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Coping with the Aging Driving Population

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16. Abstract

In recent years, there has been increased attention given to older drivers and their role in highway safety. Highly publicized crashes, increases in older driver fatality rates, and other related factors have been the basis for policy revisions, educational campaigns, and additional research aimed at reducing the safety risks associated with older drivers. Thus, this research project offers the following information to the MassDOT Registry of Motor Vehicles (RMV) Division, and other stakeholders, for possible implementation: alternative licensing strategies and/or restrictions for older drivers; an analysis of existing state regulations relevant to older drivers; and a qualitative reflection regarding the mobility options available to older adults that no longer drive. The research approach was generated by a multifaceted review of published and unpublished literature, an analysis of older driver crash characteristics, an analysis of the existing infrastructure for providing a network of mobility options for older adults that no longer drive, and a nationwide survey of State DOTs. The analysis of these specific project elements resulted in recommendations for improvements in Massachusetts regarding both licensing renewal practices and the potential implementation of alternative systems within existing mobility network for older adults.

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Coping with the Aging Driving Population

Final Report

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Executive Summary

This study, "Coping with the Aging Driving Population," was conducted by the University of Massachusetts and undertaken as part of the Massachusetts Department of Transportation (MassDOT) Research Program. The MassDOT program is funded with Federal Highway Administration (FHWA) Statewide Planning and Research (SPR) funds. Through this program, applied research is conducted on topics of importance to the Commonwealth of Massachusetts transportation agencies.

In recent years, there has been increased attention given to older drivers and their role in highway safety. Highly publicized crashes, an increase in older driver fatality rates, and other related factors have been the basis for policy revisions, educational campaigns, and additional research in order to reduce the numerous safety risks associated with older drivers. Existing research has identified that older driver safety and mobility are important factors to consider when developing highway safety programs and policies. Although there is general consensus among the highway safety community regarding the importance of addressing the issues surrounding older drivers, there is less agreement as to how we can effectively implement programs and policies that both improve the safety of this population, and also account for the importance of older drivers' continued mobility when they no longer drive. While licensing policy and regulations have the potential to improve older driver safety, it is imperative to simultaneously support alternative means for maintaining mobility for older adults who no longer drive. Continuing to develop alternative means of mobility for non-driving older adults is essential given the fact that the mobility network available to them is complex in nature with many moving parts across a myriad of agencies and stakeholders.

Thus, this research project offers the following information to the MassDOT Registry of Motor Vehicles (RMV) Division, and other stakeholders, for possible implementation: alternative licensing strategies and/or restrictions for older drivers; an analysis of existing state regulations relevant to older drivers; and a qualitative reflection regarding the mobility options available to older adults that no longer drive.

The research approach was generated by a multifaceted review of published and unpublished literature. The initial step was to document available literature regarding licensing and renewal practices that had the potential to yield practical recommendations for the improvement of such practices in Massachusetts. A second review of the literature focused on various approaches to alternative transportation that are being utilized across the United States. In addition to these literature reviews, the research included an analysis of data sources available in Massachusetts. From these, we sought to determine the nature of older driver crash characteristics, and also analyzed the circumstances of existing state infrastructures, including public transportation and community organizations that provide a network of mobility for older adults in Massachusetts. As part of the research approach, a survey was administered to state Departments of Transportation (DOTs) for the purpose of determining the varying practices undertaken relating to older driver licensing and alternative transportation. The analysis of these specific project elements resulted in recommendations

for improvements in Massachusetts regarding both licensing renewal practices and alternatives to the existing mobility network for older adults within the Commonwealth. Below is a summary of the resulting recommendations.

1. Consider graduated licensing (or de-licensing) as an option for improving older driver safety. The success of graduated licensing for teen drivers serves as a foundation not only supporting the potential for reducing crash frequency and severity, but also for the palatability of this as a policy approach.
2. Allocate state resources in order to establish licensing policies that focus on the cognitive and physical assessment of older drivers, offering case-by-case reviews of individual ability rather than a systematic approach (such as age only) to identify high-risk drivers. For example, there may be a base age at which the testing is conducted; however, decisions beyond that should be made based on the individual's current abilities.
3. Review existing and forecasted gaps within the coverage area of alternative mobility assistance programs in an effort to extend or improve service. Although there are some cities and towns with limited transportation alternatives, the projected increases in the population of adults 65 and older ensure that nearly all municipalities will have fewer programs per older adult unless services are added. A quantifiable rating system to assess the capabilities of a city or town to provide adequate transportation services should be supported. The developed metric should build upon the program-level data assembled within the framework of this research effort.
4. Create an older adult mobility advisory board within the Commonwealth to facilitate coordination across stakeholders on issues central to older driver safety and mobility.
5. Develop a coordinated plan for including the identification of older driver high crash locations. Once candidate locations are identified, agencies may perform road safety investigations with an emphasis on identifying challenges and developing countermeasures for older drivers.
6. Establish a mechanism for providing recommendations associated with training for older drivers. Training programs have been developed and successes have been documented in improving older driver performance. Although the specifics for implementation of a training intervention would need to be established, there may be fixed indicators that suggest inclusion: identified cue at time of license renewal, motor vehicle infraction or crash, etc.
7. Identify appropriate opportunities for public/private partnerships that would allow for the establishment of alternative transportation programs. Logical examples include iTN America, Ride Connection in the State of Oregon, OATs, Inc. in the State of Missouri and partnerships with private service providers, such as limousine services.
8. Develop and coordinate information resources for transportation alternatives across the Commonwealth. Using the database of documented programs collected as part of this research, establish an interactive search tool similar in nature to that maintained by the Florida DOT.

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1.0 Introduction

This study, "Coping with the Aging Driving Population," was conducted by the University of Massachusetts Traffic Safety Research Program (UMassSafe) and undertaken as part of the Massachusetts Department of Transportation (MassDOT) Research Program. The MassDOT program is funded with Federal Highway Administration (FHWA) Statewide Planning and Research (SPR) funds. Through this program, applied research is conducted on topics of importance to the Commonwealth of Massachusetts' transportation agencies.

Throughout the years, increased attention has been given to older drivers and their role in highway safety. Highly publicized crashes, increases in older driver fatality rates, and other related factors have been the basis for policy revisions, educational campaigns and additional research in order to reduce the numerous safety risks associated with older drivers. Interestingly, often absent from the dialogue around older drivers is the fact that unlike other cohorts of high-risk drivers, older drivers often pose the greatest hazard to themselves (1).

Several studies indicate that there are explanations for this troubling data; some assert that the data is skewed because there is an overrepresentation of older driver crashes in the research, and that the reality may thus be different. However, a 2006 study shows that if "miles driven" is used as an exposure measure, older driver crash rates are, in fact, higher than drivers in other age groups, due to the "low mileage bias" (2).

A study published in 2003 takes a different approach, indicating that older drivers are not necessarily overrepresented in terms of crash frequency, but instead, it is the fragility associated with an older person's physiology that contributes to the high rate of crash fatalities (3). The rate of non-driver deaths per 100 million miles in 1995 was similar for both older road users and adult road users, and was lower than the rate for teen and young adult road users (1). However, the death rate per mile begins to increase for drivers who are between the ages of 60 and 64. For the 75 to 79 year-old age group, the death rate for drivers is four times higher than the rate for drivers between the ages of 30 and 59. More recent data shows similar trends regarding the severity of injuries in older road users. In 2004, 5 percent of people injured in crashes in the United States were 70 years old or over; however, this age group represented 11 percent of all vehicle occupant fatalities (4).

The need for greater attention to older driver safety is made visible not only by the issue of injury severity, but also by the growing population of older adults in the United States. According to projection data from the 2000 United States Census Bureau report, people ages 65 or older accounted for 12 percent of the United States population. By 2050, this figure is projected to grow to 20 percent, with the percentage of the population 85 years or older quadrupling during the same time frame (5). The proportion of the driving population over the age of 65 is increasing as well. Between 1993 and 2003, the number of drivers age 70 or older increased 27 percent to 19.8 million (3). By 2030, it is projected that drivers age 65 or older will account for 20 percent of licensed drivers, compared to just 13 percent in 2004 (6).

Massachusetts injury severity trends for older vehicle occupants, including both drivers and passengers, reflect those found at the national level. In 2004, the oldest vehicle occupants (ages 85 and older) had a higher rate of fatalities per 100,000 people (8.4) than adult occupants ages 25 to 64 (6.0), or ages 65 to 84 (5.7). In addition, when considering all injuries suffered by vehicle occupants, the percentage of injuries that are most severe (fatal or incapacitating) increases with age. For occupants ages 25-64, 10 percent of injuries are fatal or incapacitating, compared to 12 percent for occupants ages 65-84, and 15 percent for occupants ages 85 and older (7).

Also reflecting national trends are the population growth trends in Massachusetts. According to the United States Census Bureau, in 2000, persons age 65 and older represented 13.5 percent of the total population in Massachusetts. By 2030, the United States Census Bureau projects that this number will increase to 21 percent. These numbers are slightly higher than the national percentages of 12 percent in 2000 and 20 percent in 2030. Additionally, the overall number of Massachusetts residents age 65 and older is projected to increase 70 percent between 2000 and 2030, compared to an increase of only 10 percent for the general Massachusetts population over the same period of time (5).

People in this age group are becoming increasingly reliant on the use of private automobiles. Approximately 90 percent of all trips made by people over the age of 65 are by automobile, with only a slightly lower percentage for people over the age of 85 who use automobiles for 80 percent of their trips (8).

Efforts aimed at improving safety for older drivers include implementing design guidelines in order to build “older-driver-friendly” roads, reviewing licensing practices, establishing guidelines to help physicians assess and counsel older drivers, and training law enforcement officers to determine if the specific operational needs of older drivers are being met. While a variety of efforts have been undertaken to improve the safety of older drivers, state licensing agencies have the unique ability to revise license renewal procedures in a way that will positively impact the older driver community. Through the implementation of license restrictions, state agencies have the ability to limit the exposure of older drivers to dangerous situations, thereby improving older driver safety. Nevertheless, several reviews of licensing practices undertaken to date have identified issues such as cost effectiveness, feasibility, and discrimination that have made the implementation of older-driver specific licensing practices and policies challenging.

Equally as important as revising policies aimed at improving the safety of older drivers is assessing the presence of viable networks of transportation alternatives such as public transportation and community-based organizations which provide mobility to older adults. There is a need to evaluate the viability of alternative transportation networks to provide mobility to older adults, as well as the need to improve the dissemination of information about such alternatives.

1.1 Research Problem Statement

Older drivers have low rates of police-reported crash involvements per capita, but per mile traveled, crash rates start increasing for drivers over the age of 75 (3), and increase markedly after age 80 (9). Drivers over the age of 65 are disproportionately involved in fatal crashes compared to police-reported crash rates (10). Because each driver loses skills and abilities at a different rate, some people are no longer safe drivers at 65, while others are competent well past age 85. While some older drivers self-limit driving as their skills diminish, choosing only to drive in dry conditions, during the day, or on surface streets (11), others fail to recognize that their driving ability has waned. As the driving population continues to age, jurisdictions are struggling to find ways to re-assess older driver competency in an equitable and cost effective manner that successfully preserves safety on the roadways, while taking into account the importance of mobility options for older adults.

The development of licensing practices specifically aimed at improving older driver safety requires careful thought in order to ensure that the methods are effective in identifying high-risk older drivers, and that their rights are protected throughout the process. The critical balance between the practice and policy of revising older driver licensing programs underscores the need for research into this topic; for example, relevant research includes determining objective licensing practices, developing strategies for identifying high-risk older drivers, and implementing policies that support the use of these results. Simultaneously, it is imperative to identify and support alternative transportation options, such as public transit, in order to ensure that older drivers who no longer drive are able to maintain a reasonable level of mobility.

1.2 Research Objectives

The MassDOT RMV is responsible for overseeing the licensing renewal procedures for all Massachusetts licensed drivers, including more than 450,000 licensed drivers who are age 65 and older. The goal of this research project is to provide information to the RMV, including the identification of relevant strategies for implementation regarding older driver licensing practices, as well as an overview and examination of issues associated with the loss of mobility for older adults.

The research objectives associated with this research effort included the following:

1. Evaluation of the nature of older driver crash characteristics and their future needs in Massachusetts using available crash, citation, hospital and population data.
2. Development of an understanding regarding policy, legislative literature, and practices nationwide that outline possible recommendations applicable to the licensing renewal of older drivers in Massachusetts.
3. Review of existing alternative transportation options for older adults in Massachusetts, along with information on projected need for those services.

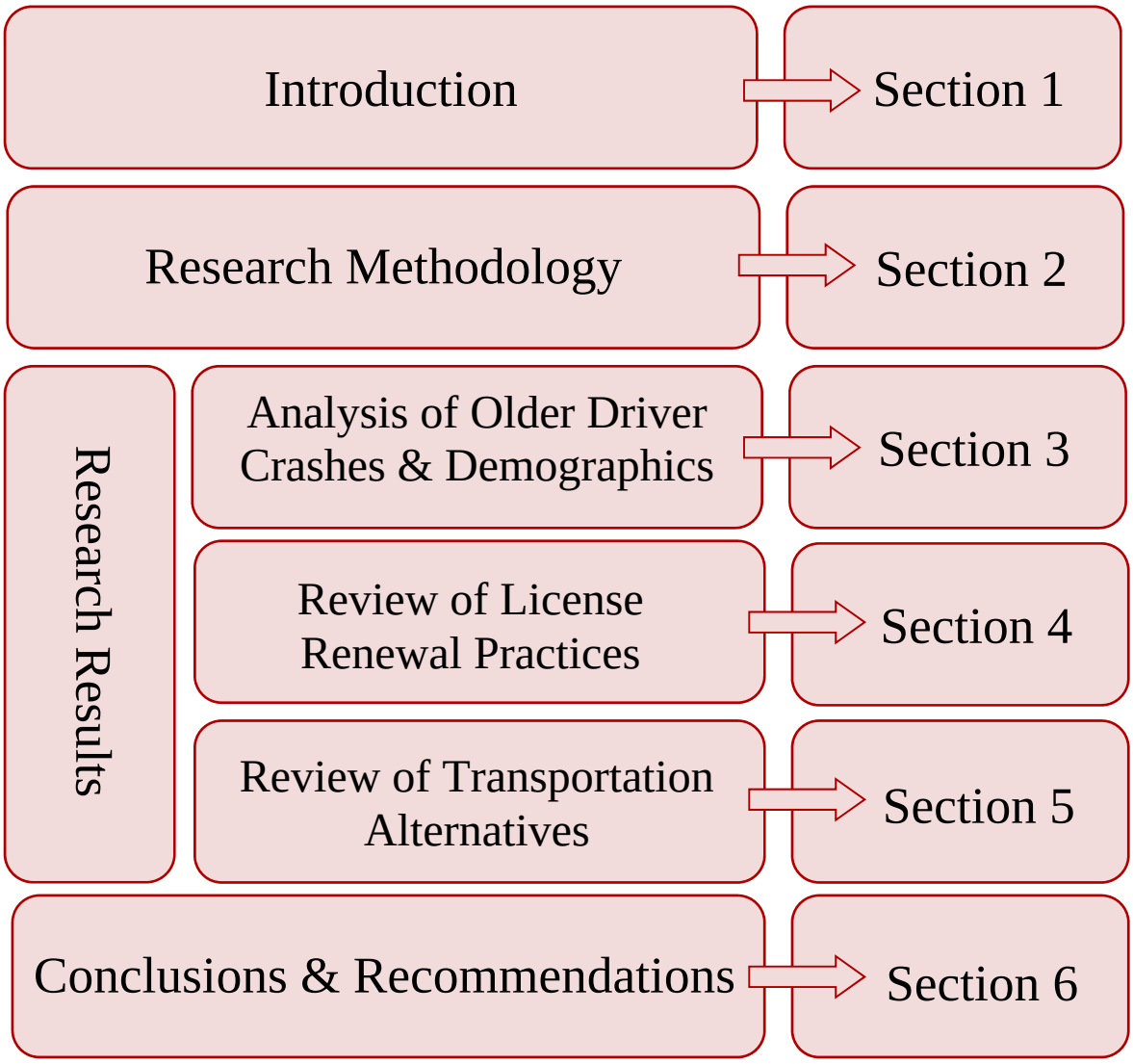
1.3 Overview of Research Approach

The research approach consisted of a multifaceted review of published and unpublished literature. The initial phase thus included documenting available literature regarding licensing and renewal practices that could yield practical recommendations for improving these practices in Massachusetts. A second review of the literature focused on various approaches to alternative transportation being utilized across the United States. In addition, the research approach included an analysis of data sources available within Massachusetts in order to determine the nature of older driver crash characteristics and the state of the existing infrastructure of mobility options for older adults in Massachusetts. As part of the research approach, a survey was administered to State DOTs for the purpose of determining the state-of-the-practice relating to older driver licensing and alternative transportation options. The analysis of these project elements resulted in recommendations for improvements in Massachusetts with regards to both licensing renewal practices and the development of alternatives within the existing mobility network for older adults within the Commonwealth.

1.4 Organization of Technical Report

The technical report is organized into six main body sections, as presented in Figure 1. Section 1 presents an introduction to the research and Section 2 presents an overview of the research methodology. Section 3 through Section 5 present additional methodological details and research findings for each of the primary research tasks. Lastly, Section 6 documents the research conclusions and resulting recommendations.

Figure 1: Organization of Technical Report



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2.0 Research Methodology

In order to successfully meet the research objectives outlined in Section 1.2 addressing older driver licensing practices and the available mobility network, certain tasks were developed. An overview of the research tasks is presented in Figure 2 and described in the section that follows. Additionally, other methodological details are included within the results sections associated with each task.

Figure 2: Overview of Research Methodology

Report Section	Research Tasks	General Task Description
Analysis of Older Driver Crashes & Demographics	1. Demographic and Spatial Analysis of Older Adults	Integrate population, licensed driver, and household data to establish a baseline for analyzing the spatial distribution of older adults across Massachusetts.
	2. Analysis of Older Driver Crash Attributes	Develop an understanding of the crash attributes common to older driver crashes in Massachusetts using available crash and hospital data.
Review of License Renewal Practices	3. Literature Review Associated with License Renewal Practices	Review the literature with a focus on renewal procedures that have been found to be effective in determining driving eligibility; locate assessment tools that can measure physical abilities associated with effective driving, isolate and medical conditions common among older people that can impact driving ability.
	4. Licensing Policies State-of-the-Practice Report	Review the current state-of-the-practice regarding licensing policies including renewal procedures, older driver restrictions, requirements of physicians to report unfit drivers and challenges associated with older driver licensing policies.
Review of Transportation Alternatives	5. Establish the Massachusetts Mobility Network for Non-Driving Older Adults	Develop a model of the existing infrastructure of the mobility network available to older adults in Massachusetts through a series of stakeholder interviews, web searches and site visits. This model was then integrated with the baseline data compiled in Task 1 to assess the adequacy of mobility coverage across the Commonwealth.
	6. Nationwide Review of Mobility Alternatives & Survey of Practices	Review the mobility networks in other states and identify transportation programs that may be implemented in Massachusetts. This task was completed through the administration of a survey to state DOTs and a review of web material for identified programs.

2.1 Task 1: Demographic and Spatial Analysis of Older Adults in Massachusetts

Task 1 included the identification and review of demographic data within Massachusetts. The review integrated population data from the United States Census, licensed driver data from the RMV, and several additional pieces of information. One subset of data available through the United States Census Bureau was the American Community Survey (ACS), which is conducted annually to provide up-to-date information regarding the social and economic needs of a community (12). The ACS provides insight into how people live, by providing information about jobs and occupations, educational attainment, veterans, whether people own or rent their home, and other topics. This information is used for many purposes, but here, the ACS was used to illuminate areas where new services may be needed. The focus of this study was on the identification of households by community with individuals 65 and older.

This combination of resources provided a baseline for analyzing the spatial distribution of older adults across Massachusetts. The intent of establishing this baseline was to provide data that could be utilized in subsequent analyses within the framework of the mobility network for older adults in Massachusetts (discussed further in Task 5).

2.2 Task 2: Analysis of Older Driver Crashes in Massachusetts

To develop a general understanding of the crash attributes common to older driver crashes, Task 2 involved analysis and review of available crash data within Massachusetts. The safety analysis was completed using safety data available through the UMassSafe Traffic Safety Data Warehouse, which provided the ability to use linked datasets. Using statistical methodologies the following data were linked to create a single dataset: driver behavior, crash characteristics,, roadway environment, and crash outcomes such as injuries and costs (hospitalizations, death certificates, citations, etc.). The synthesis of these datasets allows analysts to consider the comprehensive crash experience. One of the interim project deliverables was a “fact sheet” style document summarizing the older driver crash statistics in Massachusetts. This document includes data that goes beyond the results presented in Section 3.2 and is attached in Appendix A.

Utilized in Task 2 was Massachusetts police-reported crash data involving drivers ages 65 and older as well as crash data involving drivers ages 35 to 55, used as a comparison group. In Massachusetts, a motor vehicle crash is only considered reportable if it occurs on a public way and either results in property damage of $1,000 or greater to any vehicle or property, a non-fatal personal injury, or a fatality. Various data fields in the crash report form were analyzed, quantified, and integrated to generate a unique combination of Massachusetts older driver crash statistics and facts. For the purposes of this task, an older driver was defined as a person 65 years of age or older, and the oldest drivers were defined as persons 85 years of age or older.

Traditionally, crash analyses have been based upon the use of police-reported information collected on state-specific crash report forms. However, the series of events surrounding a crash are more complex than can accurately be recorded on the form. Ideally, data should cover the events immediately preceding a crash, the characteristics of the crash itself, and the outcomes associated with the crash. For this reason, data from the Crash Outcome Data Evaluation System (CODES) for Massachusetts was also considered. CODES employs probabilistic linkage in order to link datasets that have common information but no common unique identifier. In Task 2, three datasets were used, including crash, emergency department, and hospital inpatient. These datasets allowed for analysis of the charges associated with treatment of injuries suffered by older adults involved in crashes, both in the emergency department and inpatient settings. Additional details about the CODES linkage process and analysis are in included within Appendix B.

2.3 Task 3: Review of the Literature Associated with License Renewal Practices

Task 3 involved a review of the literature associated with license renewal practices. This task provided information about feasible options for implementation in Massachusetts specifically focused on renewal procedures, screening tools, and medical conditions that may impact older drivers. The information gathered during this review included the following items:

- Renewal procedures most effective in determining driving eligibility (written test, road test, vision test, etc.);
- Assessment tools used to measure physical abilities associated with effective driving (response time, vision, hearing, muscle strength, etc.); and
- Medical conditions common among older adults that may impact driving ability.

2.4 Task 4: Licensing Policies State-of-the-Practice Report

The Insurance Institute for Highway Safety (IIHS) is an “independent, nonprofit, scientific, and educational organization dedicated to reducing the losses — deaths, injuries, and property damage — from crashes on the nation's roads (13).” One document prepared by the IIHS is an overview of driver licensing policies in each state across the United States. Using the IIHS report as a guideline, the purpose of Task 4 was to provide additional information for policy makers that may aid in understanding the development and implementation of existing older driver licensing policies and their associated challenges (14).

Areas of interest that were studied and considered during Task 4 included the following components:

- Renewal procedures currently in use for licensing older drivers, including the length of renewal cycles;
- Older driver restrictions included as part of the licensing process;
- Requirements imposed on physicians to report unfit drivers (this includes drivers of all ages); and
- Challenges associated with perceived discrimination in older driver licensing policies.

2.5 Task 5: Establishing the Massachusetts Mobility Network

To achieve the objective of providing an evaluation of the existing structure of mobility for non-driving older adults in Massachusetts, Task 5 was undertaken. In order to develop an understanding about how different agencies are either directly or peripherally involved in providing mobility options for older adults, Task 5 began with a series of interviews with selected stakeholders. The initial project interviews provided the framework of the existing structure of mobility in Massachusetts and resulted in a list of agencies involved in providing or coordinating transportation for older adults. Agencies interviewed for this Task included the Massachusetts Bay Transportation Authority (MBTA), Regional Transit Authorities (RTAs) of MassDOT's Transit and Rail Division, the Massachusetts Area Agencies on Aging (AAA), Aging Service Access Points (ASAPs) and Councils on Aging (COAs). In order to provide a well-rounded review of the state of mobility in Massachusetts, the interviewees were selected from a mix of urban and rural locations.

Once agency interviews were completed, the remaining elements of the Massachusetts mobility network for older adults were identified through a series of web searches, site visits, and phone calls to key players.

2.6 Task 6: Review of Nationwide Mobility Alternatives and Survey of Practices

To develop an understanding around existing mobility networks in other states nationwide, a four-question survey was developed and administered. Initially, the survey form was sent out to each of the 50 states through state DOT Research Coordinators. As this individual was likely unfamiliar with the structure of mobility in their own state, the request was for the Research Coordinator to pass the survey along to the appropriate person(s) at their agency. Simultaneously, a list of target contacts was developed using information available on state DOT websites, including individuals and groups who had direct knowledge regarding their jurisdiction's older driver mobility options. This list, including officials representing state DOTs, Departments of Motor Vehicles (DMVs), Departments of Public Health (DPH) and Departments of Elder Affairs, was used for another dissemination of the survey. The survey was sent via email to individuals, and requested that that they either complete the online

survey or respond via email or phone to the research team. Depending on the structure of the responding agencies, four to five individuals were contacted from each state using this approach. For states that did not respond, follow-up phone calls and emails were made in an effort to procure remaining responses.

As noted, the survey was short and intended to be used as a comparison to the Massachusetts' mobility network established in Task 5. Details regarding the survey questions and the logic used for their inclusion are provided in Section 5.3.

An additional element within the scope of this task was to identify and document attributes associated with various alternative transportation approaches or programs across the United States. This portion of the task was completed using feedback from the survey, program data available from existing databases, and a series of web searches.

2.7 Task 7: Documentation of Findings

Task 7 consisted of the documentation of research findings, including the results of all reviews and analyses undertaken, along with a series of conclusions and recommendations for the consideration by stakeholders within the commonwealth.

3.0 Older Driver Crashes and Demographics

The initial research tasks consisted of systematic reviews of available crash, citation, hospital, and population data within Massachusetts. The intent of these tasks was to provide a baseline understanding of the spatial distribution of older adults across the Commonwealth, and to present an understanding of the current nature of older driver crashes and the variables associated with them. The analyses were disaggregated into two components, with the results presented in Section 3.1: Population Projections and Census Data for Massachusetts, and Section 3.2: Older Driver Crash Attributes in Massachusetts.

3.1 Population Projections and Census Data for Massachusetts

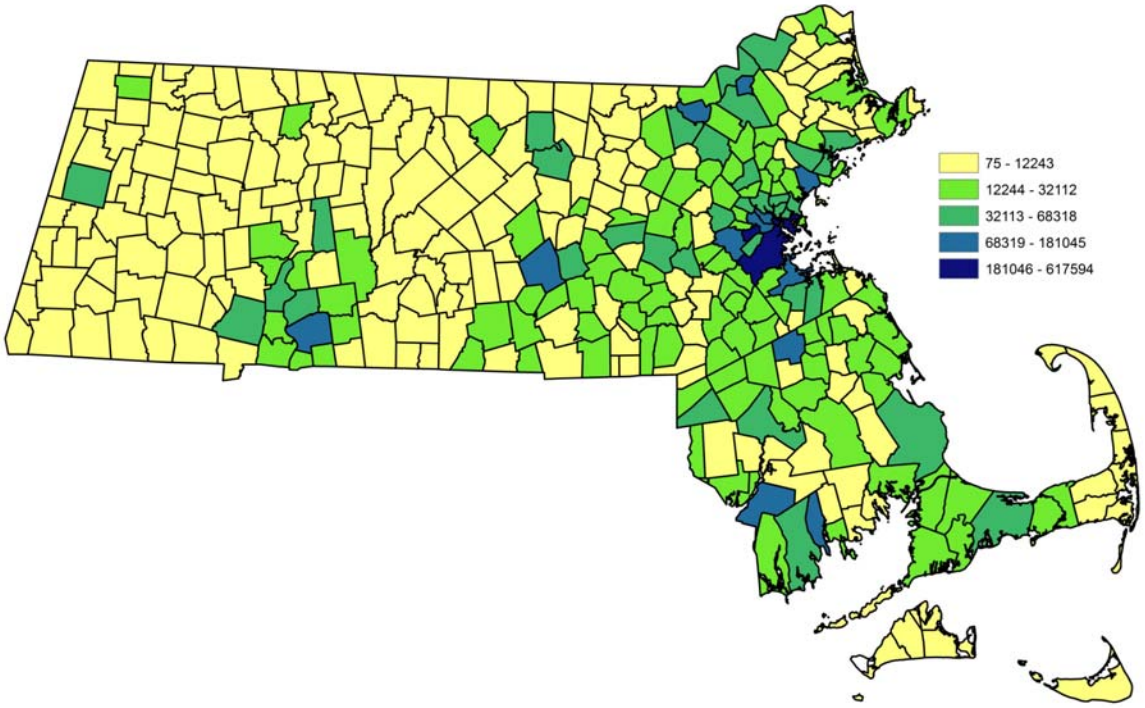
The primary objectives of this research include identifying recommendations for improvements in Massachusetts regarding licensing renewal practices in the Commonwealth, as well as improving transportation alternatives within existing mobility networks for older adults. In working toward these objectives, there was a need to review the demographics within Massachusetts in order to understand where the older population resides. Both nationally and within Massachusetts, the population and percentage of older adults will continue to increase significantly over time.

Beyond population, two additional parameters were considered as critical to documenting the needs of older adults. One of these parameters was licensed driver data from the RMV, which was analyzed. Although there is a probability that licensed driver data correlates strongly with population, there was a need to determine whether communities located in rural settings had higher proportions of licensed older adults than urban areas. The other parameter considered critical was the ACS household data.

The intent behind the review of data was to provide a baseline understanding in order to better analyze the spatial distribution of older adults across Massachusetts. This kind of comprehensive understanding is useful in forecasting the needs for transportation alternatives for older adults.

The Commonwealth is comprised of 14 counties, which are further disaggregated into 351 cities and towns. According to the 2010 United States Census, there are more than 6.5 million residents in Massachusetts with slightly more than 600,000 residents in the capital city of Boston. Although Massachusetts is considered a primarily urban state, there is variability in the distribution of population across the 351 cities and towns as shown in Figure 3. Using the natural breaks function within ArcGIS© to define the category ranges, it is clear that the majority of the state's population is clustered around the greater Boston area and in eastern Massachusetts, in general. Smaller clusters of population also exist around Worcester and Springfield.

Figure 3: Geographic Distribution of the Population in Massachusetts

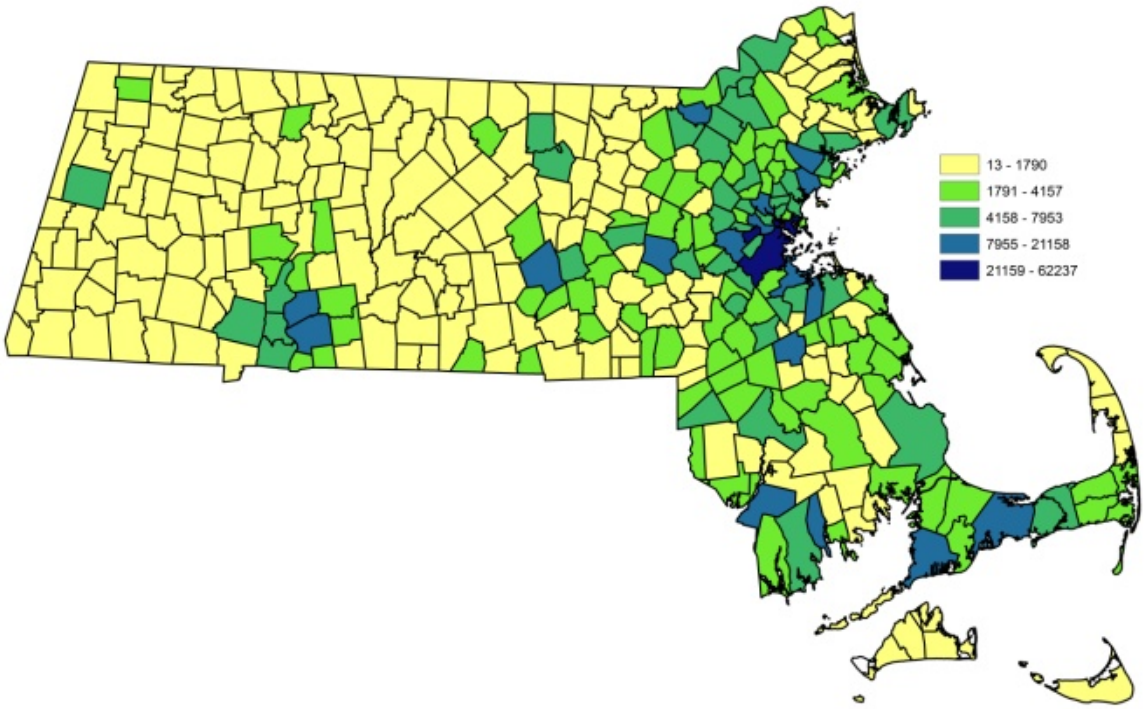


A separate analysis was completed to examine the geographic locations of older adults. At the municipal level it was important to determine the percentage of a community's population that was within a specified age group, as this data can illuminate the needs particular communities have for services. Figures 4 and 5 illustrate the frequency and percentage of adults 65 years and older, and adults 85 years and older, across the 351 cities and towns. The distribution of older adults across cities and towns in the age groups of 65 and older and 85 and older closely mirrors that of the total Massachusetts population. One exception is Cape Cod, which accounts for a slightly higher percentage of older adults than it does total population. As shown in Figures 4 and 5, there is a significant difference between the communities that have the highest frequency of older adults as compared to the communities that have the highest percentage of their population comprised of older adults. For example, the three largest cities of Boston, Worcester, and Springfield have the largest number of older adults, yet older adults account for a lower percentage of their populations than most other municipalities. By comparison, many of the communities in Berkshire County have a lower population of older adults, yet in many of these communities, older adults account for a higher percentage of the city or town population.

Comparing the distribution of the population of adults 65 years and older versus 85 years and older revealed differences. Although communities with the highest percentage of adults ages 65 years and older are located primarily in Berkshire County and on Cape Cod, the distribution of communities with the highest percentages of adult populations ages 85 years and older are more geographically diverse.

Figure 4: Frequency and Percentage of Adults Age 65 and Older by City/Town

Frequency of Population that is 65 Years and Older



Percent of a City/Town Population that is 65 Years and Older

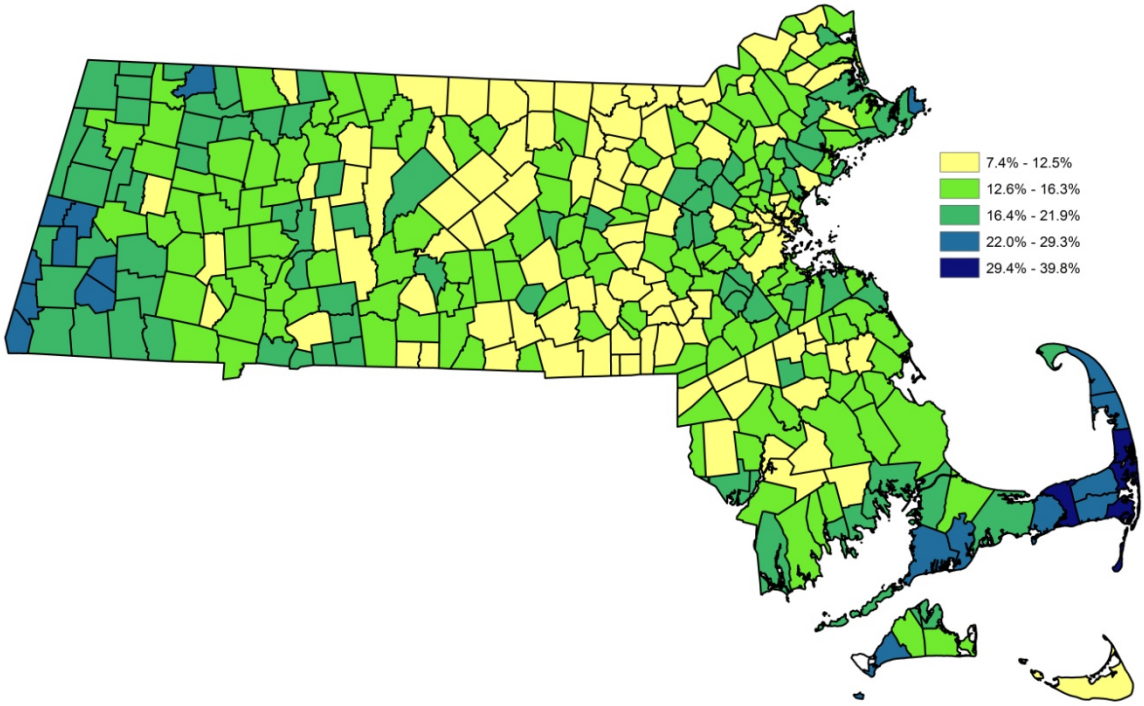
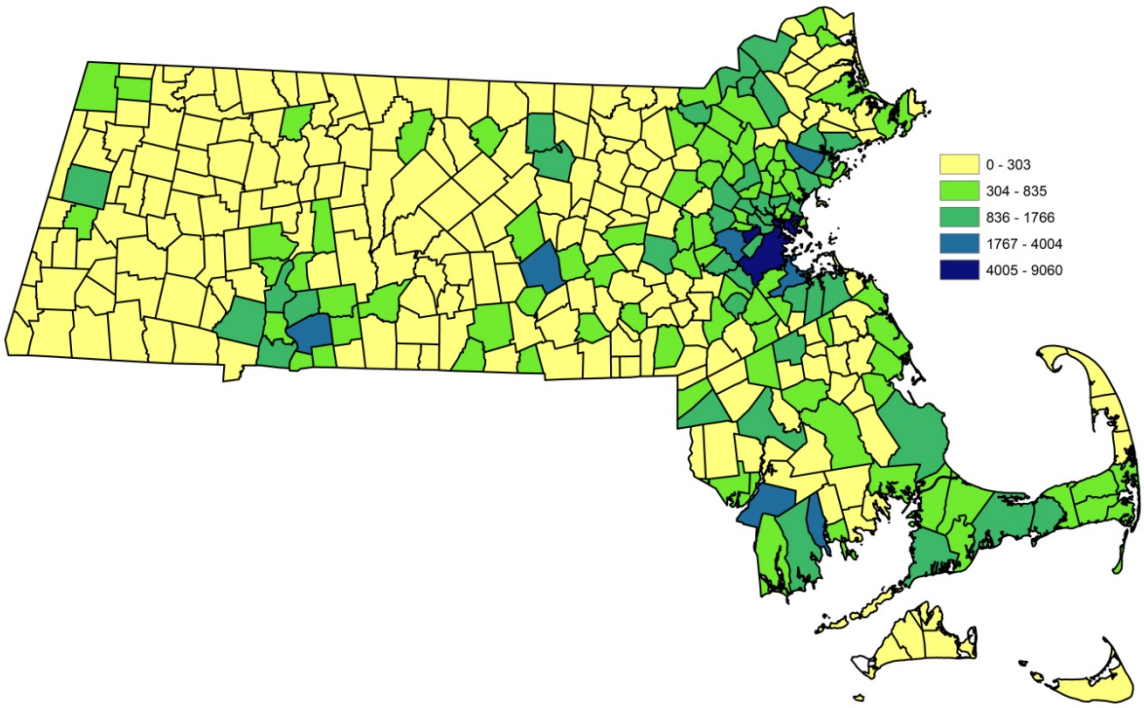


Figure 5: Frequency and Percentage of Adults 85 Years and Older by City/Town

Frequency of Population that is 85 Years and Older



Percent of a City/Town Population that is 85 Years and Older

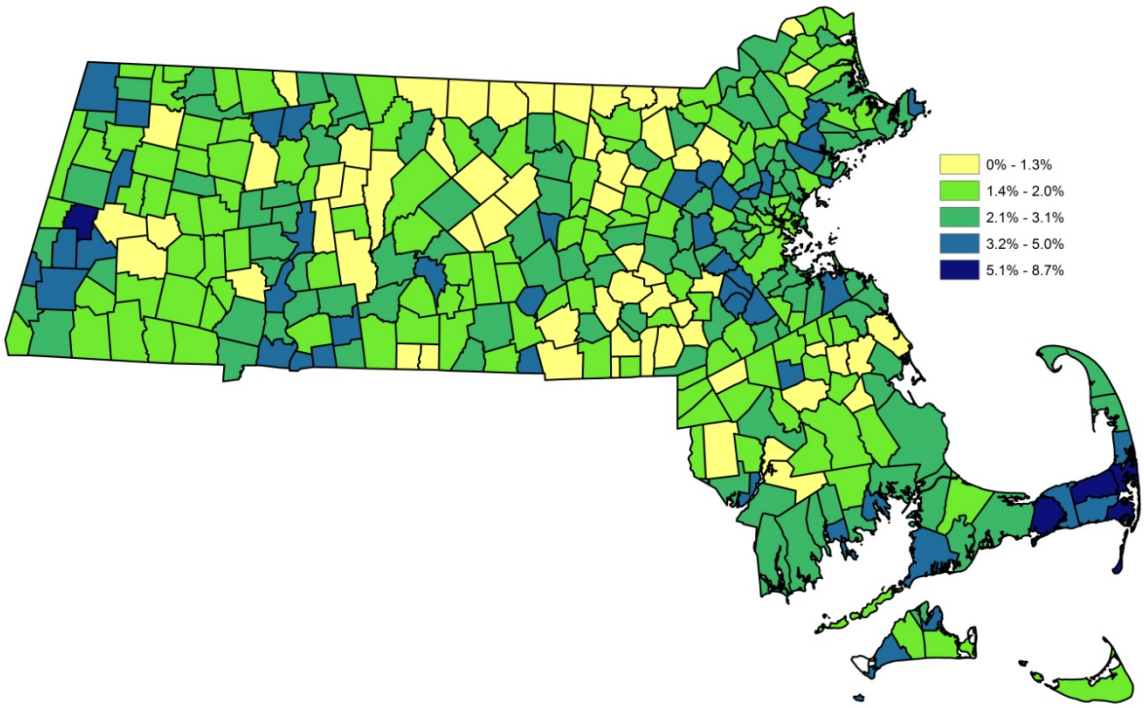


Table 1 provides descriptive statistics for the frequency and percentage of adults by various age categories within the 351 Massachusetts cities and towns, offering further insight into the makeup of the state. For example, the smallest town population has 75 total people. Also noteworthy are the median values: nearly half of the 351 cities and towns have a total population of less than 10,000 and a population of adults age 85 and older that is less than 200. When considering the percentages of each age category within a community, several differences are apparent. For example, adults ages 85 years and older make up 8.7 percent of one town's population; however, in half of the 351 cities and towns this value is less than two percent of the population.

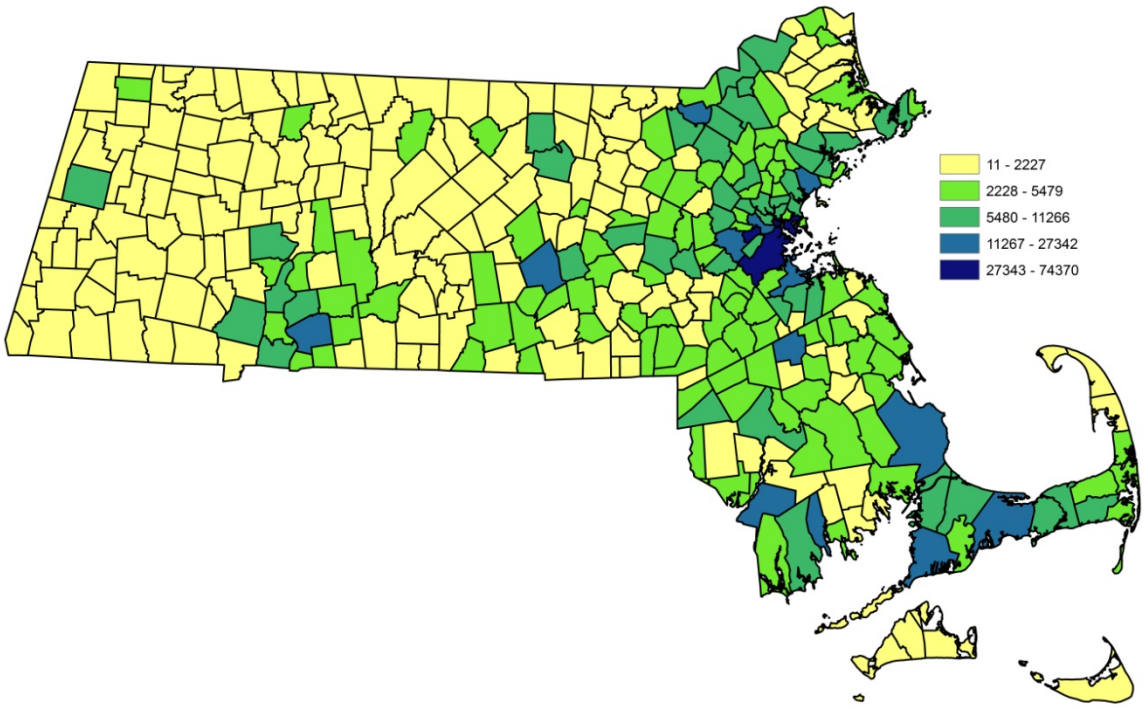
Table 1: Descriptive Statistics for Frequency and Percent of Older Adults by Age and by Population across all 351 Cities/Towns

Descriptive Statistics	Frequency of Population					Percent of Population by Age			
	All Ages	60+	65+	70+	85+	60+	65+	70+	85+
Min	75	22	13	7	0	10.62	7.39	4.85	0
Max	617549	88070	62237	43556	9060	50.66	39.80	29.36	8.70
Mean	18654	3628	2572	1818	414	21.96	15.09	10.29	2.17
Median	10209	2003	1384	973	198	20.87	14.10	9.71	1.94
St. Dev.	38833	5994	4281	3044	687	5.77	4.55	3.46	1.06

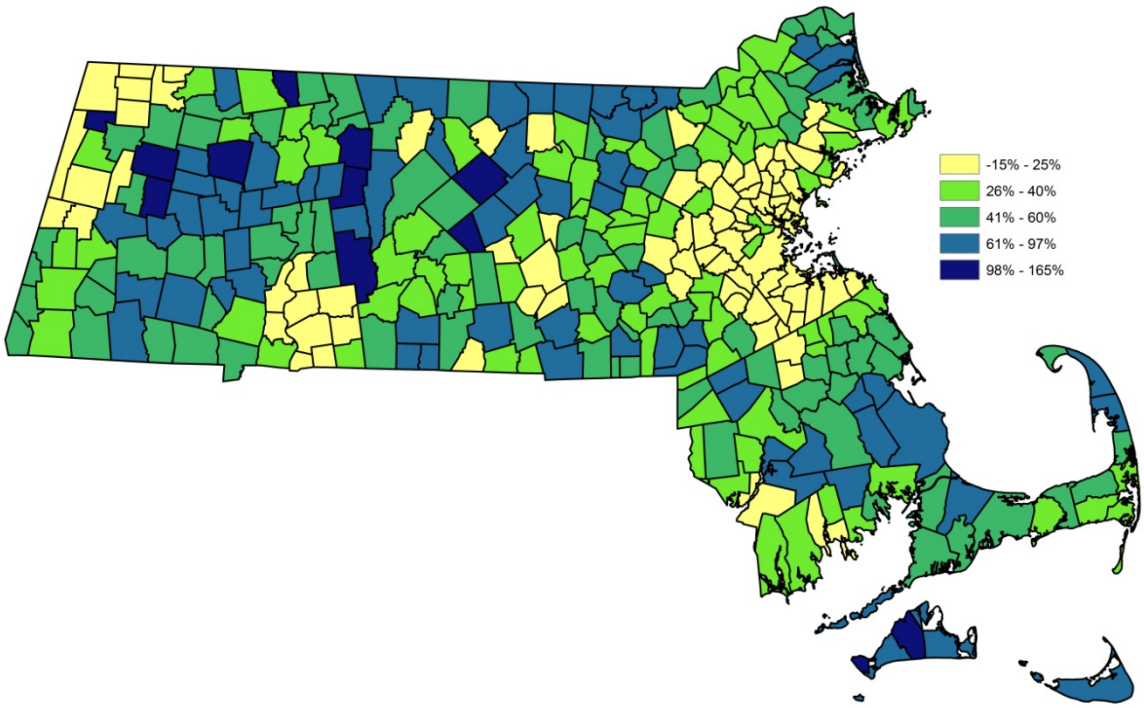
The additional population consideration made was in respect to projected increases in older adults by community. Specifically, projections available from the Research Unit of the Executive Office of Elder Affairs were used to identify potential changes in adult driving populations ages 65 years and older between 2010 and 2020. Figure 6 provides a geographical distribution of the projected changes (increases or decreases) for the 351 Massachusetts cities and towns. Also included within Figure 6 is the percent increase in the 65 years and older population within each of the communities. Although the projected increases are logically higher in larger population centers, the percent increase in many of the more rural areas is significant. Table 2 provides the descriptive statistics for the community projections.

Figure 6: Projected Frequency and Percent Change in Adults Age 65 and Older, 2020

Frequency of Projected Population Age 65 and Older, 2020



Percent of Projected Change in Adults Age 65 and Older, 2010 to 2020



As shown in Table 2, the average increase in adults ages 65 years and older by 2020 will be 786, which is an average of 44 percent. Additionally, more than half of the 351 cities and towns will see a projected increase of more than 500 adults that are 65 years and older. When trying to predict the transportation needs regarding alternative transportation options for older adults, it will be critical to have a sense of the anticipated projections.

Table 2: Descriptive Statistic for 2010 to 2020 Population Projections of Adults Age 65 and Older across all 351 Cities/Towns

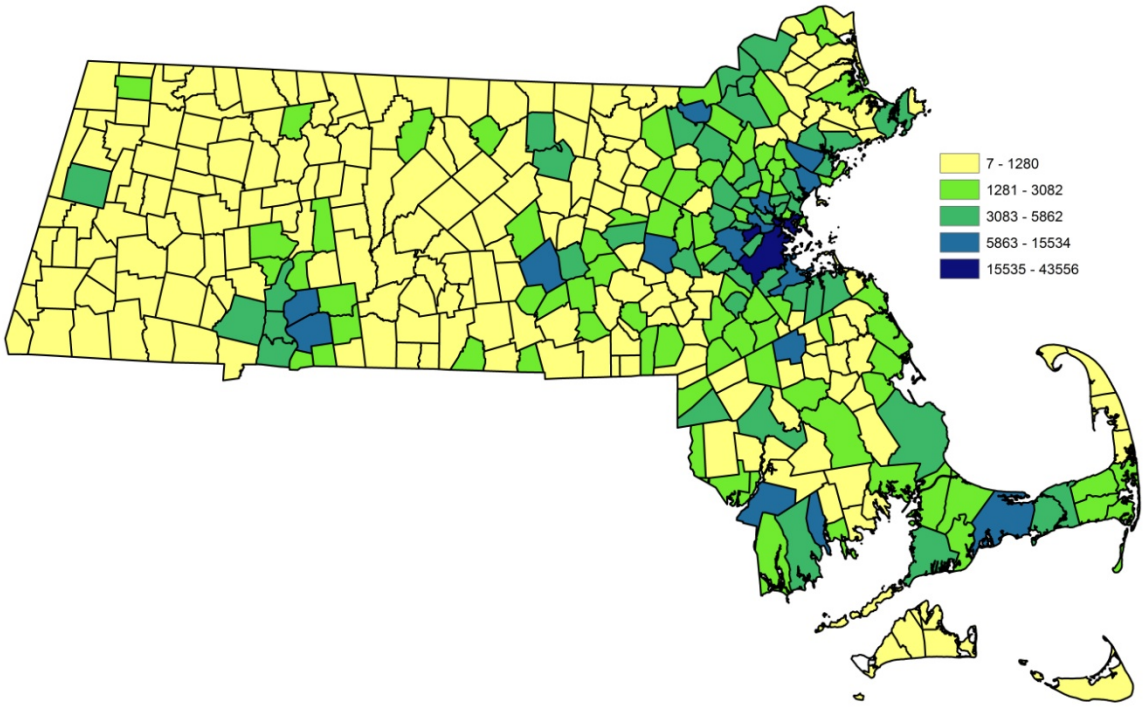
Descriptive Statistic	Projected Change in 65+ Population	Projected Percent Change in 65+ Population
Min	(-2)	(-15.38)
Max	13754	165.00
Mean	786	44.61
Median	508	40.08
St. Dev.	1060	25.94

In an attempt to capture the differing needs of older road users (due to urban density and the associated access to increased transit services), a similar breakout was completed using licensed driver data provided by the RMV. Please note that the licensed driver data provided was a snapshot captured on June 26, 2010, and its use herein is only intended to be an estimate of the licensed drivers within a given community. Because the licensed driver data is aggregated into 10-year age ranges, the analysis was completed using drivers ages 70 and older. Please note that discrepancies between the two datasets do not allow for a determination of the percentage of residents in each age range in each community that are licensed.

Figure 7 presents the frequency of licensed drivers per city and town as well as the percentage of licensed drivers that are over 70 years for each community. The descriptive statistics are displayed for this data in Table 3 and provide an indication of the differences that exist between communities across the Commonwealth. The licensed driver data correlates strongly with the population data previously presented, which is likely the result of two factors: 1) licenses serve as the primary means of identification for many Massachusetts residents, and 2) the current license renewal procedures are not prohibitive. Nevertheless, this factor is critical to consider.

Figure 7: Frequency and Percentage of 70 Years and Older Licensed Drivers by City/Town

Frequency of Licensed Drivers that are 70 Years and Older



Percentage of Licensed Drivers that are 70 Years and Older within each City/Town

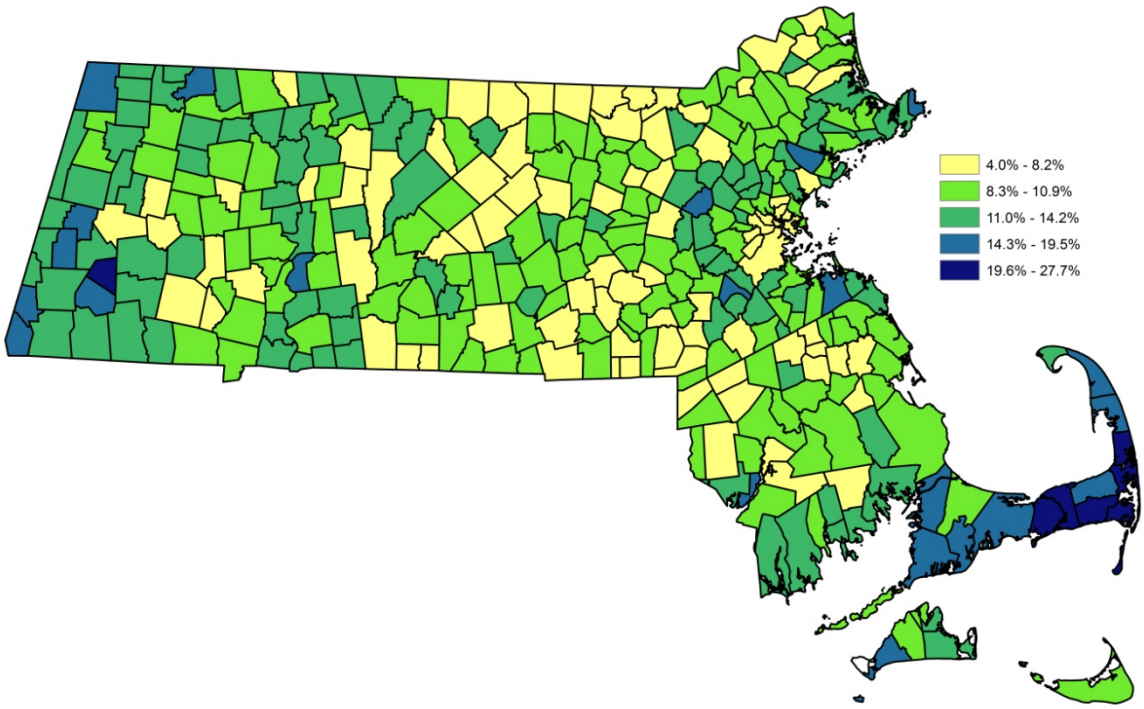


Table 3: Descriptive Statistics for Frequency and Percent of Older Adults by Age and by Licensed Drivers across all 351 Cities/Towns

Descriptive Statistic	Frequency of Licensed Drivers by Age			Percent of Licensed Drivers by Age	
	All Ages	60+	70+	60+	70+
Min	46	18	4	12.88	4.02
Max	316798	48717	18288	50.32	27.65
Mean	12825	2911	1268	25.14	10.58
Median	7971	1780	773	24.11	10.11
St. Dev.	21082	3793	1602	5.84	3.39

The final demographic aspect considered throughout this project integrated ACS data for households and older adults. More specifically, a breakout of the following attributes was completed for each of the 351 cities and towns in Massachusetts:

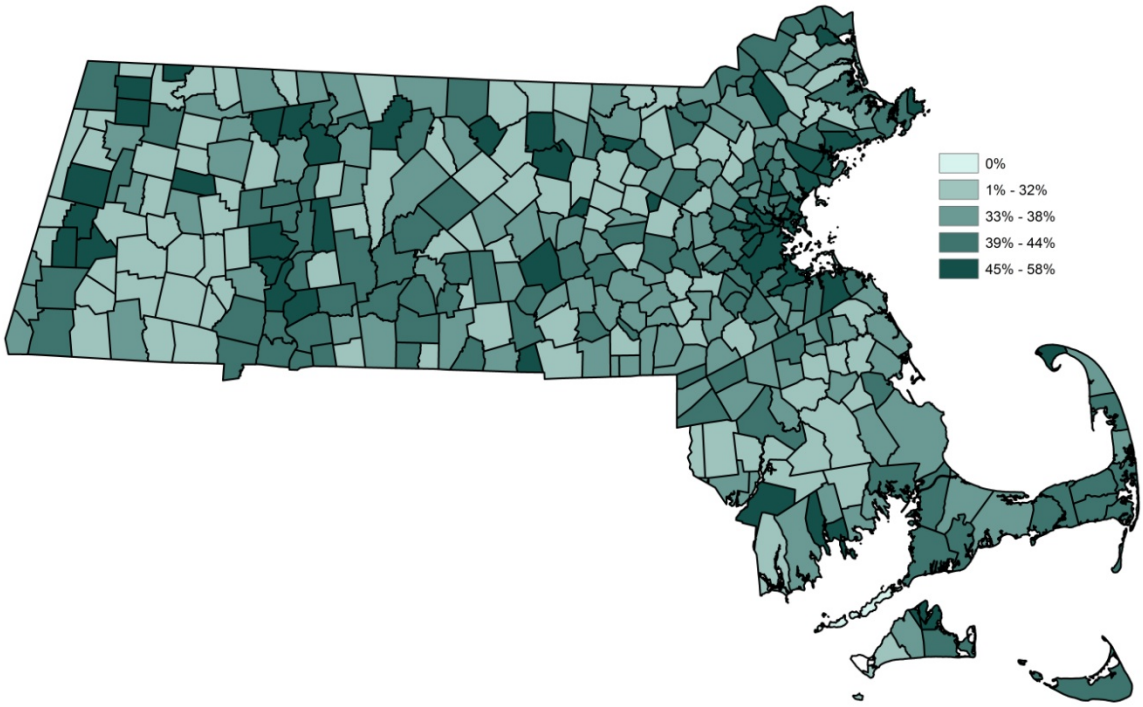
- Total number of households;
- Number of households with at least one person age 65 and older;
- Number of one-person households with at least one person age 65 or older;
- Percent of households with at least one person age 65 or older;
- Percent of households that are one-person households with one person age 65 or older; and
- Percent of households with at least one person age 65 or older that are one person households.

Table 4 presents the descriptive statistics for these attributes across all 351 cities and towns in Massachusetts. As shown, greater than 10 percent of more than half of all communities contain an individual that is 65 years or older and lives alone. On average, cities and towns have more than 27 percent of households with at least one person age 65 years or older. The number of households per community with at least one individual age 65 or older corresponds directly with the population trends presented earlier; however, when viewing the distribution for the percentage of a community's 65 years and older households that have a single household occupant, no discernible pattern exists. In other words, the cities and towns with a high percentage of single-occupant households containing an individual age 65 or older are geographically diversified across the Commonwealth as shown in Figure 8. This variable is perhaps the single greatest indicator of the need for alternative transportation services. Of course, when developing alternative transportation means, a community's potential ability to provide services must be considered.

Table 4: Descriptive Statistic for Frequency and Percent of Households (HH) for all 351 Cities/Towns

	Frequency of Household			Percent of Households		
Descriptive Statistic	Total HH	HH with 1+ people 65+ years	HH with 1+ people 65+ & 1 person HH (i.e., single occupant)	HH with 1+ people 65+ years/Total HH	1-person HH with 65+ person/Total HH	1-person HH with 65+ person /HH with 1+ people 65+
Min	39	9	0	15.29	0	0
Max	252699	48106	22772	55.19	24.18	57.90
Mean	7257	1861	772	27.29	10.23	37.24
Median	3776	980	380	26.41	10.17	37.64
St. Dev.	15670	3242	1511	5.85	3.19	7.37

Figure 8: Percent of Households with One Person Aged 65 or Older and a Single Occupant



Although there are additional demographic variables that are important, the population, licensed driver, and household data presented in the sections above provide a sufficient baseline for both forecasting a community's needs regarding older road users and alternative transportation options. The combination of this demographic data and the review of alternative transportation programs, including public transportation, are presented in Section 5.1 of this report.

3.2 Older Driver Crash Attributes in Massachusetts

Demographics show that the elderly population in Massachusetts will grow steadily over the next decade. As a result, the Commonwealth will be confronted with a host of new challenges regarding the aging driving population. A crash data analysis was completed to better understand the characteristics of crashes involving older drivers, as well as to identify where in the state the crashes are occurring. In order to analyze older driver crash characteristics, data was accessed from various agencies through the UMassSafe Traffic Safety Data Warehouse.

The UMassSafe Traffic Safety Data Warehouse is a valuable research tool that optimizes the use of highway safety data by allowing for the storage of and access to crash-related data. Datasets within the warehouse include traditional datasets, such as crash and citation data, as well as less traditional highway safety information, such as health care data and commercial vehicle safety data. The various datasets originate with data owners including the RMV (crash and citation data), the Massachusetts State Police (commercial motor vehicle data), and Massachusetts Division of Health Care Finance (hospital data), amongst others. The use of assorted, diverse data allows for truly comprehensive analyses of highway safety problem areas. Currently, 14 such datasets are housed in the UMassSafe Traffic Safety Data Warehouse; datasets and available years are outlined in Table 5.

Table 5: Data Sets Included in the UMassSafe Traffic Safety Data Warehouse

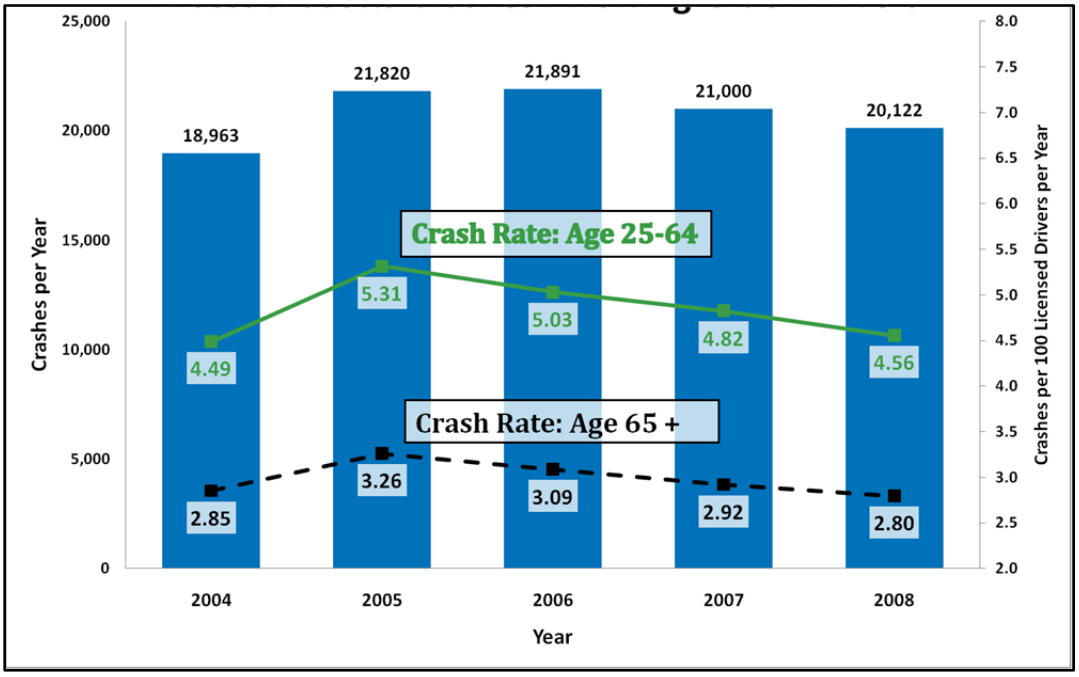
Data Set	Years of Available Data
Crash Data (CDS and ALARS)	1990-2011
Roadway Inventory	2011 version
Emergency Department	FY 2000-FY 2009
Inpatient Discharge	FY 2000-FY 2009
Outpatient Observation Stay	FY 2000-FY 2009
Commercial Vehicle Crash	1993-2011
Commercial Vehicle Inspection	1999-2011
Vehicle Miles Traveled (Projections)	2000-2025
Licensed Drivers	1996-2010
Registered Vehicles	1996-2009
Population	1996-2010
Death Certificate	1990-2006
Citation	2000-2011

The analysis included linked datasets, which were created using the datasets referenced in Table 5. Crash, citation, hospital, death certificate, and roadway inventory data have been linked using advanced statistical methodologies, creating a single dataset which allows analysts to consider the comprehensive crash experience including driver behavior, crash characteristics, roadway environment, and crash outcomes such as injuries and costs. ESRI's ArcMap© was chosen as a tool to help spatially analyze geo-located older driver crashes, because the software allows the analyst to view, edit, create, and analyze geospatial data in a single application. Approximately 85 percent of crashes are currently able to be geo-located and assigned relative x and y coordinates. The remaining 15 percent of crashes were included within all aspects of the analysis except for those requiring a specific location (i.e. spatial analysis). ArcMap© allows the user to explore data within a data set, symbolize features accordingly, and create maps. Available Massachusetts "shapefiles" downloaded from the MassGIS website that were used in the spatial analyses included the "Community Boundaries" (towns) and "MassDOT Major Roads" (15).

3.2.1 Generalized Crash Statistics for Older Drivers

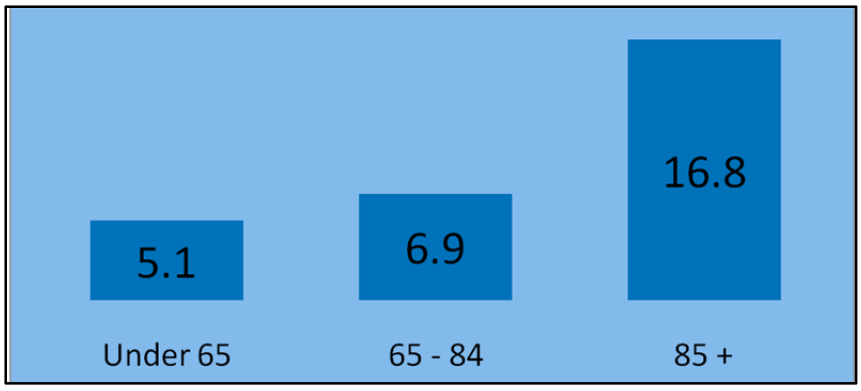
With increasing media coverage of crashes involving older drivers, it may appear that this issue has only recently become a problem. However, the data show that this is not the case. In the Commonwealth, data from the early 2000's indicate that there have been approximately 20,000 crashes involving older drivers per year. Figure 9 details the total number of crashes involving older drivers, along with the crash rate for both older and other adult drivers (per 100-licensed drivers) since 2004. While an increase in both statistics was seen from 2004 to 2005, in general, both numbers have decreased since 2005. During the same period, the total number of crashes and the crash rate for the remaining adult population followed a similar trend, although the decrease in crashes was less pronounced for older drivers. Decreases in recent years have been attributed to increases in fuel prices and the resulting decrease in vehicle miles traveled (VMT).

Figure 9: Massachusetts Crashes Involving Older Drivers, 2004-2008



As indicated previously in this report, the older population experiences a disproportionately high number of fatalities due to traffic crashes. In Massachusetts in 2008, there were 74 traffic fatalities involving individuals 65 years of age or older. This number translates into 8.5 fatalities per 100,000 population for those over 65 years of age. However, when the data are stratified into specific subsets of age, as shown in Figure 10, death rates per 100,000 population were found to be 5.1 for individuals under the age of 65, 6.9 for individuals 65-84, and 16.8 for individuals 85 years of age or older.

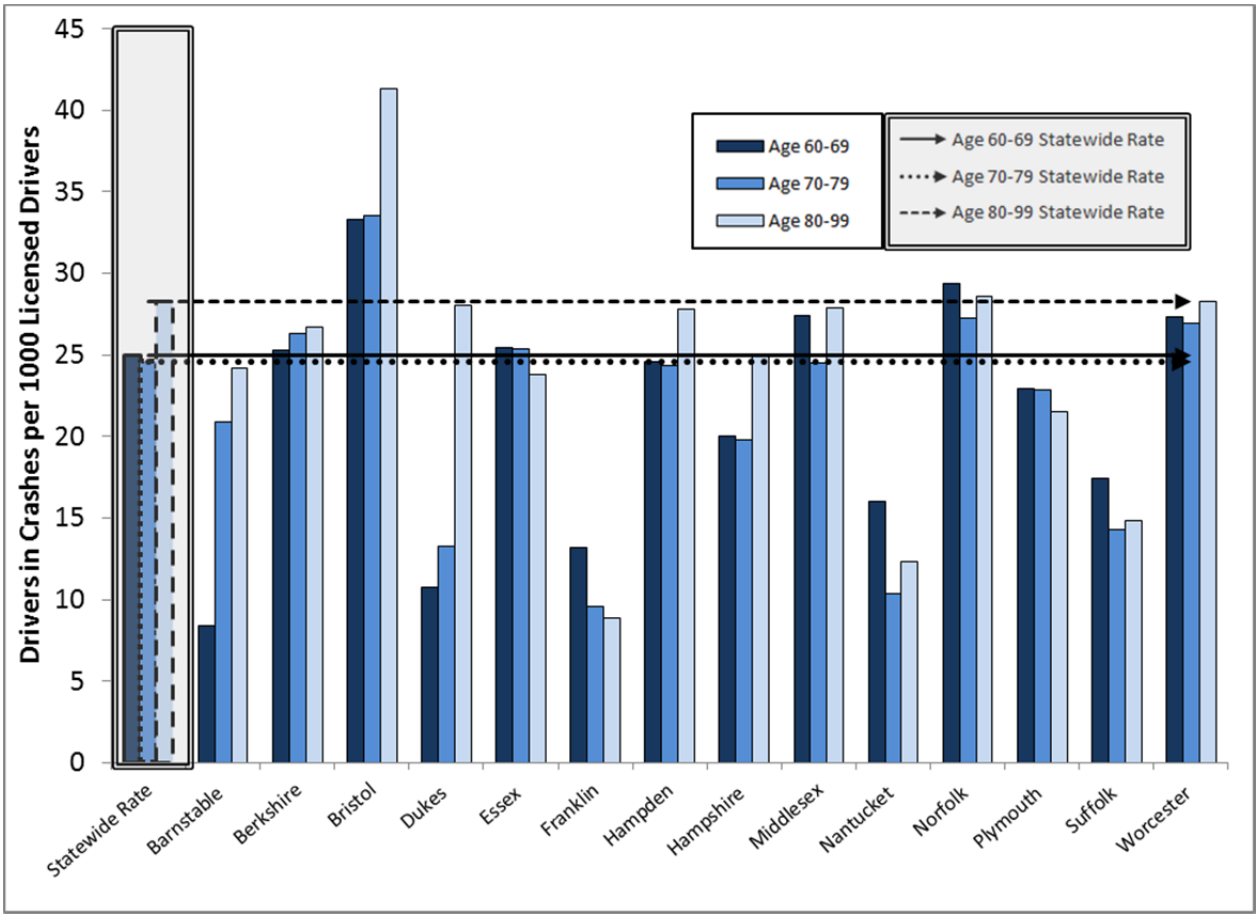
Figure 10: 2008 Motor Vehicle Fatality Rate in Massachusetts by Age Group (16)



Massachusetts crash rates were also examined per 1,000 licensed drivers by county, using 2009 crash data. As shown in Figure 11, Bristol County had a higher crash rate than the state average for each of the following age groups examined: 60-69, 70-79, and 80-99. Dukes, Franklin, Nantucket and Suffolk Counties each have lower crash rates than the statewide

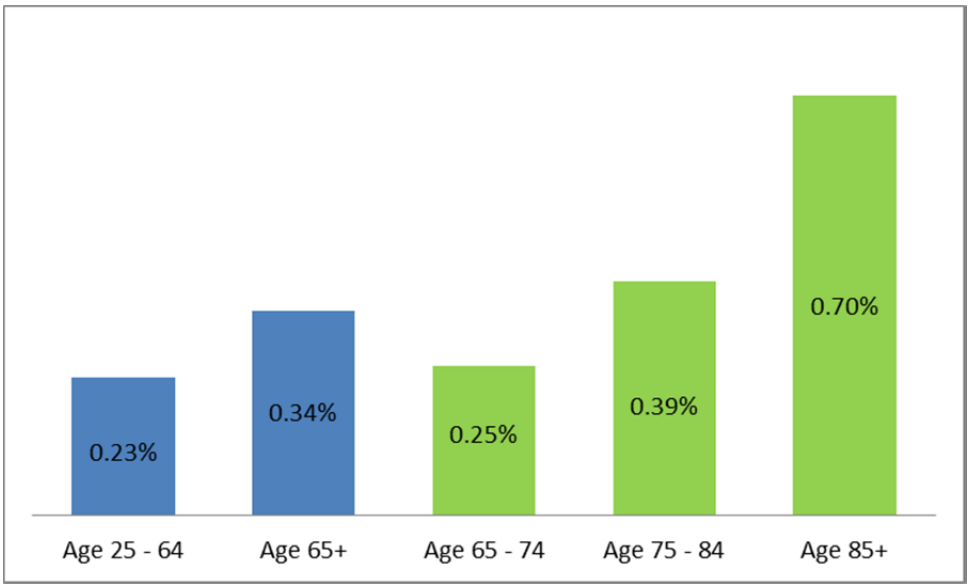
rates for both the 60-69 age group and the 70-79 age group. Bristol County has the highest crash rates per 1,000 licensed drivers in each age range evaluated. For the 80-99 year age group, there was less variation across counties.

Figure 11: Massachusetts Crash Rate per 1,000 Licensed Drivers by County, 2009



Reported crashes vary in severity from property damage only (PDO) to non-fatal and fatal injuries. The percentage of the most severe crashes (those involving fatal injuries) is greater for older drivers (0.34 percent) than other adult drivers (0.23 percent). The percentage increases concurrently with driver age within the older driver population as shown in Figure 12.

Figure 12: Percentage of Massachusetts Fatal Crashes by Age Group (2004-2008)

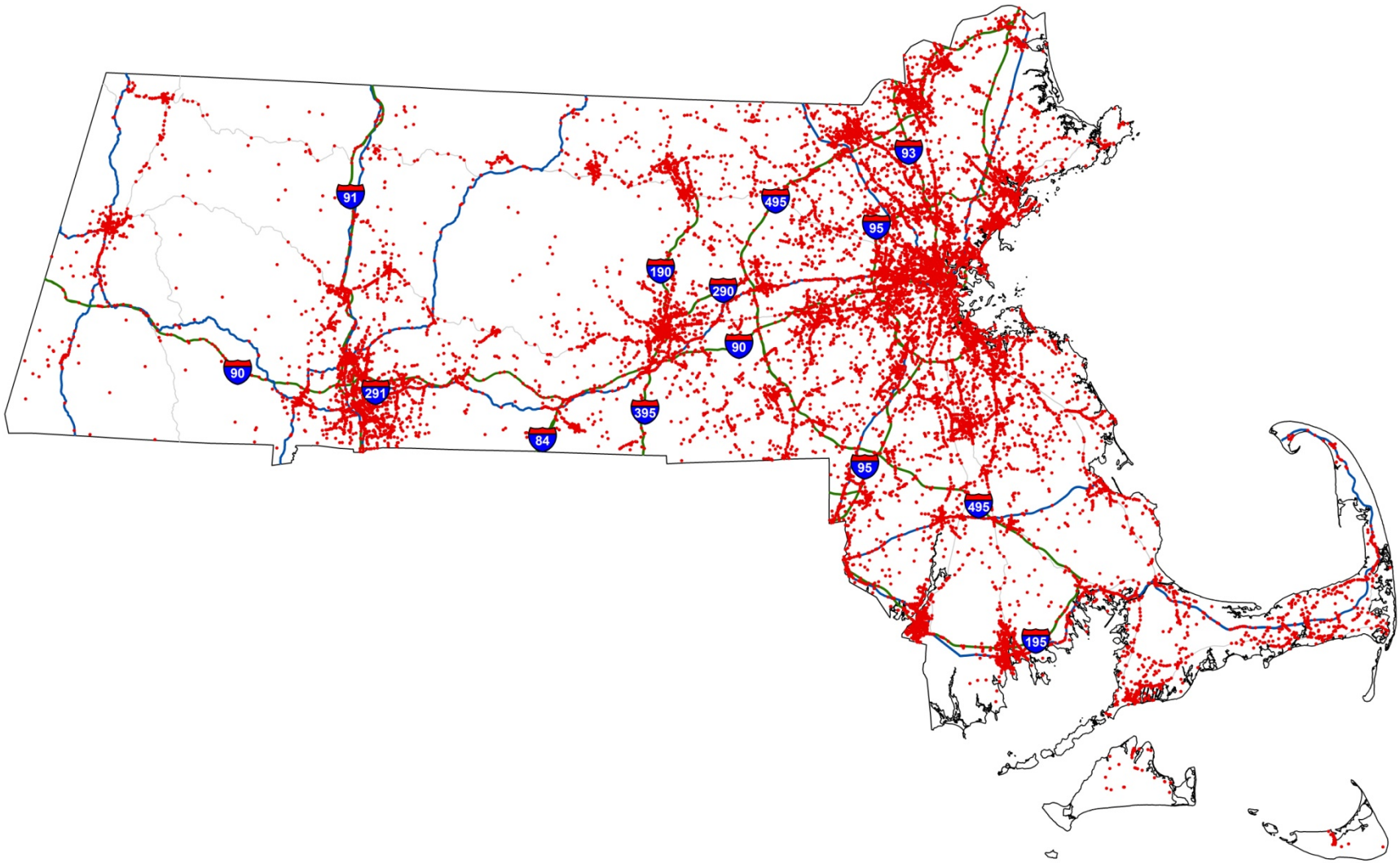


3.2.2 Spatial Identification of Older Driver Crashes

In order to comprehend the nature of crashes involving older drivers, it is important to first understand where crashes are occurring within the state. Several maps were created (and are described below) to depict the location of crashes across the Commonwealth. The maps are based on crash data from the CDS of the RMV and are representative of crashes reported by both state and local police. Crash locations are collected from the location section of the Commonwealth of Massachusetts Motor Vehicle Crash Report. Only those crashes that could be located by MassDOT were presented on this map. Coordinates are only shown for crashes that were successfully geocoded to a point, or to an approximate point, based on available crash location data.

Figure 13 represents the locations of all crashes involving older drivers in Massachusetts in 2010 and 2011. The greatest concentration of these crashes was in the most densely populated areas of the state. In the Boston Metropolitan area, along with the surrounding suburbs, there was a large concentration of crashes involving older drivers. In Western and Central Massachusetts, the crashes were clustered around population centers and the most travelled transportation corridors. There was also a high concentration of crashes on Cape Cod, as older drivers tend to make up a large portion of the driving population. This map formed the foundation for the location-based analysis. A more sophisticated study was completed that used clustering analysis to identify specific regions and corridors that experience a high number of crashes involving older drivers; while this study was outside the scope of this research, it could lead to mitigation strategies (17).

Figure 13: Massachusetts Crashes Involving Drivers Age 65 and Older (2010-2011)

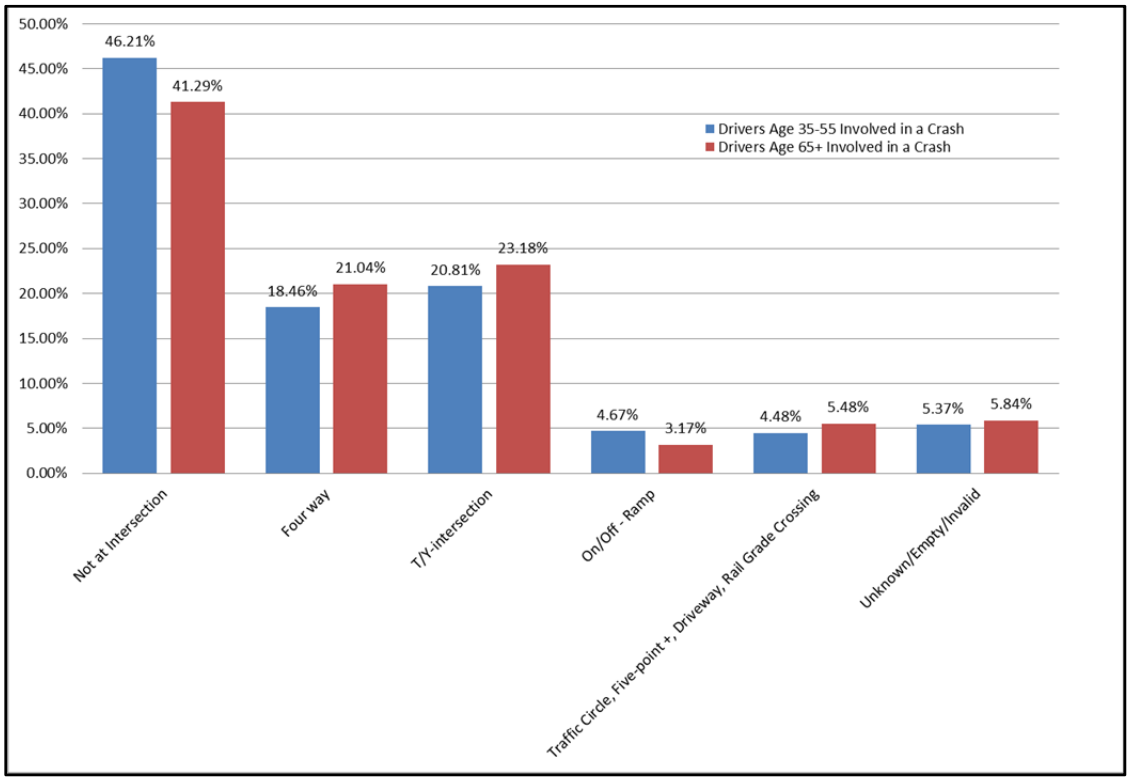


3.2.3 Older Driver Crash Variables

Further analysis involved an examination of older driver crash characteristics including a review of the roadway location (intersection/non-intersection), manner of collision, time of day, weather and light conditions, crash severity, and driver factors contributing to the crashes.

Given the potential for diminished physical and cognitive abilities associated with older drivers, this population tends to have difficulties navigating intersections. In Massachusetts from 2004 to 2008, this trend was reflected in the crash data. A significantly greater percentage of crashes involving older drivers occurred at intersections (53 percent) compared to the control group of drivers ages 35 to 55 (48 percent). Studies have shown that this trend is due, at least in part, to older drivers' difficulty in safely executing the left turn maneuver. Figure 14 shows the specific types of intersections in which these crashes occurred.

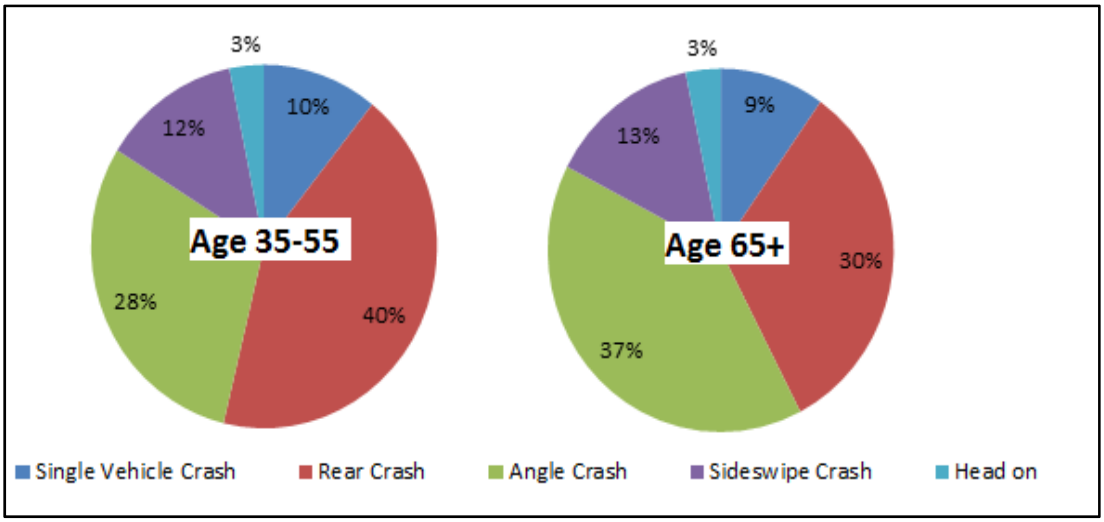
Figure 14: Percentage of Drivers in Crashes by Roadway Intersection Type (2007-2008)



To further analyze the crashes involving older drivers, the manner of collision field was examined. Different manners of collision are indicative of driving behaviors and abilities. In Massachusetts from 2007 to 2008, older drivers were involved in a higher proportion of angle crashes: 37 percent compared to 28 percent for the 35-55 age group, as shown in Figure 15. This type of crash is often associated with a driver's inability to appropriately judge gaps and respond to the actions of other drivers. Older drivers were involved in a significantly lower proportion of rear-end crashes: 30 percent of crashes compared to 40 percent for the rest of the adult population. This type of crash is often associated with

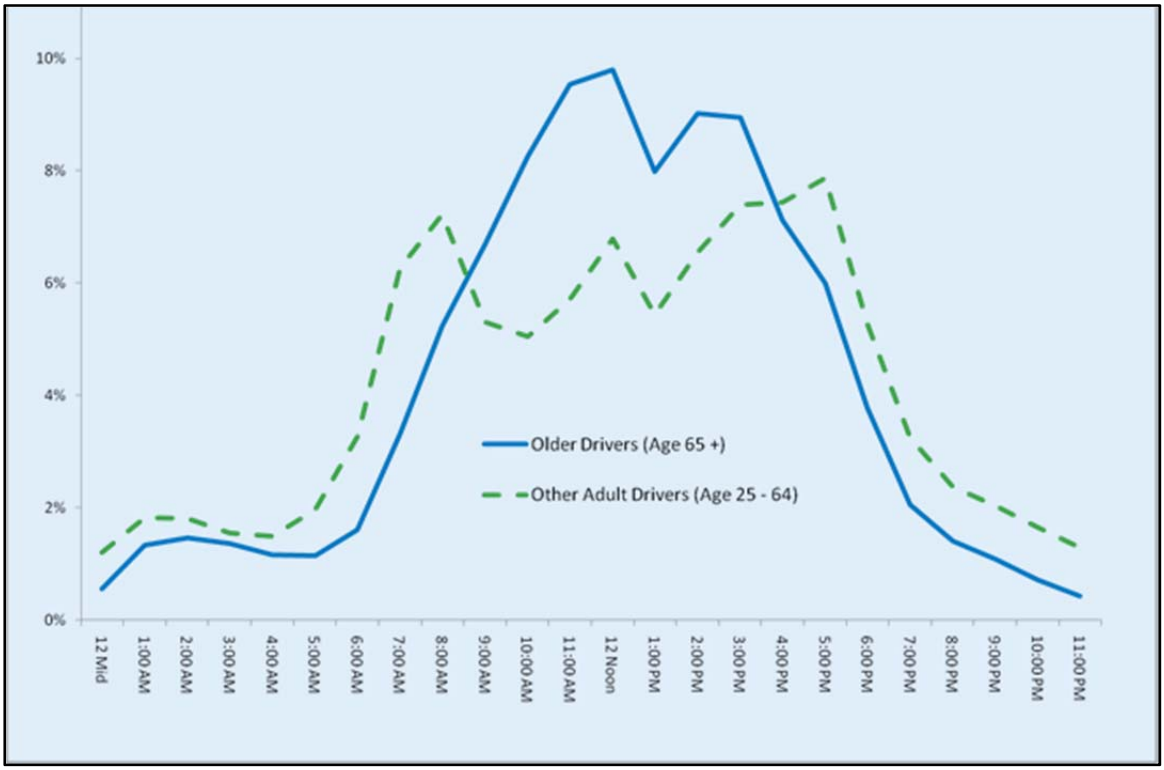
speeding, following too closely, and driver inattention, and may be suggestive of older drivers opting to travel at slower speeds and follow at greater distances.

Figure 15: Manner of Collision for Massachusetts Crashes (2007-2008)



Driving at dusk and after dark has the potential to introduce a special set of challenges for drivers. However, Massachusetts crash data from 2004 to 2008 shows that most crashes involving older drivers did not occur at this time of day, which may suggest that older drivers tend to avoid driving at dusk and after dark. Over 50 percent of crashes involving older drivers occurred between the hours of 10 AM and 3 PM. In contrast, most of the crashes for the rest of the adult population occurred during the commuting hours associated with a typical workday. Figure 16 shows the percentage of crashes occurring each hour for the older, as well as the adult, driver populations. The distribution of the older driver crashes between 10 AM and 3 PM may occur because older drivers feel most comfortable driving at this time of day. Studies have shown that the older driver population tends to self-regulate their driving by avoiding times of perceived danger such as night, dusk, and during inclement weather (18).

Figure 16: Percentage of Massachusetts Occurring by Hour of Day (2004-2008)



Poor weather and lighting conditions are often contributing factors in crashes. A number of trends emerged from the analysis of crashes occurring in Massachusetts from 2004 to 2008. As shown in Figures 17 and 18, drivers age 65 and older experience a higher percentage of crashes during daylight hours on days with fair weather. It appears that older drivers understand the risks of driving at night or in poor weather conditions, and thus limit their driving to times when they feel comfortable. In fact, 78 percent of crashes involving older drivers in Massachusetts occurred in the daylight in fair weather conditions compared to 65 percent for the rest of the adult population. The oldest drivers, age 85 and older, seemed to regulate their driving even more: 84 percent of their crashes occurred in the daylight in fair weather conditions.

Figure 17: Weather Conditions in Massachusetts Crashes by Age (2004-2008)

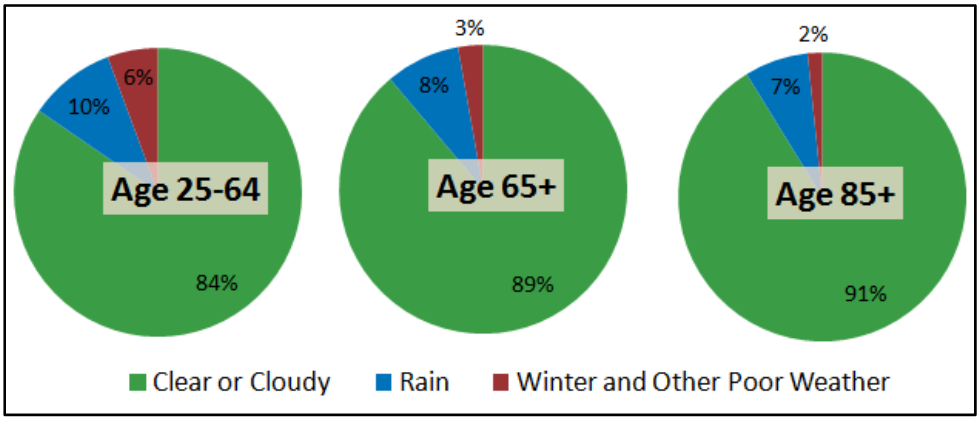
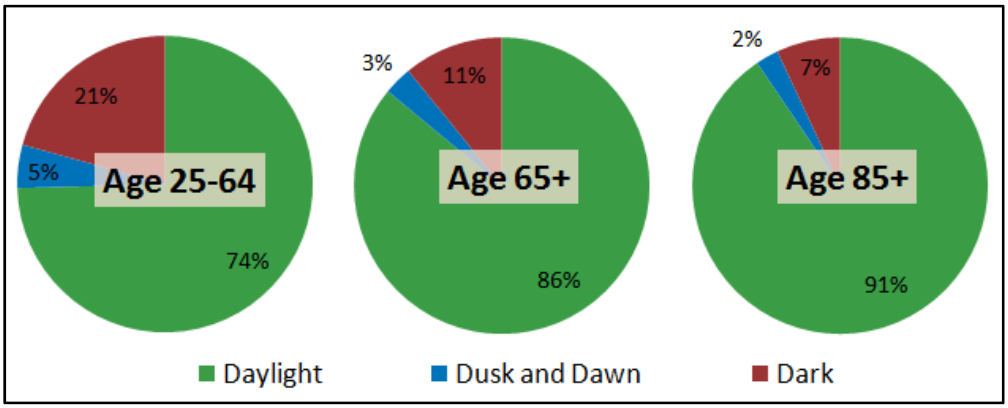


Figure 18: Light Conditions in Massachusetts Crashes by Age (2004-2008)



While there are a number of actions a driver can make that may result in a crash, crashes also happened when no improper actions were made. A number of trends were identified from the analysis of Massachusetts crashes from 2007 to 2008 which indicate the differences between driving behaviors of drivers in different age groups. For the 35–55 age group, the percentage of drivers that were noted as taking "no improper action" was 34.9. For drivers 65 years of age or older, this percentage declined to 29.1. Thus, a greater proportion of older drivers took some action that contributed to a crash. Many contributing factors were similar across age groups. However, older drivers were noted as failing to yield the right of way much more frequently (8.8 percent as compared to 4.1 percent) than younger drivers. Additionally, older drivers were reported as showing a disregard for traffic signs, signals, and other roadway markings with greater frequency than other adult drivers (2.3 percent compared to 1.3 percent). Conversely, older drivers were less likely to be following too closely, exceeding the authorized speed limit, driving too fast for conditions, or operating the vehicle in an erratic, reckless, careless, negligent, or aggressive manner.

3.2.4 Older Driver Crash Costs

The CODES dataset was used to compare the emergency room charges for older adults and a younger control group, which yielded additional findings. As shown in Figure 19 and Table 6, all combinations of payer-source and gender resulted in median charges for older drivers that were higher than for comparison drivers, except self-paying males, who paid more out of pocket than older male drivers. In some cases, such as males with public payer sources, the difference between the older driver and comparison groups, though significant, was less notable. For other groups, such as females with private payer sources, the difference was far more noteworthy. For all three payer source types, the difference between female older drivers and comparison drivers was greater than the difference between male older drivers and comparison drivers.

Figure 19: Emergency Department Charges for Older and Comparison Driver Groups

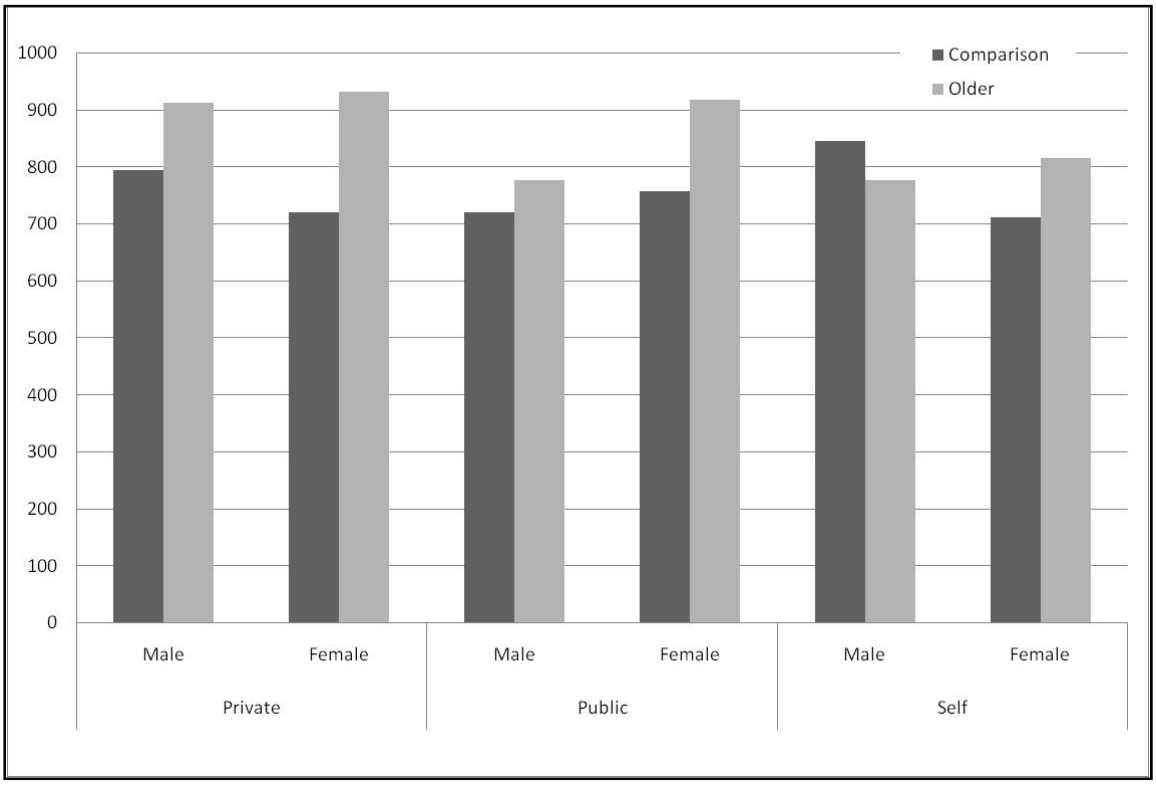


Table 6: Median Emergency Department Charges for Comparison and Older Drivers by Gender and Payer Source

Payer Source Type	Gender	Median		25th Percentile		75th Percentile	
		Comparison	Older	Comparison	Older	Comparison	Older
Private	Male	$796.00	$913.00	$794.50	$906.50	$796.00	$913.00
	Female	$722.00	$932.50	$721.00	$932.50	$722.00	$936.00
Public	Male	$722.00	$777.00	$721.00	$775.50	$727.00	$777.00
	Female	$759.00	$919.00	$759.00	$919.00	$760.00	$919.00
Self	Male	$846.00	$777.00	$846.00	$773.00	$848.00	$777.00
	Female	$713.00	$817.00	$713.00	$808.00	$713.50	$822.00

3.2.5 Summary of Findings

As noted previously, the elderly population in Massachusetts is increasing, and according to United States Census data, it will continue to do so over the next decade. Although the number of Massachusetts crashes involving older drivers has decreased since 2005, they have decreased at a slower rate than crashes involving younger adult drivers ages 25 to 64. This finding indicates that both education and enforcement regarding older driver safety policies needs to be strengthened, as does the development of new crash prevention efforts targeted at older drivers. Crash, driver, and environmental characteristics to consider in developing these countermeasures are listed below:

- The older population experiences a disproportionately high fatality rate compared to other age groups.
- The percentage of severe crashes involving fatal injuries is greater for older drivers than other adult drivers. Moreover, the percentage of older drivers involved in severe crashes increases with age.
- Specific regions of the state experience more crashes involving older drivers. As might be expected, the greatest concentration of these crashes is in the most densely populated areas of the state. In the Boston Metropolitan area, along with the surrounding suburbs, there is a large concentration of crashes involving older drivers. In Western and Central Massachusetts, the crashes are clustered around the population centers and most travelled transportation corridors. There is also a high concentration of crashes on Cape Cod as older drivers make up a large portion of the region's driving population.
- More crashes involving older drivers occur at intersections.
- Older drivers have more angle crashes and less rear-end crashes than the rest of the adult population.
- Crashes involving older drivers happen most frequently between the hours of 10 AM and 3 PM, which may be indicative of the hours in which older drivers elect to travel.
- The percentage of older driver crashes occurring during the day in clear weather conditions is higher than younger driver crashes that occur in the same conditions.
- The percentage of crashes involving older drivers in which a police report is filed indicating no improper actions is lower than that for other drivers.

- Older drivers fail to yield the right of way at a higher rate than younger drivers. Older drivers have also been reported as showing a disregard for traffic signs, signals, and roadway markings more often than other adult drivers. However, older drivers were less likely to be following too closely, exceeding the speed limit, driving too fast for conditions, or operating the vehicle in an erratic, reckless, careless, negligent or aggressive manner.
- Median emergency department charges were higher for older drivers than for the comparison drivers for all combinations of payer source and gender except for self-paying males. For all three payer sources, the difference in median emergency department charges for the older drivers versus comparison drivers was greater for females than for males.

An overview of the findings from this preliminary crash analysis was provided in a "fact sheet" format to key stakeholders and those with an interest in older driver safety. The developed fact sheet is included in Appendix A, while additional details about the CODES analysis are included in Appendix B.

3.3 Applications for Massachusetts

The demographic information presented in Section 3.1 provides the foundation for community-based analyses aimed at determining the needs for programs that provide mobility options for older adults across the Commonwealth. It is important to consider not only where older adults live, but also the makeup of a community as well. For example, if older adults comprise a dominant percentage of a community's total population, this fact may be indicative of that community's overall ability to provide mobility services. To that end, it is important to formalize tracking of household data from the ACS or a comparable source. Of particular concern would be households with only one older adult occupant, as this scenario would likely indicate a greater need for mobility services.

The Massachusetts Strategic Highway Safety Plan (SHSP) has identified Higher-Risk Transportation Users, which includes older drivers as an area of emphasis (19). Based on the overlapping nature of the mission of the SHSP and this research project, stakeholder meetings should continue in order to identify opportunities to improve traffic safety for older road users. One specific recommendation for the SHSP would be that the Safety Section within the MassDOT Highway Division coordinate with regional planning agencies to include the identification of high crash locations involving older drivers. Once candidate locations are identified, agencies may perform road safety investigations with an emphasis on identifying challenges for older drivers (17). In turn, countermeasures may be developed that improve safety for older drivers. One example of a countermeasure to improve safety for older drivers would be to utilize strategies from the FWWA "Older Driver Highway Design Handbook."

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4.0 License Renewal Practices

Older driver safety is becoming an issue of increasing importance and relevance as the population of older adults within the United States continues to increase. According to the 2000 United States Census, the number of people living in the country age 65 and older was approximately 35 million. Members of the baby boom generation (those born between 1946 and 1964) began turning 65 in 2011; this demographic of older people living in the United States is expected to double by the year 2030 (21). Needless to say, an increase in older adults translates to an increase in older drivers. According to current data, approximately 50 percent of women and 80 percent of men age 85 or older still drive (22). The increase in the number of older drivers, coupled with increased fragility as one ages, has garnered the attention of transportation safety professionals worldwide, and their intervention in older driver safety is vital: as they grapple with how best to address older driver safety, they are also accounting for the mobility needs inherent to an older adult's general well-being.

Efforts aimed at improving older driver safety include initiatives instituted at the policy and program level, as well as by older drivers themselves. As noted within the research methodology presented in Section 2.0, the approach to evaluating license renewal practices includes both a review of the literature for factors related to renewals, as well as policy review which documents the licensing practices employed across the United States. The goal of the literature review was to develop an understanding of the potentially relevant components of a revised license renewal practice that would be particularly germane to older driver safety. Factors considered included the following items: physical limitations of older drivers, safety and policy, older driver self-monitoring, and predictors and assessments of older driver performance. While developing an understanding of the factors that may be critical in revised licensing renewal practices is critical, it is also important to understand which practices and policies are currently in place for licensing older drivers (this was the specific purpose of the state-of-the practice task included within the scope of this research effort).

4.1 Physical, Visual, and Cognitive Limitations

In order to consider factors that may be implemented into a revised license renewal practice, it is critical to have a basic sense of the physical limitations that may affect the driving performance of older adults. The act of driving requires several skill sets that include visual, cognitive and physical abilities (23). Impairments in these areas due to aging have the potential to affect safety and performance in older drivers.

Vision is the sense that is most critical to driving tasks, regardless of age (22). Approximately 90 percent of the information needed to drive is related to the ability to see clearly. Visual acuity is the measure most often considered in relation to driving, and the vision test is the assessment most commonly used during the licensing process. Research

conducted by Burg in the 1960s, and reconsidered in the 1970s by Hills and Burg, has shown an association between visual acuity and crash rates for older drivers (23). The researchers noted that although statistically significant, the magnitude of the relationship was low; a link between poor visual acuity as a causal factor in crashes could not be established based on this work; thus, visual acuity should not be identified as a good test for identifying high risk older drivers. Expanding upon vision-related concepts, research has shown that dynamic visual acuity plays a role in the relationship between vision and driving. Dynamic visual acuity is the ability to see a moving object, especially in conditions with limited light such as dawn, dusk, or fog. Furthermore, dynamic visual acuity is reduced as age increases (22).

Although visual acuity is the test most commonly used during the licensing process, there is relatively little literature to support the concept that acuity tests can identify high-risk drivers. There are several explanations for why this may be the case (23). Letter-acuity tests were designed for clinical diagnosis of eye disease but were not developed for use during the evaluation of complex tasks such as driving. Severe visual acuity impairment is likely to have an impact on the ability of a driver to safely maneuver a vehicle; however, other visual impairments are also likely to impact a driver's ability to drive, and acuity tests would fail to identify those impairments (23). Another possible explanation for the lack of literature supporting the relationship between visual acuity and accident rates is that many drivers with poor visual acuity are not able to obtain licenses and are therefore not "eligible" to be involved in crashes. This situation limits the amount of information that can be collected on the relationship between acuity and crash involvement. In states where vision re-screening is not required, there exists the opportunity to collect this information, though drivers with severe acuity impairment (such as older drivers) are more likely to voluntarily surrender their license or limit their driving to less risky, more familiar situations. This scenario would, again, limit the opportunity to effectively tie impaired visual acuity to crash involvement (23).

Other visual issues that have been considered in relationship to driving are field of vision, contrast sensitivity, and color discrimination. "Field of vision" is the total area that one can see and respond to (22). As a driver ages, the field of vision typically decreases and peripheral vision is lost, creating what is commonly referred to as "tunnel vision." Several real-world studies showed that drivers with visual field impairments were not more likely to be prone to driving performance problems (23). There is no consensus in the research on this topic; this lack of agreement suggests that the inclusion of these factors within a possible licensing renewal practice may not be the best strategy for testing driving performance.

Studies examining contrast sensitivity, a visual impairment tied to the presence of cataracts (common in older adults), are less prevalent than those considering acuity or field of vision (23). Contrast sensitivity is the ability to discern between two similarly colored objects, and weak sensitivity can affect the ability to judge distance or identify objects (22). Several studies have shown a relationship between contrast sensitivity and crash rates. However, the limited availability of research in this field and the findings to date indicate the need for additional study in this area (23).

Color discrimination is tested in both personal and commercial licensing practices not so much as a measure for potential crash involvement, but to determine whether the driver can

obey color-based traffic signals. However, color discrimination has been found to be less important, as information can often be communicated using means such as luminance, position, and pattern. As such, it can be reasonably assumed that color discrimination is not a significant challenge for older drivers (23).

Other visual impairments that have been raised as potential areas for consideration in older driver safety research include glare and eye-movement disorders. However, these considerations have not been widely addressed in the literature (23).

The visual-sensory impairments discussed above are not the only relationships between vision and safe driving. Also worthy of consideration are tasks that combine vison and cognition. In the late 1980s, the "Useful Field of View Test" was developed to examine how information presented within the field of vision is used. Unlike other assessments of the visual field, this test included higher-order processing such as selective and divided attention and rapid visual-processing speed (23). Several research studies have found correlation between the types of impairment identified in this test with an increase in crash rates. This test has also been found to effectively identify high-risk older drivers suffering from Alzheimer's disease. Generally, the strength of the relationship between visual-cognitive impairment and crash rates is stronger than the relationship between crash involvement and visual-sensory function alone (23).

Dementia, which results in a decrease in cognitive understanding, is an abnormal condition related to aging which can have a significant impact on safe driving behaviors (22). Dementia is a progressive, incurable disease which was first linked to driver safety issues by Waller in 1967, subsequently studied by Johns Hopkins University researchers in 1988, and more recently by others (24). Several studies have shown that older drivers with cognitive impairments, regardless of the cause, are at least twice as likely to be involved in a crash (23). Some of the specific challenges associated with cognitive impairment and safe driving are based upon attention problems, visual search impairment, and spatial memory (23). While older drivers with Alzheimer's disease had a slightly higher crash rate than older drivers without the disease, the crash rate for older drivers with Alzheimer's disease is within the range of what is deemed acceptable for other age groups, especially young drivers (23). As a result, it is important to consider not only the impact of cognitive impairment on older drivers in relation to themselves, but also in relation to the driving population as a whole: are older drivers significantly more dangerous on the road than other drivers? The existing body of research has shown varying positions on the relationship between cognitive impairment in older drivers and driver safety as a general public health issue, pointing to the need for continued monitoring at the individual level by licensing agencies, clinicians, and others (24). There is no one cognitive measure that can be clearly integrated into licensing renewal practices based solely upon the cognitive research presented.

In addition to being able to see and understand the driving environment, safe driving requires the physical ability to maneuver and control the vehicle. Some of the important physical skills associated with driving are coordination, range of motion (head, neck, arms, legs, etc.), balance, and gait. There has been relatively little research done on the relationship between physical function and the safety of older drivers. For example, there is almost no information in the literature on minimum levels of physical performance needed to safely drive. There

exist new vehicles with controls that are aimed at meeting the needs of drivers with varying degrees of physical ability (23), as well as assistive devices that may be added to vehicles to address some of the issues raised by physical impairment (22).

Although the literature provides insight into the physical limitation of older adults that are directly or indirectly related to the driving task, there is a need to better understand additional aspects of older driver practices before considering possible revisions to licensing renewal practices.

4.2 Older Driver Self-Monitoring

In many instances, the first step to ensuring the safety of older drivers is taken by the drivers themselves. A survey conducted in 1999 by the Insurance Research Council found that 77 percent of people age 70 and older (who responded to a survey) supported annual vision tests. Other provisions supported by older driver respondents included training programs for older drivers and mandatory annual physicals (25). Older drivers have been known to employ adaptive strategies, both conscious and unconscious, in response to declining function and their existing mobility needs (18).

The adaptive strategies employed by older drivers may be categorized into three areas: strategic, tactical, and operational behaviors. Strategic behaviors are considered knowledge-based behaviors and include decision-making such as whether to drive in the rain. These decisions are generally made over time. A good strategic adaptation made by an older driver would be to live someplace where there is the greatest diversity of mode choice. For example, living in a city would increase the availability of means of transportation, thus reducing the impact of the diminished mobility resulting from age and driver safety. Older drivers, however, do not generally make this decision. Research has shown that people tend to make a choice to age in the same area they have lived for most of their lives. As populations tend to move towards the suburbs, this trend is evident in the aging population as well (18). The primary strategic adaptation employed by older drivers is to limit their own driving exposure. An Australian study found that approximately one-third of the older drivers they surveyed drove less than they did five years prior to the survey (26). Older drivers are not only likely to reduce their overall driving, but are even more likely to limit their exposure to high-risk driving situations such as driving in the winter, during the rain, during high traffic (peak hour) conditions, and at night (18). Additionally, older drivers indicated that they avoid certain types of roads such as highways and urban routes.

In addition to general strategic adaptations, those drivers who have visual or attention impairments were even more likely to report avoidance than those without similar impairments. However, individuals with cognitive impairments did not report the same level of avoidance as those with visual or attention impairments. This statistic may be due to the lack of insight regarding their own behavior. Additionally, drivers who had experienced crashes within the five years prior were more likely to report avoidance behaviors than those with clean records, indicating that the crash may have triggered these avoidance tactics (18).

The Australian study found that the following characteristics were associated with drivers age 65 or older who avoided specific driving situations:

- Age 75 or older;
- Female;
- Drivers who were not confident with their driving skills; and
- Drivers who rated their health as less than excellent (26).

The most extreme case of avoidance is the surrendering of the driver's license. A Finnish study of drivers who did not renew their licenses indicated that less than 7 percent did so as the result of professional advice. Men were more likely to continue driving until health prevented it, while women were more likely to give up their licenses as a result of the stress associated with driving (27).

Tactical adaptations that may be employed by older drivers include driving more slowly and allowing larger gaps when following other vehicles. Wasielewski and Evans studied these adaptations in two separate studies (28,29). The results of this research indicated that drivers age 50 and older adopted mean headways that were 15 percent longer than drivers over age 20; these same older drivers' mean speeds also declined as their ages increased. On average, drivers age 75 traveled 4.0 mph slower than drivers who were age 20.

Intersections present another opportunity for older drivers to employ tactical adaptations. A study by Staplin indicated that older drivers are less able to judge closing speed for approaching vehicles in an intersection and therefore rely largely on distance judgment. This tactic puts them at a greater risk when dealing with vehicles that are moving more quickly than the rest of the traffic stream (30). As a result, older drivers lengthened the gap between themselves and other moving vehicles in order to complete a left-turn maneuver. However, in some cases, adaptive tactical behaviors are not suitable given the situation. The same research study conducted by Staplin indicated that older women were less likely than all other drivers to pull into an intersection prior to completing a left turn in order to improve their view of opposing traffic. This hesitation puts older drivers at a disadvantage in terms of view, but also lengthens the time required to complete the turning movement.

Operational adaptations are far less common among older drivers, perhaps because they are cognitively or physically unable to make these adaptations (18). In both simulator and on-road experiments, older drivers performed more poorly than younger or adult drivers when asked to complete a specific task. Though many studies found that older drivers responded poorly compared to younger or adult drivers, one study by Hakamies-Blomqvist et al. found that older drivers were likely to use any combination of three controls (e.g., steering, clutch, accelerator, and brake) simultaneously, while the middle age drivers were more likely to use four or more (31). Generally speaking, the tasks that require operational adaptation often require rapid response and do not allow the older drivers the time they need to adapt appropriately.

4.3 Older Driver Safety and Policy

Older driver adaptation is one method for addressing safety issues faced by this demographic group. However, in some cases adaptation may be counterproductive, and relying on the older driver to assess potential challenges and respond effectively in all cases is unreasonable. As a result, efforts have been made to provide guidance and to offer a more systematic method for improving older driver safety while maintaining mobility.

A 2002 draft of *Safe Mobility for a Maturing Society: A National Agenda* (National Agenda) was published as part of the 2004 conference proceedings for Transportation in an Aging Society: A Decade of Experience. The National Agenda, which was developed based on information gathered through a series of regional forums, focus groups, conferences, and stakeholder roundtables, was organized around the following mission statement: the agenda seeks "to enable safe driving as late in life as possible and to offer other convenient transportation options when walking and driving are not feasible" (32). In the interest of providing safer transportation for the aging population, this agenda identified seven areas upon which professionals should focus their efforts:

- Develop state and local safe-mobility action plans;
- Promote safe, easier-to-use roadways;
- Create safer, easier-to-use automobiles;
- Improve older driver competency;
- Promote better, easier-to-use public transportation services;
- Provide better public information; and
- Explore basic and social research needs.

These focus areas included elements of design, policy and program initiatives. However, the material presented below focuses solely on policy initiatives.

Transportation policy regarding the safe mobility of older adults is an interdisciplinary issue that involves transportation professionals, public safety and human service providers, interest groups, and others (33). There are five key pieces of legislation related to older drivers that have defined access as a right, funded services and infrastructure improvements, and promoted research. The Americans with Disabilities Act of 1990 (ADA) served to redefine access to transportation as a civil right, requiring access to key bus and rail routes for persons with disabilities (33). The relationship between access for older persons and access for disabled persons is evidenced by the relative growth in disability as a person ages. The Intermodal Surface Transportation Equity Act of 1991 (ISTEA), the Transportation Equity Act for the 21st Century (TEA-21), and Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) all funded national surface transportation efforts. Each of these two pieces of legislation provided funding for research on driver safety, intelligent transportation systems (ITS), and transit resources. In ISTEA, Section 5310 specifically provided funding for private, nonprofit organizations or public agencies that coordinated transportation for older adults. In SAFETEA-LU, Section 1405 promoted road safety improvements that enhanced the safety of older drivers and eased their use of the highway system (34). The reauthorization of the Older Americans Act (OAA) in 1992

identified transportation as a priority service that is critical to the well-being of older adults; however, most of the transportation funding in this act was related to the transportation needs associated with other programs such as nutrition and health. While funds distributed through these related programs are significant transportation investments, they tend to solely address mobility needs rather than the services associated with a wider view of healthy aging (including social trips and activities that help keep older adults engaged in society) (33).

Although there are a variety of policy efforts that address some aspects of older driver safety and mobility, the remainder of this section focuses on licensing practices. Focusing on licensing does not indicate that licensing policies are the only relevant focus, but rather suggests that it is necessary to look at alternative transportation options that address the needs of older adults as they cease to drive.

Prepared by the IIHS, the *Licensing Renewal Provisions for Older Drivers* outlines the license renewal procedures for older drivers in all 50 states as well as the District of Columbia (14). In most cases, the renewal process includes a review of the driving record to ensure there are no suspensions/revocations, as well as requires the older driver to appear in person, passing a vision test, and pay the required fee. In 27 states and the District of Columbia, older drivers are governed by a shorter renewal cycle, the requirement to pass additional tests not required of other drivers (vision or road tests), and appearance in person rather than renewal by mail or electronically. In cases where the person's ability to drive is in doubt, clinicians, police, and others may notify the licensing agency, which can refer the case to a medical review board. The review board considers individuals on a case by case basis and may recommend that the older adult retake the standard licensing tests (written, road or vision), or may require physical or mental examination. Following review of the person's fitness to drive, the agency may choose to renew, refuse renewal, suspend, revoke or restrict the license. Restrictions might include limits on nighttime driving, additional mirrors required on the vehicle, or restriction to driving in specified places (such as within a certain radius of the driver's home). In states where the renewal cycle is not shorter for older drivers, agencies have the authority to reduce the renewal cycle in individual cases when they feel it is warranted. Unfortunately, the success of these measures in identifying hazardous drivers has been difficult to document. Studies have shown mixed results, and there is a question about the effectiveness of license restrictions on limiting unsafe driving (33).

In Massachusetts, the standard renewal cycle length is five years. The recent Safe Driving Bill of 2010 provided some changes to the Massachusetts licensing renewal policy as related to older drivers. Section 4 of the bill states, "An applicant for the renewal of a license 75 years of age or older shall apply for a renewal in person at a registry branch office" (35). The bill also requires that any individual appearing in person must pass a vision test at the registry branch (35).

If policy initiatives are going to consider licensing practices that may limit the mobility of older adults, it is necessary to consider the provision of supplemental transportation options. Increasingly, attention is being paid to the issue of maintaining mobility while implementing licensing restriction policies. In New Hampshire, the state's Transportation Safety Task Force's review of a proposed graduated de-licensing for older drivers noted that New Hampshire had almost no public transportation to supplement travel by personal vehicle (35).

There has been some work by the Federal Transit Administration (FTA) to provide public transit through their Non-urbanized Area Formula Program, though these efforts tend to be underfunded (33). In metropolitan areas, federal program funds have been allocated to improve fixed routes and to provide transportation for health-related trips, nutritional support, and other necessities. However, as previously mentioned, this does not provide for trips related to the overall well-being of older adults, including trips for social events or for staying active in the community.

Public transportation, via bus, light rail, or heavy rail, provides an option for many residents that can no longer drive. More desirable paratransit and other curb-to-curb services for older adults with mobility challenges continue to exist with high levels of demand, often exceeding supply capabilities. Challenges with curb-to-curb and, more specifically, door-to-door services, include cost, quality and availability. Combined funds from the Department of Health and Human Services and the DOT represent a significant contribution to non-fixed-route transit. However, car and van services that run below capacity do not optimize time nor vehicle productivity; providing trips for the range of demands can be beyond the technological and personnel resources available (33).

Another strategy to consider regarding alternative transportation options is community design, as walking can be a good method of transportation for the older population. However, community layout and connectivity by walkways can be challenging from a policy perspective, because policy is often governed at the local level by zoning, permit processes, and local history (33). Nevertheless, the Boston Indicators Project suggests how pedestrian movement can be made safer. Identifying transportation as a critical element for a livable community, the project developed performance measures that would improve the walking experience of Boston residents. Future projects utilizing this goal may have the potential to improve transportation capabilities for older adults that are no longer able to drive.

4.4 Assessments and Predictors for High Risk Older Drivers

To focus programs and policy where they are likely to be most effective, efforts have been made to develop systems for identifying high-risk older drivers (36, 37, 38, 39). Many of the attributes that may make older adults high risk drivers are often associated with the physical impairments that come with aging. The focus on medical and physical indicators may also be common because there is some opportunity for intervention by individuals involved in their care (physicians or family) or by the licensing agency (vision tests). A fair amount of research has been conducted regarding efforts to use medical and physical assessment to identify high risk older drivers.

Eby, Molnar, Shope, and Dellinger sought to develop a battery of tests that could be administered easily and inexpensively for use in longitudinal studies of older drivers (37). The goal of this work was not to test crash risk associated with the areas being assessed, but rather to provide a mechanism for measuring several aspects of health and driving behaviors that would be easy and inexpensive to administer. The tests evaluated within Eby et. al's

battery included tests of sensitivity, visual acuity, walking ability, reach, clock reading, reaction time, hand strength, stereo acuity, motor free visual perception, and a mental state exam. Also included were three questionnaires on driving, health, and demographics, among several other topics. The test sequence took, on average, less than one hour to complete and was well-received by participants and test-administrators alike. Although this assessment sequence was inexpensive, transportable, and provided acceptable results from a data collection perspective, it is important to note that it was designed specifically for data collection in a longitudinal study rather than crash risk assessment as part of the licensing process.

A Canadian study similar to that performed by Eby et. al. examined the acceptability of components from a clinical assessment battery and how well they could be implemented in a clinical setting; if successful, their inclusion might be able to predict a person's probability of involvement in a motor vehicle crash (38). The study was conducted by study nurses in the homes of 10 patients who had sought emergency department treatment. Patients underwent a 90 minute assessment that could be used in front-line clinical settings rather than in the patient's home. The tests used for this assessment included the Older American Resources and Services questionnaire to understand pre-crash daily living activities, the Timed Up and Go balance and mobility test, the Geriatric Depression Scale score, the Mini-mental State Examination, the Clock Drawing Test, a visual acuity test, a hearing test as well as several other tests. Several new tests were developed to assess peripheral vision, neck rotation, rapid foot movement and reaction time. Since the research was conducted as a pilot study and the sample size was small, no definitive conclusions could be reached. However, patients generally found the tests acceptable to participate in, and several of the tests warranted further consideration as they demonstrated promise for identifying older drivers likely to be involved in a crash. Specifically, tests of physical examination measures, such as the Timed Toe Tap, Neck Rotation, and Coin-Catch Reaction Time tests could be linked to the ability to measure fitness to drive. The Mini-mental State Examination, Driving Habits Questionnaire, and dementia questionnaire also provided valuable information for further consideration.

Another study sought to examine the relationship between medical contacts and crash risk (39). This study used logistic regression analysis to determine the odds ratios for involvement in a crash based on medical contact within the month prior to the crash. Results showed a weak but statistically significant increased risk of collisions being associated with this medical contact (OR=1.10, 95 percent CI 1.08 to 1.11).

In July 2005, NHTSA published *Strategies for Medical Advisory Boards (MABs) and Licensing Review* to document the medical review practices of 51 drivers licensing agencies in the United States with the hope of developing strategies for addressing drivers with medical conditions and functional impairments (40). Some of the recommendations made in this report included the following items:

- Use of Medical Advisory Boards (MABs) for fitness to drive determinations as well as appeals for licenses already denied;
- Use of MAB guidelines to achieve some level of consistency; however, review can be on a case-by-case basis;

- Require older drivers to appear in person to renew, with a shortened renewal cycle for older persons;
- Train police officers to identifying at-risk drivers with medical conditions or functional impairments;
- Implement functional screenings at license renewal for drivers over a specified age;
- Use restrictions that allow drivers to maintain some driving privileges in safe conditions; and
- Recognize the importance of licensing agencies not only to ensure public safety, but also to support the safe mobility of drivers with functional impairments or medical conditions.

4.5 Older Driver Licensing Policies

Although research suggests that today's older drivers are more cautious than previous cohorts of older drivers and that they are willing to self-regulate (drive in less congested conditions, avoid night-time driving, etc.), there is also the perception that this generation of older drivers are so accustomed to the mobility afforded by driving that they may not be willing to change their driving behavior in ways that will significantly impact mobility (41). The literature reminds us that one of the roles that a state DMV plays is to "ensure that drivers are capable of driving safely, and to restrict, suspend, or revoke licenses when drivers demonstrate that they are incapable" (42). However, there is less of a consensus regarding how this role should be performed in reference to older drivers. Across the United States, and in other countries, age-based restrictions have been implemented. What these restrictions are and how they are carried out varies greatly, but both point to the idea that though they may not be consistent, they are politically viable (41).

In many states, age-based restrictions include more frequent or different vision, performance, and driving tests. As described previously, these tests are not particularly effective as tools for assessing an older person's ability to safely drive. Some would argue that a road test is the most effective mechanism for assessing driver safety; however, some of the arguments against this assessment would include the fact that road tests fail to expose drivers to hazardous driving situations. For example, behavior behind the wheel during a driving test may differ from behavior behind the wheel under daily driving conditions. Thus, some of the factors considered during the driving test will not change as the driver continues to age (42).

Research has shown that age-based restrictions are not effective in reducing crash rates for older drivers (41). Many countries, and some states in the United States, are moving away from strictly age-based restrictions and moving towards behavior-based restrictions. These behavior-based restrictions are commonly associated with additional testing that takes place due to a driver's high crash frequency or at the recommendation of friends or family (41).

Whether the restrictions are age-based or behavior-based, there are challenges associated with the testing procedures. Whether an older adult is retested frequently rests at the discretion of the examiner. In some cases, examiners reported that they decided who to retest

based on how they looked, and in some rural states, they reported that their inclination to allow older people to keep their licenses (even if they were deemed unsafe) was based on the knowledge that no alternative transportation options were available (41). It is necessary for states to identify ways to implement licensing tools that are reliable, efficient, and cost effective. These tools should balance both scientific findings with the need to be fair and respectful to older drivers (42).

Licensing of drivers is a practice overseen at the state level. Although it is the responsibility of the state, and ultimately decisions are made at the state level, there are opportunities for states to learn from each other and from national experts in terms of best practices for older driver licensing. The licensing of young drivers, through junior operating licensing policies, is one example of the opportunity for states to successfully implement best practices. Although there is no single uniform junior operator licensing law, most states have similar elements such as restrictions on night driving, passenger restrictions, and the requirement for certain levels of driving experience before they can move on to the next level of licensure. To better understand how states may adopt successful elements of licensing policies from other states or national guidelines, it is important to understand current licensing practices regarding older driver licensing.

4.5.1 Older Driver Licensing Attitudes at the Licensing Agency Level

As part of the NHTSA Model Driver Screening and Evaluation Program, the licensing officials in 50 of the United States, the District of Columbia, and in 12 Canadian Provinces were asked to complete a questionnaire regarding feasibility of licensing practices in their state (43). Specifically, they were asked to consider the cost and time required to implement the model program and how that might impact their willingness to do so. Of the 62 agencies asked to participate, 60 ultimately responded from a total of 47 states, the District of Columbia, and the 12 Canadian Provinces.

When asked how new or increased screening procedures should be applied, six respondents indicated they should be applied to everyone over a certain age who applied for license renewal; 28 states (including Massachusetts) felt they should be applied only to a subset of "high risk" drivers that would likely include a disproportionate share of older drivers referred through a variety of mechanisms; 26 states indicated that drivers over a certain age and drivers at "high risk" should undergo the additional screening. Respondents were then asked to not consider cost or time associated with additional screening procedures in order to answer the additional questions in a non-biased way. The majority of respondents felt that the following licensing practices were feasible:

- Graduated de-licensing (though in some cases it would require changes in legislation);
- Public outreach/community education programs for drivers to educate them about aging and safe driving practices;
- Modification of existing vision screening to incorporate more reliable/accurate techniques;
- Modification of practices so lower levels of vision test performance (20/80 or 20/100) would result in license restrictions rather than revocation;

- Incorporation of testing for vision skills other than static visual acuity, such as dynamic visual acuity and contrast sensitivity;
- Testing for additional measures beyond vision, such as measures of attention, perception, memory, decision-making and situational awareness;
- Testing to evaluate functional capabilities of a person based on referral so as to eliminate having to wait for the end of the renewal cycle in order to revoke or restrict the license based on test results;
- Conforming to a uniform referral process in order to screen drivers based on diagnosis of medical conditions;
- Tailoring retest nature and frequency to address specific medical conditions such as dementia, stroke, Parkinson's, etc.;
- Allowing for friends or family of an older person to refer them for screening even if they have not been diagnosed by a doctor as being functionally impaired;
- Implementing a referral mechanism to be used by counter staff at licensing agencies based on a checklist or questionnaire that could be applied to those who appear before them for relicensing; and
- Tailoring road tests to specifically consider the driving skills that are likely to be most impacted by the type(s) of functional impairments identified for the driver being tested.

Just over half of the responding licensing agencies indicated that the cost of additional efforts would have to be substantially or completely offset by other savings within the department. The remaining agencies were nearly evenly divided between those who felt that half of the costs would need to be offset and would be supplemented by safety benefits, and those who felt the safety benefits alone were justification enough for implementing such measures. Additionally, when identifying the greatest amount of time that these additional measures could take for practical implementation, the responding agencies were evenly divided across four categories: 1.) under 15 minutes, 2.) 15 to 30 minutes, 3.) 30 to 45 minutes or 4.) 45 minutes to one hour or more.

4.5.2 Current State Policies for Older Driver Licensing

While it is important to continue to work towards an understanding of what licensing agencies might be willing to implement, it is also important to understand which licensing practices and policies are currently in place for older drivers.

The IIHS monitors the licensing practices in place for each state (14). Table 7 and Table 8 provide an overview of practices implemented by each state and the District of Columbia (23 states have no special safety provisions for older drivers). In general, each state has similar licensing regulations and policies, as well as renewal processes. With the exception of Wisconsin, where the renewal cycle is eight years, in most states the renewal cycle is 4 or 5 years. States which conform to this norm are herein listed: Alabama, Arkansas, Connecticut, Delaware, Kentucky, Massachusetts, Michigan, Minnesota, Mississippi, Nebraska, Nevada, New Jersey, New York, North Dakota, Ohio, Oklahoma, Pennsylvania, South Dakota, Tennessee, Vermont, Washington, West Virginia, Wisconsin and Wyoming.

There are several important aspects to consider for the aforementioned states. In Connecticut, for example, drivers over the age of 65 may choose either a two or six year renewal cycle (compared to four or six years for non-older drivers) and are asked to appear in person to renew. However, they are allowed to cite hardship and can then renew by mail instead. Both Minnesota and Massachusetts have licensing laws that specifically prohibit licensing agencies from treating drivers differently based solely on age; however, Massachusetts now requires all drivers over the age of 70 to renew in person and to pass a vision test. Nevada has similar laws, though drivers over the age of 70 who are renewing by mail must include a medical report. In Oklahoma, drivers age 62 to 64 pay a reduced fee, and drivers over the age of 65 pay no fee. Licenses for Tennessee drivers over the age of 65 do not expire.

Ten states have an accelerated renewal process as the only special provision for older drivers. In these states, the renewal cycle is one to four years less than for other drivers; the age at which the accelerated renewal process is applied ranges between 63 and 75 years old. In some states, drivers have a choice regarding the length of their renewal cycle but older drivers are required to renew at the most frequent interval. For example, Idaho allows drivers ages 21 to 62 to renew every four or eight years, while drivers ages 63 or older are required to renew every four years. The following states have only accelerated renewal processes for older drivers: Hawaii, Idaho, Indiana, Iowa, Kansas, Missouri, Montana, New Mexico, North Carolina and Rhode Island.

Ten states and the District of Columbia do not have accelerated renewal processes but do have other provisions associated with licensing older drivers. Four states require the older driver to appear in person to renew (cannot renew by mail); six states require the older driver to pass a vision test; one state requires a road test for drivers age 75 or older; and the District of Columbia requires a vision test and statement from a physician certifying the driver as competent to drive and may also require a reaction test. The ages at which these special provisions are instituted range across states from 50 to 80. The following states do not have accelerated renewal processes, but rather have other licensing provisions in place: Alaska, California, District of Columbia, Florida, Louisiana, Maryland, Massachusetts, New Hampshire, Oregon, Utah, and Virginia.

It should be noted that Maryland licensing law prohibits licensing agencies from treating older drivers differently; moreover, the age requirement for vision testing at the time of licensing in Maryland is 40 years and older. Additionally, there are special provisions for older drivers age 70 years and older who are applying for an initial license (rather than renewing).

The remaining seven states have accelerated renewal processes as well as other provisions for older drivers. Of these seven states, three have accelerated renewal cycles and prohibit renewal by mail, three have accelerated renewal cycles and require a vision test, and one has an accelerated renewal cycle and requires a road test. The renewal cycles for these states are accelerated by two to five years, and the ages at which these accelerated renewals are applied range from 60 years of age to 85 years of age. The following states have accelerated renewal cycles as well as other special provisions: Arizona, Colorado, Georgia, Illinois, Maine, South Carolina and Texas.

Table 7: Summary of Practices by Scope of Safety Provisions

Scope of Provisions	Number of States	States	Ages Provision Takes Effect	Notes Regarding State Provisions
No Special Provisions for Older Drivers	23	AL AR CT DE KY MI MN MS NE NV NJ NY ND OH OK PA SD TN VT WA WV WI WY	N/A	• MN and NV have laws prohibiting age-based provisions. • OK and TN reduce fees for older drivers.
Accelerated Renewal Only	10	HI ID IN IA KS MO MT NM NC RI	63 to 75	In some cases, accelerated renewal simply requires drivers must abide by the most frequent renewal cycle option, while other drivers have choice of renewal cycle length.
No Accelerated Renewal but Other Provisions	11	AK CA DC FL LA MA MD NH OR UT VA	50 to 80	• 4 require appearance in person to renew. • 6 require vision test. • 1 requires road test. • 1 requires vision test & physician statement of competency to drive.
Accelerated Renewal and Other Provisions	7	AZ CO GA IL ME SC TX	60 to 85	• 3 accelerate renewal and require appearance in person. • 3 accelerate renewal and require vision test. • 1 accelerates renewal and requires road test.

Table 8: Summary of Practices by Type of Safety Provisions

Type of Provision	Number of States	States	Ages Provision Takes Effect	Notes Regarding State Provisions
No Special Provisions for Older Drivers	23	AL, AR, CT, DE, KY, MI, MN, MS, NE, NV, NJ, NY, ND, OH, OK, PA, SD, TN, VT, WA, WV, WI, WY	N/A	• MN and NV have laws prohibiting age-based provisions. • OK and TN reduce fees for older drivers.
Accelerated Renewal	17	AZ, CO, GA, HI, ID, IL, IN, IA, KS, ME, MO, MT, NM, NC, RI, SC, TX	60 to 85	In some cases, accelerated renewal simply requires drivers to abide by most frequent renewal cycle option when other drivers have choice of renewal cycle length.
Vision Testing	9	DC, FL, GA, MA, ME, MD, OR, UT, VA	50 to 80	Some allow vision test conducted by physician.
Required to Appear in Person for Renewal	6	AK, CA, CO, MA, LA, TX	61 to 79	None
Road Test Required	2	IL, NH	75	None
Other	1	FL	70	• May be required to take a reaction test. • Requires statement from physician certifying physical and mental competency to drive.

4.5.3 Massachusetts Licensing Policy

Massachusetts licensing policy is governed by Massachusetts General Laws (MGL) Chapter 90, Section 8. The law states that anyone may apply for a driver's license unless their license has been suspended or revoked. Beyond minimum age requirements, the law specifically states "before a license is granted pursuant to this section, the applicant shall pass such examination as to his qualifications as the registrar, without discriminating as to age, shall require…"

While the law specifies that age cannot be used as a qualifier in licensing, there are two obvious exceptions to this language including the junior operating law and the recently

passed safe driving bill— The Safe Driving Bill of 2010. This bill requires individuals over the age of 75 to renew their licenses at a branch of the registry and to also pass a vision test.

4.6 Possible Practices for Older Driver Licensing Policy

Though there may be little consensus as to the exact mechanisms that should be implemented for the effective and fair assessment of older driver safety at the point of licensure, there seems to be agreement on the need for a two-tier system. In the first tier, screening, should be implemented to uniformly identify drivers who should undergo further evaluation (41, 42). However, screening should not be used to make final licensing decisions (42). The second tier should consist of more detailed tests in order to determine driving impairment, make licensing decisions, recommend or require additional training, and to identify opportunities for remediation (41, 42).

A great deal of the research regarding effective driver licensing policy focuses on the physical and mental capacity of older drivers. The recommended use of MABs, (programs that allow friends and family to recommend review of an older person's driving capacity), and other similar practices pay special attention to the second tier of older driver licensing practices. Importantly, there is less information available on models for screening processes. One source of information that does exist is the AAA Foundation for Traffic Safety's North American Licensing Policies Workshop entitled "Best Practices Guidelines." This source includes standardized education and guidelines for clinicians, police, and licensing personnel on fitness-to-drive issues; "best practices" also include incentives for and training to MAB members, and offering resources to sustain the mobility of older drivers even after they are no longer able to drive (42).

It may be that recommendations for medically-based fitness-to-drive tests are more available than other options because there is more research in this area. This focus is evident from the same AAA document's identification of "Research Needs" which include designing and testing assessment tools, determining whether the results yielded from assessment tools are clinically meaningful, and understanding how applicable these assessment tools may be at the individual driver level (42). Medically-based assessments are specific to individuals and require a detailed understanding of the physical and mental conditions being assessed. Screening tools, by nature, cannot employ that level of detail, and are therefore more difficult to apply at the individual driver level.

4.6.1 NHTSA Model Driver Screening and Evaluation Program

In 1996, NHTSA undertook a research project to identify the limitations associated with aging and the common disease pathologies that might impact an older person's driving ability, and to identify test procedures that could be feasibly implemented by licensing agencies (43). This research project, much like others that have sought to identify mechanisms for identifying high risk older drivers, focused on medical and psychological impairment associated with aging. Specifically, the project relied on a panel of experts to

define a list of critical issues related to safe driving (sensory function, attention/perception, and medical factors including dementia). Additionally, these experts were asked to identify gaps in existing research that should be considered as part of the program. Subsequently, a survey was submitted to 62 licensing jurisdictions (50 states and 12 Canadian provinces) to determine which of the previously identified research areas may have had scientific merit but little or no practical application.

Based on the information gathered, a pilot program was designed and tested in Maryland through collaboration with the Maryland Motor Vehicle Administration, MAB, and the Maryland Research Consortium which included representatives from government, universities, non-profit organizations, and the private sector. In this pilot, specially trained staff implemented a battery of tests at licensing outlets and community locations. The test subjects included older adults who were visiting the licensing agencies for license renewal, older adults who were referred for medical evaluation because of suspected impairment, and some subjects that lived in a residential community for older adults that used a mobile licensing facility in their residential development.

The safety measures evaluated the effectiveness of the screening processes in relation to three types of crashes (all crashes, at-fault and unknown fault crashes, and at-fault only crashes) and three type of violations (all moving violations, all moving violations except speeding, and all moving violations except speeding and occupant restraint). Results indicated that screening methods could be used effectively and efficiently, especially in four areas: 1.) directed visual search, 2.) information processing speed for divided attention tasks, 3.) ability to visualize missing information in an image, and 4.) working memory. Lower limb strength and head/neck mobility were also identified as critical measures to attend to. The research also reinforced the need to identify mechanisms for addressing functional loss and to provide alternative means of mobility for those who are no longer able to drive.

4.6.2 Medical Advisory Boards (MABs)

NHTSA, through the American Association of Motor Vehicle Administrators (AAMVA), conducted a survey of the 51 licensing agencies in the United States to understand the medical review processes used in each state (40). Licensing agencies were asked to complete a survey and to participate in a follow-up telephone interview. Based on the information gathered during this process, as well as from an examination of state licensing statutes, a qualitative review, and comparison of 45 licensing agencies' medical review processes were conducted and barriers for implementation of certain strategies were identified.

Although consensus was not generally reached regarding the roles, responsibilities, and best practices for MAB, there was general agreement on several issues specifically related to the roles and responsibilities of state sanctioned agencies and their practices and review boards, which are outlined below.

Medical Advisory Board (MAB) Structure and Responsibilities

- MABs should review individual cases for driver fitness and establish guidelines for licensing rather than review only the cases where a license has been denied and an appeal has been filed.
- Guidelines should be used to ensure consistency and case review by physicians should be used for more complex cases.
- MAB physicians should be compensated at a rate commensurate with the hourly rates they would charge for services elsewhere. Ideally, the physicians associated with MABs should be employed as full time staff members at the state licensing agency.
- In-person as well as video interviews between members of the MAB and drivers should be part of driver fitness decisions.

Licensing Review Rules and Policies

- Rules associated with medical review of drivers should not be in statute, but should be part of the Code of State Regulations in order to allow for ease of changes based on the release of new information and medical data.
- Restricted licenses should be considered, allowing for driving only in the safest of conditions (daylight, limited area, and limited speeds).
- After a certain age, drivers should be required to appear in person for license renewal and the renewal cycle should be shortened based on driver age.
- Drivers over a certain age should be subject to functional screening at license renewal. When resources prevent this type of screening, subpopulations (e.g., drivers being re-examined) should be screened or partnerships should be formed to provide outside screening with results reported to the MAB.

Licensing Agency Responsibilities and Scope of Services

- Licensing agencies should expand their scope beyond traditional responsibility for public safety to include mobility options for drivers with medical conditions and functional impairments. Services provided by licensing agencies for counseling, education, or other aid should be locally-based rather than state-based.
- State licensing agencies should work with police departments to provide education for police officers to help them identify at-risk drivers based on medical conditions and functional impairment.
- Drivers with mild dementia who are allowed to keep their driving privileges should be retested every three to six months and should be required to pass road tests in order to maintain driving privileges.

Although consensus was not reached among respondents to the survey, these concepts should be used as the foundation for developing guidelines and programs at the state and national levels.

4.6.3 Graduated Licensing for Older Drivers

The practice of licensing individuals in stages is widely accepted when applied to young drivers through graduated licensing programs. A similar practice, graduated licensing for older drivers, has been presented as an option to limit older driver exposure to the riskiest driving situations. The concept of graduated licensing for older drivers was initially introduced by Dr. Patricia Waller in 1988 (48), and subsequently defined by the American Association for the Advancement of Retired Persons (AARP) in their 1993 booklet. The AARP defined a graduated license as one that "for one reason or another has a restriction attached to it. To operate a motor vehicle, holders of such a license must "restrict their driving practices in some well-specified fashion" (47). Very little research has been conducted in order to ascertain the effectiveness of graduated licensing for older drivers as well as the use of license restrictions rather than license revocation.

The implementation of graduated licensing has been applied to older drivers in some states. A study was conducted in California in 1997 using a small sample of re-examined older drivers and 59 of their friends and family. Twenty-five of those re-examined were allowed to keep their licenses; 30 had their licenses revoked, and 10 received license restrictions. The study considered the level of difficulty the drivers indicated having while traveling to six categories of "necessary" destinations, as well as their reactions to the licensing agency's decision regarding their license status. Overall, the study found that restriction was less stressful than revocation for the driver and their friends and family. However, the study also noted that more research would be necessary in order to establish new practices for licensing.

Restricted licensing for older drivers was also studied by the University of North Carolina Highway Safety Research Center in 2000 (48). This study found that very few older drivers (approximately two percent) had restrictions on their licenses beyond corrective lenses and that many of those restrictions were the result of a failed vision test or MAB recommendations, rather than recommendations made by a license examiner. The group of older drivers that had restrictions beyond corrective lenses had a higher proportion of crashes than those who had no restrictions. Researchers concluded that there was a potential benefit in terms of safety associated with restricting older drivers, though instead of standing alone, it should happen in conjunction with older driver education, evaluation, and training (48).

A 2008 report published by the AAA Foundation for Traffic Safety examined the effectiveness of a voluntary state reporting law in Missouri (50). This report noted the possible use of license restriction over license revocation in some cases, particularly because restriction has the potential to address the weaknesses of older drivers without having to apply a universal pass/fail approach to licensing.

4.7 Applications for Massachusetts

Based on the information presented throughout Section 4 regarding existing licensing policies for older drivers and practices employed by other states, some opportunities may

exist for consideration by the RMV. Prior to reviewing potential opportunities for changes to licensing practice, several factors should be considered. These factors are listed below:

- Although current Massachusetts legislation prohibits special licensing practices based solely on age, it is evident that there are mechanisms for developing age-based licensing policies. Graduated licensing for teen drivers and the recent legislation requiring "in person" renewals for adults age 75 years and older are examples.
- Implementing changes to licensing practices may require additional resources including more services for older adults who can no longer drive, increased personnel in state agencies, or increases in funding to support these measures.
- Screening practices that may be applied to license policy changes would require standardization as well as extensive training for licensing examiners.
- Any practice that may restrict, or altogether revoke, any older driver's driving privileges must be considered in conjunction with the means necessary to ensure the preservation of mobility.
- None of the opportunities suggested herein should be considered as independent solutions, as they are most effective when implemented in conjunction with ongoing education and program evaluations.

Given these factors, the following practices should be considered for potential implementation in Massachusetts:

- The current MAB practices and policies should be reviewed in relation to the recommendations outlined in the NHTSA Model Program report. Subsequently, changes to Massachusetts MAB practices should be made in accordance with the resulting findings.
- The implementation of restricted licensing for older drivers should be examined for improving older driver safety. The use of a graduated licensing system has been widely accepted as an approach for addressing the issues of teen drivers, and should be used as a foundation not only supporting the potential for reducing crash frequency and severity, but also for the palatability of this system as a policy approach. While licensing decisions are made at the state level, the use of graduated de-licensing presents the opportunity for the provision of a framework that states can use. In the same way that a national blueprint for graduated licensing for teen drivers was developed, best practices can be compiled to provide a blueprint for an older driver graduated licensing policy. Graduated licensing, instead of license revocation, would allow older drivers to maintain a certain level of mobility. Although they may be limited to driving in lower risk environments, this licensing would still allow them to conduct trips such as grocery shopping, attainment of medical care, etc. It would also allow them to maintain a certain quality of life through the opportunity to engage in social activities. This solution has the potential to alleviate stress not only for the older driver, but also for their friends and family. It is critical that the implementation of graduated licensing for older drivers be rigorously evaluated. Though initial evaluations conducted on a small scale indicate the potential for success, larger scale efforts should be developed so as to ensure that the resulting practices improve safety for older drivers as well as allow them to maintain an acceptable level of mobility.

- The law in Massachusetts requiring in-person renewal for adults age 75 or older is consistent with recommendations in the NHTSA Model Program report. The impacts on older driver licensing practices and crashes should be reviewed to evaluate the effectiveness of this restriction. However, future licensing policies should focus on the allocation of resources aimed at cognitive and physical assessment as well as case-by-case reviews of older drivers' abilities rather than a systematic approach to identifying high risk drivers. Aging is an individual process: the onset of diminished capabilities associated with aging not only happens at different ages, but in different manners with different timeframes. As such, resources should focus on testing processes that aim to assess an individual's ability to drive. It may be that a base-age is set at which the testing is conducted (e.g., drivers age 65 or older). However, decisions beyond that should be made based on the individual's current state rather than their prior history. Additionally, while initial recommendations for further review of driver capability may be made by licensing agents, final decisions should be made by highly trained professionals, such as doctors, who are capable of judging a person's physical and cognitive abilities. Additionally, these decisions should not solely be "to license or not to license," but to also consider license restrictions rather than revocation; along these lines, doctors should also suggest a timeframe for continued assessment due to the progressive nature of the aging process.
- A mechanism should be established for providing recommendations associated with training for older drivers. There is evidence to suggest that in some instances, the documented challenges associated with older drivers may be the result of developed habits and not diminishing cognitive or physical abilities (51). More encouragingly, training programs have been developed and have documented success in improving older driver performance (51, 52). Although the specifics for implementation of a training intervention would need to be established, there may be fixed indicators that suggest inclusion: identified cue at time of license renewal, motor vehicle infraction or crash, etc.

Generally, these recommendations work toward either the implementation of new licensing practices or continued research that seeks to account for an individual older driver's needs and skills rather so as to limit the implementation of standard practices based solely on age.

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5.0 Transportation Alternatives

Mobility is widely considered an essential element for independence; it also ensures a person's quality of life. Demographic trends indicate that older drivers are the fastest growing segment of our driving population regarding the number licensed, distance driven, and overall proportion of the driving population. At the same time, there is concern about older driver safety which may translate into policy change for older driver licensing, as discussed in Section 4.0. Increasing the number of non-driving older adults will require a coordinated network of mobility, including a variety of options to enable people to move through their lives.

Several critical tasks were undertaken in order to provide an evaluation of both Massachusetts' structure for offering mobility services for non-driving older adults, and to conduct a national survey of other states' programs. Initially, a series of interviews was established with selected stakeholders to develop a more thorough understanding of the unique and complex means by which different agencies are either directly or peripherally involved in providing mobility options for older adults. Additionally, an analysis of older driver crashes related to the availability (or dearth) of driving alternatives was completed. Simultaneously, a nationwide survey was initiated to identify the extent to which states provide alternatives for older drivers.

Section 5.1 provides an overview and preliminary evaluation of the existing network of transportation mobility options available for older adults in Massachusetts. Section 5.2 presents a nationwide perspective in order to provide a comparison, and Section 5.3 introduces applications for Massachusetts based upon the findings of the prior two sections.

5.1 Massachusetts Mobility Network for Non-Driving Older Adults

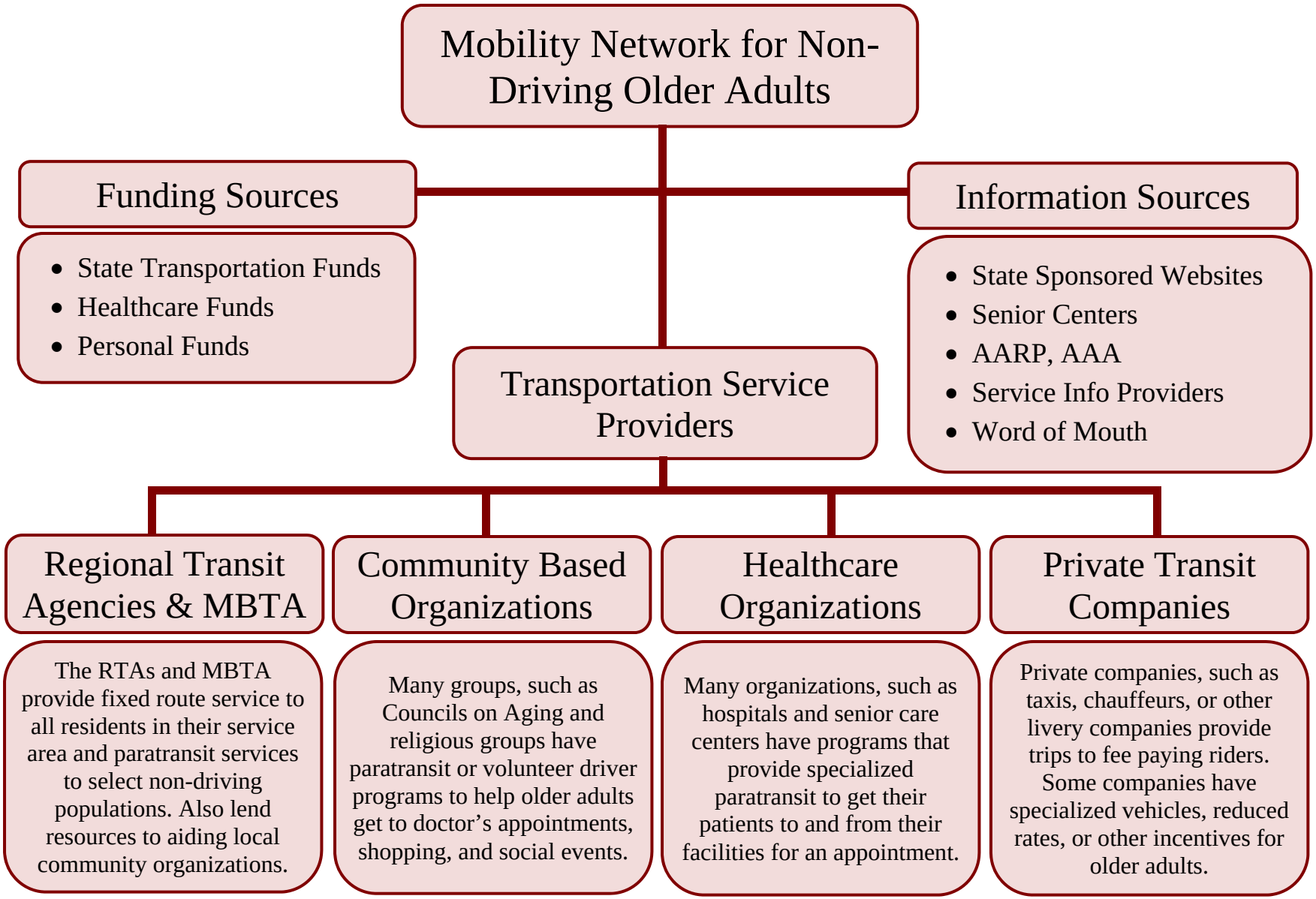
The initial goal was to develop a simplified model of the existing non-driver mobility network in Massachusetts, which is presented in Section 5.1.1. Building upon the simplified model, an analysis of the available transportation programs and demographics was completed and is presented in Section 5.1.2. A secondary objective was to evaluate the effectiveness of various components of the network. The evaluation was carried out both quantitatively and qualitatively, considering demographics, available transportation programs, and the resulting impact on crashes. The evaluation is presented in Section 5.1.3

5.1.1 Modeling the Mobility Network for Older Road Users in Massachusetts

After interviews with stakeholders, it became apparent that the existing structure was analogous to an onion with an increasing number of layers. The mobility network for non-driving older adults has three major dimensions. The most visible dimension would be the transportation service providers who deliver the services directly to older adults. Behind

these service providers, such as the RTAs and MBTA, there are many different funding sources and mechanisms that financially support these services. Lastly, there are information sources that work to connect older non-driving adults with the organizations that provide the transportation services. This integrated and dynamic web of transportation service providers, funding sources, and information sources is conceptualized in Figure 20.

Figure 20: Simplified Mobility Network Model for Non-Driving Older Adults



Funding sources within the non-driving senior mobility network are both diverse and ever-changing. The three main sources of funding include state transportation funds, healthcare funds, and private (i.e., personal) funds. The first source includes State Transportation funds, which are used to fund public transportation programs. Most of these funds support systems that operate to meet the mobility needs of Massachusetts rather than the senior population, specifically. However, in some areas these existing systems are able to meet the mobility needs of older adults as well. Other state transportation funds go directly into programs whose primary goal is to meet the mobility needs of the older population. The level of state funding for transportation services varies annually and budget cuts can lead to reductions in these services.

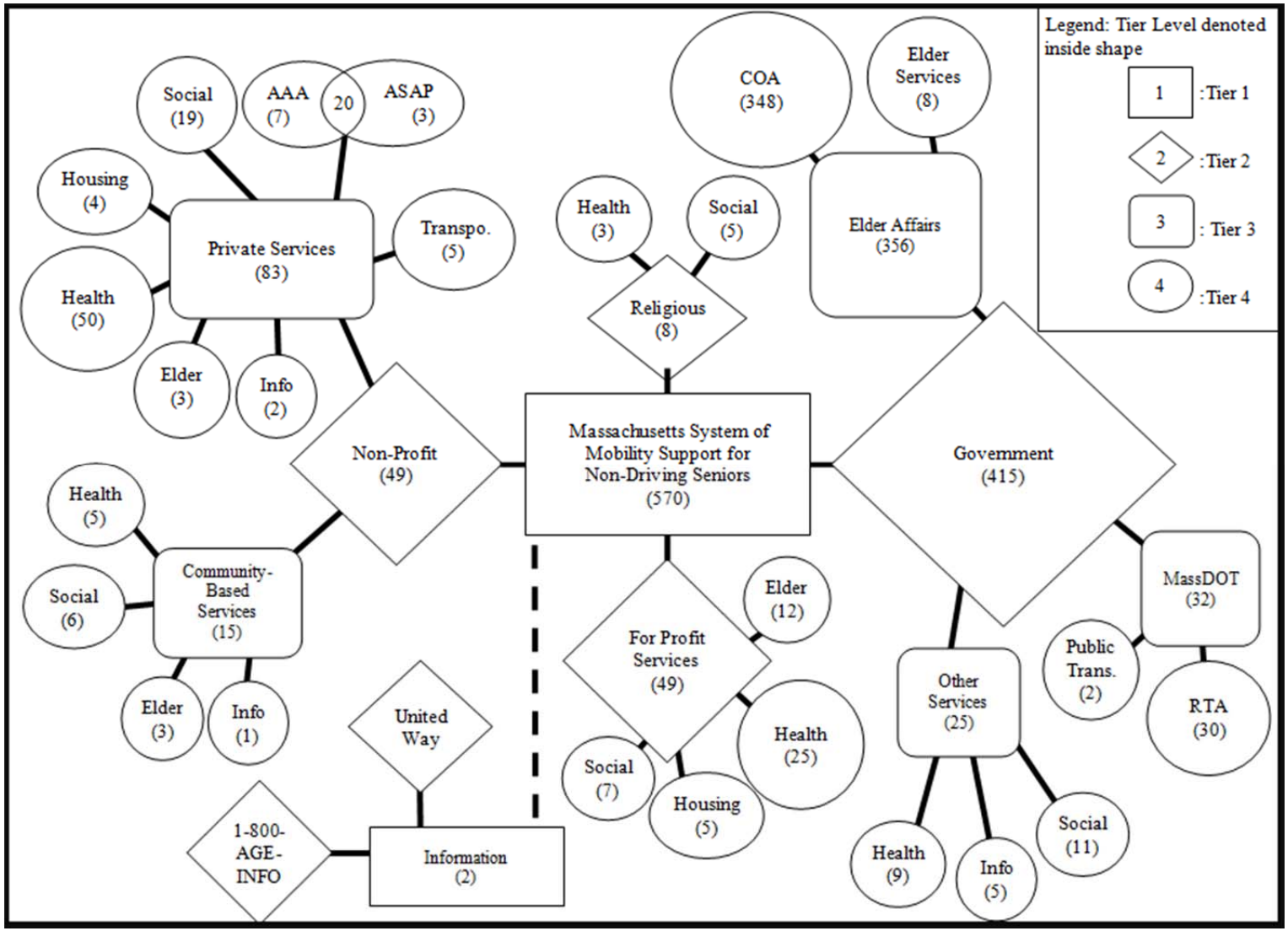
A second funding source is from the healthcare sector, typically delivered under the umbrella of health and human services. Many agencies that provide paratransit services to the elderly and disabled get a large portion of their financial support from federal funding related to the Americans with Disabilities Act. Some health care facilities pay to have patients transported to their facility for routine visits.

The third major source of funding comes from the older adults themselves. This source comes in the form of fares, donations, or membership dues for services. Typically, the user payments cover only a portion of the operating costs of the service. Additional creative funding mechanisms have been identified within the private domain that helps to fulfill unmet need. One example is funding that comes from private companies. In order to encourage patronage, some companies will help subsidize transport services to get older adults to their businesses.

Many programs in Massachusetts operate using a combination of these three primary sources. Together, these funding mechanisms provide the financial framework for transportation services older adults need to maintain their mobility. Unfortunately, even with these sources, there are significant unmet demands that often lead older adults to feel immobile and isolated. Irrespective of any funding challenges, there is also a need for effective programs for older adults and a need for older adults to be aware of their options. These latter two parts of the equation are described in the following sections.

A more comprehensive depiction of the Massachusetts system of mobility is presented in Figure 21. The mobility network is initially disaggregated into five generalized categories and further disaggregated into smaller program types in an attempt to demonstrate the diversity and relative quantity of each program type. The complexity of the network is based upon the fact that there are a considerable number of programs that are involved in transportation (senior specific or otherwise) with varying degrees of overlap and interaction. An initial estimate based upon a review of programs in Massachusetts suggests that there are greater than 570 different agencies and organizations that assist in providing information and mobility options to older adults. The largest entity in Massachusetts that provides mobility support is, unsurprisingly, the state government. Figure 21 shows the complexities associated with such a system given the overall number and unique interactions of mobility support providers. This web presents the complex nature of resources needed to permit older adults the independence they had likely been accustomed to when they were able to drive.

Figure 21: Massachusetts System of Mobility Support for Non-Driving Older Adults



The programs that exist for meeting the mobility needs of non-driving older adults are both complex and geographically scattered. These programs are coordinated by a myriad of organizations including regional transit agencies (RTAs) and the MBTA, community based organizations, healthcare organizations, and private transit companies (see Figure 21).

RTAs & the MBTA

The largest providers of transportation services as an alternative to personal automobile travel are the 15 RTAs and MBTA, all of which are included within the MassDOT Rail and Transit Division. The RTAs and MBTA are government-run and funded organizations that provide transit services to the regions of Massachusetts. There are 15 RTAs of varying size and scope across the Commonwealth. The MBTA has a mission that is consistent with the RTAs, and provides services to 175 communities in and around the greater Boston area. With the exception of MBTA's subway and commuter rail service, fixed-route transit offered by the RTAs is primarily comprised of bus routes. This fixed-route transit service is regularly used by older adults, but may prove challenging for some older adults or the disabled. Transit agencies also provide paratransit services within their regular service districts for qualified individuals that are not able to use regular transit services. Most notable is the RIDE, which is the MBTA's paratransit service.

In general, the fixed-route programs tend to be larger and provide a greater level of service in more highly populated areas; as a result, they are most often found in urban areas. The large population of older adults residing in rural and suburban regions that are not in the vicinity of fixed-route public transit may not be well served in some instances. Other limitations on service may include accessibility and availability with respect to coverage area, days of operation, and hours of operation. Additionally, some programs operate daily while others only on weekdays. Fixed-route public transit organizations commonly charge a fee, which varies depending on the service and even sometimes on the distance travelled. The vehicles vary significantly in size depending on the type of service and its demand level. Incentives for older adults such as reduced fares are available only in some systems.

Public paratransit programs are government-financed programs that currently exist in most states. This service typically provides demand responsive service for qualified individuals that may be disabled or unable to travel, and also includes Dial-A-Ride services as well as other innovative forms of paratransit services. These programs are often more attractive to older adults as they offer curb-to-curb (in some instances door-to-door) service, and a coverage area more accessible to older adults as they are typically offered in smaller and more rural towns. However, limitations might still exist regarding days of operation and hours of operation. For example, some programs provide service only during business hours, which in turn limits travel for those that are unable to drive within this timeframe. Although the primary funding source for these organizations is government subsidies, their annual budget varies significantly and can, in many cases, limit their service capabilities. As in fixed-route public transit, riders generally pay a fee which varies program to program. Similarly, the driver is typically paid and the program's vehicles are used to provide the service. The vehicles used are generally small buses and large vans because shared rides are encouraged to save money and time. In areas with aging populations, such services tend to be well developed and more widely used by older adults as they are often specifically designed to meet their needs and desires.

Community-Based Organizations

In areas that are either underserved or not served by an RTA, community-based organizations often fill a void that is necessary to meet the needs of local older adults. Organizations that have such programs include the following: COAs, church-based programs, retirement community or adult day transit programs, senior center transit programs, medical or healthcare run programs, business shuttles, and other community-based programs. These programs are generally not-for-profit organizations specifically implemented to escort older adults to and from their destination, making them highly attractive to users. Their coverage areas tend to be small, allowing attention to be given to individual needs. These programs exist in urban, suburban, and rural areas and are generally available for service on weekdays and weekends for extended business hours. In many of these programs there is no fee for riders; however, donations are accepted. Their funding sources are usually mixed, including both government subsidies and community and/or rider donations, making for a very small annual budget. Vehicles are almost always owned by the program and tend to be small vans or passenger cars. Drivers are usually a combination of paid individuals and volunteers. These services currently exist in many locations throughout Massachusetts at varying levels of service.

There are unique community-based organizations that have specialized paratransit programs which provide a mechanism to connect volunteers with older adults in need. Volunteer drivers bring older adults to various destinations and build lasting one-on-one relationships. These not-for-profit programs have become better recognized within the last 20 years. Their sizes vary significantly and as a result so do their annual budgets. Their funding sources are a mixture of government subsidies and grants, community donations, user fees and donations, and contracts with other agencies. The drivers are usually all volunteers and use their own vehicles; they are often reimbursed for mileage. The service is especially attractive to older

adults as door-to-door service is generally provided. Service is commonly provided for extended business hours on weekdays and limited on Saturdays; however, a few programs are able to sustain 24-hour service. The programs vary in their involvement from simply providing contacts between volunteers and older adults, to running a full dispatch center. Rider payment can come in the form of fees, donations, or in more unique ways such as allowing seniors to trade in their vehicles for credit towards rides. These programs often partner with other organizations to provide service in exchange for subsidies.

Healthcare Organizations

Given that a large portion of patients at healthcare organizations are non-driving older adults or other adults with disabilities that prohibit them from driving, a significant number of health care providers provide specialized paratransit services. This service allows the healthcare organization's patients to travel to and from facilities for appointments and generally utilize volunteer drivers who offer older adults door-to-door service.

Private transit organizations such as taxis, chauffeur services, and specialized paratransit services are also available for use by older adults. These paratransit services are demand responsive and provide transportation to the public. While some are affiliated with local RTAs or organizations, these private companies handle all fare collection and scheduling independently. There are many of these companies across the United States, and most are for-profit. 24-hour a day door-to-door service is usually provided; however, the service can be expensive for older adults because the programs' vehicles are driven by a paid operator. Some companies provide discounts to older adults, and others specialize incentives such as free 10-minute wait times at specific locations in order to allow older adults to complete simple tasks like picking up medication. Additionally, COAs will often provide older adults with vouchers to utilize these services. Many companies have accessible vans for those with disabilities and some offer reduced private limousine services to older adults during off-peak limousine service times.

Information Services

The final step in the mobility network connects older adults in need of service with the providers who can meet their needs. There are several types of services aimed at making this connection. On the federal and state level, there are government hosted websites, primarily through the AAAs and ASAPs, which provide a means for older adults to search by keyword for services in their geographic area and allow them to call to ask for local programs. In some instances, the AAAs will coordinate volunteer transportation, but at a minimum, each of these organizations in Massachusetts provide information when requested. Outside of government there are other service information systems, such as the 2-1-1 information systems, that connect individuals with any medical service providers they may need. On a local level, many COAs work to connect older adults with service providers, regardless of whether they provide transportation services.

Communicating transportation options to older adults across agencies and towns have various examples of success. Two immediate examples warranting further consideration for replication on a more widespread basis include the Senior Connection webpage of the

Central Massachusetts Agency on Aging, which is shown in Figure 22, and the transportation page embedded within the Town of Reading's webpage, which is shown in Figure 23 (55, 56). The effectiveness of these information-based resources is dependent upon their established popularity and/or advertising scheme. Many older adults rely on word-of-mouth from their friends or family, but that only works if the friends or family are aware of the programs in the area. There is a portion of the senior population who, despite the number of mobility options that may be available to them, remain homebound because they are not aware of their options.

Figure 22: Senior Connection Searchable Service Database

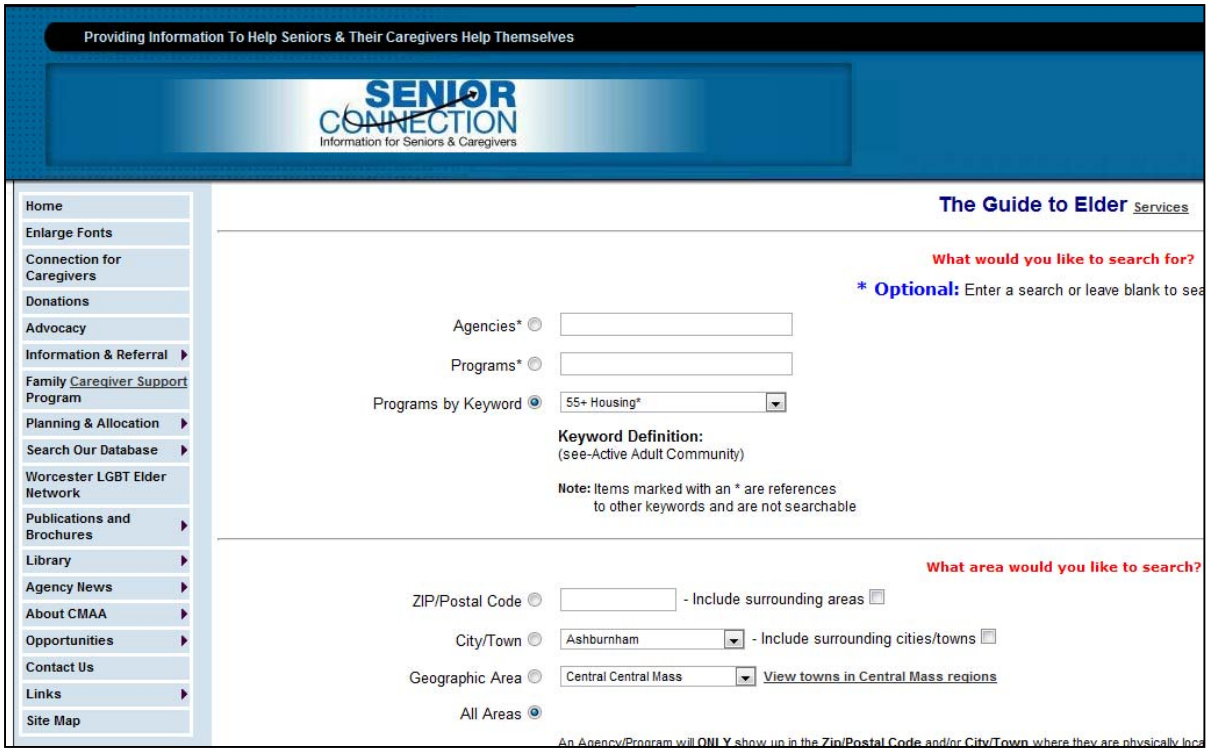
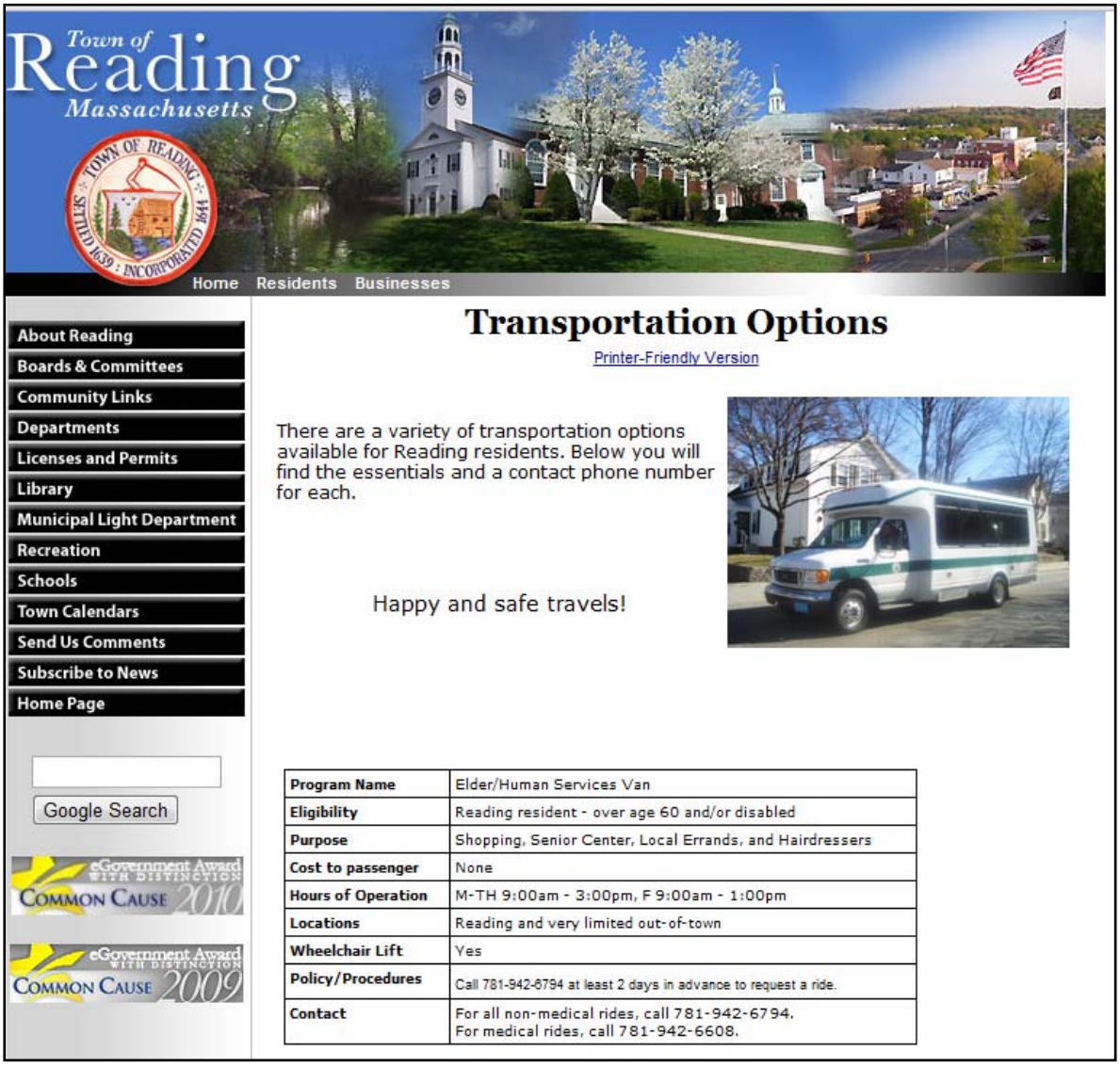


Figure 23: Town of Reading Transportation Services Information Webpage (Error! Reference source not found.**)**



5.1.2 Mobility Assistance Program Coverage

Using the demographic data presented in Section 3.1 coupled with the overlying nature of the mobility network described in the previous section, an analysis was undertaken to determine the extent to which cities and towns are able to offer alternative transportation for older, non-driving adults. A database was developed to document the various mobility assistance programs that were available to residents within each Massachusetts city or town. The identified programs were generally categorized based upon the following stipulations:

- Service provider type – RTA, community-based organizations, healthcare organizations, private organizations and other. Additional categorization was completed within the various service provider types to better characterize the

nature of service. For example, RTAs were recorded as fixed route/bus, or paratransit or rail, while community based organization categories included COAs and church groups;
- Service type – fixed route or paratransit; and
- Schedule type – advanced notice or fixed, with some consideration noted for hours of availability.

Additional information, such as hours of operation and allowable trip purposes, was captured for each identified program for possible use at a later date. As noted previously, the interaction that exists between the various programs is difficult to document. As an example, some COAs provide their own transportation services, while others rely entirely on an RTA. As another example, some of the AAAs and/or ASAPs coordinate transportation through a volunteer network (e.g., Elder Service of Berkshire County, Inc.), others solely provide transportation information (e.g. Elder Services of Cape Cod and the Islands, Inc.), and still others offer transportation when feasible (57, 58). Additional variability exists within the types of schedules and transportation purposes that are provided. For example, some programs provide transportation exclusively for an approved set of purposes. The developed database did not count completely for-profit private organizations, such as taxi services. Additionally, the included data description was limited primarily to information readily available through public sources such as websites or brochures. Nevertheless, the development of this database functions as a baseline for determining the extent of coverage that exists within each community.

Figure 24 presents a breakdown of mobility assistance programs available within each city or town. The lack of programs is not directly indicative of poor transportation service; a city or town may have one superior transportation alternative, while another may have as many as four to five average or subpar programs. Since many programs are coordinated at the county or RTA level, it is infeasible to add up programs available within each city or town to get a statewide estimate. As shown in Figure 25 there is a range in the number of programs available that correlates to the population trends presented earlier. The correlation between older road user mobility assistance programs and population, and the number of programs per 1,000 population of 65 and older adults is presented in Figure 25. Although western Massachusetts generally has fewer programs per community, the lack of population density results in a higher ratio of programs per person. When the projected increases in 65 and older adults is accounted for in the 2020 estimates, several noteworthy patterns emerge. The geographic distribution of programs per the 1,000 person estimated population increase is presented in Figure 26. As shown, several of the smaller communities will maintain a high level of programs per person given the capacity that exists within those communities today. Conversely, the large population increases in the urban centers will put added strain on the existing mobility assistance programs.

Figure 27 presents the RTA and MBTA services available within each community. As shown, there are identifiable gaps where paratransit services are not available. Many advocates for older road users indicate the need for door-to-door service rather than curb-to-curb, and in many instances the fixed route service is unusable to an older road user.

Considering both service and schedule, almost all curb-to-curb services identified required a 48-hour advance reservation.

Figure 24: Estimate of Mobility Assistance Programs Available within each City/Town

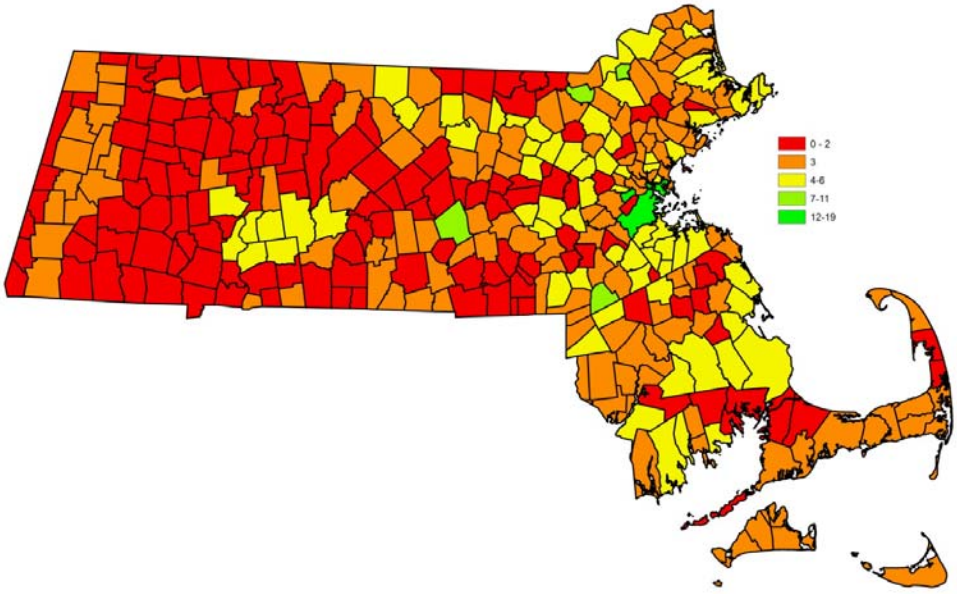


Figure 25: Estimate of Mobility Assistance Programs per 1,000 adults aged 65 and older within each City/Town

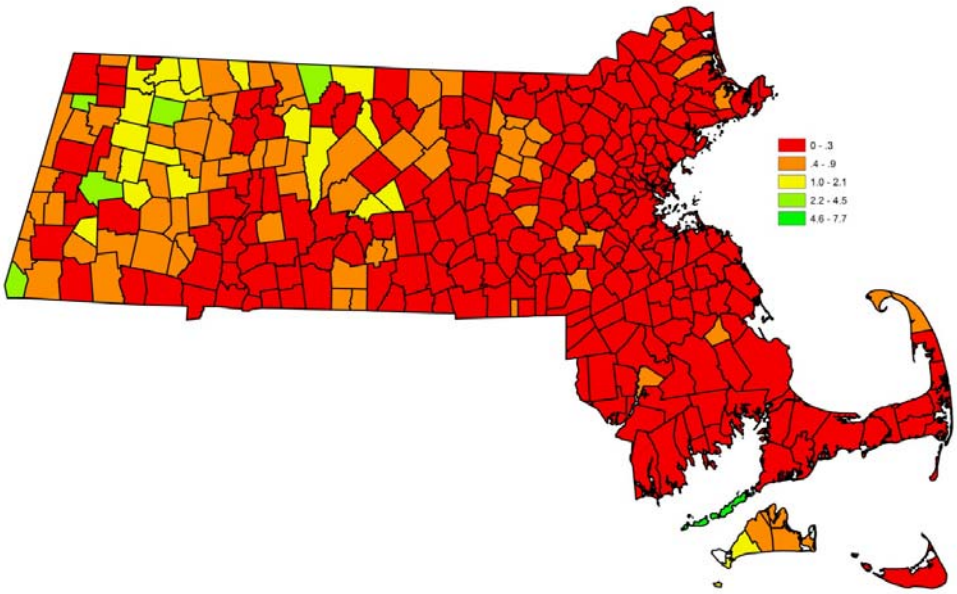


Figure 26: Estimate of Mobility Assistance Programs per 1,000 projected adults aged 65 and older by 2020 within each City/Town

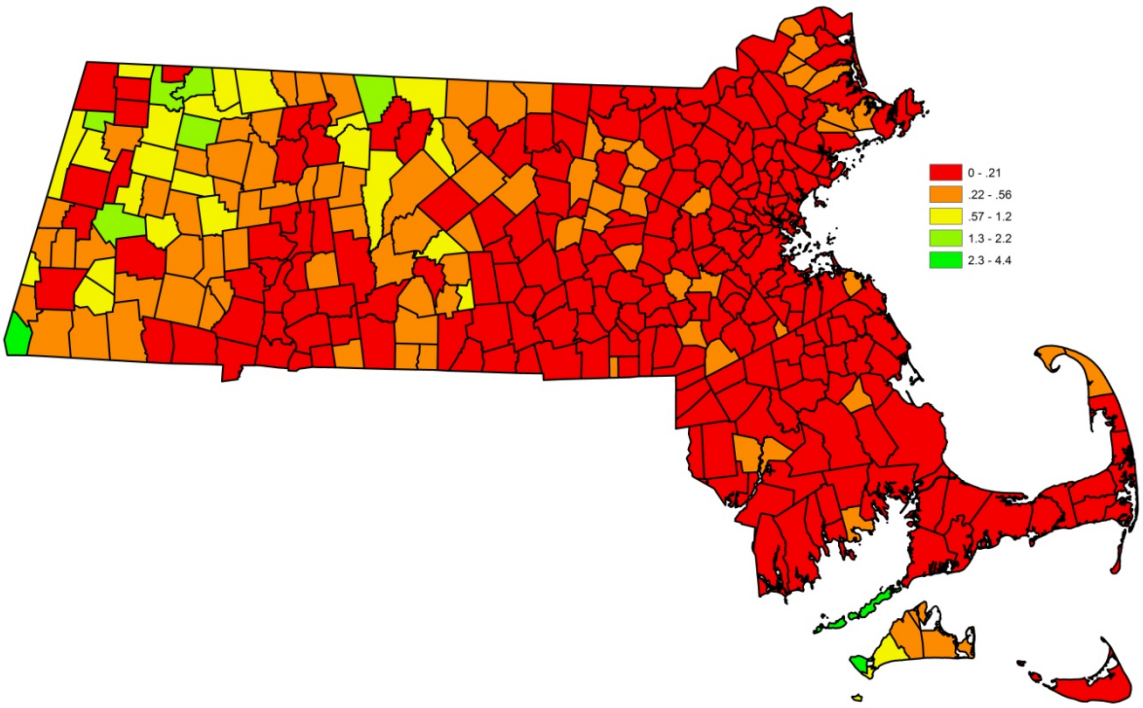
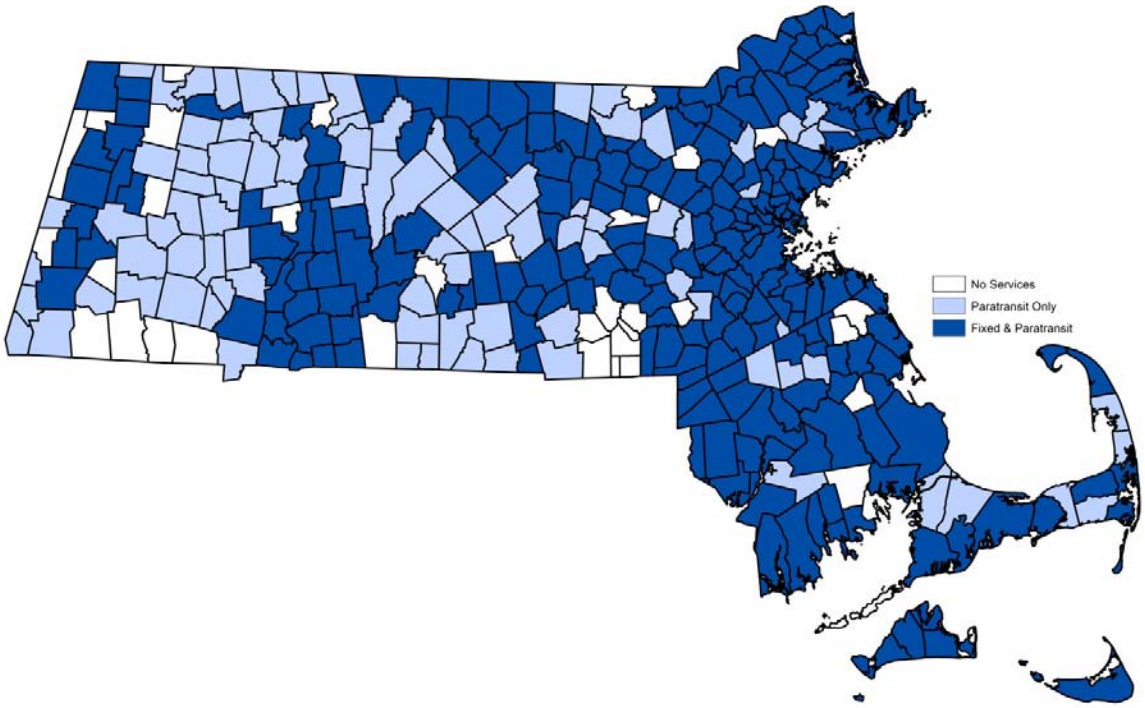


Figure 27: RTA Service Type within each City/Town



5.1.3 Evaluating the Mobility Network for Older Road Users in Massachusetts

Within Massachusetts, the current delivery of transportation programs for older adults is a complex combination of programs, funding, and information sources with varied levels of integration across programs and regions containing various resources. The geographic location within the state where an older adult lives significantly impacts the mobility options that are available to them. In a populated urban setting, older adults can take advantage of a number of public transit options that are available to all residents. Although exceptions exist, the options are generally limited in more sparsely populated areas. The options available are generally governed by the strength of the regional, municipal, and private organizations in the area. Areas with strong, well-funded RTAs tend to have a greater number of options for older adults. Other areas with strong municipal level organizations, such as COAs, often have transportation programs associated with these organizations. Finally, areas with large organizations such as medical establishments and religious establishments potentially have transportation programs as part of their overall interaction with the community.

The level of older adult mobility, as measured by the quality and quantity of programs in the area, is most closely related to the population of older adults in the area. In order to improve the statewide mobility network for older adults, it is imperative to first evaluate the existing programs and weigh their existing or potential merit. To initially evaluate this within Massachusetts, a county-based analysis of the relationships between the number of mobility programs, the population of older adults, and the number of crashes was completed. The analysis was initially completed at the county level because many of the programs that provide mobility assistance are operated or coordinated at the county or RTA level.

Figure 28 portrays the relationship between the number of mobility programs per person and the number of older driver crashes. As shown in Figure 28, counties with a higher population of older adults tend to have more programs. It is also not surprising that counties in the western portion of the state (i.e. more rural areas) have fewer programs; the exception to this norm is Berkshire County, which has 56 identified mobility assistance programs.

As shown in Figure 29, there is an inverse relationship between counties with higher program-to-senior ratio and senior-to-crash ratio. The three counties that have the highest proportion of mobility assistance programs have the lowest proportion of crashes involving individuals ages 60 and older. Furthermore, counties that have less than 5 mobility programs per 10,000 persons have the highest proportion of crashes involving individuals ages 60 and older.

Figure 28: Massachusetts Mobility Assistance Programs vs. Population of Adults Age 65 and Older by County

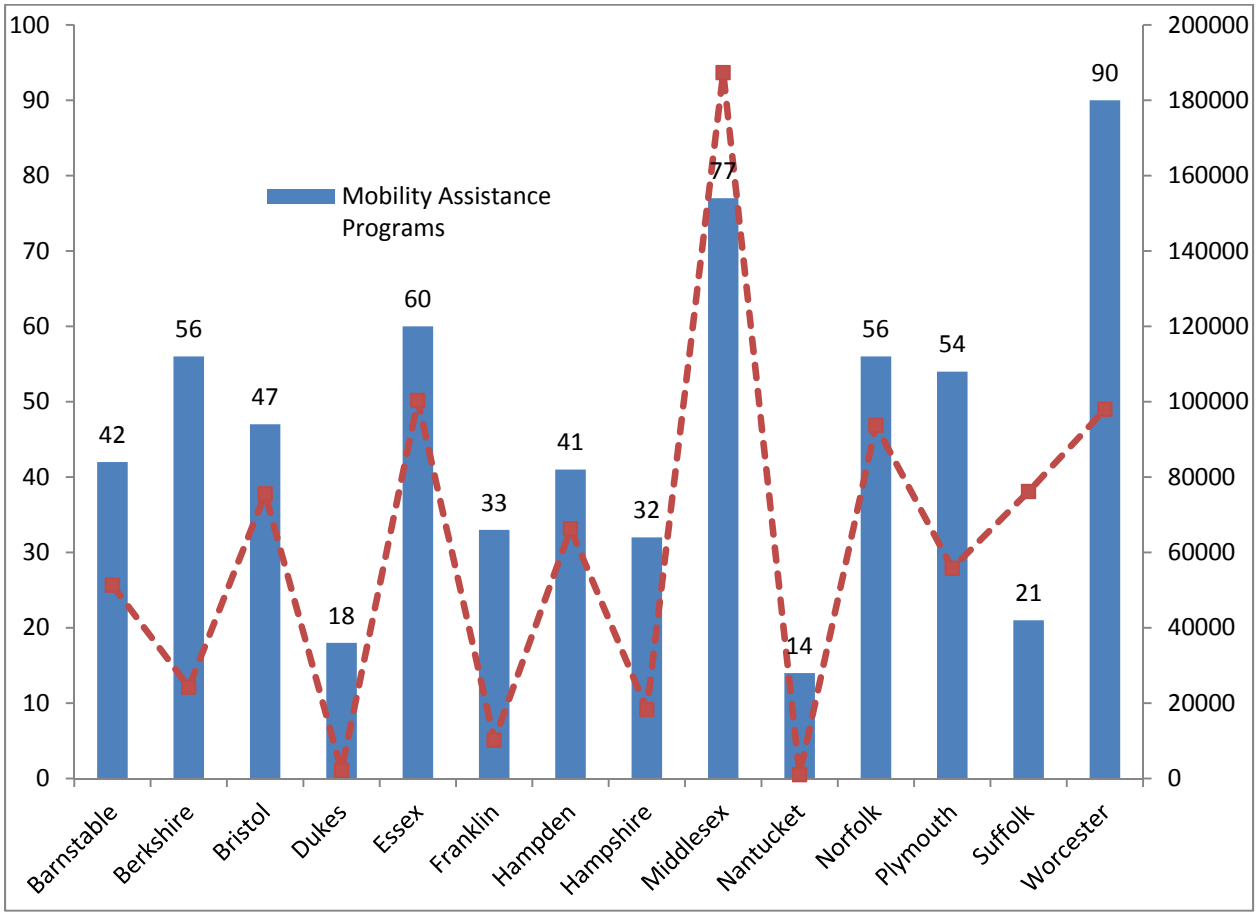
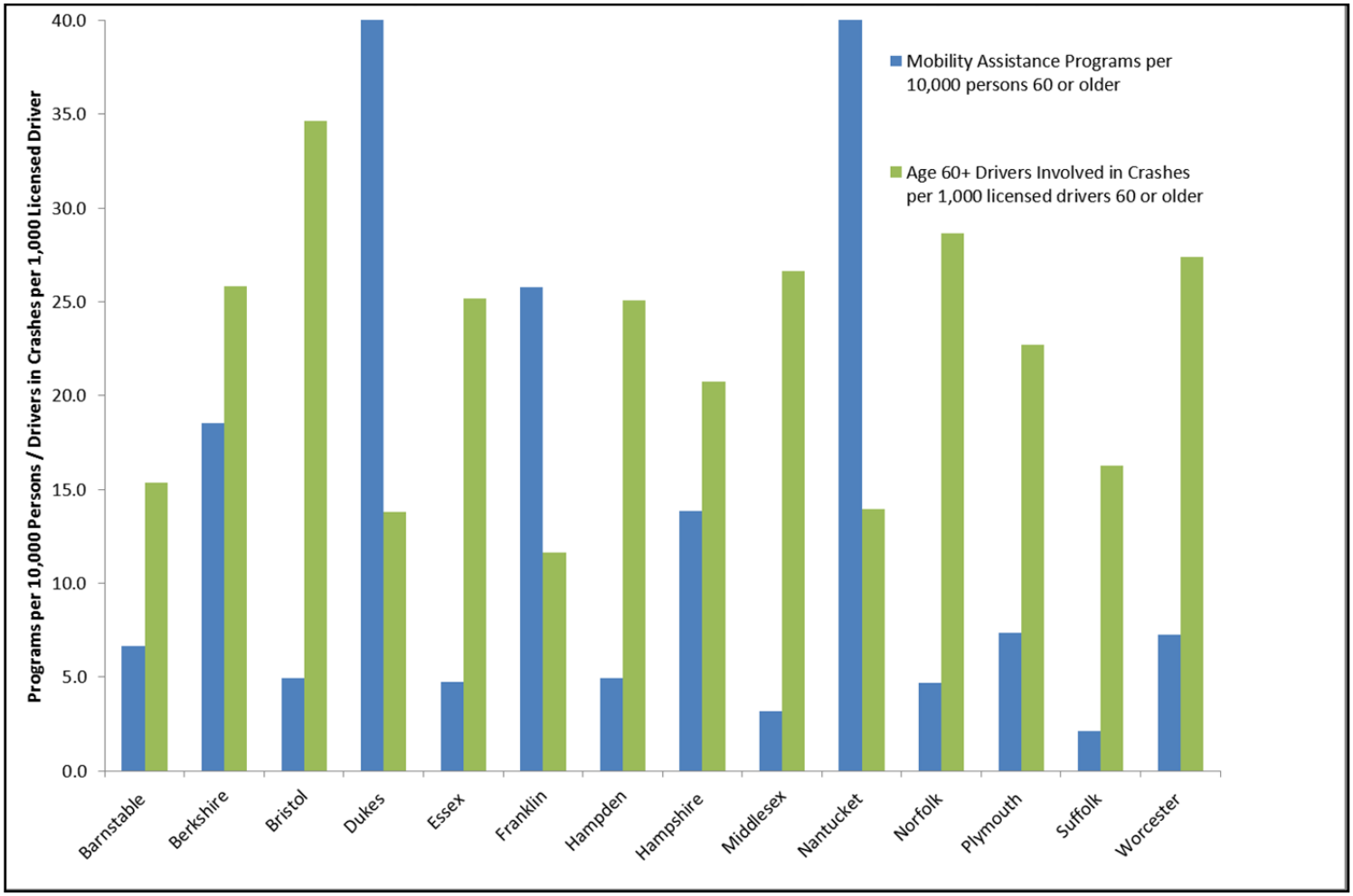


Figure 29: Massachusetts Mobility Assistance Programs per Person and Drivers Involved in Crashes per Licensed Driver vs. Population of Adults Age 60 and Older by County



5.2 Review of Alternative Transportation Options across the United States

While developing the model of mobility networks within Massachusetts, a concerted effort was made to review activities in other states specifically regarding alternative mechanisms available in order to provide transportation to older adults. The approach was twofold: 1.) develop a state-of-the-practice using available resources such as published literature, web pages, and brochures, and 2.) complete a nationwide survey of states to identify current practices.

5.2.1 Nationwide Survey of Older Road User Mobility Options

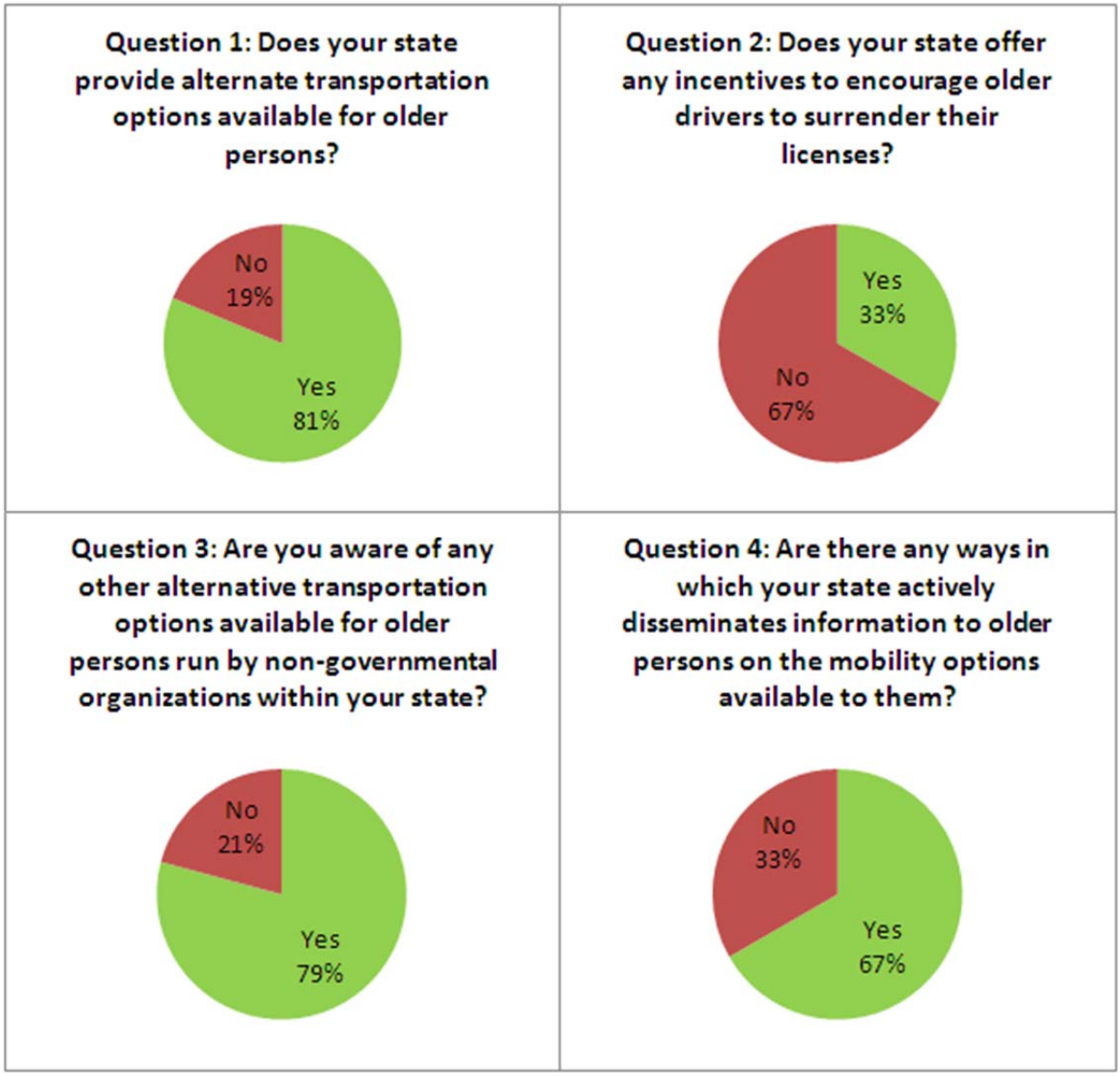
To develop an understanding of the same structure in other states, a nationwide survey was developed and administered. As noted previously, the survey link and request was initially distributed via the State Research Coordinators listserv with the intent for it to be distributed to the appropriate person and/or people within their state. At the same time, lists of potential contacts were identified from online resources. This approach resulted in typically four to five individuals within each state being contacted depending upon the structure of their various agencies.

With responses from 39 states and one Canadian province, the overall response rate was quite high. The responses, as expected, reflected a wide array of knowledge in the various aspects of mobility related to older drivers. Furthermore, the responses helped determine older driver mobility practices throughout the United States, which could be used as a reference to identify successful practices for implementation in Massachusetts. The four question survey required only yes/no responses, and in the event that a respondent answered "yes," the opportunity to elaborate was provided. The questions, described previously, dealt with a variety of issues including the following items: public and private alternative transportation options, incentives to surrender licenses, and information sharing practices. The survey questions and associated responses are presented graphically in Figure 30.

In the first question, respondents were asked if their state (or province) provided alternative transportation options for older people. The purpose of this baseline question was to determine whether the state had a statewide program and the extent to which the government was involved in its implementation. Eight states and Alberta, Canada, answered that no such program existed within their borders; however, Alberta shared that there are some local municipalities that do have some type of alternative transportation option for older people. Twelve states specified that statewide organizations and the subsequent local programs that oversee transportation programs for older adults are either run by the state or by local organizations. Additionally, ten states have transit available, usually provided at discounted rates, throughout most of the state for older people to use. Two states have similar policies in which they supply funding for local agencies to provide transportation for the elderly.

The second question asked was "do the states provide incentives for older drivers to surrender their licenses?" With an overwhelmingly large number of responses reporting that no such policy exists, it became clear that older drivers are given very few incentives to surrender their driver's license. In fact, only twelve responses indicated that their state provided some incentives to older drivers to surrender their license. Nine of these twelve states, including Massachusetts, provide complimentary state-issued identification cards. The Kansas Division of Motor Vehicles recommends that older drivers avoid license revocation by preemptively surrendering their license.

Figure 30: Summary of Nationwide Survey Responses



The third question, which was very similar to the first, asked "did the respondents know of any other alternative transportation options available to older drivers in their jurisdiction?"

Although ten of those surveyed answered "no," the majority of the surveyed reported that there were other alternative transportation options available. Of the remaining 35 responses, a majority stated that their jurisdictions had non-profit organizations that provided transportation. More specifically, respondents pointed out that some of these initiatives were led by volunteer-run organizations, religious organizations, and/or private transportation companies. Additionally, eleven responses highlighted the public transit options offered locally in both urban and rural areas.

The fourth and final question asked the respondents "if they knew of the methods used to disseminate older driver mobility option information to the population at large?" A majority of the respondents shared their knowledge of the several platforms used in their communities to relay this information. Respondents noted that AAAs, Aging Councils, marketing campaigns designed to target older drivers, Department of Motor Vehicle and Department of Transportation employees, and informational publications and websites are used to inform older drivers of their options. Furthermore, three of the jurisdictions are actively developing strategies to successfully convey information.

Not included in the survey were questions pertaining to funding mechanisms used to support these transportation programs; however, respondents often shared their unique approaches. In most cases, the states provided funding for their program; for example, in Washington, Medicaid funds transportation for the elderly. In Pennsylvania, lottery funds are used to help provide free rides on public transportation or discounted rates for paratransit services.

Although the survey itself does not have much statistical power given its simplicity and the diverse nature of the respondents, it does provide additional insight about the mechanism by which older driver mobility is provided for across the nation. The survey results also offer evidence which suggests that many state agencies have identified challenges with the older mobility network delivery method and older driver safety in general. Admittedly, the complex network of agencies, funding sources, and transportation service providers limits the ability for high-level coordination in the current structure.

5.2.2 Nationwide Review of Innovative Alternatives

As noted, an additional element within the scope of this research was to identify and document attributes associated with various alternative transportation approaches or programs across the United States. During the course of the review an overwhelming amount of programs were identified that were relatively similaras to programs or efforts already in place within Massachusetts. Nevertheless, there were several specific programs that were unique in nature and warrant further discussion within the context of this report.

In reviewing alternative transportation programs that currently exist, it is clear that there are a wide range of services offered with a great deal of variability in the character of service they provide. Successful programs are those that demonstrate desirable characteristics such as convenient hours of service, advanced scheduling, short wait time, ability to stop multiple times, curb-to-curb (or even door-to-door) services, cleanliness of the vehicles and/or facilities, driver's kindness and general demeanor with older persons, and price or relative

affordability. The programs must be both desirable to older adults and financially sound. In order to compare the relative merits of each program, they must be analyzed in a systematic manner. Each noteworthy program that was reviewed was described by characterizing the service they provide, their operational and financial model, and their measure of successfulness. Within these broad categories particular characteristics of the program were described. Additional details about the information gathered on each program that were identified are included within Appendix C. Although hundreds of programs were identified nationally, the following section describes three programs that have potential applicability in Massachusetts.

iTN America

The Independent Transportation Network (iTN America) is a nonprofit organization operating in the United States. iTN first began in Portland, Maine, but now serves older adults in a number of communities across the nation. The network, which provides 24 regional programs in various pockets of the United States, uses innovative operational and funding mechanisms to provide a level of sustainability. Two of the newest programs are in the greater Boston area. Unlike paratransit, drivers are available every day of the week at any time and the older adults can travel anywhere they desire for a fee averaging $8 per trip. Drivers provide personalized services such as helping older adults carry in their bags, help with wheelchair equipment, or assist the older adult with whatever else is needed. A major incentive is that older adults can trade in their own vehicles and receive credit towards trips. Also, volunteer drivers are able to receive credits for their time which can later be used for their own transportation needs, the needs of loved ones, or can be converted into a fund for low-income riders. Programs are only started in regions where it is deemed feasible given the geographic, demographic, and financial landscape of the area; it is not an appropriate solution for all areas (59).

The two recent programs in Massachusetts should be evaluated to determine their effectiveness. Based upon the demographic and program information presented in Section 5.1, there is evidence to suggest additional feasibility of such programs in Cape Cod or Hampshire and Franklin Counties.

Ride Connection

Ride Connection comprises several transportation programs servicing Clackamas, Multnomah, and Washington Counties in Oregon. This network of more than 30 community partners gets public funding from Tri-Met and the Oregon DOT to complement Tri-Mets ADA services (60). One program, called RideWise, teaches older adults how to use public transportation safely and efficiently (61). Additionally, door-to-door services are available Monday through Friday at varying hours depending on location for adults 60 and older. There is no charge for these services, although donations are suggested. Rides can be requested by phone or online. RideAbout is a service for adults 60 and older designed based on community feedback. As such, shuttles travel to various shopping areas to help people travel where they need to go. Other programs include WorkLink, U-Ride, and Job Access (61).

Oats, Inc.

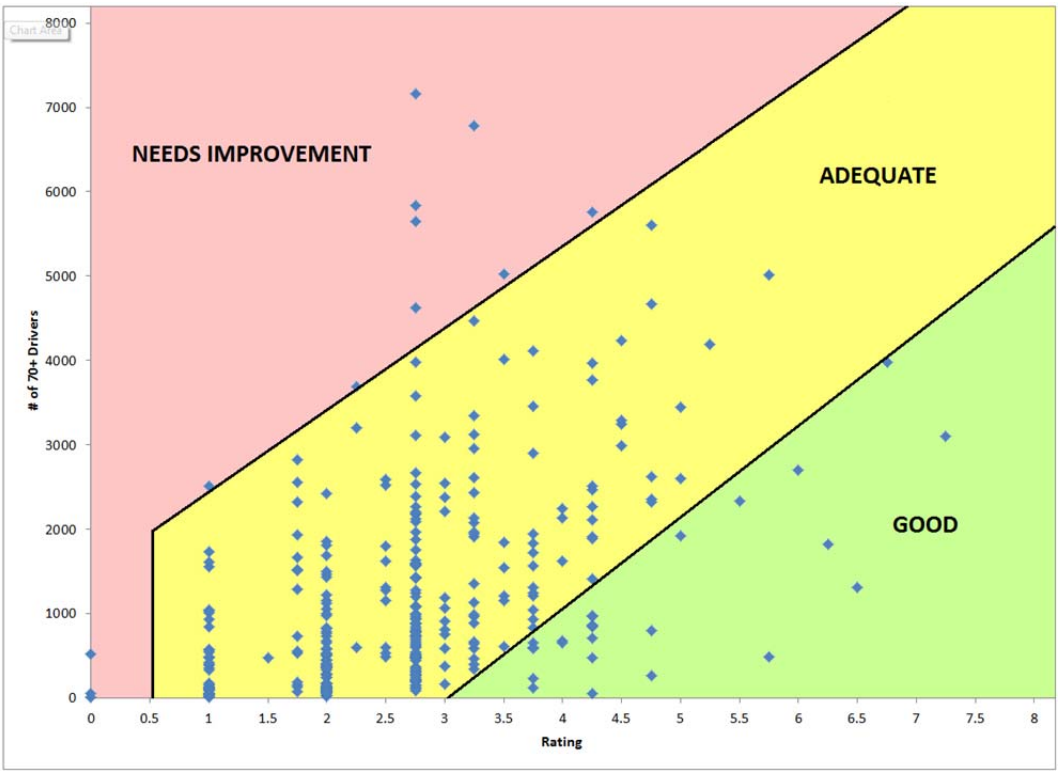
Oats, Inc. services anyone in need of transportation in the majority of Missouri (87 counties) by providing reliable transportation in rural areas. Oats, Inc. is one of the largest and most unique transportation programs in the United States. The program is funded through private contracts, state revenue, the Older Americans Act, and Federal Transit Administration programs; it covers 131,157 square kilometers, has a budget of $18.2 million, and is used by over 31,000 people. Unsurprisingly, Oats, Inc. provided over 1.5 million one-way trips last year with 622 vehicles and 530 paid drivers (62). It is perhaps the single best example of a statewide program for alternative transportation and has been in operation for more than 40 years.

5.3 Applications for Massachusetts

Based on the statewide review of existing transportation alternatives and forecasted demands, several possibilities exist for meeting current and future needs. The considerations are listed below:

- Review existing and forecasted gaps within the coverage area of alternative mobility assistance programs in an effort to extend or improve service. Although there are some cities and towns that currently have limited transportation alternatives, the projected increases ensure that nearly all municipalities will have fewer programs per older adult unless services are added. There are several mechanisms by which service levels can be maintained or possibly enhanced. An initial step is to focus on existing MBTA and RTA coverage and resource allocation. Another recommendation would be the increase of state-level incentives for communities that coordinate activities. Possible opportunities for collaboration might include pooled funds (e.g., a regional shuttle) or shared resources (e.g. paratransit van operating in one town Monday, Wednesday and Friday and in the neighboring town Tuesday and Thursday), amongst others.
- Develop a quantifiable rating system to assess the capabilities for providing adequate transportation services within each city or town. The developed metric should build on the program-level data assembled within the framework of this project and include details such as additional programs identified, ridership information, hours of operation, and allowable trip purposes and resources (i.e., funding levels). When coupled with demographic data such as populations, households, density, etc., the program data would allow for the creation of a ranking system similar to that presented in Figure 31. The regression model-based ranking system would allow for an objective evaluation of communities which would thus ensure that the needs of the older population were being met. The ranking system would identify parameters for boundaries of good, adequate, and poor coverage levels that could, in turn, be introduced into the decision-making process when deciding on potential services.

Figure 31: Conceptual Rating System for City/Town Mobility Assistance



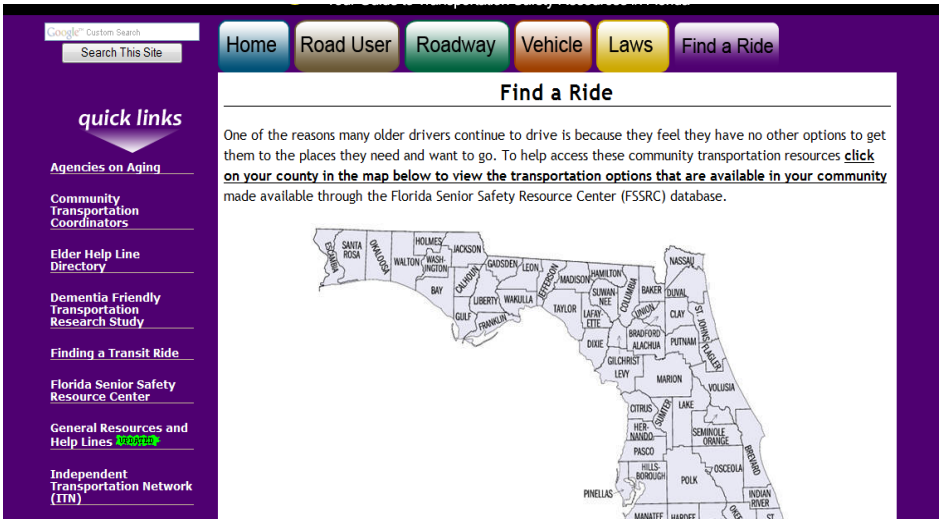
- Identify appropriate opportunities for public/private partnerships that would allow for the establishment of alternative transportation programs within selected regions of the Commonwealth. Initial suggestions are listed below:

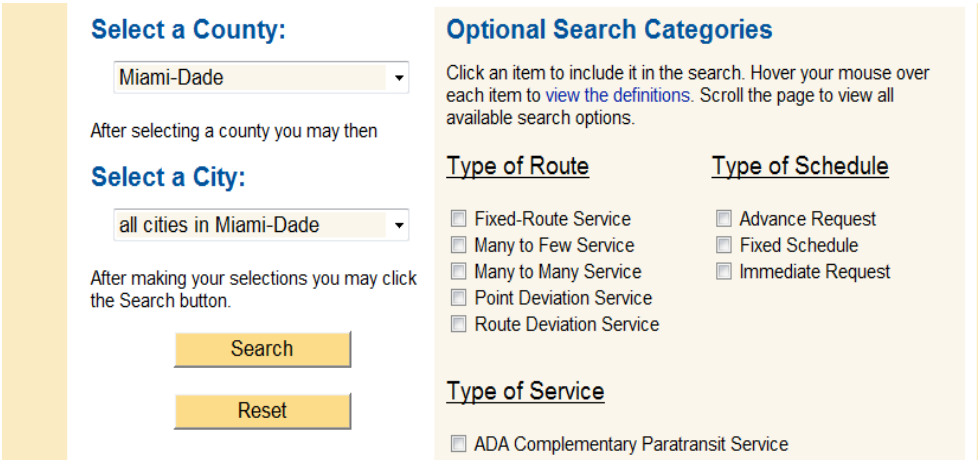
    - Monitor the initial implementation of the iTN America program in the greater Boston area and evaluate its effectiveness. Based on the operational parameters and the statewide demographics of this program, it would most likely operate effectively along Cape Cod or in Western Massachusetts (i.e., Hampshire and Franklin Counties).
    - Identify other likely partnerships that might include private service providers, such as limousine companies that often have vehicles go unused during typical business hours. An opportunity may exist to utilize the employment of these vehicles for older adult transportation during this time period.
    - Implement a program similar to the Ride Connection Program in the State of Oregon. Primarily a volunteer program that runs on suggested donations, this program aids transportation mobility in ways that move beyond simply providing transportation. For example, one specific program within Ride connection, called RideWise, teaches older adults how to use public transportation safely and efficiently (61)

- Introduce a statewide program beyond what is currently provided through the coordinated efforts of the MBTA and RTAs. Although OATs, Inc. is in many ways similar to other transportation programs, there is a statewide level of coordination that might prove useful should a similar model be developed in Massachusetts. One specific benefit would be the ability to share or reallocate resources (e.g., vehicles, funding, etc.) to various regions of the Commonwealth depending upon specific needs. Further review of this model for possible implementation in Massachusetts is recommended.

- Coordinate information resources for transportation alternatives across the Commonwealth. Two such models provide an initial concept of what may be achieved. Within Massachusetts, the senior connection database, shown previously in Figure 23, provides information on transportation services within Massachusetts; however, there are additional features that might offer enhancement. The Florida Department of Transportation maintains the "Safe and Mobile Seniors" webpage, which provides an interactive map for trip purposes and allows users to enter travel needs and schedule type (63). This interactive website is presented in Figure 32. The creation of this platform could be built using the programs database built within the scope of this research project. An additional suggestion would be the integration of this future system with existing information dissemination sources, such as the 2-1-1 program.

Figure 32: Screen Captures from Safe and Mobiles Seniors (63)





6.0 Conclusions and Recommendations

Existing research has identified older driver safety and mobility as areas for consideration in the development of highway safety programs and policies. Although there is general consensus among the highway safety community regarding the importance of addressing the issues surrounding older road users, there is less agreement in terms of how best to implement programs and policies that improve the safety of older drivers while also accounting for the importance of their continued mobility when they no longer drive. To date, efforts have focused largely on the use of medically based indicators for assessing the ability of older adults to drive safely. While the use of physical and physiological indicators for a person's ability to drive safely can be helpful in identifying high risk drivers, the process requires the skilled assessment of individual drivers by a panel or group of trained professionals. It also requires that potentially risky drivers be referred to MABs for review.

While licensing policy and regulations are important and have the ability to potentially improve older driver safety, it is imperative to simultaneously support alternative means for maintaining a reasonable level of mobility for non-driving older adults. The mobility network for non-driving older adults is complex in nature with many overlapping intricacies across a myriad of agencies and stakeholders.

This research project focused on providing information to be used by the RMV and other stakeholders and included 1.) the identification of strategies for possible implementation regarding older driver licensing restrictions, and 2.) an analysis of the existing structure of mobility options and the potential future needs of older adults that no longer drive.

Section 6.1 outlines the key findings and conclusions resulting from each of the tasks. The analysis of these specific project elements resulted in recommendations for improvements in Massachusetts for both licensing renewal practices and alternatives to the existing mobility network for older adults. The recommendations are presented in Section 6.2.

6.1. Research Findings and Conclusions

6.1.1 Demographic and Spatial Analysis of Older Adults in Massachusetts

A spatial analysis of the distribution of older adults was completed using population data, licensed driver data, and household data for each of the 351 cities and towns within Massachusetts. The intent was to establish a spatial background that could subsequently be combined with older driver program data in order to identify a city or town's ability to meet the transportation needs of older adults.

In summary, several findings were identified:

- The distribution of the frequency of older adults across cities and towns closely mirrors that of the total Massachusetts population. One exception is Cape Cod, which accounts for a slightly higher percentage of older adults than it does total population. There is, however, a significant difference between the communities that have the highest frequency of older adults compared to the communities that have the highest percentage of older adults. For example, the three largest cities of Boston, Worcester, and Springfield have the highest frequency of older adults. However, in these cities, adults ages 65 years and older account for less of the total population than most other municipalities in the state.
- Comparing the distribution of people ages 65 and older versus ages 85 and older also yields findings. Although communities with the highest percentage of adults ages 65 and older are primarily located in Berkshire County and Cape Cod, the distribution of communities with the highest percentages of people ages 85 and older are more geographically diverse across the Commonwealth.
- Nearly half of the 351 cities and towns have a total population of less than 10,000 residents and a population of adults ages 85 and older that is less than 200.
- Considering the projected increases in the 65 and older population in the state, it is a logical step to project that the increase will be higher in larger population centers. However, the percent increase in many of the more rural areas is noteworthy. The average increase in adults ages 65 and older by 2020 will be 786 per city/town with an average increase of 44 percent. Additionally, more than half of the 351 cities and towns will see a projected increase of more than 500 adults that are 65 years and older.
- As may be expected, the spatial distribution of licensed drivers across the Commonwealth correlates strongly with population. This fact is likely the result of two factors: licenses serve as the primary means of identification for many Massachusetts residents, and current license renewal procedures are not prohibitive.
- Using ACS data from the United States Census Bureau, the breakout of households with adults ages 65 and older was considered. More than half of all communities have upwards of 10 percent of households with a single occupant that is 65 years and older. On average, cities and towns have more than 27 percent of households with at least one person age 65 years or older.

6.1.2 Older Driver Crashes in Massachusetts

The older population in Massachusetts is increasing, and according to United States Census data, it will continue to do so over the next decade. Although Massachusetts crashes involving older drivers have decreased since 2005, they have decreased at a slower rate than those crashes involving the remaining adult driver population, ages 25 to 64. This statistic indicates that education, enforcement, and engineering crash prevention efforts targeted at older drivers needs to be strengthened. To this end, several patterns were identified regarding older driver crashes in Massachusetts:

- The older population experiences a higher fatality rate compared to other age groups. Additionally, the percentage of the most severe crashes is greater for older drivers than for other adult drivers. Moreover, the percentage of severe crashes within the older population increases with driver age.
- Specific regions of the state experience more crashes involving older drivers. As might be expected, the greatest concentration of these crashes occurs in the most densely populated areas of the state, such as the Boston Metropolitan area and surrounding suburbs. In Western and Central Massachusetts, the crashes are clustered around population centers and the most travelled transportation corridors. There is also a high concentration of crashes on Cape Cod, as older drivers make up a higher portion of the driving population in that region.
- Unlike other age groups, older driver crashes are more likely to occur at intersections. Additionally, older drivers have more angle crashes and fewer rear-end crashes than the rest of the adult population.
- Crashes involving older drivers happen most frequently between the hours of 10 AM and 3 PM, and may be a result of the time period during which older drivers tend to travel.
- More crashes involving older drivers occur in clear weather conditions during daylight hours than the same crashes involving the remaining adult population.
- The percentage of crashes involving older drivers in which a police report is filed indicating no improper actions is lower than that for other drivers. This could be attributed to the fact that older drivers fail to yield right of way at a higher rate than younger drivers; older drivers have also been reported as showing a disregard for traffic signs, signals, and roadway markings more often than other adult drivers. However, older drivers were less likely to be following too closely, exceeding the speed limit, driving too fast for conditions, or operating the vehicle in erratic, reckless, careless, negligent, or aggressive manner.
- Though older drivers are eligible for public insurance (Medicare), the majority of older drivers were covered by private insurance. A greater number of older female drivers were injured than older male drivers and the median emergency department charges were higher for females than for males, regardless of the payer source (private, public, or self). This result was different from the results garnered from the comparison group where more females were injured than males, but where the median emergency department charges for males were higher than for females. Overall, median emergency department charges were higher for older drivers than for comparison drivers when considering all possible combinations of payer source and gender except for self-paying male older drivers.

6.1.3 License Renewal Practices and Policies

Research has shown that older drivers often act as their own first line of screening in terms of restricting when, and under which circumstances, they drive. Older drivers tend to limit their driving based on their own perception of their skills and abilities. For example, many older

drivers limit night driving, driving on certain types of roads in certain weather conditions, and other situations that feel unsafe. However, the current generation of older drivers is heavily reliant on personal automobiles as a means of travel and is accustomed to the level of mobility afforded by automobile travel. As a result, state licensing agencies may need to play a larger role in older driver safety.

In some states, licensing agencies have implemented age-based restrictions or other licensing practices. These practices are generally applied based solely on age, and little evidence exists that suggests they are effective in improving older driver safety. Age-based restrictions include practices such as accelerated renewal cycles, additional vision testing, a personal appearance requirement for license renewal, and additional road testing. Some would argue that of these practices, road tests are most effective in identifying high-risk drivers. However, the problems with these tests are that they do not expose drivers to high-risk conditions and they do not account for the fact that individual driving ability at the time of the test may change as the driver ages (48). Given the inability to show the effectiveness of age-based restrictions, licensing agencies are moving towards more behavior-based restrictions.

Whether or not the licensing agencies choose age-based or behavior-based practices, one of the greatest challenges comes in terms of testing procedures. That is, relying on examiners at the licensing agency to make decisions regarding whether an older adult is retested, and what the results of those tests are, works to minimize testing standardization across agencies.

The information gathered during this task provides insight for state licensing agencies and also points to opportunities for further research.

- There is consensus that states should identify ways to implement licensing tools that are reliable, efficient and cost effective. Consensus has not been reached regarding how reliable, efficient, and cost effective these licensing tools may be. The NHTSA Model Driver Screening and Evaluation Program began to address these issues and provided some framework, but further examination of this area is required.
- MABs are a generally accepted element of older driver licensing practices. Areas of consensus include the importance of maintaining consistency across review practices while also maintaining the individuality associated with a case-by-case review process; the need for MABs to be part of the development of licensing guidelines rather than being used solely to review cases where licenses have been denied has been articulated; and finally, the need for members of MABs to be compensated appropriately for their efforts.
- Information gathered from licensing agencies across the United States indicates a need for additional licensing steps for older drivers including appearance in person for license renewal and functional testing at the time of renewal.
- Licensing agencies should play a role in the provision of mobility options for older adults who are no longer able to drive.

Perhaps the greatest opportunity for further exploration identified during this task was the use of graduated licensing, or graduated de-licensing, for older drivers. Utilizing a similar

framework to graduated licensing employed for new teen drivers, graduated de-licensing for older drivers would limit driving activity gradually by first reducing their exposure to high risk situations. The driving restrictions may also include limits on time of day, a reduced area in which to travel, and limits on road types, etc. The limited evaluation of this practice shows some success in terms of improving driver safety when combined with driver education and training (48). In addition, another study indicated that older adults and their caretakers found the use of license restrictions less stressful for the driver and their friends and family than revocation (50).

In Massachusetts, there are opportunities for improving older driver licensing policies based on existing best practices in the use of MAB, continued appearance in person for license renewal, and potential implementation of graduated de-licensing for older drivers. One of the challenges associated with a change in older driver licensing policy will be in the MGL language which prohibits licensing practices that discriminate on the basis of age.

6.1.4 The Massachusetts Network of Mobility for Older Adults

An initial goal of this research was to develop a simplified model of the existing non-driver mobility structure in Massachusetts, including standard public transportation provided through RTAs and the MBTA. Following the development of this model, a secondary objective was to evaluate the effectiveness of various components. The evaluation was carried out both quantitatively and qualitatively and considered both the impact on crashes and the desirability of such programs for older adults.

The network for providing transportation alternatives is complex in nature. Generally, mobility networks for non-driving older adults have three major dimensions. The most visible dimension would be the transportation service providers who deliver the services directly to older adults. Behind these service providers there are many different funding sources and mechanisms that financially support these services. Lastly, there are information sources that work to connect older adults who need transportation services with the organizations that provide the services.

In reviewing the alternative transportation programs that currently exist, it became clear that there is a considerable degree of variability in the character of service provided. Nevertheless, an analysis was undertaken to determine the extent to which cities and towns are able to offer alternative transportation. A database was developed to document the various mobility assistance programs that were available to residents within each Massachusetts city or town.

A measure of mobility assistance programs available within each city and town was developed. The number of available programs correlated with population. To better determine the correlation between older road user mobility assistance programs and the larger population, the number of programs per 1,000 adults ages 65 and older was generated. Although generally Western Massachusetts has fewer programs per community, the lack of population density results in a higher ratio of programs per person. When the projected increases in adults ages 65 and older are accounted for according to the 2020 estimates,

several findings emerge. Several of the smaller communities (mostly in Berkshire County) will maintain a high level of programs per person given the capacity that exists within those communities today. By comparison, the large population increases in the urban centers will put added strain on existing mobility assistance programs.

Considering the MBTA and RTA services available within each community, there are identifiable gaps where there are no paratransit services available— a service needed most by older adults. Many advocates for older road users indicate the need for door-to-door services rather than only curb-to-curb, and in many instances the fixed route service is unusable to an older road user. When looking at coverage currently provided statewide, there are pockets with limited or no coverage.

The level of mobility of older adults, as measured by the quality and quantity of programs in the area, is most closely related to the population of older adults in the area. In order to improve the statewide senior mobility structures, it is imperative to first evaluate the existing programs and weigh their existing or potential merit. To evaluate this potential within Massachusetts, a county-based analysis of the relationships between mobility programs, the population of older adults, and older adult crashes was undertaken. The analysis determined that counties with a higher senior population tended to have more programs. It is also not surprising that counties in the western portion of the state (i.e. more rural areas) have fewer programs; the exception to this finding is Berkshire County, which has a high level of programs. Worcester County, within central Massachusetts, has the greatest number of mobility assistance programs and one of the higher proportions of older driver crashes.

In summary, there was evidence to suggest an inverse relationship between these two variables: counties with a higher program-to-older adult ratio have a lower older adult-to-crash ratio. The three counties that have the highest proportion of mobility assistance programs have the lowest proportion of crashes involving adults ages 60 years or older. Furthermore, counties that have fewer than five mobility programs per 10,000 persons have the highest proportion of crashes involving adults ages 60 years or older. As a result of the projected increases in population for the 65 years and older age group, an increase in older driver crashes may exist without an adequate increase in the availability of transportation alternatives

6.1.5 Review of Alternative Transportation Options across the United States

While developing the model of the mobility network within Massachusetts, a concerted effort was made to review activities in other states specifically regarding existing alternative mechanisms for providing transportation to older adults. The approach was twofold: 1.) develop a state-of-the-practice using available resources such as published literature, web pages and brochures; and 2.) complete a nationwide survey of states in order to identify current practices.

A four-question survey was developed and administered to DOTs across the United States. The survey results provided evidence to suggest that many state agencies have identified challenges with the older mobility network delivery method and older driver safety in

general. Admittedly, the complex network of agencies, funding sources, and transportation service providers limits the ability for high-level coordination in the current structure.

Similarly, a review of innovative alternative transportation programs across the United States uncovered many programs that were similar in nature to those already in operation within Massachusetts; however, a few were identified that have credible possibilities for implementation in the Commonwealth.

6.2 Recommendations

The analysis of the specific project elements resulted in a series of recommendations for improvements in Massachusetts regarding both licensing renewal practices and alternative options to be considered for the existing mobility network for older adults. An initial recommendation is that key stakeholders associated with older road user safety, including representatives from both MassDOT and Elder Affairs, review the findings and recommendations to develop implementation plans as appropriate. The remaining recommendations are as follows:

- Create an older adult mobility advisory board within the Commonwealth to facilitate coordination across stakeholders on issues central to older driver safety and mobility. These issues include, but are not limited to the following items: training for older drivers, alternative transportation sources and information dissemination, crash analyses, emerging research, and demographics. One specific application of this board might be the implementation of findings and recommendations from this current research effort as deemed appropriate.
- Establish a formal mechanism for monitoring emerging research trends, given the interest in this topic. The authors are aware of several unpublished research efforts that directly complement the research undertaken herein.
- Consider graduated licensing (or de-licensing) as a viable option for improving older driver safety. The success of graduated licensing for teen drivers serves as a foundation not only supporting the potential for reducing crash frequency and severity, but also for the palatability of this policy approach. Graduated licensing, instead of license revocation, would allow older drivers to maintain a certain level of mobility. Although they may be limited to driving in lower risk environments, this approach would still allow them to conduct “required” business such as grocery shopping, attainment of medical care, etc.
- Focus licensing policies on the allocation of resources aimed at cognitive and physical assessment utilizing case-by-case reviews of ability rather than on a systematic approach to identify high-risk drivers. Aging is an individual process; the onset of diminished capabilities associated with aging not only happens at different ages, but in different manners with different timeframes. As such, resources should be focused on testing processes that aim to assess an individual’s ability to drive. It may be that a base age, such as 70 or 75, triggers that testing to

be conducted; however, at that time, licensing decisions should be made based on the individual's current state, rather than their prior history.

- Establish a mechanism for providing recommendations associated with training for older drivers. Training programs have been developed and have documented success in improving older driver performance (51, 52). Although the specifics for implementation of a training intervention would need to be established, there may be fixed indicators that suggest inclusion such as identified cues at the time of license renewal, a motor vehicle infraction, or a crash.
- Review existing and forecasted gaps within the coverage area of alternative mobility assistance programs in an effort to extend or improve service. Although there are some cities and towns that currently have limited transportation alternatives, the projected increases in the population of older adults ensure that nearly all municipalities will have fewer programs per older adult unless services are added. There are several mechanisms by which service levels can be maintained, or possibly enhanced, and are listed below:

    - Review the existing RTA and MBTA coverage and resource allocation;
    - Increase state-level incentives for communities that coordinate activities. Possible opportunities for collaboration might include pooled funds (e.g., a regional shuttle) or shared resources (e.g. paratransit van operates in one town Monday, Wednesday, and Friday, and in the neighboring town Tuesday and Thursday) amongst others; and
    - Support a quantifiable rating system to assess the capabilities for providing adequate transportation services within each city or town. The developed metric should build upon the program level data assembled as part of this project.

- Identify appropriate opportunities for public/private partnerships that would allow for the establishment of alternative transportation programs within selected regions of the Commonwealth. A logical example is to monitor the initial implementation of the iTN America program in the greater Boston area and evaluate its effectiveness. Other partnerships include private service providers, such as limousine companies, that often have vehicles go unused during typical business hours. Implementation of a program similar to the Ride Connection Program in the state of Oregon should be considered. Primarily a volunteer program that runs on suggested donations, this program aids transportation mobility in ways beyond simply providing transportation. Further review of the OATs, Inc. program in Missouri is recommended as well, as a statewide level of coordination would allow the ability to share or reallocate resources such as vehicles or funding.
- An effort should be made to coordinate information resources for transportation alternatives across the Commonwealth. Two such models provide an initial concept of what may be achieved. Within Massachusetts, the Senior Connection Database, shown previously in Figure 22, provides information about services within Massachusetts; however, there are additional features that might provide

enhancement. The Florida Department of Transportation maintains the “Safe and Mobile Seniors” webpage which provides an interactive map for trip purposes and allows users to enter travel needs and schedule type (63).

- Expand the existing collaborations between the Safety Section within the MassDOT Highway Division and regional planning agencies to include the identification of older driver high crash locations. Once candidate locations are identified, agencies may perform road safety investigations with an emphasis on identifying challenges for older drivers (17).
- Pursue future research that builds upon some of the work initiated herein. The specific application that would be of the most use is the development of an older driver crash prediction model that allows for the scientific identification of drivers for possible intervention or screening. The ability to identify high-risk older drivers prior to their involvement in an injury-causing crash could provide the foundation necessary in order to develop revised licensing procedures, educational programs, and the provision of alternative modes of transportion for older drivers who pose a significant risk.

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Appendix A: Analysis of Older Driver Safety Fact Sheet

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Massachusetts Department of Transportation

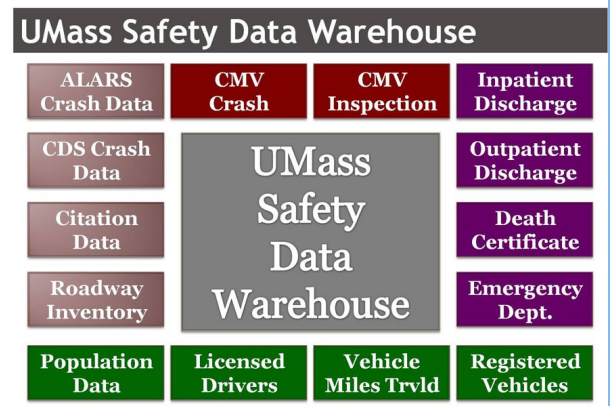
Analysis of Older Driver Demographics and Safety Data

Coping with the Aging Driving Population

Demographics show that the elderly population in Massachusetts will grow steadily over the next decade. As such, the Commonwealth will be confronted with a host of new challenges regarding the aging driving population, which continues to be an ongoing concern of the Massachusetts Department of Transportation (MassDOT). In order to develop a comprehensive plan to address the challenges of the aging driving population, an integrative understanding of the background issues must be established. The following fact sheets provide an overview of the findings resulting from the analysis of US Census Bureau data, the Registry of Motor Vehicles (RMV) crash data, and other applicable data.

Sources of Information

The information presented in these fact-sheets comes from a variety of sources. The demographics data was obtained from the US Census Bureau. The crash, citation, and other relevant data were accessed from various agencies through the UMass Safety Data Warehouse, which was developed as a tool for maximizing the use of highway safety data. Data available from the Warehouse include traditional datasets, such as crash and citation data, as well as less traditional highway safety information, such as health care data and commercial vehicle safety data. The use of assorted, diverse data allows for truly comprehensive analyses of highway safety problem areas. The schematic below shows the variety of data that is available in the UMass Safety Data Warehouse.



Definition of Older Driver

For the purpose of this analysis, an older driver is defined as a driver age 65 or older. Additionally, the term "oldest" older drivers will be used to denote drivers age 85 or older. An adult driver is defined as a driver age 25 - 64.

[1] Projected Population of the United States, by Age and Sex: 2000 to 2050. US Census Bureau. http://www.census.gov/ipc/www/usinterimproj/.
[2] National Highway Transportation Safety Administration's National Center for Statistics and Analysis

Highlights of Key Findings

- **The 65+ age group is expected to grow 7 times faster than the general population in Massachusetts from 2000 to 2030.[1]**
- **In 2008, older people accounted for 15 percent of all traffic fatalities and 18 percent of all pedestrian fatalities nationally.**
- **In Massachusetts in 2008 there were 53 older drivers involved in fatal crashes.[2]**
- **In Massachusetts, over 50% of crashes involving older drivers occurred between 10 AM and 3 PM, a relatively low crash period for the rest of the adult population.**

Analyses Included:

Demographics

The Aging Population in the State and Nation

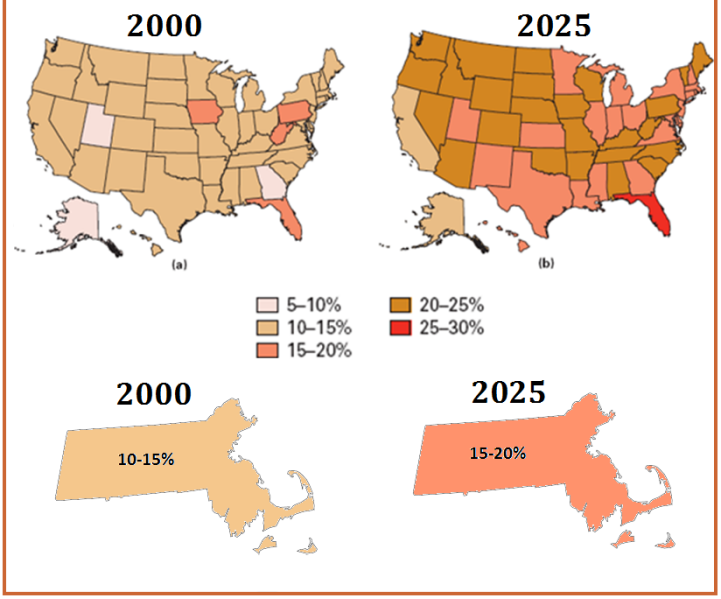
Older drivers comprise the fastest growing demographic in the driver population in the number of drivers licensed, distance driven, and proportion of the driving population. [1]

According to projection data from the US Census Bureau, the US population is expected to grow from 310 million to 439 million between 2010 and 2050, which is an increase of 42 percent. More significantly, the US population is expected to become much older. By 2025, it is estimated that 25 percent of the population (65 million people) will be 65 years or older. By 2050, 88.5 million people are expected to be 65 years or older. Due to an aging baby boom population coupled with immigration trends, the age structure of the overall population is projected to change drastically in the next forty years.[2]

These trends will be seen in every state (see figure below), and the Commonwealth is no exception. In 2000, the number of Massachusetts residents 65 years of age or older was 860,162 or 13.5 percent of the population. According to projection data from the U.S. Census Bureau, by 2030, this number is expected to increase to 1,463,110, bringing the percentage of older residents to 20.9 percent of the population. This is a 70.1 percent increase in only 30 years, while the general Massachusetts population is projected to increase by only 10 percent in the same time frame.[4]

The 65+ age group is expected to grow 7 times faster than the general population in Massachusetts from 2000 to 2030.[4]

Percentage of Population 65 Years of Age or Older [3]



The Aging Driver

Not only is the population growing and aging, but people are driving much later in life. Nationally, as a result of this trend, the proportion of the driving population that is over the age of 65 is increasing. Between 1993 and 2003, the number of drivers age 70 or older increased by 27 percent to 19.8 million. By 2030, drivers age 65 or older will account for 20 percent of all licensed drivers, compared to 13 percent in 2004.

In Massachusetts the trend is even more noteworthy. Between 2004 and 2008 the number of licensed drivers of age 65 or older, 75, or older and 85 or older increased by 8.3 percent, 5.2 percent, and 28.2 percent respectively which greatly surpassed the 0.3 percent increase in the overall driving population.

The licensed older and oldest driver populations have increases in Massachusetts from 2004 to 2008.

- **8.3%** increase in drivers age 65 or older
- **5.2%** increase in drivers age 75 or older
- **28.2%** increase in drivers 85 or older
- **0.3%** increase in overall driving population

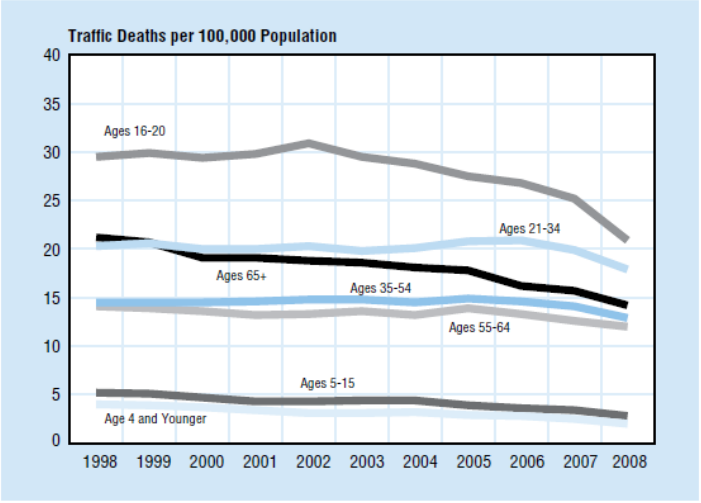
[1] *Development of Human Factors Guidelines for Advanced Traveler Information Systems and Commercial Vehicle Operations.* Literature Review. Empirical Evaluations. Driver Demographics. Publication No. FHWA-RD-95-153 . [2] Transportation Research Board. *"Critical Issues in Transportation"*. 2005. Print [3] Transportation Research Board. *"Critical Issues in Transportation"*. 2005. [4] Projected Population of the United States, by Age and Sex: 2000 to 2050. US Census Bureau. http://www.census.gov/ipc/www/usinterimproj/.

National Trends

Fatality Rate Down, but That's Not the Whole Story

The fatality rate for all age groups has declined over the last 10 years, with drivers 65 years of age or older in particular seeing a marked decrease. Additionally, as the figure to the right indicates, the fatality rate among drivers age 65 years of age or older is lower than that of both the 16-20 and 21-34 year old age groups. This statistic, however, is in number of fatalities per 100,000 persons, which does not take into account the fact that the older population drives less frequently, for shorter distances, and exclusively in favorable conditions. Looking at fatalities per mile traveled, older drivers have a greater fatality rate than other adult drivers. The fatality rate per mile for drivers age 75 to 79 is four times that of drivers age 30 to 59.1.[1]

US Motor Vehicle Traffic Fatalities by Age Group, 1998-2008 [1]



Check the Facts (2008 National Statistics from NHTSA[1]):

- 183,000 older individuals were injured in traffic crashes.
- 5,569 older drivers were involved in fatal collisions.
- 803 older drivers were involved in fatal pedestrian collisions.
- In two-vehicle fatal crashes with an older and a younger driver, the older driver's vehicle was nearly twice as likely to be the one that was struck.
- Older drivers accounted for 15 percent of all traffic fatalities and 18 percent of all pedestrian fatalities.
- In twenty two percent of crashes the older driver was turning left, four times more often than the younger driver.
- Most traffic fatalities involving older drivers occurred during the daytime (80%), occurred on weekdays (72%), and involved other vehicles (69%).

[1] Statistics and graphics on this page courtesy of the National Highway Transportation Safety Administration's National Center for Statistics and Analysis

Massachusetts Trends

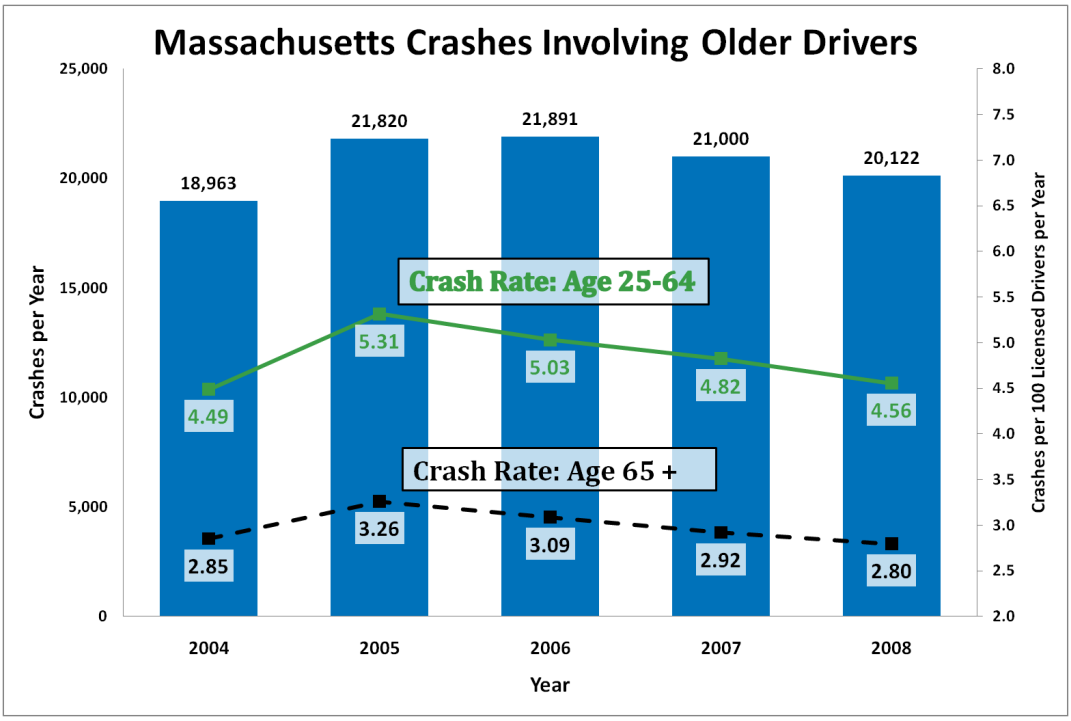
Crashes Involving Older Drivers: A New Problem?

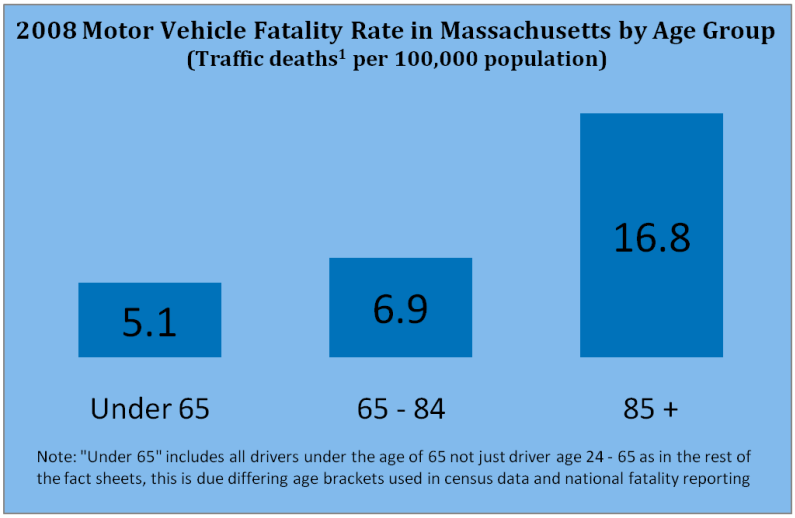
With increasing media coverage of crashes involving older drivers, it may appear that this issue has only recently become a problem. However, the data show that this is not the case. In the Commonwealth, data from the early 2000's indicate that there have been approximately 20,000 crashes involving older drivers per year.

The figure to the right details the total number of crashes involving older drivers and the crash rate for older and other adult drivers (per 100 licensed driver) since 2004. While an increase in both statistics was experienced from 2004 to 2005, in general, both numbers have decreased since 2005.

During the same period the total number of crashes and the crash rate for the remaining adult population followed a similar trend. Decreases in recent years have been attributed to increases in fuel prices and the resulting decrease in vehicle miles traveled.

Fifty three older drivers were involved in fatal crashes in Massachusetts in 2008.





Fatalities in Traffic Crashes

The older population experiences a disproportionately high number of fatalities due to traffic crashes. In Massachusetts in 2008, there were 74 traffic fatalities involving individuals 65 years of age or older. This number translates into 8.5 fatalities per 100,000 population. Examining individual age groups, we find rates of 5.1, 6.9, and 16.8 deaths per 100,000 population for individuals under the age of 65, ages 65 - 84, and 85 years of age or older respectively. This trend is largely due to the fact that relatively minor injuries can lead to potentially life threatening injuries in seniors. [1]

[1] Fatality statistics on this page courtesy of the National Highway Transportation Safety Administration's National Center for Statistics and Analysis

Location Analysis - I

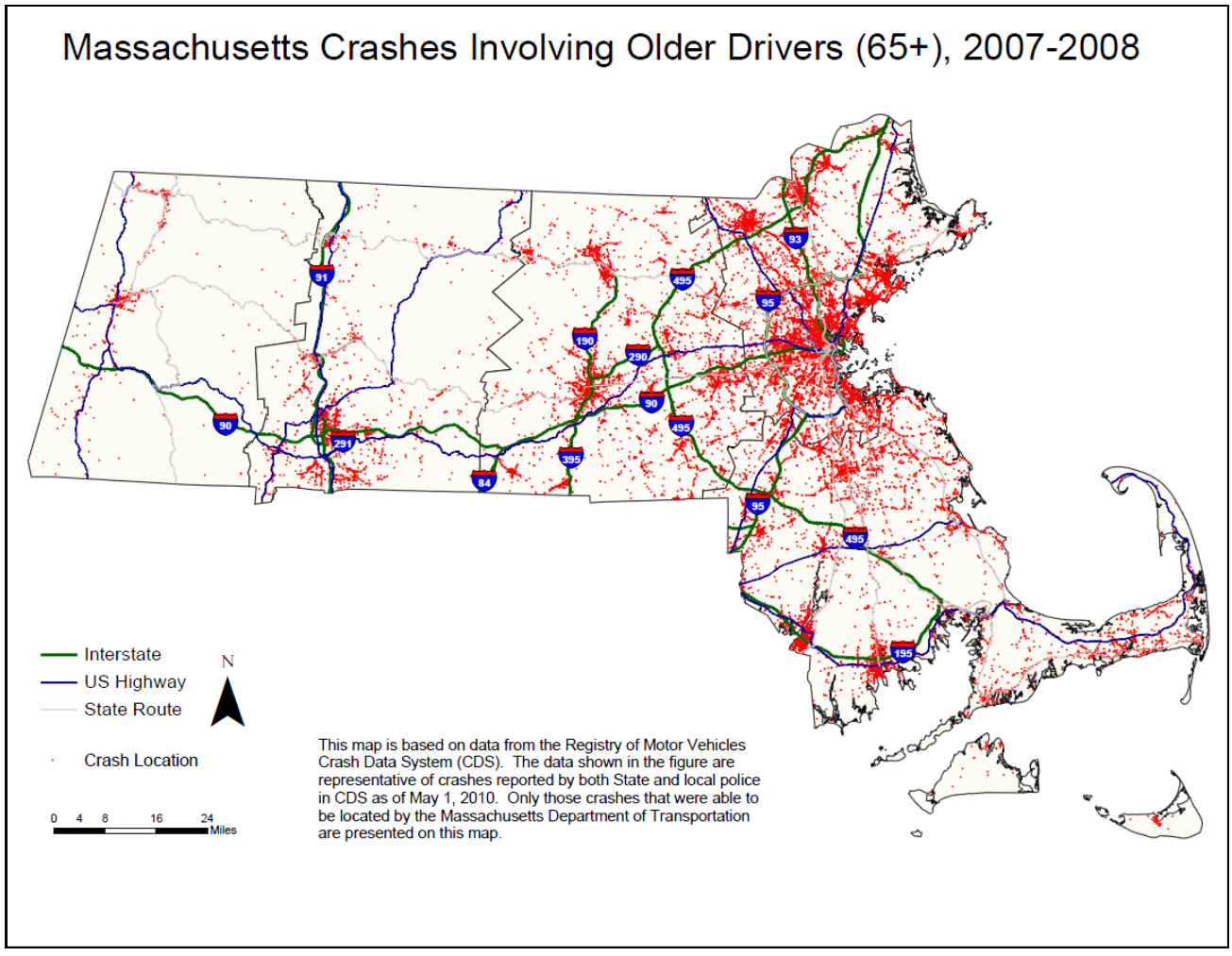
Mapping Crashes Involving Older Drivers

In order to comprehend the nature of crashes involving older drivers, you must first understand where they are occurring. The map below represents the locations of all crashes involving older drivers in Massachusetts in 2007 and 2008

As might be expected, the greatest concentration of these crashes is in the most densely populated areas of the state In the Boston Metropolitan area, along with the surrounding suburbs, there is a large concentration of crashes involving older drivers. In Western and Central Massachusetts the crashes are clustered around the population centers and most travelled transportation corridors. There is also a high concentration of crashes on Cape Cod as older drivers make up a large portion of the driving population.

This map represents the foundation for the location based analysis. A more sophisticated analysis will identify specific regions and corridors that experience a high number of crashes involving older drivers and hopefully lead to mitigation strategies.

While it is true that the greatest concentration of crashes involving older drivers occur in the most populated areas, it is a problem across the state.

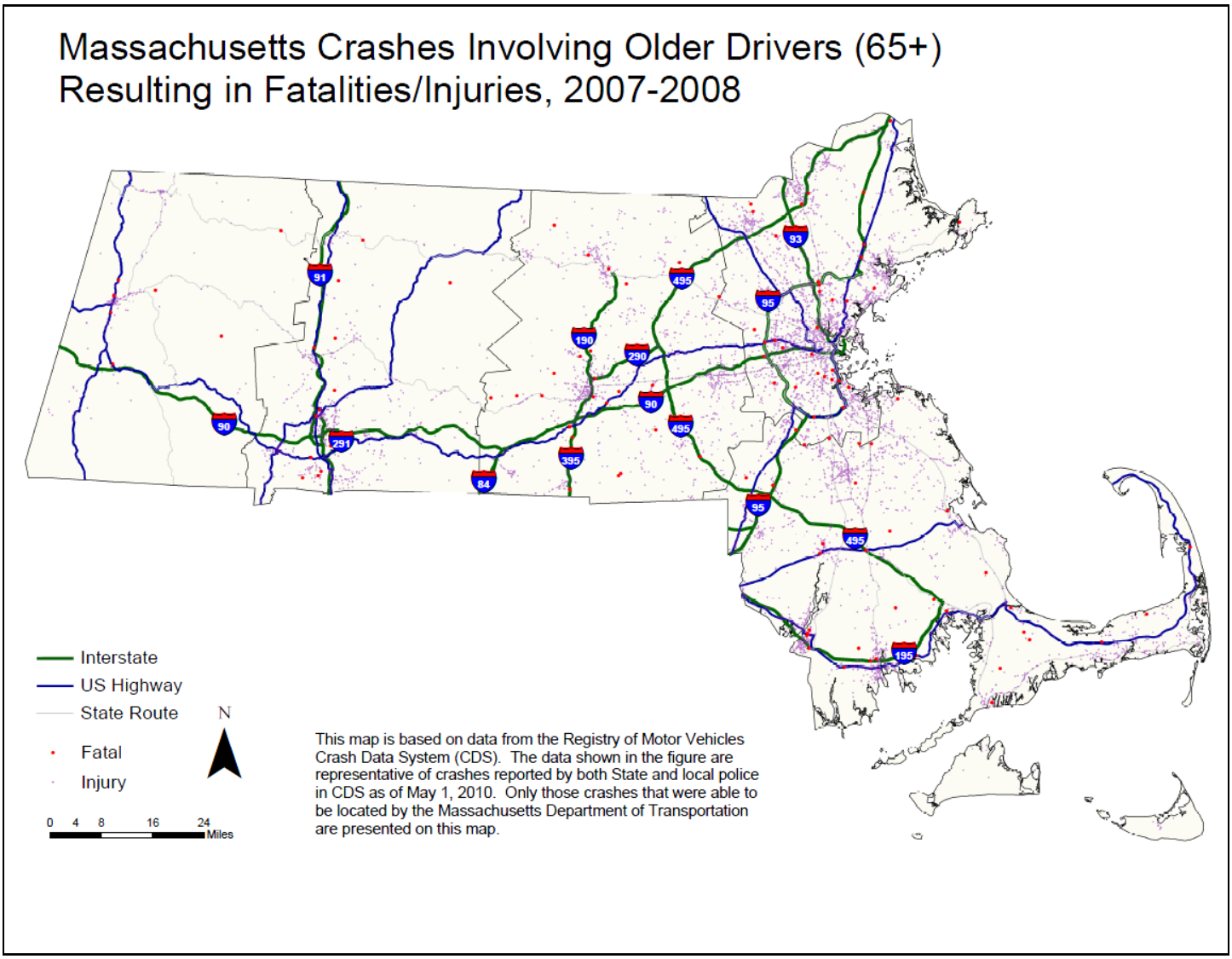


Location Analysis - II

Mapping Fatalities & Injury Crashes

Understanding where the most serious crashes involving older drivers, those involving injuries and fatalities, are occurring is an important part of devolving a solution. The map below shows the location of all crashes involving older drivers occurring resulting in injuries or fatalities in 2007 and 2008 with known locations. Crashes resulting in fatalities are represented by large red dots and crashes resulting in injuries are represented by smaller purple dots. The clustering is similar to that of the map of all crashes involving older drivers on the previous page. Older driver fatalities are clearly a problem across the state in urban, suburban, and rural communities.

In 2007 and 2008 combined there were a total of 140 fatalities of persons 65 years of age or older in Massachusetts.[1]



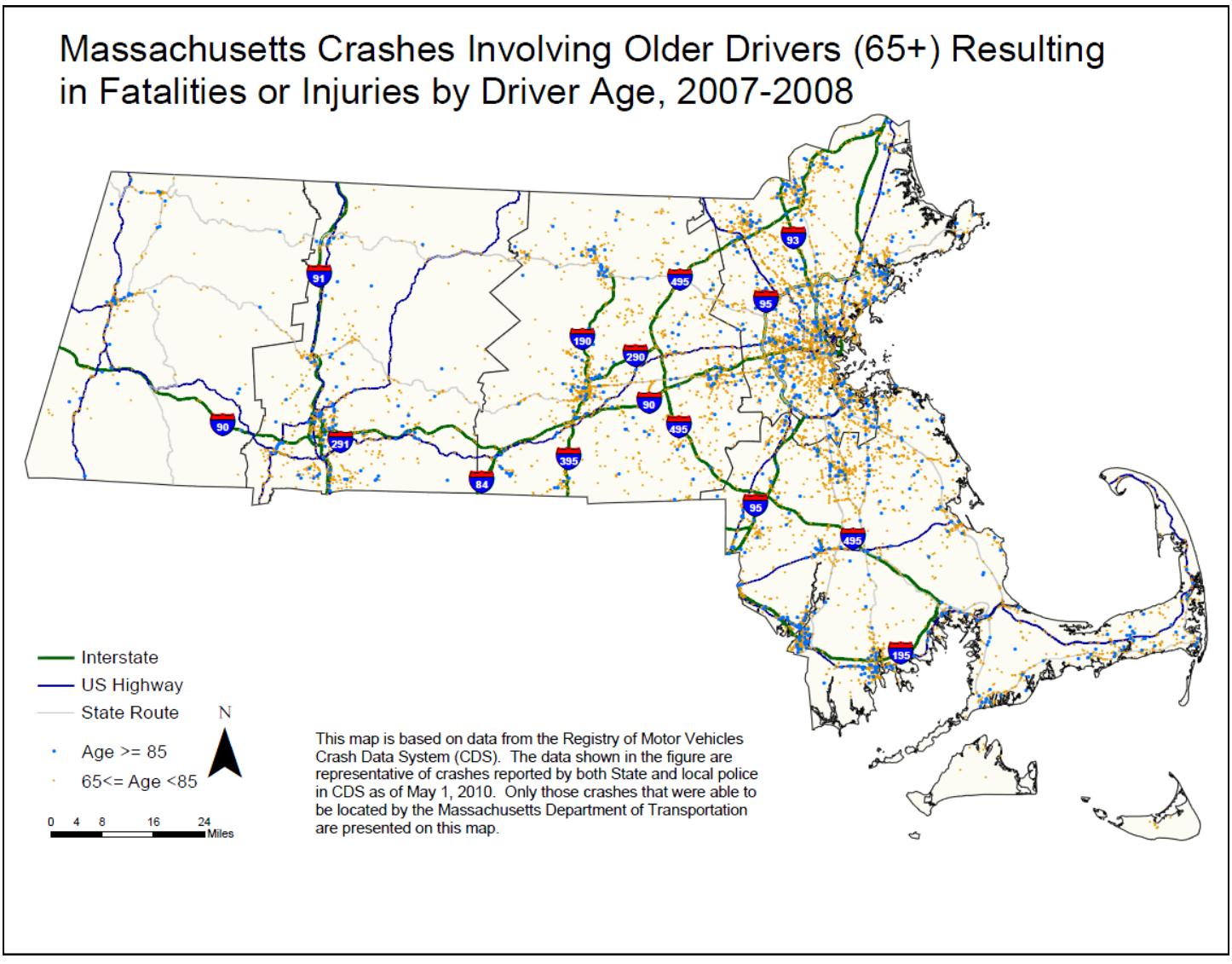
[1] National Highway Transportation Safety Administration's National Center for Statistics and Analysis

Location Analysis - III

Mapping Fatalities & Injury Crashes by Age

As drivers age increases within the older driver population their driving characteristics change. Another important step in location analysis is to analyze the older (age 65+) and oldest (age 85+) drivers separately. The map below shows the location of all crashes involving older drivers occurring that resulted in injuries or fatalities in 2007 and 2008 with known locations. Crashes resulting in fatalities or involving drivers 65 to 84 years of age are represented by large blue dots and crashes resulting in injuries or fatalities involving drivers 85 years of age or older are represented by smaller orange dots. The clustering is again similar to that of the map of all crashes involving older drivers. A more in depth spatial analysis could pinpoint specific areas with high crash rates among the older driving community.

Understanding where crashes involving older drivers are occurring will help shape the response.



Time of Day Analysis

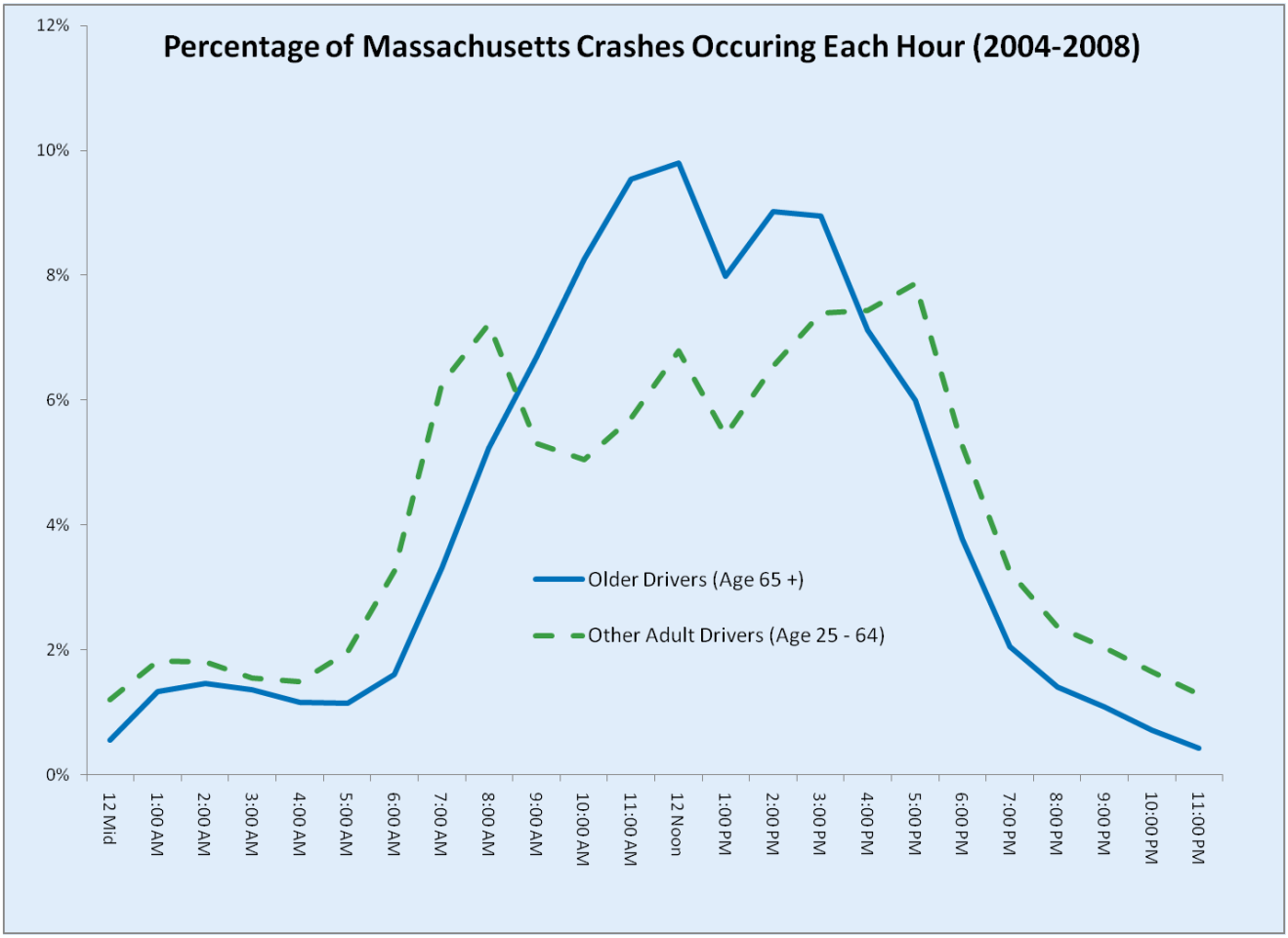
More dangerous at dusk?

Driving at dusk and after dark introduce a special set of challenges to older drivers. However, Massachusetts crash data from 2004 to 2008 suggest that most crashes involving older drivers do not occur at this time of day.

Over 50 percent of crashes involving older drivers occur between the hours of 10 AM and 3 PM. This is different than the rest of the adult population, where most crashes occur during the work day, relating to AM and PM peaks in traffic. The figure below shows the percentage of crashes occurring each hour, for the older as well as the adult driver populations.

The distribution of the older driver crashes between 10 AM and 3 PM may occur because older drivers feel most comfortable driving at this time of day. Studies have shown that the older driver population tends to self-regulate their driving, avoiding times of perceived danger such as night, dusk, and during inclement weather. The data shown in the figure below support these studies and imply that there is a potential demand for alternate transit options for seniors during these hours.

In Massachusetts, over 50% of older driver crashes occur between 10 AM and 3 PM, a relatively low crash period for the rest of the adult population.



Crash Type Analysis

Intersections Spell Danger

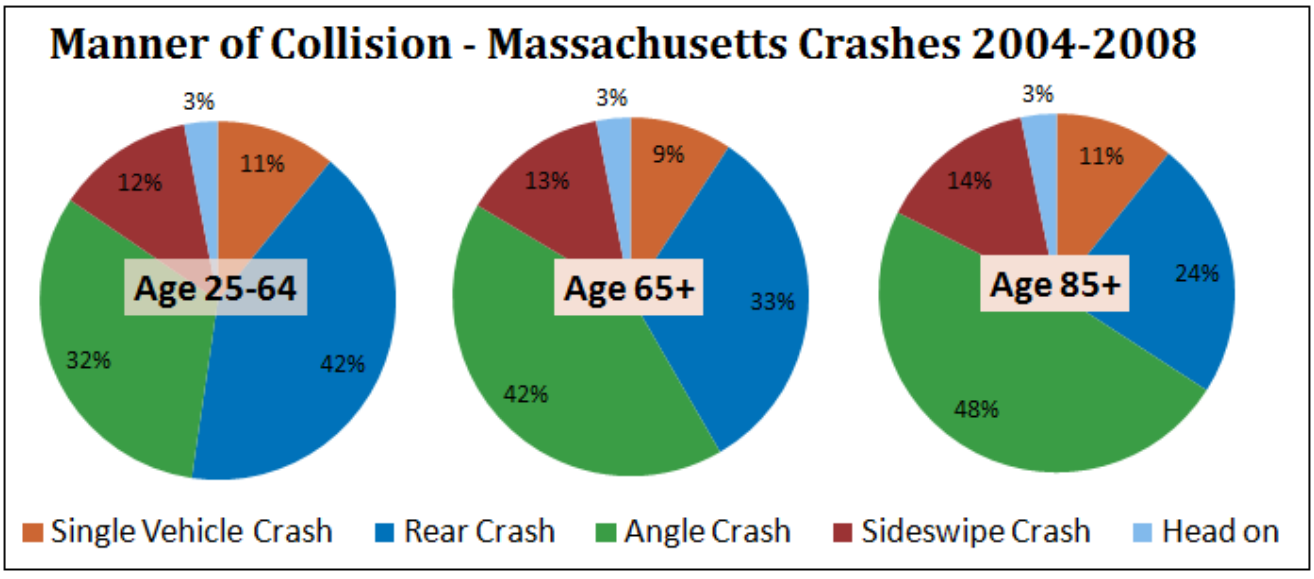
Given the diminished physical and cognitive abilities often associated with older drivers, this population tends to have difficulties navigating intersections. In Massachusetts from 2004 to 2008 this trend was reflected in the crash data. A significantly greater percentage of crashes involving older drivers occurred at intersections as compared to the rest of the adult driving population. Literature has shown that this trend is, at least in part, due to older drivers' difficulty in safely executing the left turn maneuver.

Percentage of Crashes Occurring at Intersection	
Age 25 to 64	44%
Age 65 +	50%
Age 85 +	54%

Manner of Collision

To further analyze the crashes involving older drivers it is important to examine the manner of collision. Different manners of collision are indicative of different driving behaviors and abilities. In Massachusetts from 2004 to 2008 older drivers were involved in a significantly higher proportion of angle crashes, 42% (48% of age 85+) of crashes compared to 32% for the rest of the adult population. This type of crash is often associated with drivers inability to appropriately judge gaps and respond to the actions of other drivers. Older drivers, on the other hand, were involved in a significantly lower proportion of rear crashes, 33% (24% for age 85+) of crashes compared to 42% for the rest of the adult population. This type of crash is often associated with speeding, following too closely, and driver inattention.

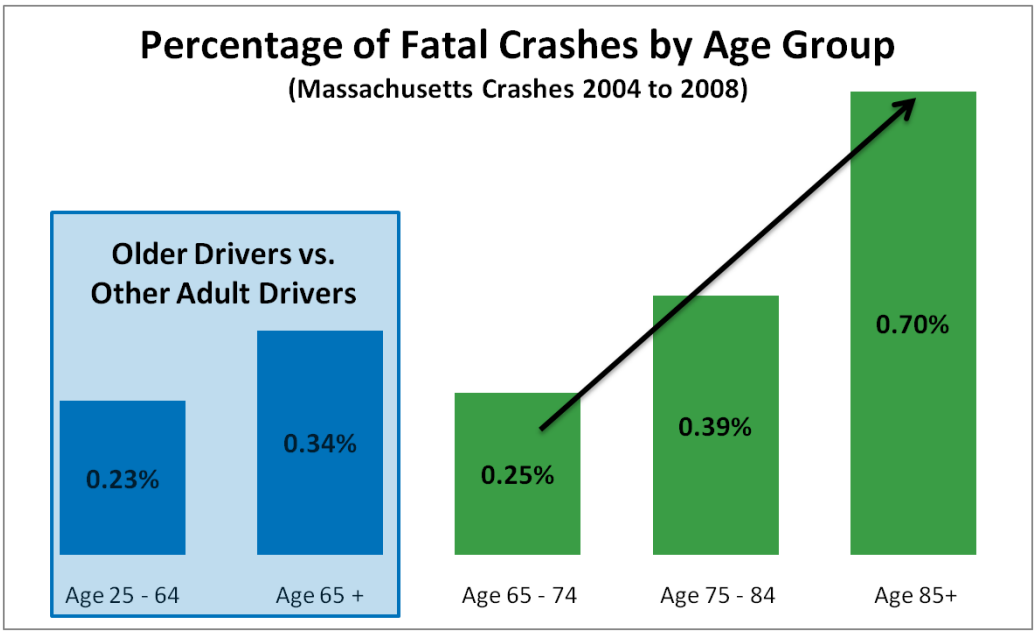
The first harmful event in 89% of reported crashes involving older driver in Massachusetts was a collision involving another vehicle. 6% involved a collision with a fixed object, and 3% involved a non-motorist.



Crash Severity

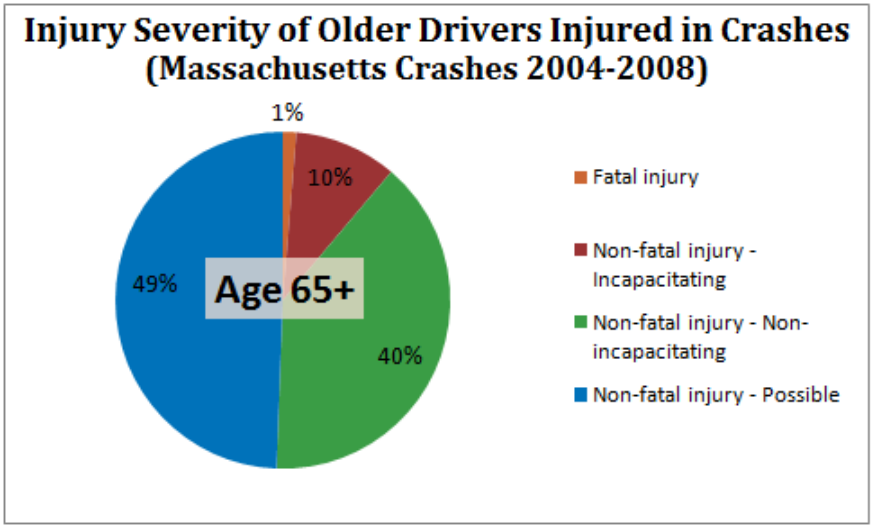
Reported Crash Severity

Reported crashes vary in severity from property damage only to non-fatal and fatal injuries. The percentage of the most severe crashes (those involving fatal injuries) is greater for older drivers (0.34 percent) than other adult drivers (0.23 percent). Additionally, this percentage increases concurrently with driver age within the older driver population, as is shown in the figure to the right.



Injuries Resulting from Crashes

Police reported crashes in Massachusetts include information regarding the injury severity of all passengers involved. Of all crashes reported in Massachusetts from 2004 to 2008, 18.4 percent of those involving older drivers resulted in injuries to the driver. The severity of these injuries is detailed in the figure below. For older drivers, 0.24 percent of all crashes were reported to have caused fatal injuries to the driver, twice the rate of other adult drivers.



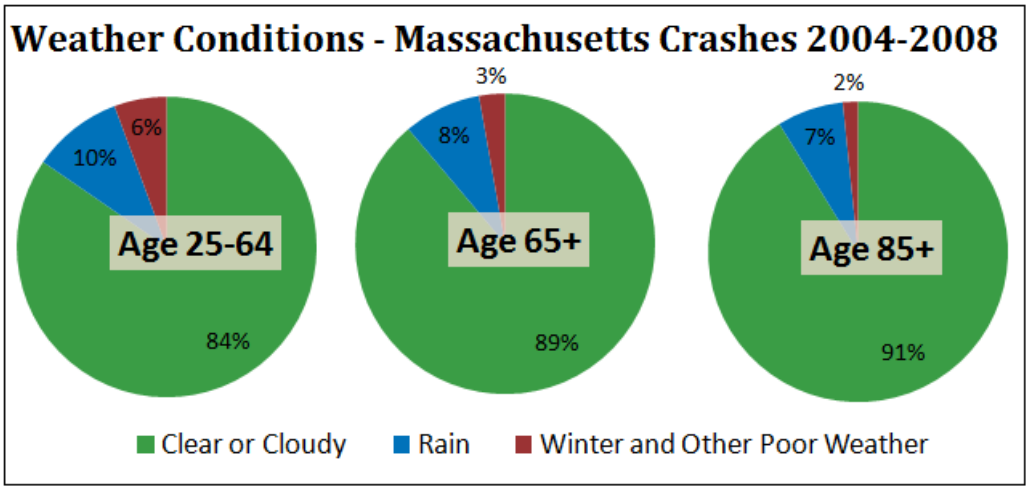
A driver 65 years of age or older is twice as likely to die in a collision as a driver age 25 to 64.

Crash Conditions

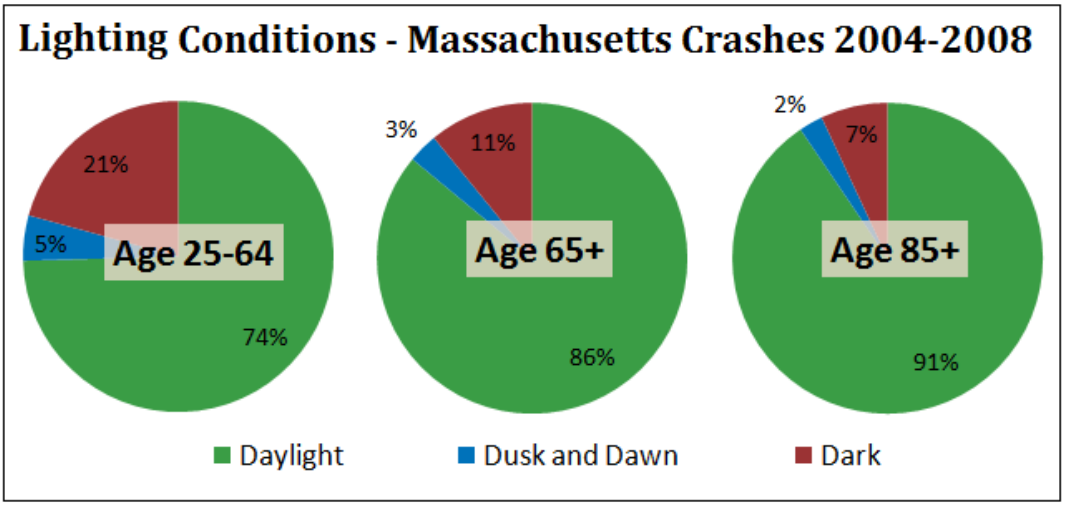
Weather and Lighting Conditions

Poor weather and lighting conditions are often contributing factors in crashes. Analyzing crashes occurring in Massachusetts from 2004 to 2008, a number of interesting trends emerge. Older drivers, especially those age 65 years of age or older, have a high percentage of crashes occurring on days with fair weather and during daylight hours. It appears that, understanding the risks of driving at night or in poor weather conditions, older drivers limit their driving to times when they feel comfortable. In fact, 78% of crashes involving older drivers in Massachusetts occur in the daylight in fair weather conditions compared to 65% of the rest of the adult population. The oldest drivers (age 85+) seem to regulate their driving even more with 84% of crashes occurring in the daylight in fair weather conditions.

78% of crashes involving older drivers in Massachusetts occur in the daylight in fair weather conditions compared to 65% of the rest of the adult population.



Less than 2.5% of crashes involving older drivers in Massachusetts occur in poor weather conditions at night.



Crash Causes

What are the Driver Factors Contributing to Crashes?

While there are a number of actions a driver can take that result in a crash, sometimes the crash happens even if the driver has taken no improper actions at all. Analyzing Massachusetts crashes from 2004 to 2008, where the contributing driver factor was noted, there are a number of trends that show the differences between driving behaviors of drivers of different ages. For the 25 –64 years old age group the percentage of drivers that were noted as taking "no improper action" was 59.2%. This percentage declined for drivers 65 years of age or older to 48.4% and even further to 32.6% for drivers 85 years of age or older. In other words, a greater proportion of older drivers took some action that contributed to the crash. Of these contributing factors many were similar across age groups. However, older drivers were noted as failing to yield right of way much more frequently than the rest of the adult driving population. Additionally, older drivers (especially those age 85 or older) were reported as showing disregard for traffic signs, signals, and roadway markings with a much greater frequency than other adult drivers. Older drivers were less likely to be noted as following too closely, exceeding the authorized speed limit, driving too fast for conditions, or operating the vehicle in erratic, reckless, careless, negligent or aggregative manner.

Top Driver Contributing Factors Leading to Crashes by Age Group in Massachusetts, 2004 - 2008
(by percent of crashes with known driver factor)

Age 25 - 64	
No improper action	59.2%
Inattention	7.8%
Failed to yield right of way	7.0%
Followed too closely	5.6%
Failure to keep in proper lane or running off road	3.1%

Age 65+	
No improper action	48.4%
Failed to yield right of way	15.0%
Inattention	11.2%
Followed too closely	4.2%
Disregarded traffic signs, signal, or road	4.0%

Age 85+	
No improper action	32.6%
Failed to yield right of way	21.3%
Inattention	14.8%
Disregarded traffic signs, signal, or road	5.5%
Followed too closely	4.0%

Older drivers are reported as showing disregard for traffic signs, signal, and roadway marking with a much greater frequency than other adult drivers in crashes in Massachusetts. This is likely due, at least in part, to driver confusion surrounding the meanings of these guides and an inability to respond to them in a appropriate and timely manner.

umass Safe Traffic Safety Research Program

These factsheets were compiled by researches at the University of Massachusetts Amherst through the UMassSafe Traffic Safety Research Program. We would like to thank the MassDOT, particularly the Registry of Motor Vehicles Division, for their support of this project.

Appendix B: Summary of CODES Analysis

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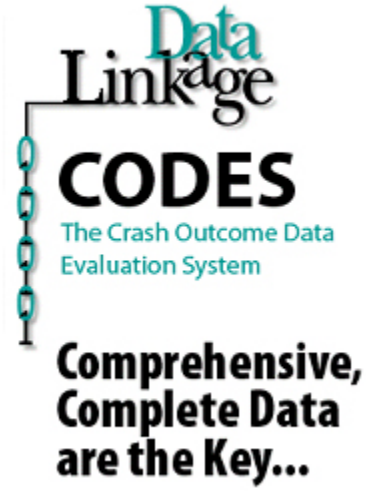
Crashes Involving Older Drivers and Associated Charges Using Massachusetts CODES Data



OVERVIEW

Research has shown that due to their fragility, older persons involved in a crash are more likely to sustain injuries. Massachusetts crash and hospital data for 2005 were linked using probabilistic linkage methodologies through the use of the Crash Outcome Data Evaluation System (CODES) program. This analysis focused on further examination of this issue through several tasks listed below:

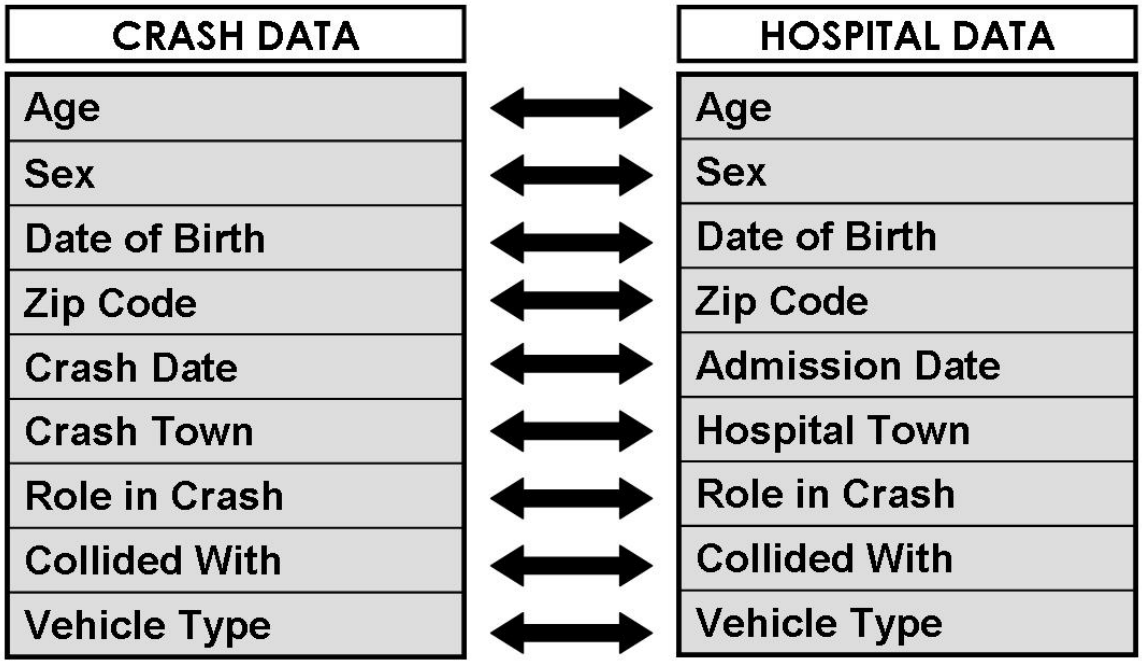
1.) linkage of crash and hospital data;
2.) assessment of charges associated with treatment of injuries sustained by older vehicle occupants in both emergency department and inpatient settings;
3.) evaluation of payer source for older vehicle occupants; and
4.) compilation of results so they may be used by policy makers for benefit cost analysis and other decision making processes.

Traditionally, analysis of crashes has been centered upon the use of police-reported information collected on state-specific crash report forms. However, events surrounding a crash are more complex than the data on a crash report form can accurately record. Ideally, data should cover the events immediately preceding a crash, the characteristics of the crash itself, and the outcomes associated with the crash. The CODES Program, which was developed and funded by the National Highway Traffic Safety Administration (NHTSA), links data collected at the crash scene to hospital databases that contain specific injury data. This program provides an enhanced understanding of crash injury outcomes by tracking crash victims through the health care system. Massachusetts CODES data includes crash, hospital, and emergency department data. These data were analyzed to examine injury outcomes of crashes involving older drivers, considering emergency department and inpatient charges, and length of stay.

CODES PROCESS

CODES employs probabilistic linkage in order to link datasets that have common information but no common unique identifier. Although the linkage requires person-level records, due to confidentiality issues, unique identifiers such as social security numbers are not provided with hospital data. As a result, the probabilistic linkage strategy is based on the probability that if two records match within similar fields across data sets, the records that match are the same person. Crash characteristics (e.g., time, location, objects struck), person characteristics (e.g., age, sex), and vehicle characteristics (e.g.. type of vehicle) that are common across data sets can be used to identify people within large datasets.
Figure 1 outlines the fields used for the Massachusetts linkage.

Figure 1: Fields used for Massachusetts CODES Linkage



By using the CODES dataset, charges associated with the treatment of injuries sustained by vehicle occupants in older driver crashes were examined. Older vehicle occupants were defined as those age 65 to 98. The comparison group of vehicle occupants involved in older driver crashes was the age group 25 to 49. Due to the insufficient number of inpatient records, focus was placed on emergency department charges. It should also be noted that only those vehicle occupants who were injured in the crash are included in the CODES dataset. However, there may have been occupants involved in the crash who were not injured and thereby were not included in the assessment.

EXAMINATION OF PRIMARY PAYER SOURCE

Additionally, because primary payer source data is included in health care data, it can be obtained through the use of CODES linked data. Since older persons are often insured by public insurance programs, payer source is perhaps more critical for an evaluation of older drivers than any other age group. As such, payer source for injury treatment in older driver crashes was examined and an overview of the charges billed to public and/or private insurance programs was developed. The following payer sources are included in health care data and were classified, as shown in Table 1.

Table 1: Categorization of Payer Types in Health Care Data

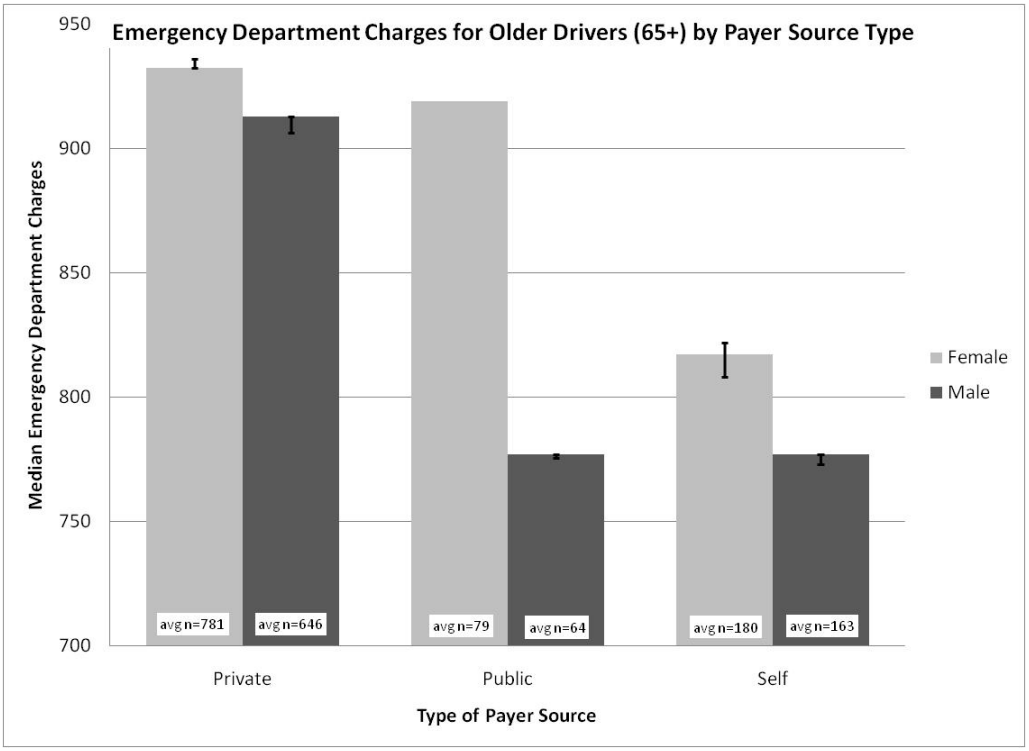
Payer Type	Payer Type Category
Self Pay	Self Pay
Workers Comp	Private
Medicare	Public
Medicare Managed Care	Public
Medicaid	Public
Medicaid Managed Care	Public
Other Government Payment	Public
Blue Cross	Private
Blue Cross Managed Care	Private
Commercial Insurance	Private
Commercial Managed Care	Private
Health Maintenance Organization	Private
Free Care	Public
Other Non-Managed Care Plans	Private
PPO and Other Managed Care Plans not Elsewhere Classified	Private
Point-of-Service Plan	Private
Exclusive Provider Organization	Private
Auto Insurance	Private
None	None

EMERGENCY DEPARTMENT CHARGES FOR OLDER DRIVERS BY PAYER SOURCE TYPE AND SEX

Having examined emergency department charges for older drivers by payer source type and sex, several notable findings emerged. The first was that while older drivers are eligible for Medicare, the great majority of those included in the analysis dataset were associated with private insurance; public insurance accounted for the fewest cases of the three payer source types, including self-pay.

The second notable finding was that for all three payer source types, median emergency department charges associated with female older drivers were significantly higher than the emergency department charges for males in the same payer source type. Additionally, for all three groups, more females were injured than males. For older drivers under private payer types, the difference between male and female median charges was statistically significant, but small ($933 for females and $913 for males). The difference between median emergency department charges for males and females was far greater for those using public payer sources ($919 for females and $777 for males). This may be due, in part, to the smaller sample size for public payer source cases; however, the more notable difference between females and males covered by public payer sources is still worthy of further consideration. Figure 2 provides an overview of findings.

Figure 2: Emergency Department Charges for Older Drivers by Payer Source Type



When conducting the same analysis for the comparison group, the results were different. Like the older drivers, most of the cases included in the analysis dataset were associated with private payer source. However, unlike the older drivers, males had significantly higher median emergency department charges for private and self-payer source types. This is especially interesting for cases involving private payer sources where more females were injured than males, yet the median emergency department charge was lower for females than for males. Interestingly, for cases involving public payer sources females had higher emergency department charges.

As shown in Figure 3 and Table 6, for all combinations of payer source and sex except self-pay males, median charges for older drivers were higher than for comparison drivers. In some cases, such as males with public payer sources, the difference between the older driver and comparison groups, though significant, were less notable. For other groups, such as females with private payer source, the difference was far more noteworthy. For all three payer source types, the difference between female older and comparison drivers was greater than the difference between male older and comparison drivers.

Figure 3: Emergency Department Charges for Older and Comparison Driver Groups

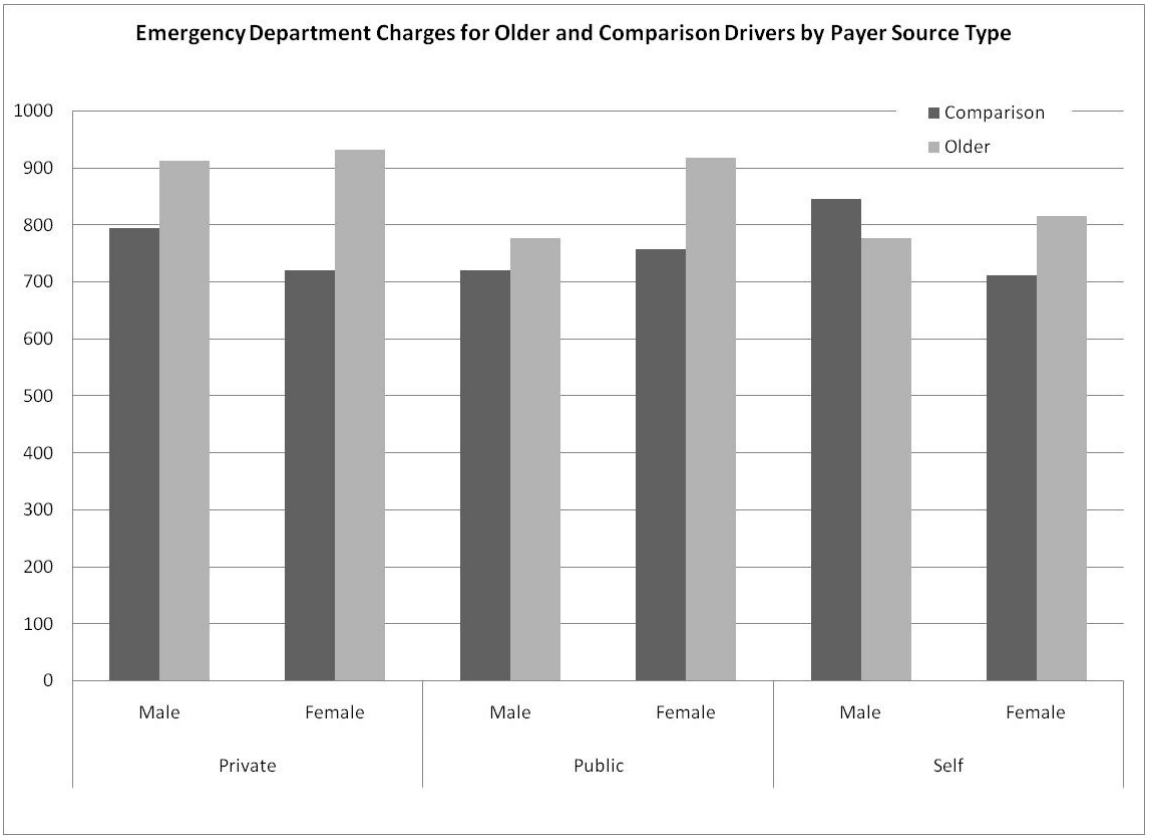


Table 9: Median Emergency Department Charges for Comparison and Older Drivers by Sex and Payer Source

Payer Source Type	Sex	Median		25th Percentile		75th Percentile	
		Comparison	Older	Comparison	Older	Comparison	Older
Private	Male	$796.00	$913.00	$794.50	$906.50	$796.00	$913.00
	Female	$722.00	$932.50	$721.00	$932.50	$722.00	$936.00
Public	Male	$722.00	$777.00	$721.00	$775.50	$727.00	$777.00
	Female	$759.00	$919.00	$759.00	$919.00	$760.00	$919.00

Summary of Findings from CODES Analysis

The probabilistic linkage of crash and health care data and subsequent analysis of the resulting dataset yielded several statistically significant findings. Generally speaking, they pointed to less notable differences across payer sources between the older driver and comparison groups than might have been expected given the availability of public insurance

for older drivers. The results also pointed to noteworthy differences between charges associated with males and females:

- Though many older drivers are eligible for public insurance (e.g., Medicare), the great majority of older drivers included in the analysis dataset were covered by private insurance.
- For all three payer source types (private, public, and self), a greater number of older female drivers were injured than older male drivers and the median emergency department charges for females were higher than for males. This is different than for the comparison group, where more females were injured than males but the median emergency department charges were higher for males than for females (except when covered by a public payer source).
- Median emergency department charges were higher for older drivers than for the comparison drivers for all combinations of payer source and sex except for self-pay males. For all three payer sources, the difference in median emergency department charges for the older drivers versus comparison drivers was greater for females than for males.

Appendix C: Summary of Program Details Evaluated

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- Program Background:
    - Service Type: Description of type(s) of service provided including fixed route, paratransit (demand-response), specialized paratransit, or a combination of types
    - Description: Brief description of program
    - Organizational Status: Categorization as government run, not-for-profit, or for-profit
    - Location: Description of location of service
    - Founded in: Year the program was founded (years of continual operation)
- Service Summary:
    - Riders Served: Description of who has access to services whether it is open to all segments of the population or limited to groups such as older adults or persons with disability
    - Type of Assistance: Description of types of services provided such as curb-to-curb, door-to-door, door-thru-door, stay at destination, or escort
    - Service Area: Description of make-up of service area including urban, suburban, rural, or a combination
    - Coverage Area: Estimate of geographic area serviced
    - Days of Operation: Description of whether the service is provided during the week, on the weekend, or both
    - Hours of Operation: Description of whether the service runs 24 hours, during extended business hours, or only during standard business hours
- Operational and Financial Summary:
    - Annual Budget: Estimate of annual budget for most recent year on record
    - Primary Funding Source: Description of where the majority of funding comes from including government subsidies, government grants, non-user donations, user fees/donations, or contracts with other agencies
    - Rider Fee Structure: Description of whether fees are collected or if donations are recommended or accepted
    - Average Rider Payment: Estimate of average rider payment
    - Type of Driver: Description of whether drivers are paid, volunteers, or a combination of the two
    - Type of Vehicle: Description of vehicle ownership whether it is owned by the program, the driver, or the rider
    - Fleet Size: Description of the type (mini-bus, van, sedan, etc.) and number of vehicles currently in service
- Measures of Success:
    - Ridership: Ridership estimates for the most recent year on record
    - User Feedback: Any noteworthy feedback from system users as supplied by the service provider, often collected through customer satisfaction surveys or testimonials