Michigan occurs on limited-access roadways (Federal Highway Administration, 1982), 10 of the sites (24 percent) within each stratum were freeway exit ramps, while the remaining 32 were roadway intersections.

Within each stratum, observation sites were randomly assigned to a location using different methods for intersections and freeway exit ramps. The intersection sites were chosen using a method that ensured each intersection within a stratum an equal probability of selection. Detailed, equal-scale road maps for each county were obtained and a grid pattern was overlaid on each county map. The grid dimensions were 62 lines horizontally and 42 lines vertically. The lines of the grid were separated by 1/4 inch. With the *3/8 inch:mile* scale of the maps, this created grid squares that were .67 miles per side. (Because Marquette County is so large, it was divided into four maps and each part was treated as a separate county.) Each grid square was uniquely identified by two numbers, a horizontal (*x*) coordinate and a vertical (*y*) coordinate.

The 42 sites for each stratum were sampled sequentially. The 32 local intersection sites were chosen by first randomly selecting a grid number containing a county within a stratum.[2] This was achieved by generating a random number between 1 and the number of grids within the stratum. So, for example, since the high belt use stratum had four grid patterns overlaying four counties, a random number between 1 and 4 was generated to determine which grid would be selected. Thus, each grid had an equal probability of selection at this step. Once the grid was selected, a random *x* and a random *y* coordinate were chosen and the corresponding grid square identified. Thus, each intersection had an equal probability of selection. If a single intersection was contained within the square, that intersection was chosen as an observation site. If the square did not fall within the county, there was no intersection within the square, or there was an intersection but it was located one road link from an already selected intersection, then a new grid number and *x*, *y* coordinate were randomly selected. If more than one intersection was within the grid

[2] It is important to note that grids were selected during this step rather than counties. This was necessary only because it was impractical to construct a single grid that was large enough to cover all of the counties in the largest stratum when they were laid side by side.

square, the grid square was subdivided into four equal sections, and a random number between 1 and 4 was selected until one of the intersections was chosen. This happened for only two of the sites.

Once a site was chosen, the following procedure was used to determine the particular street and direction of traffic flow that would be observed. For each intersection, all possible combinations of street and traffic flow were determined. From this set of observer locations, one location was randomly selected with a probability equal to 1/number of locations. For example, if the intersection, was a "+" intersection, as shown in Figure 1, there would then be four possible combinations of street and direction of traffic flow to be observed (observers watched traffic only on the side of the street on which they were standing). In Figure 1, observer location number one indicates that the observer would watch southbound traffic and stand next to Main Street. For observer location number two, the observer would watch eastbound traffic and stand next to Second Street, and so on. In this example, a random number between 1 and 4 would be selected to determine the observer location for this specific site. The probability of selecting an intersection approach is dependent upon the type of intersection. Four-legged intersections like that shown in Figure 1 have four possible observer locations, while three-legged intersections like "T" and "Y" intersections have only three possible observer locations. The effect of this slight difference in probability accounts for .01 percent or less of the standard error in the belt use estimate.

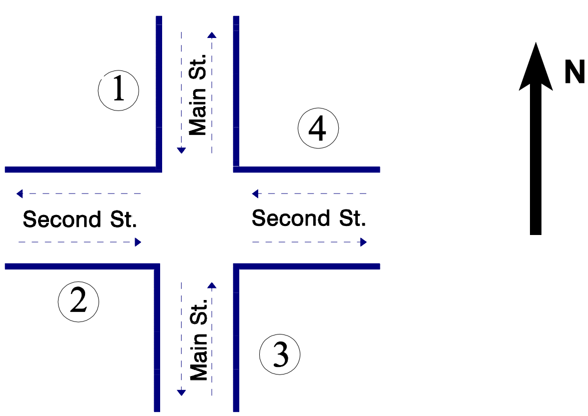

Figure 1. An Example "+" Intersection Showing 4 Possible Observer Locations.

For each primary intersection site, an alternate site was also selected. The alternate sites were chosen within a 20 x 20 square unit area around the grid square containing the original intersection, corresponding to a 13.4 square mile area around the site. This was achieved by randomly picking an *x*, *y* grid coordinate within the alternate site area. Grid coordinates were selected until a grid square containing an intersection was found. No grid squares were found that contained more than one intersection. The observer location at the alternate intersection was determined in the same way as at the primary site.[3]

The 10 freeway exit ramp sites within each stratum also were selected so that each exit ramp had an equal probability of selection.[4] This was done by enumerating all of the exit ramps within a stratum and randomly selecting without replacement 10 numbers between 1 and the number of exit ramps in the stratum. For example, in the high belt use stratum there were a total of 109 exit ramps. To select an exit ramp, a random number between 1 and 109 was generated. This number corresponded to a specific exit ramp. To select the next exit ramp, another random number between 1 and 109 was selected with the restriction that no previously selected numbers could be chosen. Once the exit ramps were determined, the observer location for the actual observation was determined by enumerating all possible combinations of direction of traffic flow and sides of the ramp on which to stand. As in the determination of the observer locations at the roadway intersections, the possibilities were then randomly sampled with equal probability. The alternate exit ramp sites were selected by taking the first interchange encountered after randomly selecting a direction of travel along the freeway from the primary site. If this alternate site was outside of the county or if it was already selected as a primary site, then the other direction of travel along the freeway was used. If the exit ramp had no traffic control device on the selected direction of travel, then a researcher visited the site and randomly picked a travel direction and lane that had such a device.

[3] For those interested in designing a safety belt survey for their county or region, a guidebook and software for selecting and surveying sites for safety belt use is available (Eby, 2000) by contacting UMTRI-SBA, 2901 Baxter Rd., Ann Arbor, MI 48109-2150, or accessing http://www-personal.umich.edu/~eby/sbs.html/.

[4] An exit ramp is defined here as egress from a limited-access freeway, irrespective of the direction of travel. Thus, on a north-south freeway corridor, the north and south bound exit ramps at a particular cross street are considered a single exit ramp location.

The day of week and time of day for site observations were quasi-randomly assigned to sites in such a way that all days of the week and all daylight hours (7:00 am - 7:00 pm) had essentially equal probability of selection. The sites were observed using a clustering procedure. That is, sites that were located spatially adjacent to each other were considered to be a cluster. Within each cluster, a shortest route between all of the sites was decided (essentially a loop) and each site was numbered. An observer watched traffic at all sites in the cluster during a single day. The day in which the cluster was to be observed was randomly determined. After taking into consideration the time required to finish all sites before dark, a random starting time for the day was selected. In addition, a random number between 1 and the number of sites in the cluster was selected. This number determined the site within the cluster where the first observation would take place. The observer then visited sites following the loop in either a clockwise or counterclockwise direction (whichever direction left them closest to UMTRI at the end of the day). This direction was determined by the project manager prior to sending the observer into the field. Because of various scheduling limitations (e.g., observer availability, number of hours worked per week) certain days and/or times were selected that could not be observed. When this occurred, a new day and/or time was randomly selected until a usable one was found. The important issue about the randomization is that the day and time assignments for observations at the sites were not correlated with belt use at a site. This quasi-random method is random with respect to this issue.

The sample design was constructed so that each observation site was self-weighted by VMT within each stratum. This was accomplished by selecting sites with equal probability and by setting the observation interval to a constant duration (50 minutes) for each site.[5] Thus, the number of vehicles observed at a site reflected safety belt use by VMT; that is, the higher the VMT at a site, the greater the number of vehicles that would pass during the 50-minute observation period. However, since all vehicles passing an observer could not be surveyed, a vehicle count of all eligible vehicles (i.e., passenger cars, vans/minivans, sport-utility vehicles, and pickup trucks) on the traffic leg under observation

[5] Because of safety considerations, sites in the city of Detroit were observed for a different duration. See data collection section for more information.

was conducted for a set duration (5 minutes) immediately prior to and immediately following the observation period (10 minutes total).

Table 2 shows descriptive statistics for the 168 observation sites. As shown in this table, the observations were fairly well distributed over day of week and time of day. Note that an observation session was included in the time slot that represented the majority of the observation period. If the observation period was evenly distributed between two time slots, then it was included in the later time slot. This table also shows that nearly every site observed was the primary site and that observations were mostly conducted during sunny and cloudy weather conditions, with a very small percentage conducted during rainy weather. No observations were conducted during snow.

Table 2. Descriptive Statistics for the 168 Observation Sites

Day of Week		Observation Period		Site Choice		Weather	
Monday	13.1%	7-9 a.m.	9.5%	Primary	98.8%	Sunny	76.8%
Tuesday	13.7%	9-11 a.m.	20.8%	Alternate	1.2%	Cloudy	22.6%
Wednesday	11.9%	11-1 p.m.	16.7%			Rain	0.6%
Thursday	16.7%	1-3 p.m.	22.6%			Snow	0.0%
Friday	17.2%	3-5 p.m.	20.9%				
Saturday	14.3%	5-7 p.m.	9.5%				
Sunday	13.1%						
TOTALS	100%		100%		100%		100%

Data Collection

Trained field staff observed shoulder belt use, sex, age, vehicle type, and vehicle purpose (commercial or noncommercial) of drivers and front-right passengers during daylight hours only. Motorists traveling in passenger cars, sport-utility vehicles, vans/minivans, and pickup trucks were included. Observations were conducted when a vehicle came to a stop at a traffic light or stop sign.

Data Collection Forms

Data were collected during the survey using personal digital assistants (PDAs). For a more detailed description of the PDA data collection process, see Appendix C. Two electronic forms were developed for data collection: a site description form and an observation form. For each site surveyed, separate electronic copies of the site description form and observation form were created in advance. The site description form allowed observers to provide descriptive information including the site location, site type (freeway exit ramp or intersection), site choice (primary or alternate), observer number, date, day of week, time of day, weather, and a count of eligible vehicles traveling on the proper traffic leg. A place on the form was also furnished for observers to electronically sketch the intersection and to identify observation location. Finally, a comments section was available to identify landmarks that might be helpful in characterizing the site (e.g., school, shopping mall) and to discuss problems or issues relevant to the site or study.

A second electronic form, the observation form, was used to record safety belt use, passenger information, and vehicle information. For each vehicle surveyed, shoulder belt use, sex, and estimated age of the driver and the front-outboard passenger were recorded along with vehicle type. Children riding in child restraint devices (CRDs) were recorded but not included in any part of the analysis. Occupants observed with their shoulder belt worn under the arm or behind the back were noted but considered belted in the analysis. Based upon NHTSA (1999) guidelines, the observer also collected data from commercial vehicles, and noted this in the electronic form. A commercial vehicle was defined as a vehicle that is used for business purposes and may or may not contain company logos. This classification includes vehicles marked with commercial lettering or logos, or vehicles with ladders or other tools on them.

Procedures at Each Site

All sites in the sample were visited by one observer for a period of 1 hour, with the exception of sites in the city of Detroit. To address potential security concerns, these sites were visited by two-person observer teams for a period of 30 minutes. Observations at other sites scheduled to be observed on the same day as Detroit sites were also completed by two observers. Because each team member at these sites recorded data for different lanes of traffic, the total amount of data collection time was equivalent to that at one-observer sites.

Upon arriving at a site, observers determined whether observations were possible at the site. If observations were not possible (e.g., due to construction), observers proceeded to the alternate site. Otherwise, observers completed the site description form and then moved to their observation position near the traffic control device.

Observers were instructed to observe only the vehicles in the lane immediately adjacent to the curb, regardless of the number of lanes present. At sites visited by two-person teams, team members observed different lanes of the same traffic leg with one observer on the curb and one observer on the median (if there was more than one traffic lane and a median). If no median was present, observers were instructed to stand on diagonally opposite corners of the intersection.

At each site, observers conducted a 5-minute count of all eligible vehicles in the designated traffic leg before beginning safety belt observations. Observations began immediately after completion of the count and continued for 50 minutes at sites with one observer and 25 minutes at sites with two observers. During the observation period, observers recorded data for as many eligible vehicles as they could observe. If traffic flow was heavy, observers were instructed to record data for the first eligible vehicle they saw, and then look up and record data for the next eligible vehicle they saw, continuing this process for the remainder of the observation period. At the end of the observation period, a second 5-minute vehicle count was conducted at one observer sites.

Observer Training

Prior to data collection, field observers participated in 5 days of intensive training, including both classroom review of data collection procedures and practice field observations. Each observer received a training manual containing detailed information on field procedures for observations, PDA use, and administrative policies and procedures. A site schedule identifying the location, date, time, and traffic leg to be observed for each site was included in the manual (see Appendix A for a listing of the sites).

After intensive review of the manual, observers conducted practice observations at several sites chosen to represent the types of sites and situations that would actually be encountered in the field. None of the locations of the practice sites were the same as sites observed during the study. Training at practice sites focused on PDA use, completing the electronic forms, determining where to stand and which lanes to observe, conducting the vehicle count, recording safety belt use, and estimating age and sex. Observers worked in teams of two, observing the same vehicles, but recording data independently on their own PDA. The data were then compared for accuracy. Teams were rotated throughout the training to ensure that each observer was paired with every other observer. Each observer pair practiced recording safety belt use, sex, age, and vehicle type until there was an inter-observer reliability of at least 85 percent for all measures on drivers and front-right passengers for each pair of observers.

Each observer was provided with an atlas of Michigan county maps and all necessary field supplies. Observers were given time to locate their assigned sites on the appropriate maps and plan travel routes to the sites. After marking the sites on their maps, the marked locations were compared to a master map of locations to ensure that the correct sites had been pinpointed. Field procedures were reviewed for the final time, and observers were informed that unannounced site visits would be made by the field supervisor during data collection to ensure adherence to study protocols.

Observer Supervision and Monitoring

During data collection, each observer was spot-checked in the field on at least two occasions by the field supervisor. Contact between the field supervisor and field staff was also maintained on a regular basis through telephone calls to report progress and discuss problems encountered in the field, e-mails to the field supervisor from each observer's PDA containing data from the preceding day, text messages to the observer's PDAs to alert them to any important information, and visits to the UMTRI office to deliver expense forms and timesheets. Field staff were instructed to call the field supervisor's home or cellular phone if problems arose during evening hours or on weekends.

Incoming data files were examined by the field supervisor and problems (e.g., missing data, discrepancies between the site description form and site listing or schedule) were noted and discussed with field staff. Comments on the site description form about site-specific characteristics that might affect future surveys (e.g., traffic flow patterns, traffic control devices, site access) were noted.

Data Processing and Estimation Procedures

The accuracy of electronic data was verified by checking for inconsistent codes (e.g., the observation end time occurring before the start time; "no passenger" marked, when passenger data were present) and missing data. Any errors noted during this process were corrected.

For each site, a computer analysis program determined the number of observed vehicles, belted and unbelted drivers, and belted and unbelted passengers. Separate counts were made for each independent variable in the survey (i.e., site type, time of day, day of week, weather, sex, age, seating position, and vehicle type). This information was combined with the site information to create a file used for generating study results.

As mentioned earlier, our goal in this safety belt survey was to estimate belt use for the state of Michigan based on VMT. As also discussed, the self-weighting-by-VMT scheme employed is limited by the number of vehicles for which an observer can accurately record information. To correct for this limitation, the vehicle count information was used to weight the observed traffic volumes so they would more accurately reflect VMT.

This weighting was done by first adding each of the two 5-minute counts and then multiplying this number by five so that it would represent a 50-minute duration.[6] The resulting number was the estimated number of vehicles passing through the site if all eligible vehicles had been included in the survey during the observation period at that site. The estimated count for each site is divided by the actual number of vehicles observed there to obtain a volume weighting factor for that site. These weights are then applied to the number of actual vehicles of each type observed at each site to yield the weighted N for the total number of drivers and passengers, and total number of belted drivers and passengers for each vehicle type. Unless otherwise indicated, all analyses reported are based upon the weighted values.

[6] As mentioned previously, the Detroit sites were visited by pairs of observers for half as long. For these sites, the single 5-minute count was multiplied by five to represent the 25-minute observation period.

The overall estimate of belt use per VMT in Michigan was determined by first calculating the belt use rate within each stratum for observed vehicle occupants in all vehicle types using the following formula:

$$r_i = \frac{\textit{Total Number of Belted Occupants, weighted}}{\textit{Total Number of Occupants, weighted}}$$

where r_i refers to the belt use rate within any of the four strata. The totals are the sums across all 42 sites within the stratum after weighting, and occupants refers to only front-outboard occupants. The overall estimate of belt use was computed by averaging the belt use rates for each stratum. However, comparing total VMT among the strata, one finds that the Wayne County stratum is only 83 percent as large as the total VMT for the other three strata. In order to represent accurately safety belt use for Michigan by VMT, the Wayne County stratum was multiplied by 0.83 during the averaging to correct for its lower total VMT. The overall belt use rate was determined by the following formula:

$$r_{all} = \frac{r_1 + r_2 + r_3 + (0.83 \times r_4)}{3.83}$$

where r_i is the belt use rate for a certain vehicle type within each stratum and r_4 the Wayne County stratum.

The estimates of variance and the calculation of the confidence bands for the belt use estimates are complex. See Appendix B for a detailed description of the formulas and procedures. The same use rate and variance equations were utilized for the calculation of use rates for each vehicle type separately.

RESULTS

As discussed previously, the current direct observation survey of safety belt use in Michigan reports statewide belt use for four vehicle types combined (passenger cars, vans/minivans, sport-utility vehicles, and pickup trucks), in addition to reporting use rates for occupants in each vehicle type separately. Following NHTSA (1999) guidelines, this survey included commercial vehicles. In the sample, only 4.0 percent of motor vehicle occupants were traveling in commercial vehicles. In order to determine if the inclusion of commercial vehicles significantly changed statewide belt use rates, the statewide rate was calculated separately both with and without commercial vehicles. Analysis showed that there was no difference between the rates. Thus, all rates shown in this report include occupants from both commercial and noncommercial vehicles together.

The purpose of the current survey was twofold. First, this survey was conducted at the same time of year and used the same methodology that has been used in Michigan since 1994. As such, the survey provides a new data point for comparison with previous years. Second, this survey was conducted during and after a safety belt mobilization effort centered around the Labor Day holiday. Therefore, data from this survey can be directly compared to a baseline survey wave conducted in August 2004, to assess the effects of the belt use mobilization. Results from the current survey alone will be presented first. These results will then be compared with the baseline data. Finally, the results of the present survey will be combined and presented with historical data since 1994.

Overall Safety Belt Use

As shown in Figure 2, 90.5 ± 0.9 percent of all front-outboard occupants traveling in either passenger cars, sport-utility vehicles, vans/minivans, or pickup trucks in Michigan between September 2 and 20, 2004 were restrained with shoulder belts. The "±" value following the use rate indicates a 95 percent confidence band around the percentage. This value should be interpreted to mean that we are 95 percent sure that the actual safety belt use rate falls somewhere between 89.6 and 91.4 percent. When compared with the use rate observed one year ago, in September 2003 (Eby, Vivoda, & Spradlin, 2003), of 84.8 ± 1.6 percent, we find that belt use has increased significantly. In fact, the current rate is the highest statewide belt use rate ever observed in Michigan, making Michigan only the fifth state to reach 90 percent belt use.

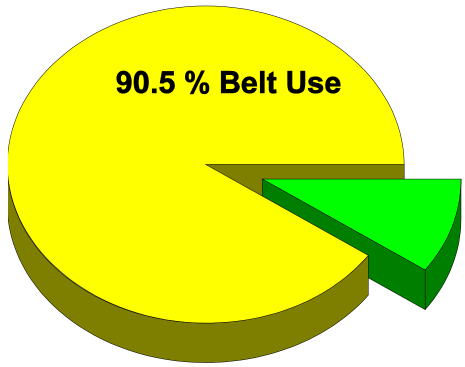

Figure 2. Front-Outboard Shoulder Belt Use in Michigan (All Vehicle Types and Commercial/Noncommercial Combined).

Estimated belt use rates and unweighted numbers of occupants (N) by stratum are shown in Table 3. Safety belt use was not significantly different in Stratum 1, Stratum 2, or Stratum 3. Belt use in Stratum 4 was lower than that observed in Strata 1 and 2, but was not different than that observed in Stratum 3. When compared with the September 2003 stratum belt use rates of 86.4, 86.6, 84.5, and 81.3 percent for Strata 1 through 4, respectively, we find increases within all strata.

Table 3. Percent Shoulder Belt Use by Stratum (All Vehicle Types)

	Percent Use	**Unweighted N**
Stratum 1	91.5 ± 1.1	4,085
Stratum 2	92.1 ± 1.8	2,527
Stratum 3	89.7 ± 2.4	1,595
Stratum 4	88.3 ± 1.5	5,667
STATE OF MICHIGAN	**90.5 ± 0.9 %**	13,874

Estimated belt use rates and unweighted numbers of occupants by stratum and vehicle type are shown in Tables 4a through 4d. Within each vehicle type, belt use is slightly lower in Stratum 4 for occupants of passenger cars, sport-utility vehicles and vans/minivans. However, for pickup truck occupants, belt use was lowest in Stratum 3. Comparisons across vehicle types reveal that belt use is lower for occupants of pickup trucks than for those in other vehicle types. This finding is consistent with previous work (Eby, Molnar, & Olk, 2000; Eby, Vivoda, & Fordyce, 2002).

When compared with the results from September 2003, we find increases in shoulder belt use for occupants of all vehicle types within every stratum. The largest increases are noted in occupants of pickup trucks, but as mentioned previously, this group continues to have significantly lower belt use than that of any other vehicle type. Thus, safety belt mobilization efforts should continue to focus upon pickup truck occupants.

Table 4a. Percent Shoulder Belt Use by Stratum (Passenger Cars)		
	Percent Use	Unweighted N
Stratum 1	91.9	2,041
Stratum 2	92.7	1,104
Stratum 3	91.3	789
Stratum 4	88.9	3,063
STATE OF MICHIGAN	**91.3 ± 0.9 %**	6,997

Table 4b. Percent Shoulder Belt Use by Stratum (Sport-Utility Vehicles)		
	Percent Use	Unweighted N
Stratum 1	92.4	793
Stratum 2	93.7	505
Stratum 3	93.5	221
Stratum 4	89.2	1,059
STATE OF MICHIGAN	**92.3 ± 1.3 %**	2,578

Table 4c. Percent Shoulder Belt Use by Stratum (Vans/Minivans)		
	Percent Use	Unweighted N
Stratum 1	93.5	559
Stratum 2	92.4	383
Stratum 3	90.2	287
Stratum 4	88.8	820
STATE OF MICHIGAN	**91.3 ± 1.6 %**	2,049

Table 4d. Percent Shoulder Belt Use by Stratum (Pickup Trucks)		
	Percent Use	Unweighted N
Stratum 1	87.0	692
Stratum 2	88.9	535
Stratum 3	81.2	298
Stratum 4	84.0	725
STATE OF MICHIGAN	**85.3 ± 2.3 %**	2,250

Safety Belt Use by Subgroup

Site Type. Estimated safety belt use by type of site is presented in Table 5 as a function of vehicle type and all vehicles combined. As is typically found in safety belt use surveys in Michigan (Eby, Molnar, & Olk, 2000; Eby, Vivoda, & Fordyce, 2002), use was higher for occupants in vehicles leaving limited access roadways (exit ramps) than for occupants in vehicles traveling on surface streets. This effect was consistent across all vehicle types.

Time of Day. Estimated safety belt use by time of day, vehicle type, and all vehicles combined is shown in Table 5. Note that these data were collected only during daylight hours. For all vehicles combined, belt use was about the same throughout the day, with slightly higher levels observed during the morning commute.

Day of Week. Estimated safety belt use by day of week, vehicle type, and all vehicles combined is shown in Table 5. Note that the survey was conducted over a 3-week period that included Labor Day. Belt use clearly varied from day to day, and no systematic differences were evident.

Weather. Estimated belt use by prevailing weather conditions, vehicle type, and all vehicles combined is shown in Table 5. There was essentially no difference in belt use observed during sunny, cloudy, or rainy weather conditions.

Sex. Estimated safety belt use by occupant sex, type of vehicle, and all vehicles combined is shown in Table 5. Estimated safety belt use was higher for females than for males in all four vehicle types studied, and for all vehicle types combined. Similar results have been found in every Michigan safety belt survey conducted by UMTRI (see, e.g., Eby, Molnar, & Olk, 2000; Eby, Vivoda, & Fordyce, 2002).

Age. Estimated safety belt use by age, vehicle type, and all vehicle types combined is shown in Table 5. As there were only two 0-to-3 year olds observed in the current study, the estimated safety belt use rate for this age group is not meaningful. Additionally, the unweighted number of 4-to-15 year olds was also quite low (425), so these results should also be interpreted with caution. Excluding these youngest age groups, the lowest level of safety belt use was observed among those age 16-to-29. Belt use was higher, and about the same, for the two oldest age groups. Within the different vehicle types, belt use among 16-to-29 year olds was consistently the lowest. However, the 60-and-above group had higher belt use in vans/minivans, while the 30-to-59 group had higher belt use in both pickup trucks and sport-utility vehicles. In passenger cars, the belt use of these two age groups was about the same. These results suggest that new and young drivers (16-to-29 years of age) should continue to be a focus of safety belt use messages and programs. Comparing these results with last year's safety belt use rates by age, we find that belt use has increased within the three oldest age groups.

Seating Position. Estimated safety belt use by position in vehicle, vehicle type, and all vehicles combined is shown in Table 5. This table shows that for all vehicle types combined, safety belt use was essentially the same for drivers and front-right passengers. Within the different vehicle types, belt use was slightly higher for drivers in passenger cars and sport-utility vehicles, while passengers' belt use was slightly higher in vans/minivans and pickup trucks.

Table 5. Percent Shoulder Belt Use and Unweighted N by Vehicle Type and Subgroup										
	All Vehicles		Passenger Car		Sport-Utility Vehicle		Van/Minivan		Pickup Truck	
	Percent Use	N	Percent Use	N	Percent Use	N	Percent Use	N	Percent Use	N
Site Type										
Intersection	89.4	9,445	90.7	4,726	91.0	1,767	90.5	1,382	83.4	1,570
Exit Ramp	92.1	4,429	91.8	2,271	94.3	811	92.4	667	89.4	680
Time of Day										
7 - 9 a.m.	91.6	1,597	92.9	883	92.9	296	94.2	212	82.6	206
9 - 11 a.m.	89.3	2,574	90.2	1187	90.0	464	90.7	448	85.7	475
11 - 1 p.m.	90.0	1,618	90.9	816	89.2	271	90.9	249	86.4	282
1 - 3 p.m.	90.5	2,905	92.0	1,468	90.1	548	90.7	429	85.9	460
3 - 5 p.m.	90.6	3,624	90.6	1,836	93.3	701	92.4	499	86.5	588
5 - 7 p.m.	90.8	1,556	91.8	807	91.3	298	92.7	212	86.1	239
Day of Week										
Monday	90.4	1,996	91.5	1,230	96.3	314	93.3	253	85.1	199
Tuesday	89.5	2,129	90.6	1,069	91.4	390	86.6	307	86.5	363
Wednesday	92.0	1,052	94.6	554	92.0	150	90.5	173	85.7	175
Thursday	90.1	2,215	91.0	1,036	92.2	394	90.9	347	85.8	438
Friday	91.0	2,597	91.4	1,233	94.3	461	92.5	423	85.9	480
Saturday	88.8	1,728	91.2	807	85.1	367	94.6	241	81.3	313
Sunday	91.0	2,157	92.6	1,068	94.4	502	90.7	305	81.3	282
Weather										
Sunny	90.2	11,171	90.9	5,651	92.5	2,005	90.7	1,657	85.6	1,858
Cloudy	92.0	2,578	93.5	1,299	91.7	539	93.8	376	84.3	364
Rainy	91.2	125	93.6	47	94.1	34	93.8	16	82.1	28
Sex										
Male	87.6	7,304	89.5	3,294	88.7	1,210	88.1	1,035	83.8	1,765
Female	93.5	6,568	92.8	3,702	95.7	1,368	94.5	1,014	91.2	484
Age										
0 - 3	54.6	2	54.6	2	---	0	---	0	---	0
4 - 15	97.0	425	96.1	182	98.2	92	96.6	97	98.2	54
16 - 29	87.6	3,753	88.8	2,327	89.7	657	83.7	253	80.9	516
30 - 59	91.2	8,326	92.2	3,706	93.1	1,689	91.7	1,449	86.4	1,482
60 - Up	91.3	1,366	92.6	780	90.9	139	92.9	249	83.9	198
Position										
Driver	90.6	10,773	91.7	5,493	92.7	1,997	91.1	1,500	84.8	1,783
Passenger	90.1	3,101	89.8	1,504	91.1	581	92.0	549	86.6	467

Age and Sex. Table 6 shows the estimated safety belt use rates and unweighted numbers (N) of occupants for all vehicle types combined by age and sex. As described earlier, the unweighted number of occupants is quite low for the two youngest age groups, and will therefore be excluded from the following discussion. Belt use for females in all age groups was higher than for males. However, the absolute difference in belt use rates between sexes varied depending upon the age group. The largest difference is found in the 16-to-29 year old age group, where the estimated belt use rate is 8.0 percentage points higher for females than for males. In fact, the belt use rate for the lowest female age group (16-to-29 year olds) is higher than the rate for the highest male age group (30-to-59 year olds). When compared with the belt use rates by age and sex from September 2003, the current rates increased within every category. These results argue strongly for statewide efforts to be directed toward persuading young males, and males in general, to wear safety belts.

Table 6. Percent Shoulder Belt Use and Unweighted N by Age and Sex (All Vehicle Types Combined)

Age Group	Male		Female	
	Percent Use	Unweighted N	Percent Use	Unweighted N
0 - 3	---	0	54.6	2
4 - 15	97.8	217	96.5	208
16 - 29	83.6	1,885	91.6	1,868
30 - 59	88.7	4,449	94.0	3,875
60 - Up	88.4	751	94.6	615

Comparison with Baseline Data

As described earlier, the current survey wave provides follow-up data for comparison with a baseline survey conducted in August 2004. The following section will discuss comparisons between the two surveys, but the complete results from the baseline survey can be found in Eby & Vivoda (2004).

The overall belt use rate of 90.5 ± 0.9 percent represents a statistically significant increase over the use rate of 88.3 ± 0.9 percent rate observed in August 2004, during the baseline survey wave. Prior to the current wave, 88.3 was the highest statewide use rate that had ever been observed in Michigan. Within each stratum, slight increases are noted, but these differences are not statistically significant. When considering belt use by vehicle type, increases are noted within each type of vehicle, but the difference is only significant for occupants of vans/minivans. Similar belt use increases (of about 2 percentage points) were observed from the baseline wave to the current wave for both males and females. When considering belt use by age group, a slight increase was noted within the 16-to-29 year old age group (1.4 percentage points); the largest increase was among 30-to-59 year olds (2.9 percentage points), while the 60-and-above age group remained the same. A further analysis of belt use by age and sex combined revealed that the largest increase (3.1 percentage points) was observed among 30-to-59 year old males. Males age 60 or older actually had a slight decline in belt use (of 1.1 percentage points), while 16-to-29 year old males increased by 1.6 percentage points. For females, the largest increase (2.4 percentage points) was also observed within the 30-to-59 year old group, followed by increases of 1.2 and 0.6 percentage points respectively, for the 60-and-above and 16-to-29 year old groups. For site type, time of day, day of week, weather, and seating position, general increases and the usual trends are noted between the baseline and the current survey. These results suggest that the mobilization efforts conducted around the 2004 Labor Day holiday were successful at increasing the overall safety belt use rate in Michigan.

Historical Trends

The current direct observation survey is the twenty-third statewide survey that utilizes the sampling design and procedures implemented in 1993 (Streff, Eby, Molnar, Joksch, & Wallace, 1993). As such, it is possible to investigate safety belt use trends over these years. The annual survey in 1993, however, only included passenger vehicles, so that survey is only included in the historical trends section relating safety belt use by vehicle type.

Overall Belt Use Rate. Figure 3 shows the statewide safety belt use rate for all vehicles combined over the last 11 years. The safety belt use rate has shown a consistent increase over this time. Since 1994, the safety belt use rate has increased by 27.8 percentage points, with an increase of 20.4 percentage points over the highest rate observed before the introduction of primary enforcement, in March 2000. This finding indicates that efforts to increase safety belt use in Michigan have been effective and should be continued. Changing the enforcement provision of the safety belt law and the recent safety belt mobilizations including "safety belt enforcement zones" have been particularly effective.

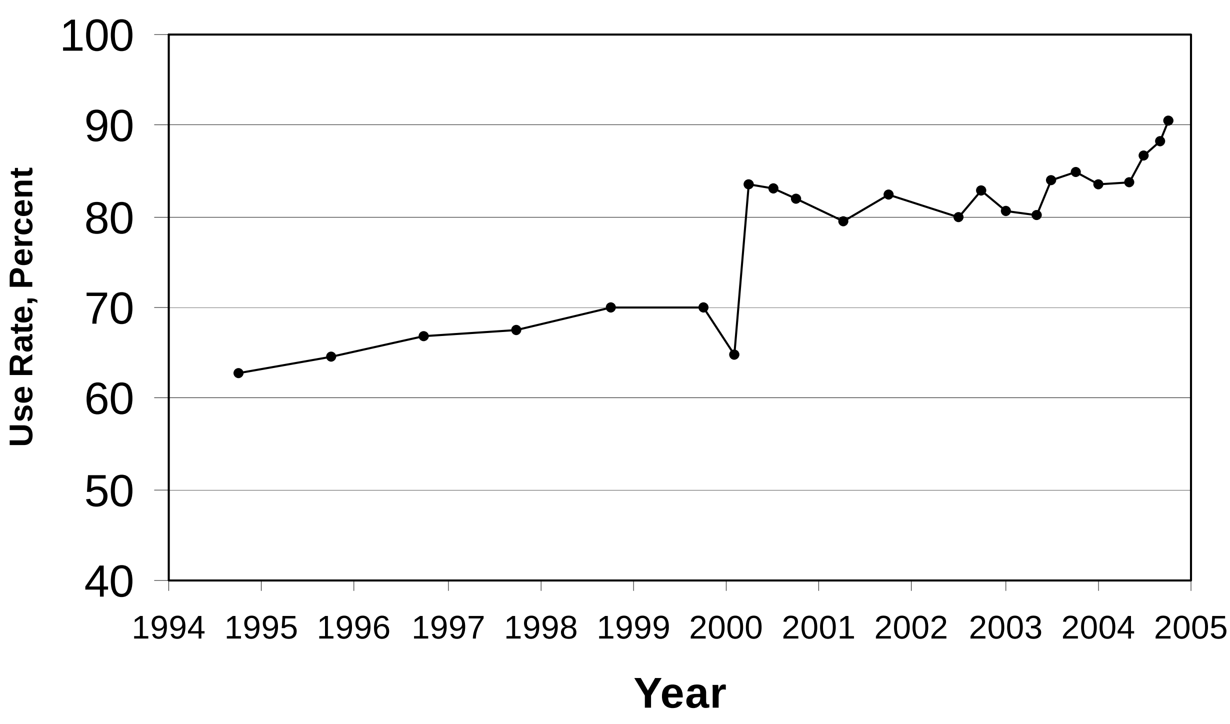

Figure 3. Front-Outboard Shoulder Belt Use by Year (All Vehicle Types Combined).

Overall Belt Use Rate by Stratum. Figure 4 shows the statewide safety belt use rate for all vehicles combined since 1994 by stratum. For all strata, there is a general upward trend in safety belt use from 1994 to 2004, with the greatest increase in use (33.1 percentage points) found in Stratum 4. Stratum 4 also experienced the largest increase in belt use immediately following the implementation of primary enforcement. Generally, overall increases in belt use rates continue to be observed in all strata. However, to maintain the current rate of high belt use, it continues to be necessary to develop and implement new strategies for programs designed to increase the belt use rate.

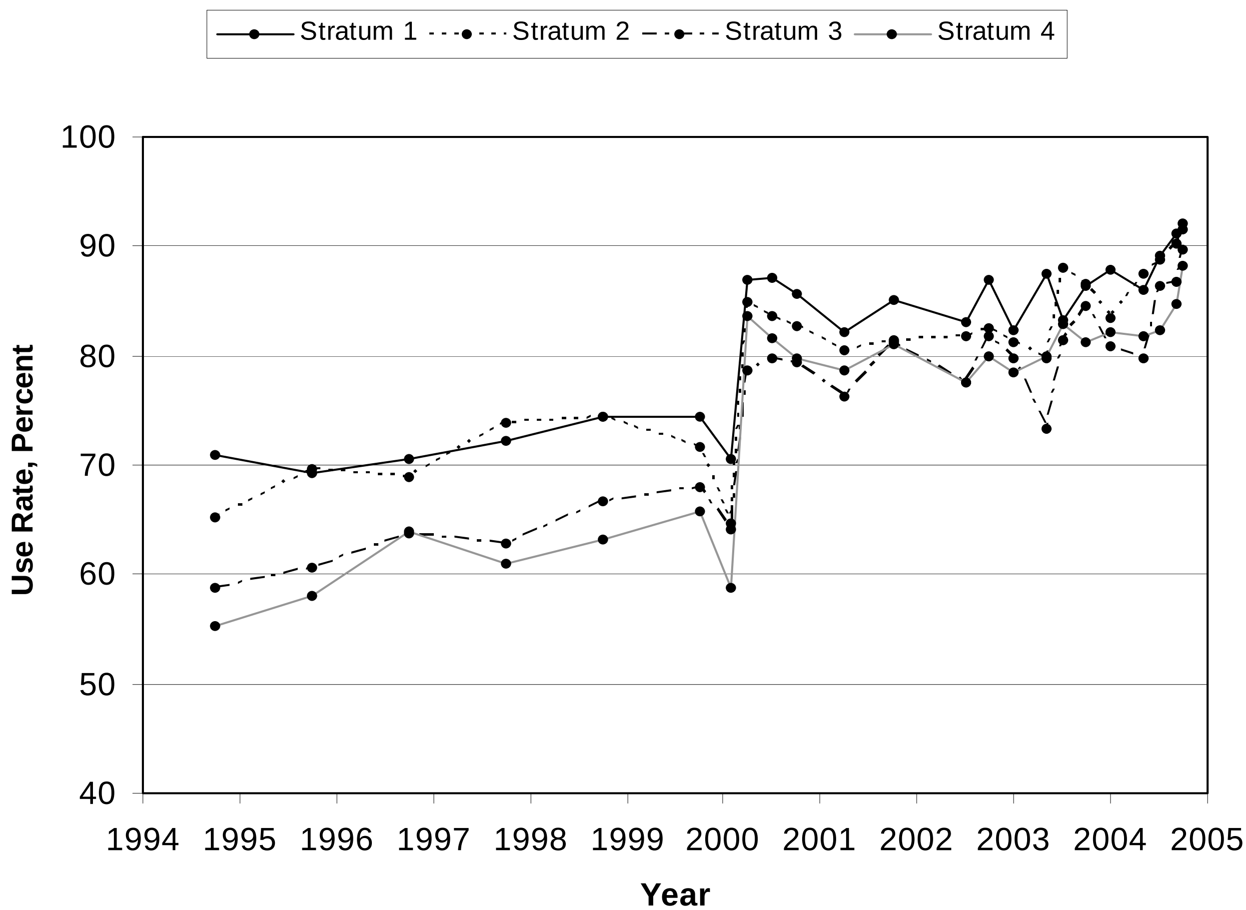

Figure 4. Front-Outboard Shoulder Belt Use by Year and Stratum (All Vehicle Types Combined).

Belt Use by Site Type. Figure 5 shows the estimated safety belt use rates for all vehicles combined as a function of whether the site was a freeway exit ramp or a local intersection. This effect has generally remained consistent since 1994, with higher belt use observed at freeway exit ramp sites, but the overall difference in belt use observed at the two types of sites has fluctuated from study to study. In the current survey, belt use observed at exit ramps was 2.7 percentage points higher than at intersection sites.

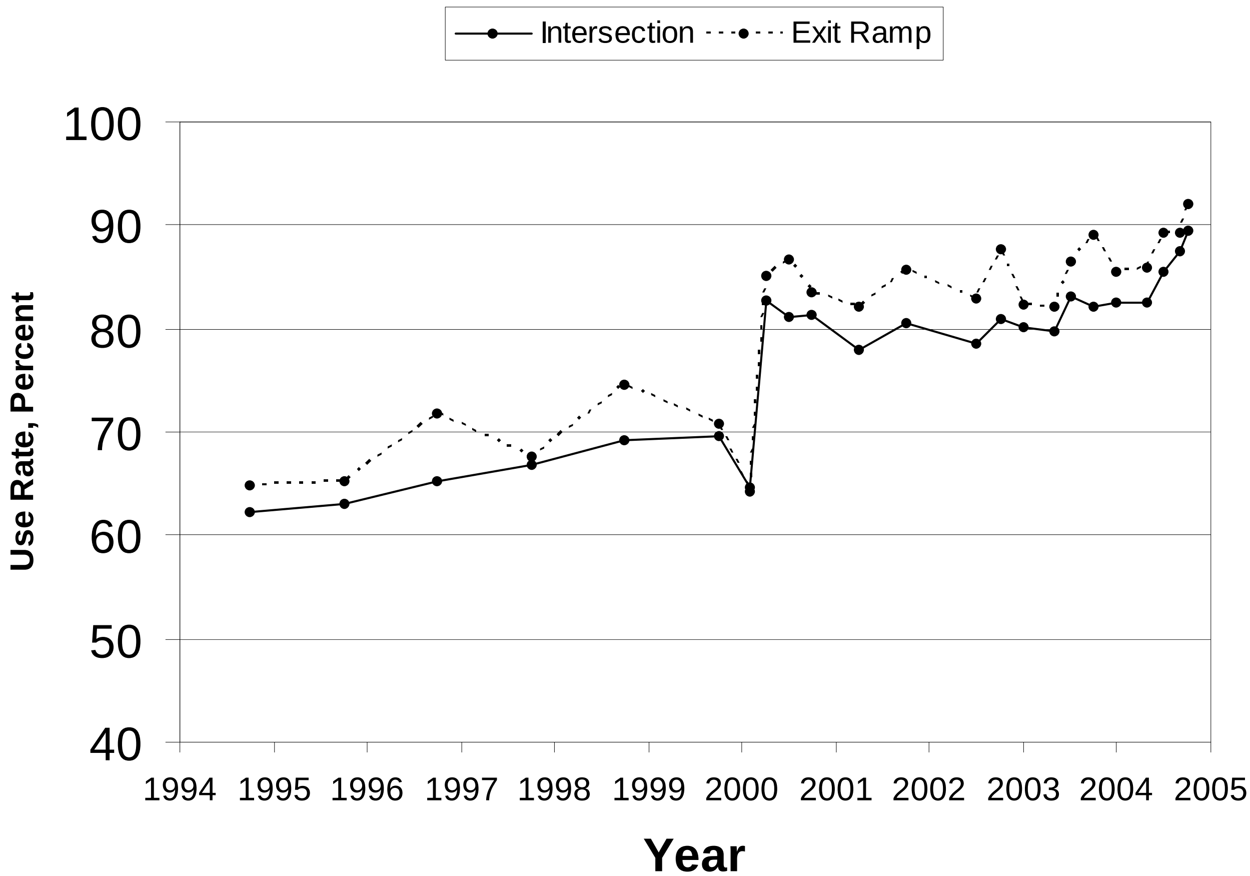

Figure 5. Front Outboard Shoulder Belt Use by Site Type and Year (All Vehicle Types Combined).

Belt Use By Sex. Figure 6 shows front-outboard safety belt use by sex since 1994. Safety belt use by females for every survey is significantly higher than for males. Significant increases in belt use, related to the introduction of primary enforcement legislation, were observed within both sexes. The difference between the two groups has declined somewhat over recent years as overall belt use compliance gets closer to 100 percent.

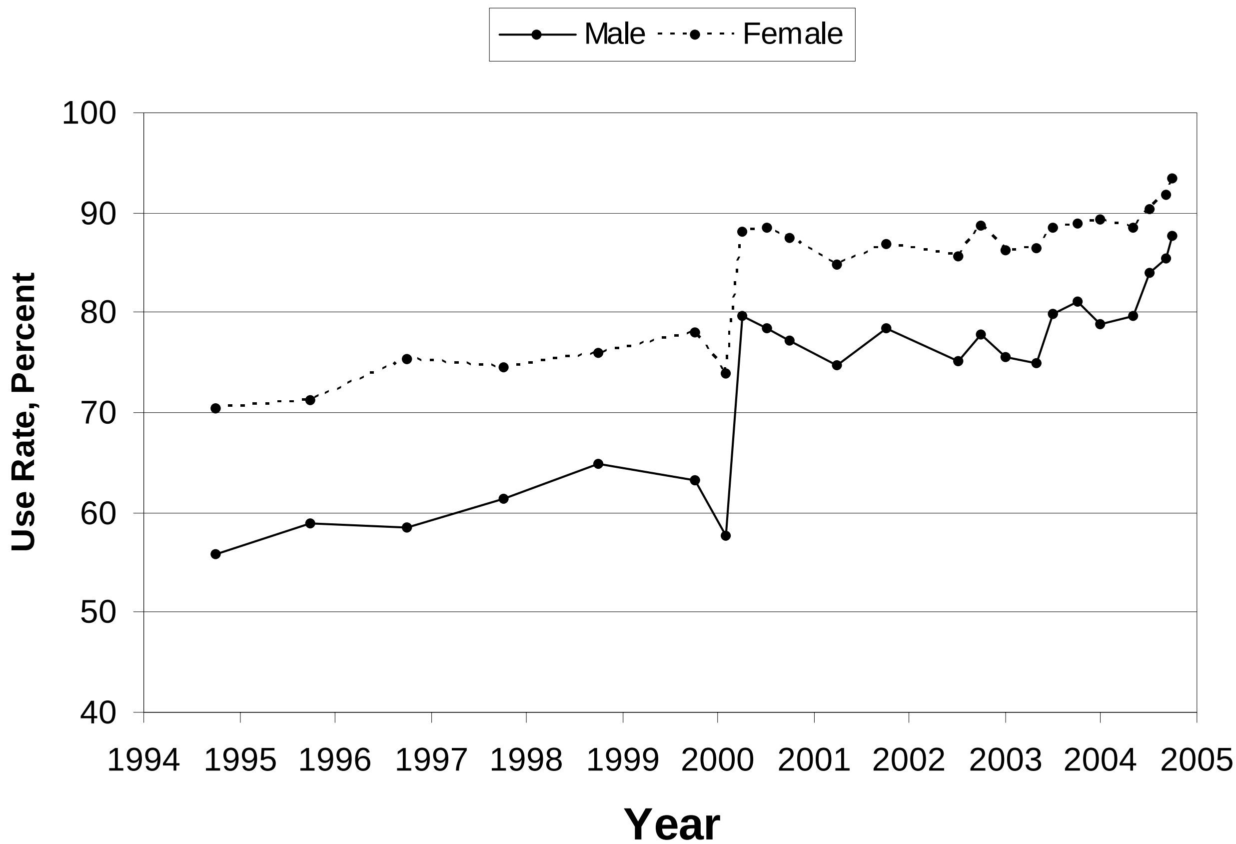

Figure 6. Front-Outboard Shoulder Belt Use by Sex and Year (All Vehicle Types Combined).

Belt Use By Seating Position. Figure 7 shows front-outboard safety belt use by seating position and year. Safety belt use by drivers has been consistently higher than for front-outboard passengers since 1994. The current difference, of only 0.5 percentage points, is indicative of a recent trend towards more similar belt use within these two groups.

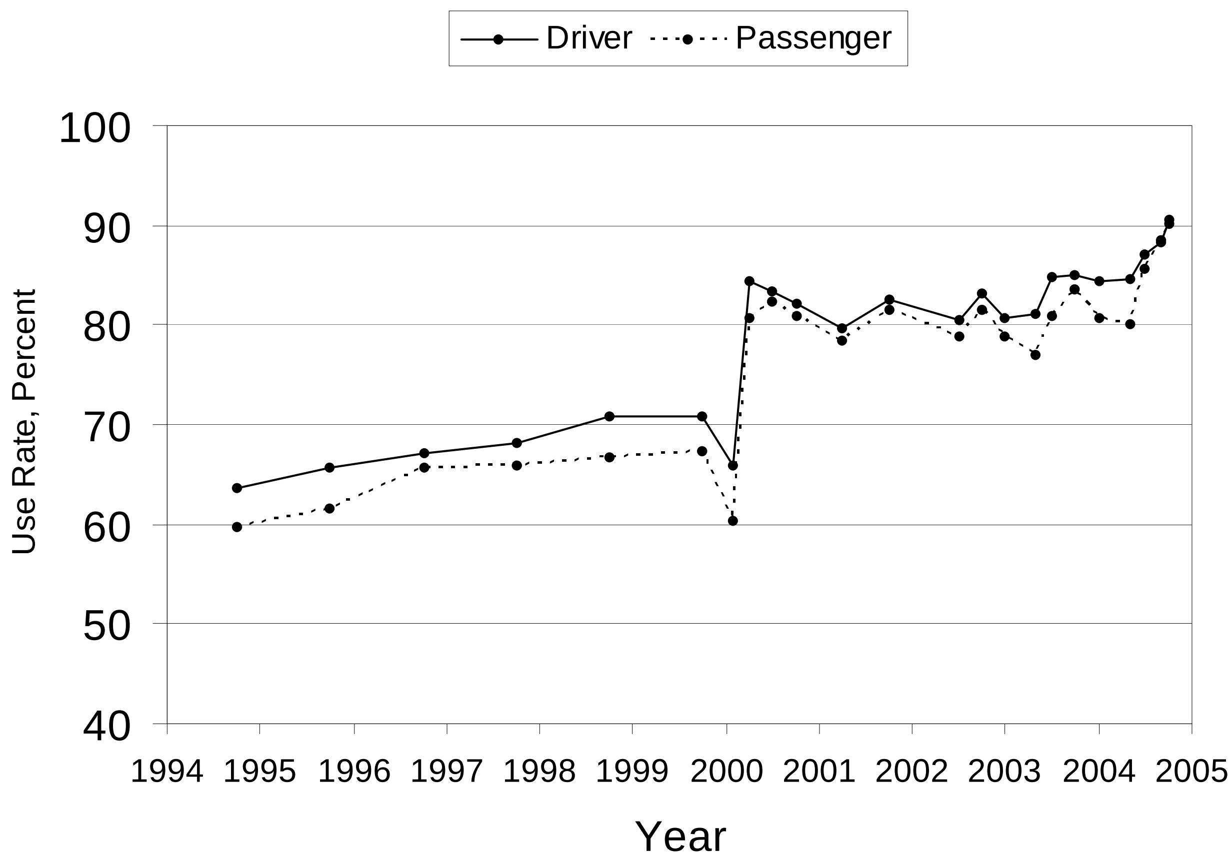

Figure 7. Front-Outboard Shoulder Belt Use by Seating Position (All Vehicle Types Combined).

Belt Use by Age. Figure 8 shows front-outboard safety belt use by age group since 1994 for all vehicles combined. The youngest age group is typically excluded from comparisons due to the very small numbers in our sample. Conclusions about the 4-to-15-year-old age group should also be made with caution as the number of occupants within this age group is quite low. Excluding these age groups, the use rates by age have been ordered consistently each year with the 16-to-29-year-old age group having the lowest safety belt use rates, followed by the 30-to-59 year olds. The highest belt use is typically observed within the 60-and-older age group. In the current study, the 16-to-29 year old age group was observed with the lowest belt use, however use rates were essentially the same for the two oldest age groups. This finding may represent a new trend in belt use as compliance with the law increases.

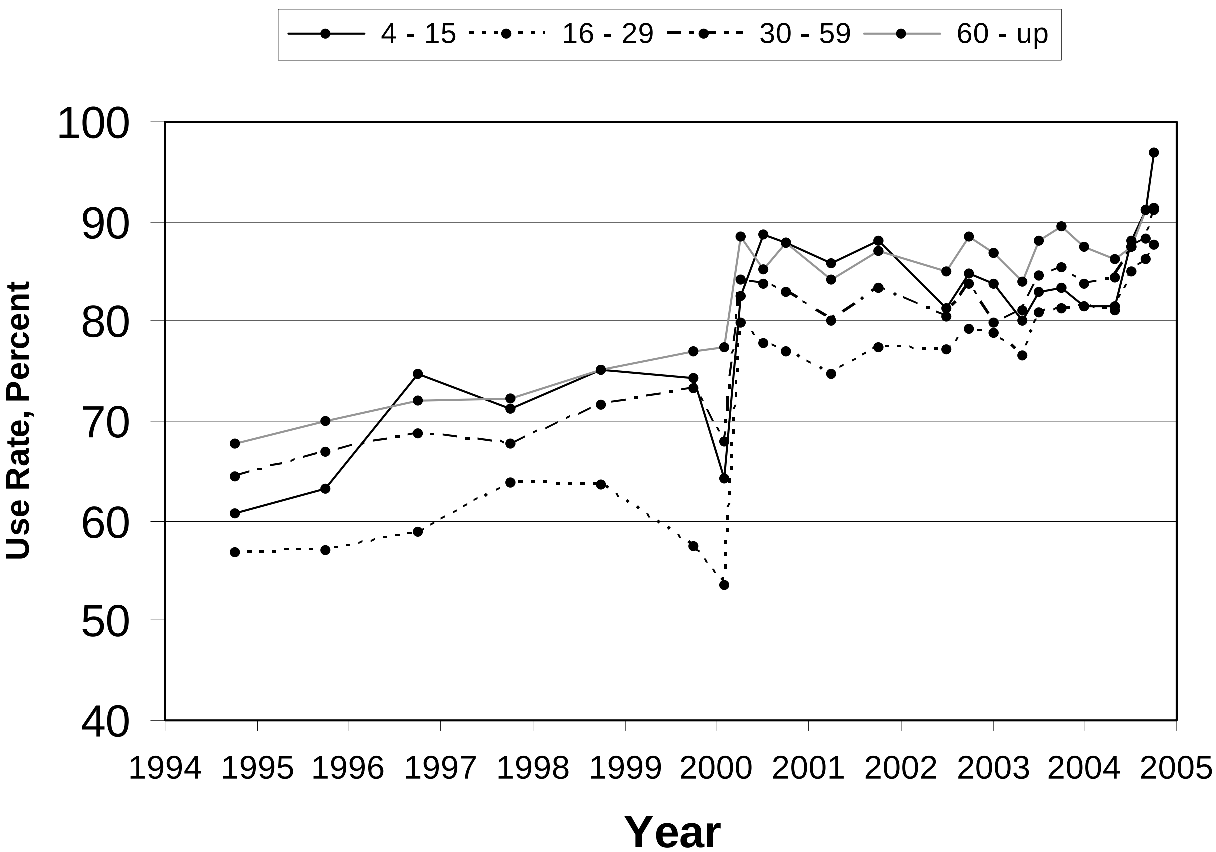

Figure 8. Front-Outboard Shoulder Belt Use by Age and Year (All Vehicle Types Combined).

Belt Use by Vehicle Type and Year. Figure 9 shows motor vehicle occupant belt use by the type of vehicle since 1993. Belt use for 1993 only shows passenger vehicles because only this vehicle type was observed in that year. Figure 9 reveals that significant increases have been observed in safety belt use rates for occupants in all vehicle types. The most notable increase (40.4 percentage points since 1994) has been observed in the belt use rates of pickup truck occupants. However, these occupants continue to be significantly less likely to use a safety belt than occupants of other vehicle types.

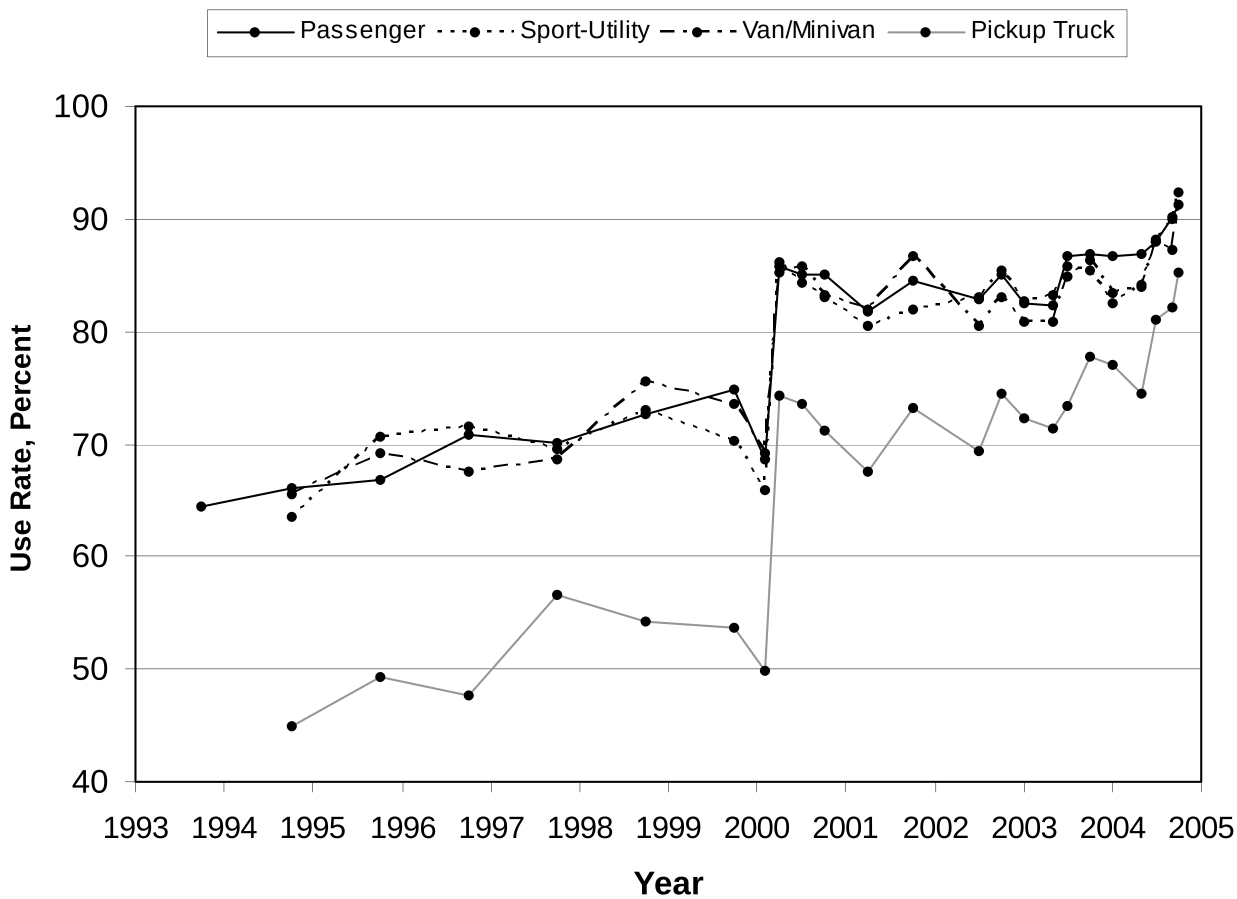

Figure 9. Front-Outboard Shoulder Belt Use by Vehicle Type and Year.

DISCUSSION

The estimated statewide safety belt use rate for front-outboard occupants of passenger cars, sport-utility vehicles, vans/minivans, and pickup trucks combined was 90.5 ± 0.9 percent. This rate represents the highest level of statewide safety belt use ever observed in Michigan. Further, this level of belt use makes Michigan only the fifth state in the country to obtain a statewide rate of 90 percent. This achievement puts Michigan in position to contribute to the national goal set for the entire US (of 90 percent), and also accomplishes the goal of 90 percent use in 2004 set by the state (OHSP, 2004). Michigan is the first state east of California to accomplish this goal, with the only others being California, Hawaii, Oregon, and Washington.

Prior to the current survey, the highest statewide belt use rate observed in Michigan was 88.3 ± 0.9 percent, observed in August 2004, just before the current study was conducted (Eby & Vivoda, 2004). While that study provided a baseline use rate for a safety belt mobilization centered around Labor Day 2004, the current study was conducted during and after the mobilization to provide follow-up comparison data. The significant increase observed between these two studies is typical of recent observational surveys conducted in Michigan. In the survey conducted in September 2003, the overall belt use rate was observed at 84.8 percent (Eby, Vivoda, & Spradlin, 2003). The results of that survey represented an important belt use increase above the 84 percent level. In the years prior to the September 2003 survey, the safety belt use rate in Michigan had mostly fluctuated between 80 and 84 percent, but could not seem to break through that plateau. Since that survey, statewide belt use has been observed at 83.6, 83.8, 86.8, and 88.3 percent in December 2003, and April, June, and August 2004, respectively. While the studies in December and April were slightly below the 84 percent level, lower belt use has been observed during the cold weather months in previous Michigan studies (see e.g., Eby, Vivoda, & Fordyce, 2000; Vivoda, Eby, & Spradlin, 2004). Together, these studies represent not only a break through the previous plateau, but a further increase above the 90 percent level.

Analyses of safety belt use by the various subcategories in the current survey revealed an upward trend in belt use when compared to both the baseline survey and other recent surveys conducted in Michigan. Over the past year, increases within these subcategories were generally relative to the increase observed in the overall belt use rate. However, the largest increases were noted within the lowest belt use groups. This result suggests that the message of recent safety belt mobilizations has reached its intended audience (the lowest belt use groups). It is important to note however, that while these groups have generally experienced the largest increases over the past year, they also continue to have lower belt use than the other groups. Given this, these groups should continue to be a focus of efforts designed to increase safety belt use.

As the overall belt use rate has risen over the past year, the differences in safety belt use between groups has decreased. Historically, differences in belt use between the following groups have been consistently larger than they are in the current survey: occupants observed traveling on exit ramps versus roadway intersections, vehicle drivers versus passengers, pickup truck occupants versus those in other types of vehicles, and males versus females. This trend is likely to continue as the overall belt use rate continues to rise and approaches 100 percent compliance. The increases in safety belt use over the past 11 years illustrate this point even more clearly. In 1994, passenger car occupants wore safety belts more often (66.1 percent) than occupants of any other vehicle type. Motorists traveling in pickup trucks buckled up at a rate of 44.9 percent, 21.2 percentage points lower than those in passenger cars. Since 1994, the belt use rate of pickup trucks occupants has increased by more than 40 percentage points. This change compares to increases of 25.2, 28.8, and 25.7 percentage points for passenger car, sport-utility vehicle, and van/minivan occupants, respectively. While the current difference between passenger car occupants and those in pickup trucks is only six percentage points, as mentioned earlier, this difference is still statistically significant.

While it remains important to focus on increasing safety belt use rates for those groups that continue to fail to buckle up, it is also important to recognize the progress that has been made over the last 11 years. Of particular note during this time frame are two important factors. First, in March 2000, the enforcement provision of Michigan's safety belt law was changed from secondary to primary enforcement. This change (along with the accompanying media and police enforcement) resulted in a net increase of more than 10 percentage points, from around 70 percent to around 80 percent belt use. The second factor has been the sustained focus of several campaigns designed to increase the belt use rate in the state. These campaigns included recent mobilizations using the *Click It or Ticket: Buckle Up or Pay Up* theme and the implementation of safety belt enforcement zones. These efforts have been effective by influencing motorists' perceptions of the risk associated with failing to buckle up, which in turn led to the observed increases in the belt use rate. The success of these efforts centered upon first changing the perceived risk of receiving a citation, and second by changing the perceived severity of the related outcome among motorists that do not wear safety belts.

During the 1990s, most of the Public Information and Education (PI&E) campaigns focused on educating people about the risks of not wearing a safety belt in the event of a crash. Additionally, these efforts focused on increasing the perception of the chances of being in a crash. For example, popular themes of these efforts were to point out that most crashes occur on short trips near one's home, and to discredit the myth that it is better to be thrown free from a vehicle during a crash. By the end of the 1990s, most people accepted that "safety belts save lives," and agreed that given a crash, they would rather be buckled than unbuckled. While these messages were successful, the corresponding increases in safety belt use appeared to be maximized. Conversely, the recent efforts implemented in Michigan to increase belt use have recognized the importance of changing the focus from the public health benefits of belt use, to the legal implications of failing to wear a safety belt. For example, these themes include the idea that if a motorist does not believe that he or she will receive a safety belt citation, that motorist will be less likely to buckle up. Similarly, if the motorist believes the consequence (i.e. fine) related to a citation is insignificant, again, that motorist will be less likely to wear a safety belt. The addition of the *Buckle Up or Pay Up* theme to the *Click It or Ticket* slogan along with the implementation of safety belt enforcement zones to existing police enforcement efforts, attempts to change these perceived risks.

The *Click It or Ticket* message specifically makes the point that if a motorist does not wear a safety belt, that person will receive a citation. Further, the *Buckle Up or Pay Up* slogan reinforces the idea that receiving a safety belt citation will result in a monetary loss. The media messages that accompanied the mobilization utilizing these tag lines specifically made these points; police officers will be ticketing motorists for failing to buckle-up, and those tickets will result in a substantial fine. Similarly, the implementation of safety belt enforcement zones also works to increase the perceived risk of receiving a citation. The high visibility of these zones resulted in news media attention, as well as important word-of-mouth attention. These efforts attempted to influence the public's perception such that motorists believed more officers would be ticketing people for failing to buckle up, and that this enforcement would be widespread.

Given the current belt use rate of 90.5 percent, and the corresponding increase of more than 20 percentage points in five years, these efforts have obviously been successful. While this hard work should be recognized, there is still work to be done to reach the goal of 93.3 percent belt use set for Michigan in 2005. Further, efforts must be continued just to maintain safety belt use at the 90 percent level. While the current model of attempting to change the perceived risk of both receiving a citation and the severity of the related consequences has been successful, future belt use campaigns should look to new and innovative ways to implement this model.

REFERENCES

California Office of Traffic Safety. (2003). *2004 Highway Safety Plan.* Retrieved November 1, 2004, from http://www.ots.ca.gov/publications/safetyplan.asp.

California Office of Traffic Safety. (2004). *Law Enforcement Cracking Down on Those Who Don't Wear Seat Belts Over Labor Day Holiday.* Retrieved November 1, 2004, from http://www.ots.ca.gov/pressRoom/2004/prsRls_0901.asp.

Cochran, W. W. (1977). *Sampling Techniques, 3rd ed.* New York, NY: Wiley.

Eby, D.W. (2000). *How Often Do People Use Safety Belts in Your Community? A Step-by-Step Guide for Assessing Community Safety Belt Use*. (Report No. UMTRI-2000-19). Ann Arbor, MI: University of Michigan Transportation Research Institute.

Eby, D.W., Molnar, L.J., & Olk, M.L. (2000). Trends in driver and front-right passenger safety belt use in Michigan: 1984-1998. *Accident Analysis & Prevention, 32*, 837-843.

Eby, D.W. & Vivoda, J.M. (2004). *Safety Belt Use in Michigan Immediately Prior to the Labor Day Mobilization, 2004*. (Report No. UMTRI-2004-33). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Eby, D.W., Vivoda, J.M., & Fordyce, T.A. (1999). *Direct Observation of Safety Belt Use in Michigan: Fall 1999*. (Report No. UMTRI-99-33). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Eby, D.W., Vivoda, J.M., & Fordyce, T.A. (2000). *A Study of Michigan Safety Belt Use Prior to Implementation of Standard Enforcement*. (Report No. UMTRI-2000-08). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Eby, D.W., Vivoda, J.M., & Fordyce, T.A. (2002). The effects of standard enforcement on Michigan safety belt use. *Accident Analysis and Prevention, 34* (6), 101-109*.*

Eby, D.W., Vivoda, J.M., & Spradlin, H.K. (2003). *Direct Observation of Safety Belt Use in Michigan: Fall 2003*. (Report No. UMTRI-2003-40). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Federal Highway Administration (1982). *Highway Statistics 1982*. Washington, DC: U.S. Department of Transportation.

Glassbrenner, D. (2004). *Safety Belt Use in 2003 - Use Rates in the States and Territories*. (Report No. DOT HS 809 713). Washington, DC: National Highway Traffic Safety Administration.

Kim, K., Kinjo, K., & Yamamura, M. (2002). Results of the 2002 Hawaii Seat Belt Use Survey. Retrieved November 1, 2004, from http://www.state.hi.us/dot/publications/safecommunities/2002survey/seatbelt_june/june-sbreport.pdf

Michigan Office of Highway Safety Planning. (2004). *90% in 2004: Michigan's Belt use Bulletin*. [Electronic Version]. Lansing, MI: Michigan Office of Highway Safety Planning.

National Highway Traffic Safety Administration. (1992). Guidelines for State Observational Surveys of Safety Belt and Motorcycle Helmet Use. *Federal Register, 57*(125), 28899-28904.

National Highway Traffic Safety Administration (1998). *Uniform Criteria for State Observational Surveys of Seat Belt Use*. (Docket No. NHTSA-98-4280). Washington, DC: US Department of Transportation.

National Highway Traffic Safety Administration. (1999, personal communication). Letter to the Executive Director of the Michigan Office of Highway Safety Planning outlining federal regulations regarding inclusion of commercial/noncommercial vehicle occupants. April, 1999.

National Highway Traffic Safety Administration. (2000). *Research Note: Observed Safety Belt Use from December 1999 & June 2000 MiniNOPUS*. Retrieved November 1, 2004, from http://www.nhtsa.dot.gov/people/ncsa

Oregon Department of Transportation. (2004). *About the Campaign....* Retrieved November 1, 2004, from http://www.odot.state.or.us/transafety/Occupant_Protection/About3flags.pdf

Streff, F. M., Eby, D. W., Molnar, L. J., Joksch, H. C., & Wallace, R. R. (1993). *Direct Observation of Safety Belt and Motorcycle Helmet Use in Michigan: Fall 1993*. (Report No. UMTRI-93-44). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Ulmer, R.G., Preusser, C.W., Preusser, D.F., & Cosgrove, L.A. (1995). Evaluation of California's safety belt law change from secondary to primary enforcement. *Journal of Safety Research, 26* (4), 213-220.

U.S. Census Bureau. (1992). *1990 Census of Population and Housing* (from University of Michigan UM-ULibrary Gopher-computer datafile).

U.S. Census Bureau. (2003). *Census 2000 Gateway*. Retrieved March 3, 2003, from http://www.census.gov/main/www/cen2000.html.

Vivoda, J.M., Eby, D.W., & Spradlin, H.K. (2004). *An Evaluation of the "Buckle Up or Pay Up: Click It or Ticket" November Safety Belt Mobilization.* (Report No. UMTRI-2004-04). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Wagenaar, A. C. & Molnar, L. J. (1989). *Direct Observation of Safety Belt Use in Michigan: Spring 1989*. (Report No. UMTRI-89-12). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Wagenaar, A. C., Molnar, L. J., & Businski, K. L. (1987a). *Direct Observation of Safety Belt Use in Michigan: December 1986*. (Report No. UMTRI-87-03). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Wagenaar, A. C., Molnar, L. J., & Businski, K. L. (1987b). *Direct Observation of Safety Belt Use in Michigan: April 1987*. (Report No. UMTRI-87-25). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

Wagenaar, A. C., Molnar, L. J., & Businski, K. L. (1988). *Direct Observation of Safety Belt Use in Michigan: Spring 1988*. (Report No. UMTRI-88-24). Ann Arbor, MI: The University of Michigan Transportation Research Institute.

APPENDIX A

Site Listing

Survey Sites By Number

No.	County	Site Location	Type	Str
001	Oakland	EB Whipple Lake Rd. & Eston Rd.	I	1
*002	Kalamazoo	EB S Ave. & 29th St.	I	1
003	Oakland	SB Pontiac Trail & 10 Mile Rd.	I	1
004	Washtenaw	SB Moon Rd. & Ann Arbor-Saline Rd./Saline-Milan Rd.	I	1
005	Oakland	WB Drahner Rd. & Baldwin Rd.	I	1
006	Oakland	SB Rochester Rd. & 32 Mile Rd./Romeo Rd.	I	1
007	Oakland	SB Williams Lake Rd. & Elizabeth Lake Rd.	I	1
008	Ingham	SB Searles Rd. & Iosco Rd.	I	1
*009	Kalamazoo	WB D Ave. & Riverview Dr.	I	1
010	Washtenaw	EB N. Territorial Rd. & Dexter-Pinckney Rd.	I	1
*011	Washtenaw	NB Schleeweis Rd./Macomb St. & W. Main St.	I	1
012	Ingham	NB Shaftsburg Rd. & Haslett Rd.	I	1
013	Oakland	NB Middlebelt Rd. & 9 Mile Rd.	I	1
*014	Washtenaw	WB Packard Rd. & Carpenter Rd.	I	1
015	Ingham	EB Haslett Rd. & Marsh Rd.	I	1
*016	Washtenaw	NB Jordan Rd./Monroe St. & US-12/Michigan Ave.	I	1
017	Washtenaw	SB M-52/Main St. & Old US-12	I	1
018	Kalamazoo	SB 8th St. & Q Ave.	I	1
*019	Washtenaw	WB 8 Mile Rd. & Pontiac Trail	I	1
*020	Oakland	SB Lahser Rd. & 11 Mile Rd.	I	1
*021	Kalamazoo	NB Ravine Rd. & D Ave.	I	1
022	Washtenaw	EB Glacier Way/Glazier Way & Huron Pkwy.	I	1
023	Washtenaw	WB Bethel Church Rd. & M-52	I	1
024	Washtenaw	SB Platt Rd. & Willis Rd.	I	1
*025	Ingham	WB Fitchburg Rd. & Williamston Rd.	I	1
026	Washtenaw	EB Merritt Rd. & Stoney Creek Rd.	I	1
027	Oakland	SB Hickory Ridge Rd. & M-59/Highland Rd.	I	1
028	Kalamazoo	SB Douglas Ave. & D Ave.	I	1
*029	Oakland	WB Walnut Lake Rd. & Haggerty Rd.	I	1
030	Oakland	NB Jossman Rd. & Grange Hall Rd.	I	1
031	Kalamazoo	EB H Ave. & 3rd St.	I	1
032	Kalamazoo	EB TU Ave. & 24th St./Sprinkle Rd.	I	1
033	Oakland	WBD I-96 & Milford Rd.. (Exit 155B)	ER	1
*034	Washtenaw	WBP I-94 & Whittaker Rd./Huron St. (Exit 183)	ER	1
*035	Kalamazoo	SBP US-131 & M-43 (Exit 38B)	ER	1
036	Washtenaw	SBD US-23 & N. Territorial Rd.	ER	1
*037	Kalamazoo	EBP I-94 & Portage Rd.	ER	1
038	Oakland	EBP I-696 & Orchard Lake Rd. (Exit 5)	ER	1
039	Kalamazoo	WBP I-94 & 9th St. (Exit 72)	ER	1
*040	Washtenaw	WBD I-94 & Jackson Rd.	ER	1
041	Kalamazoo	NBD US-131 & Stadium Dr./Business I-94	ER	1
042	Kalamazoo	NBP US-131 & Q Ave./Centre Ave.	ER	1
*043	Livingston	SB County Farm Rd. & Coon Lake Rd.	I	2
044	Bay	WB Nebodish Rd. & Knight Rd.	I	2
045	Macomb	SB Camp Ground Rd. & 31 Mile Rd.	I	2
046	Jackson	SB Benton Rd./Moon Lake Rd. & M-50/ Brooklyn Rd.	I	2
047	Allegan	SB 6th St. & M-89	I	2
048	Kent	EB 36th St. & Snow Ave.	I	2

049	Livingston	EB Chase Lake Rd. & Fowlerville Rd.	I	2
*050	Allegan	WB 144th Ave. & 2nd St.	I	2
051	Livingston	SB Cedar Lake Rd. & Coon Lake Rd.	I	2
052	Jackson	NB Mt. Hope Rd. & Waterloo-Munith Rd.	I	2
*053	Kent	WB Cascade Rd. & Thornapple River Dr.	I	2
*054	Allegan	NB 62nd St. & 102nd Ave.	I	2
055	Kent	SB Meddler Ave. & 18 Mile Rd.	I	2
056	Eaton	SB Houston Rd. & Kinneville Rd.	I	2
057	Macomb	SB M-19/Memphis Ridge Rd. & 32 Mile Rd./ Division Rd.	I	2
*058	Allegan	NB 66th St. & 118th Ave.	I	2
059	Grn Traverse	NB Silver Lake Rd./County Rd. 633 & US-31	I	2
*060	Grn Traverse	EB Riley Rd./Tenth St. & M-137	I	2
*061	Bay	SB 9 Mile Rd. & Beaver Rd.	I	2
062	Kent	SB Ramsdell Dr. & M-57/14 Mile Rd.	I	2
*063	Eaton	NB Ionia Rd. & M-50/Clinton Trail	I	2
064	Macomb	EB 23 Mile Rd. & Romeo Plank Rd.	I	2
*065	Livingston	NB Old US-23/Whitmore Lake Rd. & Grand River Rd.	I	2
066	Jackson	SWB Horton Rd. & Badgley Rd.	I	2
067	Kent	SB Belmont Ave. & West River Dr.	I	2
*068	Eaton	EB 5 Point Hwy. & Ionia Rd.	I	2
069	Allegan	WB 129th Ave. & 10th St.	I	2
*070	Eaton	EB M-43 & M-100	I	2
071	Ottawa	WB Taylor St. & 72nd Ave.	I	2
072	Bay	EB Cass Rd. & Farley Rd.	I	2
073	Allegan	EB 126th Ave. & 66th St.	I	2
074	Bay	NB Mackinaw Rd. & Cody-Estey Rd.	I	2
075	Jackson	EBD I-94 & Elm Ave. (Exit 141)	ER	2
076	Kent	NBD US-131 & 100th St. (Exit 72)	ER	2
*077	Ottawa	NBD I-196 & Byron Rd.	ER	2
*078	Kent	SBP US-131 & Hall St.	ER	2
079	Macomb	SBP M-53 & 26 Mile Rd.	ER	2
080	Bay	NBD I-75 & Wilder Rd. (Exit 164)	ER	2
081	Livingston	EBD I-96 & Fowlerville Rd. (Exit 129)	ER	2
*082	Macomb	EBP I-94 & 12 Mile Rd. (Exit 231)	ER	2
083	Jackson	WBD I-94 & Sargent Rd. (Exit 145)	ER	2
084	Allegan	NBP US-31/I-196 & Washington Rd./ Blue Star Hwy (Exit 47A)	ER	2
085	Calhoun	EB O Drive N. & 12 Mile Rd.	I	3
*086	Berrien	EB Mayflower Rd. & Chicago Rd.	I	3
*087	Marquette	SWB C.R. 456 & Sporley Lake Rd.	I	3
088	Lenawee	EB Munger Rd. & M-52	I	3
*089	Genesee	EB Pierson Rd. & Elms Rd.	I	3
*090	Clinton	NB Scott Rd. & M-21/State	I	3
091	Calhoun	WB R Dr. S. & 8 Mile Rd./Adolph Rd.	I	3
092	Calhoun	EB V Dr. N. & 20 Mile Rd.	I	3
093	Calhoun	NWB Dickman Rd./M-96 & Avenue A	I	3
094	St. Clair	WB Hewitt Rd. & Fargo Rd.	I	3
095	Monroe	SB Swan Creek Rd. & Labo Rd.	I	3
*096	Muskegon	EB Sweeter Rd. & Maple Island	I	3
*097	Calhoun	SB P Dr. N./Yawger Rd. & Hubbard Rd./5 Mile Rd.	I	3

098	St. Clair	WB Bryce Rd. & Cribbins Rd.	I	3
099	St. Clair	WB Lindsey Rd. & Palms Rd.	I	3
100	Van Buren	SB Broadway/M-140 & Phoenix Rd./BL I-196/C.R. 388	I	3
101	Ionia	SB Fisk Rd./Heffron Rd. & Montcalm Ave.	I	3
102	Clinton	EB Taft Rd. & Shepardsville Rd.	I	3
103	Calhoun	SB S. County Line Rd. & 23 Mile Rd.	I	3
*104	Calhoun	NB Waubascon Rd./4 1/2 Mile Rd. & Baseline Rd.	I	3
105	Monroe	WB Day Rd. & Ann Arbor Rd.	I	3
106	St. Joseph	WB Balk Rd./C.R. 139 & Grim Rd./Sherman Mills Rd.	I	3
107	Lapeer	EB Armstrong/C.R. 7 & M-53/Van Dyke Hwy.	I	3
*108	Saginaw	SB Chapin N./Kane Rd. & Frost Rd.	I	3
109	St. Clair	SB Werner/Ellsworth & Gratiot	I	3
110	Lenawee	NB Ogden Hwy. & US-223	I	3
111	Lapeer	SB Wheeling Rd. & Bowers Rd./M-52	I	3
112	Saginaw	NB Raucholz Rd. & Ithaca Rd.	I	3
*113	Shiawassee	NEB Winegar Rd. & Lansing Rd.	I	3
114	St. Joseph	SB Rosenbaugh Rd./40th St. & Michigan Ave./C.R. 120	I	3
*115	Saginaw	NB East Rd. & Ditch Rd.	I	3
116	Muskegon	EB Heights-Ravenna Rd. & Sullivan Rd.	I	3
117	Saginaw	S/EBD I-675 & Veterans Memorial Parkway (Exit 1)	ER	3
*118	Genesee	NBP I-475 & Bristol Rd./Hemphill/M-121 (Exit #4)	ER	3
119	Calhoun	EBP I-94 & 26 Mile Rd./25 1/2 Mile Rd. (Exit 119)	ER	3
120	Berrien	WBD I-94 & M-239/La Porte (Exit #1)	ER	3
*121	Van Buren	N/EBP US-31/I-196 & M-140 (Exit #18)	ER	3
122	Monroe	NBD I-75 & Huron River Dr. (Exit 26, to South Huron River Drive)	ER	3
123	Genesee	SBD US-23/I-75 & Mount Morris Rd. (Exit #126)	ER	3
*124	Isabella	SBD US-27/US-127 & M-20	ER	3
*125	Genesee	EBD I-69 & Belsay Rd. (Exit #141)	ER	3
126	St. Clair	WBD I-94/I-69 & Water St.	ER	3
127	Wayne	WB 8 Mile Rd. & Beck Rd.	I	4
*128	Wayne	EB Warren Rd. & Wayne Rd.	I	4
129	Wayne	EB McNichols Rd. & Woodward Ave.	I	4
*130	Wayne	NB Canton Center Rd. & Cherry Hill Rd.	I	4
131	Wayne	WB Ecorse Rd. & Pardee Rd.	I	4
132	Wayne	EB Michigan Ave. & Sheldon Rd.	I	4
*133	Wayne	EB Ecorse Rd. & Middlebelt Rd.	I	4
*134	Wayne	NB M-85/Fort Rd. & Emmons Rd.	I	4
135	Wayne	WB Glenwood Rd. & Wayne Rd.	I	4
136	Wayne	NB Haggerty Rd. & 7 Mile Rd.	I	4
*137	Wayne	WB 6 Mile Rd. & Inkster Rd.	I	4
138	Wayne	SB Inkster Rd. & Goddard Rd.	I	4
139	Wayne	SB Merriman Rd. & Cherry Hill Rd.	I	4
140	Wayne	SEB Outer Dr. & Pelham Rd.	I	4
*141	Wayne	NB Meridian Rd. & Macomb Rd.	I	4
142	Wayne	WB Ford Rd. & Venoy Rd.	I	4
*143	Wayne	SWB Vernor Rd. & Gratiot Rd.	I	4
144	Wayne	WB 5 Mile Rd. & Beck Rd.	I	4
145	Wayne	EB 7 Mile Rd. & Livernois Rd.	I	4
*146	Wayne	NB Gunston/Hoover Rd. & McNichols Rd.	I	4

147	Wayne	SB W. Jefferson/ Biddle Ave. & Southfield Rd.	I	4
148	Wayne	EB Goddard Rd. & Wayne Rd.	I	4
*149	Wayne	WB 8 Mile Rd. & Kelly Rd.	I	4
150	Wayne	SB Merriman Rd. & US-12/Michigan Ave.	I	4
151	Wayne	SB Telegraph Rd. & Plymouth Rd.	I	4
*152	Wayne	WB Sibley Rd. & Inkster Rd.	I	4
153	Wayne	NEB Mack Rd. & Moross Rd.	I	4
154	Wayne	WB Annapolis Rd. & Inkster Rd.	I	4
*155	Wayne	SB Greenfield Rd. & Grand River Rd.	I	4
156	Wayne	EB Joy Rd. & Livernois Rd.	I	4
157	Wayne	SEB Conner Ave. & Gratiot Rd.	I	4
158	Wayne	NWB Grand River Rd. & Wyoming Ave.	I	4
159	Wayne	WBP I-96 & Evergreen Rd.	ER	4
160	Wayne	WBP I-94 & Haggerty Rd. (Exit 192)	ER	4
*161	Wayne	NBD I-75 & Gibralter Rd. (Exit 29)	ER	4
162	Wayne	SBP I-75 & Southfield Rd.	ER	4
*163	Wayne	NBD I-275 & 6 Mile Rd. (Exit 170)	ER	4
164	Wayne	NBP I-275 & M-153/Ford Rd. (Exit 25)	ER	4
165	Wayne	NBD I-275 & Eureka Rd. (Exit 15)	ER	4
*166	Wayne	NBP I-75 & Springwells Ave. (Exit 45)	ER	4
167	Wayne	WBD I-94 & Pelham Rd. (Exit 204)	ER	4
168	Wayne	SBD I-75 & Sibley Rd.	ER	4

*Included in the Mini Survey Subsample

APPENDIX B

Calculation of Variances, Confidence Bands, and Relative Error

The variances for the belt use estimates were calculated using an equation derived from Cochran's (1977) equation 11.30 from section 11.8. The resulting formula was:

$$var(r) \approx \frac{n}{n-1} \sum_i \left(\frac{g_i}{\sum g_k}\right)^2 (r_i - r)^2 + \frac{n}{N} \sum_i \left(\frac{g_i}{\sum g_k}\right)^2 \frac{s_i^2}{g_i}$$

where *var(r_i)* equals the variance within a stratum and vehicle type, *n* is the number of observed intersections, g_i is the weighted number of vehicle occupants at intersection *I*, g_k is the total weighted number of occupants for a certain vehicle type at all 42 sites (14 in the mini survey) within the stratum, r_i is the weighted belt use rate at intersection *I*, *r* is the stratum belt use rate, *N* is the total number of intersections within a stratum, and $s_i = r_i(1-r_i)$. In the actual calculation of the stratum variances, the second term of this equation is negligible. If we conservatively estimate *N* to be 2000, the second term only adds 2.1 x 10^{-6} units to the largest variance (Stratum 4). This additional variance does not significantly add to the variance captured in the first term. Therefore, since *N* was not known exactly, the second term was dropped in the variance calculations. The overall estimated variance for each vehicle type was calculated using the formula:

$$var(r_{all}) = \frac{var(r_1) + var(r_2) + var(r_3) + 0.83^2 \times var(r_4)}{3.83^2}$$

The Wayne County stratum variance was multiplied by 0.83 to account for the similar weighting that was done to estimate overall belt use. The 95 percent confidence bands were calculated using the formula:

$$95\%\ Confidence\ Band = r_{all} \pm 1.96 \times \sqrt{Variance}$$

where *r* is the belt use of interest. This formula is used for the calculation of confidence bands for each stratum and for the overall belt use estimate.

Finally, the relative error or precision of the estimate was computed using the formula:

$$RelativeError = \frac{StandardError}{r_{all}}$$

The federal guidelines (NHTSA, 1992, 1998) stipulate that the relative error of the belt use estimate must be under 5 percent.

APPENDIX C

PDA Data Collection Details

During the current study, all data collection was conducted using Personal Digital Assistants (PDAs). The transition from paper to PDA data collection was made primarily to decrease the time necessary to move from the end of the data collection phase of a survey to data analysis. With paper data, there is automatically two to three weeks of additional time built-in while the paper data are being entered into an electronic format. Before making this transition, a pilot study was conducted to compare data collection by PDA to paper. Several key factors were tested during the pilot study including accuracy, volume (speed), ease of use, mechanical issues (i.e. battery life), and environmental issues (i.e. weather, daylight). The pilot study found PDA use to be equal to or better than paper data collection on every factor tested. Before making the change to PDA data collection, electronic versions of the *Site Description Form* and *Observation Form* were developed. The following pages show examples of the electronic forms and discuss other factors related to using PDAs for safety belt data collection.

The goal of adapting the existing paper forms to an electronic format was to create electronic forms that were very similar to the paper forms, while taking advantage of the advanced, built-in capabilities of the PDA. As such, the electronic *Site Description Form* incorporated a built-in traffic counter, used the PDA's calendar function for date entry, and included high resolution color on the screens. The first screen of the *Site Description Form* (Figure 2) allows users to type in the site location (street names and standing location). Observers use the PDA stylus to tap on the appropriate choices of site type, site choice, and traffic control. If a mistake is made, the observer can change the data they have input, simply by tapping on the correct choice. All selected choices appear highlighted on the screen.

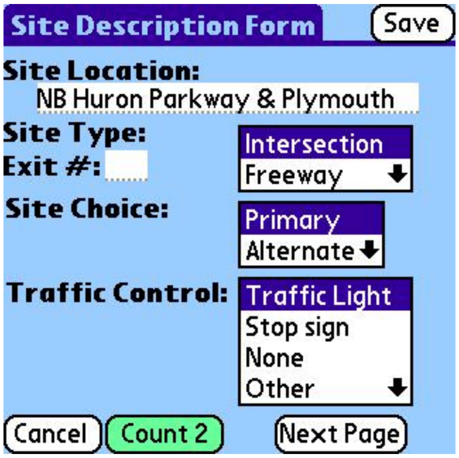

Figure 10. Site Description Form - Screen 1

Screens 2 and 3 are shown in Figure 3. As seen in this figure, observers enter their name, the weather, day of week, and median information simply by tapping the appropriate choice on the display list. Date is entered by tapping on the “Date” button. This brings up a calendar for observers to tap on the appropriate date. Screen 3 allows users to sketch in the intersection and show where they are standing, and to record the start time for the site.

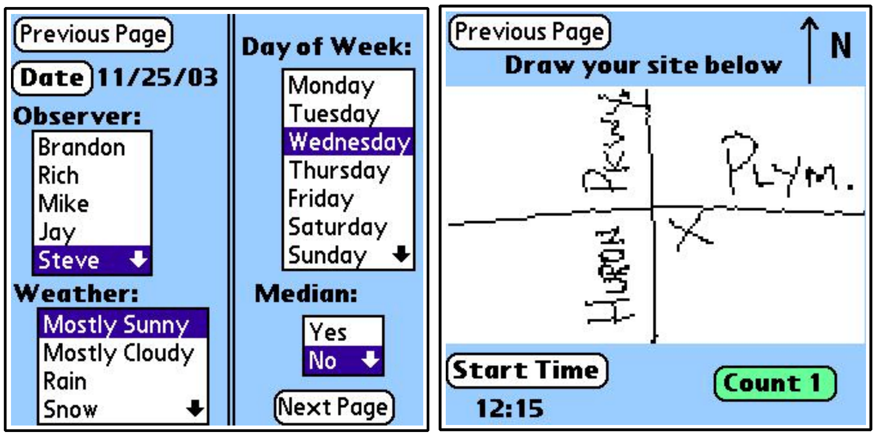

Figure 11. Site Description Form - Screens 2 and 3

In the past, observers had to put away their paper form, get out a mechanical traffic counter, and begin a traffic count after entering the start time. Using a PDA, it is possible to incorporate a traffic counter directly into the *Site Description Form*[7]. Figure 4 shows an example of the electronic traffic counter screen of the *Site Description Form*. To count each vehicle that passes, observers tap on the large “+” button. The size of this button allows the observer to tap the screen while keeping their eyes on the roadway. Each tap increases the count that is displayed at the top of the screen. If a mistake is made, the observer can decrease the count by tapping on the small “-“ button on the left of the screen.

[7]The PDA traffic counting method was compared with a mechanical counter during the pilot testing and no difference was found between the two methods.

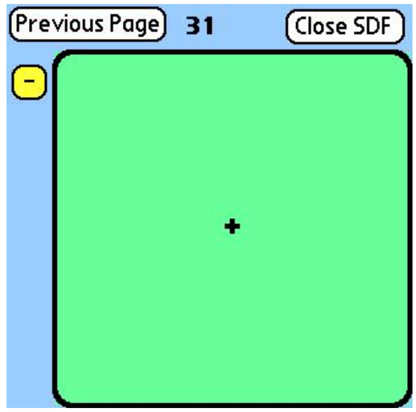

Figure 12. Site Description Form - Traffic Counter Screen

The last screen of the electronic *Site Description Form*, shown in Figure 5, allows the user to enter the end time of the site observation and interruption (if any). Finally, observers can type in any comments regarding the site or traffic flow that may be important.

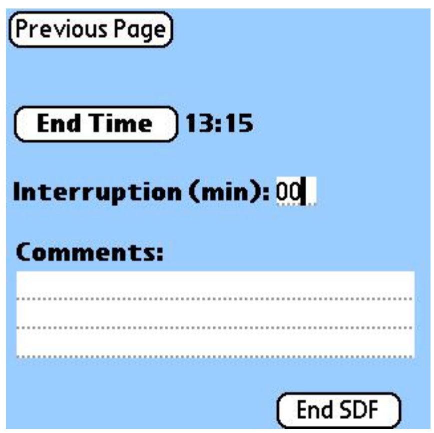

Figure 13. Site Description Form - Final Screen

To allow for easier data entry, the electronic *Observation Form* was divided into three screens, one for driver information, one for front-right passenger information, and one for vehicle information. As shown in Figure 6, each screen is accessible by tapping on the appropriate tab along the top of the screen. The screens have also been designed with different colors, with the driver screen blue, passenger screen green, and vehicle screen yellow. As shown below, the first screen that appears in the form is the driver screen. Each category of data, along with the choices for each category, are displayed on the screen. As in the Site Description Form, users simply tap on the choices that correspond to the motorist that is being observed. These data then appear highlighted on the screen.

Since most motorists are not actively using a cellular phone while driving, “No Cell Phone” is already highlighted as a default. If the motorist is using a cell phone, the proper choice can simply be selected from the list.

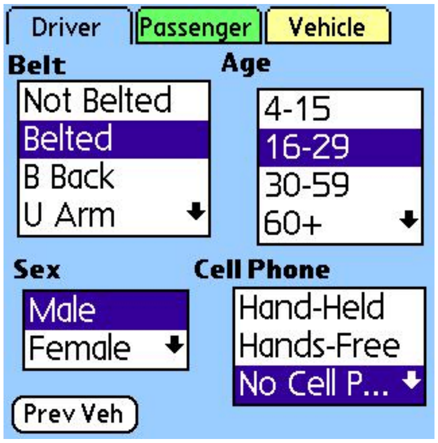

Figure 14. Observation Form - Driver Screen

Figure 7 shows the passenger and vehicle screens from the *Observation Form*. If no passenger is present, users tap on the “No Passenger” area to put a check mark in that box. On the vehicle screen, “Not Commercial” is selected as a default since the majority of observed vehicles are not used for commercial purposes. Once data are complete for one vehicle, observers tap the “Next Vehicle” button to continue collecting data.

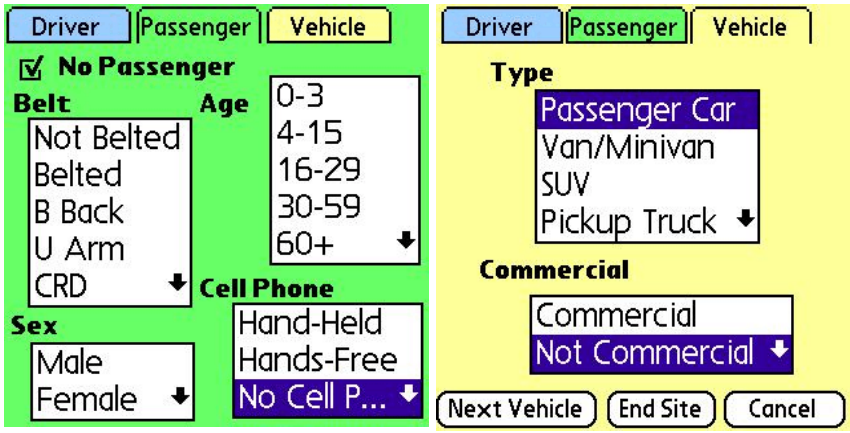

Figure 15. Observation Form - Passenger and Vehicle Screens

Each PDA also had a built-in cellular phone as well as wireless e-mail capability. At regular intervals, usually twice a day, observers e-mailed completed data directly from the PDA to the project supervisor. *Site Description* and *Observation Forms* from completed sites were "zipped," using a compression program, and then transmitted directly to a pre-determined e-mail account. The e-mailing of data allowed the project field supervisor to immediately check data for errors, and begin to compile a data analysis file as the project progressed. After data transmission, the observer transferred the site data from the internal memory of the PDA to a Secure Digital (SD) memory card.