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16. Abstract

Reported here are the results of a direct observation survey of safety belt use conducted in the fall of 2001. In this study, 15,142 occupants traveling in four vehicle types (passenger cars, sport-utility vehicles, vans/minivans, and pickup trucks) were surveyed during August 30 to September 12, 2001. Belt use was estimated for all commercial/noncommercial vehicle types combined (the statewide safety belt use rate) and separately for each vehicle type. 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 82.3 percent. When compared with last year's rate, the current rate shows that safety belt use in Michigan has remained about the same. However, a comparison with the highest rate observed before the introduction of standard enforcement reveals that the current rate reflects a 12.2 percentage point increase. Belt use was 84.5 percent for passenger cars, 81.9 percent for sport-utility vehicles, 86.6 percent for vans/minivans, and 73.2 percent for pickup trucks. For all vehicle types combined, belt use was higher for females than for males, and higher for drivers than for passengers. In general, belt use was high during the morning and evening rush hours. Belt use did not vary systematically by day of week. Belt use was lowest among 16-to-29 year olds, and highest among the 4-to-15 and 60-and-older age groups. Survey results suggest that the implementation of standard enforcement safety belt use laws and the accompanying enforcement and public information efforts have been very effective in increasing safety belt use in Michigan.

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INTRODUCTION

On July 1, 1985, legislation mandating the use of safety belts in the state of Michigan took effect. Prior to this legislation, the belt use rate throughout the state was observed to be about 19 percent (Wagenaar & Wiviott, 1985). Immediately following the introduction of this law, the belt use rate across Michigan increased to more than 60 percent (Eby, Molnar, and Olk, 2000). This dramatic increase was followed by a sharp decline that leveled off at a rate well above the prelaw level. Throughout the rest of the 80s and into the 90s, enforcement campaigns and Public Information and Education (PI&E) programs were implemented, and safety belt use continued to slowly increase. However, it took nearly nine years to match the safety belt use rate observed immediately following the introduction of the mandatory use law (Eby, Molnar, & Olk, 2000). This same trend was reported in many states as they implemented similar safety belt use legislation throughout the mid-1980s (see, e.g., Bunch, Hatsfield, Hinshaw, & Wamack, 1986; Reinfurt Campbell, Stewart, & Stutts, 1990; Ulmer, Preusser, & Preusser, 1994; Williams, Wells, & Lund, 1987).

By 1987, safety belt use across the nation had increased to 42 percent. As a result of highly visible enforcement campaigns and PI&E programs across the country, another increase to about 62 percent belt use was observed by the early 90s. However, it was generally noted that by the mid 90s, many states' safety belt use rates had begun to level off. This trend was also reflected in the estimate of safety belt use observed nationwide. By 1996, safety belt use had only reached 68 percent in the United States (National Highway Transportation Safety Administration, NHTSA, 1997). To counteract this plateau effect, many states began to reexamine the enforcement provision of their safety belt laws.

To address concerns about police harassment and the potential for violations of individual rights, many of the first safety belt use laws were implemented with secondary enforcement provisions (Moffat, 1998). Secondary enforcement allows a police officer to issue a safety belt citation only if he or she stops the vehicle for some other violation. Thus, if a vehicle is otherwise being operated in a legal manner, unbelted occupants in the vehicle cannot be stopped or cited for disobeying the mandatory safety belt use law.

These laws created a distinction between secondary enforcement and standard (primary) enforcement, where an officer can stop a vehicle and cite an occupant solely for failure to wear a safety belt (NHTSA, 1999a).

An analysis of safety belt use rates by state and type of enforcement provision revealed that belt use in states with standard enforcement were about 15 percentage points higher than belt use in states with secondary enforcement (NHTSA, 1997). Given this obvious benefit, many states began legislation to change existing secondary laws to standard enforcement. Since 1993, nine states (including Michigan) and the District of Columbia have enacted such legislation (Insurance Institute for Highway Safety, 2000). Most states reported dramatic increases in belt use since changing to standard enforcement. The average increase in safety belt use was 12.6 percentage points, with the largest increase, of about 22 percentage points, observed in the District of Columbia (Eby, Vivoda, & Fordyce, in press). However, the most recent estimate of nationwide safety belt use, conducted in June 2001, reports a belt use rate of only 73 percent across the country (NHTSA, 2001a). This rate is still far below the nationwide goal of 90 percent set for 2005 (NHTSA, 1997).

In order to collectively increase safety belt use across the country, belt use must be increased within each state. The most significant and cost-effective way for states with secondary enforcement to increase their safety belt use rate is to upgrade their mandatory safety belt law to standard enforcement (Russell, Dreyufuss, & Cosgrove, 1999). Given the dramatic increases that have been observed in nearly all states that have made the change to standard enforcement, repeating this transition in more states would likely result in increased belt use across the country.

While more states contemplate this change, it is important to look to the successes other states have experienced. Michigan recently implemented a successful campaign to increase belt use by changing the safety belt law to standard enforcement. However, simply instituting a legislative change is not enough; these changes must be carefully planned, and once implemented, must be supported and followed up in order to be successful. NHTSA has outlined the steps that were followed throughout the implementation process in Michigan as a guide for other states considering making a change to standard enforcement (NHTSA, 2000). The first step was passing a standard enforcement safety belt law. Several important factors were necessary for this step to be successful. The legislation had strong support from the Governor; the effort was organized, focused, and dealt with opposing issues. Standard enforcement was implemented in Michigan in March, 2000. The second step was highly visible enforcement of the new law. With coordination through the Office of Highway Safety Planning, Michigan experienced widespread cooperation within the law enforcement community. The third step was to implement effective PI&E campaigns. It is critical for safety belt nonusers to understand the benefits and importance of always wearing safety belts. To address this problem, the lowest belt use groups were identified and targeted with traffic safety messages. The final step in Michigan's successful campaign was to build strong partnerships with individuals, corporations, and organizations. The Michigan Safety Belt Coalition is comprised of 95 organizations, as well as individual partners and supporters (NHTSA, 2000).

In a successful campaign to increase belt use, it is also critical to understand the trends that are likely to occur when changing a safety belt law. There has been some indication that changing the enforcement provision of a belt use law would result in a behavioral trend similar to the dramatic increase and subsequent decline reported during the introduction of new mandatory use laws in the 80s. Several of the states that have made this change reported a large increase in belt use, followed by a decline that remained above the prelaw level. The District of Columbia, Oklahoma, and Louisiana all experienced this trend (Morgan & Kickham, 1999; NHTSA, 2001b). There is some evidence to suggest that Michigan may be experiencing a similar trend (Eby, Fordyce, & Vivoda, 2000b; Eby & Vivoda, 2001).

Increases in Michigan's safety belt use have been observed since the implementation of standard enforcement. However, a study conducted in March, 2001, revealed a significant decline in belt use throughout the state (Eby & Vivoda, 2001). The purpose of the current survey is to continue to monitor safety belt use throughout Michigan, in order to track changes that have occurred both prior to and after the change to standard enforcement. The current survey is the twenty-seventh wave in a series of statewide direct observation surveys of safety belt use in Michigan. To continue to maintain and increase safety belt use across the state, it is essential to understand the effect standard enforcement, and other efforts, to increase safety belt use continue to have on overall safety belt use, and on specific segments of Michigan's population.

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 the 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 which 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.

These 28 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 (greater than 54.0 percent), medium belt use (45.0 percent to 53.0 percent), low belt use (44.9 percent or lower), and Wayne County (41.9 percent belt use). The historical belt use rates and VMT by county and strata are shown in Table 1.

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.

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 (24 percent) of the sites within each stratum were freeway exit ramps, while the remaining 32 were roadway intersections.

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

Table 1. Descriptive Characteristics of the Four Strata[2]					
Strata	County	Historical Belt Use, Percent	Belt Use Average, Percent	VMT, billions of miles	Total VMT, billions of miles
1			56.3		17.48
	Ingham	54.3		1.98	
	Kalamazoo	54.3		1.98	
	Oakland	54.5		10.66	
	Washtenaw	62.0		2.86	
2			48.8		17.42
	Allegan	***45.2***		0.86	
	Bay	53.7		1.13	
	Eaton	52.5		0.90	
	Gr. Traverse	47.2		0.63	
	Jackson	46.2		1.41	
	Kent	48.9		4.07	
	Livingston	***48.7***		1.44	
	Macomb	48.0		4.83	
	Midland	***50.7***		0.68	
	Ottawa	47.4		1.45	
3			40.9		17.15
	Berrien	41.6		1.68	
	Calhoun	***43.2***		1.40	
	Genesee	42.8		4.12	
	Lapeer	39.6		0.71	
	Lenawee	44.4		0.82	
	Marquette	39.6		0.56	
	Monroe	44.2		1.53	
	Muskegon	41.8		1.11	
	Saginaw	40.7		1.86	
	Shiawassee	***41.6***		0.64	
	St. Clair	34.1		1.38	
	St. Joseph	***41.6***		0.51	
	Van Buren	36.7		0.83	
4					
	Wayne	41.9	41.9	15.29	15.29

[2]Note: Boldface italic type indicates values estimated from multiple regression. The belt use percentages were used only for statistical purposes in this design. Caution should be taken in interpreting these values.

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.[3] 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 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 randomly chosen. This happened for only two of the sites.

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[3] 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.

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 on 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.

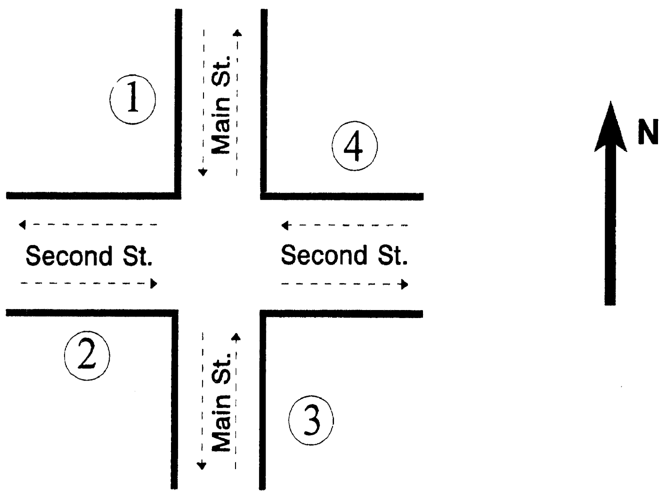

Figure 1. An Example "+" Intersection Showing 4 Possible Observer Locations.

For each chosen 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.[4]

The 10 freeway exit ramp sites within each stratum also were selected so that each exit ramp had an equal probability of selection.[5] 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 side of 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.

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[4]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/.

[5] 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 quasirandomly 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 darkness, a random starting time for the day was selected. In addition, a random number between one 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 to the sites were not correlated with belt use at a site. This pseudorandom 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.[6] Thus the number of vehicles observed at an observation 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

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

under observation 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 every site observed was the primary site and the majority of observations were conducted during sunny weather conditions.

Table 2. Descriptive Statistics for the 168 Observation Sites

Day of Week		Observation Period		Site Choice		Weather	
Monday	13.1%	7-9 a.m.	13.1%	Primary	100.0%	Sunny	76.8%
Tuesday	14.3%	9-11 a.m.	19.0%	Alternate	0.0%	Cloudy	20.2%
Wednesday	11.9%	11-1 p.m.	14.3%			Rain	3.0%
Thursday	17.2%	1-3 p.m.	22.6%			Snow	0.0%
Friday	14.9%	3-5 p.m.	17.3%				
Saturday	15.5%	5-7 p.m.	13.7%				
Sunday	13.1%						
TOTALS	100%		100%		100%		100%

Data Collection

Data collection for the study involved direct observation of shoulder belt use, estimated age, and sex. Trained field staff observed shoulder belt use of drivers and front-right passengers traveling in passenger cars, sport-utility vehicles, vans/minivans, and pickup trucks during daylight hours from August 30 through September 12, 2001. Observations of safety belt use, sex, age, vehicle type, and vehicle purpose (commercial or noncommercial) were conducted when a vehicle came to a stop at a traffic light or a stop sign.

Data Collection Forms

Two forms were used for data collection: a site description form and an observation form. The site description form (see Appendix A) provided descriptive information about the site including the site number, 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 sketch the intersection and to identify observation locations and traffic flow patterns. Finally, a comments section was available for observers 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.

The second form, the observation form, was used to record safety belt use, passenger information, and vehicle information (see Appendix A). Each observation form was divided into four boxes, with each box having room for the survey of a single vehicle. For each vehicle surveyed, shoulder belt use, sex, and estimated age for the driver as well as vehicle type were recorded on the upper half of the box, while the same information for the front-outboard passenger could be recorded in the lower half of the box if there was a front-outboard passenger present. Children riding in child safety seats (CSSs) 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 as belted in the analysis. Based upon NHTSA (1999b) guidelines, the observer also recorded whether the vehicle was commercial or noncommercial. A commercial vehicle is 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. At each site, the observer carried several data collection forms and completed as many as were necessary during the observation period.

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 teams of observers for a period of 30 minutes. Observations at other Wayne County 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 single 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 lane immediately adjacent to the curb for safety belt use, 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 on 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, data collection forms, and administrative policies and procedures. Included in the manual was a site schedule identifying the location, date, time, and traffic leg to be observed for each site (see Appendix B 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 each practice site focused on completing the site description form, 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 separate data collection forms. The forms were then compared for accuracy. Teams were rotated throughout the training to ensure that each observer was paired with every other observer at least eight times. Each observer pair practiced recording safety belt use, sex, and age until there was an interobserver 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 staff visits to the UMTRI office to drop off completed forms and through telephone calls from staff to report progress and discuss problems encountered in the field. Field staff were instructed to call the field supervisor at home if problems arose during evening hours or on weekends.

Incoming data forms 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. Attention was also given to 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).

Data Processing and Estimation Procedures

The site description form and observation form data were entered into an electronic format. The accuracy of the data entry was verified in two ways. First, all data were entered twice and the data sets were compared for consistency. Second, the data from randomly selected sites were reviewed for accuracy by a second party and all site data were checked for inconsistent codes (e.g., the observation end time occurring before the start time). Errors were corrected after consultation with the original data forms.

For each site, computer analysis programs 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.[7] The resulting number was the estimated number of vehicles passing the site if all eligible

[7] 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.

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.

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:

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

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 88 percent as large as the total VMT for the other three strata (see Table 1). In order to represent accurately safety belt use for Michigan by VMT, the Wayne County stratum was multiplied by 0.88 during the averaging to correct for its lower total VMT. The overall belt use rate was determined by the following formula:

$$r_{all} = \frac{r_1 + r_2 + r_3 + (0.88 * r_4)}{3.88}$$

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 C 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 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 (1999b) guidelines, this survey included commercial vehicles. In the sample, only 3.9 percent of occupants were 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.

Overall Safety Belt Use

As shown in Figure 2, 82.3 percent ± 1.4 percent of all front-outboard occupants traveling in either passenger cars, sport-utility vehicles, vans/minivans, or pickup trucks in Michigan during September 2001 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 80.9 percent and 83.7 percent. When compared with the September, 2000 rate of 81.9 ± 1.4 percent, this year's estimated safety belt use rate shows that safety belt use in Michigan has remained about the same over the last year.

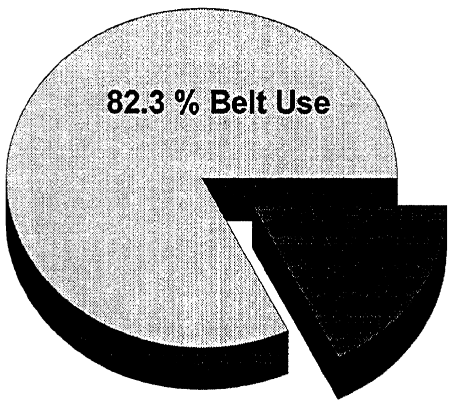

Figure 2. Front-Outboard Shoulder Belt Use in Michigan (All Vehicle Types and Commercial/Noncommercial Combined).

Estimated belt use rates and unweighted numbers of occupants (N) by stratum are shown in Table 3. As is typically found in Michigan, the safety belt use rate for Stratum 1 was the highest in the state, while the use rates for Strata 2, 3, and 4 were lower. There were no significant differences between the use rates in these three strata. When compared with last year's stratum belt use rates of 85.7, 82.7, 79.4, and 79.7 percent for Strata 1 through 4, respectively, we find little change in belt use by stratum from last year.

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

	Percent Use	Unweighted N
Stratum 1	85.1	4,403
Stratum 2	81.5	2,813
Stratum 3	81.3	2,168
Stratum 4	81.1	5,758
STATE OF MICHIGAN	**82.3 ± 1.4 %**	15,142

Estimated belt use rates and unweighted numbers of occupants by stratum and vehicle type are shown in Table 4a to 4d. Within each vehicle type we find no systematic trends in safety belt use by stratum. When compared with last year's results (Eby, Fordyce, & Vivoda, 2000b), we find little change in shoulder belt use for all vehicle types. As expected from previous surveys (e.g., Eby, Fordyce, & Vivoda, 2000b; Eby & Hopp, 1997; Eby & Olk, 1998; Eby, Streff, & Christoff, 1995; Eby, Vivoda, & Fordyce, 1999), the overall belt use rate of 73.2 ± 2.5 percent for pickup trucks was significantly lower than for any other vehicle type (Table 4d). Thus, enforcement and PI&E programs should continue to target pickup truck occupants.

Table 4a. Percent Shoulder Belt Use by Stratum (Passenger Cars)		
	Percent Use	Unweighted N
Stratum 1	87.4	2,298
Stratum 2	84.8	1,411
Stratum 3	83.1	1,028
Stratum 4	82.4	3,384
STATE OF MICHIGAN	**84.5 ± 1.7 %**	8,121

Table 4b. Percent Shoulder Belt Use by Stratum (Sport-Utility Vehicles)		
	Percent Use	Unweighted N
Stratum 1	84.2	668
Stratum 2	79.8	410
Stratum 3	84.7	223
Stratum 4	78.4	751
STATE OF MICHIGAN	**81.9 ± 2.6 %**	2,052

Table 4c. Percent Shoulder Belt Use by Stratum (Vans/Minivans)		
	Percent Use	Unweighted N
Stratum 1	87.1	639
Stratum 2	86.5	440
Stratum 3	88.5	342
Stratum 4	84.0	846
STATE OF MICHIGAN	**86.6 ± 1.7 %**	2,267

Table 4d. Percent Shoulder Belt Use by Stratum (Pickup Trucks)		
	Percent Use	Unweighted N
Stratum 1	76.9	798
Stratum 2	70.1	552
Stratum 3	71.2	575
Stratum 4	74.9	777
STATE OF MICHIGAN	**73.2 ± 2.5 %**	2,702

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, in press), use was higher for occupants in vehicles leaving limited access roadways (exit ramps) than for occupants in vehicles 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 generally highest during the morning and evening rush hours.

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, but no systematic trends 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 between sunny and cloudy weather conditions. Due to the very low number of observations during rainy conditions, we cannot make a meaningful assessment of safety belt use during rainy weather.

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

Age. Estimated safety belt use by age, vehicle type, and all vehicles combined is shown in Table 5. As there were only five 0-to-3 year olds observed in the current study, the estimated safety belt use rate for this age group is not meaningful. Excluding the 0-to-3-year-old age group, safety belt use for all vehicles combined is generally highest for the 4-to-15 and the 60-and-over age groups. Belt use for the 16-to-29-year-old age group consistently shows the lowest belt use rate, with rates for the 30-to-59-year-old age group below that of occupants older than 59 years of age. These results are similar to findings in previous UMTRI studies (see, e.g., Eby, Molnar, & Olk, 2000; Eby, Vivoda, & Fordyce, in press) and show that new drivers and young drivers (16-to-29 years of age) should be one 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 remained essentially the same across all age groups. However, the belt use rate of 77.3 for the 16-to-29-year-old age group continues to be much lower than belt use in the other 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 for drivers is slightly higher than use by front-outboard passengers. This trend was observed in occupants of passenger cars and sport-utility vehicles, but not in occupants of van/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	80.5	10,767	82.9	5,787	80.4	1,459	85.9	1,577	71.4	1,944
Exit Ramp	85.7	4,375	87.6	2,334	85.4	593	87.8	690	77.2	758
Time of Day										
7 - 9 a.m.	83.5	1,854	87.1	941	83.2	254	88.3	322	71.6	337
9 - 11 a.m.	84.4	2,035	87.5	957	85.1	282	85.8	355	76.2	441
11 - 1 p.m.	80.7	2,153	85.0	1,144	73.4	296	79.6	333	72.2	380
1 - 3 p.m.	81.8	2,952	83.3	1,635	82.1	424	87.8	428	72.6	465
3 - 5 p.m.	80.7	3,254	82.1	1,752	80.1	460	86.5	435	73.0	607
5 - 7 p.m.	82.0	2,894	84.7	1,692	78.1	336	86.3	394	74.0	472
Day of Week										
Monday	77.8	2,489	81.8	1,576	77.0	297	85.3	354	65.3	262
Tuesday	85.1	1,918	88.6	924	87.3	270	87.1	308	75.2	416
Wednesday	80.6	1,011	81.2	510	82.5	120	88.2	146	73.6	235
Thursday	83.0	2,356	86.8	1,213	83.4	295	85.1	332	72.8	516
Friday	84.2	3,635	87.1	1,910	84.5	471	86.9	540	76.4	714
Saturday	83.0	1,395	87.7	699	80.5	179	84.6	215	73.6	302
Sunday	83.8	2,338	85.0	1,289	80.4	420	88.8	372	75.6	257
Weather										
Sunny	82.3	11,421	84.3	6,191	82.1	1,551	85.6	1,704	74.6	1,975
Cloudy	82.7	3,161	85.9	1,653	81.1	429	89.4	467	69.9	612
Rainy	81.5	560	82.3	277	87.0	72	95.6	96	63.1	115
Sex										
Male	78.4	8,180	82.0	3,906	75.3	993	83.4	1,157	71.3	2,124
Female	86.8	6,962	86.8	4,215	87.7	1,059	89.8	1,110	80.2	578
Age										
0 - 3	48.8	5	0.0	2	0.0	1	100.0	1	100.0	1
4 - 15	88.0	444	89.4	229	82.1	65	94.2	88	83.3	62
16 - 29	77.3	4,194	80.3	2,694	76.0	493	79.5	291	65.6	716
30 - 59	83.4	8,851	85.9	4,135	83.8	1,382	86.9	1,613	75.2	1,721
60 - Up	87.0	1,645	87.9	1,060	87.3	111	89.4	273	79.5	201
Position										
Driver	82.5	11,863	85.1	6,394	82.0	1,592	86.3	1,692	73.2	2,185
Passenger	81.6	3,279	82.3	1,727	80.8	460	87.6	575	73.5	517

Age and Sex. Table 6 shows estimated safety belt use rates and unweighted numbers (N) of occupants for all vehicle types combined by age and sex. The belt use rates for the two youngest age groups should be interpreted with caution because the unweighted number of occupants is quite low. For better estimates of safety belt use for these age groups in Michigan see Eby, Kostyniuk, Vivoda, & Fordyce (2000); that study was designed to specifically target these age groups. Excluding the youngest age group, 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 most notable difference is found in the 16-to-29-year-old group and the 30-to-59-year-old age group, where the estimated belt use rate is 11.2 percentage points and 8.4 percentage points higher respectively, for females than for males. These results argue strongly for statewide efforts to be directed toward persuading young males, and males in general, to use their safety belts. A comparison of the current safety belt use rates by age and sex with last year's rates reveals that belt use has remained essentially unchanged.

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	50.0	2	21.5	3
4 - 15	85.7	245	90.7	199
16 - 29	71.8	2,231	83.0	1,963
30 - 59	79.6	4,811	88.0	4,040
60 - Up	85.0	889	89.2	756

Historical Trends

The current direct observation survey is the ninth yearly 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 the last several years. Also included in these analyses are four extra statewide surveys that were conducted in January, March, and June 2000, and March 2001, to assess the effect of standard enforcement in Michigan (Eby, Fordyce, & Vivoda, 2000a; Eby & Vivoda, 2001; Eby, Vivoda, & Fordyce, 2000a; Eby, Vivoda, & Fordyce, 2000b).

Overall Belt Use Rate. Figure 3 shows the statewide safety belt use rate for all vehicles combined over the last 8 years. The safety belt use rate has shown a consistent increase over the last 8 years. Since 1994, the safety belt use rate has increased by 19.6 percentage points, with an increase of 12.2 percentage points over the highest rate observed before the introduction of standard enforcement. This finding indicates that efforts to increase safety belt use in Michigan, have been effective and should be continued.

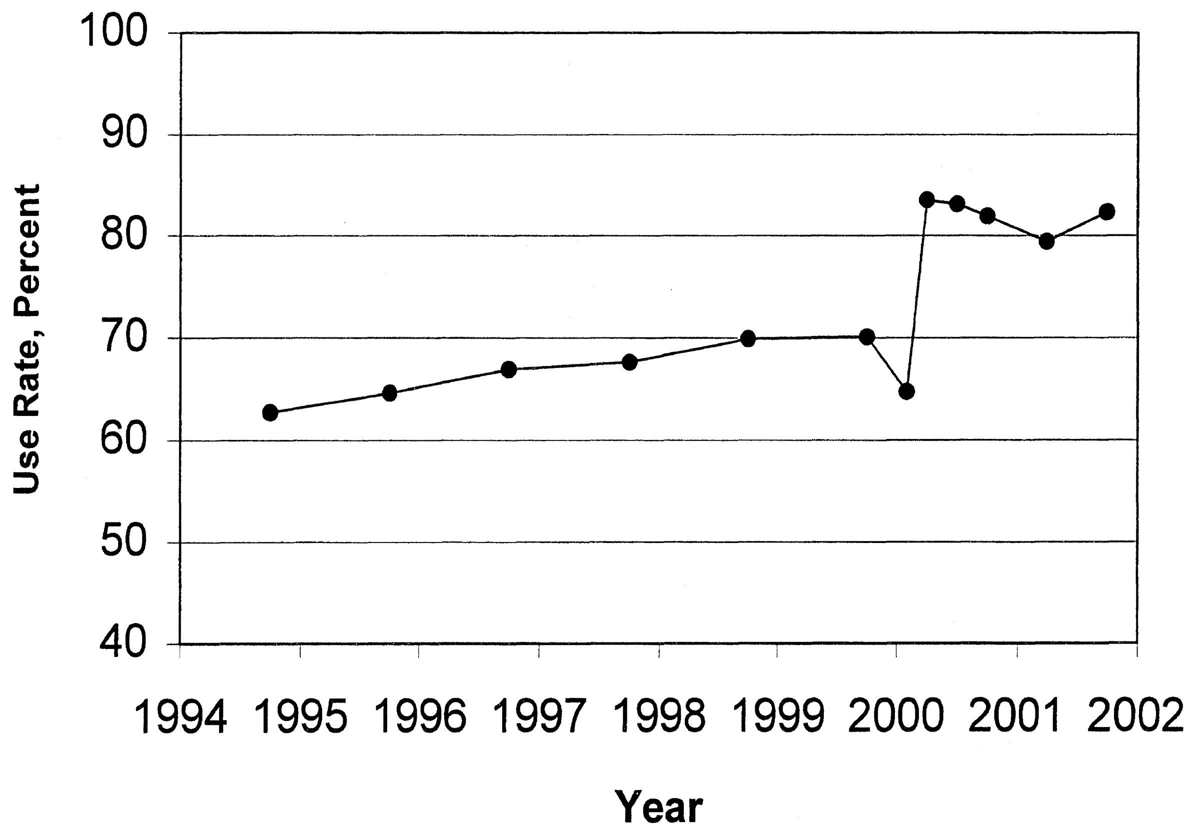

Figure 3. Front-Outboard Shoulder Belt Use by Year (All Vehicle Types Combined).

Overall Belt Use Rate by Stratum. Figure 4 shows the statewide safety belt use rate for all vehicles combined over the last 8 years by stratum. For all strata, there is a general upward trend in safety belt use from 1994 to 2001, with the greatest increase in use found in Stratum 4. Stratum 4 has seen an increase of 25.9 percentage points since 1994, with a 15.3 percentage point increase since standard enforcement was introduced. Since the implementation of standard enforcement legislation and other efforts to increase safety belt use over the last eighteen months, marked increases in the belt use rates have been observed in all strata.

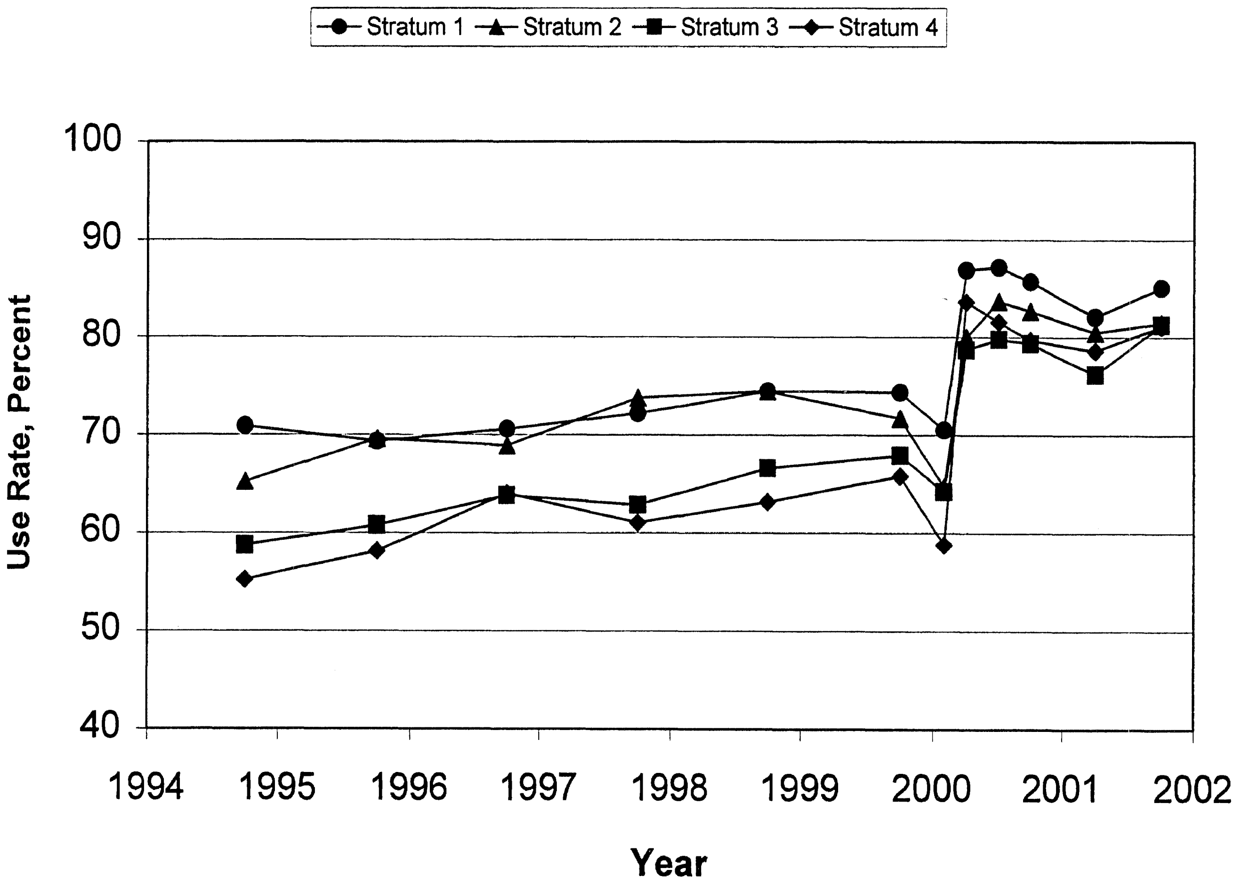

Figure 4. Front-Outboard Shoulder Belt Use by Year and Stratum (All Vehicle Types Combined).

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. The difference in use rates has remained fairly consistent over the last 8 years, with the use rate for freeway exit ramps higher than for local intersections.

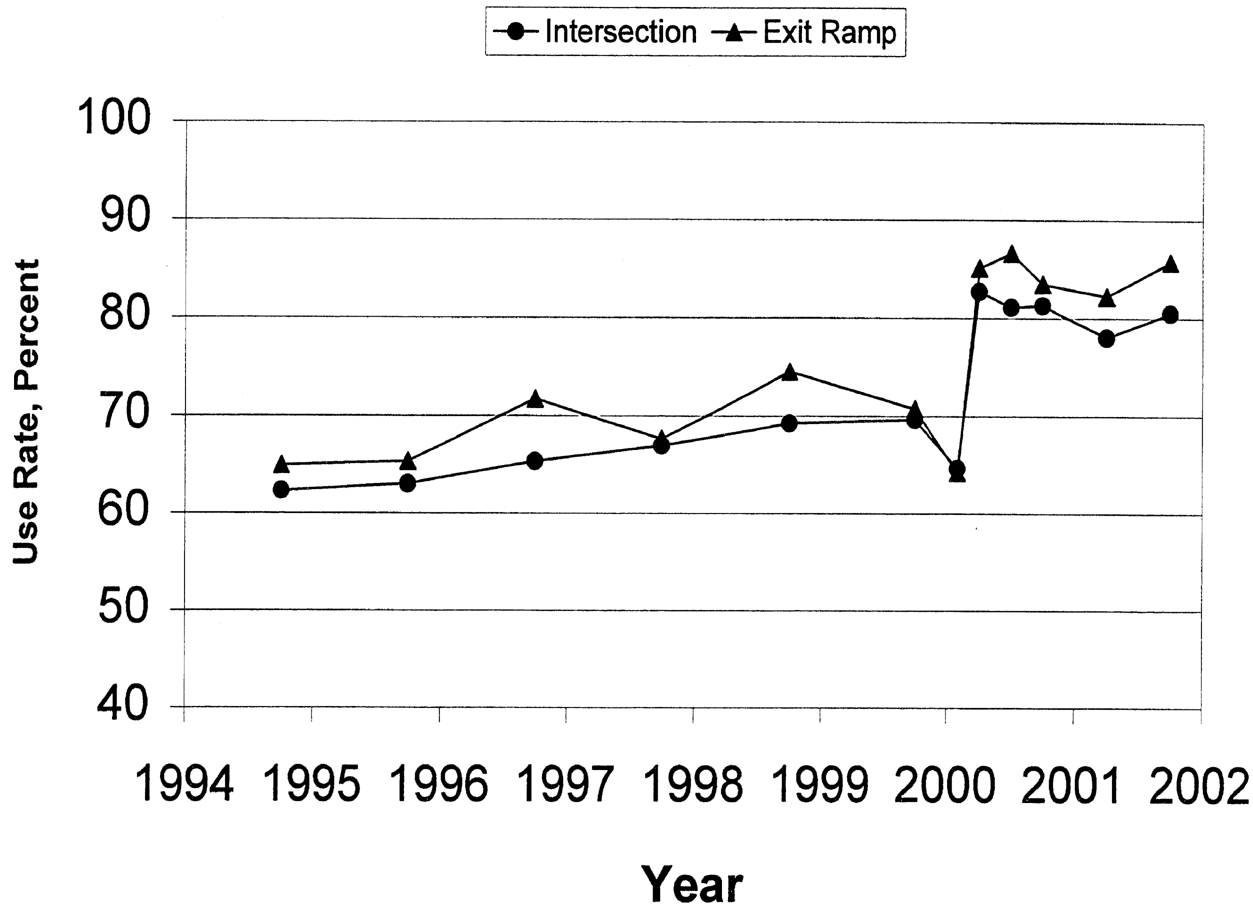

Figure 5. Front Outboard Shoulder Belt Use by Site Type and Year (All Vehicle Types Combined).

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 standard enforcement legislation, were observed within each sex.

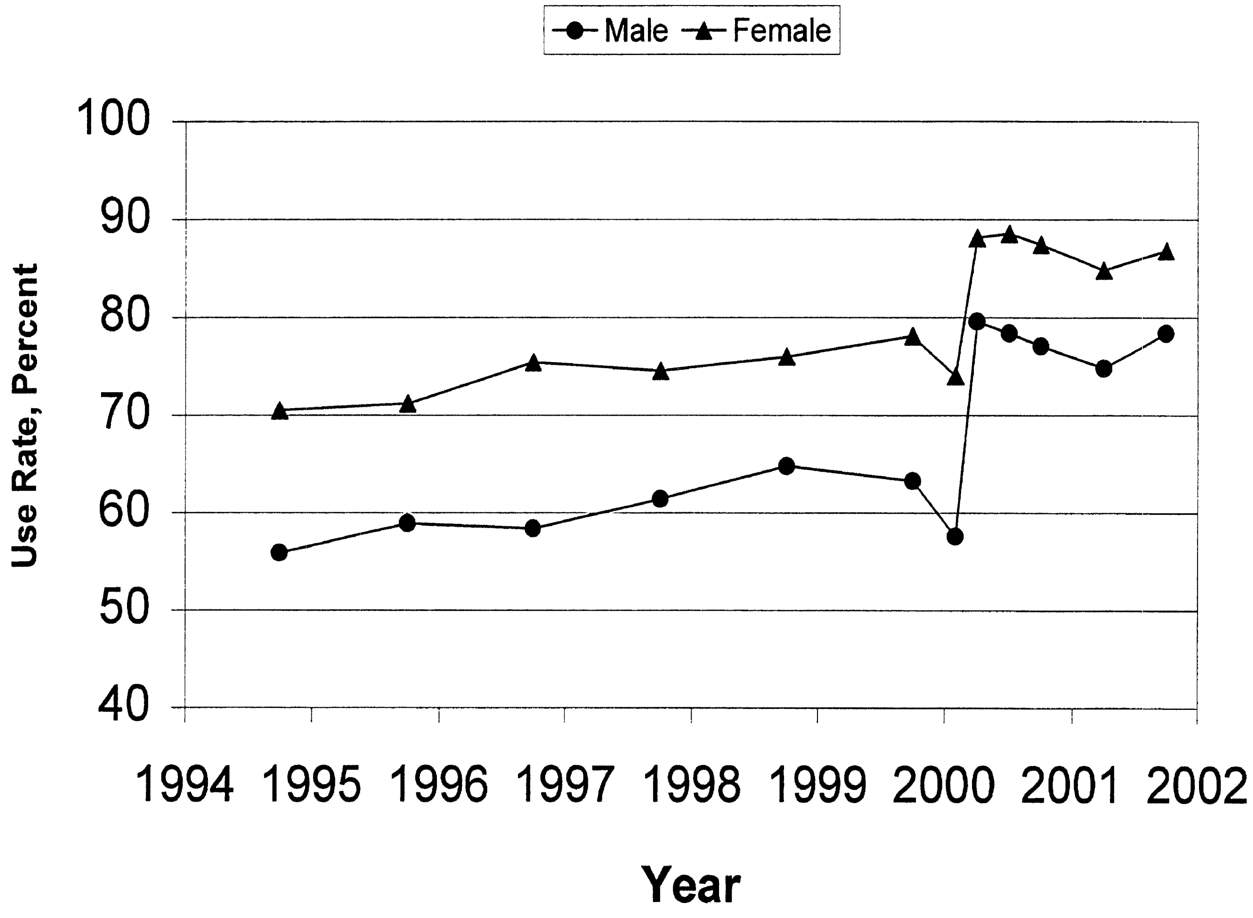

Figure 6. Front-Outboard Shoulder Belt Use by Sex and Year (All Vehicle Types Combined).

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, with little change in the absolute difference between the two.

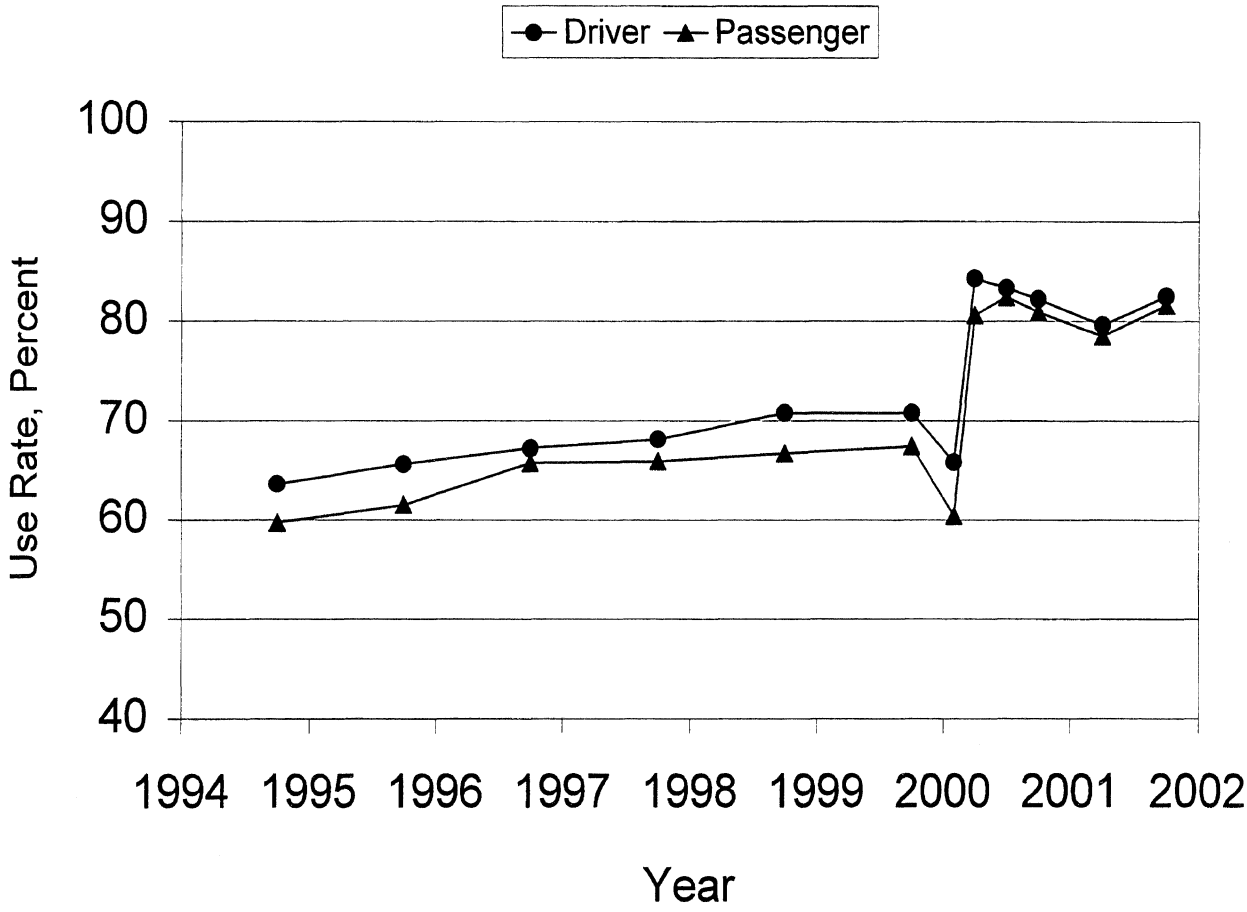

Figure 7. Front-Outboard Shoulder Belt Use by Seating Position (All Vehicle Types Combined).

Belt Use by Age. Figure 8 shows front-outboard safety belt use by age group over the last 8 years 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 observed within the 60-up age group. These trends continue to be evident in the current survey, with significant increases noted within all of the age groups since the introduction of standard enforcement.

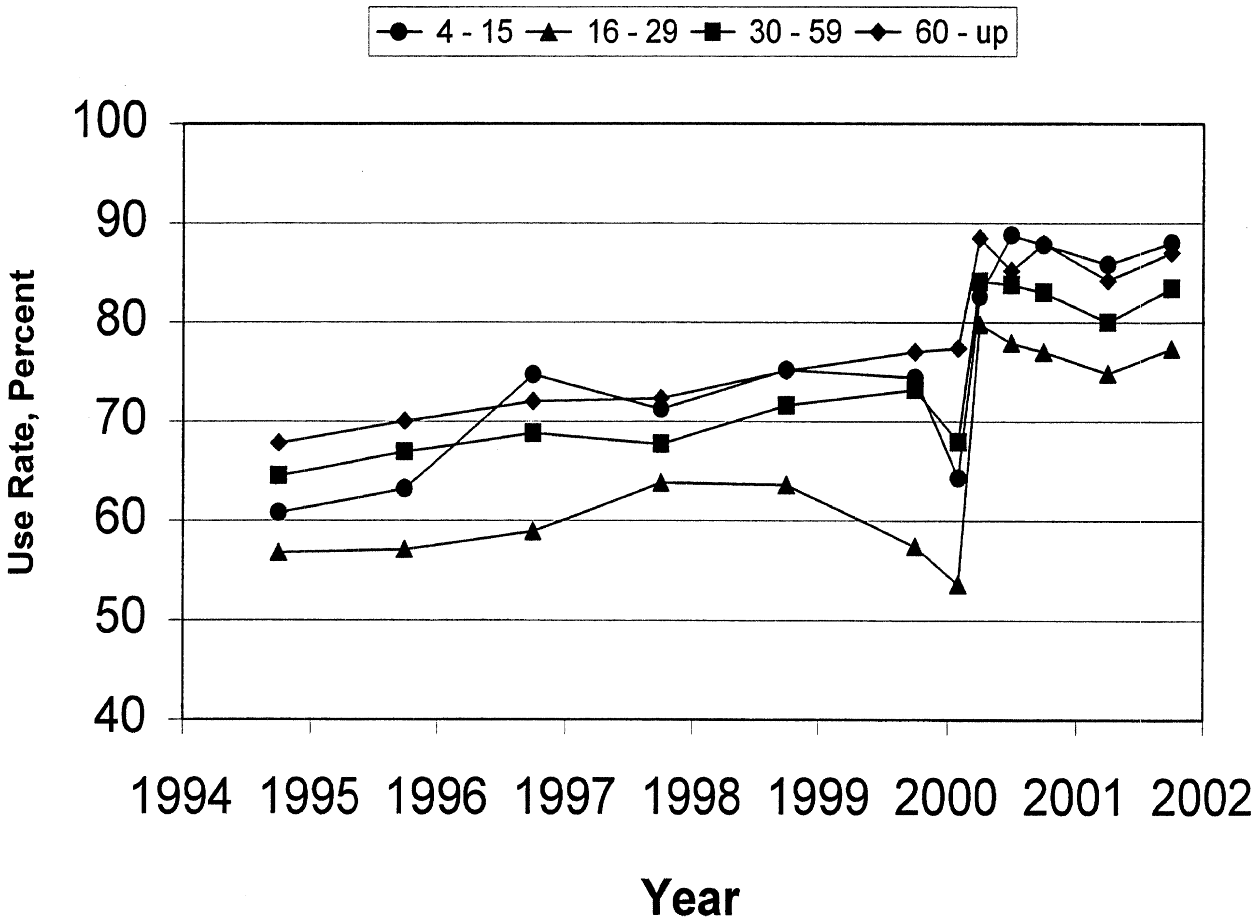

Figure 8. Front-Outboard Shoulder Belt Use by Age and Year (All Vehicle Types Combined).

Belt Use by Vehicle Type and Year. Figure 9 shows motor vehicle occupant belt use by the type of vehicle over the last 9 years. 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 (28.3 percentage points since 1994) has been observed in the belt use rates of pickup truck occupants. However, these occupants continue to be less likely to use a safety belt than occupants of other types of vehicles.

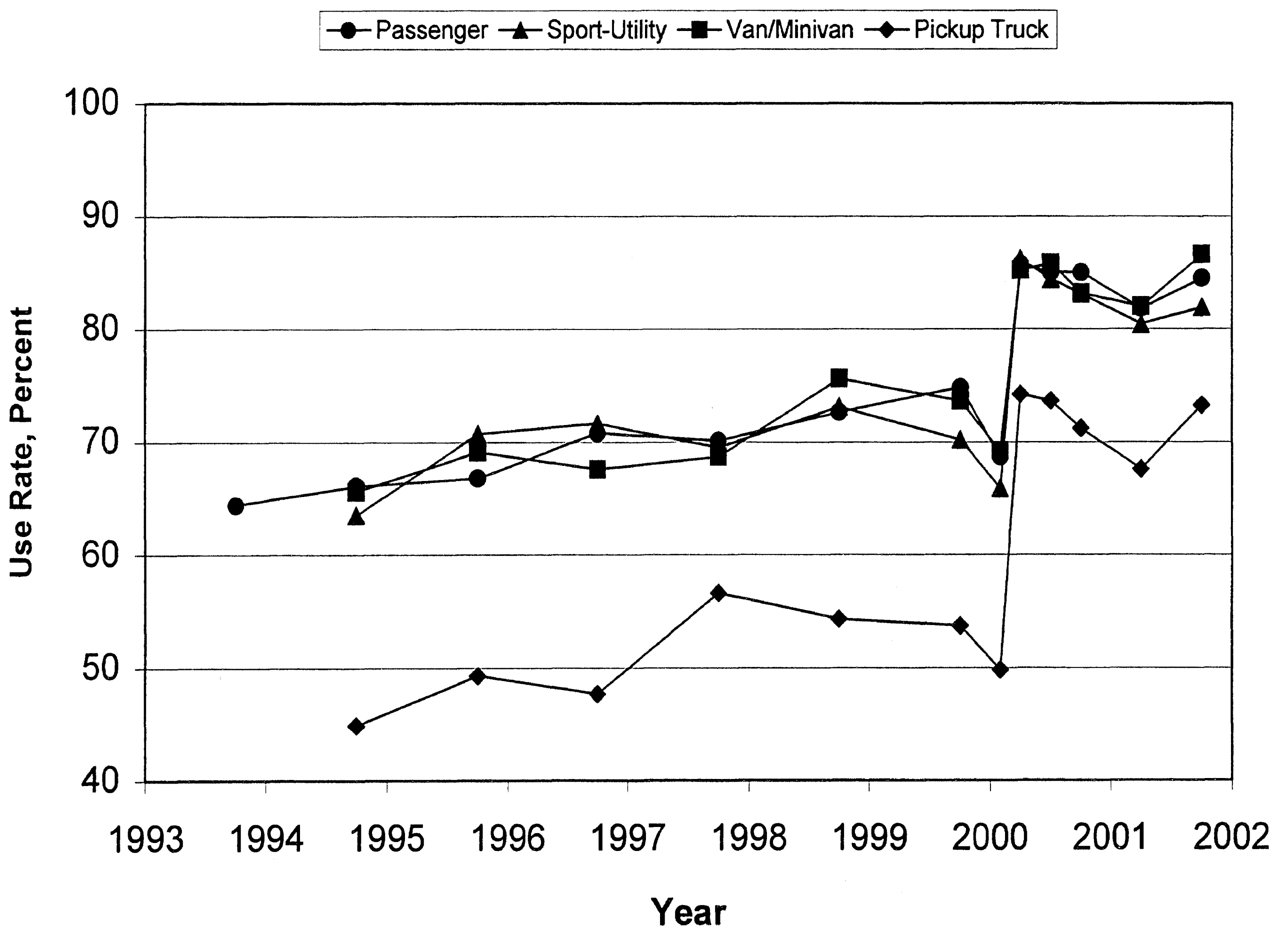

Figure 9. Front-Outboard Shoulder Belt Use by Vehicle Type and Year.

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 82.3 ± 1.4 percent. When compared with the September, 2000 combined use rate of 81.9 ± 1.4 percent (Eby, Fordyce, & Vivoda, 2000b), the current rate shows that front outboard shoulder belt use in Michigan has remained about the same. However, a comparison with the highest rate observed before the introduction of standard enforcement (70.1 ± 2.2 percent, recorded in 1999) reveals that the current rate reflects a 12.2 percentage point increase (Eby, Vivoda, & Fordyce, 1999). Furthermore, the safety belt use rate for all vehicle types combined from 1994 until now (see Figure 3), shows that belt use in Michigan has increased by 19.6 percentage points since 1994. This finding indicates that efforts to increase safety belt use in Michigan, particularly the implementation of standard enforcement legislation in March, 2000, have been effective.

Since the introduction of standard enforcement, several additional statewide direct observation surveys of safety belt use have been completed in order to track the effect of the new legislation. A study conducted immediately following the change in the law revealed a rate of 83.5 ± 1.3 percent; this was the highest safety belt use rate ever observed in Michigan (Eby, Fordyce, & Vivoda, 2000a). In June, 2000, three months after the change, the statewide rate was 83.1 ± 1.5 percent (Eby, Vivoda, & Fordyce, 2000b). In September, 2000, the annual statewide survey revealed a rate of 81.9 ± 1.4 percent (Eby, Fordyce, & Vivoda, 2000b). While each of these surveys report a lower use rate than the immediately previous study, the difference is not statistically significant. However, a study conducted exactly one year after the implementation of standard enforcement, revealed a rate of 79.4 ± 2.0 percent (Eby & Vivoda, 2001). This rate is significantly lower than the highest observed use rate, recorded in March, 2000. These results suggest that the overall safety belt use rate in Michigan may have begun to decline in the year following the introduction of standard enforcement. However, the belt use rate observed in the current survey shows that this trend is reversing.

Creating a new law, or changing an existing law, often results in a predictable pattern of behavior. For example, when Michigan first implemented a mandatory safety belt use law in 1985, there was a dramatic increase in belt use immediately following the implementation of the new law. This increase was followed by a decline in use to a level that remained substantially higher than the prelaw level (see, e.g., Eby, Molnar, & Olk, 2000). A concerted effort was made in Michigan to change this behavioral trend. After the law was implemented, intensive and carefully scheduled enforcement campaigns and PI&E programs continued, in an attempt to stabilize and continue to increase safety belt use in Michigan. The current rate of 82.3 ± 1.4 percent is not significantly different from the rate observed in March, 2000. This suggests that safety belt use in Michigan may have leveled off. Additionally, this result suggests that the efforts made by the traffic safety community have been effective in establishing the dramatic increase in safety belt use as a permanent change.

Comparing results over survey years indicates that progress has been made in increasing safety belt use among segments of Michigan's population least likely to use safety belts; travelers in Wayne County, 16-to-29 year olds, males, and pickup truck occupants. For example, the results from the current survey continue to show higher use rates in Stratum 4, which includes the city of Detroit. This stratum has traditionally had the lowest belt use in the state of Michigan. The current safety belt use rate of 81.1 in Stratum 4 is 2.5 percentage points higher than last year's rate, and has increased a total of 25.9 percentage points since 1994. The majority of this increase corresponded with the change to standard enforcement, indicating that the legislative change, recent enforcement efforts, and PI&E programs have been effective in increasing safety belt use among the Wayne County population. While current programs have been effective, the Wayne County residents who remain unbelted are likely to be the most difficult to reach. Therefore, current efforts must be maintained and new programs developed to further increase safety belt use among this segment of the population.

Some progress has also been made in increasing safety belt use among 16-to-29 years olds. Safety belt use rates have increased among 16-to-29 year olds by more than 20 percentage points since 1994; however, in the current study, belt use for the 16-to-29-

year-old age group was still the lowest of any age group, as is typically found. NHTSA has recognized that current traffic safety messages for this age group may not be cognitively appropriate and has begun an effort to better understand cognitive development and the factors which influence thinking in young drivers (see, e.g., Eby & Molnar, 1999). For instance, arguments should be presented in a positive framework. For example, it is more effective to say, "drive while you are alert and conscientious" than to say "do not drink and drive." Additionally, young drivers, in particular males, tend to overestimate their driving skills and underestimate the skills of others (optimism bias), and, therefore tend to perceive their crash risk as less than others; inclusion of peer-group testimonials that address this optimism bias might be effective in overcoming this incorrect reasoning. Such information may allow for the development of more appropriate traffic safety messages to continue to increase safety belt use among this age group.

From 1994 through 1999, statewide safety belt survey results reflect an increase of only 7.4 percentage points in the safety belt use rate for males. However, since standard enforcement was introduced, there has been an additional 15.1 percentage point increase in males' belt use, bringing the total increase to 22.5 percentage points. This finding suggests that statewide efforts to increase belt use for males have been effective over the last eight years and should be continued and intensified. In every survey, including the current survey, the safety belt use rate is higher for females than for males. Despite the fact that female belt use is significantly higher than male belt use, females should not be ignored in PI&E efforts--their current belt use rate of 86.8 percent is still below the national goal of 90 percent by 2005.

Over the past eight years, the safety belt use rate of pickup truck occupants has increased from 44.9 percent in 1994 to the current rate of 73.2 percent. The majority of this change has occurred since standard enforcement was introduced. A comparison across the years of safety belt use among pickup truck occupants shows that significant strides have been made in increasing belt use among this population. However, further analysis of this population reveals that these occupants continue to be less likely to use safety belts than occupants of all other vehicle types (see, e.g., Eby, Molnar, & Olk, 2000; Eby, Vivoda, & Fordyce, in press). This drastic and consistent difference suggests that occupants of pickup trucks may represent a unique population in Michigan, and therefore could benefit from specially designed programs. Research has shown that the main demographic differences between the driver/owners of pickup trucks and passenger cars is that driver/owners of pickup trucks are more likely to be male, have higher household incomes, and lower educational levels (Anderson, Winn, & Agran, 1999). This information provides a starting point for the development of programs designed to influence pickup truck occupant safety belt use.

Belt use by the various subcategories showed the usual trends that have been observed in Michigan over the past eight years (Eby, Molnar, & Olk, 2000; Eby, Vivoda, & Fordyce, in press). Belt use was higher for exit ramps than for intersections. This difference in use rates has remained consistent over the last eight years. As discussed by Slovic (1984; see also Eby & Molnar, 1999), this finding may show that people judge whether to use a safety belt on a trip-by-trip basis and erroneously consider travel on limited-access roadways as less safe than travel on other roadways. Such erroneous reasoning could be addressed in PI&E programs.

Safety belt use for drivers has been consistently higher than for passengers over the past eight years, although both have increased. Our analysis indicates that new efforts should be made to encourage passengers to use safety belts. Further research is essential to better understand the dynamics of passenger belt use in order to develop appropriate and effective PI&E programs.

The analysis of safety belt use by vehicle type showed that occupants in passenger cars, sport-utility vehicles, and vans/minivans used safety belts at a rate above 81 percent (see Figure 9), a significant increase over the pre-standard enforcement studies. Previous UMTRI studies have typically found that there is no difference in safety belt use rates between occupants of these three vehicle types (see, e.g., Eby, Molnar, & Olk, 2000; Eby, Vivoda, & Fordyce, in press). However, in the current survey a statistical analysis revealed that the use rate of van/minivan occupants was significantly higher than the rate of sport-utility vehicle occupants. There is no obvious explanation for this finding and more research is necessary to understand the demographic and behavioral differences among occupants of different vehicle types.

Collectively, these findings suggest that the change to standard enforcement, along with recent enforcement efforts and PI&E programs by local and state police agencies, have been effective in increasing and maintaining safety belt use in Michigan over the last eight years. Recent programs have specifically targeted groups identified as having low safety belt usage rates (Michigan Office of Highway Safety Planning, 2000). In fact, the largest increases in safety belt use have been observed in the segments of Michigan's population least likely to use safety belts. These results suggest that vehicle occupants that still remain unbelted are those that are the hardest to reach. It is therefore particularly important that enforcement campaigns and PI&E programs continue. Focused programs designed to target the remaining non-users, and comprehensive efforts such as 'Click It or Ticket' must continue if the national goal of 90 percent belt use by 2005 (NHTSA, 1997), and Michigan's goal of maintaining at least 80 percent compliance are to be realized.

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APPENDIX A

Data Collection Forms

SITE DESCRIPTION 2001

SITE # __ __ __ (1 2 3)   SITE LOCATION ________________________________

SITE TYPE
1☐ Intersection
2☐ Freeway
4

Exit No. ________

SITE CHOICE
1☐ Primary
2☐ Alternate
5

TRAFFIC CONTROL
1☐ Traffic Light
2☐ Stop sign
3☐ None
4☐ Other ________________
6

DATE (month/day): __ __/__ __/2001 (7 8 9 10)

OBSERVER
1☐ Steve
2☐ Aron
3☐ Joe
4☐ Jane
5☐ Jonathon
6☐ Linda
7☐ Dave
11

DAY OF WEEK
1☐ Monday
2☐ Tuesday
3☐ Wednesday
4☐ Thursday
5☐ Friday
6☐ Saturday
7☐ Sunday
12

WEATHER
1☐ Mostly Sunny
2☐ Mostly Cloudy
3☐ Rain
4☐ Snow
13

START TIME: __ __:__ __ (24 hour clock) (14 15 16 17)   END TIME: __ __:__ __ (24 hour clock) (18 19 20 21)

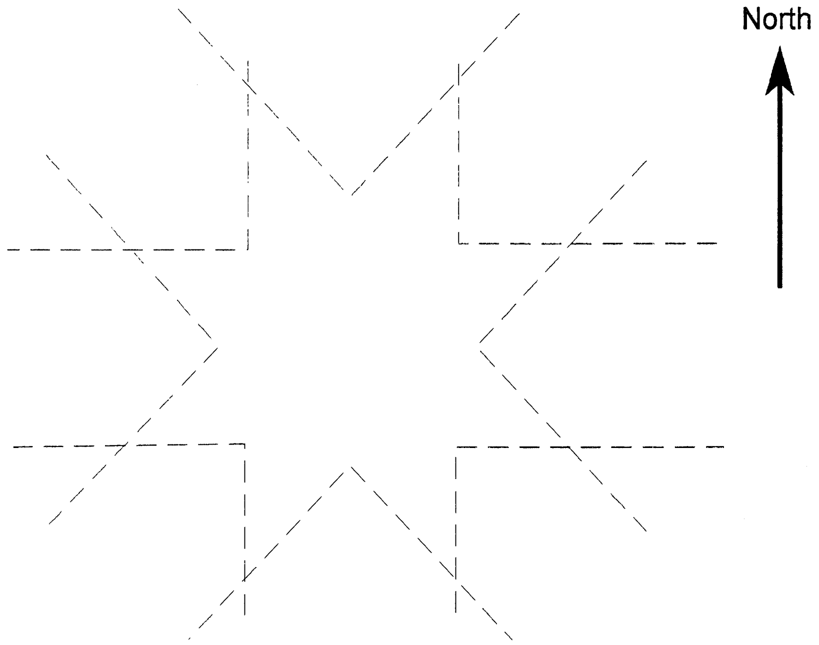
INTERRUPTION (total number of minutes during observation period): __ __ (22 23)

MEDIAN: 1☐ Yes
2☐ No
24

TRAFFIC COUNT 1: __ __ __ (25 26 27)

TRAFFIC COUNT 2: __ __ __ (28 29 30)

COMMENTS::



SITE # ___ ___ ___ PAGE #________
1 2 3

ATTENTION CODING: DUPLICATE COL 1 - 3 FOR ALL VEHICLES

DRIVER	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 4	1☐ Male 2☐ Female 5	2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 6	VEHICLE TYPE 1☐ Passenger car 2☐ Van 3☐ Utility 4☐ Pick-up 7	
FRONT-RIGHT PASSENGER	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD 8	1☐ Male 2☐ Female 9	1☐ 0 - 3 2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 10	Office Use Only: ___ ___ ___ 11 12 13	COMM. VEHICLE 1☐No 2☐Yes 14

DRIVER	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 4	1☐ Male 2☐ Female 5	2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 6	VEHICLE TYPE 1☐ Passenger car 2☐ Van 3☐ Utility 4☐ Pick-up 7	
FRONT-RIGHT PASSENGER	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD 8	1☐ Male 2☐ Female 9	1☐ 0 - 3 2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 10	Office Use Only: ___ ___ ___ 11 12 13	COMM. VEHICLE 1☐No 2☐Yes 14

DRIVER	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 4	1☐ Male 2☐ Female 5	2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 6	VEHICLE TYPE 1☐ Passenger car 2☐ Van 3☐ Utility 4☐ Pick-up 7	
FRONT-RIGHT PASSENGER	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD 8	1☐ Male 2☐ Female 9	1☐ 0 - 3 2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 10	Office Use Only: ___ ___ ___ 11 12 13	COMM. VEHICLE 1☐No 2☐Yes 14

DRIVER	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 4	1☐ Male 2☐ Female 5	2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 6	VEHICLE TYPE 1☐ Passenger car 2☐ Van 3☐ Utility 4☐ Pick-up 7	
FRONT-RIGHT PASSENGER	1☐ Not belted 2☐ Belted 3☐ B Back 4☐ U Arm 5☐ CRD 8	1☐ Male 2☐ Female 9	1☐ 0 - 3 2☐ 4 - 15 3☐ 16 - 29 4☐ 30 - 59 5☐ 60+ 10	Office Use Only: ___ ___ ___ 11 12 13	COMM. VEHICLE 1☐No 2☐Yes 14

APPENDIX B

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	Genesee	SB Van Slyke Rd. & Maple Ave.	I	3
086	Monroe	WB Ida Center Rd. & Summerfield Rd.	I	3
087	Saginaw	WB Baldwin Rd. & Fowler Rd.	I	3
088	Calhoun	NB 23 Mile Rd. & V Drive N.	I	3
089	Saginaw	WB Wadsworth Rd. & Portsmouth Rd.	I	3
090	Lenawee	WB Slee Rd. & US-223	I	3
091	Van Buren	WB 36th Ave. & M-40	I	3

092	Van Buren	EB 63rd Ave. & County Rd. 652	I	3
093	Lapeer	WB McKeen Lake Rd. & Flint River Rd.	I	3
094	St. Joseph	NB Thomas Rd. & US-12	I	3
095	Saginaw	WB Rathbun Rd. & Moorish Rd.	I	3
096	Berrien	NB Fikes Rd. & Coloma Rd.	I	3
097	Genesee	WB Hegal Rd. & M-15/State Rd.	I	3
098	Lapeer	EB M-90 & M-90/M-53	I	3
099	Saginaw	NB Thomas Rd. & Swan Creek Rd.	I	3
100	Lenawee	WB Pixley Rd. & Deer Field Rd./Beaver Rd.	I	3
101	Van Buren	NB County Rd. 665 & M-40	I	3
102	Van Buren	WB County Rd. 374 & Red Arrow Hwy./St Joseph Rd..	I	3
103	Calhoun	SEB Michigan Ave./Austin Rd. & 28 Mile Rd./N. Eaton Rd.	I	3
104	St. Clair	WB Norman Rd. & M-19/Emmett Rd.	I	3
105	Monroe	EB Oakville-Waltz Rd. & Sumpter Rd.	I	3
106	Berrien	WB Glenlord Rd. & Washington Ave.	I	3
107	Muskegon	NB Whitbeck Rd. & Fruitvale Rd.	I	3
108	Monroe	SB Petersburg Rd. & Ida West Rd./Division Rd.	I	3
109	St. Clair	WB Masters Rd. & M-19	I	3
110	St. Joseph	SB Zinmaster Rd. & M-60	I	3
111	Shiawassee	NB State Rd. & Lansing Rd.	I	3
112	Van Buren	EB Celery Center Rd. & M-51	I	3
113	Shiawassee	SB Geeck Rd. & M-21	I	3
114	Muskegon	SB Holton Duck Lake Rd. & Ryerson Rd./ Fourth St.	I	3
115	Berrien	WB Glenlord Ave. & Hollywood Rd.	I	3
116	Lenawee	SB S. Piotter Hwy & Deer Field Rd.	I	3
117	Monroe	SBP I-75 & Front St./Monroe St. (Exit 13)	ER	3
118	Lapeer	WBD I-96 & Nepessing Rd. (Exit 153)	ER	3
119	Lapeeer	EBP I-69 & Lake Pleasant Rd. (Exit 163)	ER	3
120	Berrien	WBD I-94 & US-33/M-63/Niles Rd. (Exit 27)	ER	3
121	Van Buren	EBP I-94 & 64th St. (Exit 46, Hartford)	ER	3
122	Van Buren	EBD I-94 & County Rd. 652/Main St.(Exit 66)	ER	3
123	Muskegon	NBD US-31 & M-46/Apple St.	ER	3
124	Van Buren	NBP I-196 & M-140 (Exit 18)	ER	3
125	Calhoun	WBD I-94 & 26 Mile Rd.	ER	3
126	Monroe	NBP US-23 & Ida-West Rd. (Exit 13)	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

APPENDIX C

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:

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

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 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 2.1×10^{-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:

$$var(r_{all}) = \frac{var(r_1) + var(r_2) + var(r_3) + 0.88^2 \times var(r_4)}{3.88^2}$$

The Wayne County stratum variance was multiplied by 0.88 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.