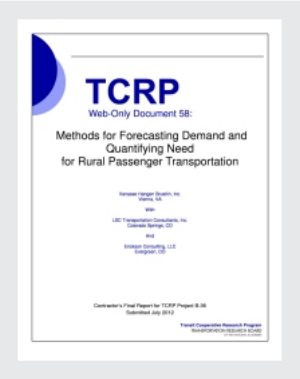


Methods for Forecasting Demand and Quantifying Need for Rural Passenger Transportation

DETAILS

0 pages | 8.5 x 11 | PAPERBACK
ISBN 978-0-309-43456-0 | DOI 10.17226/22618

AUTHORS

Vanasse Hangen Brustlin, Inc.

Table of Contents

Executive Summary ES-1
Need ES-2
Demand ES-3
General Purpose Rural Passenger Transportation ES-3
Demand for Rural Public Transportation (not market specific) ES-3
Program Trips ES-4
Small-City Fixed Route ES-4
Commuters from Rural Counties to Urban Centers ES-4
Introduction 1
Background 1
Research Objectives 2
Approach to Research 4
Review of prior work 4
Discussions with practitioners 5
Identification of data sources 5
Methods Development 7
Phase I 7
Analysis and Findings in Phase I 7
Need 8
Average Daily Trip Rates for Rural Households 10
Need Related to Population Characteristics 10
Mobility Gap 22
Demand – Phase I Analyses 23
Travel on Public Systems 24
State Level Analysis 25
Program or Sponsored Trips 32
Small City Fixed Route Service 38
Commuter Trips 44
Workshops 48
Purpose 48

Organization 48
Workshop planning 48
Locations and attendance 48
Venues 49
Syllabus 50
Course Materials 52
Results of Workshops 52
Data Obtained 52
General Public Rural Transit (Non-Program Trips) 54
Program (sponsored) Trips 55
Small City Fixed Route 55
Commuters from Rural Area to Central City 55
Findings 56
Phase II 57
Analysis and Findings 57
Need 57
Demand 59
Travel on Public Systems 59
Program (sponsored) Trips 73
Small-City Fixed Route 76
Development of Final Demand Function 78
Correlation of variables 78
Commuters from Rural Counties to Urban Centers 82
Recommend Practice 87
Need 87
Demand 88
General Purpose Rural Passenger Transportation 88
Program Trips 88
Small-City Fixed Route 88
Commuters from Rural Counties to Urban Centers 89
Demand for Rural Public Transportation (not market specific) 89
Future Research Needs 89
Appendix A – A Note on commuting data from ACS vs. LEHD 91

List of Figures

Figure 1: Census Divisions 9
Figure 2: National Average Daily Trips per Rural Household by Age 11
Figure 3: Division 7 Average Daily Trips per Rural Household by Age 12
Figure 4: National Average Daily Trips for Rural Households by Poverty Level 13
Figure 5: Division 6 Average Daily Trips for Rural Households by Poverty Level 13
Figure 6: Division 7 Average Daily Trips for Rural Households by Poverty Level 14
Figure 7: National Average Daily Trips for Rural Households by Age and Income 16
Figure 8: Average Daily Trips for Rural Households by Age and Vehicle Ownership 17
Figure 9: National Average Daily Trips for Rural Households by Income and Vehicle Ownership 18
Figure 10: National Average Daily Trips for Rural Households by Age and Poverty for Households with 0 Vehicles 19
Figure 11: National Average Daily Trips for Rural Households by Age and Poverty for Households with 1 Vehicle 19
Figure 12: National Average Daily Trips for Rural Households by Age and Poverty for Households with 2 or more Vehicles 20
Figure 13: Average Daily Rural Person Trips by Age 21
Figure 14: Average Daily Rural Person Trips by Age and Vehicle Ownership 21
Figure 15: Rural Annual Regular Unlinked Transit Trips per Capita, by State (2006 NTD) 26
Figure 16: Rural Regular plus Coordinated Transit Trips per Capita, by State (2006 NTD) 27
Figure 17: Rural Transit Trips vs. Rural Vehicle-Miles 28
Figure 18: Rural Trips per Capita vs. Vehicle-Miles of Service Provided 28
Figure 19: Rural Transit per Capita vs. Rural Population Density 29
Figure 20: Rural Transit per Capita vs. Rural Transit per Rural Roadway Mile 29
Figure 21: Rural Transit Trips vs. Rural Vehicle-Hours of Service 30
Figure 22: Rural Trips per Capita vs. Vehicle-Hours of Service 30
Figure 23: Template for Estimation of Individual Program Transit Demand 37
Figure 24: Ridership vs. Revenue-Hours of Service 41
Figure 25: Ridership vs. Revenue-Hours per Capita 42
Figure 26: Ridership vs. Student Population (no student pass program) 42
Figure 27: Ridership vs. Student Population (with student pass program) 43
Figure 28: Relationship between Total Commuter Trips and Commute Trips Using Transit 46
Figure 29: Daily Trip Rates for Rural Households (NHTS, 2009) 58
Figure 30: Percentage of Mobility Gap Met vs. County Population 58
Figure 31: Comparison of Reported General Public Demand vs. Estimate Based on Report 3 Function 60
Figure 32: Comparison of Reported General Public Demand vs. Estimate Based on Trips per Vehicle-Mile 61
Figure 33: Comparison of Reported General Public Demand vs. Estimate Based on Trips per Vehicle-Hour 61
Figure 34: Comparison of Reported General Public Demand vs. Estimate Based on Trips per Vehicle-Hour per Capita 62
Figure 35: Reported Ridership vs. Estimated Demand (function derived from workshop data) 63
Figure 36: Residuals of Estimated Demand Plotted Against Service Density 64
Figure 37: Annual Unlinked Trips vs. Vehicle-Miles (2009 Rural NTD 50% sample) 65
Figure 38: Annual Unlinked Trips vs. Vehicle-Miles (2009 Rural NTD 50% sample) 65
Figure 39: Annual Unlinked Trips vs. Population in Poverty (2009 Rural NTD 50% sample) 66

Figure 40: Annual Unlinked Trips vs. Population in Age 60+ (2009 Rural NTD 50% sample) 66
Figure 41: Trip Need vs. Regular Trips Served (2009 NTD) Need < 2,000,000..... 69
Figure 42: Trip Need vs. U + C Trips Served (2009 NTD) Need < 2,000,000 69
Figure 43: Regular Unlinked Trips Reported vs. Computed Trip Need (2009 NTD) Log Scale..... 70
Figure 44: Annual Unlinked plus Coordinated Trips Reported vs. Computed Trip Need (2009 NTD) Log Scales; Need < 1,000,000 70
Figure 45: Observed vs. Estimated for General Public Demand Function based on 2009 NTD 71
Figure 46: Observed vs. Estimated for General Public Demand Function based on 2009 NTD; Observed < 30,000 72
Figure 47: Small-City Fixed Route, Demand reported by Workshop participants vs. Estimate Using Phase 1 Function 76
Figure 48: Observed vs. Estimated; Phase 1 Small-City Fixed-Route Demand Function vs. Data Reported in the 2009 Rural NTD 77
Figure 49: Observed vs. Estimated; Small-City Fixed-Route Demand Regression Using 2009 NTD Data... 78
Figure 50: Estimated Fixed-Route Demand vs. Reported Demand 80
Figure 51: Fixed-Route Estimated Residuals compared with Reported Demand..... 81
Figure 52: Fixed-Route Estimated Residuals compared to Reported Demand (Annual Trips < 100,000) .. 81
Figure 53: Percent of Commuters using Passenger Transportation – Rural County to Urban Center 85
Figure 54: Residual Analysis – Percent of Commuters Using Passenger Transportation 86

List of Tables

Table 1: States included in Census Divisions 9
Table 2: Daily Trip Rates for Rural Households by Census Division (2001 NHTS) 10
Table 3: Average Daily Trips for Rural Households by Vehicle Ownership 15
Table 4: Mobility Gap based on 2001 NHTS 23
Table 5: Rural Passenger Trips per Capita 27
Table 6: Records in Dataset Used for Commuter Trip Analysis 45
Table 7: Workshop Locations and Attendance 49
Table 8: Workshop Schedule and Syllabus 51
Table 9: Workshop Attendees Providing Data about General Public (non-program) Trips 54
Table 10: Correlation of General Public Ridership with Other Factors (data from workshop attendees) 63
Table 11: Correlation of Unlinked Trips with Other Factors (National and by Census Division) 67
Table 12: Correlation of Unlinked plus Coordinated Trips with Other Factors (National and by Census Division) 68
Table 13: Comparison between program trips reported by workshop attendees and program trip estimates using the TCRP methodologies 73
Table 14: Comparison between program trips reported through other projects and program trip estimates using the TCRP Report 3 methodology 74
Table 15: Correlation of Demand reported for Small-City Fixed-Route Services in 2009 Rural NTD Data vs. Other Factors 79
Table 16: Correlation of Demand reported for Small-City Fixed-Route Services in 2009 Rural NTD Data vs. Other Factors 80
Table 17: Correlation Analysis – Percent of Commuters Using Passenger Transportation vs. Other Factors 84
Table 18: Mobility Gap by Census Division (based on 2009 NHTS) 87

Author Acknowledgments

This research was conducted under TCRP Project B-36 by Vanasse Hangen Brustlin (VHB). Mr. Frank Spielberg of VHB was the Principal Investigator. The other contributors to the project and authors of this report are Mr. Stephen Corey Pitts of VHB, Ms. Jenny Goldschmidt of VHB, Mr. Albert T. Stoddard of LSC Transportation Consultants (LSC), Ms. Tangerine Almeida of LSC, Mr. Robert Jones of LSC, Mr. Gordon Shaw of LSC, and Jeanne Erickson of Erickson Consulting.

Abstract

This report documents the development of methods for use by planners in rural areas and operators of rural passenger transportation systems to quantify the need for passenger transportation services and the demand that is likely to be generated if passenger transportation services are provided. The methods for estimating need are of two types – the number of persons likely to have a need for passenger transportation and the number of trips that would be required to provide persons lacking a personal vehicle with a level of mobility equal to those having access to a personal vehicle. The methods for estimating demand address four specific markets – general public rural passenger transportation, passenger transportation specifically related to social service or other programs, travel on fixed-route services in micropolitan areas, and travel on commuter services from rural counties to urban centers. The methods were developed using data from the Rural National Transit Database (2006, 2009, and 2010), the National Household Transportation Survey (2001 and 2009), the American Community Survey (various years) and the Longitudinal Employment-Household Dynamics dataset as well as data on services operated and ridership on those services provided by over 200 individuals who participated in workshops held in a dozen states in 2010 and 2011.

The report documents the process used by the research team in developing the need and demand estimation methods, the findings of the analyses, and recommendations for functions to be used in estimation of need and demand.

Executive Summary

Transit Cooperative Research Program Project B-3 completed in 1996 conducted analysis of the demand for rural passenger transportation services based on detailed data on the services provided, and the use of those services, collected from thirty-nine rural counties across the nation chosen to be representative of nine groupings of counties. The product of that study was *TCRP Report 3, Workbook for Estimating Demand for Rural Passenger Transportation*. Over the period since the publication of *Report 3* there have been changes in rural transportation. The nature of some human service programs have changed, federal legislation has established a requirement for the preparation of Coordinated Public Transit Human Service Transportation Plans, and information on rural service provided and used is now reported annually to the Rural National Transit Database (Rural NTD). Given these new issues and data sources, Project B-36 was initiated to see if it would be possible to develop new methods that better reflected the diversity of conditions under which rural transit is provided across the nation and that could address markets not considered in *Report 3*.

In Phase 1 of this project, completed in 2009, national datasets, including the Rural NTD for reporting year 2006, the year 2000 decennial census, the 2005-2007 American Community Survey, and the 2001 National Household Travel Survey, were used to identify factors that could serve as indicators of the need for passenger transportation service and to explore the possibility of developing functional relationships between the characteristics of the population, transportation service provided, and the demand for transportation service. While practical relationships were developed using the newly available data it was not clear that the methods developed were, for the same markets, significantly better than those in *Report 3*. Possible relationships were developed for two new markets.

Based on these findings Phase 2 of the project was structured to include outreach to train staff from agencies with responsibilities for planning or transportation in rural areas in the use of the proposed methods to quantify need and estimate demand for passenger transportation services. As part of the Phase 2 work, new agency and county level data were to be collected that could be used to develop refined relationships. During the interval between the completion of Phase 1 and the analysis of data collected at the workshops, three new national level datasets became available. These were the 5-year American Community Survey (ACS) for the years 2005-2009; the 2009 National Household Travel Survey, and the 2009 Rural NTD. In Phase 1 the project team had noted that the 2006 Rural NTD lacked any information about the areas served by the reporting systems which made it difficult to associate any demographic data with the observed patterns of demand. In the 2009 Rural NTD information was included that permitted associating demographic information from the ACS with service and demand data from the NTD. This has permitted development of more satisfactory functional relationships.

This report documents work efforts and findings of both phases of the project.

A general finding is that the national level data sources have improved substantially in completeness and robustness to support development of fully satisfactory functions for estimating need or demand. Using the data available from national sources and the workshop participants, methods have been developed, and are reported, for estimating:

- Need - two procedures are suggested
    - A value based on the number of people likely to have a need for passenger transportation
    - A value based on the number of trips that would have to be served to meet all needs
- Demand - procedures for four market segments are suggested
    - Use of public (i.e., Section 5311 funded) services
        - Non-program (general public) trips only
        - All trips using 5311 funded services
    - Number of program or sponsored trips
    - Demand for fixed rural service in small urban towns in rural areas.
    - Commuters from rural areas to central cities

Need

For the **estimation of need**:

- **Number of persons in need** = population residing in households with income below the poverty line + population residing in households having no personal vehicle
- **Trip Need** = Households having no personal vehicle x Mobility Gap

The Mobility Gap is defined as the difference between the daily trip rate for rural households having one personal vehicle and rural households having no personal vehicle. Basing the gap on households having one vehicle rather than one or more vehicles yields a more conservative estimate of the gap. These rates by Census Division based on the 2009 National Household Travel Survey are:

Mobility Gap by Census Division (based on 2009 NHTS)

Census Division	States	Mobility Gap Trips per Day
National		1.5
Division 1:	ME, VT, NH, MA, CT, RI	1.7
Division 2: Middle	NJ, NY, PA	1.3
Division 3: East North Central	WI, MI, OH, IN, IL	1.4
Division 4: West North Central	ND, SD, NE, KS, MO, IA, MN	1.7
Division 5: South Atlantic	MD, DE, WV, VA, NC, SC, GA, FL	1.2

Census Division	States	Mobility Gap Trips per Day
Division 6: East South Central	KY, TN, AL, MS	1.4
Division 7: West South Central	OK, AR, TX, LA	2.0
Division 8: Mountain	ID, MT, WY, CO, UT, NE, AZ, NM	0.8
Division 9: Pacific	WA, OR, CA, AK, HI	1.1

Demand

For the **estimation of demand** methods are suggested for four markets –use of public services general purpose rural non-program trips, program trips, small city (micropolitan) fixed-route, and commuters from rural counties to urban centers. An additional method is suggested for demand (all market types) for rural public transportation systems defined as those systems eligible for reporting to the National Transit Database.

General Purpose Rural Passenger Transportation

Non-program Demand (trips per year) = (2.20 * Population age 60+)
+ (5.21 * Mobility Limited Population age 16 to 64)
+ (1.52 * Residents of Households having No Vehicle)

In this equation the Mobility Limited Population is taken to mean those defined in Census reports as those having Independent Living Difficulty.

Demand for Rural Public Transportation (not market specific)

The following function, developed using data from the Rural National Transit Database for Reporting Year 2009 and data from the American Community Survey for the three years ending in 2009, makes use of the estimate of need, measured in the number of trips and a measure of the amount of service provided.

Annual Demand on Rural Public Services = 2.44 * (Need$^{0.028}$) * (Annual Vehicle-miles$^{0.749}$)

Need is computed using the Mobility Gap method described above. Annual vehicle-miles of service may be either the miles currently being operated or the number planned to be operated. This method can be used to estimate how demand (ridership) is likely to change as service is expanded or reduced.

A general estimate of the demand for service can be made using:

Rural Transit Trips = 0.2 trips per rural vehicle-mile
or
Rural Transit Trips = 3.7 trips per rural vehicle-hour

The analysis of that productivity measured by trip rates per unit of service provided based on the Rural NTD shows little variation of a wide range of service provided. This suggests that demand is limited by service provided and that increasing service would, in most cases, result in concomitant increases in demand.

Program Trips

For trip demand related to specific social service programs the recommended practice involves not a specific function or equation but rather a method that is based on obtaining information from the agencies that operate the programs. The information to be obtained includes:

- Number of program participants
- Number of days per week that the program meets
- Number of weeks per year that the program meets
- Proportion of registered participants who attend on a typical day
- Proportion of participants that require transportation service

Small-City Fixed Route

Annual Unlinked passenger trips = 5.77 x Revenue-Hours of Service + 1.07 x Population + 7.12 x College Enrollment

This function will work best for systems that provide 70 or fewer vehicle-hours per day.

Commuters from Rural Counties to Urban Centers

The recommended method for estimating demand is:

Proportion using Transit for Commuter Trips from Rural County to Urban Place =

0.024 + (0.0000056 * workers commuting from the rural county to the central place) – (0.00029 * distance in miles) + 0.015 if the central place is a state capital

Demand (trips per day) = Proportion using transit x number of commuters x 2

The number of commuters can be obtained from the state transportation agency, the Metropolitan Planning Organization for the urban center, or the Bureau of the Census Longitudinal Employer-Household Dynamics website, http:/lehd.did.census.gov/led/.

Introduction

Background

TCRP Report 3, the product of TCRP Project B-3, published in 1995 presented a methodology for Estimating Demand for Rural Passenger Transportation. The methodology of Report 3 built upon previous studies from the 1970s and 1980s and original data collection and analysis. In the decade following the publication of TCRP Report 3 the methodology was considered for and applied in multiple locations. Some users of the methods found them to be satisfactory; others reported that the forecasts did not match their expectations or were for other reasons not suitable for their desired uses. A few researchers developed alternative methods to be used in specific situations.

Project B-36 began with a specific scope to improve upon or develop new methods for estimating need and quantifying demand for passenger transportation in rural areas. The study was envisaged as a single phase effort in which data would be assembled, relationships analyzed, methods developed and tested, and reports prepared. Over time the project evolved into a two phase effort in which the second phase included development of training materials, the presentation of a dozen workshops to train prospective users, and use of data obtained from workshop attendees to further improve the methods.

Before embarking on the data collection and analysis tasks of the TCRP Project B-36 effort to prepare *Methods for Forecasting Demand and Quantifying Need for Rural Passenger Transportation* a review was conducted of activities related to forecasting of passenger transportation need and demand in rural areas that have been undertaken since the completion *Report 3*. Work related to forecasting of rural need and demand that had occurred since 1995 was reviewed and documented. Conversations were held with 17 individuals who are knowledgeable in the field of rural passenger transportation to discuss their experience with the TCRP methodology and other methodologies, to identify the features of the various methods that they liked or thought essential and those that they found difficult or unnecessary; and probed for the attributes of a new methodology that they would find most useful or appropriate. Those impressions and needs were considered relative to the various extant forecasting methodologies. A listening session was held in October 2008 at the National Rural Transit Conference in Omaha, NE.

One comment heard about the Report 3 methods was that they were based on a limited, and probably outdated, dataset; other more recent data that had become available and on which an enhanced methodology could be based were explored. Some of these data were used to prepared new relationships. Another comment was that new markets had emerged that were not treated in the Project B-3 methodology – particularly work trip commuting from rural counties to urban centers. An approach to assessing demand for the commuting market was developed.

In addition, a methodology for assessing "*need*" as well as "*demand"* was proposed.

Based on the review of the literature and the discussions with both experts and potential users of the methodology, a framework for the procedures to be developed in TCRP B-36 was proposed. The methodologies described were developed in accord with those procedures and presented to the project panel in July 2009. The panel approved the work done but suggested the improved methods might be further refined if additional data were obtained. To obtain additional data, and at the same time to

introduce the methods for forecasting demand and quantifying need for rural passenger transportation to a wider audience, the panel proposed conducting a series of Workshops across the nation followed by new analyses of the data to see if enhanced methods could be developed.

In the second phase of the project, the project team arranged for and presented one-day workshops in twelve states to train prospective users (e.g., rural transit agency planner and managers, rural planning agency staff) in the use of the proposed methods for estimating need and demand for passenger transportation services in rural areas. As an ancillary purpose of the workshops was to gather further data about the uses of transit services in rural areas relative to the amount of service provided and the characteristics of the service area, the attendees at the workshops were asked to provide information about the services operated and used by their agencies and/or services operated, and the use of those services, by all providers of transit in the area in which they worked. Those data were then used to test the demand estimation relationships developed in Phase 1 and to develop improved relationships.

The workshop-based data gathering phase of the project ended in summer 2011. At about the same time the Rural NTD data for 2009 were released. In Phase 1 of the project, the team had noted that the Rural NTD data were difficult to use for analysis of demand relationships because no information was provided about the geographic areas served by each reporting agency making it impossible to associate demographic data from the Census with the information about service provided and trips made as reported in the NTD. In the 2009 data, released in fall of 2011, a list of the counties served by each agency was provided. This enabled the association of demographic and service data which, in turn, supported an enhanced analysis of general public demand in rural communities and development of improved methods.

The methods for assessing need and estimating demand for passenger transportation services in rural areas proposed in this document represent a synthesis of work reported in *TCRP Report 3*, the data collection and analysis of Phase 1 of the study, and the enhanced data collected in Phase 2 supported by data from the 2009 Rural NTD. For those having interest in or responsibilities for rural passenger transportation the suggested methods provide a starting point for a systematic analysis of local needs and of the demand that can be expected if a given amount of service is provided. As with any forecasting methodology there will be a range of error associated with the projections. Those making use of the methods should recognize that the forecasts are estimates of what might be expected in a typical county having the characteristics applied to the forecasting methods. The actual need or demand in a specific county will vary from the mean expectation and users should apply local knowledge and judgment to assess how applicable the estimates are to the area under study.

Research Objectives

Initial work on estimating demand for rural passenger transportation was published in 1995 in *TCRP Report 3*. In the ensuing years, not only has the nature of rural public transit and human services transportation changed but also there has been increased emphasis on coordination of services in order to control costs while making better service options available to potential patrons.

With increased emphasis on coordination and increased investment in rural public transit by SAFETEA-LU, investigations are being conducted into rural transit need and the demand for human services transportation in rural areas. Many of these plans have made use of *TCRP Report 3* methods of demand

projection. Limitations of the *TCRP Report 3* methodology include development based on a sample of 39 counties, the exclusion of needs estimates for service planning and future funding purposes, and limited applicability to sub-county areas.

An accurate and reliable estimation tool for rural public transit and human services transportation demand was needed to support the development of coordination plans for rural localities throughout the United States as required by SAFETEA-LU. The objective of the research is build upon the work documented in *Report 3* to develop an updated estimation tool that will give local decision makers better information to allocate and coordinate scarce transportation resources to address local passenger transportation mobility needs.

The overall objectives of this research are to:

1. Provide improved methods for forecasting rural passenger-transportation demand, and

2. Develop methods for quantifying passenger-transportation needs.

In Phase 1 the work was focused on the use of national level data sources to see if stable relationships could be developed and if the data suggested or supported the use of methods or values that varied by geographic area. In Phase 2 additional funding was made available so that the work could include an effort to obtain and use detailed data from a large number of rural transportation agencies while concurrently creating a knowledgeable user base by exposing the methods to a large number of potential users.

The recommended methods include two procedures for assessing need, suggestions for data collection techniques to support appropriate analyses, demand-forecasting methods for four identified markets, and other components needed for an effective process for forecasting rural passenger-transportation demand and quantifying passenger-transportation needs.

Approach to Research

Review of prior work

The project began with a review of previous work in the topic of the need and/or demand for rural passenger transportation. This included not only the work presented in *TCRP Report 3* but also published documents reporting on work conducted by others in the intervening years.

This included:

- Casavant, Painter, Washington State Transportation Center, Washington State University, University of Washington, Demand Forecasting for Rural Transit, June 1999, Washington
- BRW Inc, Region 10 Transit Development Program, 2000-2006 (Appendix), June 1999, Colorado
- Thole, Harvey, Florida Department of Transportation, Update Methodology for ADA Demand Estimates: Lessons Learned, July 2005
- Attaluri, Seneviratne, Javid, Journal of Transportation Engineering, Modeling Demand for Public Transit Services in Rural Areas, 1997
- Mobility Gap Method, Stoddard and Donahue, Proceedings of the 7th National Conference on Transportation Planning for Small and Medium-Sized Communities, Transportation Research Board, Use of Mobility Gap to Quantify Rural Transportation Needs

These various reports were examined with a view to understanding the deficiencies perceived in the *Report 3* methods that led the authors to develop alternative procedures and the ways in which the authors had sought to overcome those deficiencies. Among the issues identified were:

- Social service program categories used in the TCRP workbook do not always correspond to programs in the specific state.
- There is a lack of county level data available to estimate annual vehicle miles by population subgroup in the specific state.
- Overestimation of demand for systems that charge a fare.
- The *Report 3* method is data intensive; employment and poverty levels have changed since 1990, and allows for some overlap and potential double-counting.
- State required a methodology with greater focus on ADA services.
- *Report 3* method failed to account for transit services in small towns and cities in rural counties.

Discussions with practitioners

Conversations were held with 17 individuals knowledgeable in the field of rural passenger transportation in which the project team discussed their experience with the TCRP methodology and other methodologies, identified the features of the various methods that they liked or thought essential and those that they found difficult or unnecessary; and probed for the attributes of a new methodology that they would find most useful or appropriate. The team related these impressions and needs to the various extant forecasting methodologies. In addition a listening session was held in October 2008 at the National Rural Transit Conference in Omaha, NE in which participants were asked to state what properties they thought would be desirable and/or essential in improved methods for estimating the need and demand for rural passenger transportation.

One comment heard about the previous methodology was that it was based on a limited, and probably outdated, dataset; other more recent data had become available and on which an enhanced methodology could be based were explored. Some of these data have been used to prepare new relationships. Another comment was that new markets had emerged that were not treated in the *Report 3* methodology – particularly work trip commuting from rural counties to urban centers. In response an analysis to develop a method for assessing demand for the commuting market was incorporated in the work program.

Identification of data sources

Following the review of other research and the discussion with practitioners, including several members of the project panel, it was determined that a useful product would provide methods for the analysis of need and of demand related to four specific markets – general public rural passenger transportation, program related trips, fixed-route services in micropolitan areas, and commuters from rural counties to urban centers. In keeping with the desire to develop methods that would provide consistency in both analysis and eventual application, data sources were sought that would be readily available and contained information for all areas of the nation. Data sources were then identified that could be used to explore the relationships related to each area.

For analysis of **need** it was determined that two types of data would be required; data documenting the number of persons in groups likely to require passenger transportation services, and data about the rates of trip making for these various groups in order to better understand the characteristics that revealed a need. Data from the year 2000 decennial Census and the American Community Survey were identified as the source for information about the number of persons in groups likely to have needs while the 2001, and subsequently 2009, National Household Transportation Surveys were identified as the data source for information about the trip rates of households and persons in populations having needs.

Analysis of **demand** was conducted by market. For the *general public rural transportation* market the Rural National Transit Database (Rural NTD) was identified as a source that covered the entire nation and had a uniform reporting format. At the time of Phase 1 of the study, the most recent Rural NTD data were those for the 2006 reporting year. For the *program related market* no standardized dataset was available. Data collected as part of other studies done by the project team were identified as a reasonable source. For the *micropolitan fixed-route* market the Rural NTD supplemented by readily

available information from other sources thought to have a bearing on the use of small-city fixed route services were identified as the data sources. Ultimately, data on college and university enrollment from The College Board (www.collegebaord.com) were used for analyses related to this market. For the commuters from rural counties to central place market the journey-to-work information from the 2000 decennial Census was identified as a source for county-to-county commuter trips by mode. Data from the Census were also used to determine whether a given county should be treated as rural or as an urban central place. Other information, such as the distance between counties could be determined from easily available sources (e.g., Google Maps). However, no sources were identified that would provide consistent information about passenger transportation services available to commuters; the fares charged for such services; and the ease of commuting (travel time, parking cost and availability) as a driver or member of a carpool.

By the time the analysis efforts in Phase 2 of the project were initiated the Rural NTD for reporting year 2009, and subsequently reporting year 2010, became available. These sources included information about the areas served by rural transportation systems not available in the 2006 Rural NTD and proved to be quite valuable for development of the recommended methods.

Methods Development

Phase I

Analysis and Findings in Phase I

The following principles were established to guide the development of the new methodologies:

- Need – is defined as both the number of people in a given geographic area likely to require a passenger transportation service and the number that would have to be served in order that the population in need could make as many trips as those who have access to personal vehicles. The methodology is based on using demographic data from the American Community Survey (ACS), the survey that superseded information that in the 2000 U.S. Census and previous years had been collected on the "long form." A Mobility Gap estimate, based on the National Household Transportation Survey has also been developed that may be used to estimate the magnitude of the additional number of trips needed to be served so that residents of households owning no personal vehicle could achieve the same level of mobility as automobile owning households. Mobility gap rates have been developed by Census Division to provide some information reflecting differences across the various portions of the nation.

- Demand – is defined as the number of trips that are likely to be made over a given period within a given geographic area for a given price and level of service. The procedures for preparing forecasts of demand have been stratified by market and consist of:

    - Travel on public (i.e., 5311 funded) systems
        - Analysis has been based on data from the Rural NTD. This category includes all trips made on a public system regardless of service type (e.g., fixed-route, route-deviation) or who pays for the trip.

    - Program or sponsored trips
        - The rates reported in Project B-3 are retained. These have been modified or expanded when sufficient information from other sources was available. The number of categories has been reduced.

    - Small city fixed route service
        - A small city is defined as an urban place having a population less than 50,000 within rural county. Demand forecasts reflect a methodology that relates annual trips per capita to service measured in vehicle hours. The presence of a college or university was also found to contribute to small city ridership. A term reflecting college or university enrollment is included in the demand estimation function. The rates are based on analysis of data from the rural and urban NTD augmented by US Census data, and information gathered from other sources.

- Commuters from rural communities to central cities
  - A methodology for estimating the demand for transit has been developed using year 2000 Census Journey-to-Work data. For future application other methods based on the American Community Survey or state based travel forecasting models are supplied.

Need

Determination of the demographic groups that should be used to define need for passenger transportation services was considered by comparing the trip rates of all rural households and of persons resident in rural households to those of households or persons resident in rural households that met specific criteria. The finding that the average daily trip rate for households having a certain characteristics was significantly less than the trip rate for households not having that characteristic is viewed as an indicator of transportation need. For example, as discussed below, the trip rate for rural households having no personal vehicle is significantly lower than the rate for rural households having one personal vehicle.

Using 2001 National Household Travel Survey (NHTS) data, average daily trip rates for rural households were analyzed. The analysis addressed reported daily trips for rural households in the nation as a whole and for each of the nine Census Divisions. The analysis addressed the trip rates for rural households related to:

- All Rural Households
- Age of Household Residents
- Income (as a percent of poverty level)
- Vehicle Ownership
- Age by Income
- Age by Vehicle Ownership
- Income by Vehicle Ownership
- Age by Income by Vehicle Ownership

Census divisions were selected as the geographic unit for analysis in order to gain insight into possible variations in trip rates by region of the nation. The number of samples collected in the NHTS proved to yield too few observations to permit analysis by state.

Figure 1 illustrates the states included in each Census Division.

Figure 1: Census Divisions

The list of states in each division is shown in Table 1.

Table 1: States included in Census Divisions

Division 1, New England	Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island
Division 2, Middle Atlantic	New Jersey, New York, Pennsylvania
Division 3, East North Central	Wisconsin, Michigan, Ohio, Indiana, Illinois
Division 4, West North Central	North Dakota, South Dakota, Nebraska, Kansas, Missouri, Iowa, Minnesota
Division 5, South Atlantic	Maryland, Delaware, West Virginia, Virginia, North Carolina, South Carolina, Georgia, Florida
Division 6, East South Central	Kentucky, Tennessee, Alabama, Mississippi
Division 7, West South Central	Oklahoma, Arkansas, Texas, Louisiana
Division 8, Mountain	Idaho, Montana, Wyoming, Colorado, Utah, Nevada, Arizona, New Mexico
Division 9, Pacific	Washington, Oregon, California, Alaska, Hawaii

Average Daily Trip Rates for Rural Households

The average daily trip rate for all rural households was calculated nationally and for each of the nine Census Divisions (Table 2). The national average daily trip rate per household is 9.0. The largest deviations from the national average are in Division 6: East South Central (Kentucky, Tennessee, Alabama, Mississippi) with 8.2 trips per household and Division 9: Mountain (Idaho, Montana, Wyoming, Colorado, Utah, Nevada, Arizona, New Mexico) with 9.8 trips per household.

Table 2: Daily Trip Rates for Rural Households by Census Division (2001 NHTS)

Division	Average Trips Per Rural Households	Sample Size
National	9.0	17,260
Division 1: New England	9.2	327
Division 2: Middle Atlantic	9.0	4,223
Division 3: East North Central	9.5	5,578
Division 4: West North Central	9.3	1,116
Division 5: South Atlantic	8.5	1,648
Division 6: East South Central	8.2	1,520
Division 7: West South Central	8.4	1,701
Division 8: Mountain	9.8	300
Division 9: Pacific	8.7	847

Sample sizes in some of the Divisions were small. As households are stratified by age, income, and vehicle ownership, the number of valid samples in each stratum decreases. It is also important to be aware of the sample sizes when comparing trip rates across Divisions, as the trip rates calculated from small samples may not accurately represent the travel behavior of the population of the Division.

Need Related to Population Characteristics

Need was defined above as the number of people in a given geographic area likely to require a passenger transportation service. The data from the NHTS could be used to determine the number of people in various population segments living in rural households who made use of a passenger transportation service, but that would be representative of only those who lived in locations where service was available and the density of service in those areas; in essence, the demand in those areas. To determine what population data readily available to state and local agencies should be used for assessing *need*, the average daily trip rates for households having specific characteristics were examined. The supposition is that substantial differences in the observed trip rates for households having a personal vehicle – and thus the ability to travel as they wish – and those that do not have such access, indicates a population in need of passenger transportation.

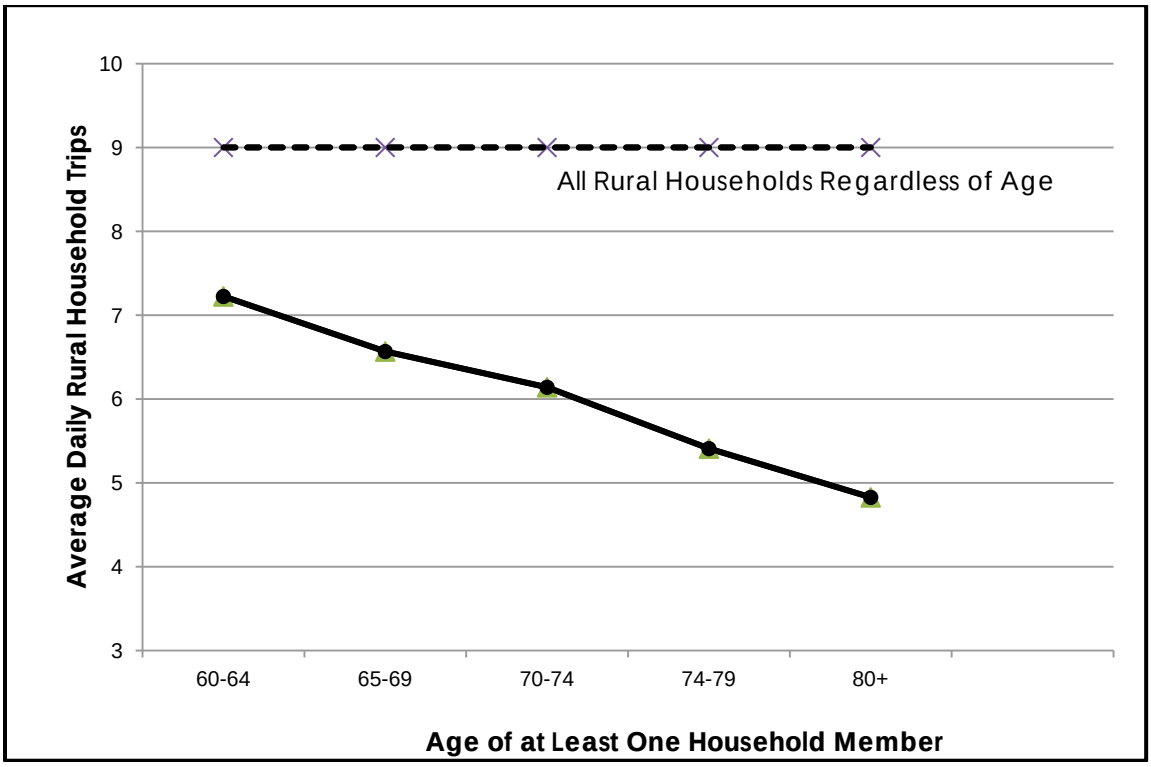
Age of Household Resident

The average daily trips for households with a household member age 60 to 64, 65 to 69, 70 to 74, 74 to 79, and 80 and older were determined. The age 85 and older group was initially included; however, these sample sizes in some of the Divisions were too small to yield valid results. For example in Division 1 there were only nine households in the sample with a household member age 85 and older. For consistency sake, this age group was not included in the analysis for any of the Divisions.

Nationally, the average daily trips per household steadily declines from age 60 to 64 (7.2 trips per household) to age 80 and older (4.8 trips per household) as shown in Figure 2.

There is a broad range of trip rates by age across the Divisions. For households with household members age 60 to 64, the average daily trip rates range from 9.8 in Division 1 (New England) to 5.8 trips in Division 8 (Mountain). For households with household members age 80 and older, the average daily trip rates range from 6.2 in Division 1 (New England) to 3.4 trips in Division 4 (West North Central).

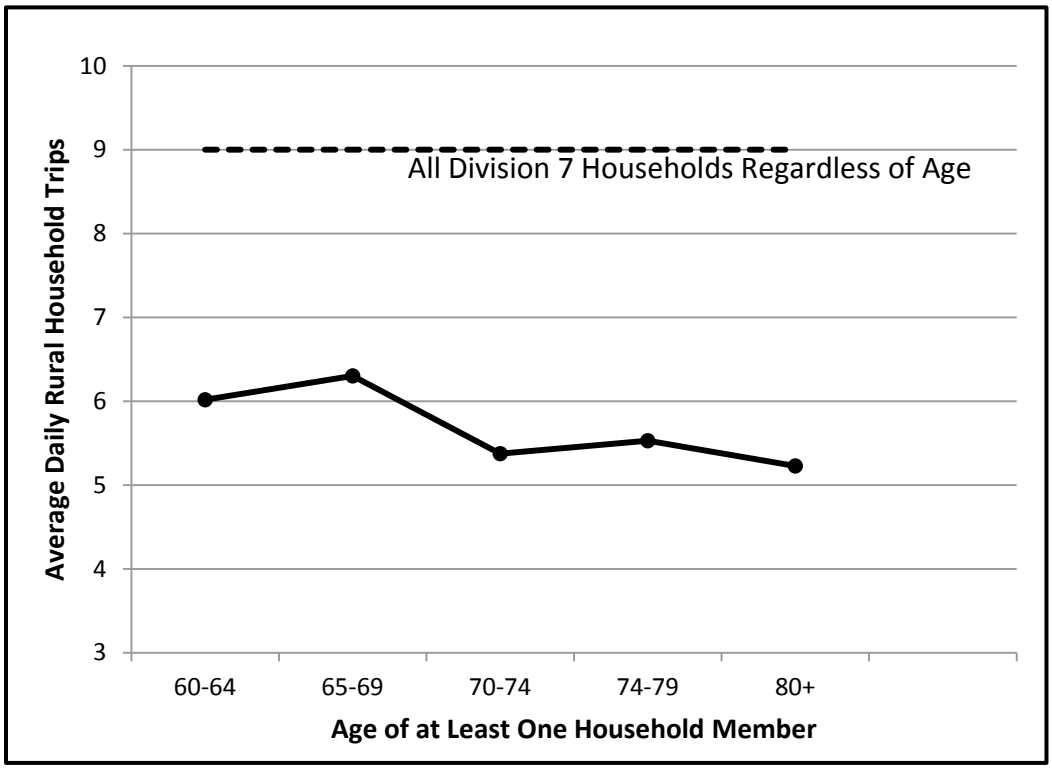
Figure 2: National Average Daily Trips per Rural Household by Age



The trip rate by age for Division 2 (Middle Atlantic), which has the same average daily trip rate of 9.0, for all rural households, closely follows the national trend. The average daily trips per household steadily declines from age 60 to 64 (7.4 trips per household) to 80 and older (4.8 trips per household). Conversely, the average daily trip rate for all rural households in Division 7 (West South Central) has

relatively little variation from ages 60 to 80. As shown in Figure 3, the trip rate only declines from 6.0 trips for households with members age 60 to 64 to 5.2 for households with members age 80 and older.

Figure 3: Division 7 Average Daily Trips per Rural Household by Age



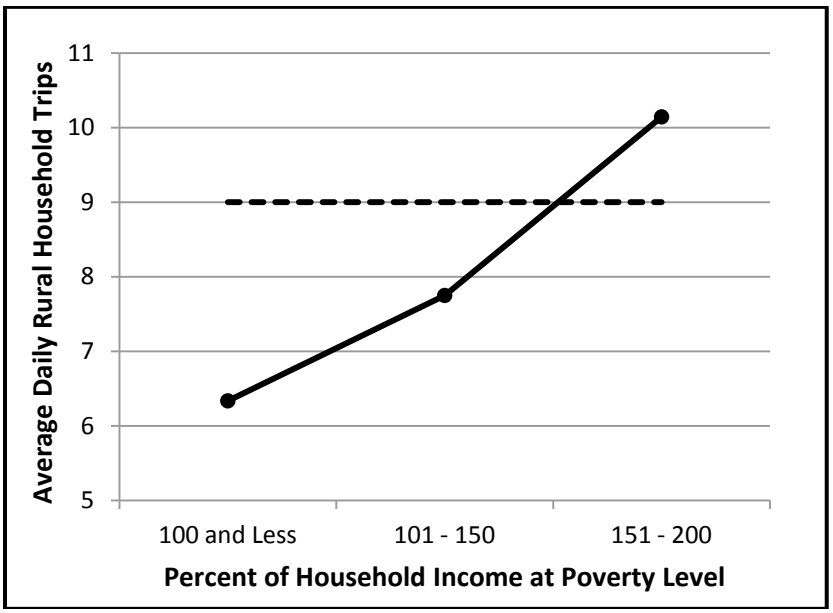
These data suggest that households with elderly members constitute a population group that have a need for a passenger transportation service. However, further analysis presented later in this section suggests that the situation is not that simple. In fact, other factors including income and availability of a personal vehicle are apparently of greater importance in establishing need.

Income

The average daily trips for rural households by income, as a percent of poverty level, were determined for 100% and below, 101% to 150%, and 151% to 200% at the poverty level (Figure 4).

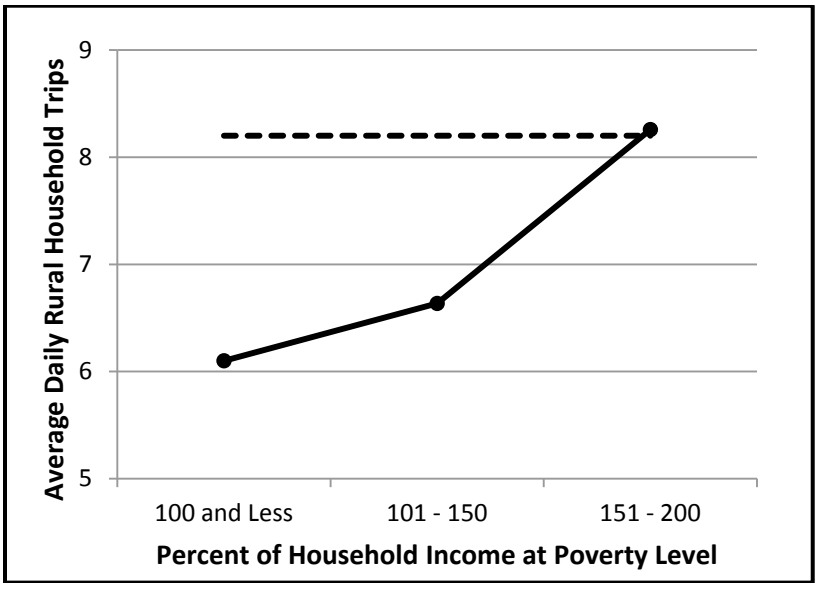
Nationally, the average rate of daily trips per households at or below poverty (100% poverty level) of 6.3 trips is well below the average daily household trips for all households of 9.0 trips. The number of average daily household trips increases as income increases. Households with an income of 151% to 200% of the poverty level have daily trip rates above the average rate for all households (Figure 4).

Figure 4: National Average Daily Trips for Rural Households by Poverty Level



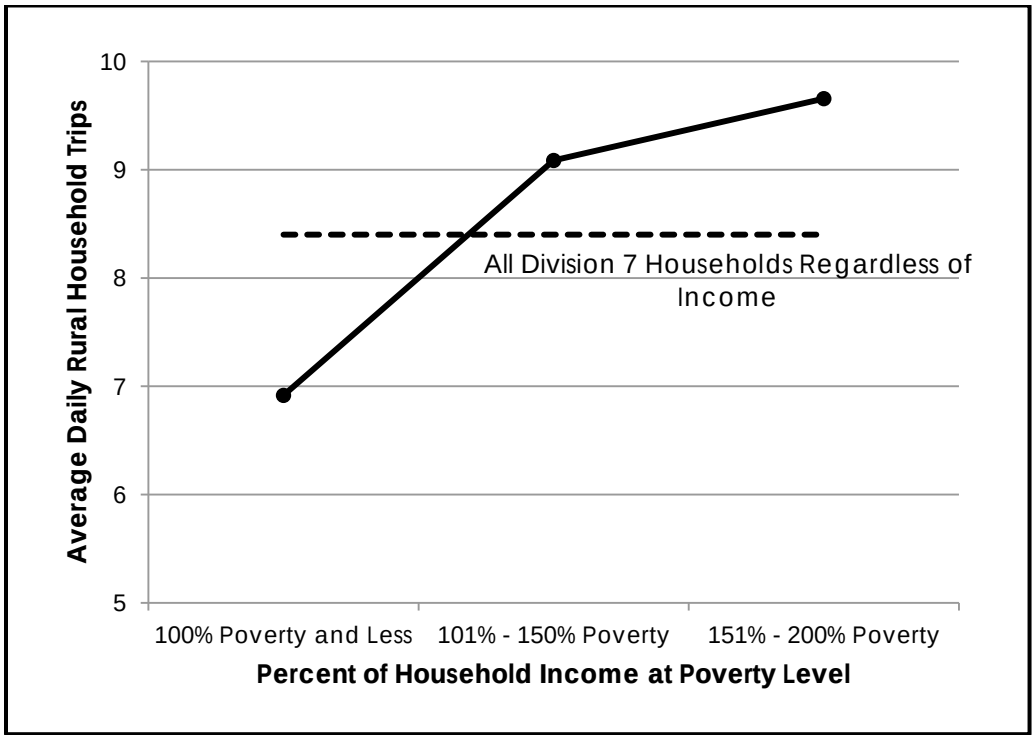
The general trend of lower daily trip rates for households at 100% or less of the poverty level holds true across all Census divisions. The pattern is less consistent across divisions for households with higher incomes. In Division 6 (East South Central) the daily trip rate for households with incomes in the range of 151% to 200% of the poverty level is essentially the same as the Division average (Figure 5).

Figure 5: Division 6 Average Daily Trips for Rural Households by Poverty Level



For Division 7, (Figure 6) the average daily trips for households with incomes of 100% of the poverty level and below are less than the Division average. However, for household incomes in the range of 101% to 150% and 151% to 200% of the poverty level the daily trip rates are greater than the Division average. For Division 8, the average daily trips for all of the poverty levels are above the Division average. However, the trip rates are based on very small sample sizes, and therefore should be discounted as representative of the travel behavior of the Division.

Figure 6: Division 7 Average Daily Trips for Rural Households by Poverty Level



Vehicle Ownership

Availability of a personal vehicle to rural households is a significant indicator of the need for passenger transportation service. The average daily trip rates for rural households by household vehicle ownership with households with 0, 1, or 2 or more vehicles were determined from the survey data for the nation and for each Census Division. Nationally, the average daily trips per rural household steadily increase as vehicle ownership increases. The average daily trip rate for households with 0 vehicles is 3.3 trips, for households with 1 vehicle is 5.4 trips, and for households with 2 or more vehicles, 10.1 trips. Trip rates by vehicle ownership for each Division are shown in
Table 3. The average daily trip rate for rural households with 0 vehicles is far below the average daily trip rate for all households for all Divisions. The one exception is Division 1. The trip rate for households with 0 vehicles in Division 1 is based on a sample size of only 9 households, and therefore may not be an accurate representative of the travel behavior of the Division. The average daily trips per household for

rural households with 2 or more vehicles are above the average daily trips per households for all households in the Division.

Table 3: Average Daily Trips for Rural Households by Vehicle Ownership

Division	Number of Vehicles Per Household			Division Average
	0	1	2 or more	
National	3.3	5.4	10.1	9
Division 1: New England	**	5.3	10.1	9.2
Division 2: Middle Atlantic	3.1	5.9	10.3	9
Division 3: East North Central	3.3	4.9	10.4	9.5
Division 4: West North Central	2.3	5.1	10.3	9.3
Division 5: South Atlantic	3.1	5.5	9.5	8.5
Division 6: East South Central	3.1	4.9	9.2	8.2
Division 7: West South Central	3.7	5.2	9.4	8.4
Division 8: Mountain	5.2	6.4	10.7	9.8
Division 9: Pacific	3.3	5.8	9.8	8.7

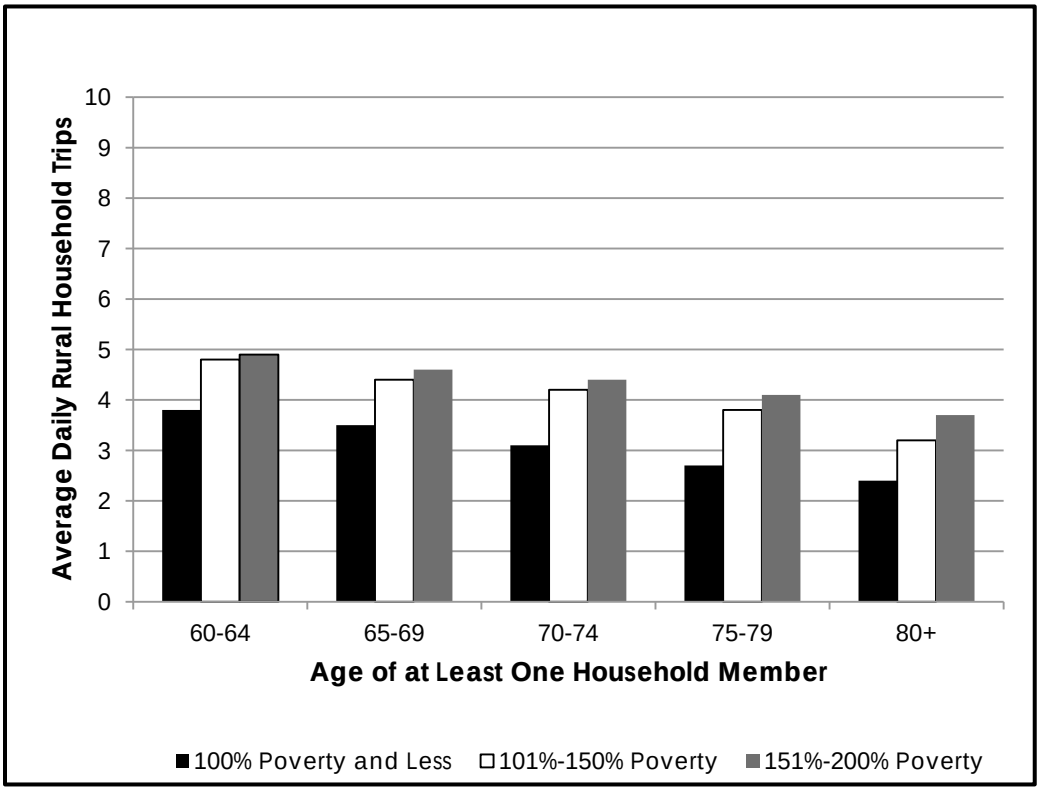
** Sample size of only 9 households.

These data strongly show that lack of access to a personal vehicle is a significant indicator of restricted mobility and difficulty in traveling to the degree that would be desired absent that limitation.

By Age and Income

The average daily rural household trip rates were determined by age and income. Trips per household decrease for each poverty level as the age of at least one household member increases (Figure 7). For households with a member age 60 or older and at or below the poverty level, the average daily trip rate is 3.8. This is 5.2 trips below the national average of 9.0 for all households. For households with a member age 80 or older and at or below the poverty level, the average daily trip rate is 2.4. This is 6.6 trips below the national average of 9.0 for all households.

Figure 7: National Average Daily Trips for Rural Households by Age and Income



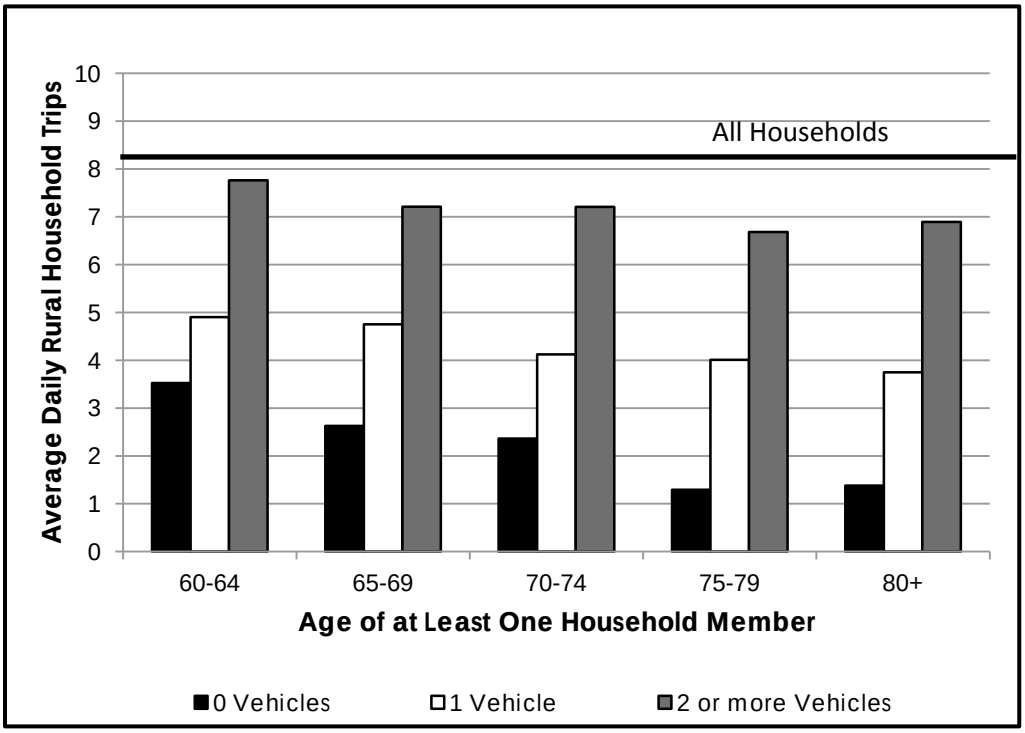
The sample sizes for each category are small for Division 1, Division 8, and Division 9, and therefore, these three Divisions are not included in this analysis. For the remaining Divisions, trip rates by age and income generally follow the same pattern as the national trip rates.

The data show the same decrease in daily trip rate with age as seen above, but also show that across all age groups lack of income contributes to reduced trip making.

Age by Vehicle Ownership

The average daily rural household trip rates were determined by age and vehicle ownership. Nationally, trip rates for households owning multiple vehicles do not greatly vary by age as shown in Figure 8. For households with 0 vehicles, and one member age 60 to 64, the trip rate is 3.5. For households with 0 vehicles, and one member age 80 or older, the trip rate is 1.4; 7.6 trips below the national average. Conversely for households with 2 or more vehicles, and one member age 60 or older, the trip rate is 7.8. For households with 2 or more vehicles, and one member age 80 or older, the trip rate is 6.9.

Figure 8: Average Daily Trips for Rural Households by Age and Vehicle Ownership



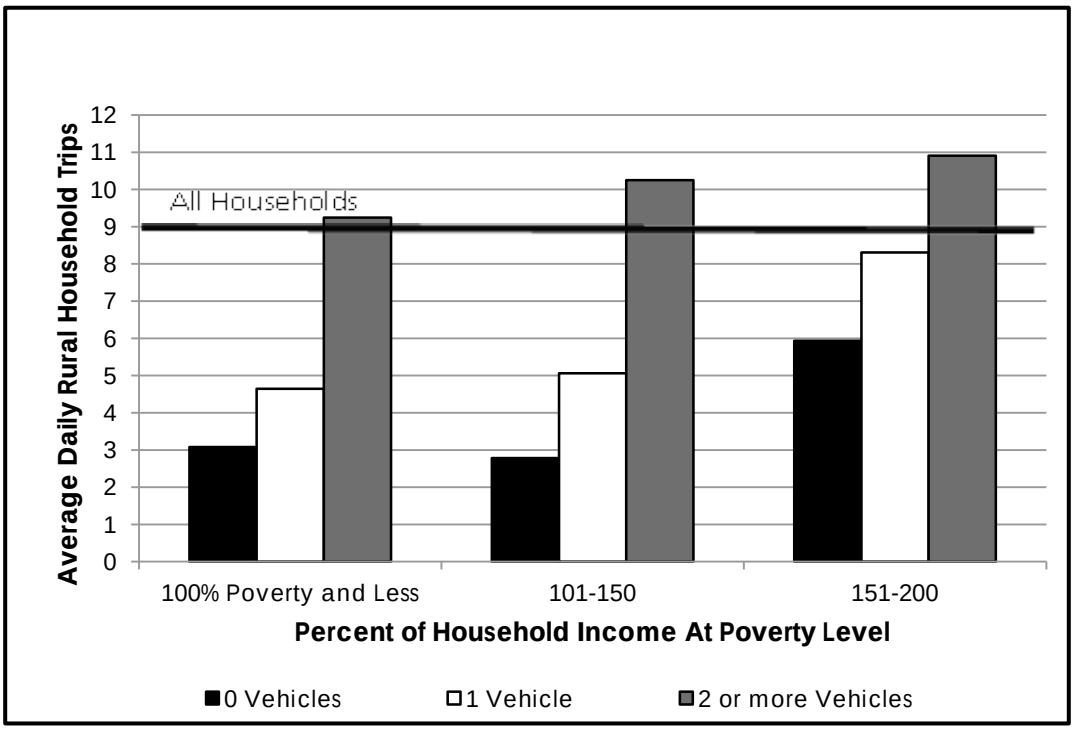
The sample sizes for each category are small for Division 1, Division 8, and Division 9, and therefore, these three Divisions are not included in this analysis. Division 2, Division 3, Division 5, and Division 7 trip rates by age and income generally follow the same pattern as the national trip rates. For Division 4 and Division 6, there is more variability by age.

The national data confirm the finding that reduced trip making is more strongly related to vehicle availability than to age, at least up to age 80. Households with 2 or more vehicles show only a slight reduction in the daily trip rate as the age of a household member increases from 60 to 80. Households having one car or no car show greater reductions in daily travel.

By Income and Vehicle Ownership

The average daily trips per rural households were determined by income and vehicle ownership. Nationally, trip rates by income and vehicle ownership show far greater variation than do rates by age (Figure 9).

Figure 9: National Average Daily Trips for Rural Households by Income and Vehicle Ownership



Age by Income by Vehicle Ownership

The average daily trip rate for households by age and income and vehicle ownership was calculated for the nation and for all Divisions. However, there were not very large sample sizes for each of the breakdowns by Division. Therefore only national trip rates are included in this analysis. The average daily trip rate for households by age and income for households with 0 vehicles, 1 vehicle, and 2 or more vehicles are shown in Figure 10, Figure 11 and Figure 12. The data illustrated in these figures show that trip making is far more strongly related to vehicle ownership than to either age or income. Note in Figure 10 that, due to the small size of the sample, trip rate data are not available for some categories.

Figure 10: National Average Daily Trips for Rural Households by Age and Poverty for Households with 0 Vehicles

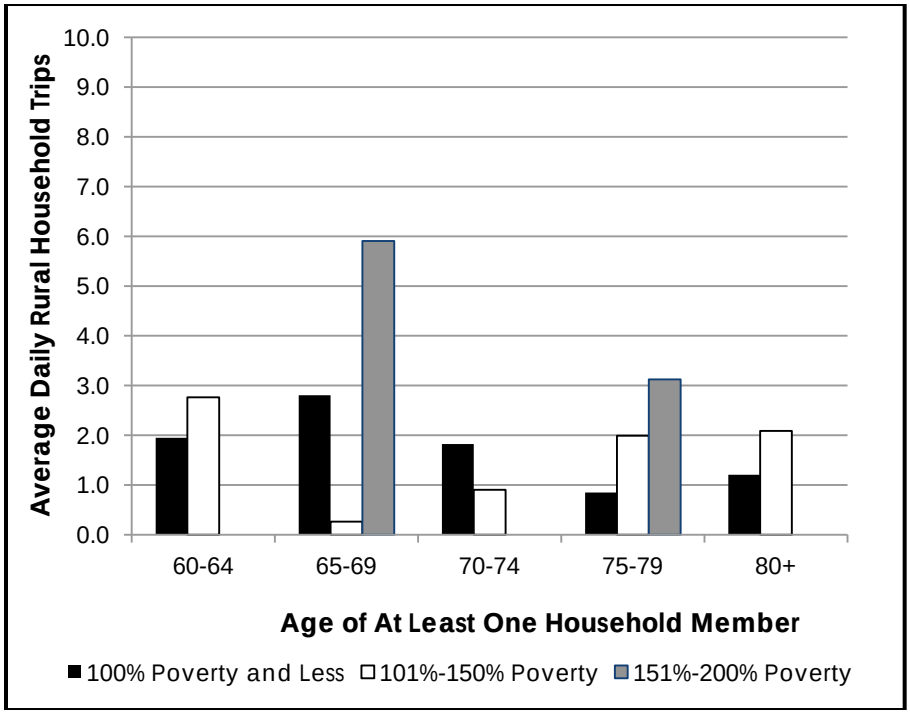


Figure 11: National Average Daily Trips for Rural Households by Age and Poverty for Households with 1 Vehicle

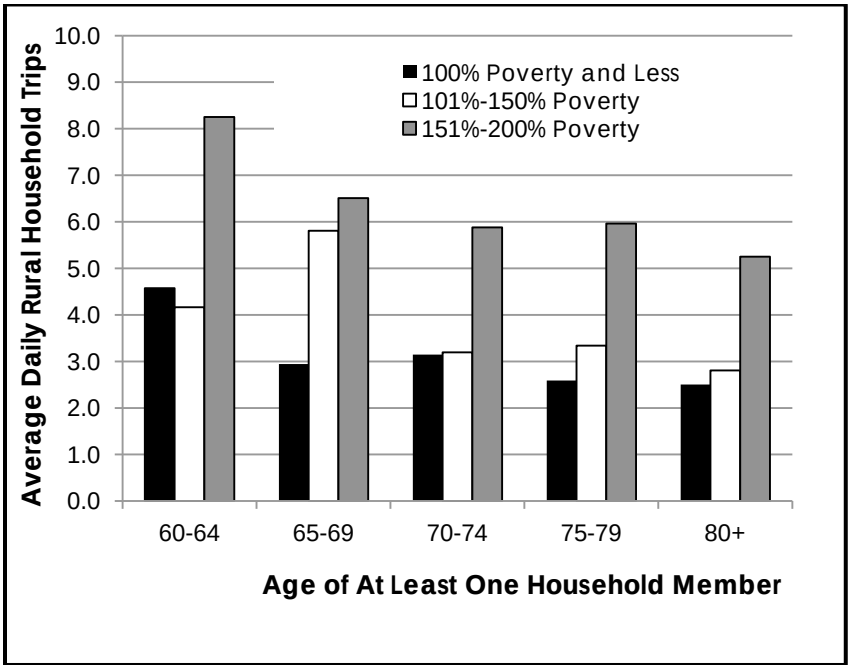
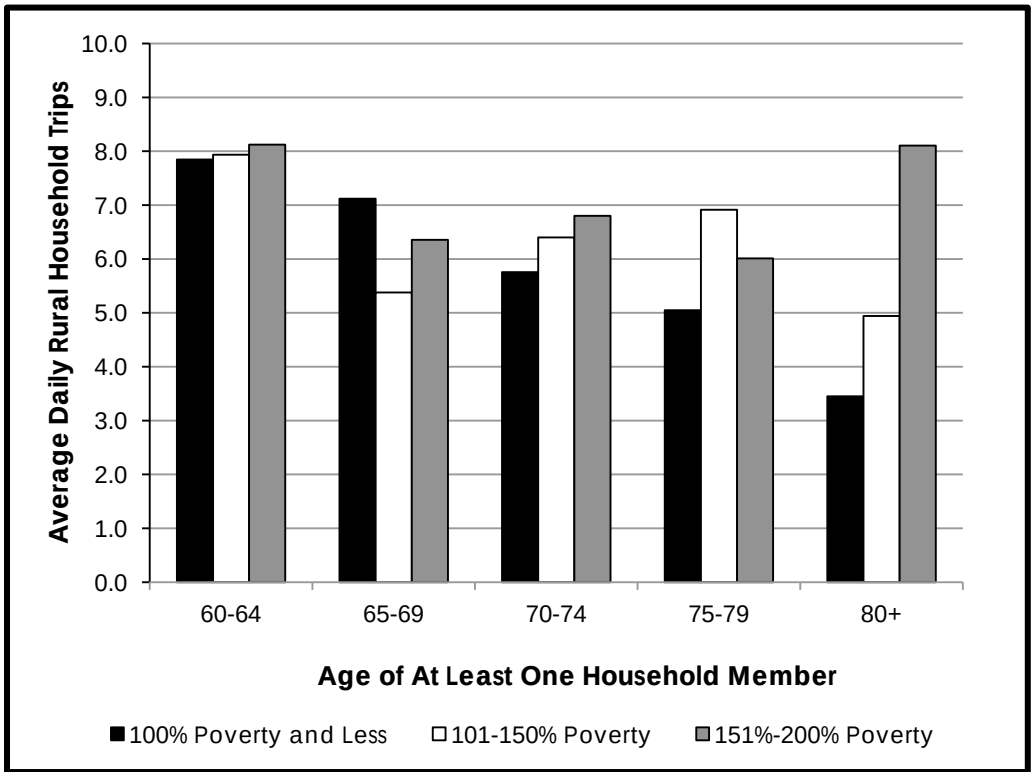


Figure 12: National Average Daily Trips for Rural Households by Age and Poverty for Households with 2 or more Vehicles

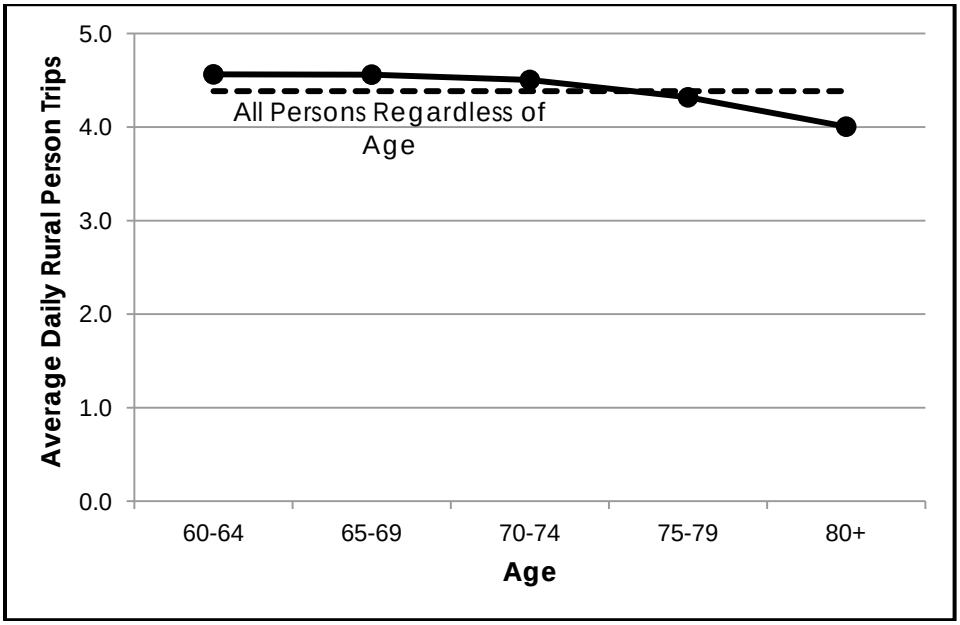


Average Daily Trip Rate – Persons in Rural Areas

Data related to trips *per household* can be misleading when analyzing travel patterns related to age, as the number of persons per household declines with age for households beyond the child rearing years. Figure 2 illustrated that rural *households* with at least one resident over age 60 have trip rates substantially lower than the average of 9 trips per day found for all rural households and that the daily household trip rate declines from about 7 trips per day at age 60 to below 5 trips per day at age 80.

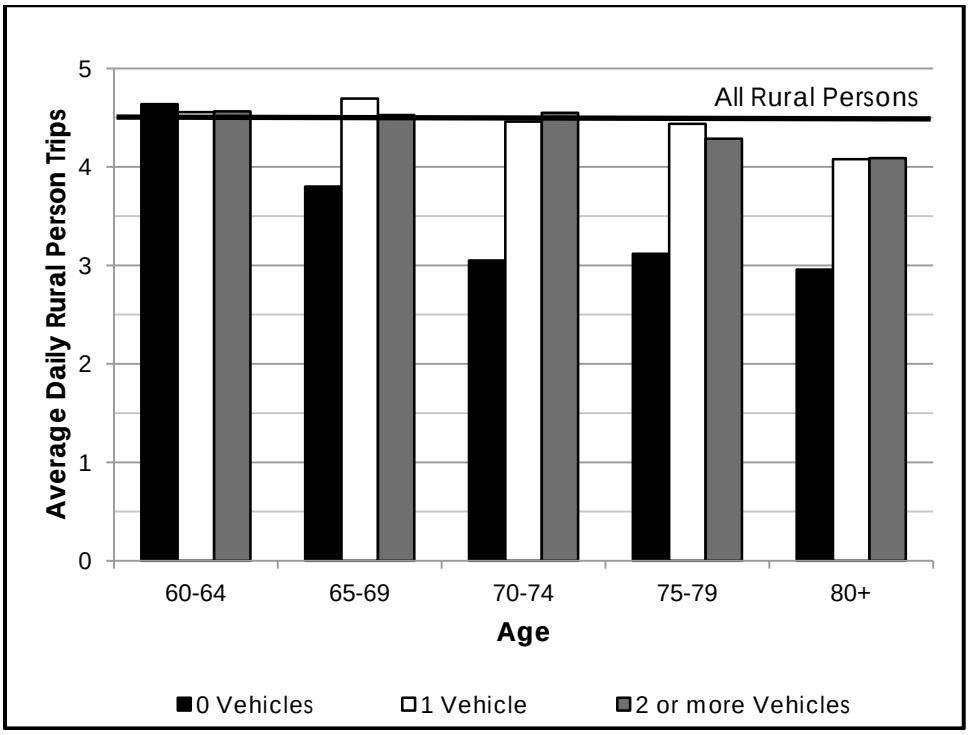
When the analysis is presented based on *trips per person* the findings are rather different. As illustrated in Figure 13 the rate of trips per day for persons of age 60 to 80 is essentially the same as for all rural persons. The daily trip rate drops below the average only at age 75. Even at age 80 the rate is 4.0 person trips per day compared to the average of 4.3 person trips for data for all persons residing in rural households.

Figure 13: Average Daily Rural Person Trips by Age



The person trip rate related to vehicle ownership, and in particular, the gap in the trip rate between households owning no vehicle and those owning one or more vehicles, remains a better indicator than age of the need for passenger transportation (Figure 14).

Figure 14: Average Daily Rural Person Trips by Age and Vehicle Ownership



Summary - Need Related to Population Characteristics

While the data clearly show that there is a decline in the daily trip rate for individuals as they age, the data do not fully support the use of age as a sole indicator of need. Rather, poverty and the lack of auto ownership are the more significant indicators of need.

Recommendation – Estimates of need for passenger transportation services in rural areas should be presented as:

- **Number of persons resident in households with income below the poverty level, plus**
- **Number of persons resident in households owning no vehicle.**

Data related to both poverty and vehicle availability have been collected regularly as part of the decennial U.S. Census and are available by county from the year 2000 Census. After the year 2000 these data are being collected as part of the American Community Survey (ACS). Small area data from the ACS were not yet available for all population and household characteristics at the county level at the time of the Phase 1 analysis, but were released late in 2010. The Data for specific geographic area (i.e., a specific county) can be obtained using the American Fact Finder available at the ***United States - Data Sets - American FactFinder*** website. (***http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml***)

Mobility Gap

In the preceding discussion *need* was measured by the number of people likely to require a passenger transportation service. That measure is likely to be appropriate for use with non-technical audiences. An alternative way of expressing need is the "mobility gap." This measure is based on the theory that households that have access to one or more personal vehicles, regardless of other household characteristics, have the ability to make as many trips as they need. Thus, the observed trip rate of auto owning households of any given type represents the unconstrained demand, or stated another way, the number of trips perceived by these households as "needed." Households lacking access to a personal vehicle have lower trip rates. The difference between the observed trip rates for these two types of households – those having access to personal vehicles and those lacking such access – represents a "mobility gap" and is, therefore, a measure of the number of additional trips that would have to be served in order to fill all travel needs.

The "**Mobility Gap**" was defined using data from

Table **3**, which summarized the daily trip rates by Census Division for households having no vehicle, one vehicle and two or more vehicles. On the premise that households with at least one vehicle can make trips as needed to satisfy their mobility needs, then the Mobility Gap can be defined as the difference between that rate and the rate of trips for households that lack access to even a single vehicle (Table 4). Working with a trip-based number provides a basis for estimating the amount of service (e.g., vehicle-hours) that would be required to carry the target number of annual trips.

The estimates of need made using the Mobility Gap method are typically far greater than the number of trips actually observed on rural passenger transportation systems and are likely greater than the

demand that would be generated for any practical level of service. Much of the remaining trip-based Mobility Gap is likely filled by friends and relatives willing to drive residents of non-car-owning households. Therefore, agencies choosing to use the Mobility Gap may wish to establish a target or goal for the proportion of the gap to be satisfied by publically provided services. In the testing of these suggested methodologies with a number of rural transit agencies, it was found that at best only about 20% of the Mobility Gap trip-based need was met.

Table 4: Mobility Gap based on 2001 NHTS

Division	Trips per Rural Household Per Day		
	Vehicles Available		Gap
	0	1+	
National	3.3	5.4	2.1
Division 1: New England	*	5.3	*
Division 2: Middle Atlantic	3.1	5.9	2.7
Division 3: East North Central	3.3	4.9	1.6
Division 4: West North Central	2.3	5.1	2.8
Division 5: South Atlantic	3.1	5.5	2.4
Division 6: East South Central	3.1	4.9	1.8
Division 7: West South Central	3.7	5.2	1.5
Division 8: Mountain	5.2	6.4	1.2
Division 9: Pacific	3.3	5.8	2.5

* Insufficient data, use of National values is suggested.

Demand – Phase I Analyses

Need exists regardless of whether or not passenger transportation services are available and is related to the characteristics of the population in the area under study. Demand is a function of the services provided and the travel opportunities available to residents of an area. Methodologies for estimating the demand for passenger transportation - defined as the number of trips that are likely to be made over a given period within a given geographic area for a given price and level of service - have been developed for four market segments. These market segments are those that were identified in the interviews with knowledgeable professionals and the listening session at the 2008 Rural Transit conference.

- Travel on public (i.e., 5311 funded) systems
  - Analysis in Phase 1 was based on data from the 2006 reporting year Rural NTD. This category includes all trips made on a public system regardless of service type (e.g., fixed-route, route-deviation) or who pays for the trip.

- Program or sponsored trips
  - The limited data on program trips available to the project team from previous studies were reviewed and it was determined that there was no basis for changing the rates reported in *TCRP Report 3*. To supplement the use of the rates from *Report 3* a method was proposed to estimate demand using information provided by social service program sponsors.

- Small city fixed route service
  - A demand forecasting method was proposed that relates annual trips per capita to service measured in vehicle hours. The presence of a college or university was also found to contribute to small city ridership. A term reflecting college or university enrollment is included in the demand estimation function. The rates are based on analysis of data from the rural and urban NTD for reporting year 2006 augmented by US Census data, and information gathered from other sources.

- Commuters from rural communities to central cities
  - A method for estimating the demand for transit was developed using year 2000 Census Journey-to-Work data. For future application other methods based on the American Community Survey or state based travel forecasting models are supplied.

Travel on Public Systems

In the rural demand estimation methodology developed under *TCRP Report 3*, two types of transit trips were considered: program trips, defined as trips that would not be made but for the existence of a specific social service program; and non-program trips which were defined as trips for which the passenger determined the trip time and destination. Non-program trips are akin to, but not the same as, general public transit trips. No distinction was made related to the nature of the agency providing non-program trips or the funding source for those trips. That methodology related the demand for non-program transit trips to the number of persons in three segments of the population – elderly, low-income, and persons with a disability – and the quantity of service provided as measured in units of annual vehicle-miles per square mile of service area.

In the discussion with those engaged in the planning for, or provision of rural passenger transportation it was determined that while some users found this methodology satisfactory, others sought an alternative approach. In particular, there was a desire for a methodology that could be used more directly to assess the demand for general public transportation.

Most general public transportation available in rural areas receives funding under Section 5311 of the Federal Transit Act and is, therefore, required to file reports for inclusion in the Rural NTD. This provides a standard national source of data relating measures of service provided (vehicle-miles and vehicle-hours) and service consumed (trips made). For purposes of this analysis, rural public systems are defined as those receiving assistance under 49 USC 5311. These systems typically serve a variety of public and social service needs within an area, and many are operated by municipalities, counties, or regional transit authorities.

Data Sources

In Phase 1 the primary source for data about the travel on general public systems operating in rural areas was the Rural NTD. The Federal Transit Administration made available to the research team data included in the Rural NTD for reporting year 2006. This included, for the agency fiscal year ending in the twelve months preceding December 31, 2006, information on:

- State in which service is operated
- Name of agency operating the service
- Website address (url) for the agency operating the service (when available)
- Annual vehicle-miles operated
- Annual vehicle-hours operated
- Regular unlinked passenger trips
- Coordinated unlinked passenger trips
- Type of operation (i.e., fixed-route or demand-response)

This dataset provided information on the rural service supplied and used for 1,569 agencies in 47 states as well as the District of Columbia, twelve tribal systems and several territorial systems. Only the data for agencies reported by states were included in the analysis.

Other state level data assembled from existing sources included:

- Population of rural areas
- Area of each state considered rural (square-miles)
- Miles of roadway in rural areas in each state

While the data can be easily summarized by state and related to other factors found in other databases (e.g., Census) that might affect the demand for service such as population density or the number of persons in various categories, it was found to be difficult with the available data to easily match the data reported in the Rural NTD for any specific agency to the demographic characteristics of the population in the specific areas served by those agencies. In order to explore relationships at the agency level, the research team attempted to determine the specific counties served by a selected set of agencies, either from the agency websites or direct contact with the agency. This permitted the team to build a dataset of observed use of rural public transit services and the characteristics of the areas served.

State Level Analysis

Trips per Capita

Since data on the size of the rural population, the area of each state considered rural, and amount of general public rural transit service provided and used were readily available, the initial phase of the analysis explored relationships at the state level. Considered for the nation as a whole, there are 2.5 trips per year per rural resident on rural general public transit. As illustrated in Figure 15, there is significant variation in this rate by state, with rural trips per person per year ranging from a low of 0.3 to a high of 16.5. The 50th percentile (median) value is 1.5 trips per year per rural resident. These aggregate data, however, can mask many state specific factors. States with rates substantially higher than the mean tend to have specific unique conditions. Colorado and Wyoming both have rural areas

that attract large numbers of tourists (e.g., Aspen, Vail, Jackson Hole) and in which high quality transit service is provided. In Aspen and Vail, the service is free-fare. Washington State had a strong funding program for all transit and no fares are charged on some of the larger rural systems. States with low rates of general public rural trips per capita may have other services that provide needed mobility. In Florida, almost all rural trips are part of a coordinated system and are reported as such in the NTD.

Figure 15: Rural Annual Regular Unlinked Transit Trips per Capita, by State (2006 NTD)

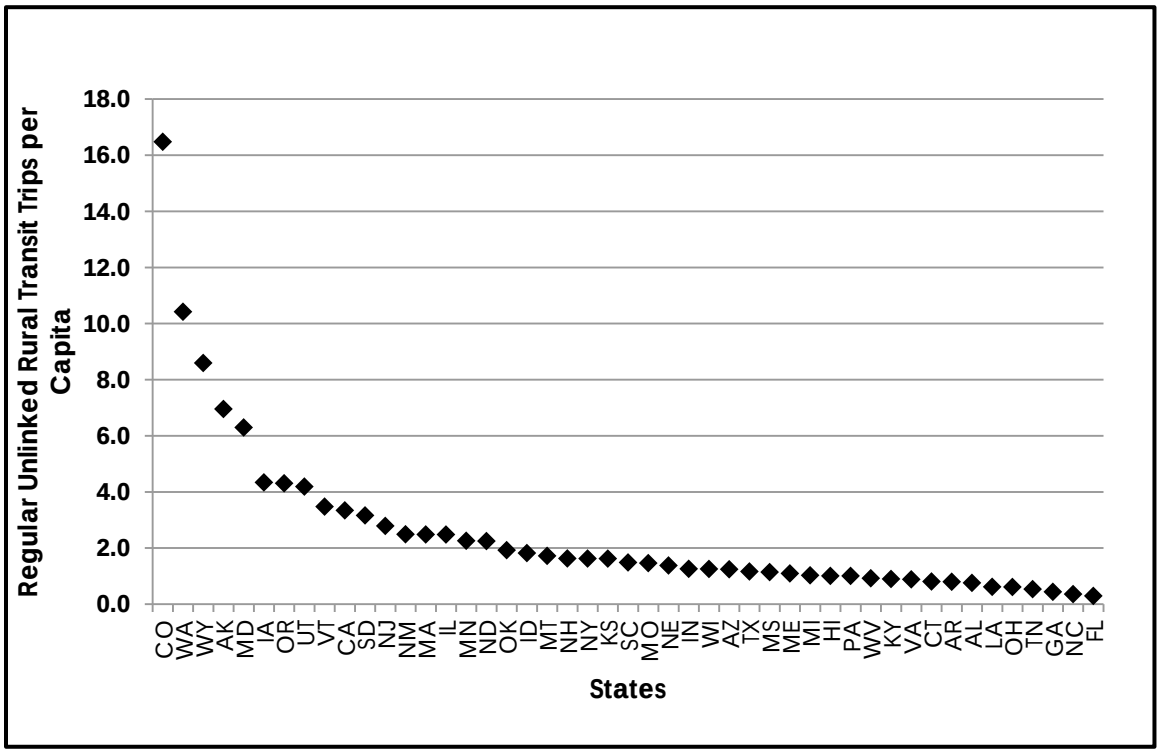
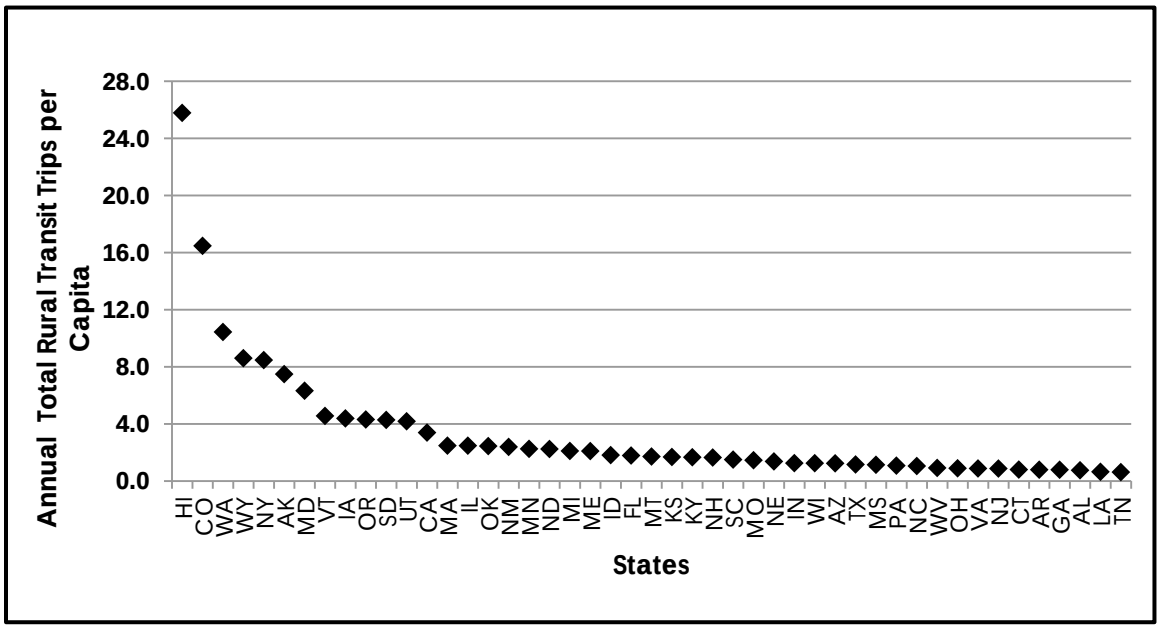


Figure 16 illustrates the variations by state when "coordinated" trips are added to the unlinked passenger trips.

Figure 16: Rural Regular plus Coordinated Transit Trips per Capita, by State (2006 NTD)



Overall the values for rural trips per rural person as derived from the 2006 Rural NTD are:

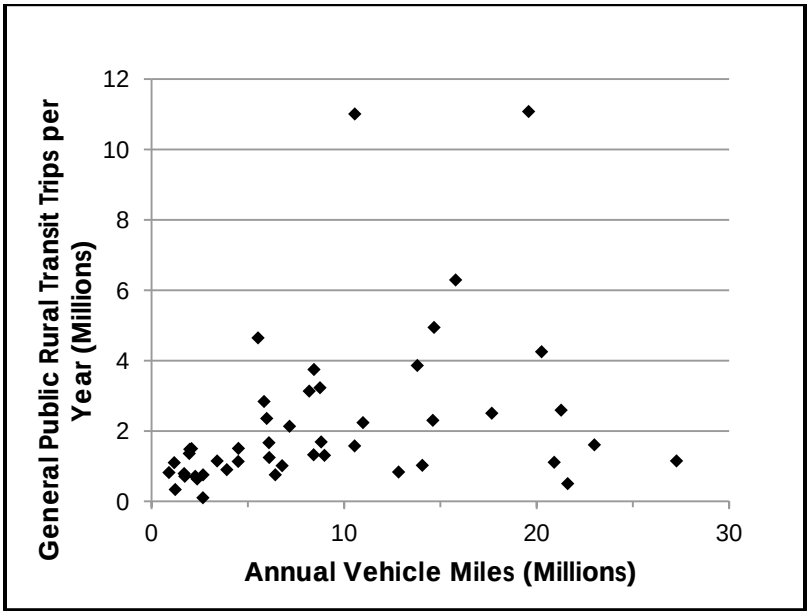
Table 5: Rural Passenger Trips per Capita

	Unlinked Passenger Trips	Unlinked + Coordinated
National mean	1.79	2.08
Average of all state values	2.54	3.37
Median of state values	1.55	1.75

Trips per Vehicle Mile

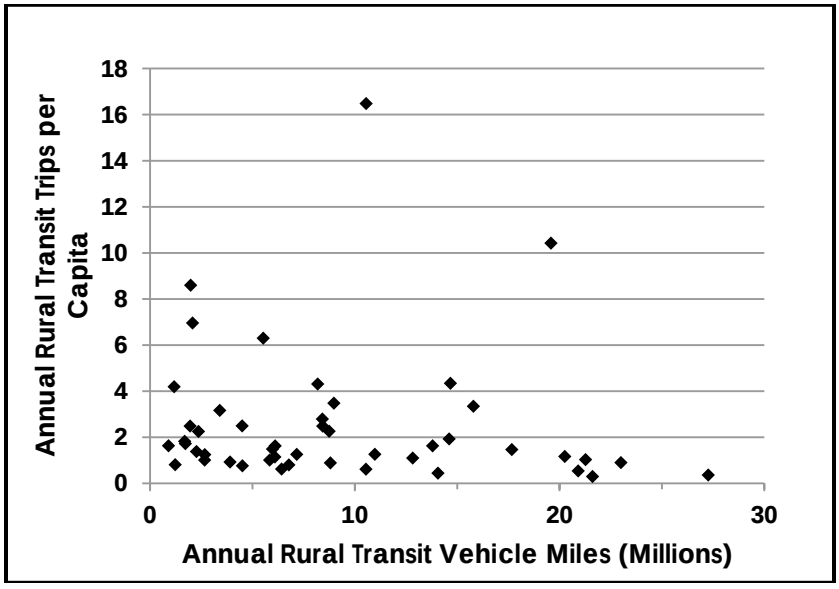
Service consumed (i.e., trips made) is often related to the amount of service provided, although cause and effect relationships can be difficult to untangle. As illustrated in Figure 17 there is a discernable relationship between the trips made and the service provided, about 0.20 trips per vehicle-mile with an r-square value of 0.5.

Figure 17: Rural Transit Trips vs. Rural Vehicle-Miles



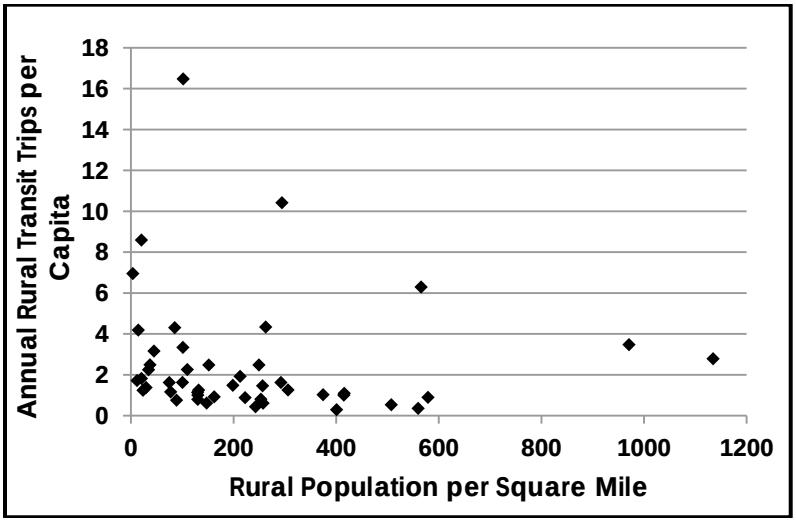
In an attempt to get a better understanding of the causal relationship affecting use of rural general public transit services, other relationships were explored using the state level data. Figure 18 illustrates that there is no clear relationship between the total miles of service provided and the rate of use of the service by rural residents. This is understandable given the great diversity in the characteristics of the population in each state and the size of the states.

Figure 18: Rural Trips per Capita vs. Vehicle-Miles of Service Provided



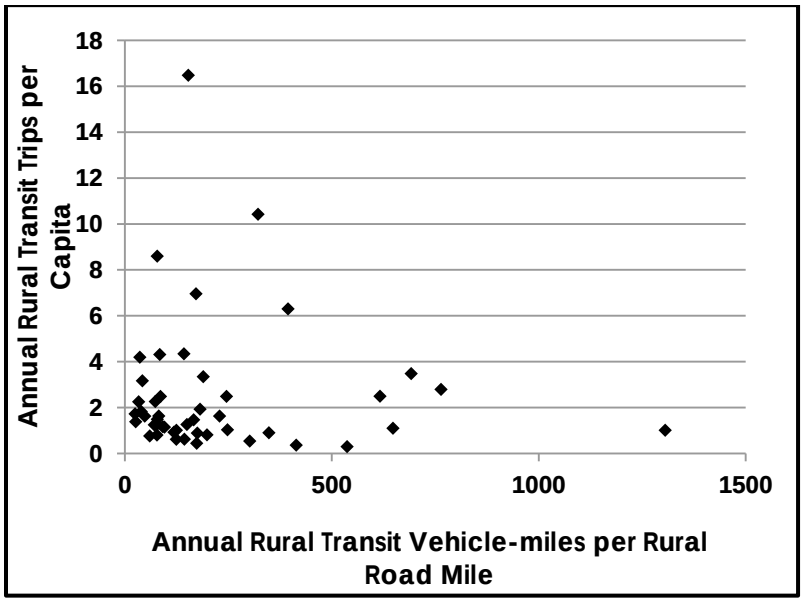
Population density is often thought to be a factor in the use of public transit services, but as illustrated in Figure 19, the data suggest that there may actually be a slight decline in the per capita use of rural service with increased rural density.

Figure 19: Rural Transit per Capita vs. Rural Population Density



The possible effect on rural transit use of the coverage provided, as measured by the ratio of rural transit vehicle-miles to rural roadway miles in each state was also explored, (Figure 20) but no satisfactory relationship was seen.

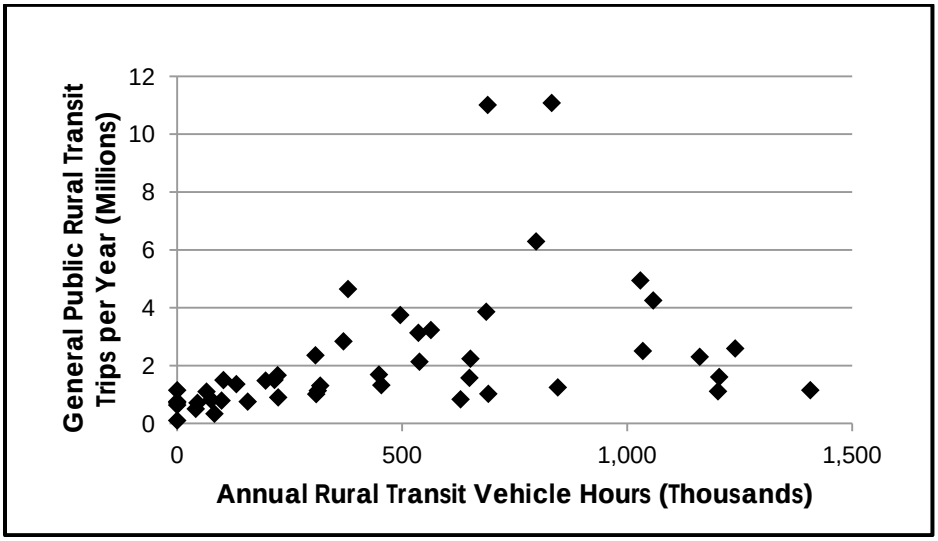
Figure 20: Rural Transit per Capita vs. Rural Transit per Rural Roadway Mile



Trips per Vehicle Hour

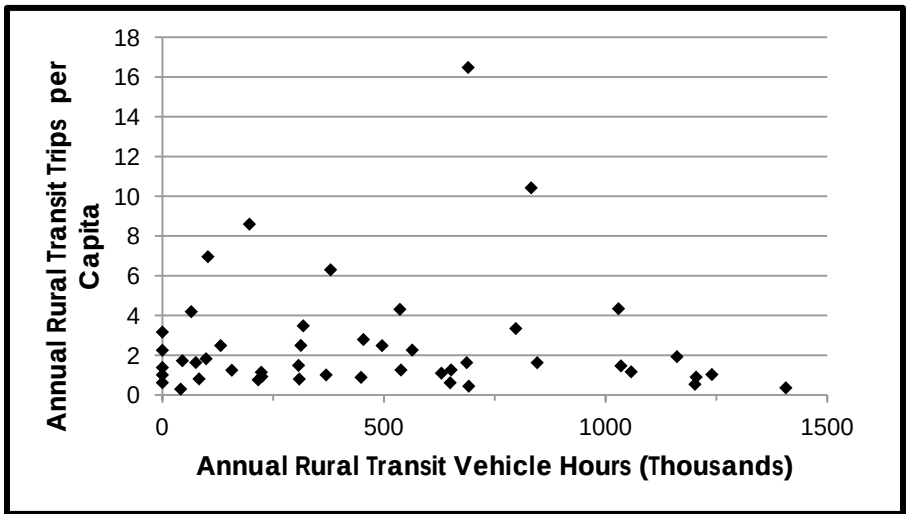
The possible relationship between rural transit trip demand and the hours of service provided was also explored. The resulting relationship, illustrated in Figure 21, is 3.7 trips per vehicle hour with an r-squared of 0.51, just slightly stronger than the relationship observed between trips and miles of service.

Figure 21: Rural Transit Trips vs. Rural Vehicle-Hours of Service



As illustrated in Figure 22, however, there is no strong relationship between per capita transit use and the hours of service provided.

Figure 22: Rural Trips per Capita vs. Vehicle-Hours of Service



Other functional relationships involving vehicle hours of service at the state level as related to size of population, density of service, and other factors were analyzed. None proved to yield relationships that would be satisfactory.

Based on the state level data from the 2006 Rural NTD the most satisfactory relationships, developed using state level data, for estimating the demand for rural general public transit service were found to be:

Rural Transit Trips = 0.2 trips per rural vehicle-mile

or

Rural Transit Trips = 3.7 trips per rural vehicle-hour

Data at the level of individual states may be better than national aggregations, but still mask many of the factors that affect the demand for passenger transportation at the level of individual agencies. In order to explore the possibility that a more localized analysis, as was carried out for a limited number of counties (39) in *TCRP Report 3*, might yield more stable and robust relationships, the data for 214 rural agencies in 10 states - Alabama, Illinois, Mississippi, Montana, Nebraska, North Carolina, Oklahoma, Pennsylvania, Vermont, and Washington - were taken from the 2006 Rural NTD. For each of these agencies an estimate of "population served", a data item not reported in the NTD, was estimated by determining the counties reported as being served by each agency (from the agency web site or other sources) and then obtaining the reported rural population from the year 2000 Census.

The analysis at the agency level was severely limited by the lack of data that could be directly associated with the systems included in the dataset. Without knowing the service area to which the reported ridership and service provided apply, values for population served are at best only an estimate, and other attributes such as population density or service density would be second order estimates. Given the lack of valid data no attempt was made to derive data for second order estimates.

With this agency based sample data the annual trips per capita were analyzed for 178 sampled rural services that reported non-zero values for miles, hours and trips. Upon examination the agencies serving over 200,000 trips per year appear to have specific conditions that may not apply uniformly. Many of the agencies reporting ridership in this range are in Pennsylvania or Washington. In Pennsylvania seniors ride free and Washington has historically had well funded rural transit operations, which allows several larger rural systems to operate fare-free. Focusing on systems with ridership less than 200,000 yielded a rather different picture. A pattern emerged that revealed at least some relationship between the number of trips made and the population served. However, the statistical relationships between rural population and trips made varied substantially.

The data from the agency sample revealed a clear pattern of more trips made when the miles of service provided increased but the scatter was so great that no function useful for forecasting demand could be derived**.** However, when the per capita use of the services (trips per capita) is examined relative to hours of service provided per capita, a slight pattern did emerge revealing a tendency for a marginal

reduction in the ridership gained per capita as the hours of service per capita are increased. This relationship yielded the following function:

$$\text{Trips/person} = 1.97\ (\text{Vehicle-hours/person})^{0.69}$$

This relationship did not have strong explanatory power, yielding an r-square value of only 0.24, but did illustrate a tendency to decreasing returns as services are increased.

As a result the use of relationships based on state level data rather than the relationships developed from the dataset developed for individual systems was suggested. For the individual systems, defining the size of the area served proved to be quite difficult, and the data showed wide variation.

Development of an updated methodology for projecting demand for general public passenger transportation in rural areas, based on national data as reported to the Rural NTD for reporting year 2006 illustrated that there is a relationship between the service provided and the passenger demand, but did not yield robust relationships with strong explanatory power. Those relationships used as measures of elasticity may be useful for estimating how ridership on an existing system would change were service to be added or reduced, especially if combined with peer group data for other systems in the same state or region, but would provide only limited guidance for studies of a new system in a rural area not presently having transit service.

In the absence of an enhanced procedure based on updated data, it was determined that the procedures recommended for non-program trips in *TCRP Report 3* remained a valid option. While some researchers had reported lack of satisfactory results with those methods, others had found them quite useful. In a study of a well established rural system, conducted by a firm not affiliated with the project team, it was found that the non-program ridership for the system as a whole estimated using the B-3 methodology was only 1.5% higher than the observed non-program ridership, although the variation by county was greater.[1] This suggested that the B-3 estimation function, which includes characteristics of the population in the areas served and measures of the amount of service provided, remained a useful tool.

The full *Report 3* may be downloaded from the following web address:
http://www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=1024.

Program or Sponsored Trips

TCRP Report 3 described transit demand estimation techniques for rural areas. The *TCRP Report 3* methodology separated rural transit demand into two categories:

- program related demand and
- non-program related demand.

[1] RLS & Associates, JAUNT Transit Development Plan, November 23, 2008.

The methodology for estimating program related transit demand was revisited to see if more current information and practices of the transit industry and social service environment would call for changes in the methods.

Existing Methods

Program related transit demand is defined as trips which would not occur *but for* the existence of specific human service program activities. For example, if a county does not include a senior nutrition program, passenger trips would not be made to and from senior program lunches. The first step in estimating program related transit demand in the *TCRP Report 3* process was to identify the various existing types of social service programs that generated a need for transit trips. An extensive survey effort was performed, on a national level, to categorize human service programs and obtain program related data. Based on that survey, the *TCRP Report 3* identified 16 human service and related trip generators:

- Developmental Services: Adult
- Developmental Services: Case Management
- Developmental Services: Children
- Developmental Services: Pre-School
- Group Home
- Head Start
- Head Start: Home Base
- Head Start: Other
- Homeless Transportation
- Mental Health Services
- Mental Health Services: Case Management
- Job Training
- Nursing Home
- Senior Nutrition
- Sheltered Workshop
- Substance Abuse

The next step in evaluating program related transit demand was to quantify the number of participants for each program type. The *TCRP Report 3* suggested contacting program administrators to obtain this information. In the event that a new social service program was planned or program participant numbers could not be obtained, the *TCRP Report 3* method provided a technique for estimating participant numbers based on the survey data. The final step in the method was to estimate the number of trips generated by each program type. *TCRP Report 3* provided formulae to estimate program related transit demand based on the number of program participants and a multiplicative factor. The formulae were based on regression analysis of the survey data for various human service agencies.

Study Process

An underlying objective of the current project was to update the rural transit demand forecasting methods including the technique described above for assessing the demand for program related travel. This issue has taken on new importance with the requirement for enhanced coordination between Human Service Transportation services and Public Transportation services. With the implementation of SAFETEA-LU, projects funded by three Federal Transit Administration funding sources (Section 5310: Elderly Individuals and Individuals with Disabilities, Section 5316: Job Access Reverse Commute and Section 5317: New Freedom) must be derived from a locally developed "Coordinated Public Transit Human Service Transportation Plan." This effort has two components:

- Reviewing the demand forecasting functions presented in *TCRP Report 3*, in light of more recent data on the ridership observed on program related transportation service to determine if the relationships remain valid, and

- Reviewing the types of human service programs that are found in rural settings to see if the program types addressed in *TCRP Report 3* were still pertinent and to determine if an updated methodology is needed to address additional program types.

However, it was not within the scope of this study to duplicate the nationwide survey of human service agencies performed in 1995. Initially an attempt was made to access data documenting revealed demand for program related transportation by reviewing information developed in response to the federal program requirements and presented in the many Public Transit-Human Service Coordination plans for rural areas available on state websites. Many such plans had been developed across the country in the two years preceding the analysis. While the format of these plans varied by region, most include a list or description of the various public transit and human service agencies which provide transportation to low-income, disabled, and elderly persons in their respective regions. Many also included program statistics and transit operating data. Therefore, these coordinated plans were considered to be a potential source of readily available current data to which the program related demand estimation technique could be compared. Coordinated plans and rural transit studies conducted throughout the country were initially reviewed. The majority of these plans were available on the internet or in the libraries of the research agencies.

These plans and studies were first reviewed to survey the different human service program types. Specifically, the following key questions were considered:

"Are the program types identified in 1995 still valid today?"

"Are there any new program types that should be added?"

The disadvantage of using data previously collected by various parties is that the data provided varies from plan to plan. Additionally, the primary focus of a Coordinated Transportation Plan is to identify transit and human service agencies that provide or purchase transportation for their clients. Human service agencies that do not provide transportation may have been overlooked.

Program Types

The following program types were not identified as part of *Report 3*, but were identified in several of the various plans reviewed as part of this study.

Veteran Services: This category is frequently identified in the coordinated plans reviewed as part of this study. Trips are usually to medical appointments at a Veteran's Administration hospital in a more urbanized area. Although these trips fall into the Non-Emergency Medical Transportation (NEMT) category, they are program related and could be considered when analyzing transit demand.

Native American Services: Regions with Native American populations often include Native American-specific human service programs. Trips can be for medical appointments, education, and social/recreational purposes.

Children Services: This is a general category that can include early education, programs for at risk youth, assistance to needy families, mentoring sessions, and family counseling. Programs can be operated by

non-profit organizations, such as churches or Boys and Girls Clubs. Programs can also be a part of a larger human service organization.

County Health and Human Services Departments: Many of the programs listed above such as Senior Services and Job Training fall under the auspices of county Health and Human Services departments. Health and Human Services departments often maintain their own fleet of vehicles. Some of the plans and studies listed Health and Human Service departments as one transit provider. It should be noted that many of the trips in this category are for medical purposes.

Easter Seals: Easter Seals annually assists more than one million children and adults with disabilities and their families through a nationwide network of more than 450 service sites. Each center provides services tailored to meet the specific needs of the particular community it serves. Several of the plans reviewed identified Easter Seals as a human services transportation provider.

Housing Authority: Two plans identified Housing Authority as a social service program type generating program-related transit ridership.

Probation and Parole: Only one plan identified this category as a purchaser of transportation, although it is likely that some transit demand is generated by this trip purpose in many counties.

Of the program categories treated in *Report 3*, the following program types were not mentioned in any of the plans/studies reviewed:

- Mental Health Services – Case Management
- Homeless Transportation
- Developmental Services – Pre-School (could fall under Early Intervention category)
- Developmental Services – Adult (could fall under other Developmental Services categories)
- Head Start: Home Base
- Head Start: Other

The fact that these programs were not identified in the plans/studies does not necessarily imply that these programs no longer exist, but that they do not tend to be large transit generators or are typically considered under one of the other program type categories.

Conclusions from Survey

The following conclusions were drawn from this phase of the study:

- Most of the program types identified in *TCRP Report 3* are consistent with program types listed in the coordinated plans and studies.

- Homeless Transportation, Head Start: Home Base, Head Start: Other – are no longer relevant programs.

- Mental Health Service – Case Management is not a large transit generator.

- Developmental Services should be separated into Employment/Job Assistance (include sheltered workshop) and Day Programs/Respite Services. This would require collecting participant and ridership data for a sufficient number of programs in these two categories to allow evaluation of appropriate ridership rates.

- A category for Veteran Services should be considered. This would require collection of adequate information on the type of program (medical and/or nutritional), number of program participants, and associated transit ridership to allow calculation of trip rates at an adequate level of statistical significance.

- Although Native American transit services were not mentioned frequently by respondents, any region with a large Native American community should consider evaluating transit demand for the Native American population. TCRP Report 154 provides is a Guidebook for Developing, Enhancing, and Sustaining Tribal Transit Services. The rural transit demand methodologies presented in this workbook may be applied to Native American populations in rural areas.

- Of the 54 counties surveyed in the coordinated/transit plans 15 counties (28 percent) included estimates for the number of program participants for at least one human service program. Nineteen (35 percent) of the counties provided an estimate of annual ridership generated from at least one human service program. Only 13 (24 percent) of the plans for counties surveyed included data for both program participants and ridership.

- Considering only those programs evaluated in the coordinated plans, of the 82 total social programs included in the surveyed plans, the plans presented information for the following number of programs:

  - Passenger-trips: 49 (or 60 percent)
  - Vehicle-miles of service: 30 (or 37 percent)
  - Number of program participants: 15 (or 18 percent)

Data on all three of these items were provided for only 13 (or 16 percent) of the programs.

As very few of the coordinated plans and transit studies reviewed included both the actual number of program participants and the number of trips provided, there were insufficient data in these coordinated plans to update the program related transit demand formulas. Additionally, there is a wide variation in the specific types of services provided under the broad categories of program types. For instance, similar sized developmental services agencies in Missouri and in California can be quite different and require different types of transit. This level of detail can only be determined by contacting the agency directly. With the growth of the Internet, contact information for human service agencies can be obtained relatively easily. In some counties, a social services provider directory that includes contact information may also be available. If the transit director or planner considering program related transit demand is required to contact the human service providers to obtain participant numbers, it would be reasonable to take this action one step further and request from the agency an estimate of the number of trips made by program participants.

Given the individuality of each human service program, program-related transit demand in a specific jurisdiction would be more accurately estimated by directly surveying human service agencies. It would also benefit the community and the transit agency for a transit director to develop a relationship with

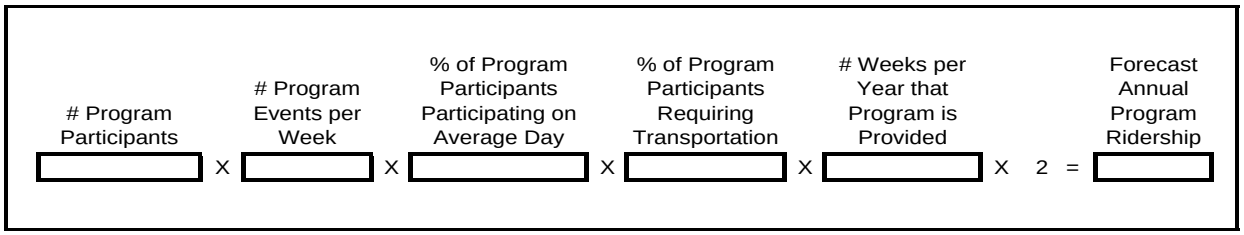
human services providers. This method of estimating program-related transit demand is also in the spirit of coordinated transportation planning required under the federal surface transportation program.

Figure 23 presents a template to assist a transit planner with obtaining relevant information for estimation of individual program transit demand. The following information needed from each human service agency:

- Approximate number of program participants.
- Number of program events per week.
- The proportion of total program participants who attend the program on an average day.
- The proportion of program participants that are transit dependent and do not typically get a ride from family members – therefore requiring public transportation.
- Number of weeks per year that the program is offered.

The flowchart yields the forecast annual program ridership generated from the particular human service program.

Figure 23: Template for Estimation of Individual Program Transit Demand



Suggestions for Coordinated Plans

FTA Circular C 9070 sets forth guidelines for the coordinated planning process and documentation that is required if applying for Elderly Individuals and Individuals with Disabilities, Job Access Reverse Commute, and New Freedom grant programs:

"At a minimum, coordinated plans should include the following elements at a level consistent with the local environment and available resources:

- *An assessment of available services that identifies current transportation providers (public, private, and non-profit).*

- *An assessment of transportation needs for individuals with disabilities, older adults, and people with low incomes. This assessment can be based on the experiences and perceptions of the planning partners or on more sophisticated data collection efforts and gaps in service.*

- *Strategies, activities, and/or projects to address the identified gaps between current services and needs as well as opportunities to achieve efficiencies in service delivery.*

- *Priorities for implementation based on resources, time, and feasibility for implementing specific strategies and/or activities identified."*

It is apparent from the coordinated plans reviewed as part of this study that most jurisdictions put forth significant effort to contact human service agencies. Although the FTA Circular states that the assessment of transportation needs can be based on sophisticated data collection efforts, the majority of coordinated plans reviewed as part of this evaluation approached transportation needs in a more qualitative manner. If the agencies preparing coordinated plans were to use a more quantitative approach to address the required elements, the coordinated plans could yield more useful data regarding program-related transit demand. Such quantitative data would also better support peer analysis to assess overall demand and coordination opportunities. At a minimum, the agencies preparing coordinated plans should attempt to provide the following for each program:

- Number of program participants;
- Number of annual passenger-trips; and
- Number of annual vehicle-miles of service.

Collection of this information would allow development of simple ridership and service productivity rates, provide individual jurisdictions with a better understanding of the relative size of services and needs within their jurisdictions, and allow better comparison between jurisdictions at the state or regional level. (For many social service transportation programs, vehicle-miles operated over the course of a year are much more readily available than vehicle-hours of service, as vehicle-miles can be easily obtained from vehicle odometers while staff hours used for transportation services may not be recorded for drivers that also perform other functions.)

It would also be useful for coordinated transportation plans to collect the additional data items:

- Number of program events per week;
- Percentage of program participants participating on an average day;
- Percentage of program participants requiring transportation; and
- Number of weeks per year each program is provided.

This information would allow program transit demand to be estimated for each individual jurisdiction, allowing the coordination plans to better quantify overall transportation needs, both met and unmet.

Small City Fixed Route Service

Many comments received from users of the *Report 3* methods for estimating demand for rural passenger transportation were related to a lack of procedures for small community fixed-route transit systems. This lack was also cited as a deficiency of the *Report 3* methods in the review of the literature. The methods of *TCRP Report 3* were limited to demand-response service in rural areas and were not recommended for small cities. To fill this gap, an approach for estimating demand for fixed-route transit service in small communities with a population under 50,000 was developed.

While the methods for forecasting public transit demand used in larger metropolitan areas could, in theory, be applied to fixed-route operation in smaller cities situated in rural counties (micropolitan

areas) there are practical difficulties. The methods applied in larger cities are integrated into a set of travel forecasting models developed and maintained by the local Metropolitan Planning Organization (MPO). MPOs do not exist in areas with a population less than 50,000, so some other agency would need to develop and maintain the model sets. The transit forecasting procedures estimate the share of trips being made from each of the many subareas to other subareas based on the relative travel times and costs of highway and transit travel. The estimate of the total trips is based on a set of models developed from data gathered in periodic surveys of households in the area under study. Few micropolitan areas will have such data. The costs of gathering the data required to develop and apply the tools used for estimating transit use in larger cities cannot be justified in the smaller areas. Simplified methods are better suited for the needs of small areas in which the choice to use transit is a function of the characteristics of the travelers rather than the travel times and costs of highway and transit.

The discussion below presents the data analysis. This initial analysis was conducted using data from fixed-route transit service in communities with populations between 50,000 and 100,000, as reported in the National Transit Database for reporting year 2006. It was initially thought that transit demand characteristics would be similar for these smaller urbanized areas and the small cities located in rural counties. The approach was to develop the relationships using the small urbanized area dataset and then apply the relationships to small cities located in rural counties to test the relationships. However, when the resulting demand relationships were applied to the cites in rural counties there was significant error residual between the estimates produced by the model and the demand reported by the cities in rural counties indicating a poor fit between the relationships developed using small urbanized area data and the reported data for the cites in rural counties. The approach based on use of data from smaller urbanized areas included in the NTD was abandoned and new demand relationships were developed using the Rural NTD data for fixed-route transit systems.

Demand estimation procedures frequently make use of independent variables related to the population characteristics of those groups often considered to have a high propensity to be transit-dependent. The review of literature for this project showed that the most common population groups used include low-income population, elderly population, mobility-limited population, zero-vehicle households, and single-vehicle households. Each of these data items can be obtained from the US Census or American Community Survey. These population groups have also been used to develop transit demand models for small fixed-route transit systems.

Each of these population groups was considered in the analysis. The presence of a significant university or college population was also considered. These data are not available in any single national data source, but should be readily available to those developing forecasts of demand for any specific rural system or rural area. The level of service provided in the community was also incorporated in the analysis as measured by the number of revenue-hours as reported in the NTD and the revenue-hours per capita.

The variables that were found to have the strongest relationship to demand were the low-income population, number of college/university students, and the revenue-hours of service. In some cases, population groups considered to be transit-dependent were found to have a negative correlation with fixed-route transit demand, although this should not be taken as evidence of causality.

Using the small urban community data, regression was used to establish demand relationships. It was found that the demand functions developed using the number of students and the revenue-hours as

independent variables had a strong relationship, with an R^2 value of 0.78. However, when this function was applied to the smaller non-urban communities the results showed a high residual error. Demand functions incorporating the same independent variables but using the non-urban community data yielded R^2 values ranging from 0.43 to 0.63, depending on the size of the community. Additional review of the Rural NTD data indicated that there is far more variability of demand in small non-urban communities. This may result from the wide variation in community characteristics among these communities with populations of less than 50,000.

The resulting demand relationships may be expected to give an indication of the level of fixed-route demand in a community, but do not substitute for detailed service and route planning.

Statistical Analysis

Datasets

The data used for analysis were drawn from three sources:

- National Transit Database (NTD) data,
- Census information, and
- College and university enrollment data, excluding community colleges.

Data for transit systems that operate in areas that have an urbanized area population between 50,000 and 100,000 residents were obtained from the National Transit Database (NTD) 2006 reporting year. Only systems that operate a fixed-route service were selected for statistical analysis. Information taken from the NTD included ridership, revenue-hours, urbanized area population, and service area population.

Census data that correspond to the urbanized area population were gathered for each of the transit systems. Information was gathered for six categories that were hypothesized to have a potentially strong relationship with transit ridership. These categories are elderly population, youth population, mobility-limited population, low-income population, zero-vehicle households, and single-vehicle households.

Lastly, information on college and university enrollment for each urbanized area was gathered from college and university websites. Community colleges and technical schools were not included. Where applicable, multiple institution enrollments were added together to create an aggregated number. In addition, data were collected to determine if college students were able to ride the systems without paying a direct fare, either through the transit agency or the school.

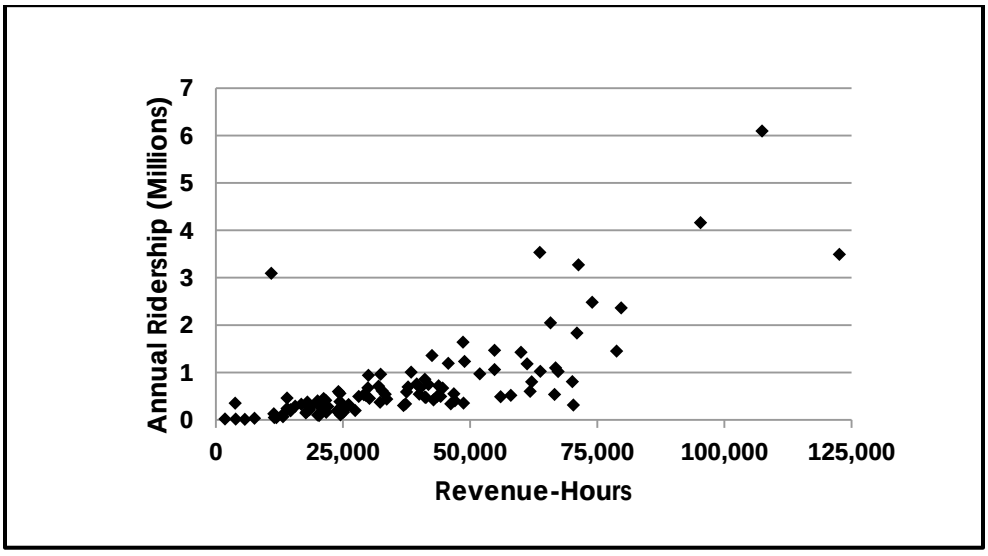
Analysis

Correlation

The first step in the analysis was to create a correlation matrix to determine if relationships existed between relevant variables. Of the independent variables considered ridership had a strong relationship only with revenue-hours (0.73) and a weak relationship with low-income population (0.36).

The next step of analysis was to create graphs that depict variables in the dataset. Plots were created with ridership on the Y-axis and the other variables on the X-axis. Figure 24 shows the plot of ridership and revenue-hours. This graph shows a strong linear relationship.

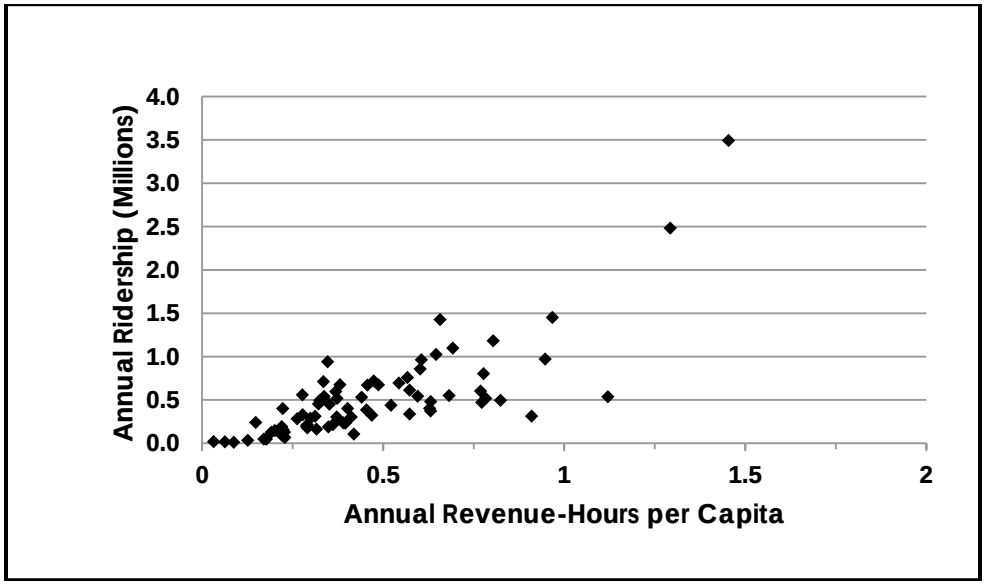
Figure 24: Ridership vs. Revenue-Hours of Service



Plotting ridership against other possible variables revealed no notable patterns. Synthesis variables were created, such as revenue-hours per capita and revenue-hours per low-income capita. Plots were also developed for college enrollment data disaggregated by whether or not students were able to ride for free.

For example, Figure 25 presents a graph of ridership and revenue-hours per capita for transit systems that do not have a free pass program. This graph shows that a strong linear relationship exists between the two variables—as revenue-hours per capita rises, so too does ridership. This level of analysis showed that there was generally a strong relationship between ridership and both revenue-hours per capita and revenue-hours per low-income capita. There was not a significant relationship between ridership and revenue-hours per student, but there is a relationship that exists between ridership and the raw number of students, especially when discussing transit systems where a college has a free ride program.

Figure 25: Ridership vs. Revenue-Hours per Capita



To further explore this relationship, consider Figure 26 which illustrates the relationship between ridership and student population for small-urban centers when there is no student pass program. For these systems there is, at best, a weak relationship between the student population and system ridership. Next consider the relationship between ridership and the number of students when a student pass program is in place (Figure 27). For these conditions a clear relationship is apparent that reflects the influence of a student population on the expected demand for passenger transportation on the small urban area fixed route system.

Figure 26: Ridership vs. Student Population (no student pass program)

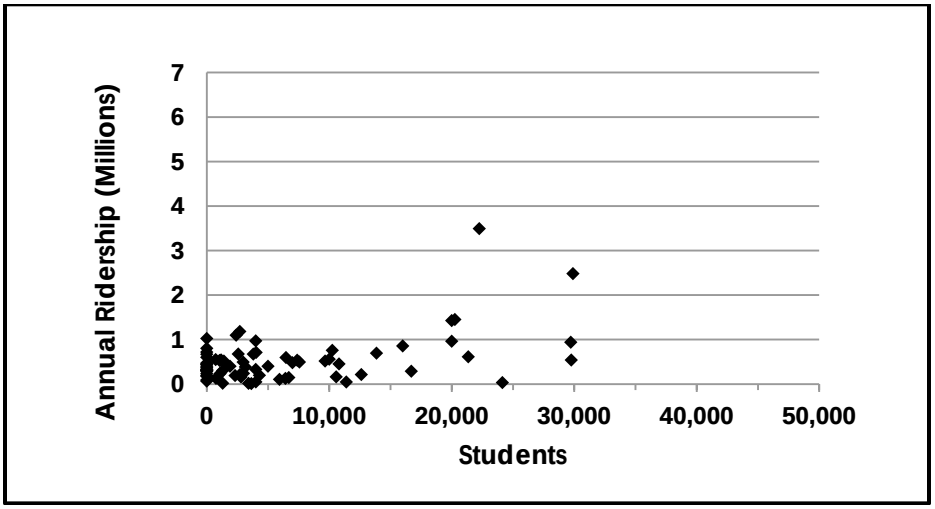
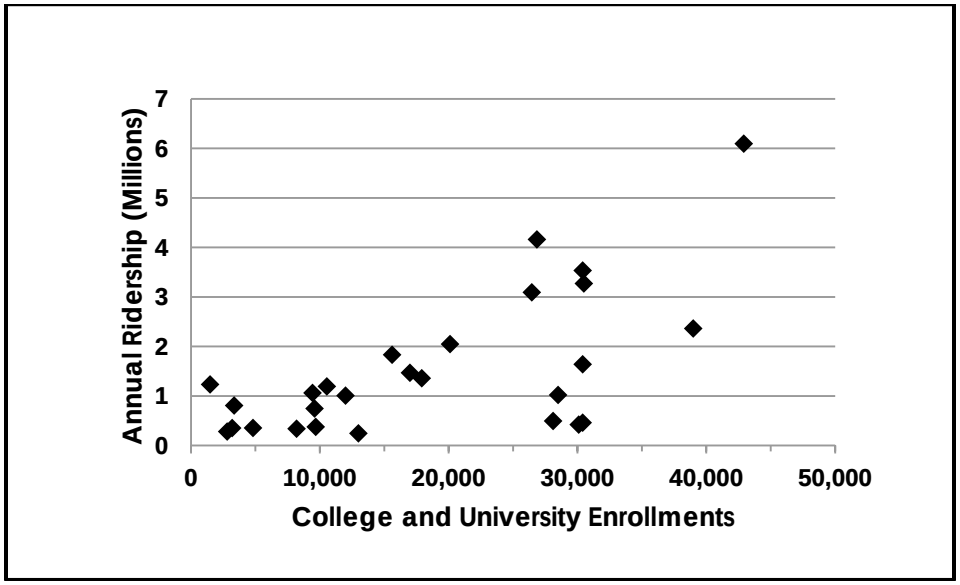


Figure 27: Ridership vs. Student Population (with student pass program)



The next step in the analysis was to perform multiple regressions to evaluate the nature of linear relationships that might exist between ridership and the several independent variables. The four variables identified as having a high correlation to ridership (students, revenue-hours per capita, low-income population, and revenue-hours per low-income capita) were evaluated using a univariate regression. This analysis showed that three of the four variables were significant at the level of 95 percent. The three remaining variables (students, revenue-hours per capita, and revenue-hours per low-income capita) were evaluated in a multivariate regression model. The variable revenue-hours per low-income capita turned out to be not significant and was eliminated. The remaining two independent variables were students and revenue-hours per capita.

Several alternative forms of an estimation function were tested including both combinations and transforms of the independent variables and non-linear forms. None of these demonstrated improved estimation. Estimation functions stratified by population were developed but these did not yield better results.

After reviewing the results of the various analyses the following form for the estimation function for small-city fixed route systems was selected:

*Annual Ridership = 6.22 * College and University Enrollment + 10.68 * Annual Revenue-Hours*
Conditions of application: Revenue-hours > 0; Population of urban center < 50,000

This function has an R^2 of .55 as opposed to the model using revenue-hours per capita, which had an R^2 value of .36. In addition, when each model was tested, the model using revenue-hours had an average residual that was far less than that of the revenue-hours per capita model (107,766 compared to 126,510). Because there are a plethora of factors that affect transit ridership (e.g., density, income, service frequency), no one model can precisely predict transit ridership. The recommended model, however, seems to be the best predictor of ridership for small urban centers in rural areas.

Commuter Trips

One comment heard from potential users of the methodology was that new markets have emerged that were not treated in *Report 3* – particularly work trip commuting from rural counties to urban centers. An approach to assessing demand for the commuting markets from rural areas to workplaces, particularly work places in urban centers, was noted as a method that would be useful to many agencies.

Comprehensive data on the use of passenger transportation services for commuters from rural environments are not readily available. Data in the Rural NTD are stratified neither by trip purpose nor by the location and characteristics of trip destinations. Further, while the location of each transit agency is provided in the Rural NTD, there is no indication of the geographic area served by each system, so determining the population within the service area of the agencies would require specific examination (e.g., review of website or phone contact) with each agency. Of greater import for assessing the demand for commuter travel, there is no way other than specific examination of each rural county to determine how the population is distributed within the county (e.g., new developments clustered close to the boundary with an urban area or scattered throughout the county).

The single comprehensive source of commuting data – in total and by mode – has been the U.S. Census. In the year 2000 Census one of six households was asked to complete the long form – a series of additional questions about the characteristics of the dwelling unit in which the respondent lived and the characteristics of all residents of the household, including the place-of-work of each employed resident and the mode of travel used for commuting. To analyze possible relationships that could be used to estimate the demand for commuting travel from rural counties to urban centers, a database was constructed. The information contained in the database was:

- From the year 2000 Census:
  - Residence county
  - Workplace county
  - Commuters, by mode, from residence county to workplace county as reported in year 2000 Census
  - Population of residence county
  - Employment in workplace county

- From American Fact Finder[2]
  - Area of residence county
  - Area of workplace county

- From Google Earth
  - Coordinates of center of workplace county and of residence county
  - Distance from center of residence county to center of workplace county (computed from coordinates)

[2] http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml.

The dataset was constructed to include all county to county commuting movements for four states – Minnesota, Ohio, Georgia and Kansas (Table 6). These were chosen to reflect a diversity of environments, climate and mix of rural counties and urban centers. The one key data item that could not be included was the presence or absence of transit service. Data from the 2000 Census Transportation Planning Package were downloaded from the Census website for the four selected states. This yielded a dataset of 6,685 observed non-zero county-to-county commuter trips.

Table 6: Records in Dataset Used for Commuter Trip Analysis

State	Number of counties	Number of county-to-county non-zero commuter records
Georgia	86	1484
Kansas	89	1630
Minnesota	158	2595
Ohio	88	976
Total	**421**	**6685**

Other data that could be obtained and that were considered to possibly have a relationship to the demand for passenger transportation (e.g., distance, employment density) were appended to each record of county-to-county travel.

This basic dataset was used to examine some general relationships. The next step was to remove from the dataset all travel from urban (i.e., non-rural) residence counties. To do this all counties having a population density greater than 1000 persons per square mile were removed from the dataset. The remaining residence counties meet the general definition for non-urban, but some portions of these counties may have greater population density and may be included in an urbanized area.

Further analyses were conducted using this dataset. While it was possible to develop relationships that apparently resulted in satisfactory statistical relationships (for example):

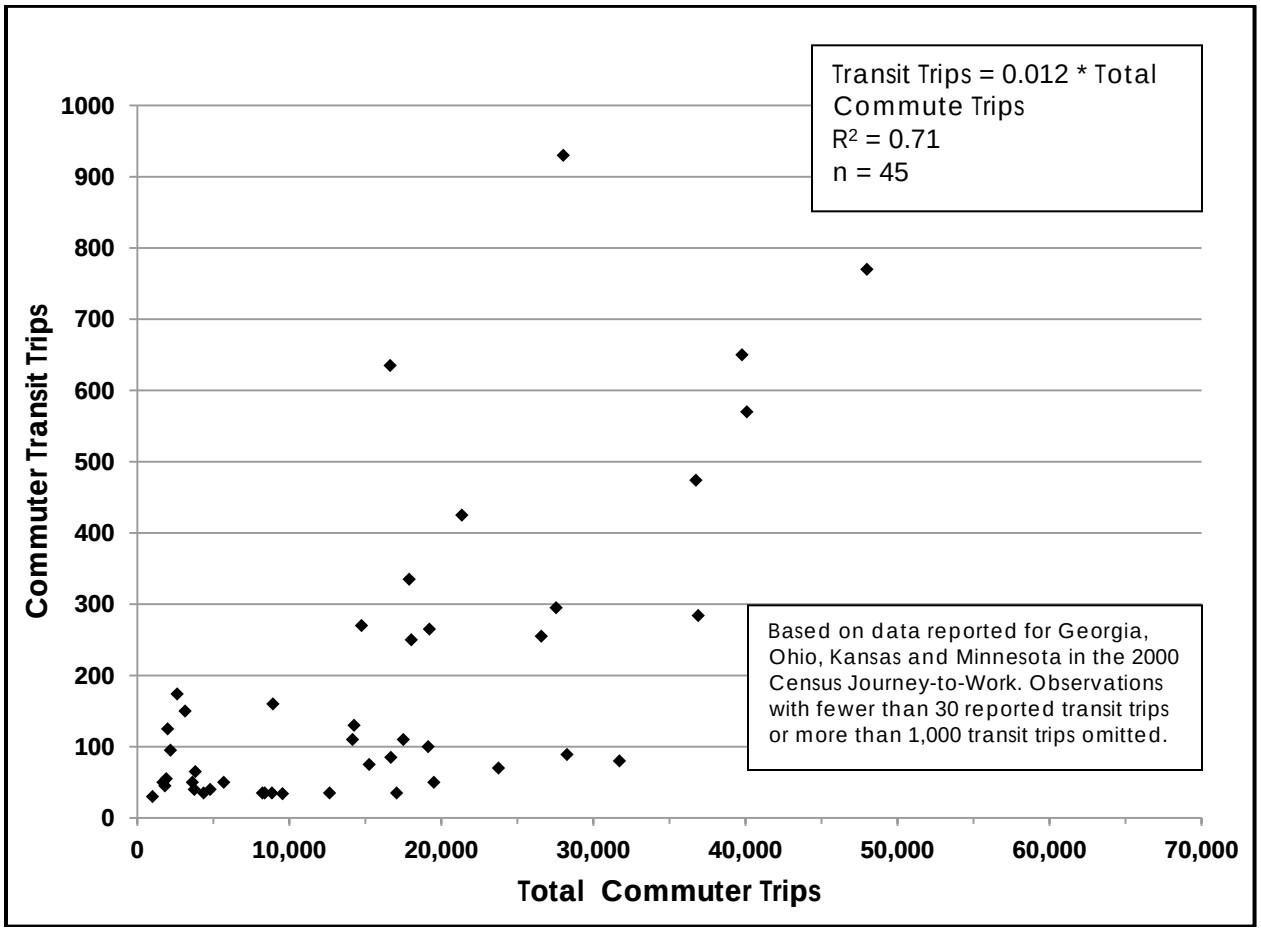
> *Transit Trips = f(rural county population, destination county employment, distance between counties)*

Further review of the data showed that the resulting relationship yielded little explanatory power and the estimated values for any given county-to-county movement could differ substantially from the values reported in the Census.

The next step in the analysis was to remove from the dataset those county-to-county movements for which the observed transit trips were either zero or quite low. As the commuting data were based on a 1 in 6 sample of households, observed values of transit trips in the dataset of 4 trips actually reflect one observation. Low (or zero) values for reported commuting trips, when there are a reasonable number of commuting trips by other modes, likely reflects a situation in which there is no available transit service. Such observations may reflect current conditions, but are not a valid indicator of either need or demand. Reasonable relationships for projecting the demand that would be found if transit service were provided can only be obtained by analysis of similar conditions.

The data presented in Figure 28 were developed using Year 2000 Journey-to-Work data from the Census. County-to-county interchanges for which fewer than 30 transit trips were reported have been removed from the dataset as being too small to be considered reliable, as have two observations that reported more than 1,000 transit trips. Those two observations were for travel to work in Hennepin County (Minneapolis) MN.

Figure 28: Relationship between Total Commuter Trips and Commute Trips Using Transit



Clearly there are many other factors that enter into the forecasting of the demand for passenger transportation service for commuting from rural counties to urban centers. The population of the rural county, the number of jobs in the urban center and the distance between the two counties are factors that affect commuting patterns. These factors are, however, reflected in the values reported in the Census. What is missing for estimation of the demand for transit service are factors reflecting the cost and quality of transit that is available. In addition, the concentration or dispersion of worksite locations within the urban center can have a strong effect on the viability of transit service. If available, this information would no doubt help to explain much of the variation seen in Figure 28. Unfortunately, specific data for these locations cannot be obtained without detailed analysis of each urban center.

However, as illustrated in Figure 28, an estimate of the demand for passenger transportation based on 1.2% of the total number of commuting trips is a reasonable first estimate for planning transit services from rural counties to urban centers.

Workshops

Purpose

Following the preparation of the initial Methodology Report and Workbook the project team was authorized to develop and conduct a series of workshops in various locations. The intent of the workshops was twofold – 1) to present the methodologies to planners and operators having responsibilities related to rural passenger transportation services, and 2) to obtain data from workshop attendees that could be used to validate, revise, and enhance the methodologies. Workshops were held in twelve states in the period between October 25, 2010 and July 13, 2011. Just under 200 persons attended the workshops. Data related to operations and ridership at the systems represented was obtained for 90 counties. Data for an additional 91 counties in Kansas were provided by University of Kansas staff. Data for additional counties in Indiana were obtained through the state transit association and data for Montana counties were obtained with data from the Montana Department of Transportation.

Organization

Workshop planning

Workshop planning began by identifying a set of states that were thought by the project team to satisfy the direction from the panel to obtain information that would reflect regional differences and likely to have both an interest in participating and rural transit agencies that would provide information that would be of use. The project budget allowed for workshops to be held in a dozen states.

An initial list of likely states was developed and contacts made with the designated RTAP representative in each state and, as appropriate, other representatives of each state's transportation agency or transit association known to team members.

The project team developed a preliminary workshop syllabus and schedule for a one-day program. It was determined that the workshops should be designed for about 15 to 25 attendees and would require attendees to access the Internet to obtain data necessary for the application of the various methodologies.

Locations and attendance

Project staff contacted the identified representatives for the targeted states by phone and/or e-mail and, after initial contact, sent to the designated individual a brief message outlining the scope and purpose of the workshops, the actions required of the contact person, the needs for the facility in which the workshop would be held, and the workshop syllabus. After the state representative had time to review the materials and, in some cases confer with others, the dates for the workshop and locations were confirmed. The venues for the workshops varied. Several were held in conjunction with state transportation association meetings. Others were held in training rooms of state DOTs, local rural transportation providers, or university classrooms. Those held in conjunction with state transportation

association meetings tended to have higher initial registration but also had conflicts with other conference-related activities or schedules.

To accommodate a special request from the local sponsor the final workshops, held in Indiana, were held on consecutive days in two different locations.

Table 7: Workshop Locations and Attendance

	Number of Attendees	Number of Attendees Providing Data
Arkansas	9	5
California	24	8
Colorado	14	8
Indiana	30	11
Kansas	15	14
Missouri	14	6
Montana	8	2
New York	21	14
Oregon	30	11
Pennsylvania	20	10
Virginia	5	4
Wisconsin	8	8
Total	198	101

Venues

The venues and facilities in which the workshops were held were varied. The venues included:

- Hotel or conference center in conjunction with state transit association meeting (California, Colorado, Montana, Oregon)
- Computer training room in state DOT building (New York, Wisconsin)
- Computer training room at university (Kansas)
- Training room at university conference center (Pennsylvania)
- Training room in rural transit agency headquarters (Arkansas, Indiana, Missouri, Virginia)

Each location had its advantages and disadvantages. The workshops held in conjunction with the state transit association meetings tended to have greater attendance but holding the audience was at times difficult. In some circumstances the workshop was scheduled concurrent with other sessions so some participants would choose to attend other activities for part of the day. At other locations the workshop was scheduled for the last day of the conference and many attendees did not stay for the entire workshop. In Oregon, many people left because of travel concerns related to a pending snow storm. The workshops held in the computer training rooms of state transportation agencies or universities, with computers in place, proved to be the easiest for the presenters. Since all of the computers had the

same software and configurations, if a difficulty arose in executing some aspect of the methodology, it required solving only once before the whole class could proceed. The disadvantages were:

- Class size needed to be limited. Training rooms with computers tended to have limited capacity (15 to 25) so not all interested parties could be accommodated.
- Attendees did not do the exercises on their own computers. This meant that data developed during the workshop was not available to the attendees afterward unless they took the time to make a copy.

The workshops held in training rooms of a conference center of a transit agency required that attendees bring their own portable computer. This was also true for workshops held in conjunction with state transit conferences. This led to some time consuming handholding and problem solving by the instructors as the computers of the participants tended to have different versions of required software (e.g., Excel 2003, Excel 2007, and Excel 2010). In addition, some attendees' computers had been configured by their agency's IT department in ways that made it difficult to make modifications necessary to access the local wireless connection, to access certain websites, or run specific software. Excel spreadsheets with embedded macros were a common problem. In some cases, the number of people accessing the internet simultaneously affected the performance of the connection. Despite these initial challenges, once these IT problems were resolved the resulting benefit was that the attendee now had a working version of the software on her or his computer. In addition, the datasets that had been developed during the workshop remained on the attendee's computer.

Syllabus

A syllabus was developed for the workshops covering all of the topics in the Methodology Report and the Workbook. For each topic an estimated time required to cover the subject matter, including class participation, was identified. An initial set of PowerPoint presentations was prepared for each topic and reviewed by all members of the team. The revised PowerPoints were then "presented" by the team in a meeting to time the presentations, develop presentation notes, and make necessary revisions.

The workshop syllabus is presented in Table 8. The PowerPoints used in the workshops are included as an Appendix. The initial syllabus and PowerPoints were prepared in the summer of 2010 prior to the first workshops. During the fall of 2010 and the winter of 2010-2011 there were several changes in data products developed by others that necessitated changes in the course materials.

The organization of the Census Main Page changed, requiring that several sides in the presentation be modified along with the written instructions. The first release of the American Community Survey 5-year data occurred in late 2010. This is the only dataset that provides information for areas having a population of less than 20,000; the situation in about 25% of the counties served by persons attending the workshops. Accessing the 5-year ACS data requires use of Census prepared and distributed software. A new unit was added to the workshop syllabus, along with a new PowerPoint and an addendum to the Workbook. These materials were used in the spring 2011 workshops. Finally, in early 2011 the Federal Highway Administration released data from the 2009 National Household Travel Survey. Data from this survey are used in the definition of the Mobility Gap – a factor in assessing the "need" for rural passenger transportation. New data based on the 2009 NHTS were prepared and

discussed in the workshops, but neither the course materials nor the distributed spreadsheet were updated to use the 2009 values.

Table 8: Workshop Schedule and Syllabus

Schedule & Syllabus

1. Introductions ..... 10 Minutes
2. Background (review of B-36 scope and process) …… …….. 15 Minutes
3. Introduction to the B-36 Workbook ..... 10 Minutes
4. Important Definitions ..... 15 Minutes

Estimating Need for Passenger Transportation

5. Population Segments Method ..... 15 Minutes
   5A. Exercise –Obtain data for their service area (Internet) ..... 30 Minutes

Break ..... 15 Minutes

6. Mobility Gap Method ..... 15 Minutes
   6A. Exercise – Develop Mobility Gap analysis for their service area (Internet)…….....30 Minutes

Estimating Demand for Passenger Transportation

7. General Public Rural
   7A. Peer Data ..... 15 Minutes
      7A1. Peer Exercise – Participants report data ..... 15 Minutes
   7B. Trip Rate Functions ..... 15 Minutes

Lunch ..... 60 Minutes

8. Non-Program Trips ..... 15 Minutes
   8A. Non-Program Trip Exercise ..... 15 Minutes
9. Program Trips ..... 15 Minutes
10. Small City Fixed-Route ..... 20 Minutes
11. Commuters to Urban Centers ..... 10 Minutes
12. Introduction to US Census' Local Employer-Household Dynamics ..... 15 Minutes
    12A. Accessing LEHD Data Exercise…… ..... ….……15 Minutes

Break ..... 10 Minutes

13. B-36 Excel Spreadsheet ..... 50 Minutes

Questions and Course Evaluation ……..10 Minutes

14. Accessing ACS 5-Year Data (Optional) ..... 30 Minutes

Internet access was essential for attendees to participate in the hands-on exercises which were included in the syllabus. In each exercise, the instructors described the method, provided an on-screen demonstration, and then walked participants through the exercise where they obtained data for their

community or county. In the first exercise, participants obtained data from the Census website to calculate the transit need based on population segments and then used the data again to calculate the Mobility Gap in the second exercise. Calculating demand using the peer system approach and the non-program trip methods were completed as exercises. As part of the non-program trip exercise, data were obtained from the Census website for that method and the demand calculated for each of the three market segments (elderly, mobility-limited, and general public). The Longitudinal Employer-Household Dynamics website was used to obtain commuter data for use in estimating commuter demand.
The workshops held in 2011 included a session on accessing the American Community Survey 5-year data. Instruction was provided in use of the spreadsheet tool to extract the data. Table number differences were given between the three-year and five-year data sets. As this information is applicable to places with a population under 20,000, it was included at the end of the workshops as an optional item for those who were interested.

The hands-on exercises were well received in all of the workshops. Participants were able to test their ability to obtain the data and could use the data in the future if they had it on their computer or took a copy on their flash drive.

Course Materials

Printed materials developed for use in the workshops included:

- A schedule and syllabus for the workshop
- A copy of the preliminary TCRP B-36 project workbook
- Copies of all PowerPoints used in the workshop session

Flashdrives were prepared containing copies of all the printed materials plus a copy of the spreadsheet developed to apply the methodologies and, for the workshops conducted in 2011, a copy of the Census spreadsheet used to access 5-year American Community Survey Data.

Each person attending the workshops was given a binder containing all the printed materials listed above and a flashdrive to take back to their respective agencies.

Results of Workshops

Data Obtained

A spreadsheet was developed to obtain from each person attending a workshop data related to the services provided in the county or counties in which their services operated and the use of these services. About two weeks prior to each workshop, an e-mail was sent to each registered attendee requesting that they fill in the spreadsheet and return it to the project team in advance of the workshop. During the workshops the instructors used these data in conjunction with the attendees to get a sense of how well the methodologies produced estimates that reflected their current operations.
In addition, the questions were designed in an attempt to get data for use in model refinement that proved in the methodology development to be unavailable or very difficult to obtain. For example, data on transit commuting services from rural settings to urban places, a market for which the project panel had requested a methodology, are not easily obtained from any existing sources. Questions to the

workshop attendees were an attempt to compile data on this market that could be used to refine the initial methodology.

The data requested from each operating agency included:

- Agency name
- Name and position of person completing data request
- Type of agency (local government, non-profit, for-profit, area Agency on Aging, other)
- Agency contact information (address, phone number, e-mail, website)
- Definition of agency service area, including a map if possible
- Service area population
- Service area size (square miles)
- Fleet size and composition
- Types of services operated (rural fixed-route, rural demand response, small city fixed-route, small city demand response, other). Maps of fixed route services were requested.
- For each service: annual vehicle-miles, annual vehicle-hours
- Annual one-way trips served, by market (elderly, disabled, other)
- Annual trips funded by other agencies including for each the agency name, the type of trips served, the annual number of trips served and the trip purpose
- Other transportation providers in their service area including the geographic area and types of trips served by each other agency and the annual number of trips served by each other agency.
- Whether the agency or operator provided commuter transportation service to an urban place. If yes, for each service the name of the urban place to which service is provided, the number of vehicle-trips provided on a weekday, the number of boardings per day, and the number of days per year that service is operated.
- List of colleges and universities in their service area and the enrollment at each

Recognizing that not all attendees were employees of operating agencies, a separate list of data was requested from those with planning agencies. These data included:

- Agency name
- Name and position of person completing data request
- Type of agency (local government, non-profit, for-profit, area Agency on Aging, other)
- Agency contact information (address, phone number, e-mail, website)
- Definition of agency service area, including a map if possible
- Information about agencies in the planning area that provide transportation (for each agency):
    - Agency name
    - Name and position of person completing data request
    - Type of agency (local government, non-profit, for-profit, area Agency on Aging, other)
    - Agency contact information (address, phone number, e-mail, website)
    - Service area size (square miles)
    - Fleet size and composition

- Types of services operated (rural fixed-route, rural demand response, small city fixed-route, small city demand response, other). Maps of fixed route services were requested.
- For each service: annual vehicle-miles, annual vehicle-hours
- Annual one-way trips served, by market (elderly, disabled, other)
- Annual trips funded by other agencies including for each the agency name, the type of trips served, the annual number of trips served and the trip purpose
- Whether the agency or operator provided commuter transportation service to an urban place. If yes, for each service the name of the urban place to which service is provided, the number of vehicle-trips provided on a weekday, the number of boardings per day, and the number of days per year that service is operated.
- List of colleges and universities in their service area and the enrollment at each

General Public Rural Transit (Non-Program Trips)

Data from 207 agencies providing non-program type services from 14 states were collected (Table 9). The breakdown of the number of agencies by state can be seen in the table below. A review of the data collected revealed that some of the agencies were part of urban areas and others did not provide sufficient data to conduct a full analysis. Once these agencies were removed from the initial figure there were 150 agencies remaining.

Table 9: Workshop Attendees Providing Data about General Public (non-program) Trips

State	Number of Agencies Reporting
Arkansas	9
California	18
Colorado	8
Indiana	50
Kansas	14
Maryland	1
Missouri	13
Montana	23
New York	25
Oregon	11
Pennsylvania	9
Virginia	4
Wisconsin	17
Wyoming	18

Program (sponsored) Trips

Program trips are defined as those trips that would not be made but for the existence of some type of social service program. In many cases the agency providing the program also provides the transportation service; in some instances transportation to the social service program activity is provided by the rural transportation agency. For program trips the time of travel and the destination of the trip is designated by the agency rather than the traveler.

Since the workshop attendees were mostly general public transit providers, the data obtained about human service agencies and program trips were limited. Even though the ridership was categorized by market segment—elderly, people with disabilities, and other riders—the information was not specific to the trip purpose or to the specific program or activity being served. Therefore, most of the information was not directly useful for enhancing program trip demand estimation methods. Information received from most senior transportation services grouped the total number of trips into one number and did not separate the trips by trip purpose, such as senior meals, shopping, etc. Also, many senior transportation providers, especially in Indiana and Montana, also provide transportation to the general public and are not restricted to seniors.

Most of the program trip data were obtained through questions that asked providers to list funding agencies and the number of annual trips funded by that agency or to list other transportation providers that offer passenger transportation in the area. The service areas and the eligibility requirements to use the service were not asked of these funding agencies and other transportation providers in the area and hence these factors were assumed based on the name of the agency providing the trips and information obtained directly or indirectly about the agency.

Small City Fixed Route

In many rural counties there exist one or more small cities in which a traditional fixed-route, fixed-schedule transit service is operated. Data were collected at the workshops and directly from state DOTs that participated in the workshops. Participants included systems operating fixed-route transit service. A number of the fixed-route systems however were from urbanized areas and were not included in the testing of the demand estimation. After screening out any systems in urbanized areas and systems with insufficient data, information from 19 small city fixed-route transit systems was available.

Commuters from Rural Area to Central City

One of the new markets that prospective users of the methods requested be addressed was commuter travel from rural counties to the central city of a metropolitan area. There is no convenient source for data about this type of travel. The journey-to-work component of the decennial Census for 2000 and the American Community Survey for 2005 and subsequent years does have information about the number of persons resident in each county who work in other counties or cities. Similar information can be found in the Longitudinal Employer-Household Dynamics datasets [www.lehd.did.census.gov] maintained by the Bureau of the Census. The Census and ACS data also provide information on the number of commuting trips made using each mode of travel, so a percentage of commuting trips by transit for any given county-to-city market can be computed. Census data can also be used to determine

the number of workers resident in any given rural county and the number of persons employed in any given central city of a metropolitan county. What is lacking is any readily available information about the presence or absence of transit services available for the commuters or the quality and cost of such services.

In the data collection instrument provided to each workshop attendee, a question was asked about the existence of transportation service from the attendee's rural county to a metropolitan center. Sixteen attendees reported that such services existed. Of these, ten proved on examination to truly represent a rural to urban market and provided sufficient information to permit estimating a percentage of commuters using transit for the travel market served.

Findings

While not attracting as many attendees as might have been desired, the workshops proved to be a successful method of introducing those who did attend to not only the specific product of project B-36 but also to TCRP in general. While some attendees were quite familiar with TCRP many were not. The workshops served to make them aware of the many TCRP products that could be of use in planning or operating their services. In addition, for many attendees the workshops were their first introduction to the data products available for the U.S. Census. Familiarity with the Census websites and data products were seen by many as useful skills for various aspects of their job responsibilities.

The workshops and discussions made it clear to the presenters that it was not necessary, and may even have been counter-productive, to present the detailed mathematical functions that supported the Non-Program demand analysis. The data from the functions were summarized in a chart and a table for use in the workshop training sessions. This same approach will also be used in the revised workbook. Workshop attendees seemed to be generally satisfied with the methods even with the many limitations. One participant expressed the opinion that the estimation of "need" should reflect not only residents of households having no private vehicle but also should include rural workers resident in single car households. This is a topic that could be pursued in greater depth in subsequent research. Another workshop participant identified as a market the weekend transportation patterns of family and visitors to prison facilities. This market and other unique markets such as resort area demand would require additional studies as well.

Phase II

Phase 2 of the project included not only the workshops but also reanalysis of the suggested demand estimation functions using both data obtained from the workshop attendees and data sources that had become available since the completion of Phase 1 in 2009. The two primary new sources were the 2009 National Household Transportation Survey and the reporting year 2009 Rural NTD. The latter was particularly useful since, unlike the reporting year 2006 Rural NTD, the 2009 data included identification of the counties served by each reporting agency. This permitted associating demographic data from the 2010 decennial Census and the American Community Survey with data in the Rural NTD. In addition the release late in 2010 of the 5-year American Community Survey data provided information about counties having a population of less than 20,000 that had not previously been available.

Analysis and Findings

Need

The definitions of need developed in Phase 1 were presented in the workshops. The participants tended to agree that the suggest approach using two measures – one measure of need related to the number of individuals likely to require a passenger transportation service for at least some of their travel and a second measure of need related to the number of trips – was appropriate and useful. As in Phase 1 the populations in need were defined as:

- Persons residing in households with income below the poverty line
- Persons residing in households lacking a personal vehicle

The use of the Mobility Gap, defined as the difference in daily trip rates for rural households having one vehicle and rural households having no vehicle was also retained but the values of the gap were updated based on the 2009 NHTS (Figure 29). Note that the gap is measured against households having one vehicle rather than one or more vehicle. This yields a more conservative estimate of need. The quantitative measure, by Census Division, was revised to reflect data from the 2009 National Household Transportation Survey.

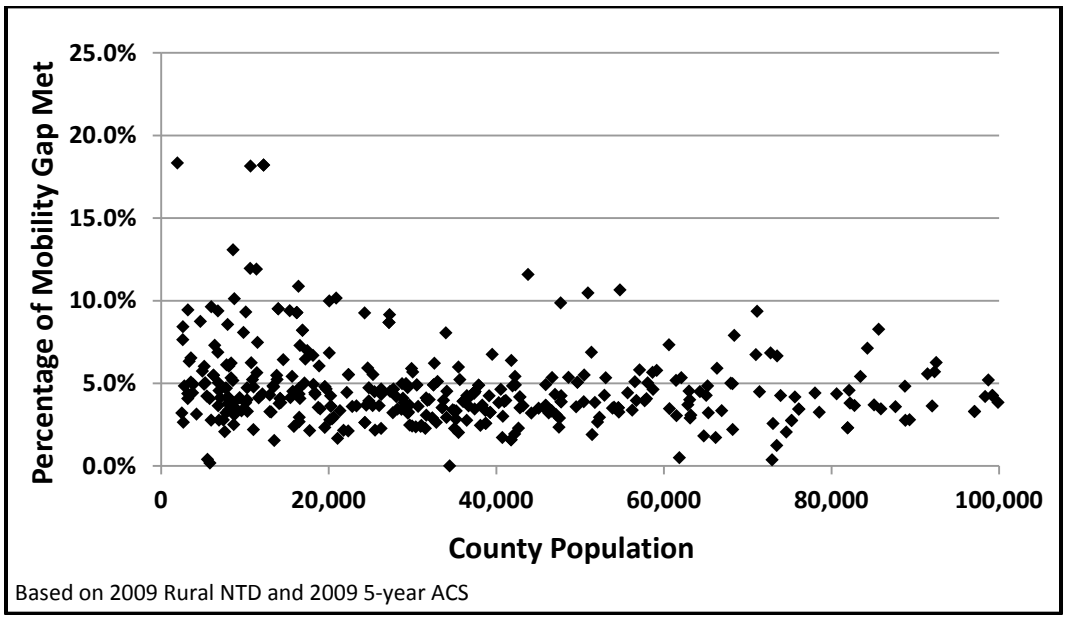
The definitions of need, measured in the number of trips that would have to be served to fully close the Mobility Gap, yields values that are quite large. This is an indication that households lacking a personal vehicle find other ways to satisfy their travel needs, such as riding with a friend or relative, or simply forgo certain trips. While these strategies enable residents of these households to satisfy their basic needs, the lesser trip rates are an indication that residents of rural households lacking a personal vehicle are restricted from full participation in the opportunities offered by society.

Given the large value of the unmet trip need suggested by the Mobility Gap, it is useful to understand how well current rural systems are doing in meeting this need. The data in Figure 30 illustrate that in the majority of rural counties 5% or less of the Mobility Gap is met by existing services and that even in the best circumstances less than 20% of the gap is filled.

Figure 29: Daily Trip Rates for Rural Households (NHTS, 2009)

Division	States	Trips per Rural Household Per Day			
		Vehicles Available		Gap	Change from 2001 NHTS
		0	1		
National		3.2	4.7	1.5	-0.6
Division 1:	ME, VT, NH, MA, CT, RI	3.3	5.0	1.7	*
Division 2: Middle	NJ, NY, PA	3.5	4.8	1.3	-1.4
Division 3: East North Central	WI, MI, OH, IN, IL	2.7	4.1	1.4	-0.4
Division 4: West North Central	ND, SD, NE, KS, MO, IA, MN	2.4	4.5	1.7	-1.1
Division 5: South Atlantic	MD, DE, WV, VA, NC, SC, GA, FL	3.2	4.5	1.2	-1.2
Division 6: East South Central	KY, TN, AL, MS	2.7	4.1	1.4	-1.4
Division 7: West South Central	OK, AR, TX, LA	2.9	4.9	2.0	-0.5
Division 8: Mountain	ID, MT, WY, CO, UT, NE, AZ, NM	5.2	6.0	0.8	-0.4
Division 9: Pacific	WA, OR, CA, AK, HI	3.8	4.9	1.1	-1.4

Figure 30: Percentage of Mobility Gap Met vs. County Population



Based on 2009 Rural NTD and 2009 5-year ACS

Demand

Travel on Public Systems

Travel by the general public, referred to as non-program trips, in Phase 1, are those trips for which the passenger determined the trip time and destination. Non-program trips as they were defined in Phase 1 are akin to, but not the same as, general public transit trips as there are some types of passenger transportation services that are not tied to a specific program activity yet are restricted to use by specific client groups. Some programs funded under the Older American Act are of this type as use of such services is limited to persons age 60 or older. Where such services exist the amount of service available to persons age 60 or older is greater than the service available to the general public; a distinction thought to be relevant is the demand for passenger transportation is related to the amount of service supplied. In the workshops the participants understood this distinction but did not see it as relevant to the services with which they were familiar. In addition, data that identifies such services and the ridership on those services are not easily obtained in any national database and were not reported by workshop attendees. For Phase 2, therefore, the research team adopted the definition "Travel on Public Systems" to reflect this type of trip. Public systems are defined as those which are eligible to submit data to the National Transit Database.

Procedures based on data obtained from workshop attendees

Workshop attendees provided information about 220 general public transportation services. As noted previously in this report, the method for estimating demand presented in *TCRP Report 3* was based on the number of persons resident in the county of interest in each of three markets:

- Population age 60 or over
- Population age 16 to 64 with a mobility limitation
- Persons resident in households with income below the poverty line

These were then each multiplied by a factor computed using a logistic function of service provided measured in annual vehicle-miles per square mile:

$$D = R_e E \left(\frac{1}{1 + K_e e^{-U_e}}\right) + R_m M \left(\frac{1}{1 + k_m e^{-U_m}}\right) + R_p P \left(\frac{1}{1 + k_p e^{-U_p}}\right)$$

where:

D = Demand for passenger transportation service (trips per year)
E = Number of persons age 60 or over
M = Number of persons having a mobility limitation
P = Number of persons resident in a household with income below the poverty line
$R_e = R_m = R_p = 1{,}200$

$$U_e = 0.000510 \text{ x } \frac{Annual\ Vehicle\ Miles\ Available\ to\ the\ Elderly\ Market}{Area\ of\ the\ County}$$

$$U_m = 0.000400 \text{ x } \frac{Annual\ Vehicle\ Miles\ Available\ to\ the\ Mobility\ Limited\ Market}{Area\ of\ the\ County}$$

$$U_p = 0.000490 \text{ x } \frac{Annual\ Vehicle\ Miles\ Available\ to\ the\ Low-income\ Market}{Area\ of\ the\ County}$$

$k_e = e^{6.38}$; $k_m = e^{6.41}$; $k_p = e^{6.63}$

Report 3 provided the full function as specified above, but also provided charts that permitted the user to obtain the values from the chart without going through the computations. The spreadsheet provided with *Report 3* incorporated the full function.

The workbook developed for Phase 1 of this project provided three additional methods:

- passengers per vehicle-mile,
  Annual Rural Transit Trips = 0.2 trips per annual rural vehicle-mile
- passengers per vehicle-hour, and
  Annual Rural Transit Trips = 3.7 trips per annual rural vehicle-hour
- annual vehicle hours per capita
  Annual Trips/Person = 1.97 x (Annual Vehicle-hours/person)$^{0.69}$

Using the data obtained from workshop attendees the demand was estimated using each of the methods and compared to the annual ridership as reported by the attendees. The comparison of observed and estimated for each of the methods is shown in Figure 31 to Figure 34.

Figure 31: Comparison of Reported General Public Demand vs. Estimate Based on Report 3 Function

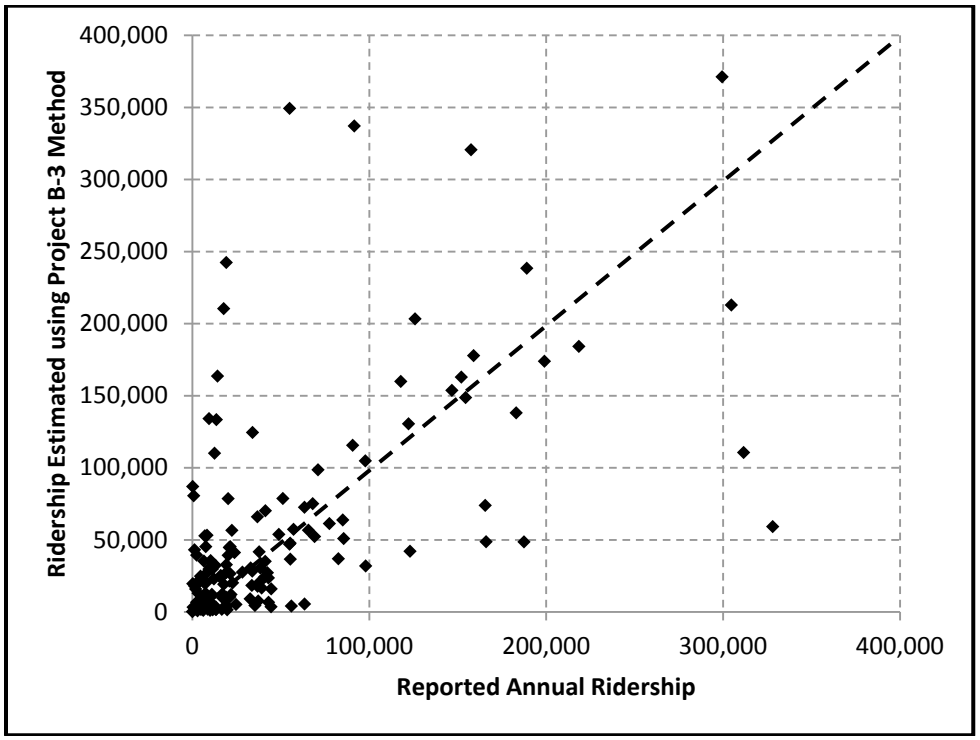


Figure 32: Comparison of Reported General Public Demand vs. Estimate Based on Trips per Vehicle-Mile

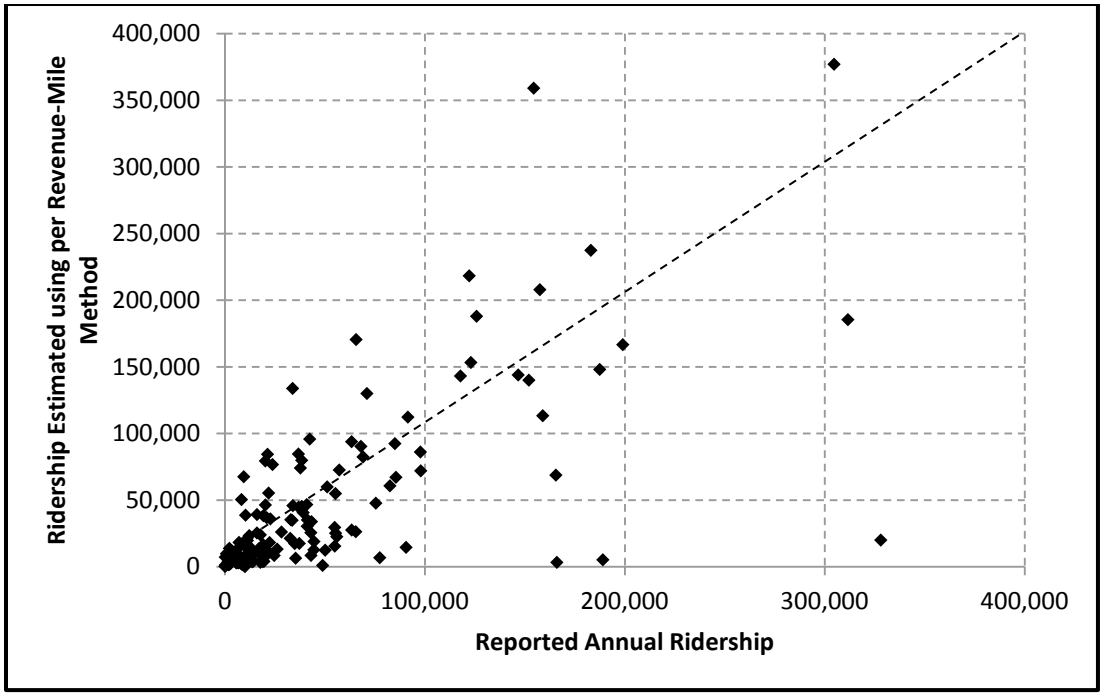


Figure 33: Comparison of Reported General Public Demand vs. Estimate Based on Trips per Vehicle-Hour

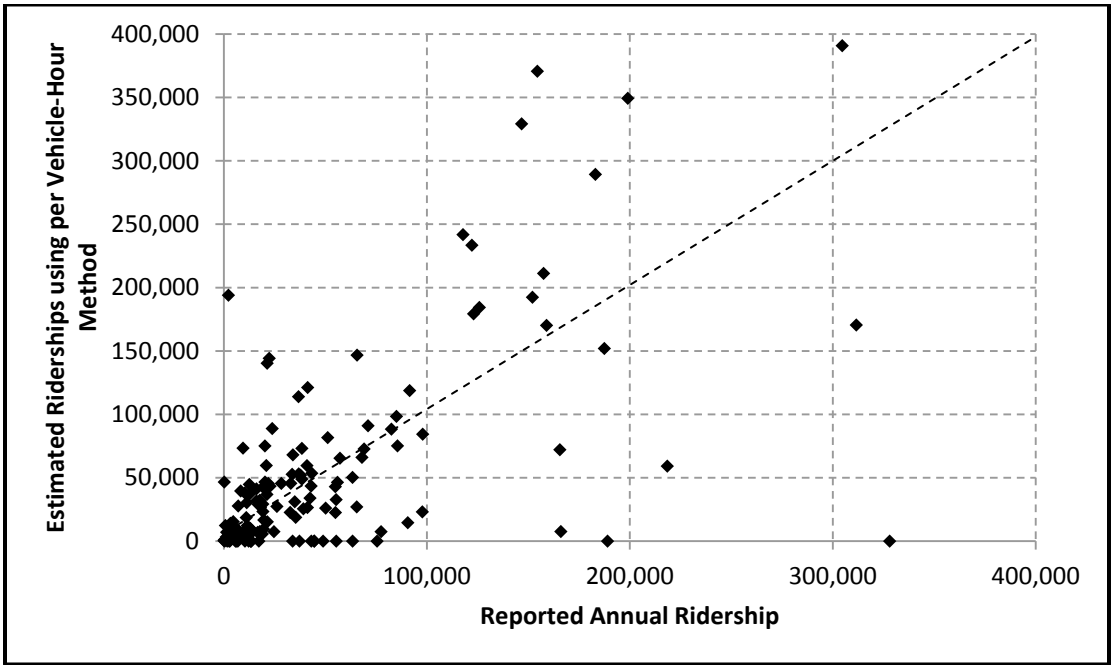
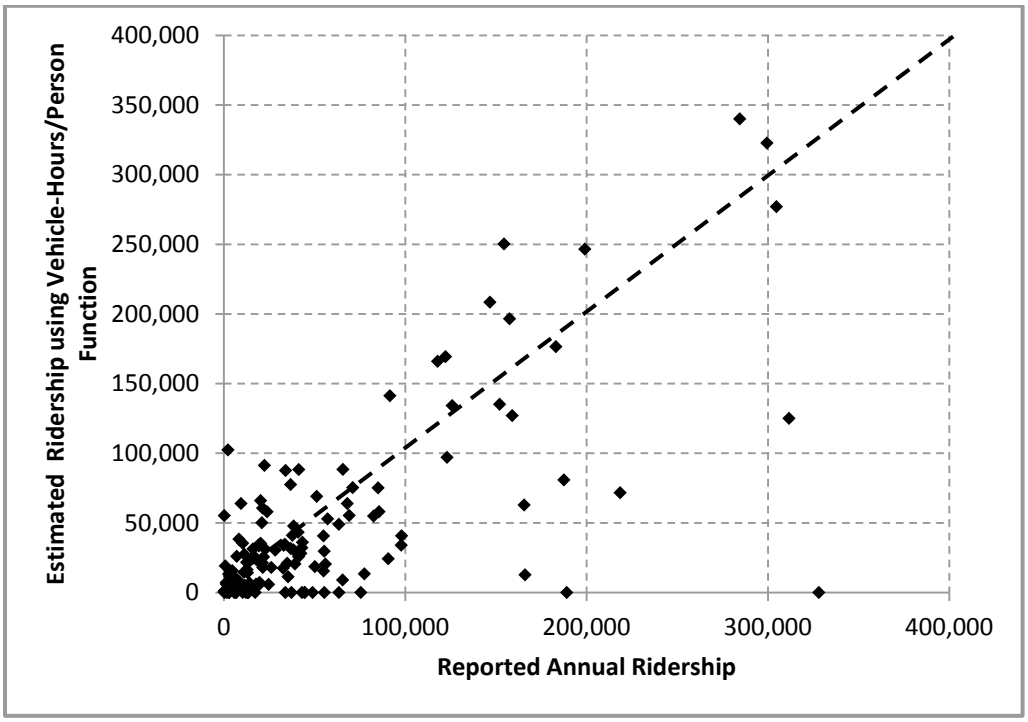


Figure 34: Comparison of Reported General Public Demand vs. Estimate Based on Trips per Vehicle-Hour per Capita



Each of the methods showed a relationship between the observed and estimated values but none was clearly superior. The two methods incorporating a measure of the amount of service provided yielded only slightly better results. In addition, the *Report 3* method, the most complex, when applied in practice was found to yield only slight variations in the estimated demand within the range of the amount of service provided by operating agencies.

While the methods based on the vehicle-miles or vehicle-hours operated do yield reasonable estimates of demand, as measured by observed ridership, there are serious cause and effect issues. Agencies offer services in response to demand, so that miles or hours operated may reflect the quantity of service needed to meet demand. Alternatively, the observed relationship between the quantity of service offered and ridership may represent the real world constraints on the number of passengers that can be served in a rural environment in an hour. The fact that the average value of passengers per mile and passengers per hour is stable over a wide range of observed values is likely a reflection of the fact that there is a reservoir of latent, unserved demand that would make use of passenger transportation services were more service provided. The large gap between need as computed based on the Mobility Gap and the reported trips served supports this thesis.

To explore possible general public demand relationships revealed by the data obtained from workshop attendees a simple correlation analysis was performed assessing the correlation of reported ridership to demographic factors known to describe the likely markets and factors related to the quantity of service provided (Table 10). While the highest correlations are with the amount of service provided, these are not desirable as key elements in a predictive function due to the cause-and-effect issues discussed above.

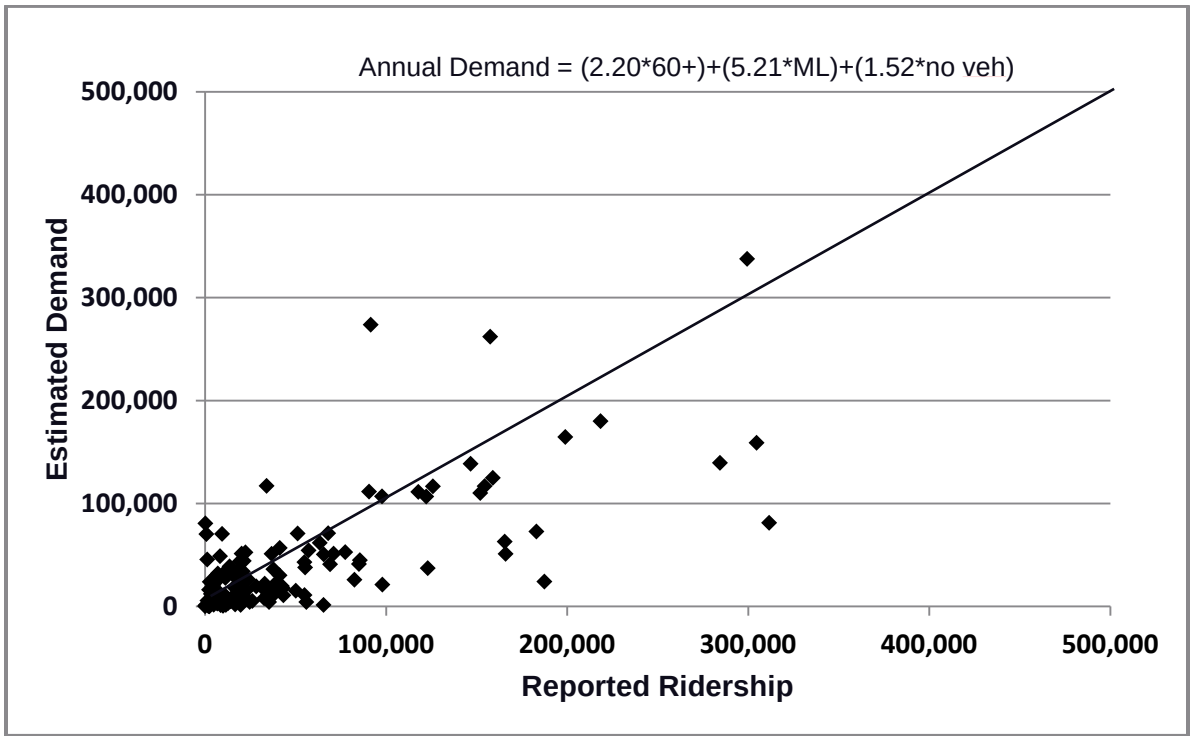
Table 10: Correlation of General Public Ridership with Other Factors (data from workshop attendees)

Factor	Correlation (r)
Population	0.51
Persons in poverty	0.51
Persons age 60+	0.54
Mobility limited persons age 16 to 64	0.54
Persons living in household with no vehicle	0.38
Vehicle-miles	0.66
Vehicle-hours	0.64

Linear regression was performed to assess possible relationships. The function based solely of demographic factors yielding the most satisfactory relationship is:

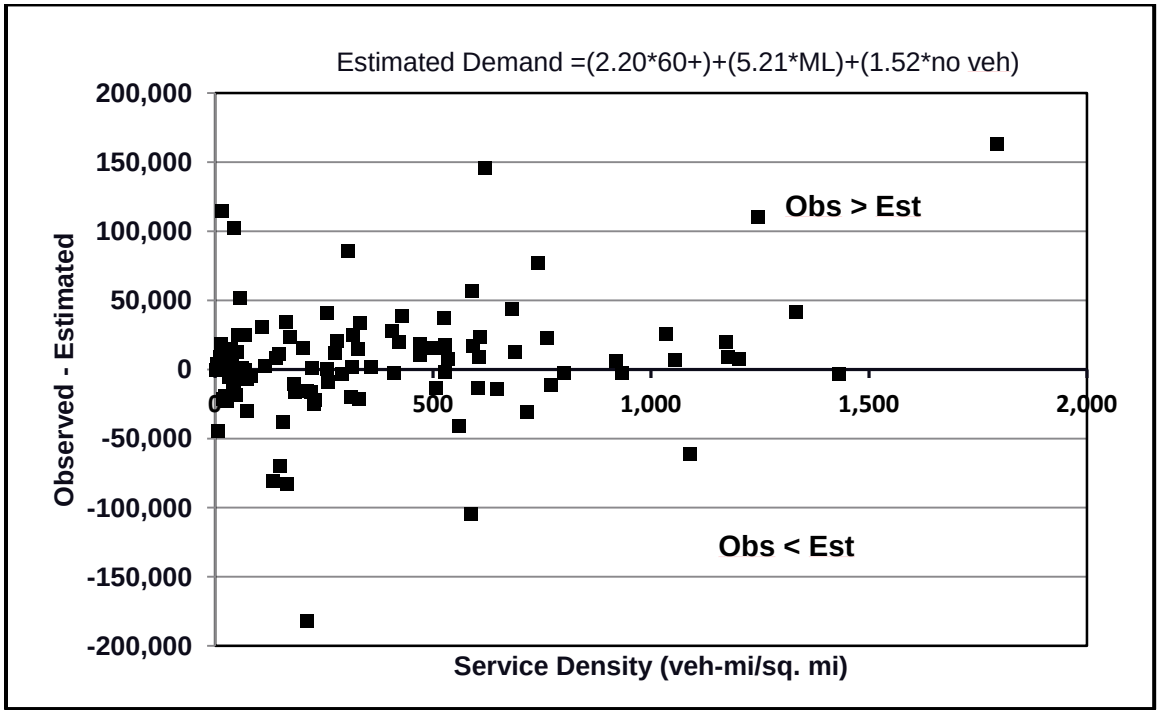
Non-program Demand (trips per year) = (2.20 * Population age 60+)
+ (5.21* Mobility Limited Population age 16 to 64)
+ (1.52 * Residents of Households having No Vehicle)

Figure 35: Reported Ridership vs. Estimated Demand (function derived from workshop data)



To test the effect that adding a factor related to the quantity of service available, the residuals were plotted against the service density measure annual-vehicle-miles per square-mile (Figure 36).

Figure 36: Residuals of Estimated Demand Plotted Against Service Density



The data in Figure 36 suggest a slight relationship of residuals vs. service density. This was tested and it was found that adding a service density term did little to increase the r^2 value of the resulting linear relationship.

Procedures based on data from the National Transit Database

At about the same time as the conclusion of the workshops and the beginning of the general purpose demand analysis using the workshop data, the 2009 Rural NTD data also became available. This dataset included information of the counties served by each reporting agency; information that had not been available in the 2006 dataset. Knowing what counties are served permitted the addition of information to the NTD dataset about the population, population age 60+, mobility limited persons, persons resident in households with no vehicle, and approximate size of service area for each of the reporting agencies. The 2009 Rural NTD included information from 1,634 non-intercity providers of which 1,125 reported providing demand-response services. The reported data included annual vehicle-miles operated, annual vehicle-hours operated, the number of regular unlinked trips served and the number of coordinated trips served. Since linking demographic data from the 2009 ACS and county area information to the NTD reporting was a manual process, a 50% sample was drawn from the NTD data by taking every-other record from the data file. The other data were then associated with the reported data for this sample resulting in 511 samples available for analysis. As would be expected, as illustrated in Figure 37 and

Figure 38, these data show that there is some correlation between reported ridership and service provided, although there is substantial scatter.

Figure 37: Annual Unlinked Trips vs. Vehicle-Miles (2009 Rural NTD 50% sample)

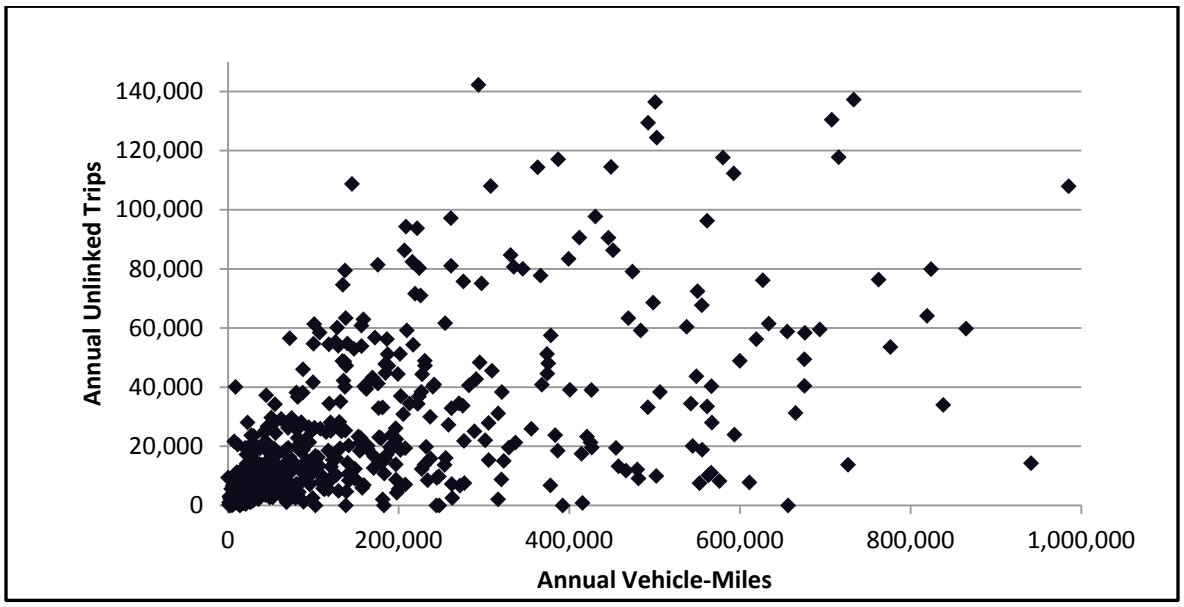
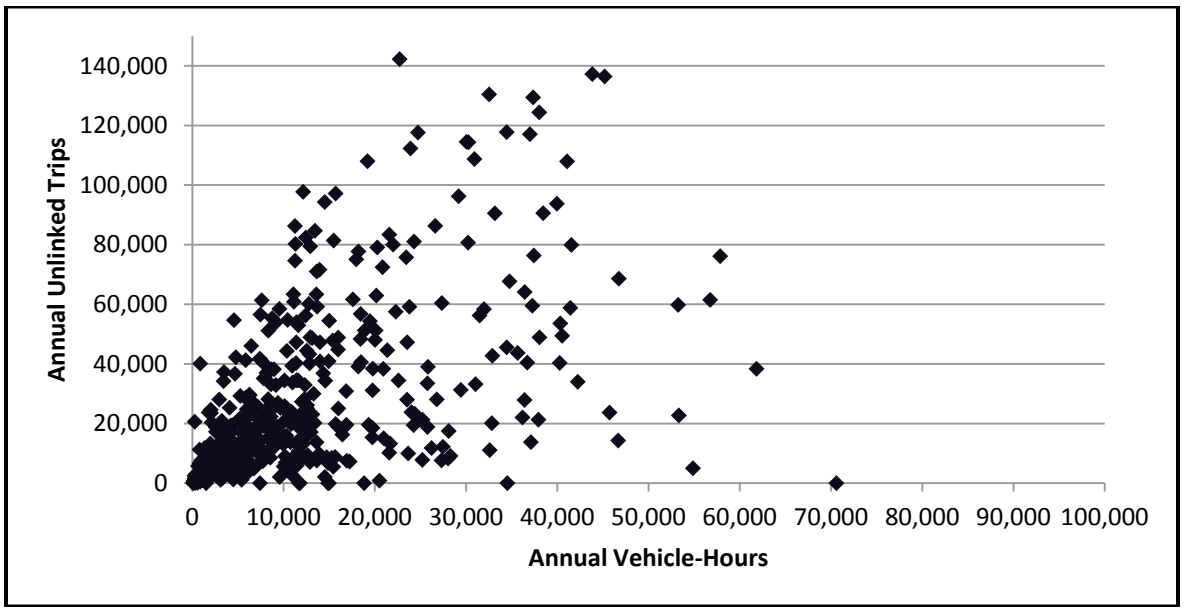


Figure 38: Annual Unlinked Trips vs. Vehicle-Miles (2009 Rural NTD 50% sample)



The relationships between reported unlinked trips and the factors identified as indicators of need show weaker relationships (Figure 39 and Figure 40).

Figure 39: Annual Unlinked Trips vs. Population in Poverty (2009 Rural NTD 50% sample)

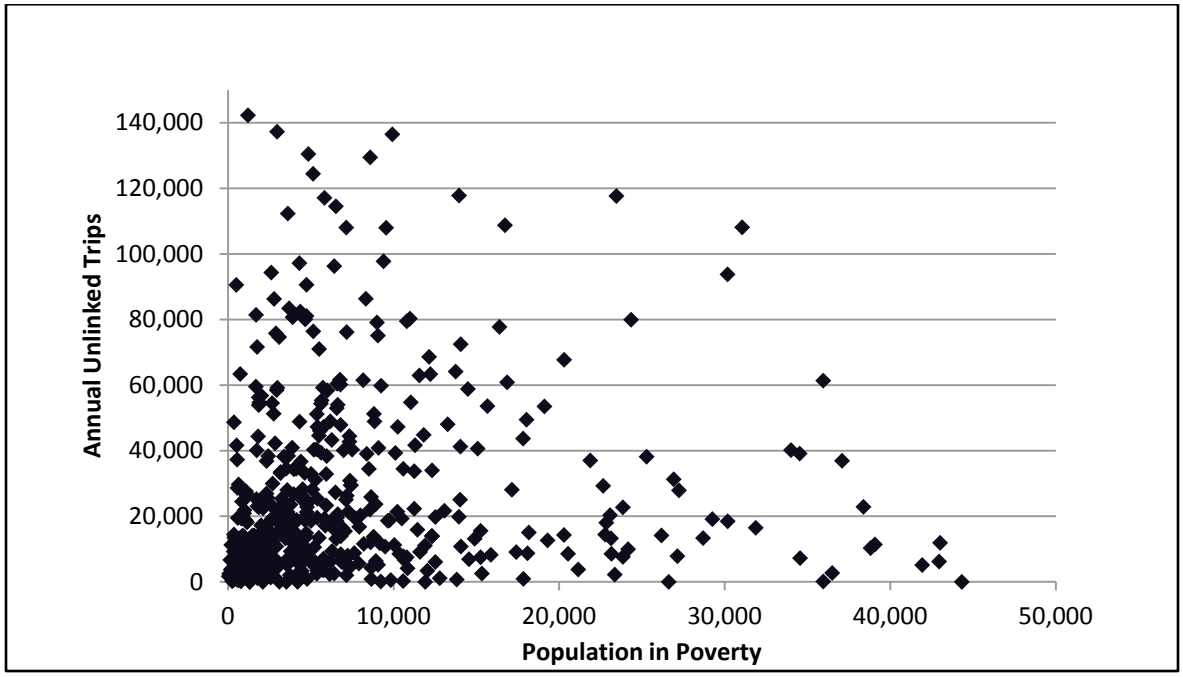
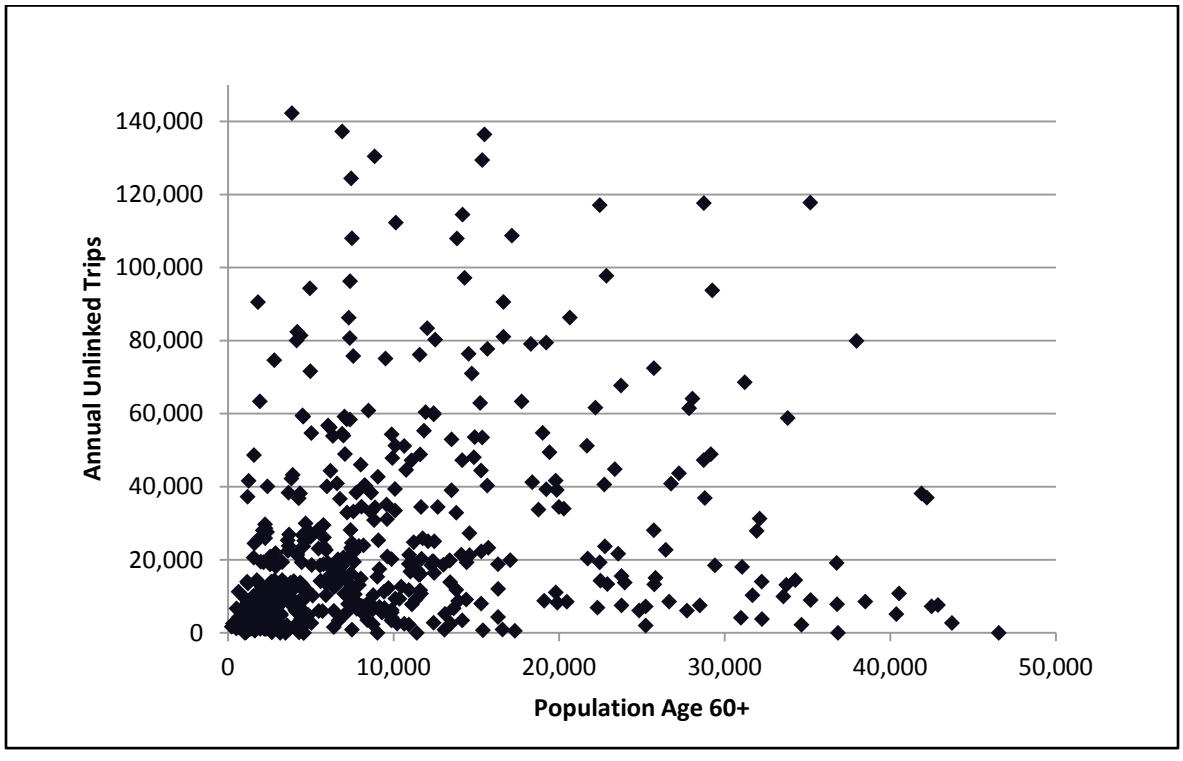


Figure 40: Annual Unlinked Trips vs. Population in Age 60+ (2009 Rural NTD 50% sample)



The relationships of reported unlinked plus coordinated trips against the same factors are similar but show slightly less scatter.

To explore the factors that might be most useful in a relationship for estimating the demand for rural general public transportation and also the way in which these relationships might vary across the nation correlation analysis was done relating both regular unlinked trips and unlinked plus coordinated trips to other factors (Table 11 and Table 12).

Table 11: Correlation of Unlinked Trips with Other Factors (National and by Census Division)

Census Division	1	2	3	4	5	6	7	8	9	All
Number of Observations	14	8	100	65	96	32	34	112	50	511
Vehicle-Miles	0.11	0.85	0.76	0.88	0.58	0.34	0.26	0.58	0.47	0.33
Vehicle-Hours	0.16	0.83	0.75	0.86	0.70	0.27	0.10	0.63	0.68	0.34
Population	-0.05	0.78	0.04	0.07	0.26	-0.08	0.38	-0.01	-0.04	0.05
Pop in Poverty	0.21	0.13	0.00	0.05	0.29	-0.04	0.48	0.00	0.04	0.10
Pop Age 60+	0.35	0.89	0.04	0.11	0.36	-0.06	0.37	0.00	-0.09	0.06
Pop in no car HH	0.32	0.57	-0.02	0.02	0.24	-0.09	0.44	0.00	-0.04	0.06
Poverty + Age 60+	0.31	0.80	0.03	0.09	0.35	-0.05	0.45	0.00	-0.02	0.08
Poverty + No car + Age 60+	0.31	0.79	0.02	0.08	0.33	-0.06	0.45	0.00	-0.02	0.08
Vehicle-mi per Sq. Mi.	-0.23	0.25	0.65	0.67	-0.18	0.41	-0.02	0.26	0.44	0.43

Table 12: Correlation of Unlinked plus Coordinated Trips with Other Factors (National and by Census Division)

Census Division	1	2	3	4	5	6	7	8	9	All
Number of Observations	14	8	100	65	96	32	34	112	50	511
Vehicle-Miles	0.91	0.85	0.84	0.83	0.89	0.82	0.30	0.59	0.72	0.63
Vehicle-Hours	0.96	0.83	0.83	0.84	0.87	0.77	0.16	0.64	0.87	0.61
Population	0.19	0.78	0.02	0.05	0.23	0.09	0.35	-0.01	0.01	0.05
Pop in Poverty	0.28	0.13	0.00	0.03	0.38	0.16	0.46	0.00	0.07	0.09
Pop Age 60+	0.06	0.89	0.02	0.08	0.33	0.10	0.35	0.00	-0.02	0.07
Pop in no car HH	0.17	0.57	-0.04	0.00	0.26	0.14	0.41	0.00	0.03	0.06
Poverty + Age 60+	0.13	0.80	0.01	0.06	0.36	0.13	0.42	0.00	0.03	0.08
Poverty + No car + Age 60+	0.14	0.79	0.01	0.05	0.35	0.13	0.42	0.00	0.03	0.08
Vehicle-mi per Sq. Mi.	0.42	0.25	0.70	0.65	-0.19	0.65	-0.02	0.26	0.47	0.53

As can be seen not only are strong correlations between reported trips and demographic factors generally lacking but also there is wide variation between the correlations by Census Division.

In a previous section the concept of need, and the definition of need in terms of the mobility gap, was introduced. Need was defined in terms of trips per day based on the Mobility Gap. In order to compare the estimated need to the trips as reported, the estimated daily need was multiplied by 300 days per year. The next step in the analysis was to explore the relationship between reported trips and estimated need. This would have the desirable properties of linking the method for estimating demand with the estimation of need and, since the Mobility Gap is defined by Census Division would to some extent, reflect the variations by Census Division. Figure 41 and Figure 42 illustrate the relationships between need and reported trips. A slight linear trend is apparent. Given that the estimates of need are greater by almost an order of magnitude than the number of trips reported served, it was thought desirable to consider logarithmic relationships. Figure 43 illustrates the data on a logarithmic scale.

Figure 41: Trip Need vs. Regular Trips Served (2009 NTD) Need < 2,000,000

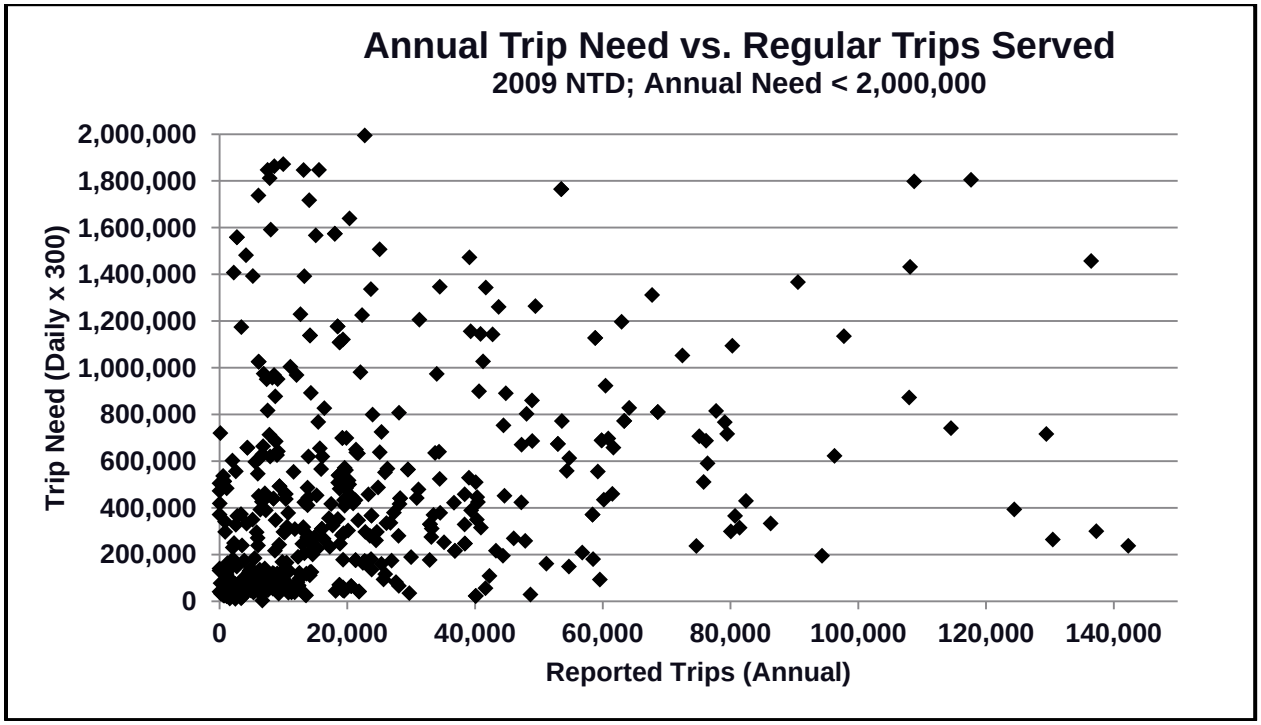


Figure 42: Trip Need vs. U + C Trips Served (2009 NTD) Need < 2,000,000

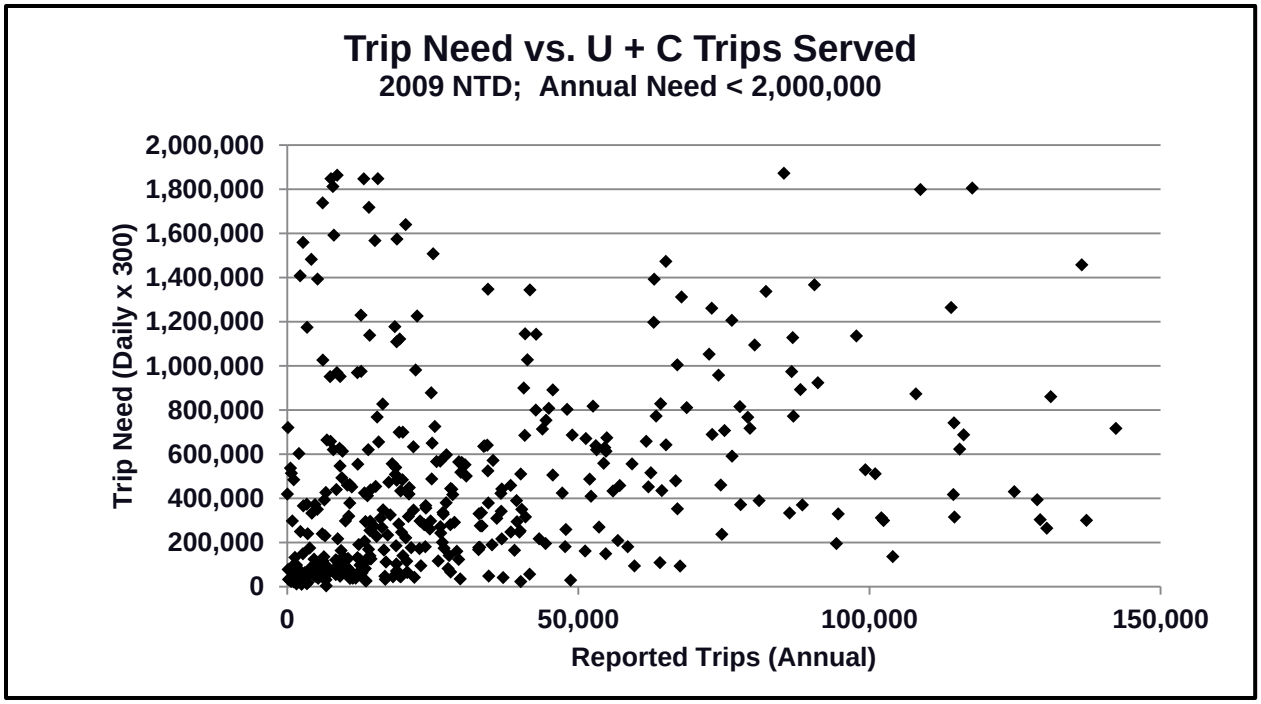


Figure 43: Regular Unlinked Trips Reported vs. Computed Trip Need (2009 NTD) Log Scale

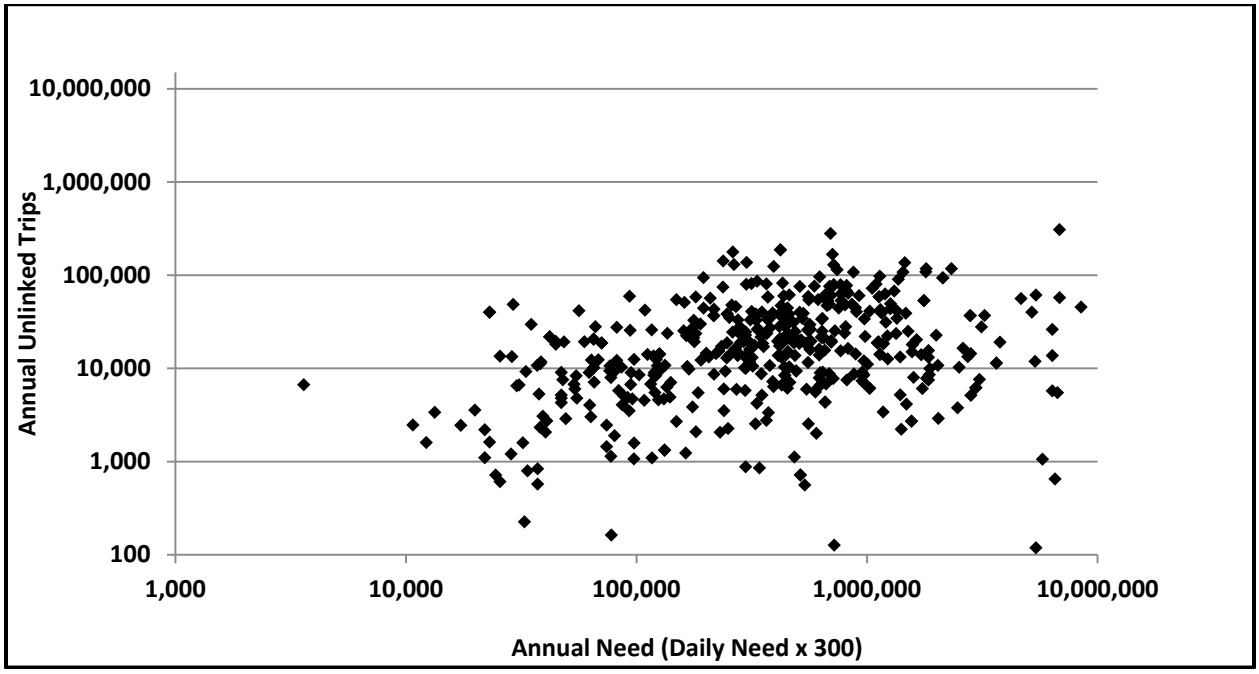
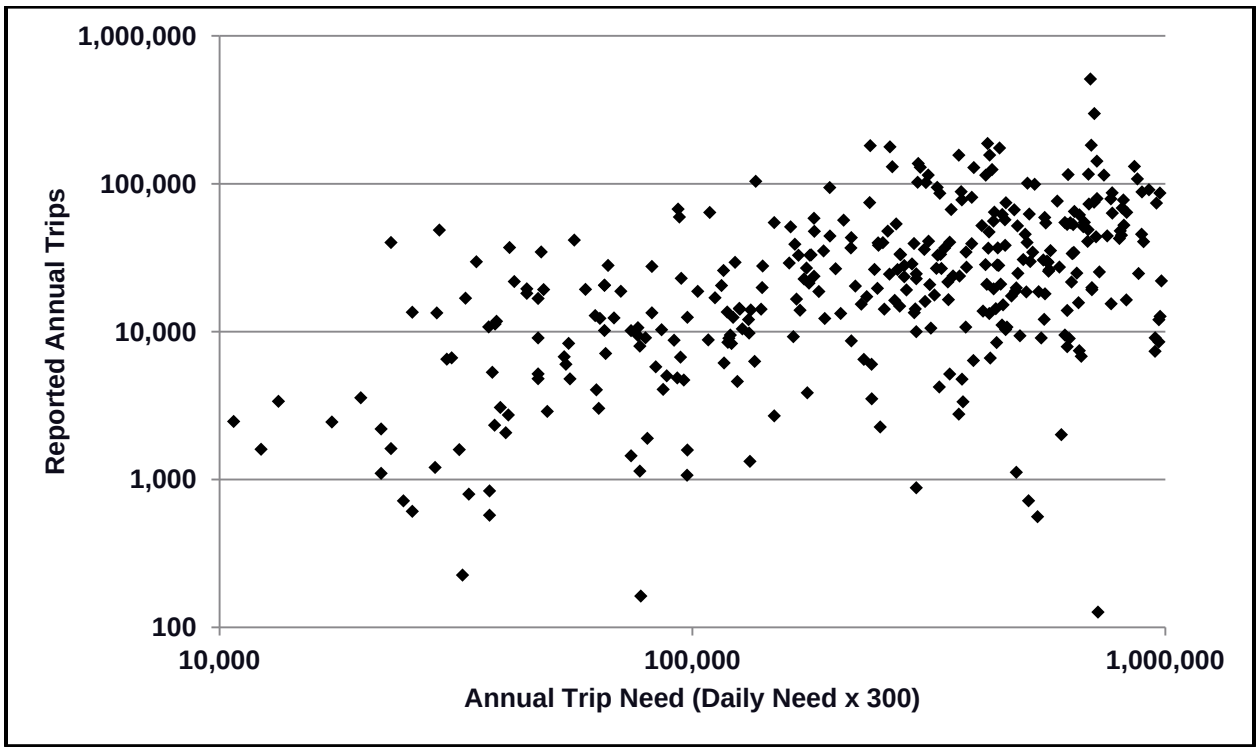


Figure 44: Annual Unlinked plus Coordinated Trips Reported vs. Computed Trip Need (2009 NTD) Log Scales; Need < 1,000,000



The plots show that relationships are apparent that appear linear when plotted with a logarithmic scales. This suggested that the basic functional relationships may be multiplicative rather than additive. This also suggested that there could be a reasonable way to construct a function that reflected both the demographic elements reflected in the estimation of need with the observation that ridership is related to the amount of service provided in a way that did not muddle the cause-and-effect relationships. (i.e., that reflected the concept that a greater quantity of service would likely generate greater demand, all else equal).

Based on these observations several alternative relationships were developed and tested.

The best function derived was:

$$\textbf{Annual Demand on Rural Public Services} = 2.44 * (\text{Annual Need}^{0.028}) * (\text{Vehicle-miles}^{0.749})$$

Figure 45 illustrates the estimated demand vs. the reported trips for the entire range. It can be observed that there is a tendency for the function to underestimate demand when reported trips exceed about 40,000 per year.

Figure 46 shows, however, that in the range below 30,000 trips per year, the bulk of the observed data, the error exhibits less bias. Further analysis suggests that the area reporting the greater number of trips per year have characteristics that are atypical for rural services such as being a tourist venue.

Figure 45: Observed vs. Estimated for General Public Demand Function based on 2009 NTD

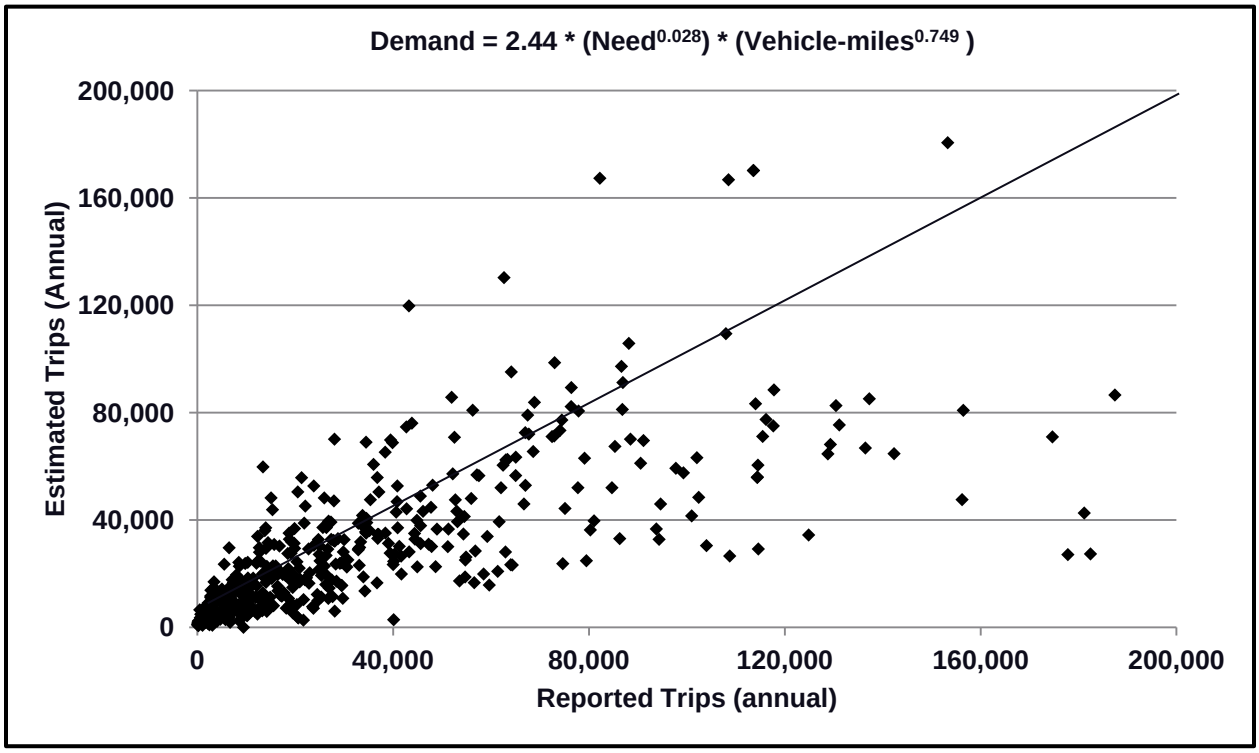
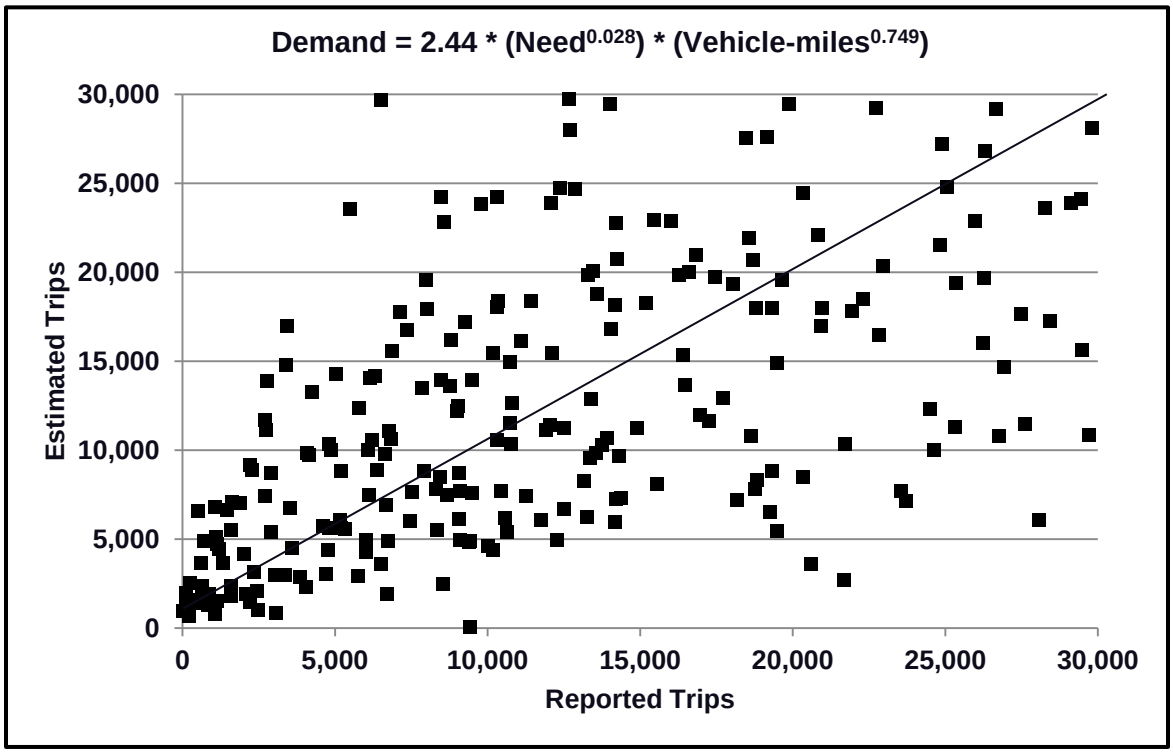


Figure 46: Observed vs. Estimated for General Public Demand Function based on 2009 NTD; Observed < 30,000



Summary of Analysis

There is a reasonably strong relationship for travel on public systems between the amount of service offered, the demographic characteristics of the area, and the number of trips served in a year. A basic estimate can be developed using only demographic characteristics:

General Public (non-program) Annual Demand = (2.20 * Population age 60+)
+ (5.21* Mobility Limited Population age 16 to 64)
+ (1.52 * Residents of Households having No Vehicle)

but the relationship is improved when a term representing the amount of service available is added.

Annual Demand on Rural Public Services = 2.44 * (Need$^{0.028}$) * (Vehicle-miles$^{0.749}$)

Adding a term such as service density, as was done in *Report 3* as a surrogate for service quality, has little effect on the estimation function. This suggests that for most areas there is latent, unserved demand that would appear if more service were provided.

Program (sponsored) Trips

For trip demand related to specific social service programs the recommended practice involves not a specific function or equation but rather a method that is based on obtaining information from the agencies that operate the programs. The information to be obtained includes:

- Number of program participants
- Number of days per week that the program meets
- Number of weeks per year that the program meets
- Proportion of registered participants who attend on a typical day
- Proportion of participants that require transportation service

Data received from workshop attendees were used to determine how well the estimates produced by the *TCRP Report 3* and the Phase 1 program trip methodologies compared with the annual demand as reported by the attendees. Since limited information about program trips was provided by workshop attendees, who were mostly general public transit providers, there was only a small sample of program trips to compare. Most of the information gathered was from the request that agencies list other transportation providers that offered passenger transportation in the area in which they operated. Out of the 158 programs for which trip data were gathered directly or indirectly from the agencies that provided the information, it was possible to calculate program trips for only five programs and make valid comparisons based on the information received.

Table 13 shows the comparison between program trips reported and the program trip estimates using the two methodologies. The estimate uses both the *TCRP Report 3* and the TCRP B-36 Phase 1 methods. As seen in Table 13, for this sample of five program trips, the majority of the estimates using both methods were much less than the actual number of trips reported.

Table 13: Comparison between program trips reported by workshop attendees and program trip estimates using the TCRP methodologies

Agency Name	Annual Trips Reported	TCRP B-36 (estimated no. of participants)	TCRP B-36 (annual 1-way passenger trips)	TCRP Report 3 (annual 1-way passenger trips)	Difference*
Butte Sheltered Workshop, Inc.	45,000	43	17,000	16,668	28,000
Arrowhead West, Inc.	79,343	47	15,500	18,418	63,843
Four County Mental Health Center	123,000	43	15,300	14,843	107,700
Oswego Industries/ ARC of Oswego County	91,690	104	40,021	39,900	51,669
Call. Co. Special Services/Medicaid Waive	9,430	52	20,000	20,091	(10,570)

Note= Difference between annual trips reported and the estimated program demand based on the TCRP B-36 Phase 1 method.*
Source: Data collected from workshop attendees

Coordinated human services transportation trips as reported in the 2009 National Transit Database (NTD) data were also examined. The NTD data collected did not specify the type of program trips or the programs being served and hence it was not possible to compare the NTD data with estimates from the TCRP B-36 methodology reported/funded by that agency.

Additional program trip data that were collected through other projects completed by members of the research team were compared with the program trip estimates using the *TCRP Report 3* methodology as shown in Table 14. As seen in Table 14, in most cases, the program trips using the *TCRP Report 3* methodology under estimated the annual trips compared to the reported number of trips.

Table 14: Comparison between program trips reported through other projects and program trip estimates using the TCRP Report 3 methodology

Agency Name/ Counties Served	State	Type of Program	Annual Trips Reported	Estimated annual trips (using TCRP Report 3 methodology)	Difference*
Vocational Rehabilitation	MO	Job Training	3,900	194,540	-190,640
Pathways Comm. Behavioral Healthcare	MO	Mental Health Services	156	6,940	-6,784
Boone County, Missouri	MO	Nursing Home	11,222	10,561	661
Central Missouri Area Agency on Aging	MO	Senior Nutrition	5,300	26,563	-21,263
Boone County, Missouri	MO	Sheltered Workshop	8,840	6,528	2,312
Boone County, Missouri	MO	Group Home	1,560	9,580	-8,020
Boone County, Missouri	MO	Head Start	148	26,300	-26,152
Lee, Itawamba, Pontotoc, Union, Benton and Chickasaw Counties, Mississippi	MS	Mental Health	54,119	20,858	33,261
Benton and Tippah Counties, Mississippi	MS	Substance Abuse/ Mental Health	17,955	4,630	13,325
A.W.A.R.E., Inc.	MT	Group Home	201,884	64,546	137,338
Achievements, Inc.	MT	Group Home	12,767	4,974	7,793
Big Sandy Activities	MT	Job Training/ Developmental Services	4,684	964	3,720
Community Option Resource Enterprises (COR)	MT	Developmental Services	54,970	82,509	-27,539
Mission Mountain Enterprises	MT	Group Home	33,407	2,622	30,785
New Horizons Unlimited, Inc.	MT	Group Home	2,488	1,058	1,430
Northern Rocky Mountain Easter Seal	MT	Developmental Services	32,236	48,849	-16,613
Opportunity Resources, Inc.	MT	Group Home	87,732	9,941	77,791
Quality Life Concepts	MT	Group Home	67,924	9,354	58,570

Agency Name/ Counties Served	State	Type of Program	Annual Trips Reported	Estimated annual trips (using TCRP Report 3 methodology)	Difference*
Reach, Inc.	MT	Developmental Services	38,987	30,856	8,131
Spring Meadow Resources	MT	Group Home	24,762	8,031	16,731

Note= Difference between annual trips reported and the estimated program demand based on the TCRP B-36 methodology.*
Source: Data applied from previous projects

As seen in both Table 13 and Table 14, there is a wide variation between the annual trips reported and the annual program trip estimates. This is due to the many varying factors such as number of participants, number of events offered per week, number of similar programs offered in the area, type of program and services offered, and transportation needs of program participants based on existing transportation services offered in an area. For example: a human service agency may not choose to provide any transportation service because they are well served by the general public transportation provider in their area. There are different cultural attitudes between communities, with participants in some communities making use of transportation services at a high rate while in others the use of transportation services is very low. These data indicate a formal methods that seeks to define functional forms for estimation of program trips that is applicable in all settings is impractical. Rather, the recommended approach is to collect information specific to the programs of interest. The specific information unique to each human service agency includes number of program participants, the average proportion of eligible participants who participate daily, the portion of program participants who are dependent on the agency to provide them transportation services, and the number of days and weeks that the program is offered, as shown by the formula below:

To estimate Program Transit Demand:

Number of Program Participants
multiplied by
Program Events per Week
multiplied by
The Proportion of Program Participants who attend the Program on an Average Day
multiplied by
The Proportion of Program Participants that are Transit Dependent (those participants who rely on the agency for transportation services)
multiplied by
The Number of Weeks per Year the Program is Offered
multiplied by
2 (trips per participant per event)

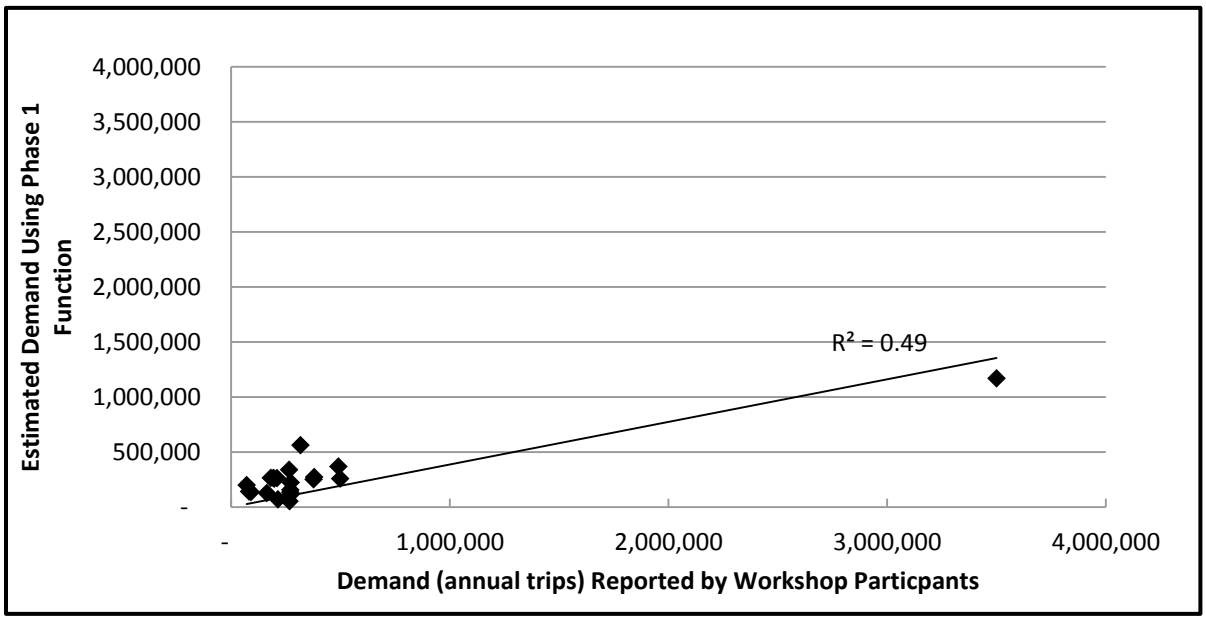
In applying this approach, the analysis must consider the transportation services that are available and the proportion of participants who may use the different services. For example, a community may have a high quality public transportation service that can meet the needs of a large percentage of a program's participants. The calculation can be used to estimate this demand or the demand for specialized transportation service to support the program. Observations of the research team also confirm the wide variance in demand among similar programs in different communities. As an example, some senior nutrition programs have a high rate of personal auto use while a similar program in another community may be observed to have far lower use of personal autos and more use of the transportation service. This approach will require communication with the individual programs. This could be routinely part of developing a local coordinated transportation plan and identifying the unmet transportation needs in a community. Using information unique to each specific program will result in a much better estimate of the program trip demand and relies on a simple, straightforward calculation.

Small-City Fixed Route

Workshop Results

In many rural counties there exist one or more small cities in which a traditional fixed-route, fixed-schedule transit service is operated. Data were collected at the workshops and directly from state DOTs that participated in the workshops. Participants included systems operating fixed-route transit service. A number of the fixed-route systems however were from urbanized areas and were not included in the testing of the demand estimation. After screening out any systems in urbanized areas and systems with insufficient data, information from 19 small-city fixed-route transit systems was available. This is a small sample and is used for illustration of the Phase 1 methodology approach and comparison of the results (Figure 47).

Figure 47: Small-City Fixed Route, Demand reported by Workshop participants vs. Estimate Using Phase 1 Function



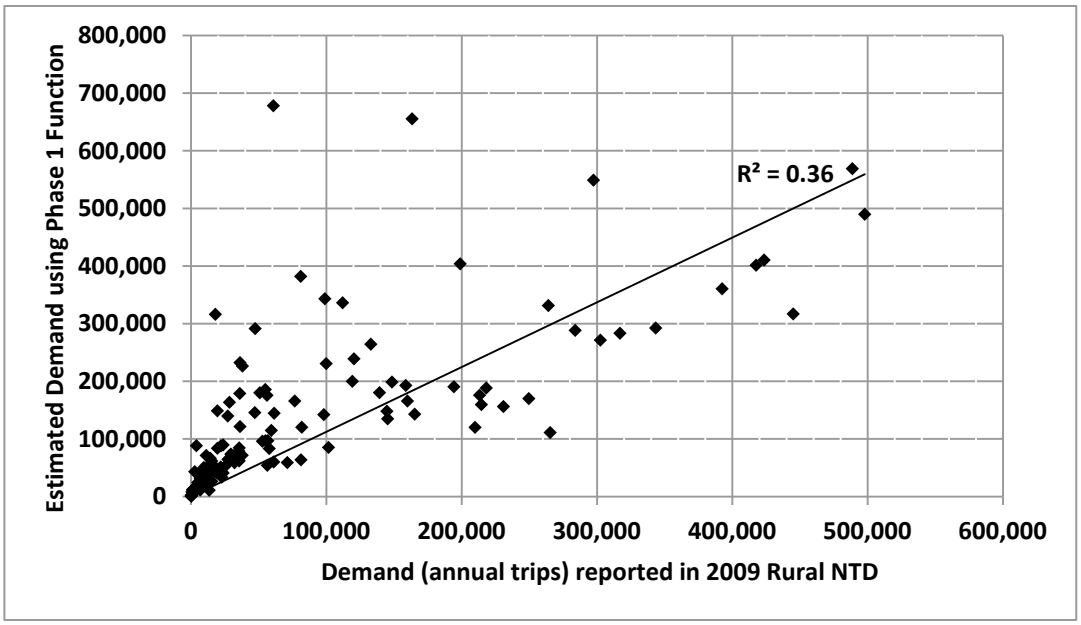
The demand relationship developed in Phase 1 was applied using data supplied by the workshop participants. The results are shown in Figure 49 with a resulting correlation of only 0.49. As seen in the graph, one system was well out of the range of all others. The system which has significantly higher demand than any of the others is TCAT serving Ithaca, Cornell University, and Tompkins County, New York. The system operates rural commuter routes, city routes, and on-campus shuttles which contribute the high demand. The estimated demand had a difference from the observed demand of 67 percent.

The results indicate that the Phase 1 variables and demand relationship may be appropriate for these types of systems, but with low predictive ability. As with any estimate, one must consider special circumstances such as the high frequency of service for shuttles on the Cornell campus.

Phase 2 Analysis

As described earlier, the Phase 1 demand methodology was applied using the data provided by workshop attendees with only moderate results. To conduct a more robust analysis, the 2009 NTD was used for rural transit systems. The 2009 and 2010 data became available after the workshops were held. For purposes of this analysis data were drawn from the 2009 Rural NTD for services reported as fixed-route (FR). The first step in the analysis was to apply the Phase 1 demand relationship to the 2009 data set. A sample of the data was selected by using every other system in the database, similar to the method used for the rural demand analysis. The results were less than satisfactory as shown in Figure 48. The correlation coefficient between the estimated demand and the reported demand was only 0.36.

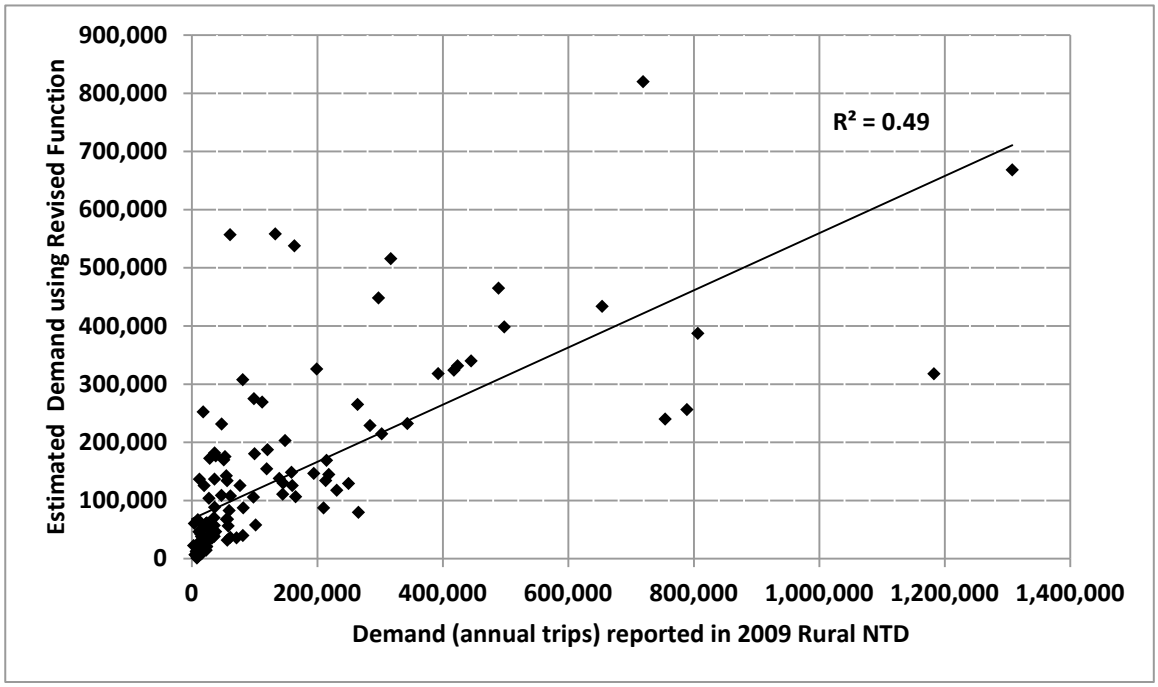
Figure 48: Observed vs. Estimated; Phase 1 Small-City Fixed-Route Demand Function vs. Data Reported in the 2009 Rural NTD



Given the poor results obtained using the demand function developed in Phase 1, the 2009 Rural NTD data were used to determine if a better relationship would result using the same variables of revenue-hours and college enrollment, but with recalculated coefficients. The resulting relationship exhibited an R^2 of 0.49. The comparison of the observed values against the values estimated using the revised function is shown in Figure 49. If the regression relationship is held to a zero intercept, the correlation

drops to about 0.35. These results are worse than the original demand relationship developed in Phase 1 and are no better than the results from applying the Phase 1 demand relationship to the 2009 data.

Figure 49: Observed vs. Estimated; Small-City Fixed-Route Demand Regression Using 2009 NTD Data



Development of Final Demand Function

Based on the poor results from using the demand function developed Phase 1, additional analysis was completed to identify a better demand relationship. This involved repeating much of the analysis conducted in Phase 1, but using the 2009 Rural NTD data set. Data reporting has improved since the 2006 reporting year used in the Phase 1 analysis. The accuracy of the data was anticipated to have improved with more experience in the reporting process.

Correlation of variables

The first step was to look at the correlation of possible variables with the number of unlinked passenger trips. As shown in Table 15, demographic characteristics had low correlation with the number of passenger-trips. The low correlation was similar to that found in Phase 1 using the 2006 NTD data. The highest correlation was with the number of vehicle-hours of service and the second highest was college enrollment, the two independent variables identified during Phase 1. Even though these were the variables with the highest correlation, the analysis described previously showed that these two variables alone did not provide a good demand relationship. These results indicated the need for additional analysis.

Table 15: Correlation of Demand reported for Small-City Fixed-Route Services in 2009 Rural NTD Data vs. Other Factors

Factor	Correlation (r) relative to reported demand
Population	0.20
Persons in poverty	0.25
Persons age 60+:	0.08
Mobility limited persons age 16 to 64	-0.21
Persons living in household with no vehicle	0.10
College Enrollment	0.30
Vehicle-hours	0.50

The 2009 NTD included coordinated trips as a separate data field. The coordinated trips are those trips provided for clients of a human services agency and paid for by that agency. These trips were then included with the unlinked passenger trips to calculate total trips. A similar correlation analysis was conducted with similar results. The number of coordinated trips reported in the NTD on the fixed-route systems is relatively small and did not significantly change the results. Based on the review of the coordinated trips and the insignificant difference, coordinated trips were not included in the demand relationships for fixed-route systems. The demand for coordinated trips on fixed-route service should be estimated using the approach described earlier for program trips as the programs and relationships are very different in each community.

Other forms of the demand function were considered to determine if an exponential or other non-linear function would improve the results. Again, the results were no better.

The final step considered was to impose additional limitations on the applicability of the model. Two restrictions were imposed. The first was to eliminate any community with a service area population over 50,000. While this may limit the application in a few rural communities, it will still apply to the vast majority of small cities with a population under 50,000. The second limitation was to use a range of annual passenger trips of less than 500,000. Again, while this limits the application in some communities it will still serve smaller cities that are considering a new service. Situations where this approach would not apply include communities with a major campus and a transit system that is operating a no-fare, high frequency, on campus shuttle.

By constraining the database to populations of less than 50,000 and annual passenger trips to less than 500,000, better correlation results were achieved as shown in Table 16. In this case, the revenue-hours of service was again the most highly correlated variable, but college enrollment was lower than other demographic variables including total population and low-income population.

Table 16: Correlation of Demand reported for Small-City Fixed-Route Services in 2009 Rural NTD Data vs. Other Factors

Factor	Correlation (r) relative to reported demand
Population	0.30
Low Income Population	0.30
Zero-Vehicle Households	0.28
College Enrollment	0.18
Revenue-Hours of Service	0.69

A step-wide regression was performed using the variables in Table 16. Because of the high correlation between the population variables of total population, low-income population, and zero-vehicle households, only one of these variables was significant in developing the demand function for small-city fixed-route service. The variables which were found to be significant in the final function were revenue-hours of service, total population, and college enrollment. The final demand function is:

Unlinked passenger trips = 5.77 x Revenue-Hours of Service + 1.07 x Population + 7.12 x College Enrollment

The final function resulted in an R^2 value of 0.70, accounting for 70 percent of the variance in the demand estimation. The comparison of the estimated demand using this function and the reported demand is shown in Figure 50. The demand function tends to underestimate the demand for systems with higher demand.

Figure 50: Estimated Fixed-Route Demand vs. Reported Demand

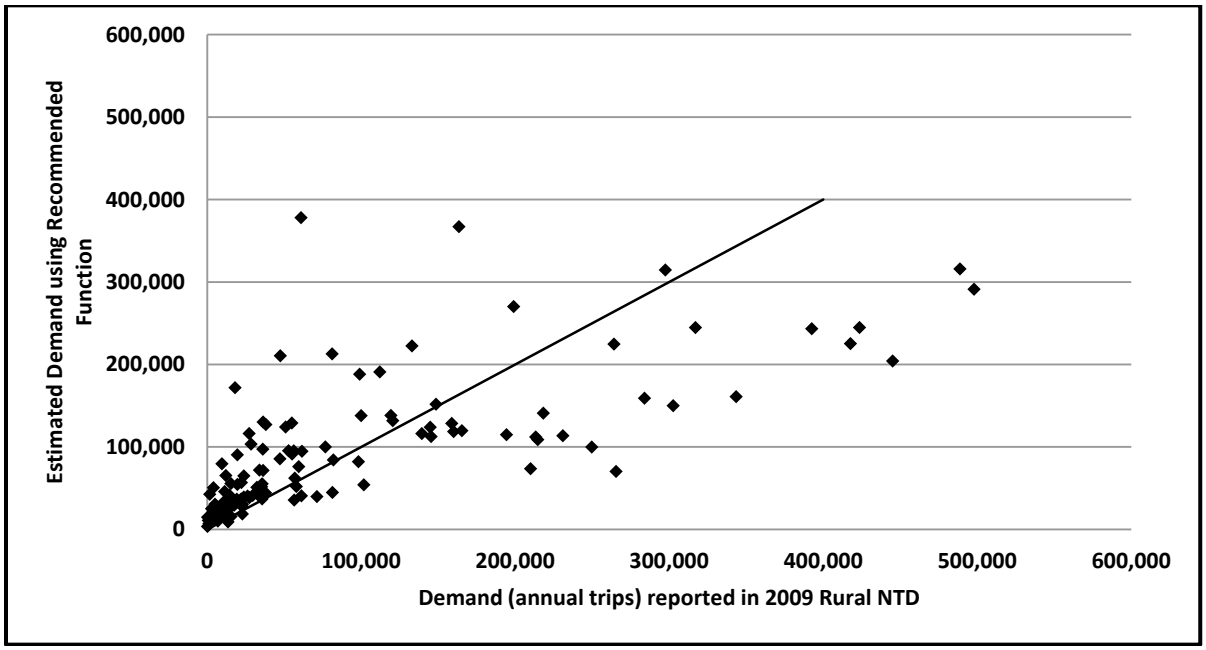


Figure 51 shows the residuals compared with the reported demand. As anticipated, the residuals are higher for systems with higher demand. The positive residuals compared to the reported demand are consistent with under estimating at the higher levels of demand. In Figure 52 the residuals are shown only for those systems reporting less than 100,000 trips per year. Of the 120 systems included in this analysis, 86 report fewer than 100,000 annual passengers.

Figure 51: Fixed-Route Estimated Residuals compared with Reported Demand

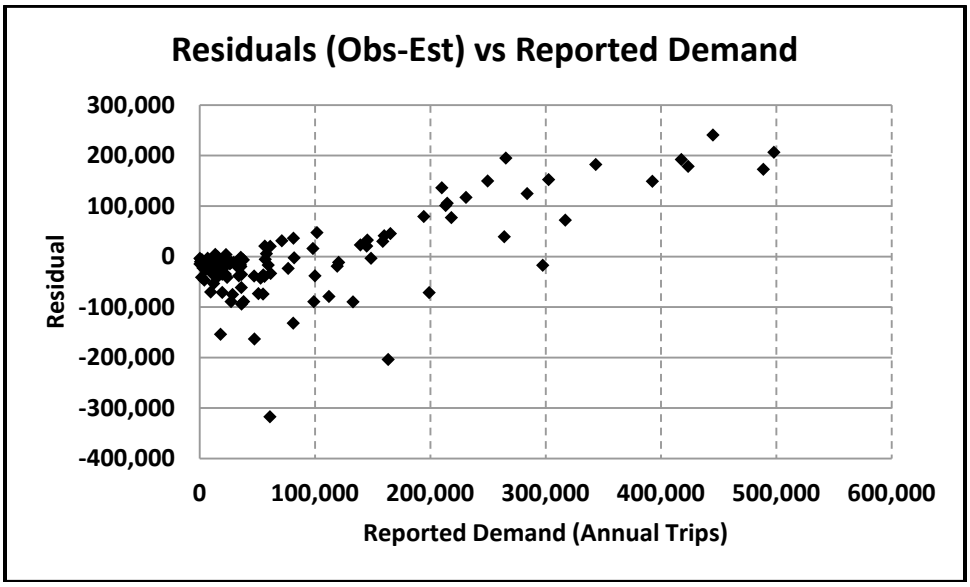
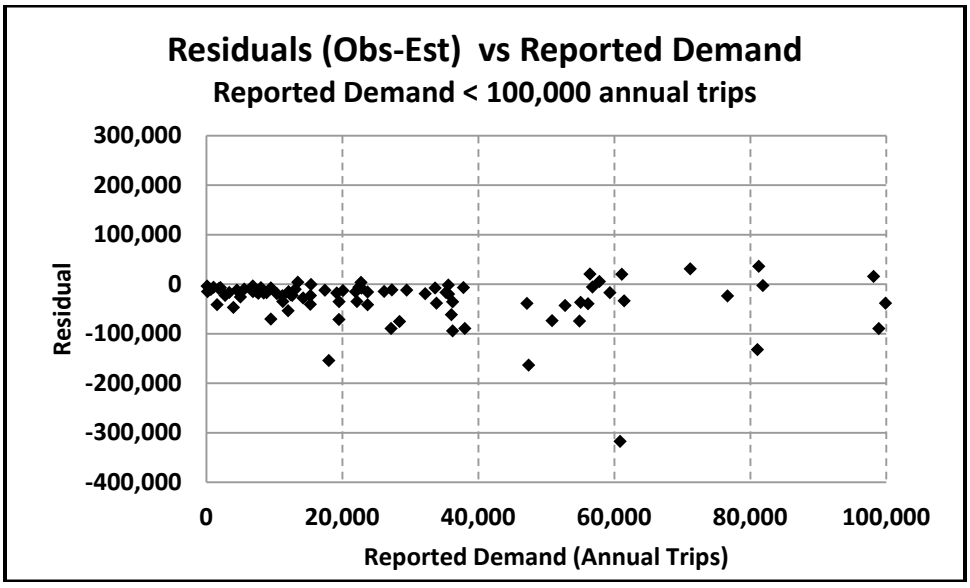


Figure 52: Fixed-Route Estimated Residuals compared to Reported Demand (Annual Trips < 100,000)



While the residuals and predictive capability of the demand model indicate less desirable results at relatively high levels of demand, the demand model will be useful for small cities considering a fixed-

route service. If the community is considering a high level of service on a college or university campus, the results should be used with caution, realizing the potential to underestimate the actual demand. For systems that would serve a small city, the demand estimates will be a useful planning tool to determine the appropriate level of service.

The median passengers per hour for the small-city fixed-route systems used in this analysis is 4.9. At 5 passengers per hour a system serving 100,000 passengers per year would operate 20,000 hours per year or about 68 hours per day assuming 300 operating days per year. Sixty-eight hours per day is equivalent to 5 buses operating 13 hours per day; a reasonable amount of service for a small-city with a population less than 50,000. Small-cities that operate more than 68 vehicle-hours per days likely have special characteristics that create conditions that generate greater than expected ridership. Free-fare could be a factor of this type. Lacking detailed information about each of the systems reporting to the Rural NTD and the environments in which they operate it is impossible to treat in a demand estimation function all of the many factors that can influence ridership. However, based on the analysis conducted the recommended function:

Annual Unlinked passenger trips = 5.77 x Revenue-Hours of Service + 1.07 x Population + 7.12 x College Enrollment

should yield reasonable estimates for demand for small-city systems operating fewer than 70 vehicle-hours per day.

Commuters from Rural Counties to Urban Centers

In Phase 1 of this project a function for estimation of the demand for passenger transportation by persons commuting from a rural county to an urban center was developed based on commuting data from the year 2000 decennial Census and geographic information from other sources assembled in a specially constructed dataset. Lacking from that dataset was other significant information including whether or not there actually was a passenger transportation service available in a given market, the number of trips per day operated, congestion on roads serving the market, and other key factors. That analysis led to a suggested passenger transportation demand function of 1.2% of the commuting market.

The workshops held as part of this project were used as a means to collect data about commuting services and their use. In the data collection instrument provided to each workshop attendee, a question was asked about the existence of transportation service from the attendee's rural county to a metropolitan center. Data were provided for sixteen rural to urban center services. Of these, eleven were on further examination found to represent true rural to urban center commuter services.

Based on the prior work it was decided to retain the same basic form for the demand estimation function. That is, not to estimate directly the expected number of commuters or trips that would use a passenger transportation services but rather to estimate the *share* of commuter trips in the market that would make use of a passenger transportation service. There are many sources for data on both current and projected commuting that are available to those planning or analyzing rural transit services. Having a method to estimate the share of those trips that would use a passenger transportation service frees the planner of the need to estimate the total market.

The data on current ridership on commuting services from rural counties to urban centers provided by the workshop attendees were augmented with information about population and employment in the counties and centers served by the services derived from the American Community Survey, with data about the current commuting markets derived from the Census Longitudinal Household-Employer Dynamics (LEHD) data, and distances derived from Google maps. A simple correlation analysis was then performed to explore possible relationships (Table 17). As the number of observations was quite small the correlations should be taken only as indications of possible relationships since the confidence interval will be quite large.

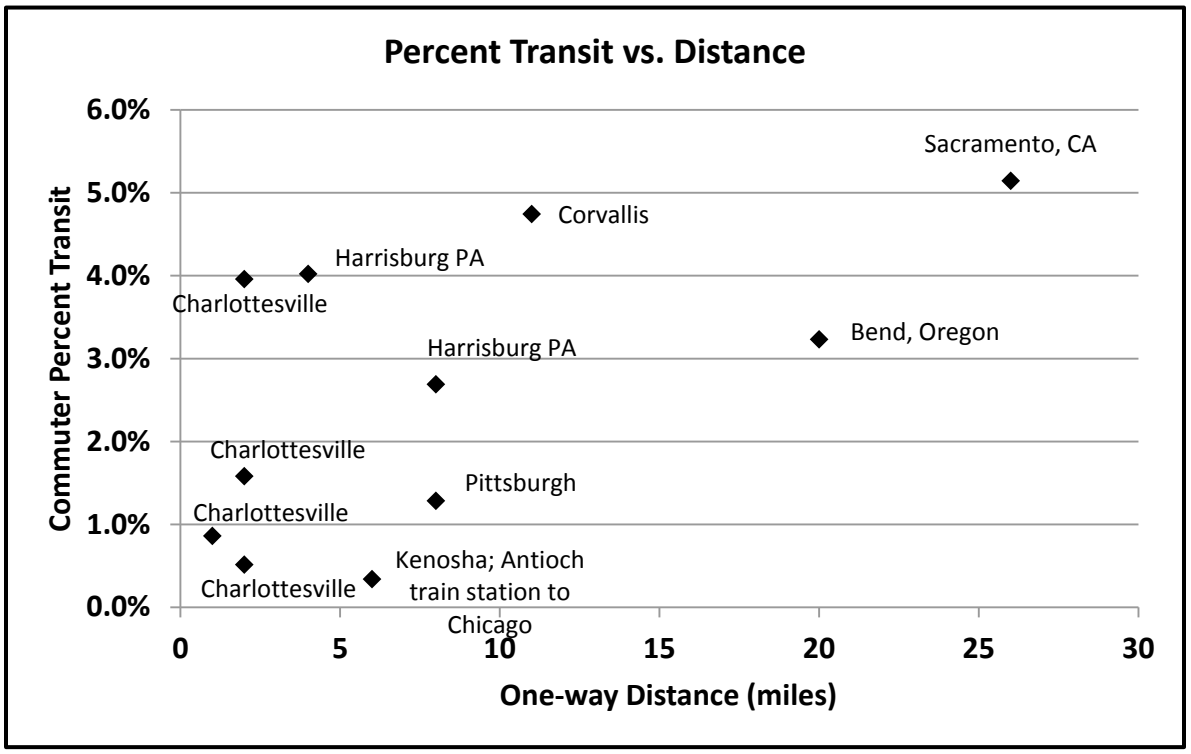
The data show a positive correlation of the percent of commuters using the passenger transportation service with the number of commuters in the specific market but a negative correlation with the total number of workers in the urban center. There is also a positive correlation with the number of bus trips per day, but this likely reflects scheduling to meet demand. A factor also revealed to have a positive correlation is whether or not the urban center is a state capital. This may reflect the fact that office workers are more likely to be able to use a transit service for commuting.

The negative correlation between trip distance and percent of commuters using passenger transportation is a bit surprising. An examination of the plotted data (Figure 53) would seem to suggest a slight positive correlation, but the analysis does not support this. In Figure 53 and similar charts the multiple points for two areas – Charlottesville, VA and Harrisburg, PA – represent services operated from different rural counties to the central city.

Table 17: Correlation Analysis – Percent of Commuters Using Passenger Transportation vs. Other Factors

	Percent of Commuters Using Transit	Jobs in the Urban Place (from LEHD 2009)	Workers commuting from the rural county to the urban center	Distance (miles one-way)	Distance Squared	Urban place is State Capital (1=yes)	Bus vehicle trips per day (in plus out)
Percent of Commuters Using Transit	**1.0**						
Jobs in the Urban Place (from LEHD 2009)	**-0.36**	**1.0**					
Workers commuting from rural county to urban center	**0.57**	**0.09**	**1.0**				
Distance (miles one-way)	**-0.21**	**0.46**	**-0.20**	**1.0**			
Distance Squared	**-0.14**	**0.47**	**-0.17**	**0.8**	**1.0**		
Urban place is State Capital (1=yes)	**0.43**	**-0.12**	**0.41**	**0.34**	**0.32**	**1.0**	
Bus vehicle trips per day (in plus out)	**0.56**	**0.04**	**0.87**	**-0.18**	**-0.16**	**0.36**	**1.0**

Figure 53: Percent of Commuters using Passenger Transportation – Rural County to Urban Center



An initial linear regression on the data suggested a function that included the number of workers in the central place and the distance from the rural county to the urban place. Examination of the residuals from that function indicated that another factor; whether or not the urban place was a state capital was also of importance. Further analysis led to an improved estimation function:

Proportion of Transit for Commuter Trips from a Rural County to Urban Place =

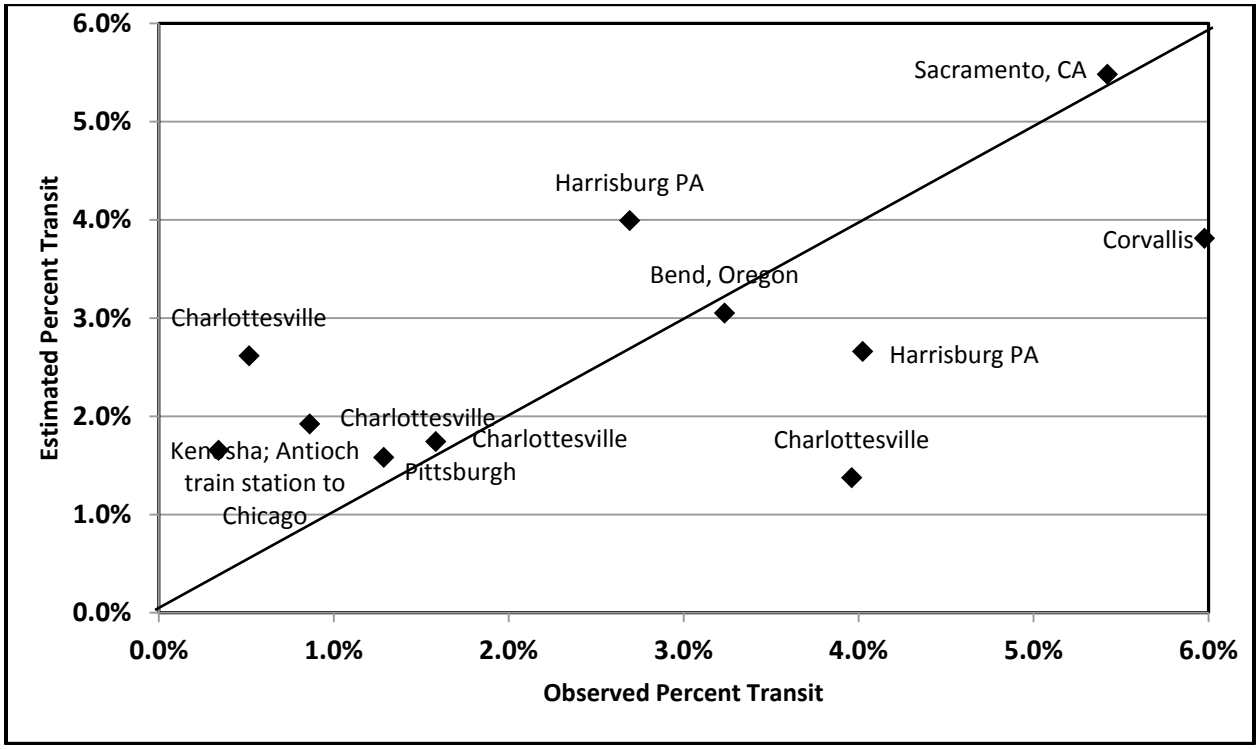
0.024 + (0.0000056* workers commuting from the rural county to the central place)
– (0.00029 * distance in miles)
+ 0.015 if the central place is a state capital,

R^2 = 0.42

This function provides an estimate of the demand that could be expected if service is available. Obviously, if there is no service there will be no patronage.

The residual analysis shown in Figure 54 illustrates that this function is only a "best fit" to a limited set of data and that estimates of demand obtained using this function should be thought of as first order indictors subject to refinement based on local conditions.

Figure 54: Residual Analysis – Percent of Commuters Using Passenger Transportation



Recommend Practice

The methods developed and reported herein present a systematic and consistent way to assess the need for passenger transportation services in rural areas and to develop initial estimates of the demand that may be generated when service is provided. The methods make use of data that are available to planners in rural communities and to the operators of transportation services. These data include operating statistics describing the existing or planned transportation services and information available from the U.S. Bureau of the Census. Census data can be accessed at www.census.gov.

The methods suggested are:

Need

For the **estimation of need**:

- Number of persons in need = population residing in households with income below the poverty line + population residing in households having no personal vehicle
- Trip Need = Households having no personal vehicle x Mobility Gap

The Mobility Gap is defined as the difference between the daily trip rate for rural households having one personal vehicle and rural households having no personal vehicle. These rates by Census division based on the 2009 National Household Travel Survey are:

Table 18: Mobility Gap by Census Division (based on 2009 NHTS)

Census Division	States	Vehicles Available		Mobility Gap (Trips per Day)
		0	1	
National		3.2	4.7	1.5
Division 1:	ME, VT, NH, MA, CT, RI	3.3	5.0	1.7
Division 2: Middle	NJ, NY, PA	3.5	4.8	1.3
Division 3: East North Central	WI, MI, OH, IN, IL	2.7	4.1	1.4
Division 4: West North Central	ND, SD, NE, KS, MO, IA, MN	2.4	4.5	1.7
Division 5: South Atlantic	MD, DE, WV, VA, NC, SC, GA, FL	3.2	4.5	1.2
Division 6: East South Central	KY, TN, AL, MS	2.7	4.1	1.4
Division 7: West South Central	OK, AR, TX, LA	2.9	4.9	2.0
Division 8: Mountain	ID, MT, WY, CO, UT, NE, AZ, NM	5.2	6.0	0.8
Division 9: Pacific	WA, OR, CA, AK, HI	3.8	4.9	1.1

Demand

For the **estimation of demand** methods are suggested for four markets - general purpose rural (non-program trips), program trips, small city (micropolitan) fixed-route, and commuters from rural counties to urban centers. An additional method is suggested for demand (all market types) for rural public transportation systems defined as those systems eligible for reporting to the National Transit Database.

General Purpose Rural Passenger Transportation

Non-program Demand (trips per year) = (2.20 * Population age 60+)
+ (5.21* Mobility Limited Population age 16 to 64)
+ (1.52 * Residents of Households having No Vehicle)

Program Trips

To estimate Program Transit Demand:

Number of Program Participants
multiplied by
Program Events per Week
multiplied by
The Proportion of Program Participants who attend the Program on an Average Day
multiplied by
The Proportion of Program Participants that are Transit Dependent (those participants who rely on the agency for transportation services)
multiplied by
The Number of Weeks per Year the Program is Offered
multiplied by
2 (trips per participant per event)

Small-City Fixed Route

Annual Unlinked passenger trips = 5.77 x Revenue-Hours of Service + 1.07 x Population + 7.12 x College Enrollment

This function will work best for systems that provide 70 or fewer vehicle-hours per day.

Commuters from Rural Counties to Urban Centers

The recommended method for estimating demand is:

Proportion using Transit for Commuter Trips from a Rural County to Urban Place (if service is offered) =

0.024 + (0.0056 * workers commuting from the rural county to the central place)
– (0.00029 * distance in miles)
+ 0.015 if the central place is a state capital

Demand (trips per day) = Proportion using transit *x* number of commuters *x* 2

The number of commuters can be obtained from the state transportation agency, the Metropolitan Planning Organization for the urban center, or the Bureau of the Census Longitudinal Employer-Household Dynamics website. http:/lehd.did.census.gov/led/

Demand for Rural Public Transportation (not market specific)

The following function, developed using data from the Rural NTD for Reporting Year 2009 and data from the American Community Survey for the three years ending in 2009, makes use of the estimate of need, measured in the number of trips and a measure of the amount of service provided.

$$\text{Annual Demand on Rural Public Services} = 2.44 * (\text{Need}^{0.028}) * (\text{Annual Vehicle-miles}^{0.749})$$

Need is computed using the Mobility Gap method described above. Annual vehicle-miles of service may be either the miles currently being operated or the number planned to be operated. This method can be used to estimate how demand (ridership) is likely to change as service is expanded or reduced.

Future Research Needs

The methods suggested by this research provide estimates of the demand for rural passenger transportation service at a given point in time. In practice, however, demand is constantly changing and when a new service is introduced the observed demand is typically significantly less than the mature demand. Some have suggested that it takes about a year for demand to mature once a new service is introduced. These studies, however, are based on observed data from urban transportation systems. Research to measure the time from rural service initiation for demand to mature would be useful.

A related project would address the ways for marketing rural transportation services. Rural agencies operate with limited budgets making it difficult to undertake major campaigns to promote awareness and use of rural services. Some states (e.g., Alaska, Missouri) have undertaken marketing programs for all rural services with limited success. Other states (e.g., Louisiana, Maine, and Oregon) have presented marketing training programs for rural systems but the effectiveness of these efforts has not been reported. Documenting the various methods used and the effectiveness of those methods in attracting riders would be useful to rural agencies.

Blank page

Appendix A – A Note on commuting data from ACS vs. LEHD

The methodology recommended for estimating the demand for passenger transportation for commuting travel from rural counties to urban centers is the use of a function for estimating the *share* of commuting trips that would use a passenger transportation service. Data on commuting patterns, and in particular the number of persons commuting from one area to another, is available from the Census Bureau from two sources – the American Community Survey and the Longitudinal Household-Employment Dynamics data.

A discussion of the use of these datasets can be found in NCHRP 08-36, Task 098 *Improving Employment Data for Transportation Planning.* This report can be found at: http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP08-36(98)_FR.pdf

Of relevance for the estimation of demand for travel between rural counties and urban centers is the finding that "the LEHD-OTM is an excellent source of data for constructing or validating a detailed OD table of home-to-work flows between geographic areas that can range from as small as individual Census Blocks to entire states. Unlike sample-based surveys (such as the CTPP), the LEHD-OTM provides a (nearly) complete enumeration of home-to-work flows covering over 90 percent of all workers and employers in the United States. As such, it includes many more OD pairs containing low frequency home-to-work flows than are collected through sampled data." Because the flows from rural counties to urban centers are likely to be small compared to flows within urban areas, the use of LEHD-OTM as the basis for estimation of the demand for passenger transportation for commuters is recommended.

The text in the remainder of this Appendix is taken directly from NCHRP 08-36.

Longitudinal Employer Household Dynamics

The LEHD Program is based on a negotiated partnership arrangement between the Census Bureau and each state ESA. This partnership has evolved over a period of more than a decade, with the last few states joining as recently as 2010. Under the LEHD Program, the Census Bureau obtains a copy of the same enhanced microdata files that used to produce the QCEW, and merges these data with additional administrative data on individual workers that the Census Bureau collects from other federal agencies. The data are merged internally within the Census Bureau and are subjected to a series of —disclosure proofing procedures to prevent release of confidential information on the identity of an individual worker or employer. The integrated employer-worker data is then made available through two different databases – the QWI and OTM.

OnTheMap

The LEHD-OTM is a unique database that combines information on both the residence and workplace locations of workers at a level of geographic resolution (Census Block) that is most useful for transportation planning and travel demand modeling applications. Unlike the QCEW and QWI, which are employer-based, the LEHD-OTM is more worker-based, providing information on where workers in specific socio-demographic categories (i.e., age, income) and industry sectors live and work. The LEHD-OTM is published annually, approximately one year following the reference year for which the data are collected.

Comparison of LEHD-OTM and CTPP Databases

The LEHD-OTM work flow data were compared with journey-to-work trip data collected through the Census Transportation Planning Products (CTPP) in an effort to further evaluate the strengths and limitations of LEHD-OTM data for transportation planning applications. The comparisons included county-to-county flows using the LEHD-OTM, CTPP 2000, and the CTPP 2006-2008 3-year summary databases, and Tract-to-Tract flows for two metropolitan areas using the LEHD-OTM and CTPP 2000 databases. Table ES.1 highlights key differences among the three databases.

Key Differences in Employment Data Available from the CTPP and the LEHD-OTM Databases

	CTPP 2000	CTPP 2006-2008	LEHD-OTM (2008)
Data Source	2000 Decennial Census Journey to Work (JTW) questions	3-year compilation of JTW questions from American Community Survey (ACS)	Administrative records of workers and employers covered by state UI
Sample Size	~17% of all U.S. households	~7.5% of all U.S. households	Full enumeration of covered employment categories
Geographic Coverage	Includes all counties	Excludes counties with less than 20,000 population	Excludes data from newer LED states: (CT, DC, MA, NH)
Geographic Resolution	Block Groups	Counties (over 20,000 population)	Census Blocks
Employer-Industry Categories	All employers and industry categories in sample universe	All employers and industry categories in sample universe	Excludes employment not covered by state UI
Job Categories	Excludes second jobs held by workers with multiple jobs	Excludes second jobs held by workers with multiple jobs	Includes all jobs held by workers in covered employment categories

Comparisons at the county and Census Tract levels showed that both the CTPP 2000 and CTPP 2006-2008 databases include more total home-to-work flows than the LEHD-OTM database, but distribute those flows among a significantly smaller number of OD pairs. This results in significantly higher average flow rates for each non-zero OD pair in the CTPP databases, but many more OD pairs (with lower average flow rates) in the LEHD-OTM database.

The comparisons suggest that the LEHD-OTM data captures many more of the low frequency OD pairs than either the CTPP 2000 or CTPP 2006-2008 databases. The CTPP databases are derived from a sample of U.S. households, which are then expanded to the universe of all households based on demographic factors.

One consequence of this methodology is that OD pairs with a low frequency of home-to-work trips that are sampled in the CTPP get weighted more heavily, while low frequency OD pairs that are not sampled are assumed to have no home-to-work flows. The result is a —lumpy distribution of flows that becomes even more —lumpy as the sample size decreases (i.e., from the CTPP 2000 to the CTPP 2006-2008). The county-to-county and Tract-to-Tract flows from the LEHD-OTM were also compared against the CTPP databases with respect to travel distance between OD pairs. While the distributions are generally

similar in shape, a larger percentage of flows in the LEHD-OTM are longer distance (i.e., 25+ miles) than in the CTPP databases. While some of this difference can be attributed to the large number of longer distance, low-frequency OD pairs identified in the LEHD-OTM that were not sampled in CTPP databases, other contributing factors may include (1) the absence of self-employed workers in the LEHD-OTM, who are more likely to work at home or at workplaces closer to home than other employment categories; and (2) employers with multiple worksites who file incomplete multiple worksite reports (MWR) with a state ESA. Workers could therefore be misallocated to an employer's primary worksite, rather than a secondary worksite that is closer to their residence.

LEHD-OTM data were compared to CTPP databases with respect to both employment destinations and residence-to-workplace flows, both at the county and Census Tract levels of geography. The findings from these comparisons were inconclusive as to whether inaccuracies in MWR reporting leads to serious inaccuracies in employment site locations. While significant differences in work destinations were clearly observed between the databases, many of these differences could be attributed to missing employment categories in the LEHD-OTM, the absence of flows between low frequency OD pairs in the CTPP data, or temporal differences in when the data was collected (i.e., 2000 CTPP vs. 2006 LEHD-OTM). Additionally, potential indicators of locational inaccuracies attributable to multi-site employers (e.g., higher work flows to locations housing state capitals or headquarters for large corporations) were not consistent from one site to another.

The LEHD-OTM should not be viewed as an alternative to either household travel surveys (including the CTPP) or to employer-based surveys (such as the QCEW), but rather as a complement to both types of data. The LEHD-OTM database does not contain information about the work trip itself; there are no attributes describing the choice of mode, route, travel and departure times, or costs for the trip to work. However, the LEHD-OTM is an excellent source of data for constructing or validating a detailed OD table of home-to-work flows between geographic areas that can range from as small as individual Census Blocks to entire states. Unlike sample-based surveys (such as the CTPP), the LEHD-OTM provides a (nearly) complete enumeration of home-to-work flows covering over 90 percent of all workers and employers in the United States. As such, it includes many more OD pairs containing low frequency home-to-work flows than are collected through sampled data.