



Comparison of Household Travel Surveys for 1985-1988, 1999, and 2006 in the Puget Sound Region

EXECUTIVE BOARD

Mayor Ray Stephanson, City of Everett — President

Commissioner Josh Brown, Kitsap County — Vice President

Councilmember Carol Arends, City of Bremerton
Mayor Linda Bird, City of University Place — Other Cities in Pierce County
Commissioner Bill Bryant, Port of Seattle
Councilmember Shawn Bunney, Pierce County
Councilmember Mary-Alyce Burleigh, City of Kirkland — Other Cities in King County
Councilmember Richard Cole, City of Redmond — Other Cities in King County
Mayor Suzette Cooke, City of Kent
Mayor Grant Degginger, City of Bellevue
Mayor Jack Dovey, City of Federal Way
Councilmember Jan Drago, City of Seattle
Secretary Paula Hammond, Washington State Department of Transportation
Councilmember Bruce Harrell, City of Seattle
Councilmember Darlene Kordonowy, City of Bainbridge Island — Other Cities in Kitsap County
Mayor Denis Law, City of Renton
Councilmember Mike Lonergan, City of Tacoma
Commissioner Bill Mahan, Port of Bremerton
Mayor Joe Marine, City of Mukilteo — Other Cities in Snohomish County
Commissioner Richard P. Marzano, Port of Tacoma
Executive Pat McCarthy, Pierce County
Councilmember Richard McIver, City of Seattle
Councilmember Sally Nelson, City of Burien — Other Cities in King County
Mayor Greg Nickels, City of Seattle
Commissioner Connie Niva, Port of Everett
Commissioner Dan O'Neal, Washington State Transportation Commission
Councilmember Julia Patterson, King County
Councilmember Sonny Putter, City of Newcastle — Other Cities in King County
Executive Aaron Reardon, Snohomish County
Deputy Mayor Sue Singer, City of Auburn – Other Cities in King County
Councilmember Dave Somers, Snohomish County
Acting Executive Kurt Triplett, King County

Funding for this document provided in part by member jurisdictions, grants from U.S. Department of Transportation, Federal Transit Administration, Federal Highway Administration and Washington State Department of Transportation. PSRC fully complies with Title VI of the Civil Rights Act of 1964 and related statutes and regulations in all programs and activities. For more information, or to obtain a Title VI Complaint Form, see <http://www.psrc.org/about/titlevi/index.htm> or call (206) 464-4819. Sign language, and communication material in alternative formats, can be arranged given sufficient notice by calling 206-464-7090. TDD\TTY: 206-464-5409.

Additional copies of this document may be obtained by contacting: Puget Sound Regional Council

Information Center
1011 Western Avenue, Suite 500
Seattle, WA 98104-1035
206-464-7532 • fax 206-587-4825 • info@psrc.org

Abstract

REPORT TITLE: Comparison of Household Travel Survey Results for 1985-1988, 1999, and 2006 in the Puget Sound Region

PROJECT TITLE: Origin-Destination Household Travel Surveys; Transportation Data.

SUBJECT: Trip rates, trip time and length, trip mode by characteristics of households. Results from the three survey years are presented.

DATE: June 2009

SOURCE OF COPIES: Puget Sound Regional Council Information Center
1011 Western Avenue
Seattle, Washington 98104
(206) 464-7532
info@psrc.org
www.psrc.org

ABSTRACT: This report documents the results of the 1985-1988, 1999 and 2006 Puget Sound Household Travel Surveys and trends in travel behavior over that time. The surveys are an essential element in the regional study of transportation activity and travel patterns within the four-county jurisdiction of the Puget Sound Regional Council (PSRC).

Table of Contents

Executive Summary	v
1. Introduction	1
Background	1
Household Travel Surveys Overview	2
Transportation Terms Used in this Report	3
2. Puget Sound Regional Characteristics	7
Overview	7
Household Size	9
Household Member Age	10
Household Income	10
Lifecycle Stage	11
Vehicles per Household	12
3. Household and Person Trip Rates	14
Overview	14
Household Trip Rates by Purpose	15
Trip Chaining	16
Household Trip Rates by Purpose and County/Sub-County Area	18
Household Trip Rates by Household Size	20
Household Trip Rates by Household Income	21
Household Trip Rates by Vehicle Availability	23
Household Trip Rates by Lifecycle Stage	25
4. Trip Characteristics	27
Introduction	27
Trip Mode	27
Mode by County/Sub-County Area	28
Mode by Lifecycle Stage	31
Mode by Vehicle Availability	32
Trip Time and Length	33
Time of Day	46
Appendix A: Cumulative Distribution of Time and Length Charts	49
Appendix B: 1961/1971 Household Surveys	61
Appendix C: 1985-1988 Household Travel Surveys Methods	62
Appendix D: 1999 Household Travel Survey Methods	66
Appendix E: 2006 Household Travel Survey Methods	77
Appendix F: Survey Weighting	86

List of Figures

Figure 1-1. Recruited/Participant Household	3
Figure 1-2. Trip Typology	4
Figure 1-3. Typology of Tours.....	5
Figure 2-1. Map of the Central Puget Sound Region	7
Figure 2-2. Regional Population from 1985 to 2006	8
Figure 2-3. Regional Population in 1985, 1988, 1999 and 2006	8
Figure 2-4. Travel Survey Household Locations in 1999 and 2006.....	9
Figure 2-5. Household Size	9
Figure 2-6. Household Member Age	10
Figure 2-7. Percent of Households by Household Income Group, 1999	11
Figure 2-8. Percent of Households by Household Income Group, 2006.....	11
Figure 2-9. Household Lifecycle Stage	12
Figure 2-10. Vehicles per Household.....	12
Figure 2-11. Vehicles per Household by Lifecycle, 1999	13
Figure 2-12. Vehicles per Household by Lifecycle, 2006	13
Figure 3-1. Average Daily Person Trips per Person.....	14
Figure 3-2. Average Person-Trips per Household by Trip Type	15
Figure 3-3. Percent Total Trips by Trip Purpose	16
Figure 3-4. Tours by Tour Type	17
Figure 3-5. Tours by Tour Type	17
Figure 3-6. Tours by Age and Employment Status	18
Figure 3-7. Number of Stops per Tour by Tour Type.....	18
Figure 3-8. Daily Person Trips per Household by County/Sub-County Area.....	19
Figure 3-9. Percent Daily Person-Trips per Household by Trip Purpose and County/Sub-County Area.....	19
Figure 3-10. Average Daily Person-Trips by Household Size.....	20
Figure 3-11. Average Daily Person-Trips per Household By Household Size	20
Figure 3-12. Average Daily Person-Trips per Household by Household Income Range	21
Figure 3-13. Average Daily Person Trips per Household by Vehicles per Household	23
Figure 3-14. 1999/2006 Average Daily Person-Trips by Vehicle Availability by County/Sub-County Area.....	24
Figure 3-15. Average Daily Person-Trips per Household by Vehicle Availability by County/Sub- County Area	24
Figure 3-16. Trips by Lifecycle Stage.....	25
Figure 3-17. Average Daily Person-Trips per Household by Lifecycle Stage and Trip Purpose.....	26
Figure 3-18. Percent Person-Trips per Household by Lifecycle Stage and Trip Purpose	26
Figure 4-1. Mode Shares, All Trips	27
Figure 4-2. Mode Shares, All Trips	28
Figure 4-3. Percent of Trips Using Transit by County/Sub-County Area	29
Figure 4-4. Percent of Trips in Vehicles with Two or More Persons	29
Figure 4-5. Percent of Total Trips by Mode.....	30
Figure 4-6. Percent of Home-based Work Trips by Mode	30
Figure 4-7. Average Person-Trips per Household by Lifecycle and Mode	31
Figure 4-8. Percent of Total Trips by Mode and Lifecycle	32
Figure 4-9. Percent of Trips Using Transit.....	32

Figure 4-10. Percent of Trips by Walking	33
Figure 4-11. Home-Based Work Trip Length and Time	34
Figure 4-12. Home-based Work Trip Length and Time	34
Figure 4-13. Home-Based Work Trip Length and Time by Mode	35
Figure 4-14. Average Trip Time by Trip Type and Trip Mode	36
Figure 4-15. Average Trip Length by Trip Type and Mode	37
Figure 4-16. SOV Average Trip Time (Minutes), 1988-2006	38
Figure 4-17. HOV Average Trip Time (Minutes), 1988 – 2006	38
Figure 4-18. Transit Average Trip Time (Minutes), 1988 – 2006	39
Figure 4-19. Walk Average Trip Time (Minutes), 1988 – 2006	39
Figure 4-20. SOV Average Trip Length (Miles), 1988–2006	40
Figure 4-21. HOV Average Trip Length (Miles), 1988–2006.....	40
Figure 4-22. Transit Average Trip Length (Miles), 1988–2006	41
Figure 4-23. Walk Average Trip Length (Miles), 1988–2006.....	41
Figure 4-24. Trip Time Frequency Distribution, HBW Trips.....	43
Figure 4-25. Trip Time Frequency Distribution, HBO Trips	43
Figure 4-26. Trip Time Frequency Distribution, NHB Trips	44
Figure 4-27. Trip Length Frequency Distribution, HBW Trips	44
Figure 4-28. Trip Length Frequency Distribution, HBO Trips	45
Figure 4-29. Trip Length Frequency Distribution, NHB Trips.....	45
Figure 4-30. Total Person-Trips by Time of Day, 1999-2006	46
Figure 4-31. HBW Person-Trips by Time of Day, 1999-2006	47
Figure 4-32. HBO Person-Trips by Time of Day, 1999-2006	47
Figure 4-33. NHB Person-Trips by Time of Day, 1999-2006	48
Figure A-1. Cumulative Distribution of HBW Trip Time by SOV	49
Figure A-2. Cumulative Distribution of HBW Trip Length by SOV	49
Figure A-3. Cumulative Distribution of HBW Trip Time by HOV	50
Figure A-4. Cumulative Distribution of HBW Trip Length by HOV	50
Figure A-5. Cumulative Distribution of HBW Trip Time by Transit.....	51
Figure A-6. Cumulative Distribution of HBW Trip Length by Transit	51
Figure A-7. Cumulative Distribution of HBW Trip Time by Walk	52
Figure A-8. Cumulative Distribution of HBW Trip Length by Walk.....	52
Figure A-9. Cumulative Distribution of HBO Trip Time by SOV	53
Figure A-10. Cumulative Distribution of HBO Trip Length by SOV	53
Figure A-11. Cumulative Distribution of HBO Trip Time by HOV	54
Figure A-12. Cumulative Distribution of HBO Trip Length by HOV	54
Figure A-13. Cumulative Distribution of HBO Trip Time by Transit.....	55
Figure A-14. Cumulative Distribution of HBO Trip Length by Transit	55
Figure A-15. Cumulative Distribution of HBO Trip Time by Walk.....	56
Figure A-16. Cumulative Distribution of HBO Trip Length by Walk	56
Figure A-17. Cumulative Distribution of NHB Trip Time by SOV	57
Figure A-18. Cumulative Distribution of NHB Trip Length by SOV	57
Figure A-19. Cumulative Distribution of NHB Trip Time by HOV.....	58
Figure A-20. Cumulative Distribution of NHB Trip Length by HOV	58
Figure A-21. Cumulative Distribution of NHB Trip Time by Transit.....	59
Figure A-22. Cumulative Distribution of NHB Trip Length by Transit	59
Figure A-23. Cumulative Distribution of NHB Trip Time by Walk.....	60
Figure A-24. Cumulative Distribution of NHB Trip Length by Walk	60

Figure D-1. 1999 Estimated Number of Households in Study Area by County and King County Sub-Area.....	66
Figure D-2. Sample by County and King County Sub-Area	66
Figure D-3. 1990 Estimated Percentage of Households: Household Size by Auto Ownership	67
Figure D-4. Total Sample Distribution by Household Size and Auto Ownership.....	67
Figure D-5. Study Area Telephone Coverage	68
Figure D-6. Advance Call Outcomes.....	69
Figure D-7. Recruitment Call Outcomes.....	70
Figure D-8. Final Distribution of Households	71
Figure D-9. Final Distribution of Households as a Percentage of the Goal	71
Figure D-10. Distribution of Households by Day-of-Week	71
Figure D-11. Comparison of Sample Data with 1990 Census Data	72
Figure D-12. Descriptive Statistics of Key Variables.....	73
Figure E-1. Recommended and Completed Sample Sizes by Survey Activity	78
Figure E-2. Recommended and Completed RDD Sample Sizes by Geographic Area	78
Figure E-3. 2004 American Community Survey Data for Number of Households by Sampling Area	79
Figure E-4. Recommended and Completed Number of RDD Households by Number of Autos and Household Size	79
Figure E-5. Recommended and Completed RDD Households by Number of Workers	80
Figure E-6. Distribution of Transit Access Targeted Zip+2 Areas	80

Executive Summary

This report contains summaries of the household travel surveys conducted by the Puget Sound Council of Governments (PSCOG) between 1985-1988, and the Puget Sound Regional Council (PSRC) in 1999 and 2006. The surveys were conducted in the central Puget Sound region and include King, Kitsap, Pierce, and Snohomish counties. The report compares regional characteristics, household and person trip rates, and other trip characteristics to identify trends in household travel over the 20-year timeframe. For some characteristics, results from 1961 and 1971 surveys are included.

Overall, travel behaviors in the region are changing. This change is characterized by longer commute trips, more transit and walk trips, shortened discretionary trips, a slowed rate of travel growth and changing patterns of travel. The duration and length of the average commute trip has steadily increased since the 1960s. Residents are living further from regional employment centers due to a variety of reasons, including lifestyle choices, housing costs, development patterns and many other factors. Transit and walk trips increased to account for almost 12 percent of all trips. Overall transit use increased the most in Central King, while transit use for commute trips increased the most in Snohomish County. Distance and time for home-based other and non-home-based trips decreased or remained level. These types of trips are a mix of discretionary and essential trips, indicating that, when possible, trips are being shortened. Growth in the rate of average person-trips per household slowed.

Trip rates among most households without children increased only marginally or declined. People are chaining trips together less on work, eating out and recreation tours. Work tours are not keeping pace with the growth of tours overall or the growth of the population. Further analysis indicates that, in 2006, fewer people had more than one job, which can require multiple work tours. Social and personal business tours increased, while more expensive recreation and shopping tours decreased. By and large, single-occupancy vehicle travel is still the most common mode used in the region; however, certain shifts in mode choice and travel behavior can be seen through the analysis of these travel surveys that span two decades.

Comparisons between the 1985-1988 survey and the later surveys have been limited by the differences in how the surveys were processed and weighted. The 1999 and 2006 surveys are compatible because they were processed and weighted using the same assumptions. The 1985-1988 data, however, were not weighted, and their processing may have some differences from those used in the 1999 and 2006 surveys.

Page intentionally left blank

1. Introduction

Background

This report documents the results of the 1985-1988, 1999 and 2006 Puget Sound Household Travel Surveys conducted by the Puget Sound Regional Council (PSRC). The surveys are an essential element in the study of transportation activity and travel patterns within the four-county central Puget Sound region.

The purpose of the surveys was to provide data for the continuing development and refinement of the regional travel demand forecasting model, as well as to provide a better understanding of travel behavior in the Puget Sound region. The study areas consisted of King, Kitsap, Pierce and Snohomish counties. The data sets are used to fulfill the travel model's functions of estimating trip generation and distribution, mode choice and assignments (i.e., the four-step trip-based travel demand forecasting model). The 2006 survey will also be used to support a new activity-based travel demand forecasting model.

The 1985-1988, 1999, and 2006 Puget Sound Household Travel Surveys relied on the willingness of area residents to complete diary records of their daily travel over one or more days. Household recruitment was conducted through a "recruitment window," in which respondents were informed of the survey, its purpose and the respondents' obligation to complete diaries if they agreed to participate in the survey. Data on households and household members were collected during the recruitment interviews.

The surveys used scientifically formulated sample designs, appropriate instruments for data collection, packages of written materials and Internet-based methods to communicate with survey respondents, toll-free survey hot-lines, and data collection, processing and reporting procedures.

Participating households were assigned specific travel days during which household members were asked to record travel information in diaries for the specified time period. The information was retrieved by either having the respondents mail back the diaries or by phone interviews.

Some tables include results from household travel surveys conducted in 1961 and 1971 by the Puget Sound Governmental Conference, a predecessor agency to PSRC. See appendices for the survey methodologies and weighting.

The available statistics for the 1985-1988 surveys come from tables created for the 1990 report "Household Travel Surveys, 1985-1988"; however, the original survey data files are no longer available and new results cannot be calculated. Therefore, where 1985-1988 results exist to compare with the later surveys, we've included them in this report. Where they do not, as is the case in some mode-related results, they've been omitted.

Household Travel Surveys Overview

1985-1988 Puget Sound Household Travel Surveys

Six separate household travel surveys were conducted between 1985 and 1988. The target sample size was 4,800 households (800 from each subregion); the final sample was 4,563 households with completed diaries. Three of the six surveys were in King County, and these were carried out jointly between the Puget Sound Council of Governments (PSCOG) and the Municipality of Metropolitan Seattle (Metro). The other three surveys, one each in Kitsap, Pierce and Snohomish counties, were PSCOG projects. In the three King County surveys, all household members 15 years and older completed multi-day surveys (three to four days) while children ages 5-15 completed one-day surveys. In Kitsap, Pierce and Snohomish counties, persons 5 years and older completed one-day surveys. All surveys were conducted in either the spring or fall months. Completion rates for recruited households were 55 percent. The data collected in the 1985-1988 surveys were not weighted originally, but regional figures were adjusted using estimated household totals for each county and city prepared by the Washington State Office of Financial Management.

1999 Puget Sound Household Travel Survey

The 1999 Puget Sound Household Travel Survey was conducted between July and November 1999 by NuStats Research and Consulting on behalf of the Puget Sound Region Council (PSRC). A total of 9,028 households (46 percent of households contacted) were recruited to participate in the study. Of these, 6,000 households (67 percent) completed two-day travel diaries for a two-day period. All household members of all ages were asked to complete travel diaries. Of the completed surveys, 5,257 households were available for analysis after cleaning and geocoding were done. An attitude survey about transportation and land use issues was included in the packet of travel diaries mailed to the households, to be filled out by those 16 years of age or older. There were a total of 3,890 completed attitude surveys out of more than 11,000 sent out. The data collected for the 1999 survey were also not originally weighted, but regional figures for this report were compiled using a weighted scheme developed for the 2006 survey to provide consistency among these surveys.

2006 Puget Sound Household Travel Survey

The 2006 Puget Sound Household Travel Survey was conducted between March and June 2006 by MORPACE International, Cambridge Systematics, Mark Bradley Research and Consulting, and ECO Northwest on behalf of the Puget Sound Regional Council (PSRC). A total of 8,818 households were recruited in the study. Of these, 4,631 households (54 percent) completed travel diaries. A second component of the survey was a GPS tracking of a representative subset of households participating in the diary portion of the study. Final data for the GPS survey included 220 households with up to three vehicles per household equipped with GPS units. Analysis of the GPS tracking data has contributed to the understanding of underreporting of trips and provided insight into potential biases in the data. The third component was a stated-preference (SP) survey of a subset of adult (age 16+) respondents participating in the diary portion of the survey, whose revealed trips fit criteria of interest for possible public transit and highway toll alternatives. More than 900 SP surveys were completed, with some receiving only transit-related exercises, some only tolling exercises, while others received both sets of exercises. The SP instrument included a short series of attitudinal statements, with stated-preference exercises consisting of mode and service choices, as well as toll choices, individually customized to the travel patterns of interest revealed by the respondent as a part of the initial household activity survey. Data from the SP survey will

provide input to the activity choice models, and were used to better understand the market for transit services.

Data collected for the 2006 survey were weighted to simultaneously match Census-based target data for household size, household vehicle ownership, household number of workers, household income, and household lifestyle distributions.

Figure 1-1. Recruited / Participant Households

	1985-1988	1999	2006
Recruited Households	8,296	9,028	8,818
Households Completed Travel Diaries	4,563	5,837	4,631
Completion Rate	55%	65%	53%

Transportation Terms Used in This Report

Selected transportation terms and concepts are discussed below. Unless these definitions are clearly stated, it is difficult to compare survey results from other areas of the United States or other countries

Typology of Trips and Trip Chaining

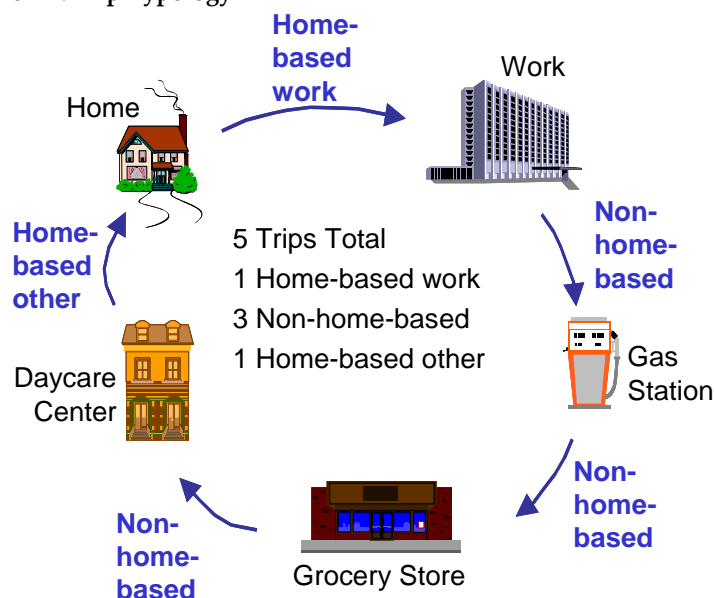
A trip is counted each time a person makes a stop for another purpose. A typology of trips:

- **Home-based work (HBW):** Trips from home to work or work to home with no stops along the way. Trips to a college/university made by a student are treated as work trips.
- **Home-based other (HBO):** Trips from or to home with an origin or destination other than work, e.g., from home to the store.
- **Non-home-based (NHB):** Trips that have neither origin nor destination with a home-end, e.g., work to restaurant, grocery store to dry cleaner.

If a person makes a stop on the way home from work, it results in a count of two trips. The only time when two reported trips have been *linked* as one trip is when two modes are used for one trip purpose. For example, a person may drive to a park-and-ride lot and then catch a bus to get to work. These two trips are reported in the diary as two trips, but have been linked as one trip for reporting in the tables presented herein.

Each stop along the way results in another **counted** trip. For example, trips from work on the return home may include a stop at a grocery store, gas station, or day care center. These trips, because of the intervening stop, are NOT coded as home-based work trips. Instead, they are coded as non-home-based trips, and a home-based other trip, as demonstrated in Figure 1-2.

Figure 1-2. Trip Typology



Additional work on trip "chaining" using the survey data will be pursued in the near future. Little work on trip chaining has been done using data from urban American household surveys. Chaining behavior may result from several very different factors: increasing use of child day care services, increased reliance on convenience/take-out foods, expanding time of operation of services (banking hours, grocery and department store shopping), and location of services relative to work, home, and mode transfer location.

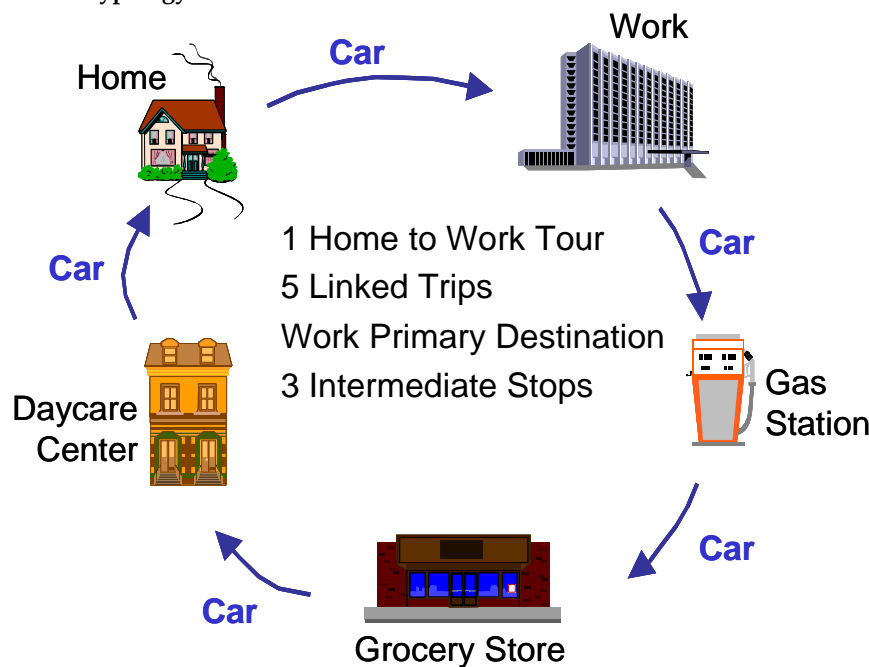
Typology of Tours

A tour is counted each time a person leaves home and includes all trips made until the person returns home. A typology of tours:

- **Work tours:** All trips from home to work and back home again, including all stops made on the way to or from work. The work purpose has the highest precedence in assigning types of tours.
- **School tours:** All trips from home to school or a college/university and back home again, including all stops made on the way to or from school.
- **Other tours:** All trips from home to an origin or destination other than work or school and back home again, including all stops made on the way to or from the destination. The purpose in a multi-purpose tour that takes up the most time determines the type of tour, although appointments generally have precedence regardless of activity time.
- **Work-based sub-tours:** All trips from work to a destination other than home and back to work again, including all stops made on the way to or from the destination.

Tours are put together to recognize that many decisions are based on the full set of trips making up a tour rather than on individual trips within a tour. A sample work tour is presented in Figure 1-3. This figure shows a work tour where the person has to go to work and then stop for gas and groceries, and then pick up their child from daycare on the way home. In this case, the person may choose to drive so that they have their car for the extra stops on the way home. The person will likely choose to shop at a store near their child's daycare rather than near their home or work because these trips are linked together. And the person will necessarily shop in the afternoon hours because they must pick up their child from daycare by a certain time. All of these travel decisions are interrelated based on the series of trips making up the work tour.

Figure 1-3. Typology of Tours



Person Trips vs. Vehicle Trips

Most of the tables and charts in this report include all trips made by persons age five and over. "Person-trips" include trips made by walking, bus, ferry, taxi, bicycle, as well as those by private vehicle. "Vehicle trips" include trips as a driver or passenger in any *private* vehicle like a passenger car or truck. That is, a passenger in a public transit bus would not be counted as making a "vehicle trip." When a table or chart is restricted, for example, to vehicle trips only, then it is so labeled.

Trip Time and Trip Length

Diary respondents were asked to fill out the start and end times of each trip. Travel time is the total reported minutes from the travel diaries. Historically, people underestimate trip time for vehicle-drive and vehicle-passenger trips and overestimate trip time for transit and walk trips. When reporting travel times, people often forget to count walking time from their parking

space to their final destination. In addition, some respondents round up 5, 10, or 15 minutes and some respondents round down, leading to an inaccurate estimate of trip time overall. As a result, trip time is computed from the starting and ending location identified by the respondent, traveling along the shortest time path in the PSRC travel demand model highway and transit networks by mode and time period. If the path is congested, the time path takes this into account. This establishes a more accurate trip time than can be achieved using the respondents' values. This process also allows us to calculate trip length (in miles) for the same path from the origin to the destination, ensuring consistency between trip time and trip length and accuracy for each respondent.

Vehicle Occupancy

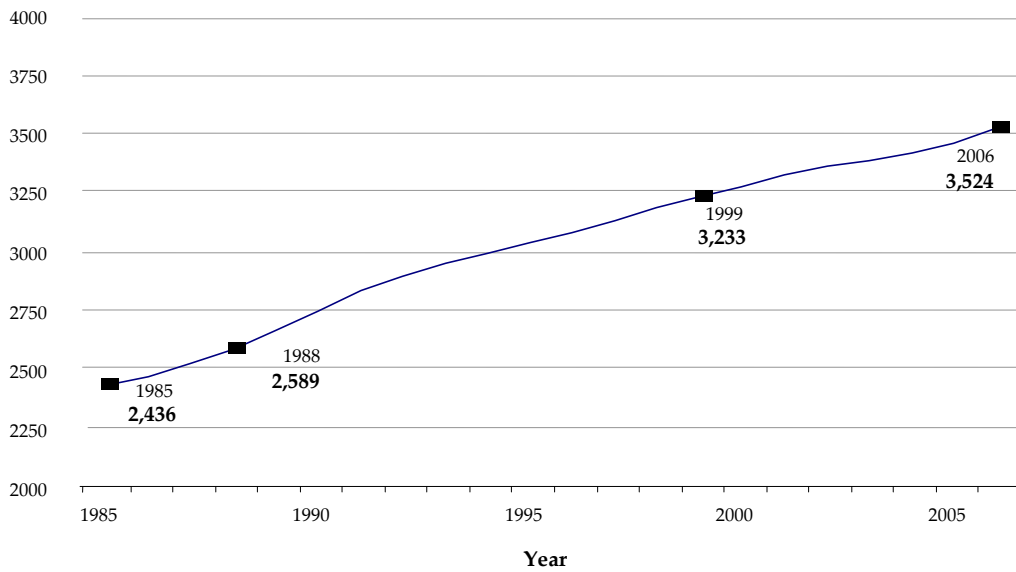
Vehicle occupancy is the number of persons, both driver and passenger(s), in a private vehicle. One person, driving alone, represents a vehicle occupancy of one, and his/her car is typically referred to as an "SOV" or single-occupant vehicle. Two or more persons driving together is typically referred to as "HOV" or high-occupant vehicle. Vehicle occupancy is of interest in examining policies related to HOV lanes and high-occupancy toll lanes, such as the recent demonstration project on SR-167.

Vehicle Availability

Vehicle ownership in a household is a strong factor in the estimation of mode choice because households without any vehicles are "captive" to non-auto modes (transit, walk, and bike). Vehicle availability is defined as the total vehicles available for use in a household. The vehicles can be passenger cars, motorcycles, sports utility vehicles, or small trucks for personal use. Vehicles that are owned or leased or borrowed and available for use should also be factored into vehicle availability.

Figure 2-2 and Figure 2-3 present the regional population and the county populations from the Office of Financial Management for the PSRC region between 1985 and 2006, respectively. This growth represents a 45 percent increase in population over 21 years, or an annual growth rate of 1.8 percent per year. Snohomish County grew faster than the other counties during this time, at 2.7 percent per year. Both Pierce and Kitsap Counties grew at 1.8 percent per year (the regional average) and King County grew more slowly at 1.4 percent per year.

Figure 2-2. Regional Population from 1985 to 2006 (in thousands)



Source: Office of Financial Management (OFM)

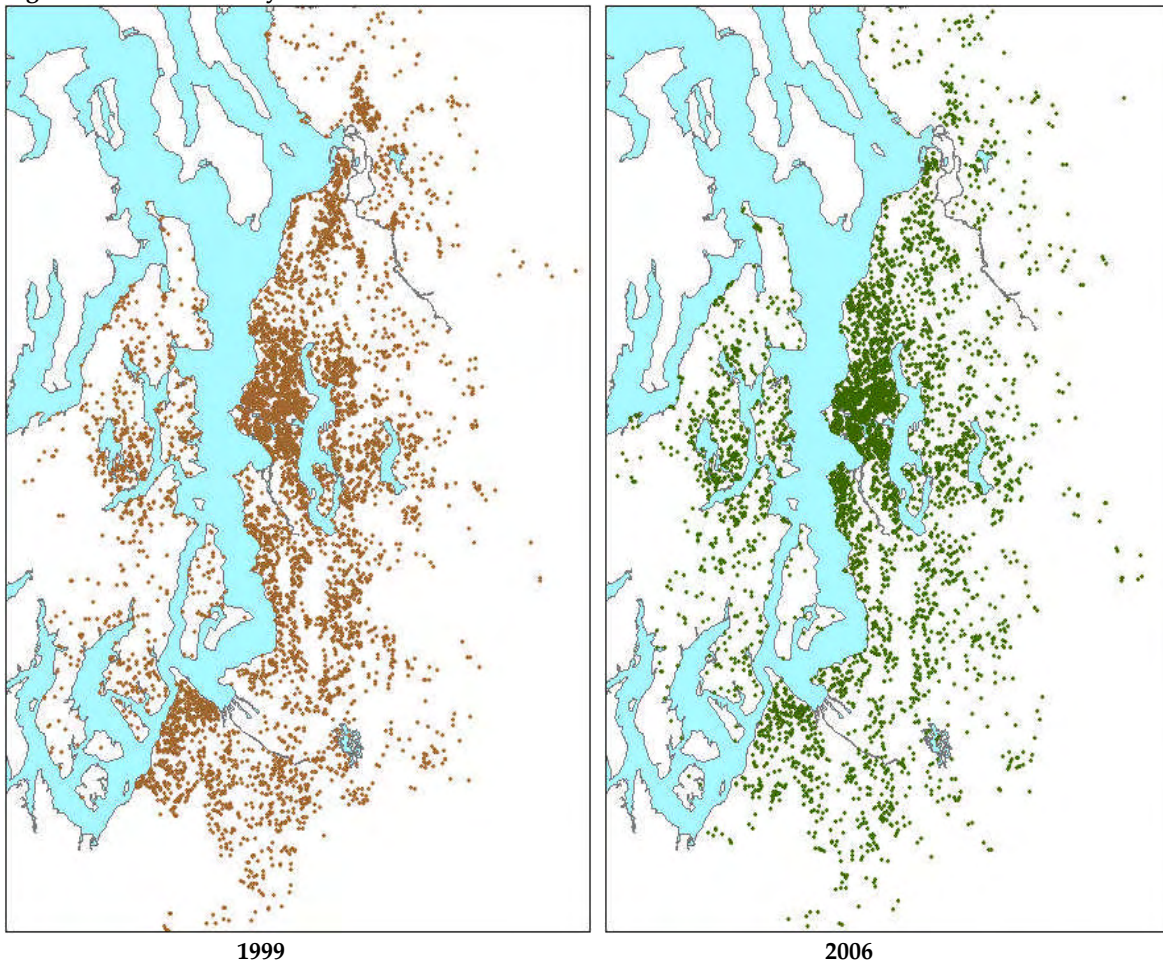
Figure 2-3. Regional Population in 1985, 1988, 1999, and 2006

	1985	1988	1999	2006
King	1,356,552	1,428,605	1,720,098	1,835,300
Kitsap	168,709	179,365	229,568	243,400
Pierce	529,753	558,259	691,565	773,500
Snohomish	381,094	422,387	591,590	671,800
Region	2,436,108	2,588,616	3,232,821	3,524,000

Source: Office of Financial Management (OFM)

Figure 2-4 shows the geographic locations of households who completed the surveys in 1999 and 2006, representing a random sample of households in the region in both surveys. The 1999 survey had more households regionally (5,874) than the 2006 survey (4,631) and therefore has a slightly more dense representation of households than in 2006, but the distributions are still quite similar.

Figure 2-4. Travel Survey Household Locations in 1999 and 2006



Household Size

Average household size in the Puget Sound region has been declining since 1960 and has started to plateau at approximately 2.5 persons per household since the late 1980s (Puget Sound Regional Council Population, Household and Housing Estimates). Figure 2-5 presents the distribution of households by size for the 1985-1988, 1999 and 2006 surveys. This demonstrates that the proportion of one-person households have increased in this timeframe, while households with three or more persons per household have decreased in this timeframe.

Figure 2-5. Household Size

Household Size	1985-1988		1999		2006	
1 person	909	19.9%	337,872	27.2%	402,142	29.2%
2 persons	1,748	38.3%	424,845	34.2%	473,752	34.4%
3 persons	825	18.1%	196,702	15.8%	197,325	14.3%
4+ persons	1,082	23.7%	283,898	22.8%	302,483	22.0%
Total	4,563	100.0%	1,243,316	100.0%	1,375,702	100.0%

Note: The 1985-1988 surveys were not weighted so the data cannot be expanded to represent the region.

Household Member Age

As the population ages across the country and in our region, age is becoming a more critical component of our travel behavior analysis. Figure 2-6 presents the age of household members for the region. Data on age of household members are not available from the 1985-1988 surveys, so are not included in this table. This table confirms that there are more households with members over age 45 in 2006 than in 1999. Persons ages 16 and 17 are holding steady, but all other age groups below age 45 are declining between 1999 and 2006, indicating that as a population we are aging and having fewer children. The median age in 1999 was 37 and the median age in 2006 was 39, an increase of 2 percent.

Figure 2-6. Household Member Age

Age	1999		2006	
Under 5	204,145	6.8%	211,656	6.5%
5 to 15	486,370	16.2%	486,005	14.9%
16 to 17	84,911	2.8%	98,792	3.0%
18 to 24	175,332	5.8%	172,806	5.3%
25 to 34	455,055	15.1%	461,658	14.1%
35 to 44	520,704	17.3%	479,702	14.7%
45 to 54	487,829	16.2%	558,360	17.1%
55 to 64	288,931	9.6%	453,256	13.9%
65 or older	302,188	10.1%	344,807	10.6%
Total	3,005,465	100.0%	3,267,043	100.0%

Note: Household member age is not available from the 1985-1988 surveys.

Household Income

Household income was collected in income group ranges for each survey. Because the average household incomes continue to increase over time, the average household income groups have also increased over time, so there is not a one-to-one match between the income groups. In 1985-1988, there were only four income groups, with the highest group defined as more than \$35,000 per year. The 1999 survey had eight income categories, with the highest group "\$75,000 or more." In the 2006 survey there were 11 income categories, and the highest group was "\$100,000 or more." Figures 2-7 and 2-8 report the distribution of households by income group from each survey. The overall average household income (in year-of-reporting dollars) increased from \$51,132 per year in 1999 to \$55,031 per year in 2006.

Figure 2-7. Percent of Households by Household Income Group, 1999

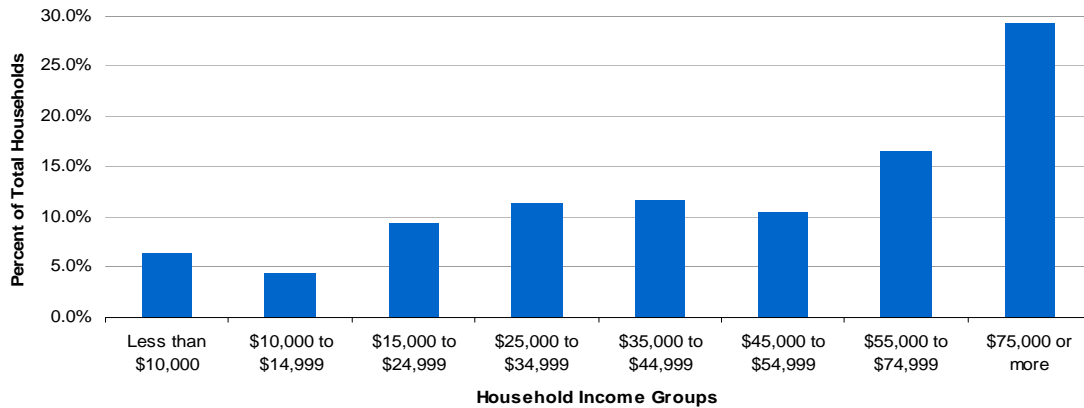
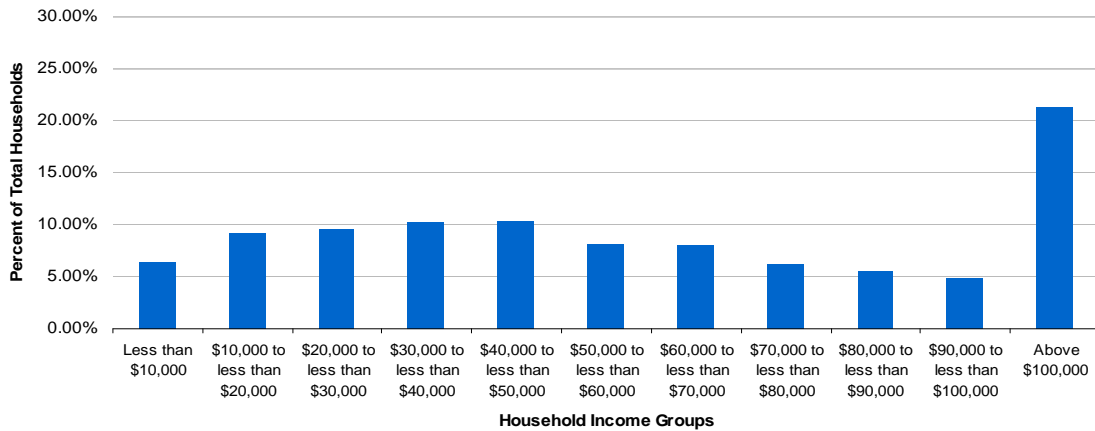


Figure 2-8. Percent of Households by Household Income Group, 2006



The 1985-1988 surveys reported income, but the ranges were <\$15,000, \$15-25,000, \$25-35,000, and >\$35,000. Since these ranges are much lower than the 1999 and 2006 surveys, this comparison was not equivalent, so these surveys were not included in the household income comparison.

Lifecycle Stage

Another approach to understanding household trip-making behavior is to look at the lifecycle stage of each household. Eight lifecycle stages for households have been defined for this report:

1. Young Children Any number of adults with any children under age 6
2. School Children Any number of adults with only children age 6-17

The next six stages have no children present in the household.

3. Young Adult 1 adult, under age 35
4. Mid - Adult 1 adult, age 35-64
5. Older Adult 1 adult, age 65 and over
6. Young 2+ Adult 2 or more adults, oldest under age 35
7. Mid 2+ Adult 2 or more adults, oldest age 35-64
8. Older 2+ Adult 2 or more adults, oldest age 65 and over

The 1985-1988 surveys did not collect any data on the lifecycle stage of households, so they are not included in this table. A comparison of the 1999 and 2006 household surveys shows that the proportion of households with children decreased 2 percent since 1999, while households with any number of mid-adults increased. The young and older adult categories remained relatively steady. This trend is consistent with the household member age discussed previously in this section.

Figure 2-9. Household Lifecycle Stage

Lifecycle	1999		2006	
Young Children	187,977	15.1%	185,804	13.5%
School Children	240,806	19.4%	262,044	19.0%
Young Adult	72,857	5.9%	83,657	6.1%
Mid-Adult	172,199	13.8%	217,063	15.8%
Older Adult	92,899	7.5%	101,422	7.4%
Young 2+ Adult	97,659	7.9%	100,247	7.3%
Mid 2+ Adult	256,755	20.7%	289,604	21.1%
Older 2+ Adult	122,164	9.8%	135,861	9.9%
Total	1,243,316	100%	1,375,702	100%

Note: Household member age is not available from the 1985-1988 surveys

Vehicles per Household

For many decades, the average number of vehicles per household has been increasing nationally, from 1.2 in 1969 to 1.7 in 1983 to 1.9 in 2001¹. In the Puget Sound region, we are seeing a similar trend between 1999 and 2006 of a slight increase in the number of vehicles per household, from 2.1 in 1985-1988 to 1.8 in 1999 and 1.9 in 2006. The trend may be attributed to the weighting associated with both the 1999 and 2006 surveys compared to the 1985-1988 surveys which were not weighted. Unweighted surveys have a tendency to under-represent zero-vehicle households and thereby over-estimate average vehicles per household. Given the comparison with national averages, we believe that the 1985-1988 surveys cannot be adequately compared to the 1999 and 2006 surveys for vehicles per household.

Figure 2-10. Vehicles per Household

Vehicles per Household	1985-1988		1999		2006	
0 vehicles	141	3.1%	95,384	7.6%	101,762	7.4%
1 vehicle	1,207	26.7%	415,146	33.4%	443,633	32.2%
2 vehicles	1,855	41.0%	486,577	39.1%	514,071	37.4%
3+ vehicles	1,320	29.2%	246,208	19.9%	316,236	23.0%
Total	4,523	100.0%	1,243,316	100.0%	1,375,702	100.0%

Note: The 1985-1988 surveys were not weighted so the data cannot be expanded to the regional level.

The comparison of the 1999 and 2006 surveys shows that the overall rate of vehicles per household rose slightly due to a small increase in the percent of households with three or more vehicles. The increase in vehicles per household can be further examined in relation to household lifecycle. Figures 2-10 and 2-11 demonstrate the changes in vehicle ownership by lifecycle. In general, between 1999 and 2006, vehicle ownership increased for all lifecycle categories except mid-adults living alone. Households with children and households with two or more mid-adults are now more likely to own three or more vehicles. The number of young and older adults living alone without a car decreased significantly. Households with two or more young adults or older adults

¹ April 2003 Highway Information Quarterly Newsletter, published by FHWA Office of Highway Policy Information (<http://www.fhwa.dot.gov/ohim/hiq/bar2.htm>)

increasingly have two cars rather than one or zero. Six percent more mid-adult households have zero cars since 1999, while 5 percent fewer have one car.

Figure 2-11. Vehicles per Household by Lifecycle, 1999

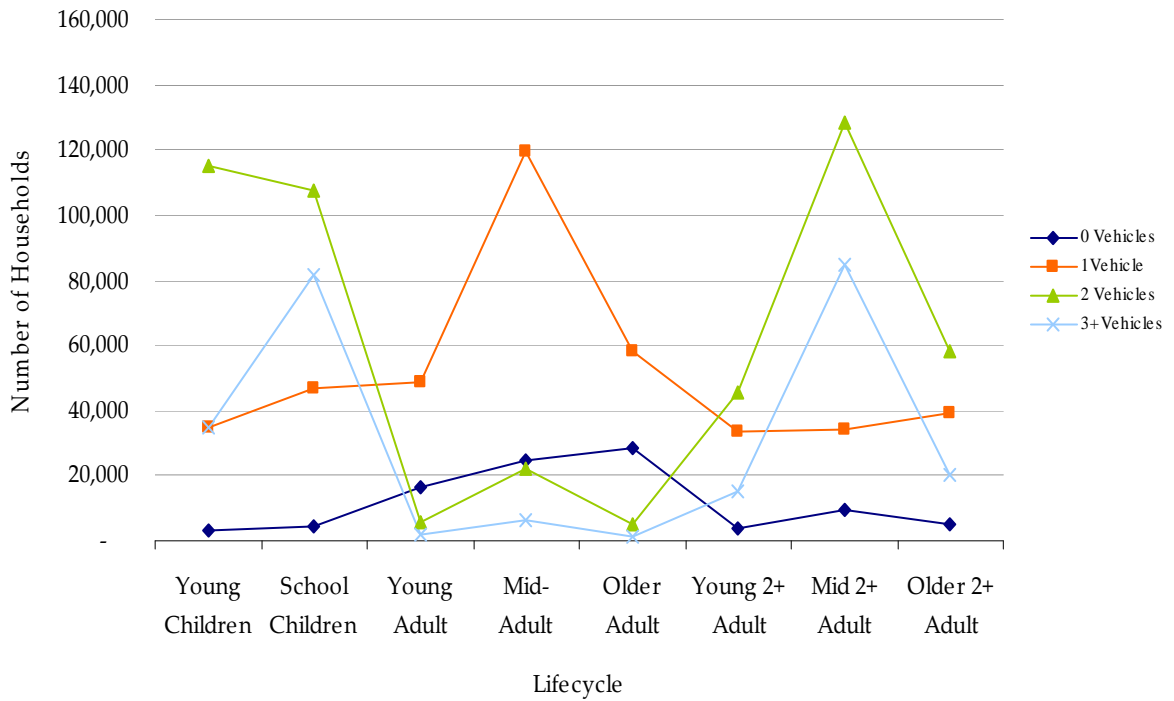
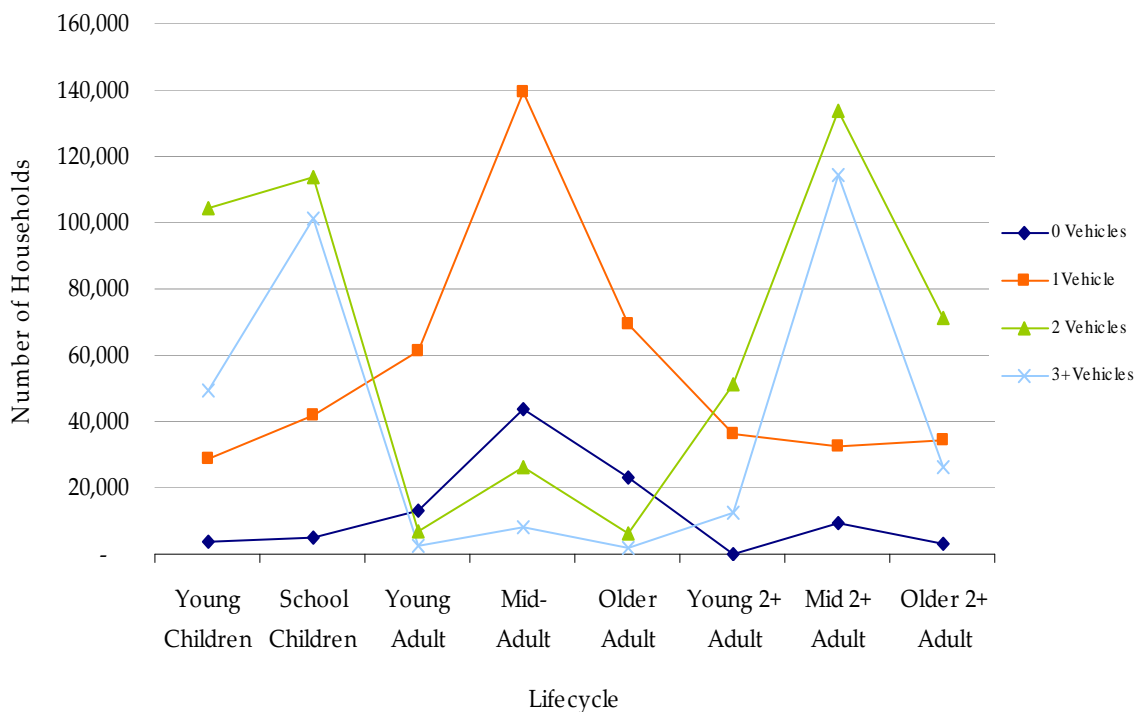


Figure 2-12. Vehicles per Household by Lifecycle, 2006

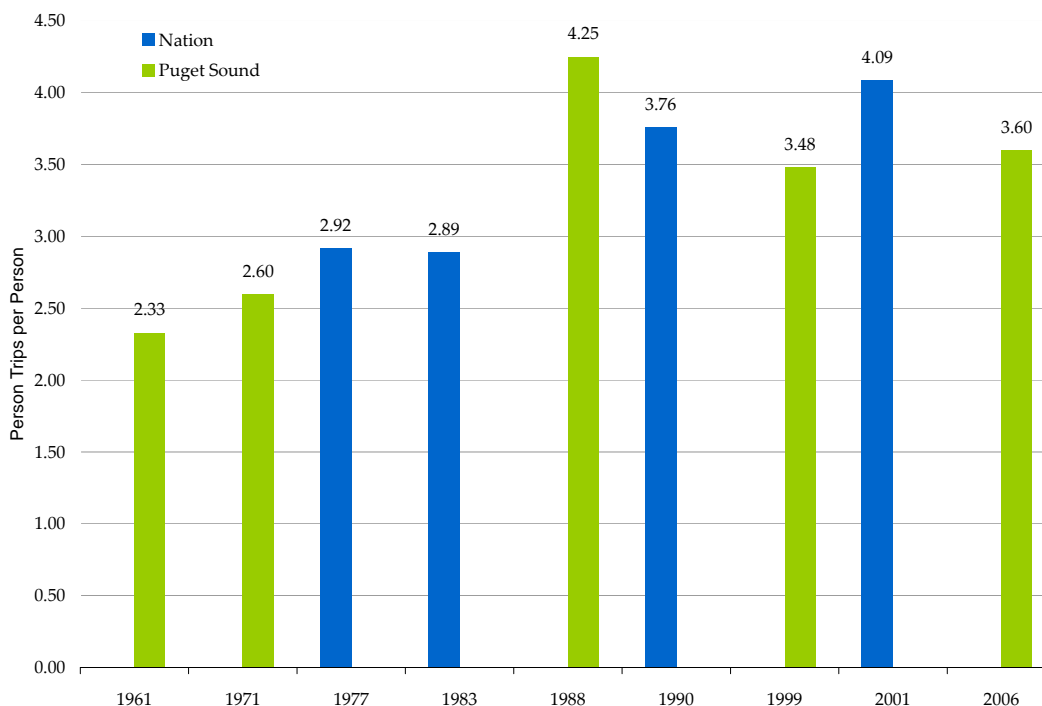


3. Household and Person Trip Rates

Overview

Steadily rising since 1961, trip-making on a per-person and per-household basis has slowed in recent years in the Puget Sound region, while continuing to increase for the nation as a whole (see Figure 3-1). Trip rate summaries for the region comprise all trips, including motorized (e.g., auto and bus), nonmotorized (e.g., walk and bike), and other modes such as ferries. The higher trip rate for the 1985-1988 surveys may well be attributed to a bias in survey data collection rather than a much higher trip rate in those years. The 1985-1988 surveys were not weighted to represent the population as the 1999 and 2006 surveys were done. This process of weighting accounts for any biases from households who are more difficult to contact (i.e., they have no phones) or households who are more likely to refuse to participate or households who are less likely to complete the survey after agreeing to participate. These factors contribute to biases in the overall results that may be apparent in some summary statistics, such as the person trip rates. For example, it is common for surveys to under-represent low-income households and young adults. Both of these populations have significantly lower trip rates per person than the average, so under-representing them in the survey would tend to over-estimate trip rates. The 1999 and 2006 surveys were weighted to adjust for these biases. As a result, the 1985-1988 person trip rates are likely over-estimated in this comparison with 1999 and 2006, but it is unclear how much this over-estimation explains the difference.

Figure 3-1. Average Daily Person Trips per Person



Note: The 1961, 1971 and 1985-1988 surveys were not weighted and expanded to represent the full population and may contain biases inherent in not weighting surveys, so are likely to be over-estimating trip rates as a result. The 1999 and 2006 surveys were weighted to account for these biases. The national data for 1977, 1983 and 1990 are from the Nationwide Personal Transportation Survey (NPTS). The national data for 2001 are from the National Travel Survey (NHTS).

Household Trip Rates by Purpose

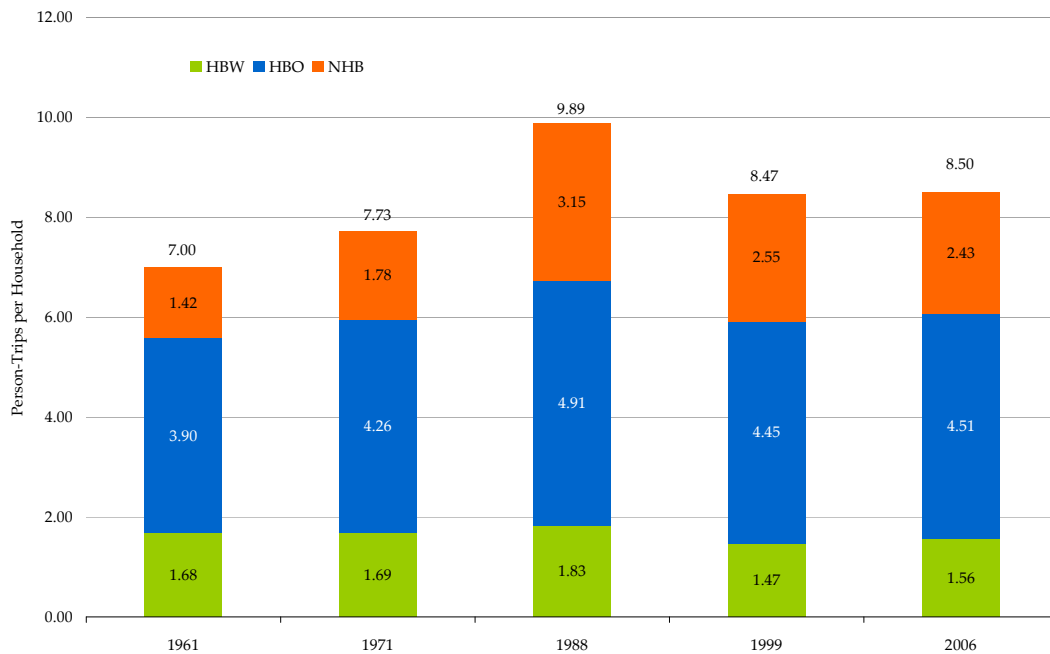
As discussed in previous chapters, three types or purposes are used to categorize trips in this report:

- Home-based work (HBW)
- Home-based other (HBO)
- Non-home-based (NHB)

Home-based work household trip rates have remained stable while home-based other and non-home-based household trip rates have increased since the early 1960s (see Figure 3-2). As a percent of total trips, though, the percent of trips by trip type shows a slight decline in home-based work and home-based other trips and a slight increase in non-home-based trips since 1961 (see Figure 3-3). This increase in non-home-based trips is likely a result of increases in trip chaining. As more people live farther from work, they tend to chain trips together on the way to or from work rather than making separate trips from home.

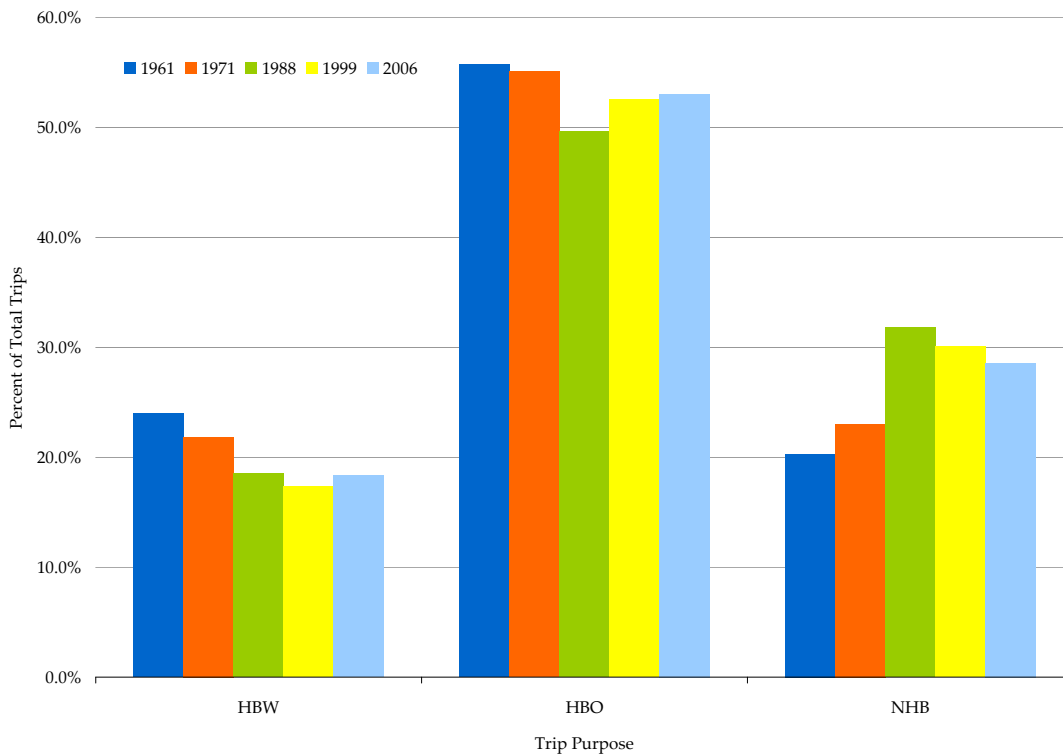
This flattening of the overall home-based work household trip rates is attributable to the declining average household size and larger numbers of smaller households (i.e., one-person) since the 1960s rather than changing travel habits and despite the increase in multi-worker households. This trend is also explained by the increasing number of stops made during home-to-work and work-to-home travel. Stops at the coffee shop and/or the day care center on the way to work and stops at the grocery store or dry cleaning store on the way home from work are categorized as home-based other or non-home-based trips. It is this trip-chaining behavior that makes analyses of travel “tours” and “journeys,” rather than individual person-trip segments, more relevant and meaningful when examining current household travel habits.

Figure 3-2. Average Person-Trips per Household by Trip Type



Note: The 1961, 1971 and 1985-1988 surveys were not weighted and expanded to represent the full population and may contain biases inherent in not weighting surveys, so are likely to be over-estimating trip rates as a result. The 1999 and 2006 surveys were weighted to account for these biases.

Figure 3-3. Percent Total Trips by Trip Purpose



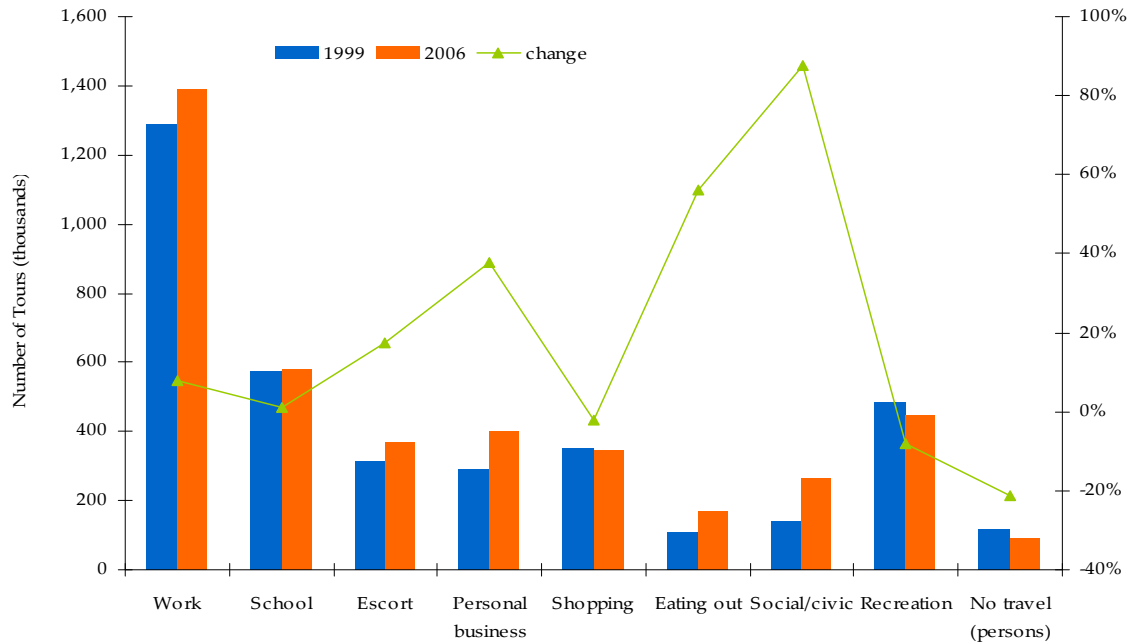
Note: The 1961, 1971 and 1985-1988 surveys were not weighted and expanded to represent the full population and may contain biases inherent in not weighting surveys, so are likely to be over-estimating trip rates as a result. The 1999 and 2006 surveys were weighted to account for these biases.

Trip Chaining

In the 1999 and 2006 surveys, data processing allows us to summarize the trips in the survey based on the tours each household makes each day. These tours represent all trips made on a journey from home. Households may make several tours each day from home and possibly one or more tours from work (and returning to work). The trends noted over the last 40 years for increased trip chaining do not hold true when comparing the details in the 1999 and 2006 surveys, where there is a slight decline in trip chaining. This is likely a flattening of the longer-term trend based on shifting economic concerns. This analysis is described below.

Overall, more tours are being made in the Puget Sound region in 2006 compared to 1999, increasing 11.5 percent from a daily average of 3.55 million tours to 3.96 million (see Figure 3-4). Compared to population growth, which was 10.5 percent (Puget Sound Regional Council Population, Household and Housing Estimates) in the intervening seven years, tour-making increased by 1 percent more than population growth. Looking at the primary purpose for making a tour, travel devoted to eating out, social/civic activities, and the catch-all category of personal business saw the largest increases in 2006. Some of the change in the frequency of social tours is attributable to how trips were coded in the two surveys. In the 2006 survey, “visiting friends” was usually coded as a social activity, while the same activity in 1999 was often coded as a recreation trip. On a percentage basis, work, school and shopping tours declined in this timeframe, likely due to the more difficult economy. Compared to 1999, fewer people had more than one job in 2006, which may also explain the decline in work tours. Another significant difference is in the number of people who took no trips at all in the two-day travel period. Compared to 1999, 21 percent fewer persons (from 116,615 to 91,604) stayed at home during the travel period in 2006.

Figure 3-4. Tours by Tour Type



Note: Tours not created for 1985-1988 survey.

Figure 3-5. Tours by Tour Type

Tour Purpose	Number of Tours				
	1999	Percent	2006	Percent	Change
Work	1,290,809	36.3%	1,389,928	35.1%	7.7%
School	573,634	16.1%	580,984	14.7%	1.3%
Escort	313,539	8.8%	368,102	9.3%	17.4%
Personal business	290,762	8.2%	400,661	10.1%	37.8%
Shopping	353,117	9.9%	346,188	8.7%	-2.0%
Eating out	108,326	3.0%	169,183	4.3%	56.2%
Social/civic	140,666	4.0%	263,729	6.7%	87.5%
Recreation	484,106	13.6%	445,737	11.2%	-7.9%
Total Tours	3,554,959	100.0%	3,964,511	100.0%	11.5%
No travel (persons)	116,615		91,604		-21.4%

Note: Tours not created for 1985-1988 survey.

On average, people took marginally more tours in 2006, increasing 1.4 percent from 1.27 to 1.29 daily tours per person (see Figure 3-5), but made the same number of stops per tour, which results in a minor increase in the household trip rate. Those with the largest increases in the number of tours made on an average day are part-time workers and 16- and 17-year-olds. The only category of adult person who saw a significant decrease in tour-making activity in 2006 was the other non-worker (those who are not working but also not retired) (see Figure 3-5).

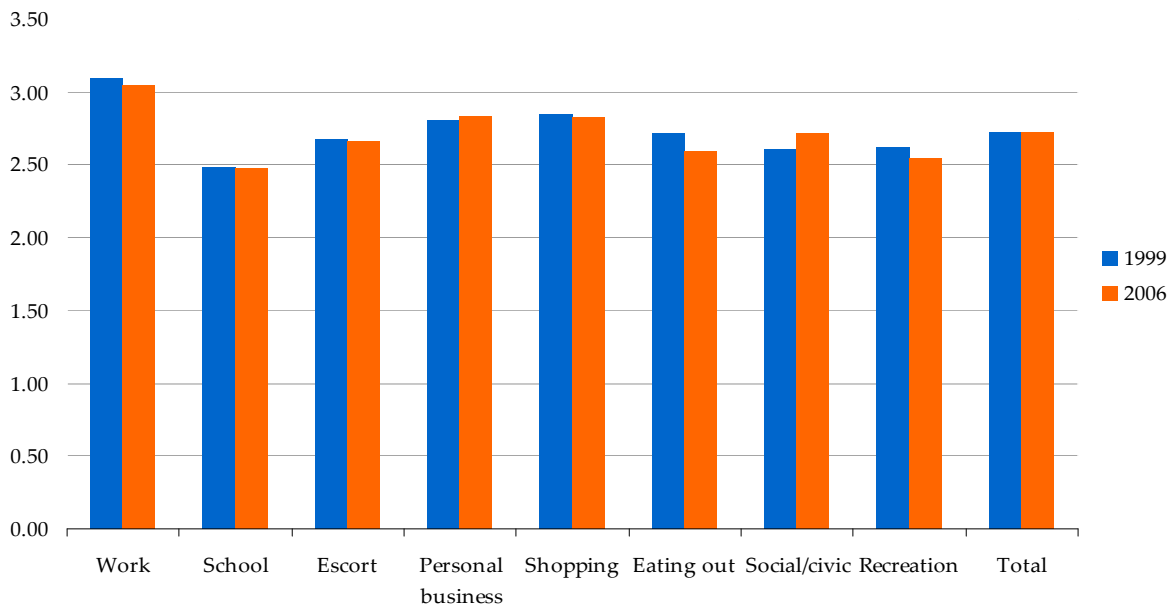
Figure 3-6. Tours by Age and Employment Status

Person status	Average Tours per Person		
	1999	2006	Change
Full-time worker	1.30	1.30	0.5%
Part-time worker	1.52	1.60	5.5%
Retired non-worker	1.07	1.07	-0.3%
Other non-worker	1.39	1.34	-3.9%
Adult student	1.55	1.54	-1.1%
Child age 16-17	1.37	1.46	6.2%
Child age 5-15	1.23	1.24	0.8%
Child age 0-4	0.97	0.88	-9.4%
Total	1.27	1.29	1.4%

Note: Tours not created for 1985-1988 survey.

The number of stops made in a tour saw little change between 1999 and 2006, at 2.7 stops per tour in each survey (see Figure 3-7). There were fewer stops on work and school tours in 2006 than in 1999, indicating less trip chaining. This may be a result of fewer discretionary stops due to a difficult economy. There were also fewer stops to eat out, which declined 4 percent, possibly indicating fewer spontaneous stops to eat out (but more eating out tours, indicating more conscious travel to eat out).

Figure 3-7. Number of Stops per Tour by Tour Type

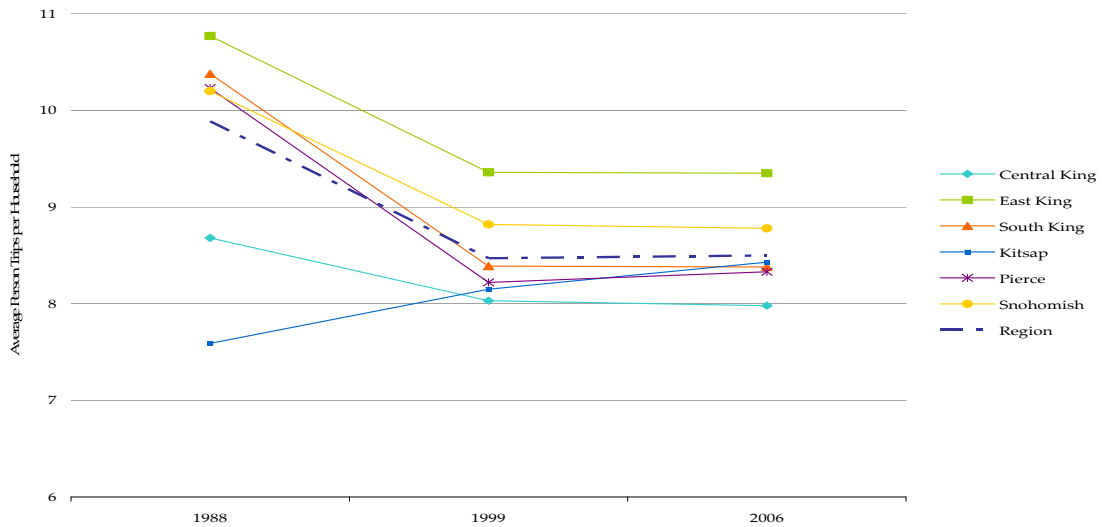


Note: Tours not created for 1985-1988 survey.

Household Trip Rates by Purpose and County/Sub-County Area

The regional average rate of person trips per household are fairly stable across the region, with the exception of Kitsap County (see Figure 3-8). Kitsap County saw the largest increase at just over 3 percent since 1999 in the average trip rate per household. The household trip rate for the region as a whole grew only 0.5 percent.

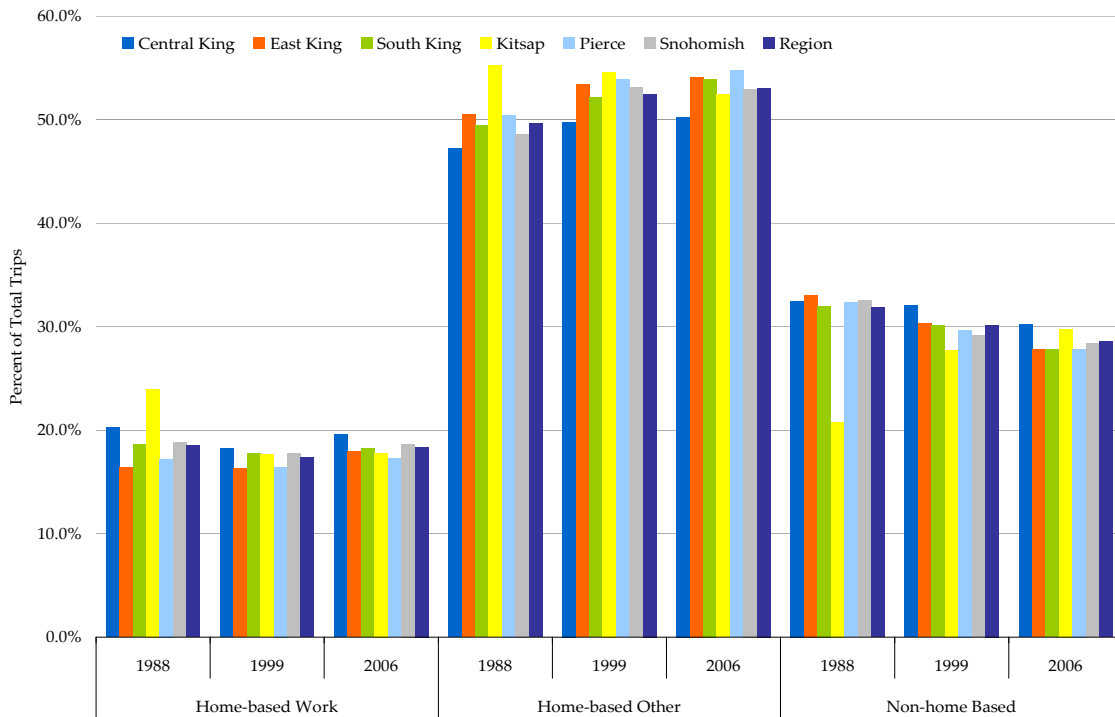
Figure 3-8. Daily Person Trips per Household by County/Sub-county Area



Note: The 1985-1988 surveys were not weighted and may contain biases in trip rates for certain categories. The 1999 and 2006 surveys were weighted to account for these biases.

Although the average rate of daily person trips per household for the region has been steady since 1999, percent average daily person-trips per household by purpose and county/sub-county area reveal a changing underlying pattern (see Figure 3-9). Overall, since 1988, the percent of home-based work trips remained relatively stable, home-based other trips increased slightly, and non-home-based trips waned to some extent. However, Kitsap County shows a contrary pattern; home-based work trips and home-based other trips decreased and non-home based trips grew markedly.

Figure 3-9. Percent Daily Person-Trips per Household by Trip Purpose and County/Sub-County Area



Note: The 1985-1988 surveys were not weighted and may contain biases in trip rates for certain categories. The 1999 and 2006 surveys were weighted to account for these biases.

Household Trip Rates by Household Size

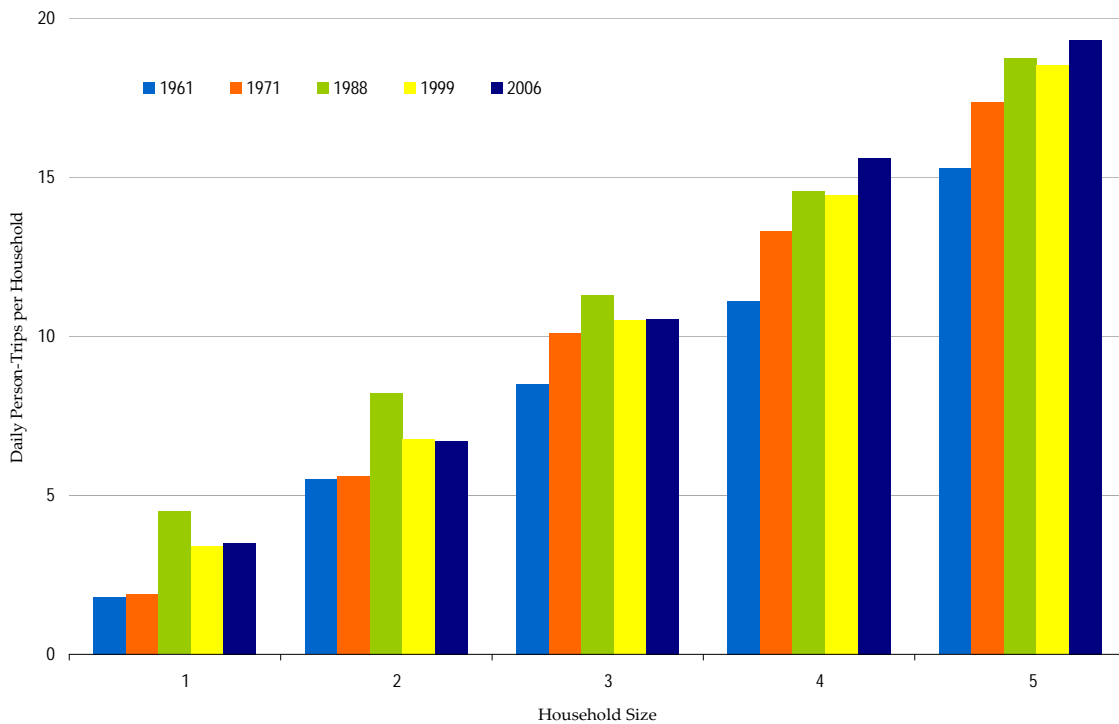
When person-trips are examined by household size, the average number of trips per household increased since 1961 in most household size categories (Figure 3-10) through 2006, with the exception of the 1988 surveys. Two-member households saw a slight decrease, while three-person household trip rates held steady. The 1961, 1971 and 1988 surveys were not weighted and may contain biases that were accounted for in the weighting of the 1999 and 2006 surveys.

Figure 3-10. Average Daily Person-Trips by Household Size

Household Size	1961	1971	1988	1999	2006
1	1.8	1.9	4.5	3.4	3.5
2	5.5	5.6	8.2	6.8	6.7
3	8.5	10.1	11.3	10.5	10.5
4	11.1	13.3	14.6	14.4	15.6
5+	15.3	17.4	18.8	18.5	19.3

Note: The 1961, 1971 and 1985-1988 surveys were not weighted and may contain biases in trip rates for certain categories. The 1999 and 2006 surveys were weighted to account for these biases.

Figure 3-11. Average Daily Person-Trips per Household by Household Size

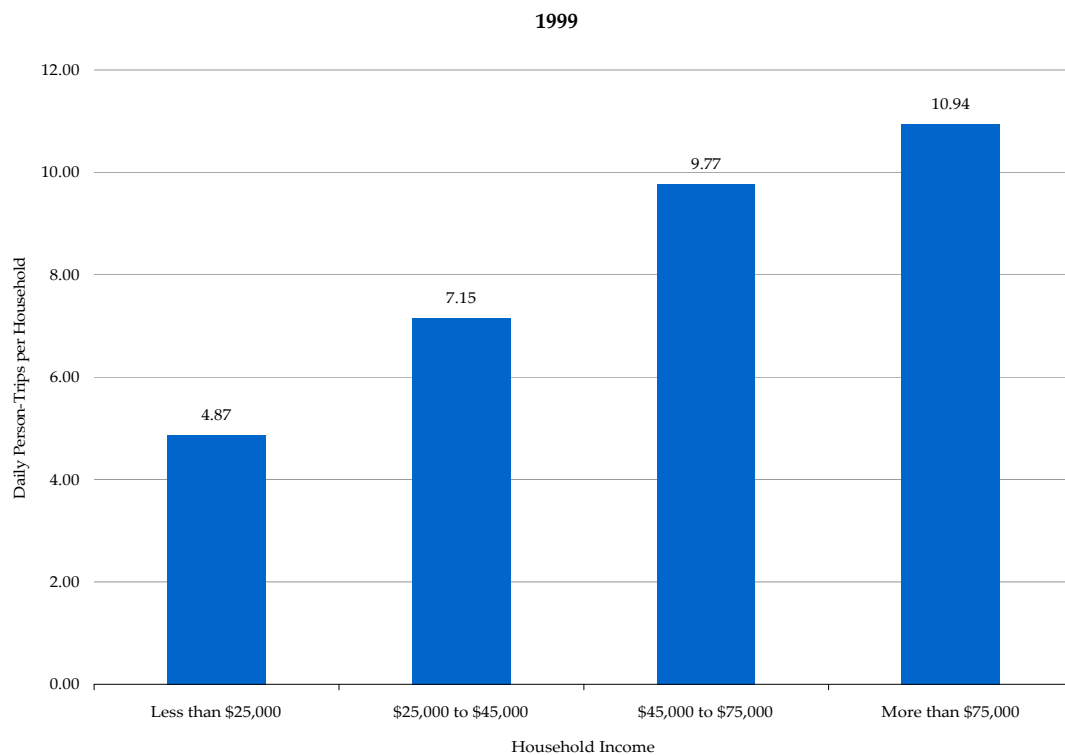
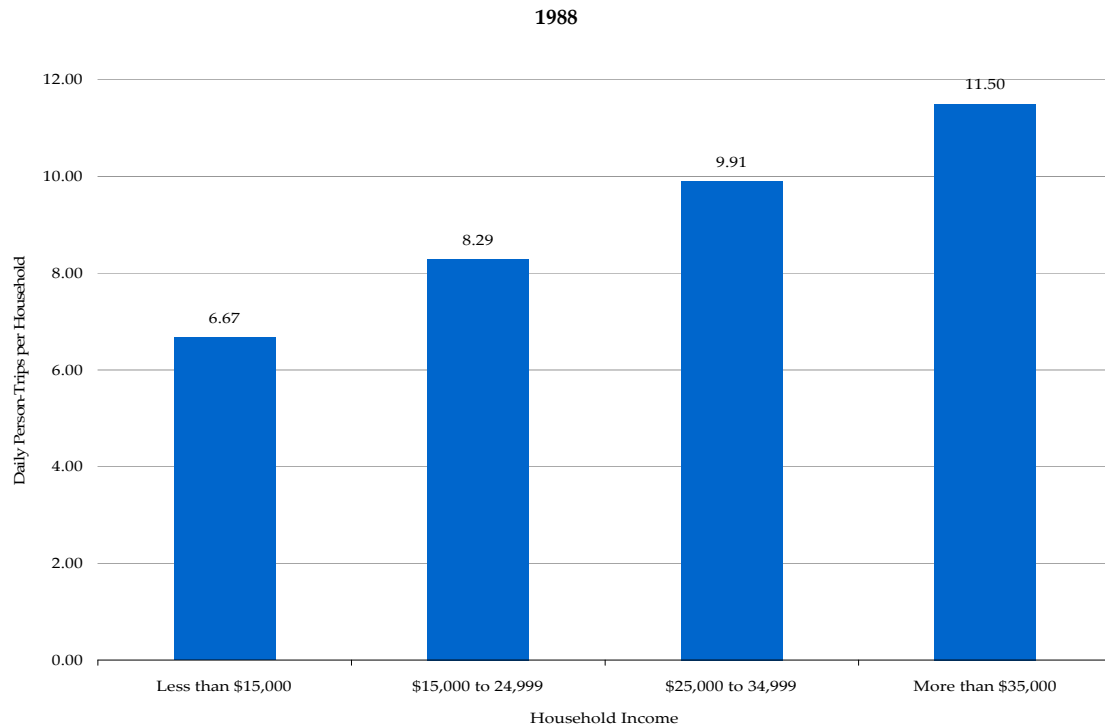


Note: The 1961, 1971 and 1985-1988 surveys were not weighted and may contain biases in trip rates for certain categories. The 1999 and 2006 surveys were weighted to account for these biases.

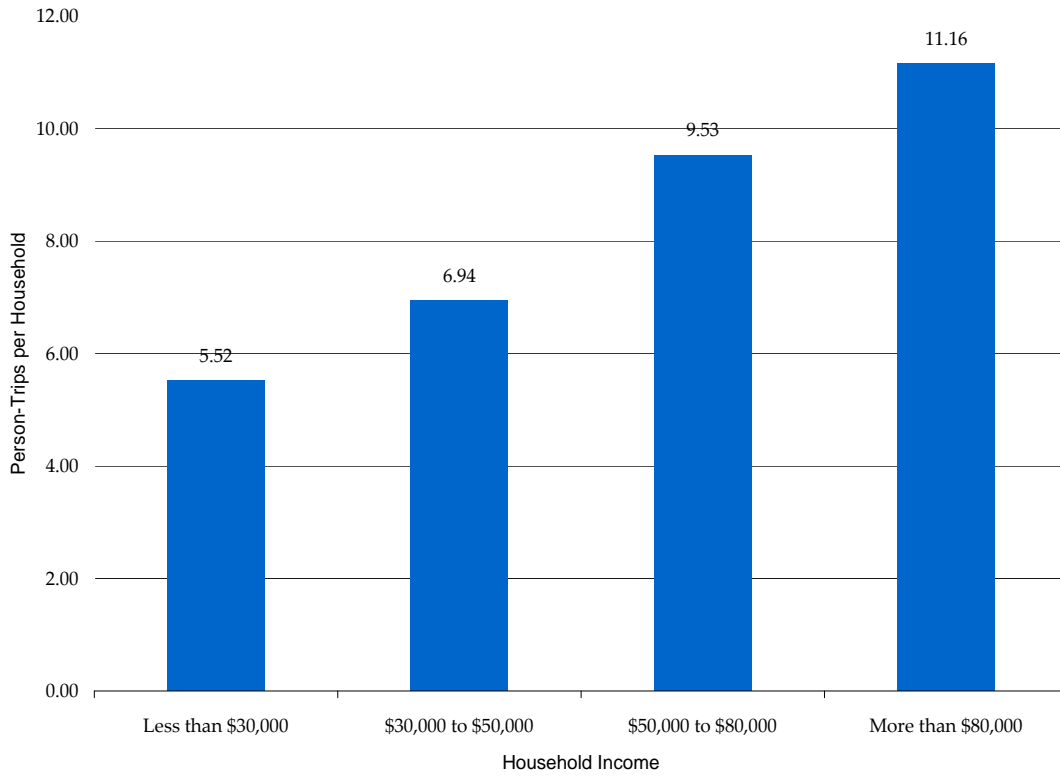
Household Trip Rates by Household Income

Household income has a direct relationship to the number of person trips per household. Trips per household increase as income increases in 1988, 1999 and 2006 (Figure 3-12). Income levels were not adjusted for inflation and cannot be directly compared from year to year.

Figure 3-12. Average Daily Person-Trips per Household by Household Income Range



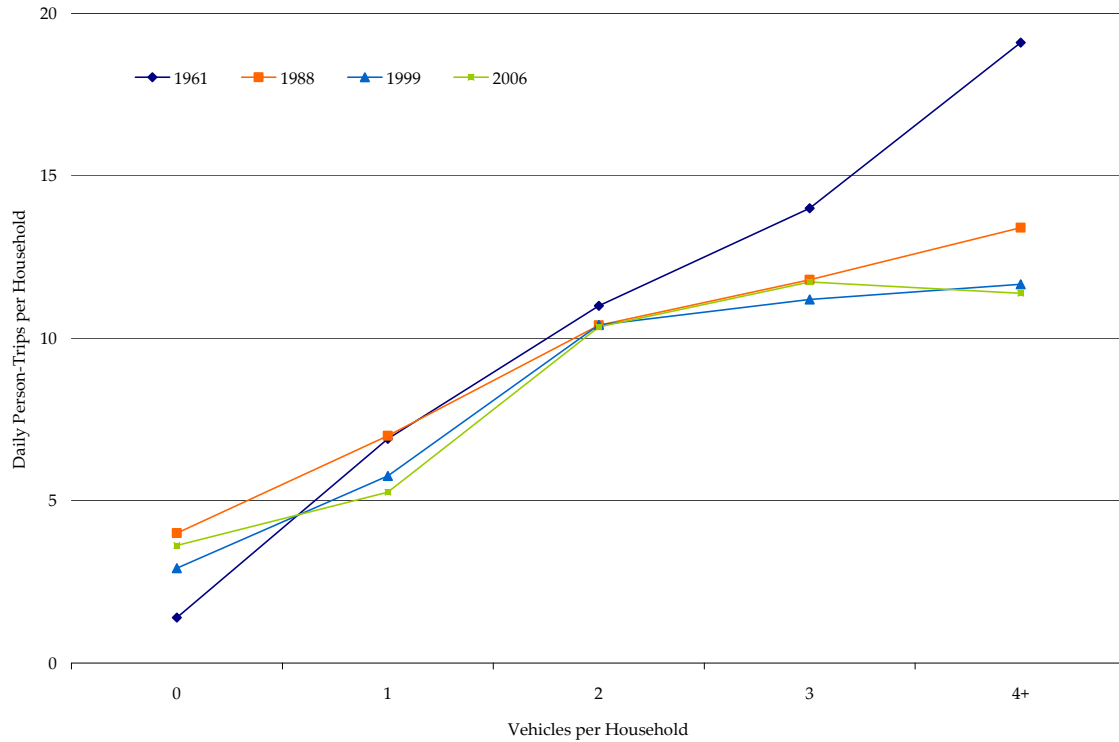
2006



Household Trip Rates by Vehicle Availability

Vehicle availability, once considered a strong factor for prediction of trip making behavior, appears less reliable as access to vehicles increases. Figure 3-13 shows that in 1961 there was a direct relationship between the number of vehicles owned and the number of trips made by households. By 1988, the data reveal a weaker relationship, in part due to the number of households having more vehicles than persons of driving age.

Figure 3-13. Average Daily Person Trips per Household by Vehicles per Household



Note: The 1961 and 1985-1988 surveys were not weighted and may contain biases in trip rates for certain categories. The 1999 and 2006 surveys were weighted to account for these biases. Not available from the 1971 survey.

Figure 3-14 indicates that, for most counties/sub-county areas, the trip making rate increased the most from zero- to two-vehicle households and rose significantly less or even declined from two-to four-or-more vehicle households. For example, in central King County in 2006, one-vehicle households made 64 percent more trips on average than households with zero vehicles, and households with four or more vehicles made only six percent more trips than three-vehicle households. According to this data, the impact on trip making lessens as the number of vehicles per household increases.

Figure 3-14. 1999/2006 Average Daily Person-Trips by Vehicle Availability by County/Sub-County Area

Vehicle Availability	Pierce		South King		East King		Central King		Snohomish		Kitsap	
	1999	2006	1999	2006	1999	2006	1999	2006	1999	2006	1999	2006
0 Vehicles	1.90	2.66	3.13	3.94	2.23	4.51	3.46	3.65	3.12	3.98	1.95	2.80
1 Vehicle	5.63	5.00	5.31	4.67	5.49	5.14	6.44	5.98	5.22	4.84	5.92	5.24
2 Vehicles	9.95	10.03	9.94	10.17	11.43	10.81	10.81	10.71	10.40	10.39	9.32	9.43
3 Vehicles	10.78	11.81	11.14	10.84	11.66	12.87	11.46	12.61	11.41	10.80	10.25	11.62
4+ Vehicles	11.27	9.20	12.53	12.08	10.80	11.99	13.59	13.40	11.42	11.99	10.59	10.77

Note: Not available for 1985-1988 survey

Using the vehicle availability ratio, Figure 3-15 shows that for households, regardless of the size, average trip rates are generally somewhat lower for those households that had less than one vehicle per licensed driver compared to those with one or more vehicles per driver. For Pierce, South King and East King, the change in trip rate per household across time generally lessens as the household size increases. For example, in 2006 in Pierce County, person trips per household increased 22 percent for one-person households with less than one vehicle per licensed driver, but only 12 percent for two-person households, and decreased 10 percent for three-person households.

Figure 3-15. Average Daily Person-Trips per Household by Vehicle Availability by County/Sub-County Area

Vehicle Availability	Pierce			South King			East King			Central King			Snohomish			Kitsap		
	1988	1999	2006	1988	1999	2006	1988	1999	2006	1988	1999	2006	1988	1999	2006	1988	1999	2006
Less than One Vehicle/Licensed Driver																		
1-person HH	3.43	1.87	2.28	3.17	1.67	3.14	na	2.55	4.48	3.93	4.21	3.86	2.83	3.39	3.17	3.23	2.68	2.30
2-person HH	7.67	5.40	6.06	7.96	5.82	7.16	8.95	6.22	6.34	8.57	7.95	7.94	7.22	6.00	6.78	4.44	4.74	6.55
3+ person HH	14.88	12.89	11.66	15.83	12.60	12.05	17.80	16.21	14.48	12.53	14.71	14.92	14.60	10.96	13.09	10.16	13.02	11.49
One or More Vehicle/Licensed Driver																		
1-person HH	4.71	3.07	3.94	4.69	3.57	3.83	4.80	3.52	3.87	4.83	3.75	4.60	4.58	3.12	4.24	3.29	2.79	3.79
2-person HH	8.23	6.29	7.72	8.28	6.70	7.73	8.70	7.26	7.88	8.64	7.12	8.85	8.30	6.89	7.76	6.16	6.80	7.68
3+ person HH	14.06	12.94	12.72	14.34	13.76	13.24	14.25	13.89	14.05	14.67	14.51	15.26	13.55	13.58	14.07	10.88	12.27	13.15

Note: The 1985-1988 surveys were not weighted and may contain biases in trip rates for certain categories. The 1999 and 2006 surveys were weighted to account for these biases.

Household Trip Rates by Lifecycle Stage

Figure 3-16 and Figure 3-17 compare the average number of person-trips per household across all lifecycle stages (see page 12 in Chapter 2 for the definition of lifecycle stages). Households with children (Young Child and School Child) made the greatest number of trips of all the lifecycle stages. Even though these two groups had larger average household sizes than the other lifecycles, in 2006, the average number of trips per household is still proportionally larger than any other lifecycle group, as seen in Figure 3-18. School-age children have many activities to which they are transported. Many of those of driving age have their own vehicles. Between 1988 and 2006, households with children continued to make the most person trips per household, and households with a young child increased the average number of person trips by two trips. Trip rates among most household types without children (except one older adult living alone) increased only slightly or decreased between 1999 and 2006. Total trip rates did not vary much between the younger adult and middle-aged adult households. Trip rates for older adult groups were somewhat lower. However, households with one older adult living alone increased their trip rates notably, indicating a more active elderly population.

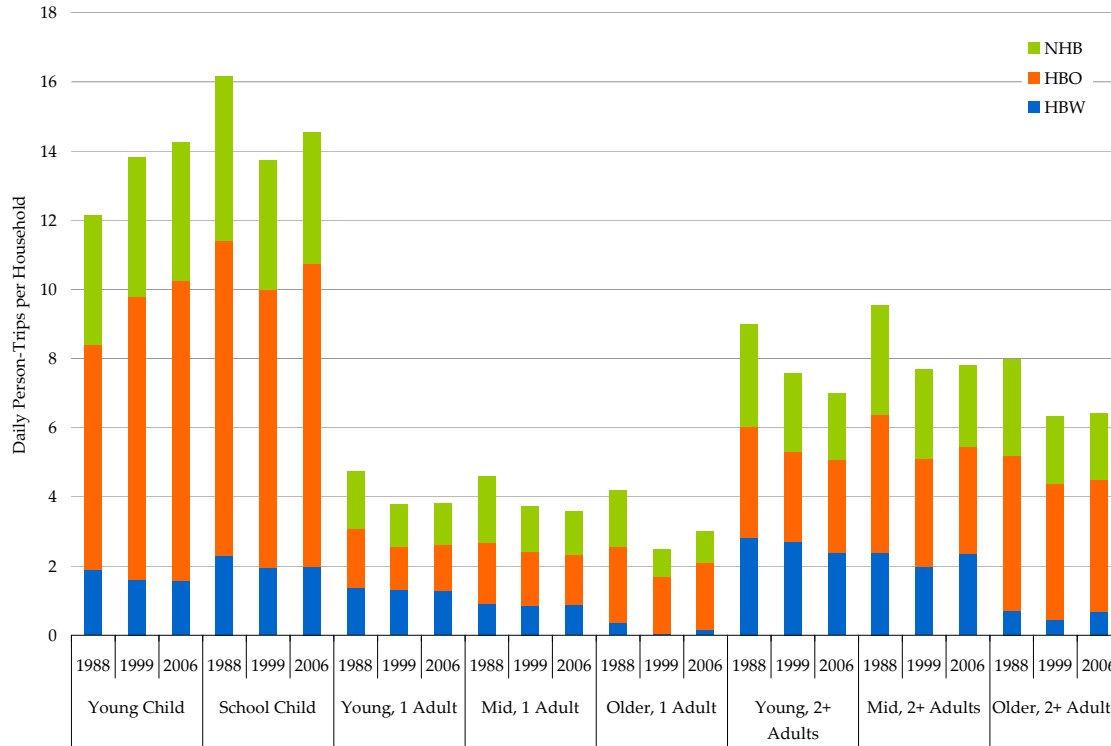
Figure 3-16. Trips by Lifecycle Stage

Lifecycle Stage	All Trips			HBW			HBO			NHB			Average HH Size		
	1988	1999	2006	1988	1999	2006	1988	1999	2006	1988	1999	2006	1988	1999	2006
Young Child	12.15	13.83	14.26	1.88	1.60	1.56	6.46	8.18	8.70	3.81	4.05	4.00	4.00	4.01	3.92
School Child	16.18	13.75	14.53	2.27	1.93	1.98	9.14	8.07	8.75	4.76	3.75	3.80	3.63	3.70	3.69
Young Adult	4.76	3.78	3.81	1.39	1.32	1.29	1.70	1.23	1.32	1.67	1.23	1.20	1.00	1.00	1.00
Mid Adult	4.61	3.73	3.60	0.90	0.84	0.89	1.75	1.56	1.46	1.96	1.33	1.24	1.00	1.00	1.00
Older Adult	4.18	2.49	3.01	0.25	0.05	0.16	2.29	1.64	1.94	1.63	0.80	0.91	1.00	1.00	1.00
Young 2+ Adults	8.99	7.59	6.99	2.81	2.69	2.39	3.22	2.63	2.67	2.96	2.26	1.93	2.05	2.16	2.05
Mid 2+ Adults	9.53	7.70	7.80	2.39	1.96	2.37	3.99	3.15	3.07	3.14	2.59	2.36	2.25	2.24	2.20
Older 2+ Adults	8.00	6.34	6.43	0.67	0.43	0.67	4.55	3.96	3.82	2.78	1.95	1.94	2.13	2.18	2.12

Note: The 1985-1988 surveys were not weighted and may contain biases in trip rates for certain categories. The 1999 and 2006 surveys were weighted to account for these biases.

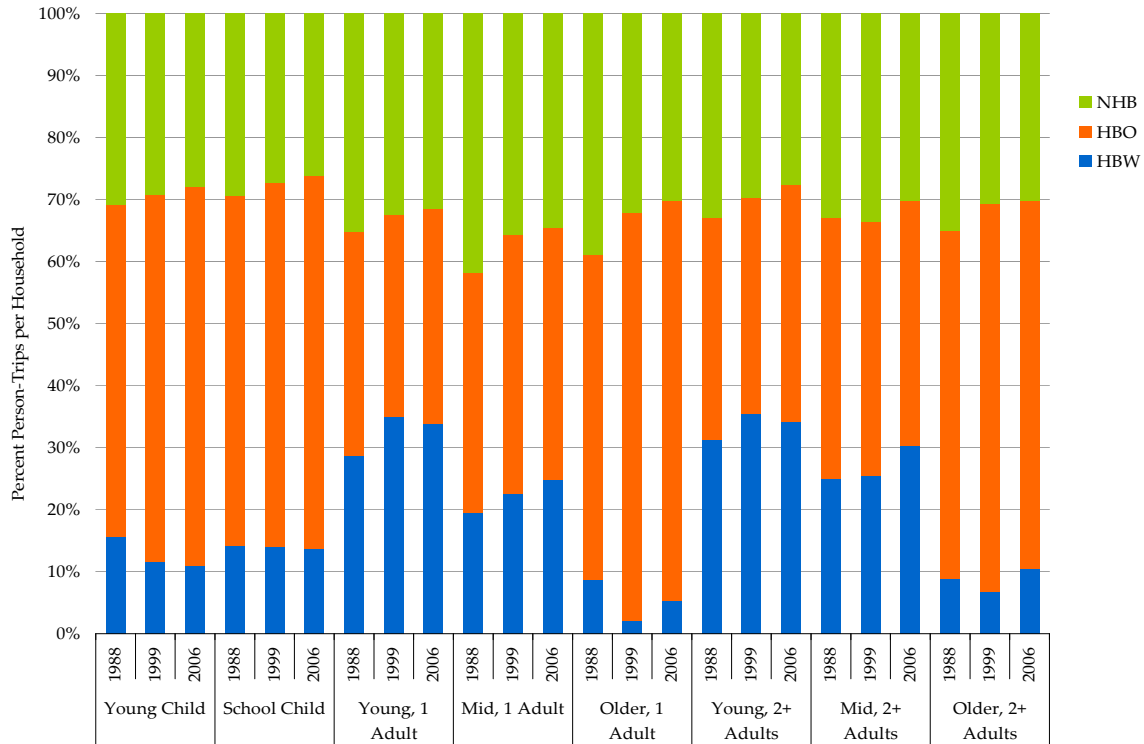
Trips vary distinctly by type in each lifecycle stage. As expected, households with adult(s) age 65 or over make proportionately fewer home-based work trips. Households with children make a higher proportion of home-based other trips and a lower proportion of home-based work trips relative to other life-cycle stages with all adults under age 65.

Figure 3-17. Average Daily Person-Trips per Household by Lifecycle Stage and Trip Purpose



Note: The 1985-1988 surveys were not weighted and may contain biases in trip rates for certain categories. The 1999 and 2006 surveys were weighted to account for these biases.

Figure 3-18. Percent Person-Trips per Household by Lifecycle Stage and Trip Purpose



Note: The 1985-1988 surveys were not weighted and may contain biases in trip rates for certain categories. The 1999 and 2006 surveys were weighted to account for these biases.

4. Trip Characteristics

Introduction

This chapter examines several aspects of the trips reported in the diaries:

- Trip Mode
- Mode by County/Sub-county Area
- Mode by Lifecycle
- Mode by Vehicle Availability
- Trip Time and Length
- Distribution of Trip Time and Length
- Time of Day

Trip Mode

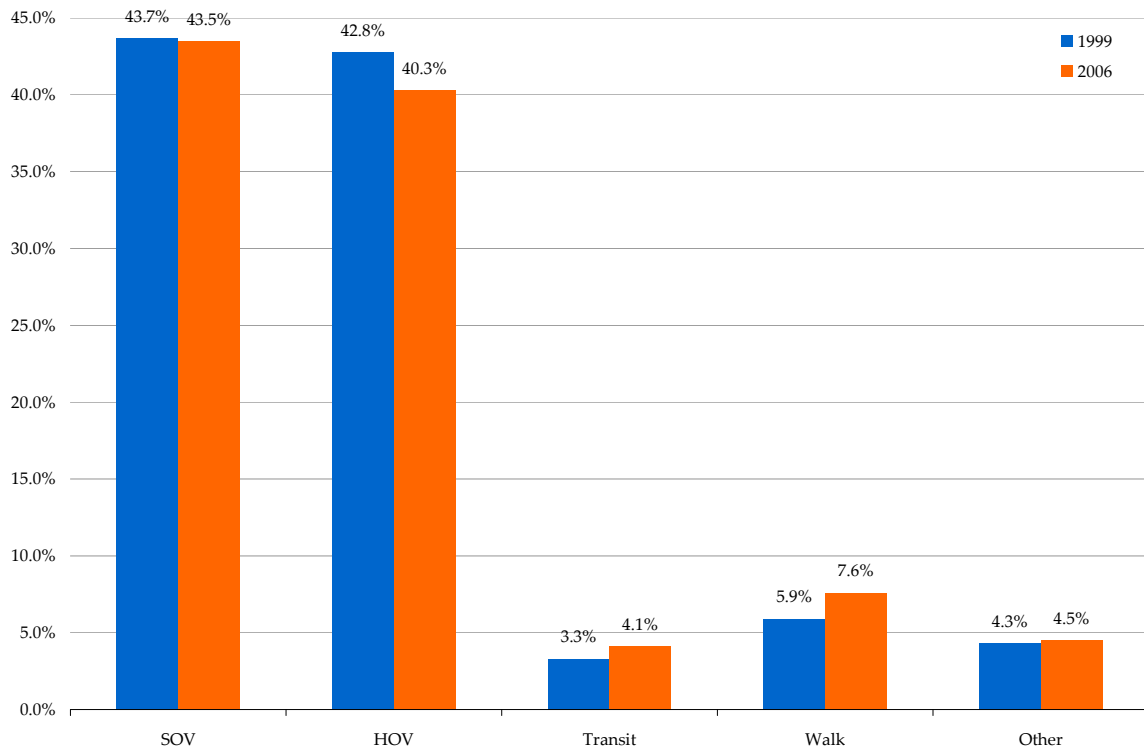
Regionally in 2006, over 80 percent of all trips were made by private vehicle: 43 percent in a single-occupancy vehicle, and 40 percent with two or more passengers (see Figure 4-1). Transit trips, including ferry, represented 4.1 percent of all trips reported. This is an increase from the 3.3 percent reported in 1999. Walk trips increased significantly during this time, from 5.9 percent to 7.6 percent.

Figure 4-1. Mode Shares, All Trips

Mode	1999	2006
SOV	43.7%	43.5%
HOV	42.8%	40.3%
Transit	3.3%	4.1%
Walk	5.9%	7.6%
Other	4.3%	4.5%
TOTAL	100.0%	100.0%

Nationwide, results from three National Personal Transportation Surveys (NPTS) have shown a decrease in the proportion of trips using public transit, from 3.4 percent in 1969 to 1.6 percent in 2001. Between 1999 and 2006, the Puget Sound region increased transit use. This difference is likely due to a recent trend in increasing transit ridership across the country in response to higher gas prices. Walk and other trips also grew in mode share during this timeframe. The increases in alternative modes came from the carpool mode, which dropped in this timeframe (see Figure 4-2) from 43 percent in 1999 to 40 percent in 2006.

Figure 4-2. Mode Shares, All Trips



Mode by County/Sub-County Area

Total trips by type of mode were similar for south King, east King, Snohomish, Pierce and Kitsap counties. Central King County has a higher proportion of total transit trips, at 8.6 percent in 2006, as shown in Figure 4-3. For home-based work trips, the mode composition of each county includes a relatively significant portion of transit ridership, especially in the Seattle (23.4), east King (11.5) and Kitsap (11.7) areas. The home-based work trip transit ridership trend in Kitsap County shows a large increase in 1999 and a decrease down to 11.7 percent in 2006. While the 1999 and 2006 transit data include walk-on ferry trips, the 1985-1988 data do not include these trips, which accounts for the low percentage of transit ridership compared to the later survey years. Between 1985-1988 and 1999, Kitsap Transit expanded bus service, which contributed to the jump in transit use. However, between 1999 and 2006, walk-on ferry boardings in Bremerton decreased 15 percent and boardings in Bainbridge Island dropped 5 percent². During this time, Kitsap Transit ridership dropped 20 percent³. These factors contributed to the decrease in home-based work transit ridership in Kitsap County.

² WSDOT Washington State Ferries 2006 Origin-Destination Onboard Survey Report (<http://www.wsdot.wa.gov/NR/rdonlyres/C029B73C-53E1-41A0-9393-3B280A6D5D40/0/WSF2006TravelSurveyCentralSound.pdf>)

³ Kitsap Transit April 2006 Ridership Report, Kitsap Transit

Figure 4-3. Percent of Trips Using Transit by County/Sub-County Area

County	HBW			Total		
	1988	1999	2006	1988	1999	2006
Pierce	1.2%	6.0%	6.0%	1.7%	1.7%	2.4%
South King	3.0%	7.0%	8.8%	2.2%	2.2%	3.2%
East King	6.5%	9.4%	11.5%	1.7%	2.4%	3.3%
Central King	19.1%	22.0%	23.4%	11.0%	7.1%	8.6%
Snohomish	3.1%	5.6%	8.7%	1.2%	1.8%	2.5%
Kitsap	4.4%	17.4%	11.7%	1.6%	4.5%	3.6%
Region	6.3%	11.2%	12.3%	3.3%	3.3%	4.1%

* The 1985-1988 transit trips do not include ferry trips.

Figure 4-4 shows that carpooling is fairly consistent throughout the region. About 9 percent of home-based work trips in 2006 were made in a carpool, which is down from 12.8 percent in 1988. Home-based other and non-home-based trips use carpool more than home-based work trips, causing the percent of total trips with two or more occupants to be much higher, at 40 percent in 2006. The carpool rate for total trips in the region has remained constant since 1988.

Figure 4-4. Percent of Trips in Vehicles with Two or More Persons

County	HBW			Total		
	1988	1999	2006	1988	1999	2006
Pierce	12.0%	10.4%	8.8%	39.8%	45.5%	42.3%
South King	12.2%	9.5%	9.0%	42.5%	45.7%	41.9%
East King	11.2%	7.6%	7.4%	43.9%	44.3%	40.7%
Central King	13.5%	11.2%	10.3%	35.3%	36.2%	34.5%
Snohomish	12.7%	11.1%	9.5%	40.4%	43.6%	42.2%
Kitsap	18.3%	12.4%	8.9%	38.7%	44.5%	43.2%
Region	12.8%	10.3%	9.1%	40.3%	42.8%	40.3%

* The 1985-1988 survey does not include ferry trips.

Figure 4-5 demonstrates that central King County has much higher percentages of walk and transit trips than other counties. This translates into lower auto modes, both for SOV and HOV trips. Figure 4-6 shows the same information for work trips and highlights the higher mode shares for transit trips as well as lower mode shares for carpool trips. The large increase in SOV also demonstrates that most workers travel to work alone, where many non-work trips are conducted with another person and are identified as carpool trips.

Figure 4-5. Percent of Total Trips by Mode

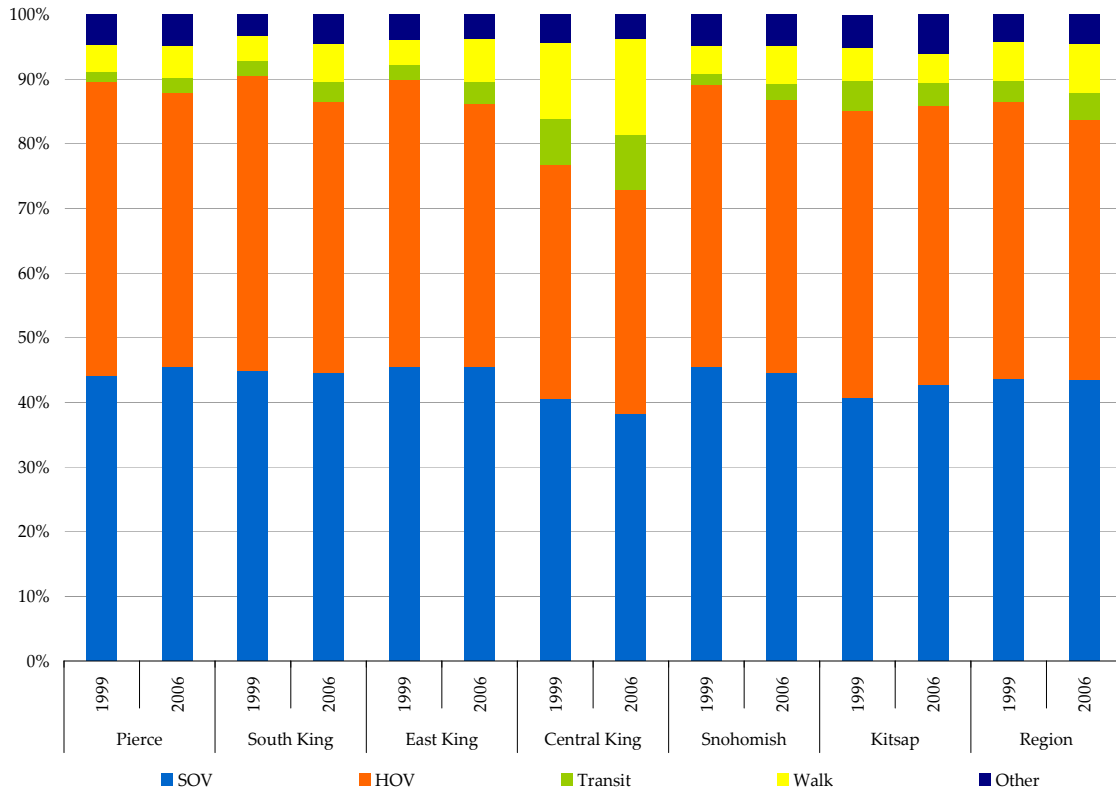
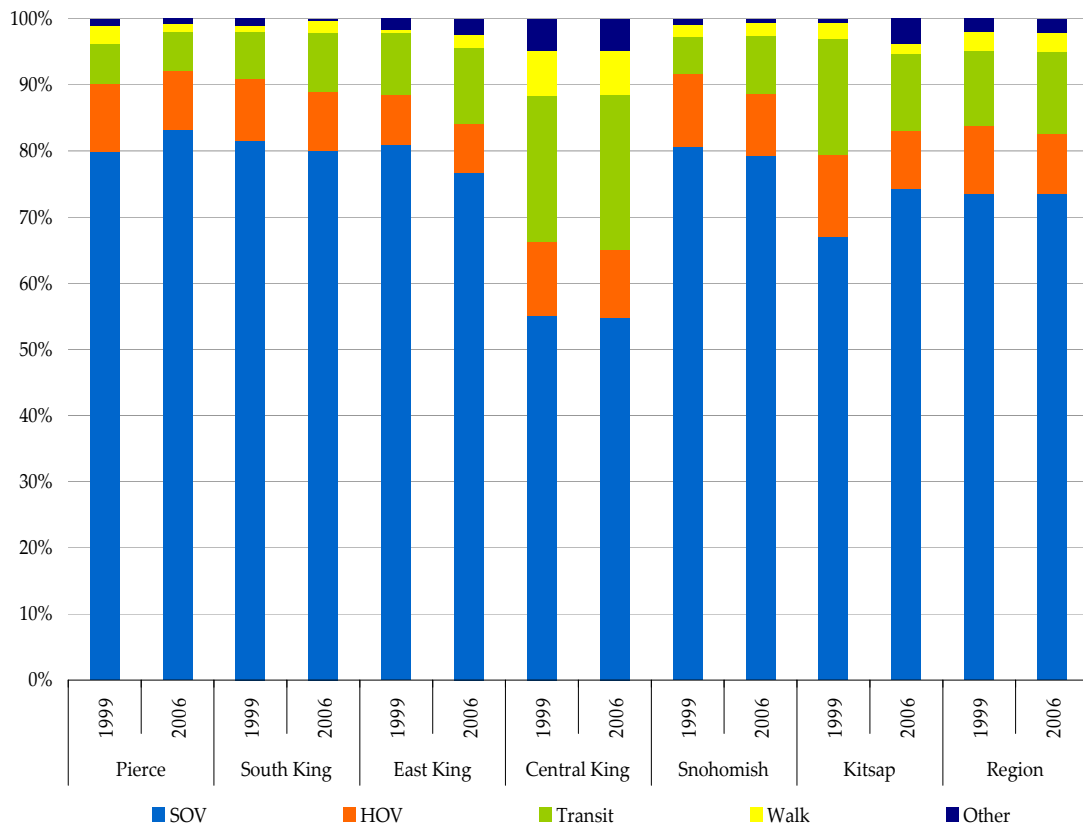


Figure 4-6. Percent of Home-Based Work Trips by Mode



Mode by Lifecycle Stage

The average number of person trips per household by lifecycle stage and mode choice is shown in Figure 4-7 (see page 12 in Chapter 2 for the definition of lifecycle stages). For all household types with no children, SOV trips have the greatest share. Households in the Young Child and School Child lifecycle stages traveled by HOV significantly more often than households in the other stages across both survey years. Transit, Walk and Other were consistently the lowest, but have increased since 1999 for all lifecycle stage categories except for Older Adults living alone.

Figure 4-8 demonstrates that persons in the Young Adult categories made a higher proportion of transit and walk trips compared to the other lifecycle stages, and increased their number of walk and transit trips between 1999 and 2006. Persons in the Mid-Adult category living alone decreased their SOV use the most, by 8 percent since 1999. This group also increased their transit and walk trips the most, by 7 percent. Persons age 65 and over in households with two or more people and households with children made the smallest proportion of transit trips at 3 percent and 2 percent.

Figure 4-7. Average Daily Person-Trips per Household by Lifecycle and Mode

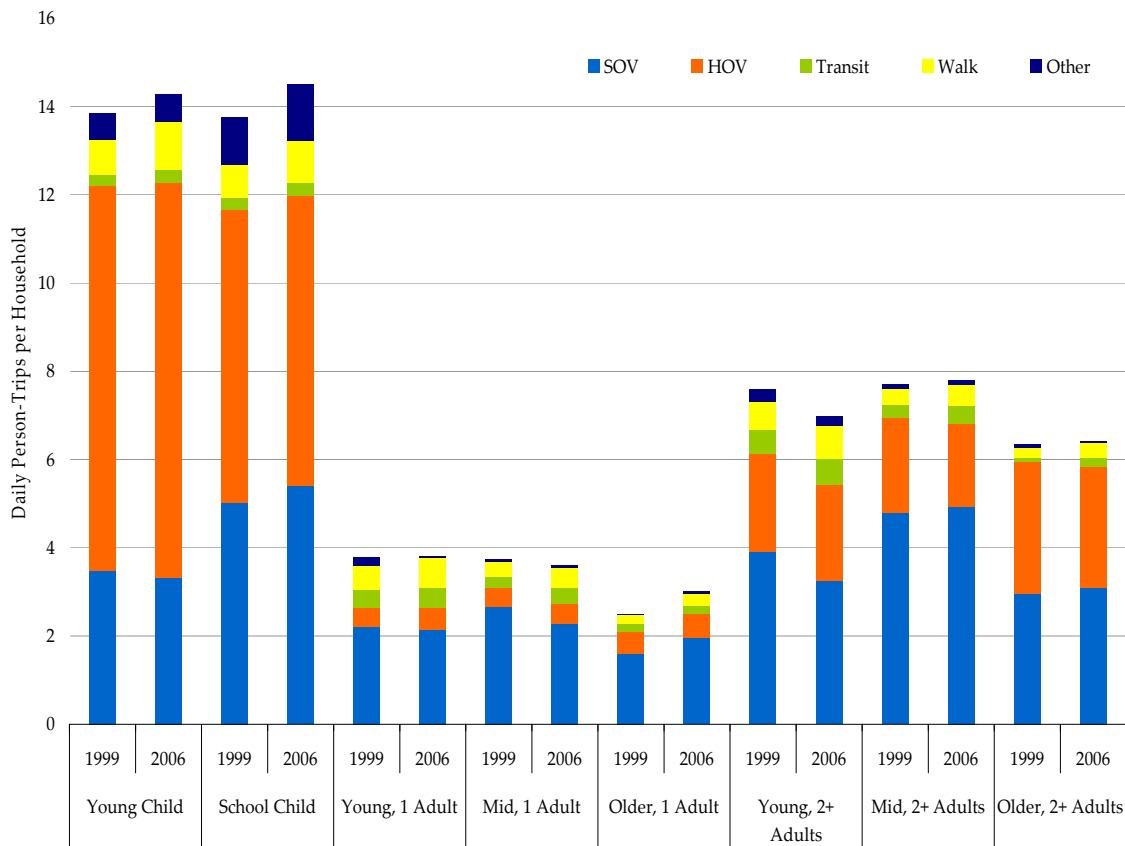
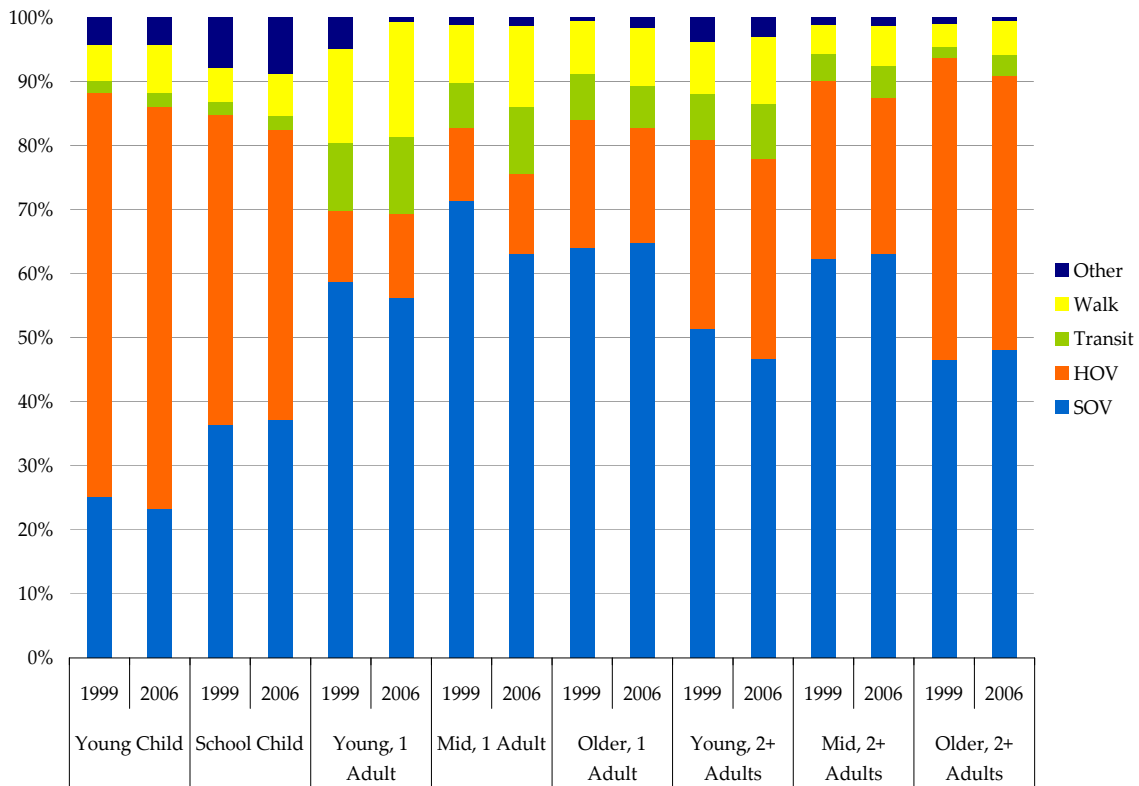


Figure 4-8. Percent of Total Trips by Mode and Lifecycle



Mode by Vehicle Availability

Households with less than one vehicle per licensed driver are more likely to use transit and to walk than those households with one or more vehicles per driver (see Figure 4-9 and Figure 4-10). This is especially true for one-person households, since this means *no* car is available.

Figure 4-9. Percent of Trips Using Transit

Vehicle Availability	Pierce			South King			East King			Central King			Snohomish			Kitsap		
	1988	1999	2006	1988	1999	2006	1988	1999	2006	1988	1999	2006	1988	1999	2006	1988	1999	2006
Less than One Vehicle/Licensed Driver																		
1-person HH	45.3	21.5	29.0	*na	27.3	41.5	36.8	65.1	18.1	33.3	29.3	34.6	33.3	37.3	36.7	26.5	15.3	18.9
2-person HH	21.0	8.4	9.4	7.6	6.9	7.3	2.7	6.9	16.0	9.0	13.6	15.0	5.4	0.9	2.8	3.5	15.5	3.4
3+ person HH	19.3	2.2	1.5	1.7	2.0	1.4	2.5	3.7	1.6	6.0	7.9	5.4	2.0	3.8	1.4	4.8	3.5	3.3
One or More Vehicle/Licensed Driver																		
1-person HH	9.3	3.5	1.3	1.1	4.8	4.5	2.6	3.3	1.9	7.8	10.2	5.3	0.4	2.2	3.6	2.3	7.7	3.0
2-person HH	6.5	0.9	1.6	1.3	2.4	1.7	1.1	2.2	3.1	6.2	5.4	3.6	0.3	2.1	1.9	1.0	3.8	3.3
3+ person HH	7.4	1.0	0.3	1.8	1.2	0.7	2.4	1.5	2.3	3.6	3.4	4.5	1.0	1.2	1.7	1.3	3.9	1.6

* Omitted because sample is too small.

Figure 4-10. Percent of Trips by Walking

Vehicle Availability	Pierce			South King			East King			Central King			Snohomish			Kitsap		
	1988	1999	2006	1988	1999	2006	1988	1999	2006	1988	1999	2006	1988	1999	2006	1988	1999	2006
Less than One Vehicle/Licensed Driver																		
1-person HH	27.1	32.3	28.6	*na	15.8	36.0	21.0	*na	29.4	33.3	41.7	36.3	31.2	51.3	14.4	14.7	26.8	9.3
2-person HH	22.4	4.9	7.8	3.5	1.6	1.3	6.7	7.3	12.1	14.4	17.9	19.3	13.6	4.7	6.2	12.1	8.3	4.5
3+ person HH	13.3	4.0	4.7	2.6	3.3	6.4	1.7	2.8	6.4	7.0	10.2	10.5	5.0	7.1	5.7	7.9	7.1	4.0
One or More Vehicle/Licensed Driver																		
1-person HH	9.3	2.6	3.7	3.6	4.0	3.4	2.6	3.4	5.6	4.7	16.8	13.1	1.2	3.5	3.9	5.0	6.4	5.4
2-person HH	7.5	2.8	1.7	1.3	2.0	2.8	2.0	3.6	2.8	3.6	9.8	10.6	2.5	3.4	4.7	2.4	4.5	2.6
3+ person HH	7.7	4.5	3.4	1.8	5.0	1.7	3.7	4.1	4.1	4.2	7.9	7.4	6.0	4.2	3.0	4.2	4.5	3.3

* Omitted because sample is too small.

Trip Time and Length

Trip time is the total minutes for a trip as reported from the travel diaries. Participants were asked to write down the start and end times of their trips. It is known that people tend to underestimate trip time for SOV and HOV trips and to over-estimate trip time for transit and walk trips. People also tend to round off their travel times, to 5, 10, or 15 minute increments. Trips that take from 25 to 35 minutes are often rounded to 30 minutes. For these reasons, trip times derived from the origin and destination of the trip matched to the shortest time path from the PSRC travel demand model highway and transit networks are more consistent and accurate. However, for the purposes of comparison with earlier surveys, for which we don't have such network travel times, only recorded times are used. For this reason, the trip time frequency distribution charts, especially for home-based work trip times, show clustering around the 15 and 30 minute intervals.

Trip length in miles is a computed figure for each trip, using average distances between origin and destination in the PSRC highway network. For each survey, the travel diary did not request each person to estimate the length in miles of each trip.

There has been considerable debate as to whether trip lengths on the journey-to-work have been increasing. Nationwide, the National Personal Transportation Survey (NPTS) has shown little change between 1969 and 2001. In 1969 the average trip length was 9.9 miles; in 1983, 9.9 miles; in 1990, 9.5 miles; and in 2001, 10.0 miles. Other metropolitan areas have shown increases: in San Diego, SANDAG reported an increase from 10.6 miles in 1986 to 11.9 miles in 2007⁴.

In the Puget Sound region, the average calculated trip length in 2006 for home-based work trips from the diaries was 11.6 miles. This is an increase from 11.2 miles in 1999, and 9.8 miles in 1988. Average trip time for home-based work trips has also increased: from 24.5 minutes in 1988, to 32.0 minutes in 1999 and 33.2 minutes in 2006. These trip times are compared for home-based work trips in Figure 4-11.

⁴ 2030 Regional Transportation Plan: Pathways for the Future (http://www.sandag.org/uploads/publicationid/publicationid_1342_7635.pdf)

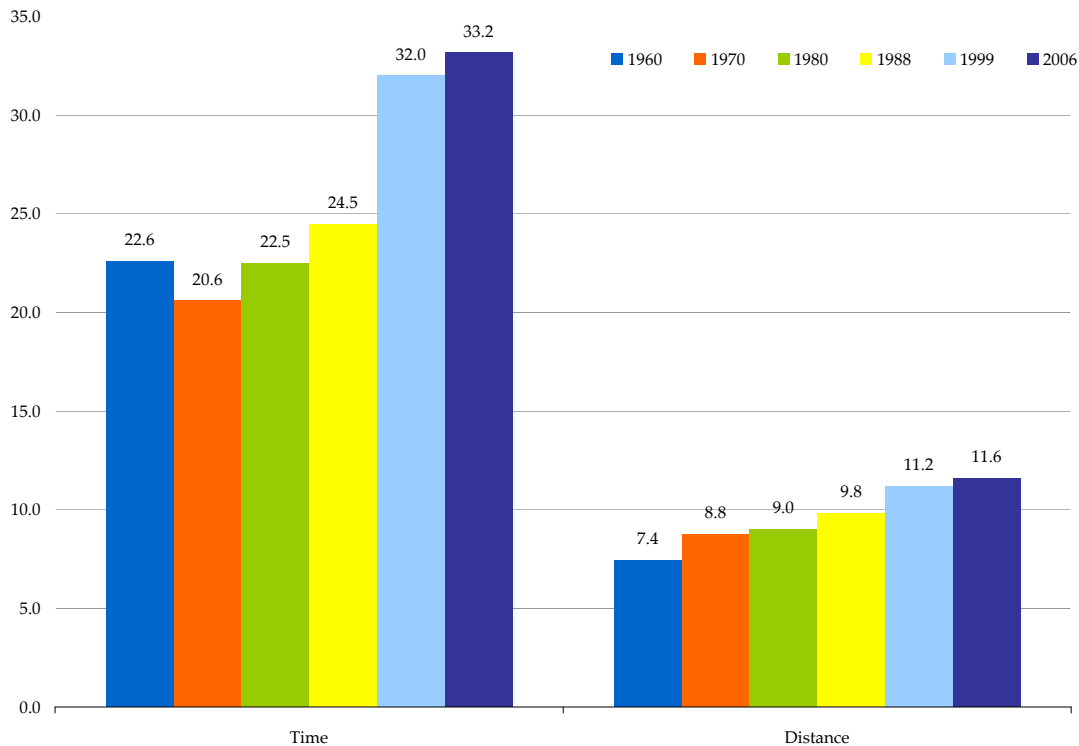
Figure 4-11. Home-Based Work Trip Length and Time

Year	NPTS		Puget Sound Region	
	Trip Length (miles)	Trip Length (miles)	Trip Length (miles)	Trip Time (minutes)
1960			7.4	22.6
1969	9.9			
1970			8.8	20.6
1980			9.0	22.5
1983	9.9			
1988			9.8	24.5
1990	9.5			
1999			11.2	32.0
2001	10.0			
2006			11.6	33.2

Note: 1960, 1970 and 1980 distance and time data for Puget Sound region are from Census Journey-to-Work data.

Home-based work trip distance also increased from 1960 to 2006 (see Figure 4-12) from 7.4 miles in 1960 to 11.6 miles in 2006, an increase of 57 percent in this 46-year timeframe. This is higher than the 47 percent increase in trip times for home-based work trips during this timeframe, indicating that commuters are traveling farther, but at slightly higher speeds: 21 miles per hour in 2006 compared to 20 miles per hour in 1960.

Figure 4-12. Home-Based Work Trip Length and Time



Note: 1960, 1970 and 1980 distance and time data for Puget Sound region are from Census Journey-to-Work data.

For the home-based work trip, the average distance traveled in 2006 was about the same whether the person traveled by drive-alone (11.8 miles) or carpool (11.7 miles), as shown in Figure 4-13. Transit trips were slightly higher (13.9 miles) and the average distance was much lower for walk trips (1.3 miles). Home-based other and non-home-based trips were generally much shorter, averaging closer to 6 miles.

Figure 4-13. Home-Based Work Trip Length and Time by Mode

	Trip Length (miles)			Trip Time (minutes)		
	1988	1999	2006	1988	1999	2006
Drive Alone	10.1	11.3	11.8	23.6	28.9	29.9
Car, 2+ Persons	9.5	10.9	11.7	22.9	30.4	32.7
Transit	9.4	14.0	13.9	40.8	57.7	56.8

Between 1988 and 2006, home-based work trip distance and time for HOV and SOV trips increased, indicating that residents in the region are living farther from work (see Figure 4-14 and 4-15). Home-based other HOV and SOV trips similarly increased between 1988 and 1999, but decreased by 2006. Non-home-based trips experienced an increase in distance and time between 1988 and 1999, but by 2006 had plateaued. Home-based other and non-home-based trips are a mix of essential and discretionary trips. The decrease in distance and time of these trips points to the pressures of gas price increases over the past several years and the increased use of transit.

Trip times for all types of transit trips were over twice that of driving alone, and three times that of driving in a car with two or more people. In 2006, for all types of trips, the average trip time was 20.8 minutes for drive-alone, 16.9 minutes for car-2+ persons, and 50.8 minutes for transit. For home-based work trips, the average was 29.9 minutes for drive-alone, 32.7 minutes for car-2+ persons, and 56.8 minutes for transit. Transit trip distance and time peaked in 1999 for each trip type due to expanded service in the region between 1999 and 2006. More routes and increased frequency of service gave commuters more options for shorter trips and shortened the average transit trip in 2006. This expanded service also partly explains the large jump between 1988 and 1999; also, the exclusion of certain kinds of trips from the 1988 analysis may have the effect of under-representing some long trips (see note below).

Figures 4-16 through 4-23 are graphic representations of Figures 4-14 and 4-15.

Figure 4-14. Average Trip Time by Trip Type and Trip Mode

Trip Type	Mode	Trip Time (minutes)		
		1988	1999	2006
All Types	SOV	17.6	21.0	20.8
	Car, 2+	15.8	18.2	16.9
	Transit	31.1	52.9	50.8
	Walk	13.3	11.2	13.0
Home-Based Work	TOTAL*	24.5	32.0	33.2
	SOV	23.6	28.9	29.9
	Car, 2+	22.9	30.4	32.7
	Transit	40.8	57.7	56.8
	Walk	18.6	17.1	17.6
Home-Based Other	TOTAL*	15.8	18.9	17.1
	SOV	14.5	17.5	16.0
	Car, 2+	15.0	18.1	15.9
	Transit	26.5	46.4	44.3
	Walk	13.6	11.9	14.0
Non-Home-Based	TOTAL*	16.1	17.6	18.0
	SOV	15.8	17.9	17.7
	Car, 2+	15.9	16.9	17.0
	Transit	30.4	45.5	42.1
	Walk	11.1	8.9	10.0

Note: TOTAL includes all trip modes; therefore, the four MODE categories will not add up to TOTAL.

Note: The following types of trips were deleted from the 1985-1988 data because the accuracy of most of these types of trips could not be verified (no similar exclusion was applied to the 1999 or 2006 data):

- Any trip longer than 2.5 hours
- Home-based work trips longer than 2 hours
- Walk trips longer than 90 minutes
- Any linked trips

Figure 4-15. Average Trip Length by Trip Type and Mode

Trip Type	Trip Length (miles)			
	Mode	1988	1999	2006
All Types	SOV	6.8	7.7	7.8
	Car, 2+	5.7	6.2	6.0
	Transit	6.7	11.9	11.1
	Walk	1.6	1.1	1.3
Home-Based Work	TOTAL*	9.8	11.2	11.6
	SOV	10.1	11.3	11.8
	Car, 2+	9.5	10.9	11.7
	Transit	9.4	14.0	13.9
	Walk	1.7	1.4	1.5
Home-Based Other	TOTAL*	5.1	5.8	5.3
	SOV	5.3	6.2	5.8
	Car, 2+	5.4	6.0	5.7
	Transit	4.3	8.3	7.5
	Walk	1.8	1.3	1.4
Non Home-Based	TOTAL*	5.4	5.7	5.7
	SOV	5.6	6.3	6.3
	Car, 2+	5.5	5.8	5.8
	Transit	8.3	10.1	8.3
	Walk	1.3	0.8	1.0

Note: TOTAL includes all trip modes; therefore, the four MODE categories will not add up to TOTAL.

Note: The following types of trips were deleted from the 1985-1988 data because the accuracy of most of these types of trips could not be verified (no similar exclusion was applied to the 1999 or 2006 data):

- Any trip with a distance greater than 50 miles
- Any trip outside the four-county region
- Any trip with a missing origin or destination census tract
- Any linked trips

Note: The following types of trips were deleted from the 1999 and 2006 data because the accuracy of most of these types of trips could not be verified (no similar exclusion was applied to the 1985-1988 data):

- Any trip outside the four-county region
- Any trip with a missing origin or destination census tract

Figure 4-16. SOV Average Trip Time (Minutes), 1988 – 2006

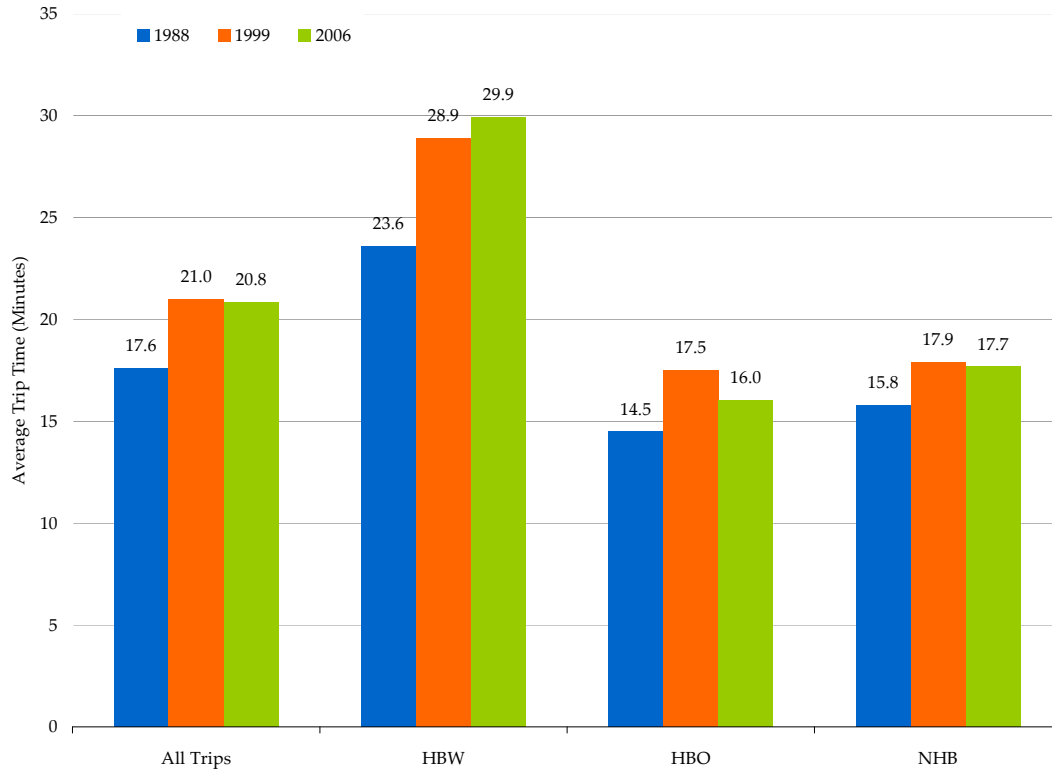


Figure 4-17. HOV Average Trip Time (Minutes), 1988 – 2006

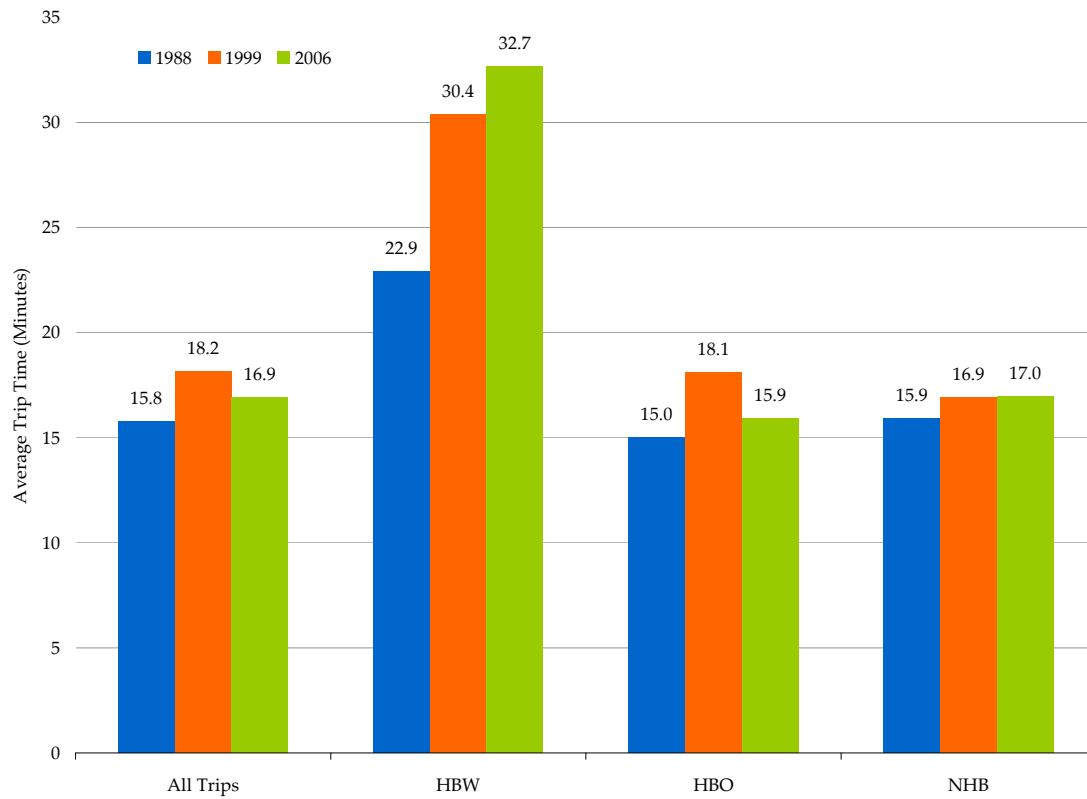


Figure 4-18. Transit Average Trip Time (Minutes), 1988 – 2006

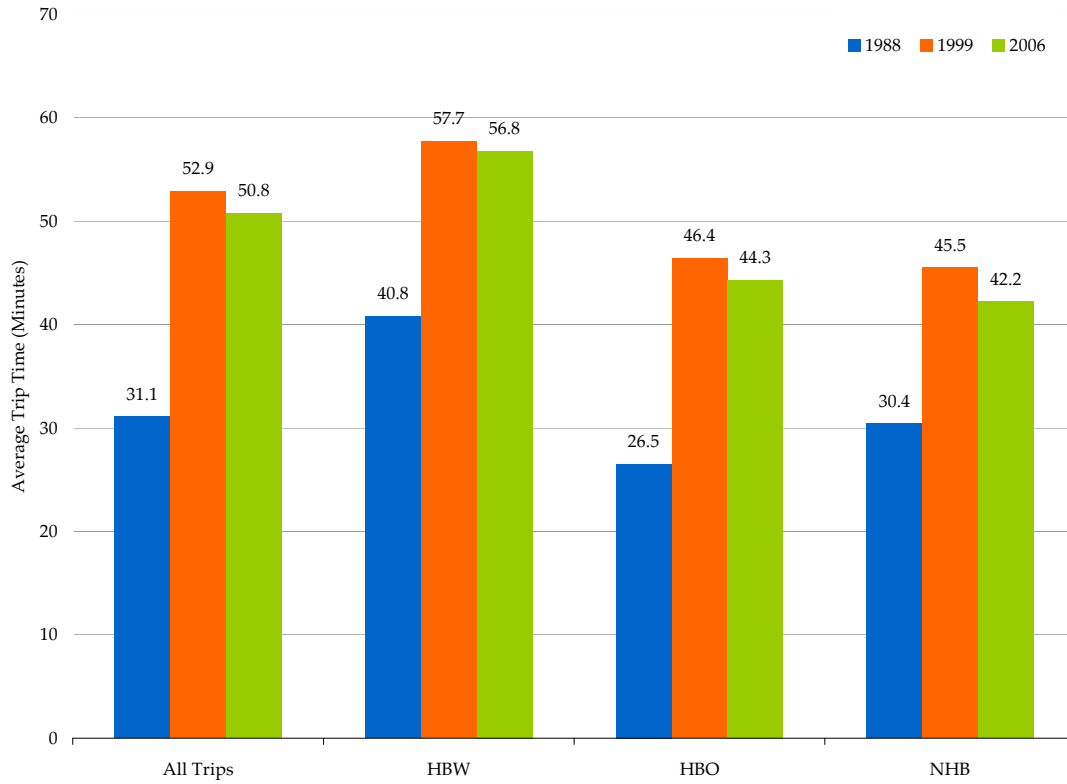
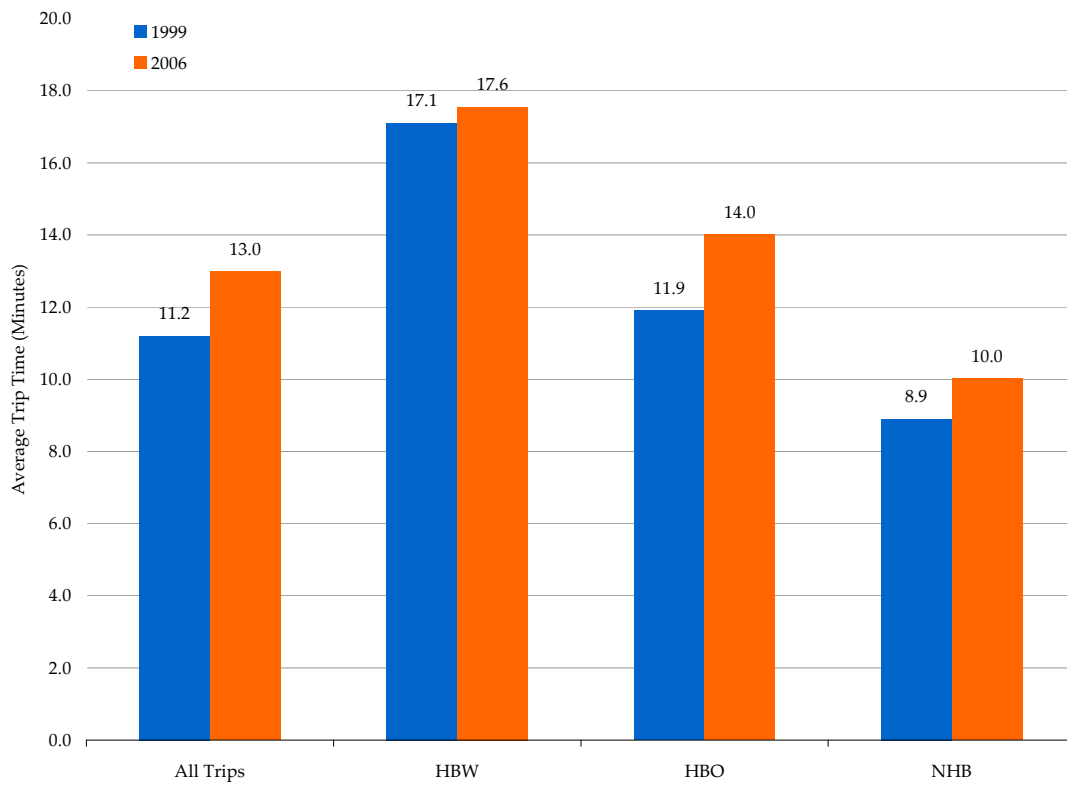


Figure 4-19. Walk Average Trip Time (Minutes), 1988 – 2006



NOTE: Data from the 1988 survey did not capture short trips to the degree of the 1999 and 2006 surveys, and accordingly have been omitted.

Figure 4-20. SOV Average Trip Length (Miles), 1988–2006

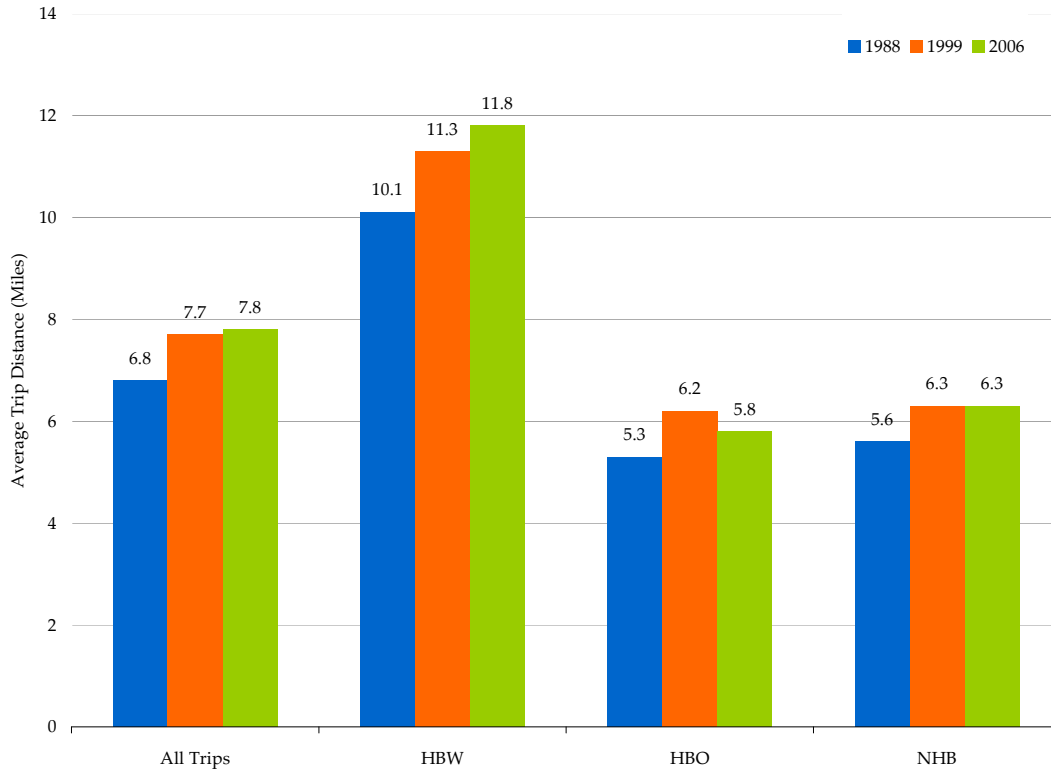


Figure 4-21. HOV Average Trip Length (Miles), 1988–2006

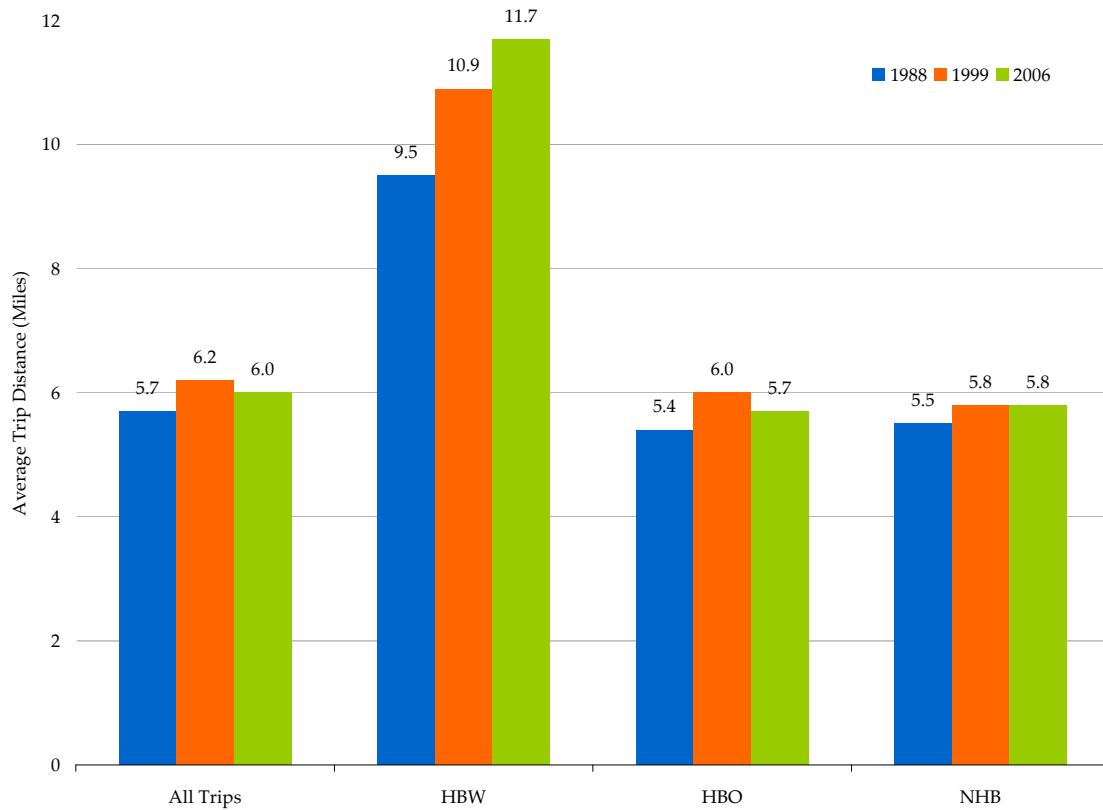


Figure 4-22. Transit Average Trip Length (Miles), 1988–2006

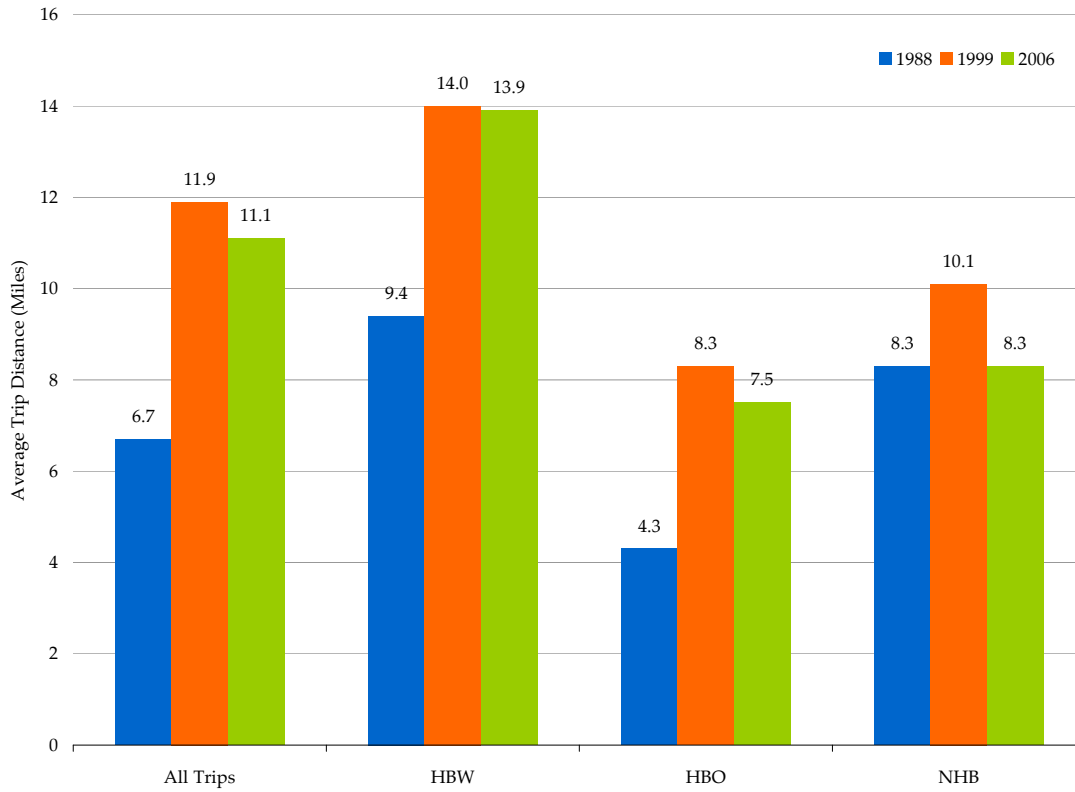
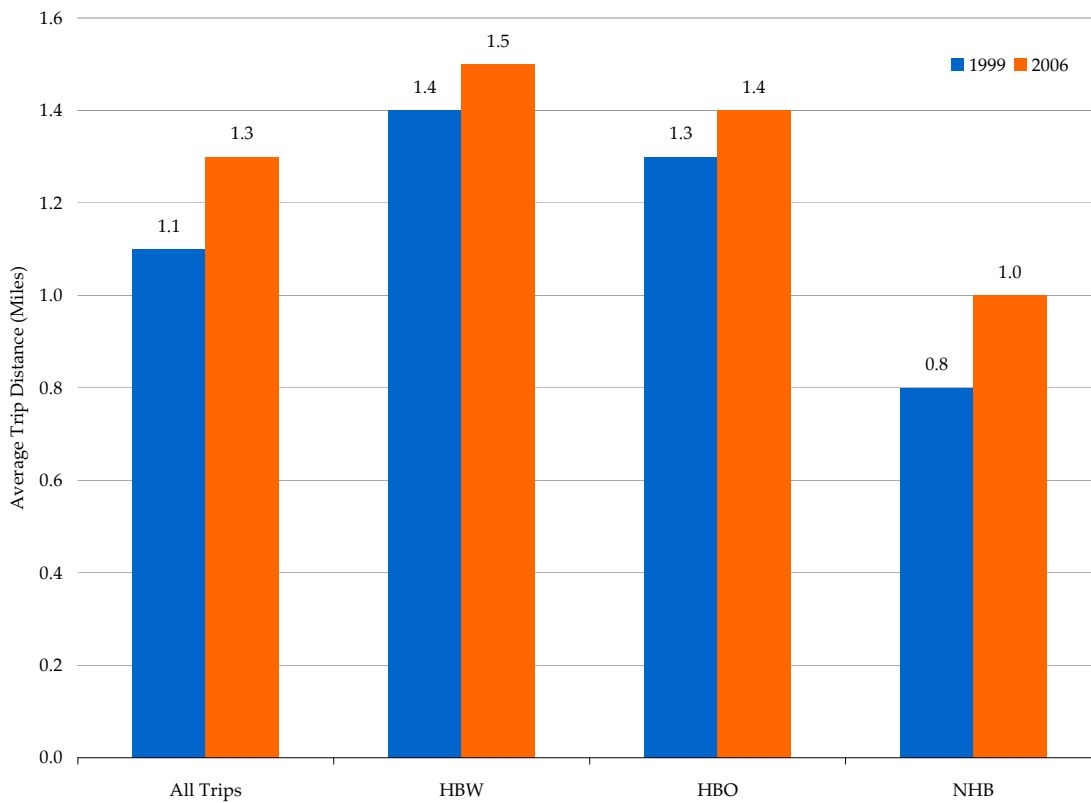


Figure 4-23. Walk Average Trip Length (Miles), 1988–2006



NOTE: Data from the 1988 survey did not capture short trips to the degree of the 1999 and 2006 surveys, and accordingly have been omitted. Distribution of Trip Time and Distance

While averages tell part of the story, the examination of distributions of trip length and time is also useful. These distributions are illustrated in Figures 4-24 through 4-29 on the following pages and Figures A-1 through A-24 in Appendix A.

Home-based work trips have the widest variation in trip time compared to other trip types. For instance, there was, in 2006, the same percentage of trips of 1 to 5 minutes as there were for trips lasting 31 to 35 minutes, 36-40 minutes, and 56 to 60 minutes. Overall, there has been a shift since 1988 from home-based work trips that were predominantly under 15 minutes and 5 miles, to ones with a large percentage over 30 minutes and 15 miles in 2006. Only with home-based work trips is there a significant percentage of trips taking 40 minutes or longer. The share of home-based work trips over 30 minutes increased 12 percent, while the percent of trips under 15 minutes decreased 12 percent. The percent of home-based work trips 15 miles and over increased 10 percent, and the share of trips 5 miles or less decreased 12 percent. Overall, home-based work trips have consistently increased in distance and time since 1988.

Home-based other and non-home-based trips are much shorter than home-based work trips, both in distance and time. In 2006, nearly 70 percent of trips (drive-alone and car [2+ persons]) took 15 minutes or less. For these types of trips, fewer than 5 percent took longer than 40 minutes. In terms of distance, approximately 60 percent of home-based other and non-home-based trips were 5 miles or less in length and only roughly 10 percent were over 11 miles. The trends for home-based other and non-home-based trips of all modes are more complicated than for home-based work trips. Between 1988 and 1999, these types of trips experienced increases in distance and time by all modes. However, since 1999, home-based other trips have actually decreased or held steady, while the rate of increase for non-home-based trip distance and time slowed. From 1988 to 1999, 4 percent fewer home-based other trips were 15 minutes or less, and in 2006, 0.6 percent more trips were in this time category. Between 1988 and 1999, the percent of home-based other trips 5 miles or less decreased 7 percent, yet from 1999 to 2006, that percentage increased 2 percent. Between 1988 and 1999, 2 percent fewer non-home-based trips were 5 miles or less and 3 percent fewer were 15 minutes or less. From 1999 to 2006, 1 percent fewer trips were 15 minutes or less and 0.7 percent fewer were 5 miles or less.

Transit trips, as in the discussion of average trip time, are generally longer: 55 percent of home-based work trips using transit take over 45 minutes, and 30 percent take over one hour. Only 50 percent of transit home-based work trips last 11 miles or less, yet 85 percent of home-based non-work transit trips and almost 80 percent of non-home-based transit trips last 11 miles or less. Transit trips have increased in distance and time significantly. In 1988, 24 percent of home-based work trips were 25 minutes or less. By 2006, that number had decreased to 11 percent. In 1988, 65 percent of transit home-based other trips were 30 minutes or less and 78 percent were 5 miles or less, compared to 48 and 54 percent by 2006.

Figure 4-24. Trip Time Frequency Distribution, HBW Trips

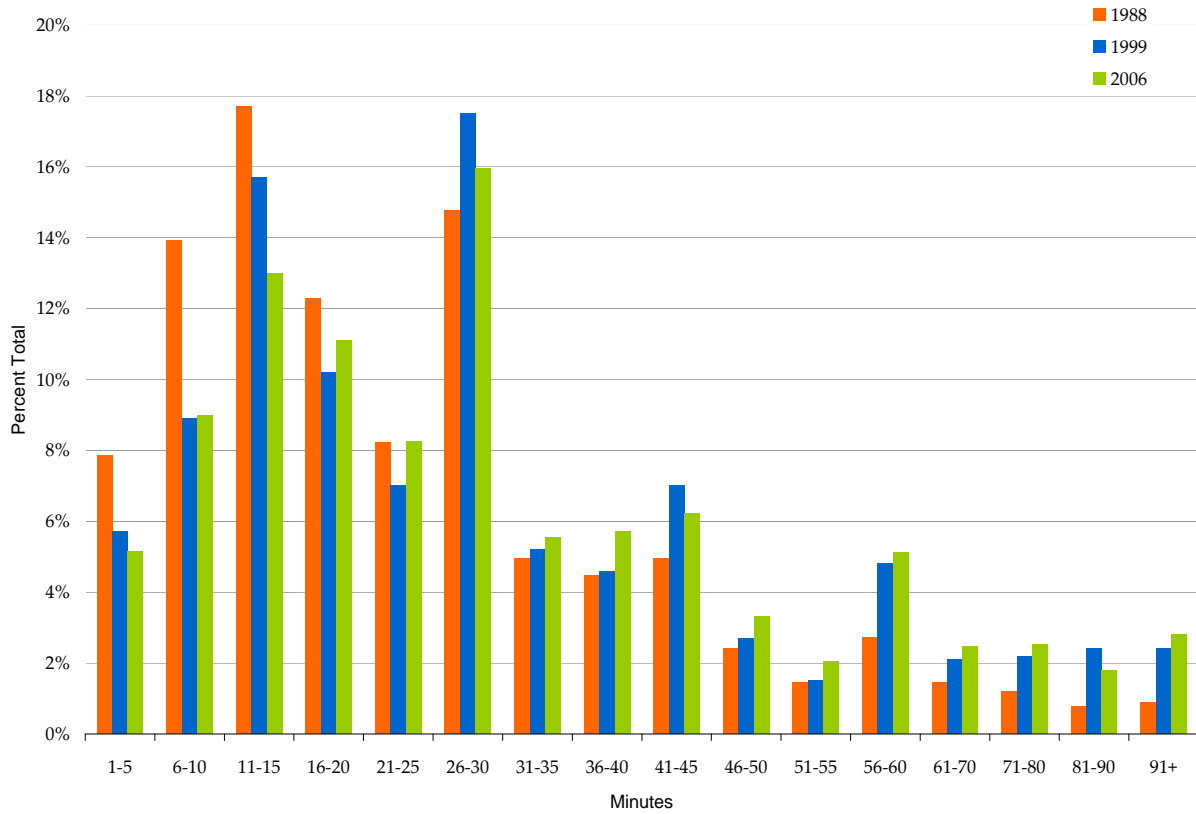


Figure 4-25. Trip Time Frequency Distribution, HBO Trips

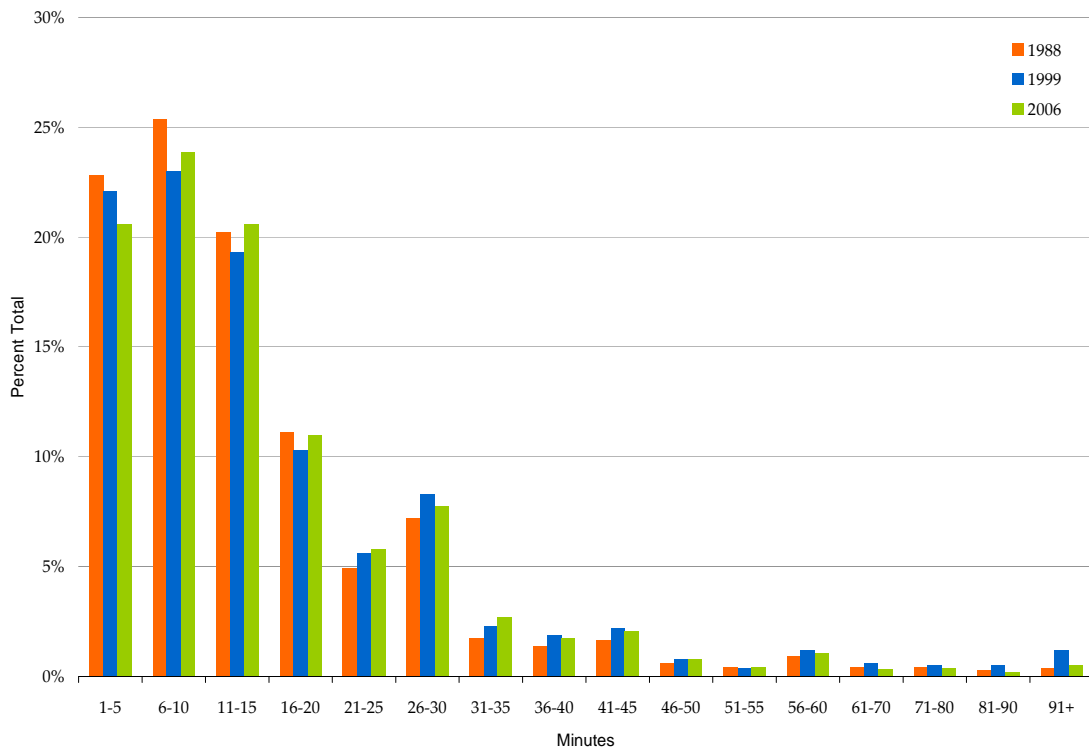


Figure 4-26. Trip Time Frequency Distribution, NHB Trips

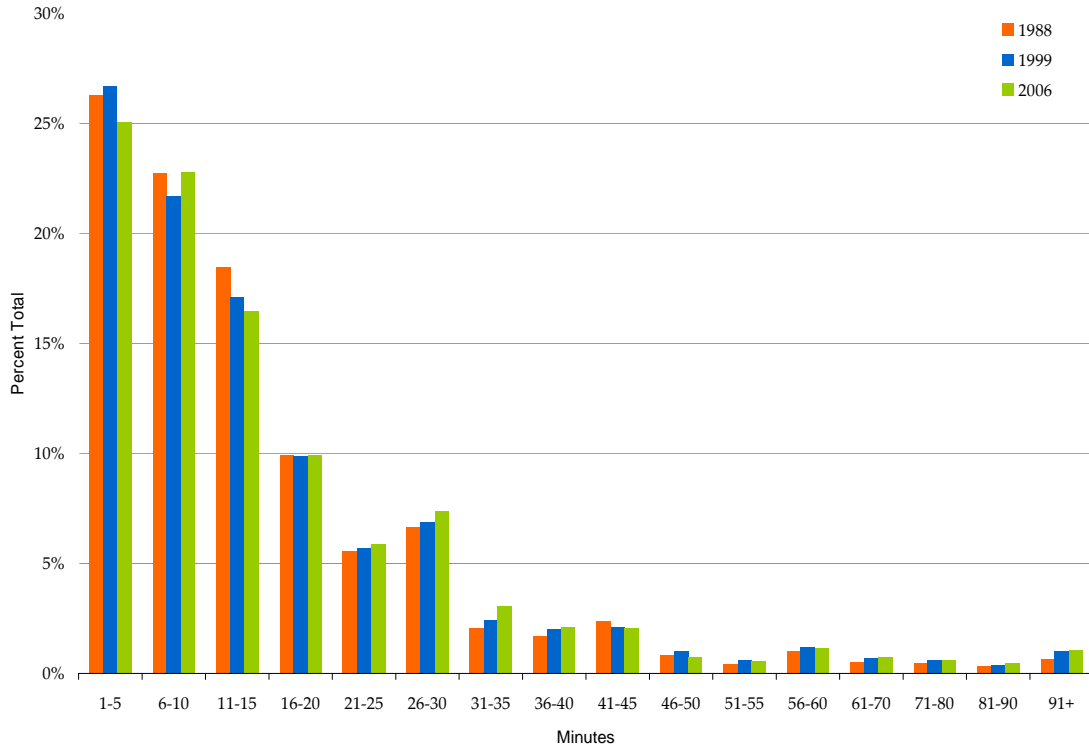


Figure 4-27. Trip Length Frequency Distribution, HBW Trips

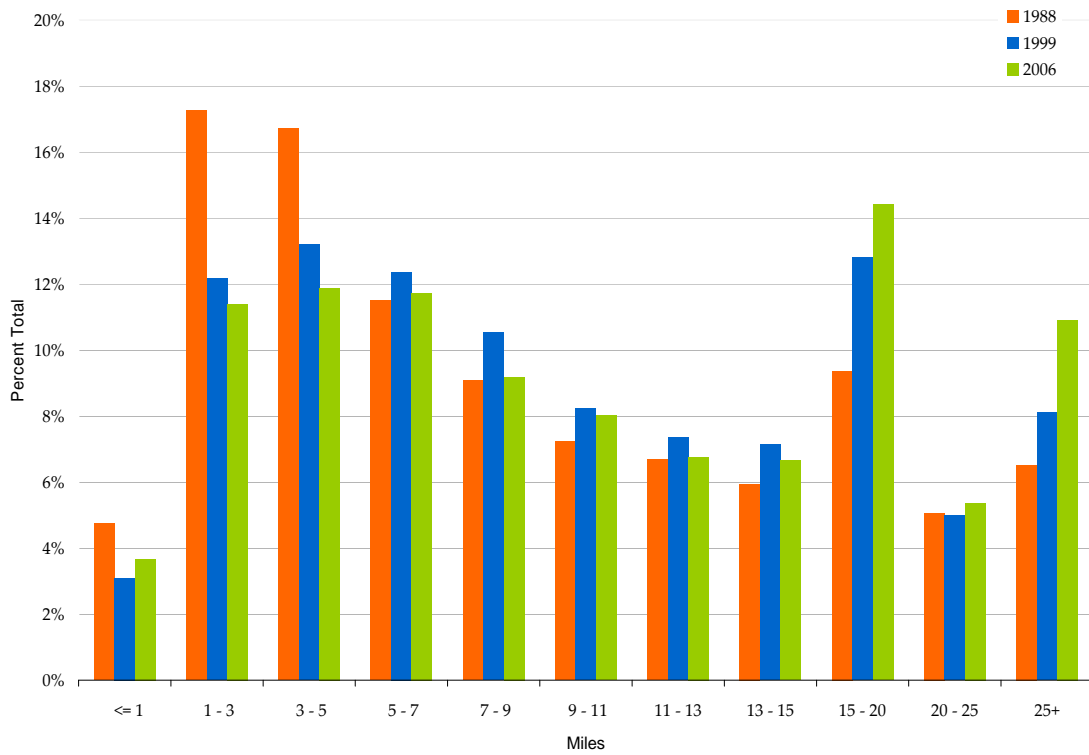


Figure 4-28. Trip Length Frequency Distribution, HBO Trips

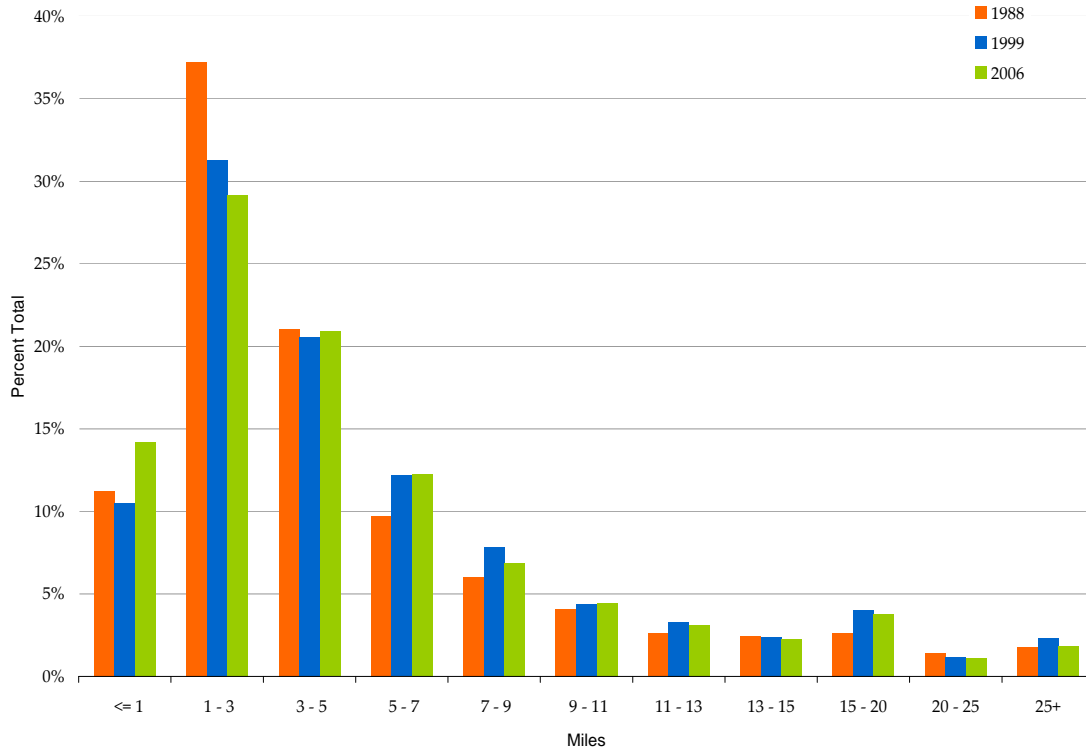
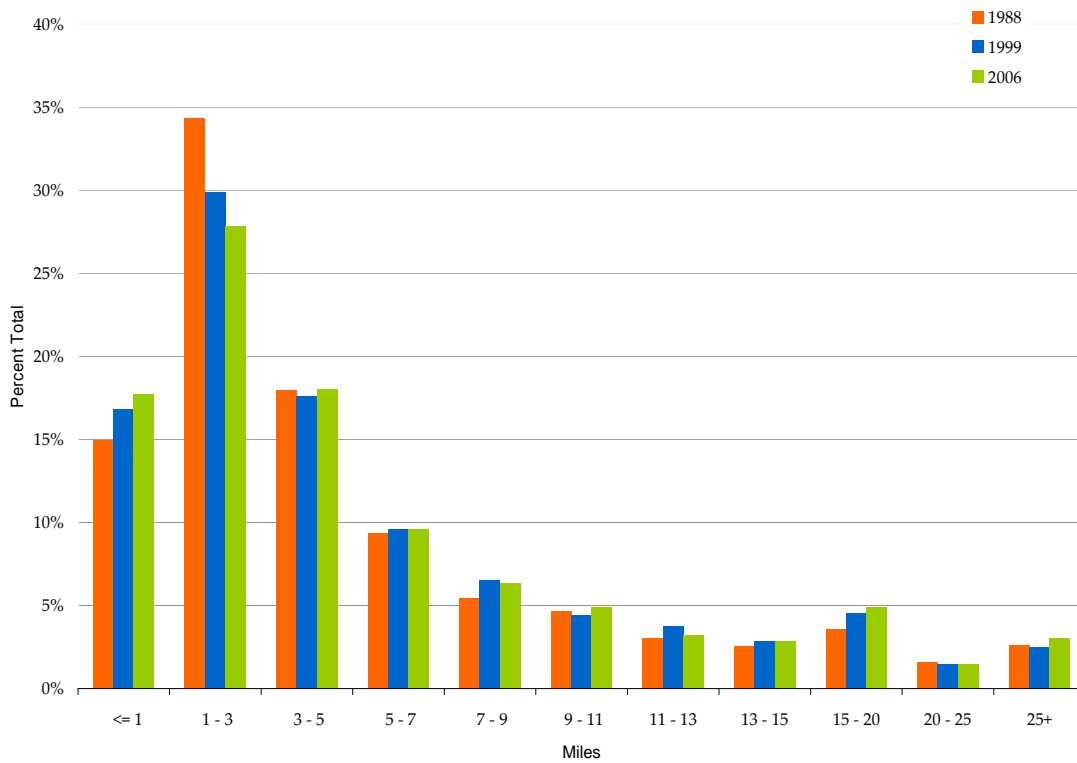


Figure 4-29. Trip Length Frequency Distribution, NHB Trips



Time of Day

Person-trips by time of day in the region are shown in Figures 4-30-33. There are two peaks in the number of trips taken during a day. The morning peak is between 6:00 and 9:00 a.m., and in the afternoon, there is a five-hour peak between 2:00 and 7:00 p.m. The morning and evening peaks have risen and become slightly more pronounced since 1999.

When analyzed by trip type, peak travel periods differ quite clearly. Home-based work trips have two well-defined peaks, one between 5:00 and 9:00 a.m., and one between 3:00 and 7:00 p.m. The home-based work peak has changed little between 1999 and 2006, with a slight lessening of the a.m. and p.m. peaks and a minor increase in midday trips. Home-based other trips have a similar curve, but with the a.m. peak coming somewhat later, between 7:00 and 10:00 a.m. and the p.m. peak spread through the afternoon and early evening between 2:00 p.m. and 8:00 p.m. The percent of trips in this purpose category have increased during the peak travel times and decreased during midday. The peaks for non-home-based trips occur at lunch time and again between 3:00 and 5:00 p.m. Notably, the lunch time peak has clearly declined since 1999 while the afternoon peak has grown.

Figure 4-30. Total Person-Trips by Time of Day, 1999-2006

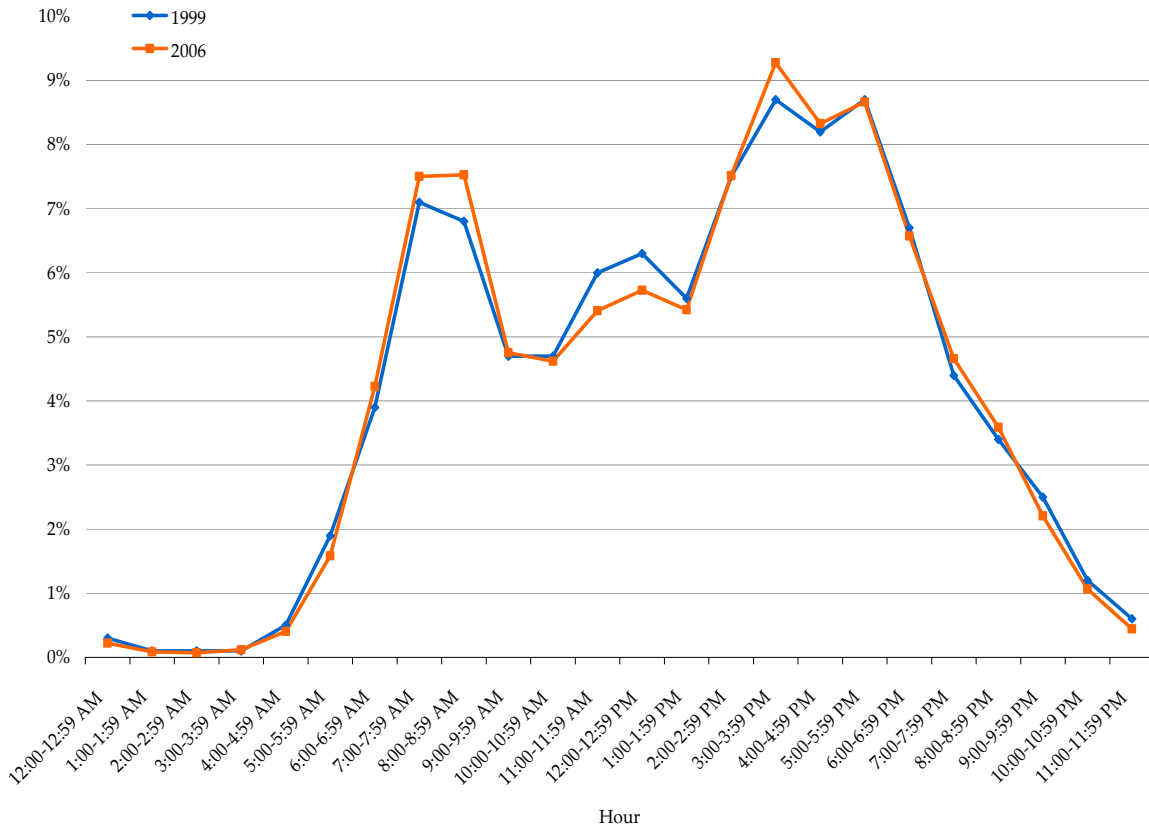


Figure 4-31. HBW Person-Trips by Time of Day, 1999-2006

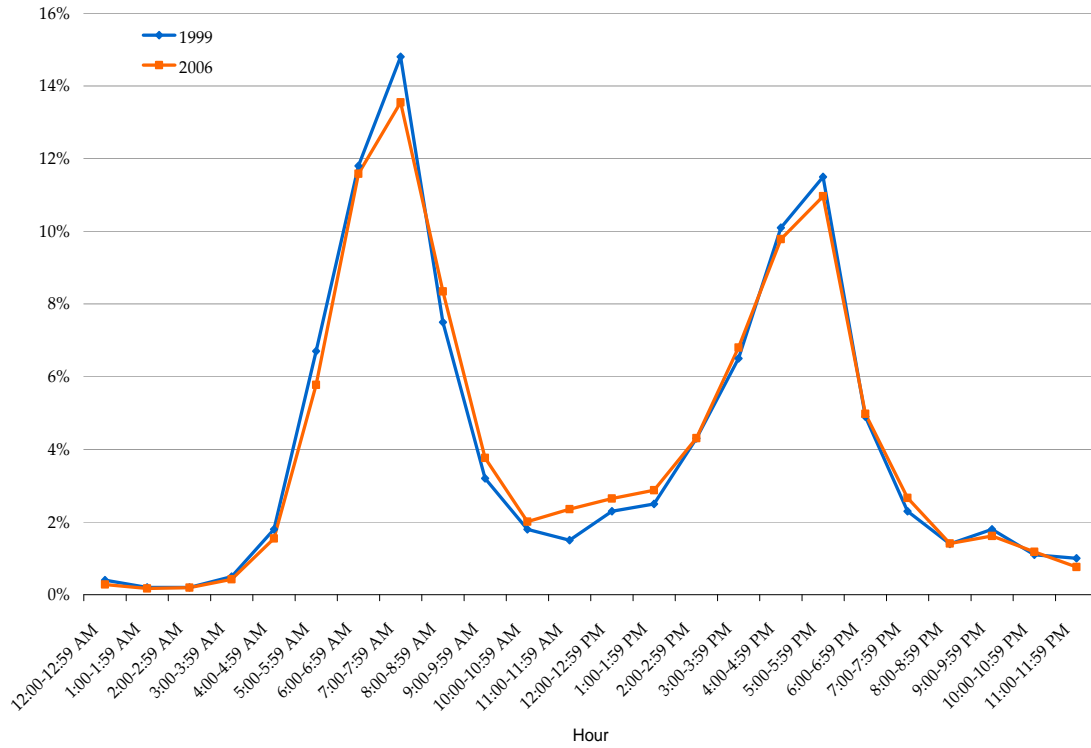


Figure 4-32. HBO Person-Trips by Time of Day, 1999-2006

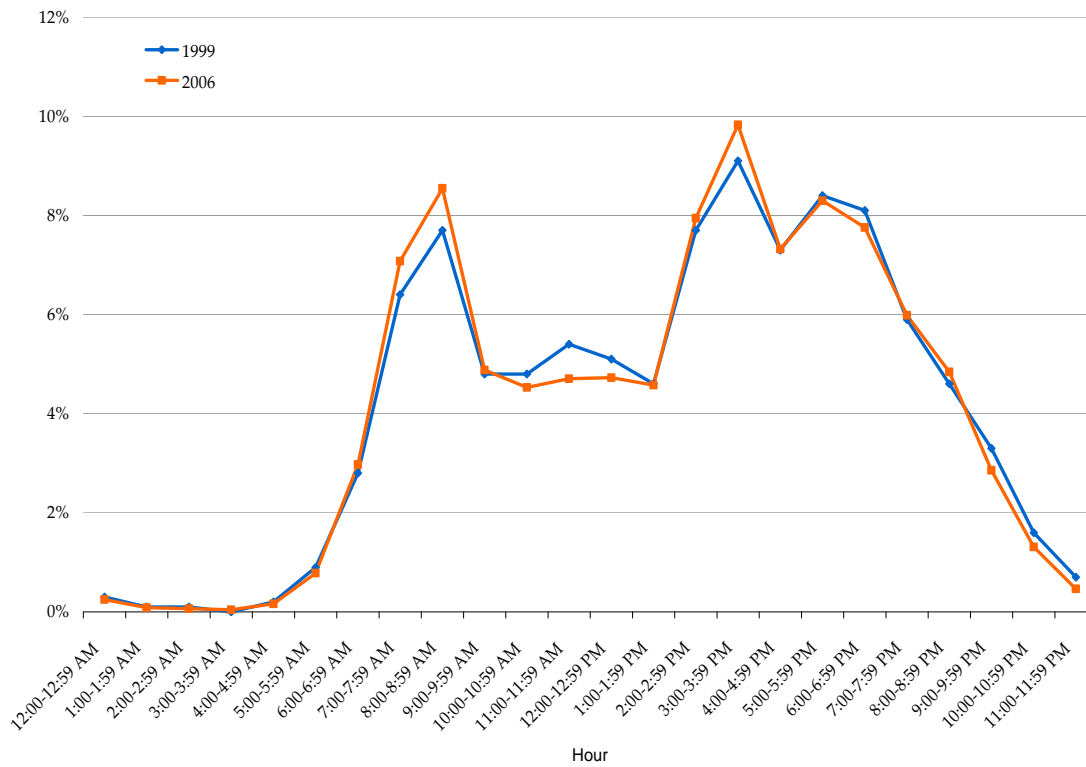
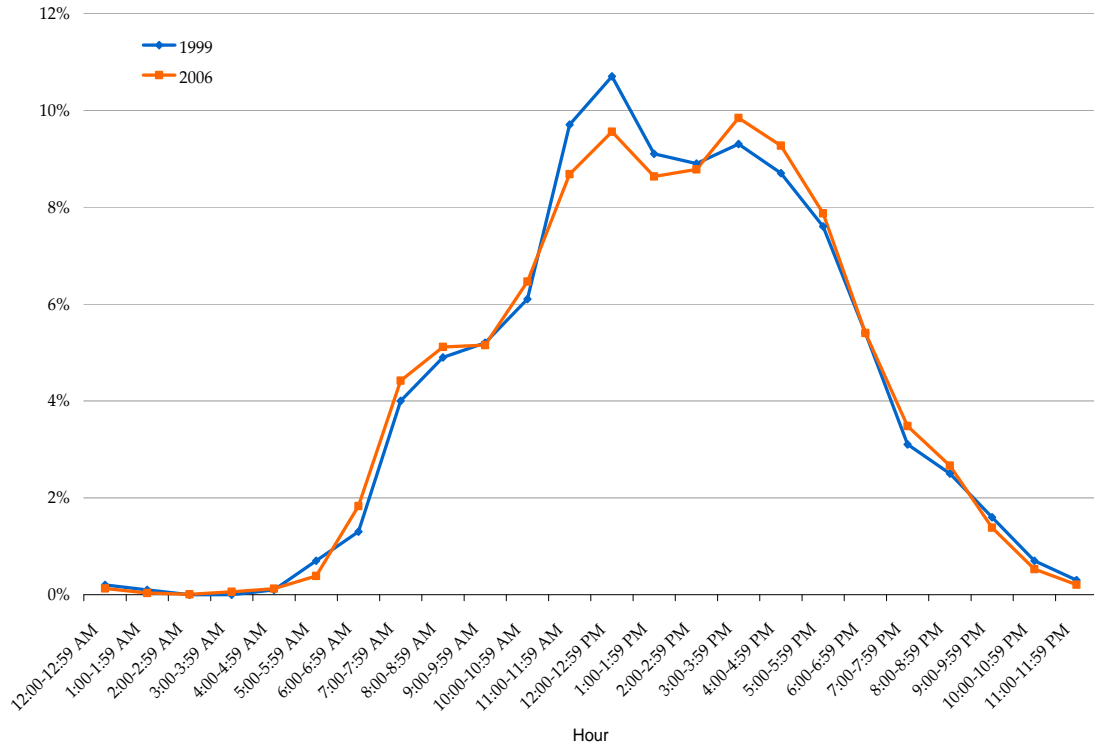


Figure 4-33. NHB Person-Trips by Time of Day, 1999-2006



Appendix A: Cumulative Distribution of Time and Length Charts

Distributions of trip length and time are illustrated in Figures A-1 through A-24.

Figure A-1. Cumulative Distribution of HBW Trip Time by SOV

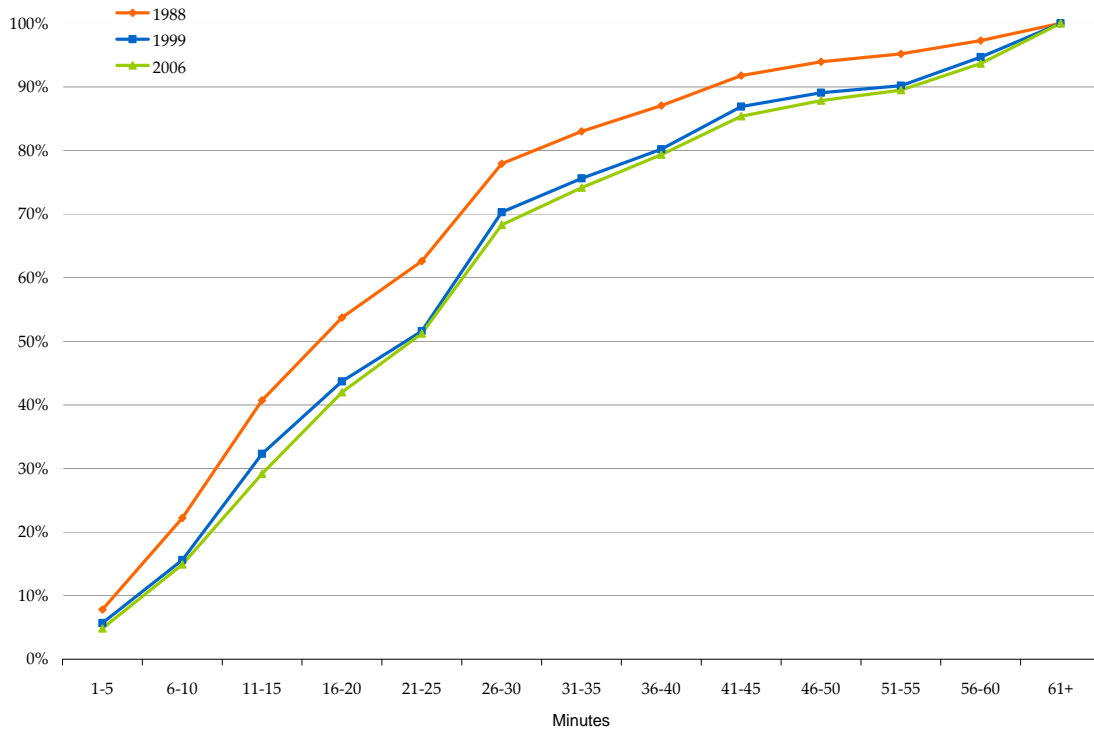


Figure A-2. Cumulative Distribution of HBW Trip Length by SOV

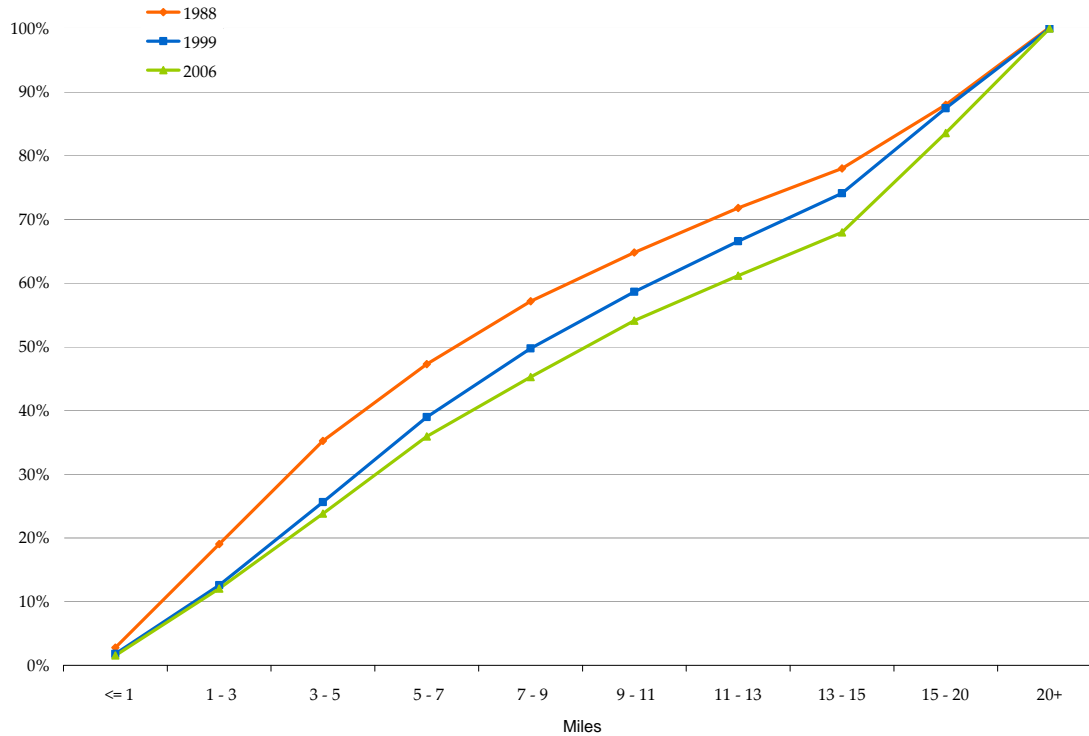


Figure A-3. Cumulative Distribution of HBW Trip Time by HOV

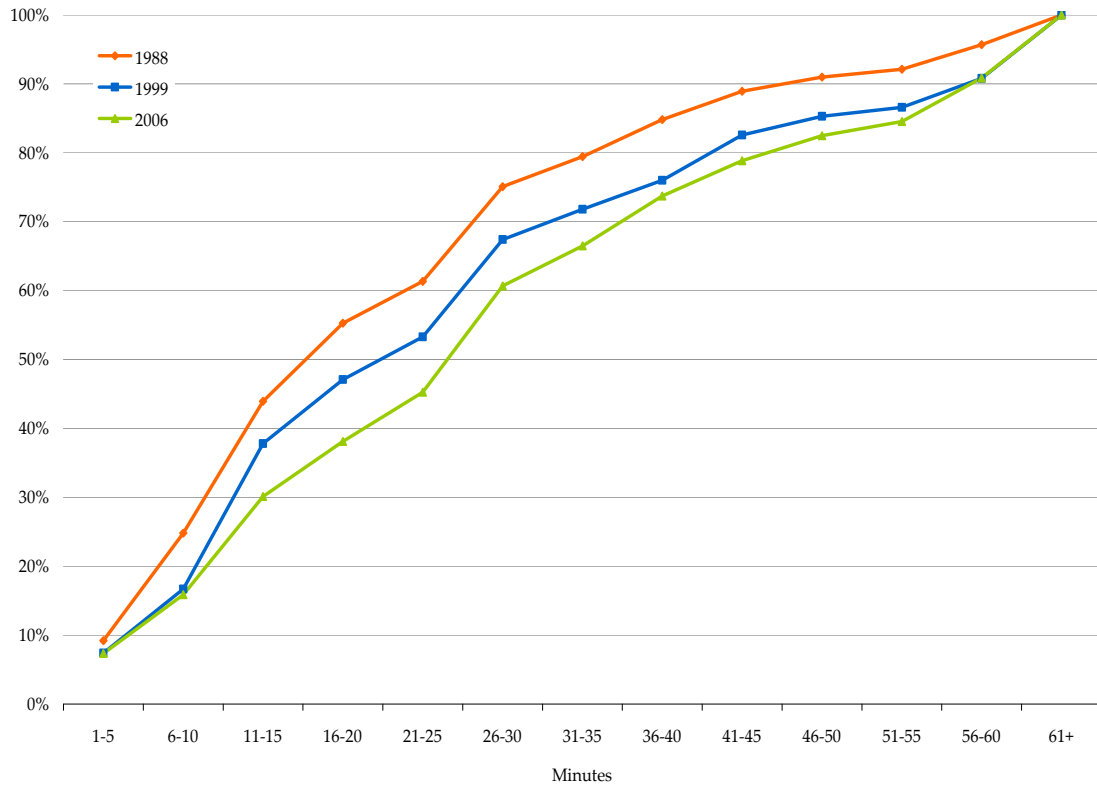


Figure A-4. Cumulative Distribution of HBW Trip Length by HOV

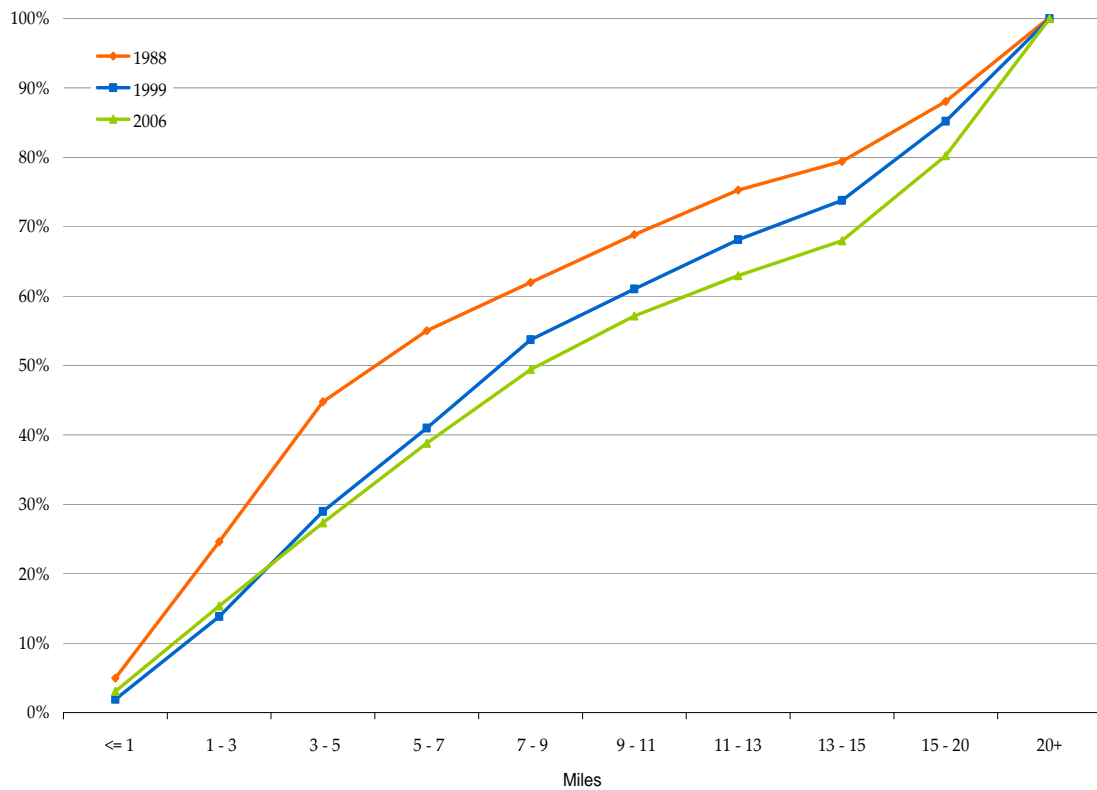


Figure A-5. Cumulative Distribution of HBW Trip Time by Transit

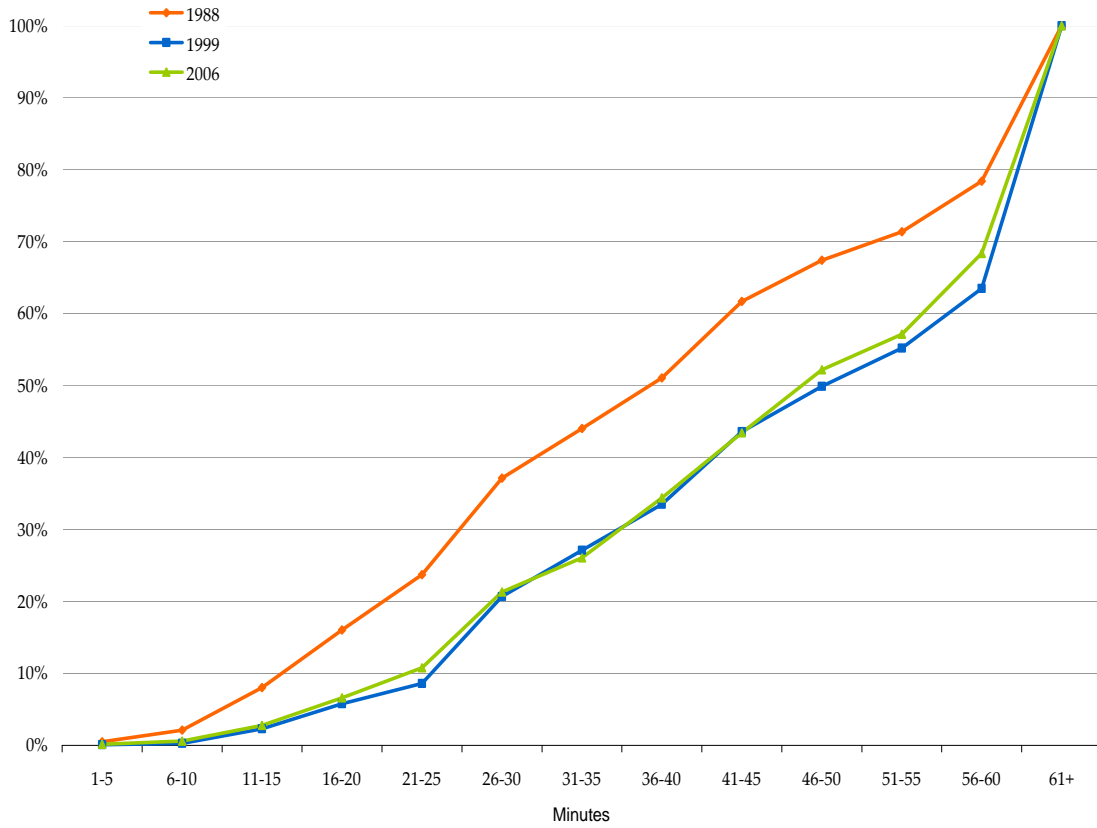


Figure A-6. Cumulative Distribution of HBW Trip Length by Transit

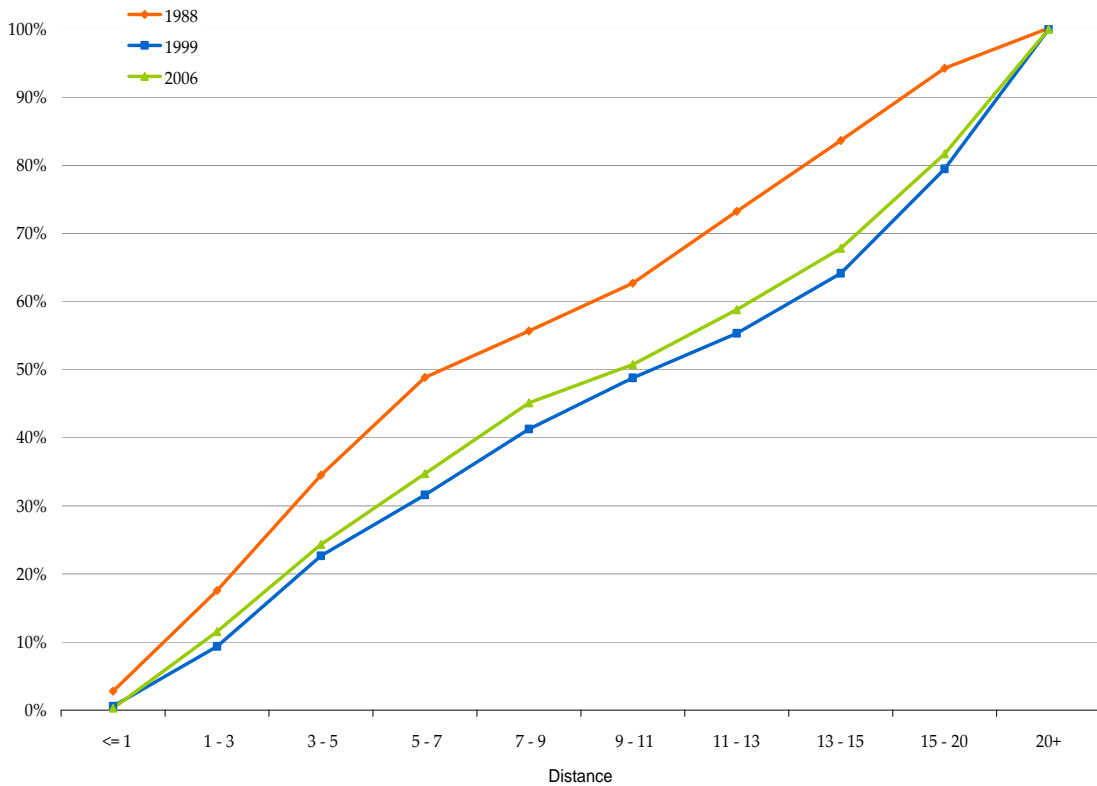


Figure A-7. Cumulative Distribution of HBW Trip Time by Walk

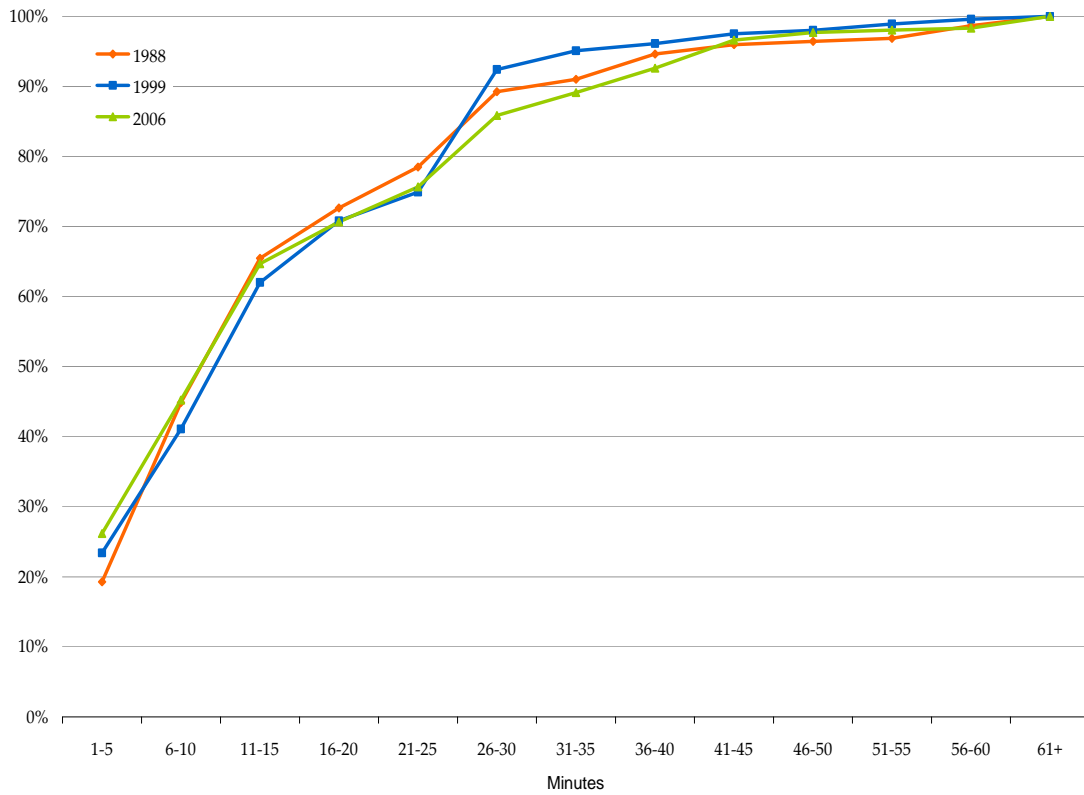


Figure A-8. Cumulative Distribution of HBW Trip Length by Walk

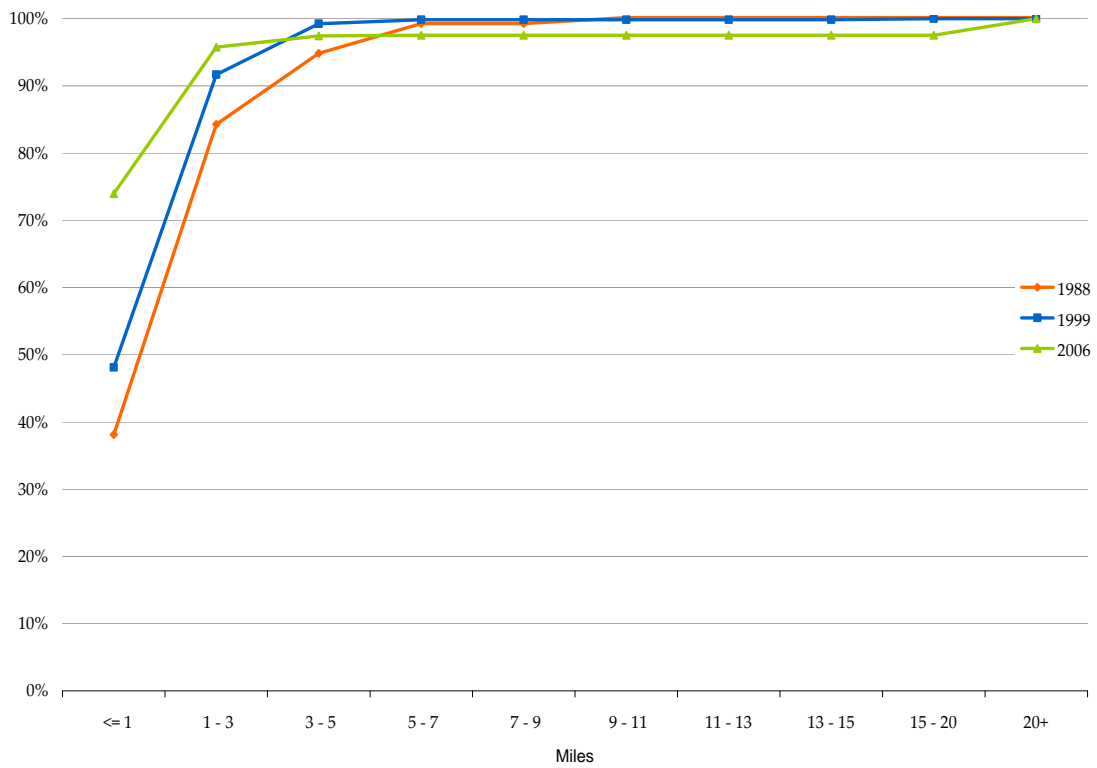


Figure A-9. Cumulative Distribution of HBO Trip Time by SOV

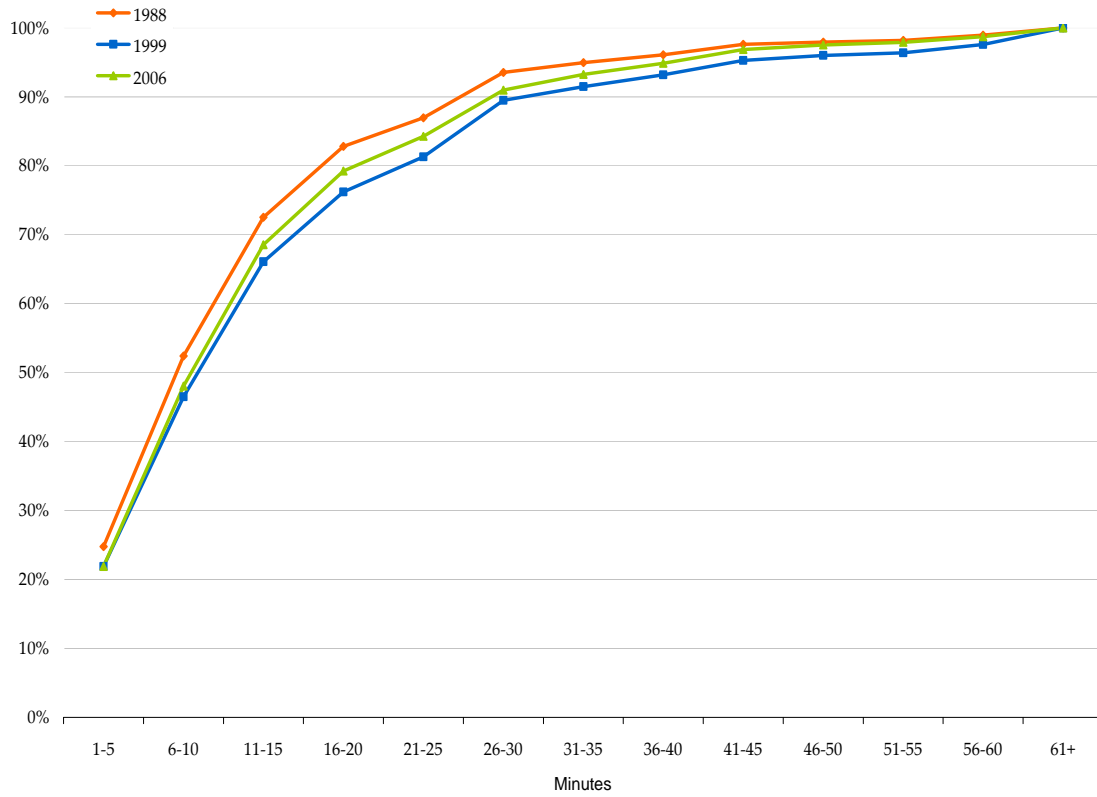


Figure A-10. Cumulative Distribution of HBO Trip Length by SOV

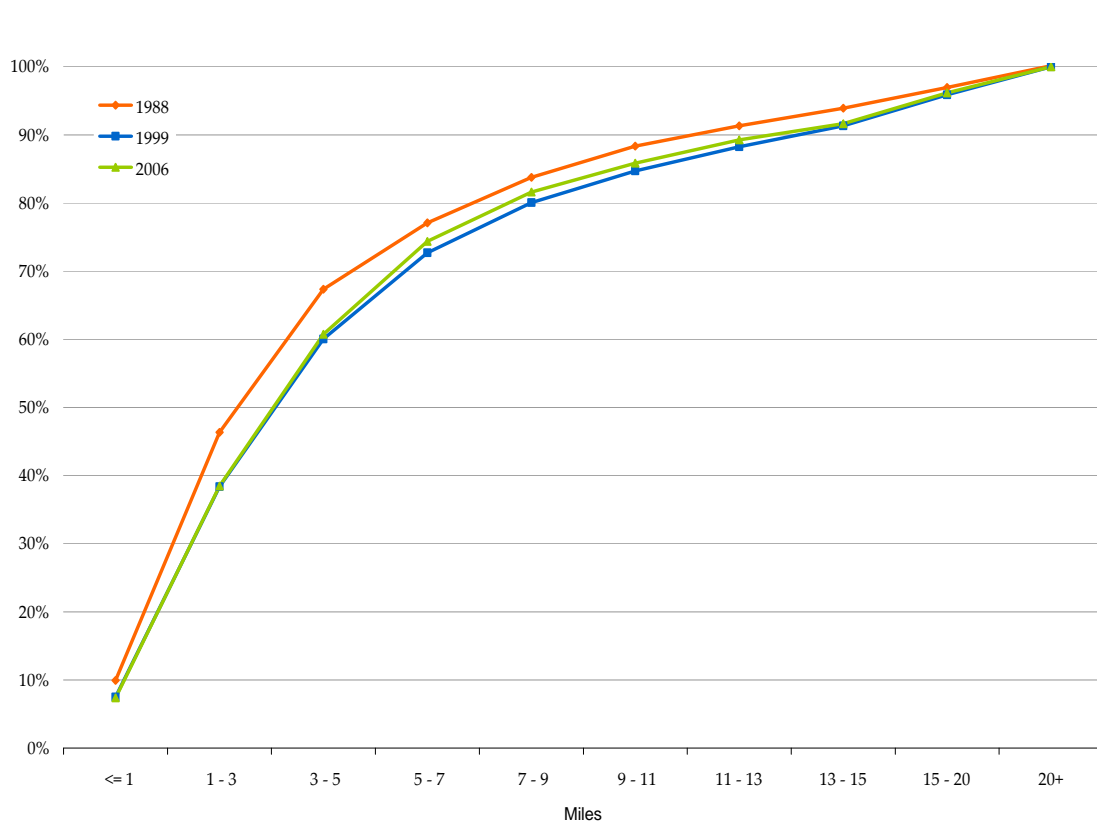


Figure A-11. Cumulative Distribution of HBO Trip Time by HOV

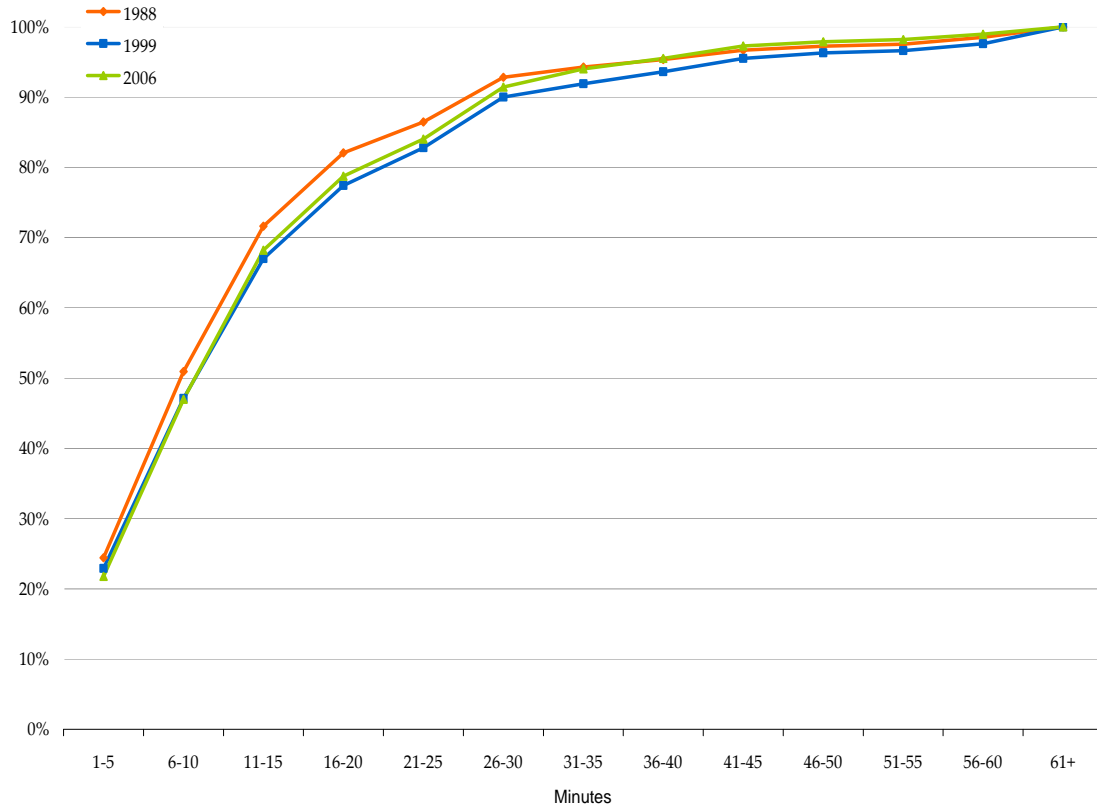


Figure A-12. Cumulative Distribution of HBO Trip Length by HOV

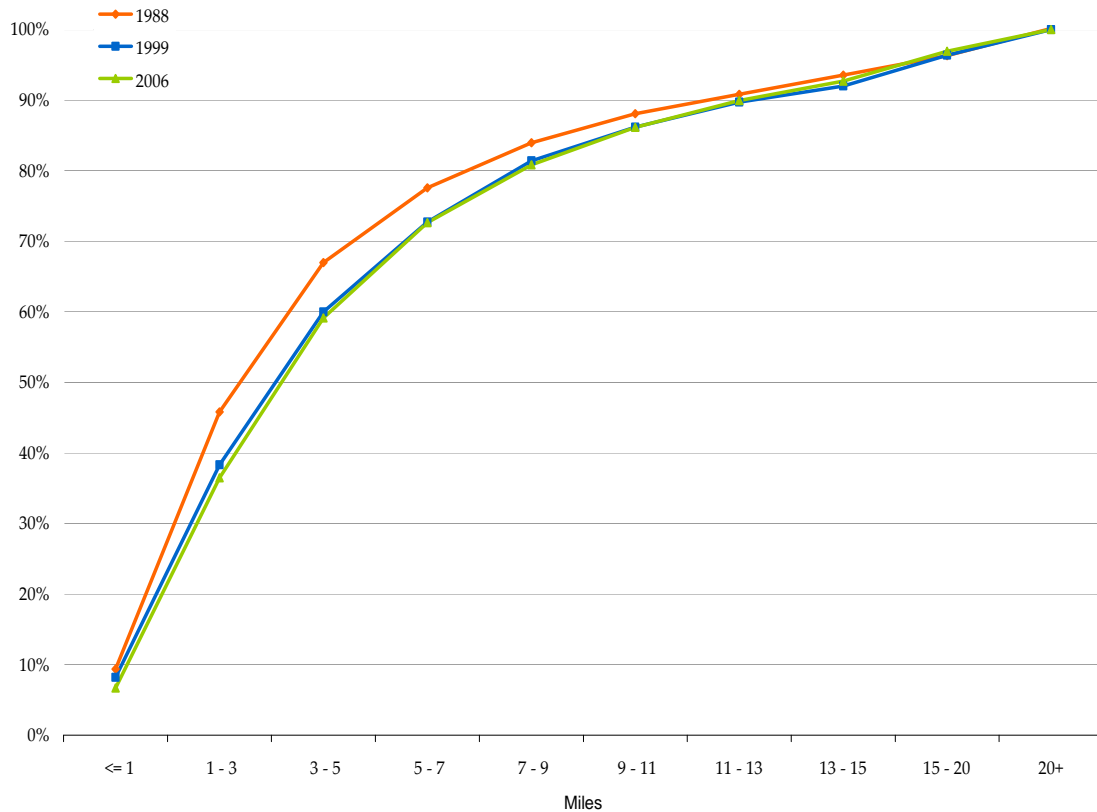


Figure A-13. Cumulative Distribution of HBO Trip Time by Transit

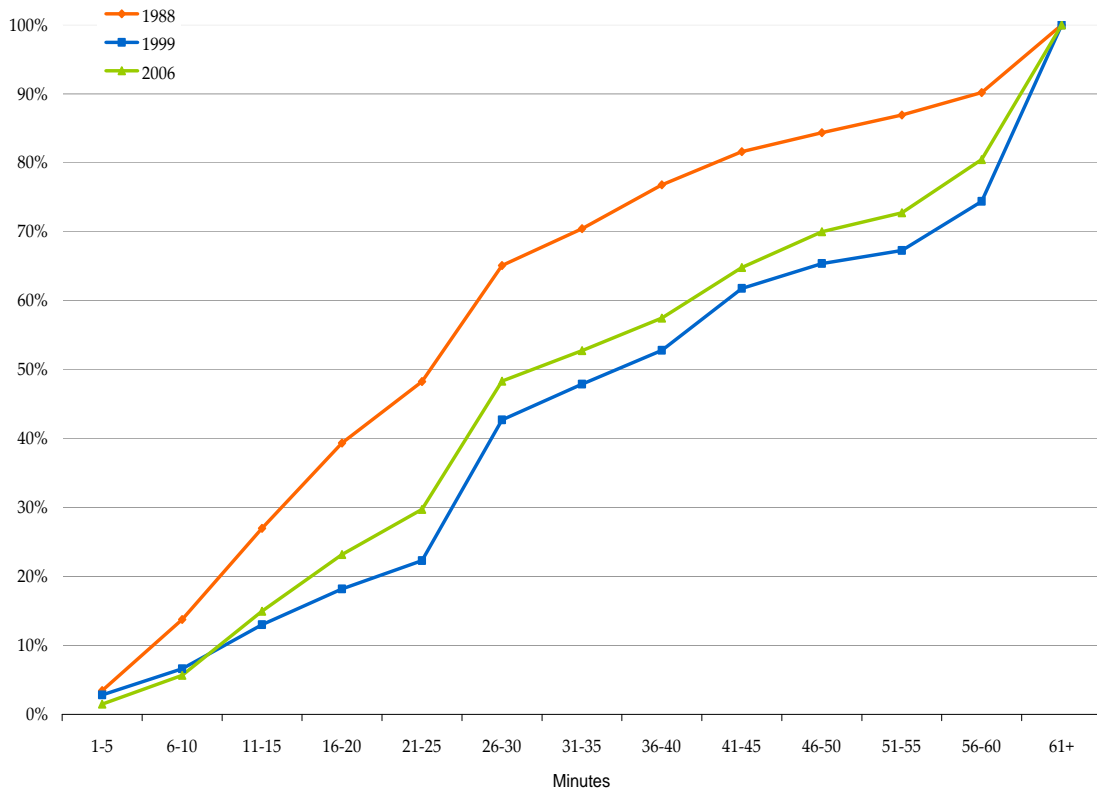


Figure A-14. Cumulative Distribution of HBO Trip Length by Transit

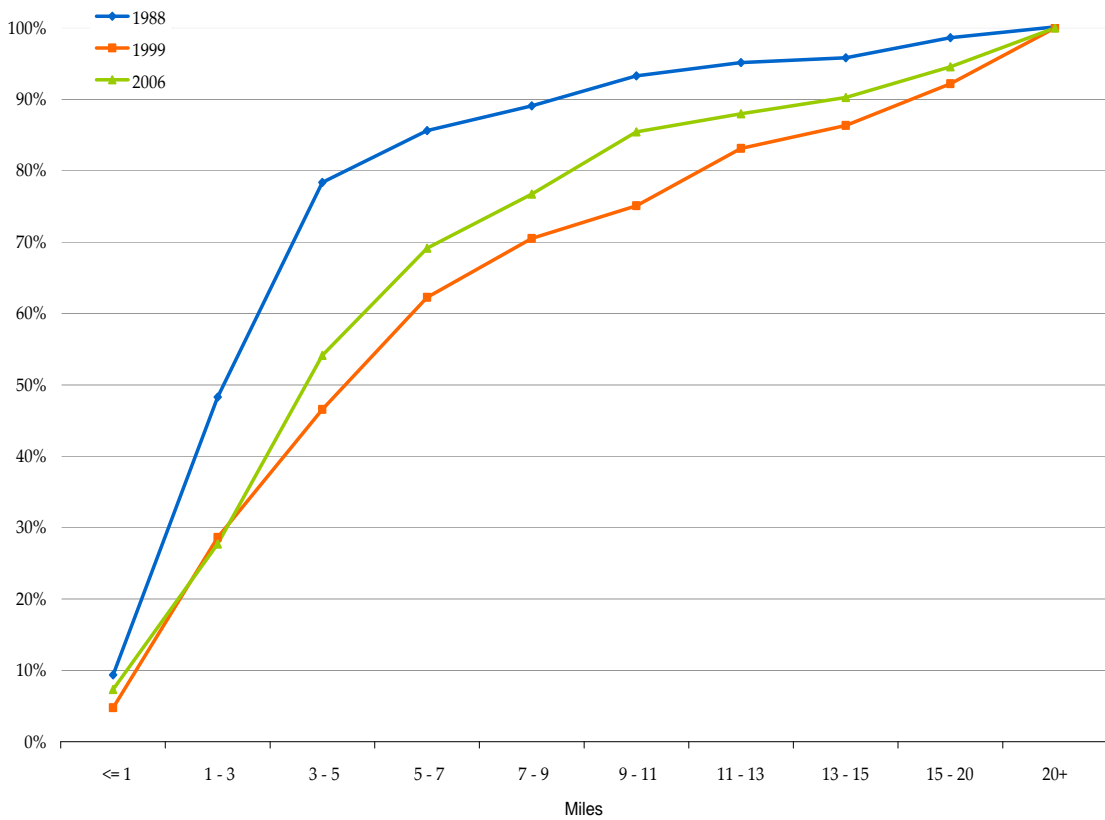


Figure A-15. Cumulative Distribution of HBO Trip Time by Walk

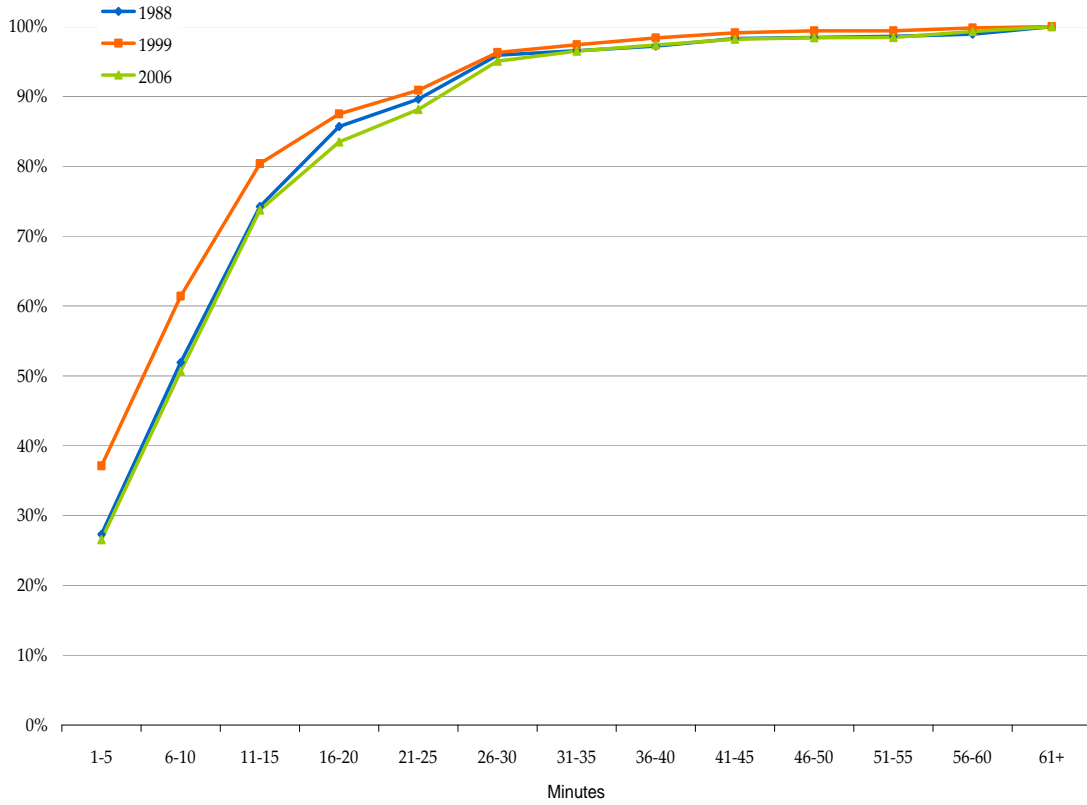


Figure A-16. Cumulative Distribution of HBO Trip Length by Walk

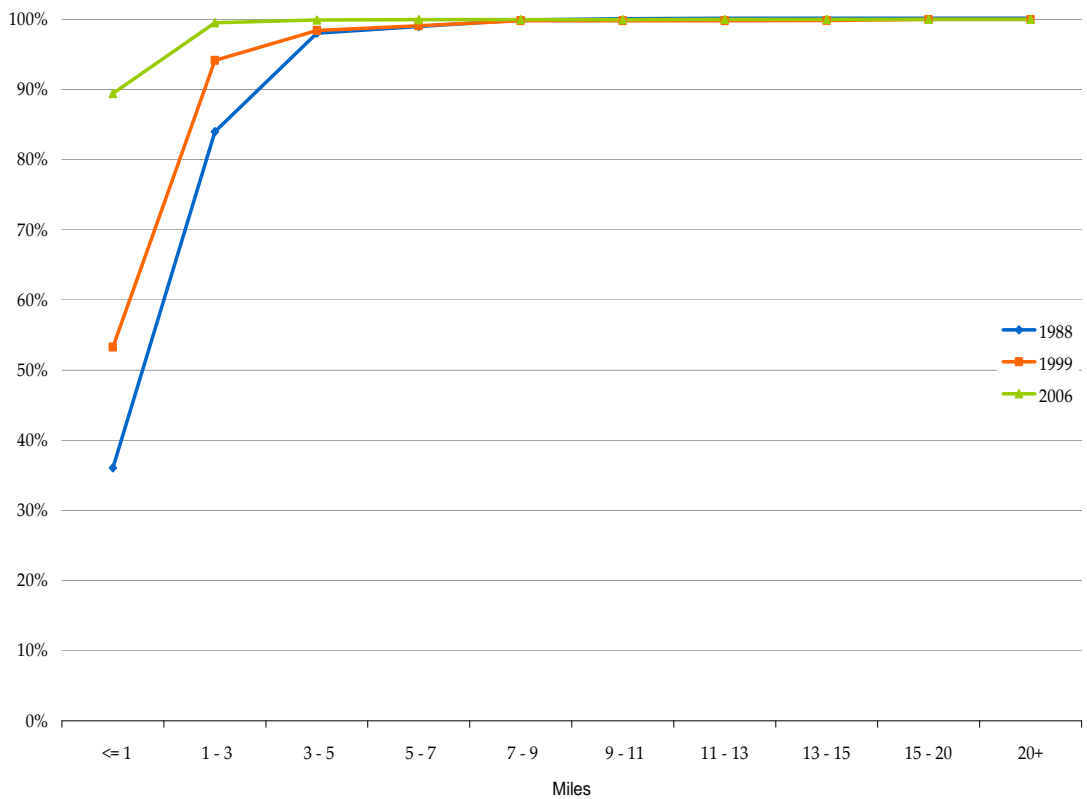


Figure A-17. Cumulative Distribution of NHB Trip Time by SOV

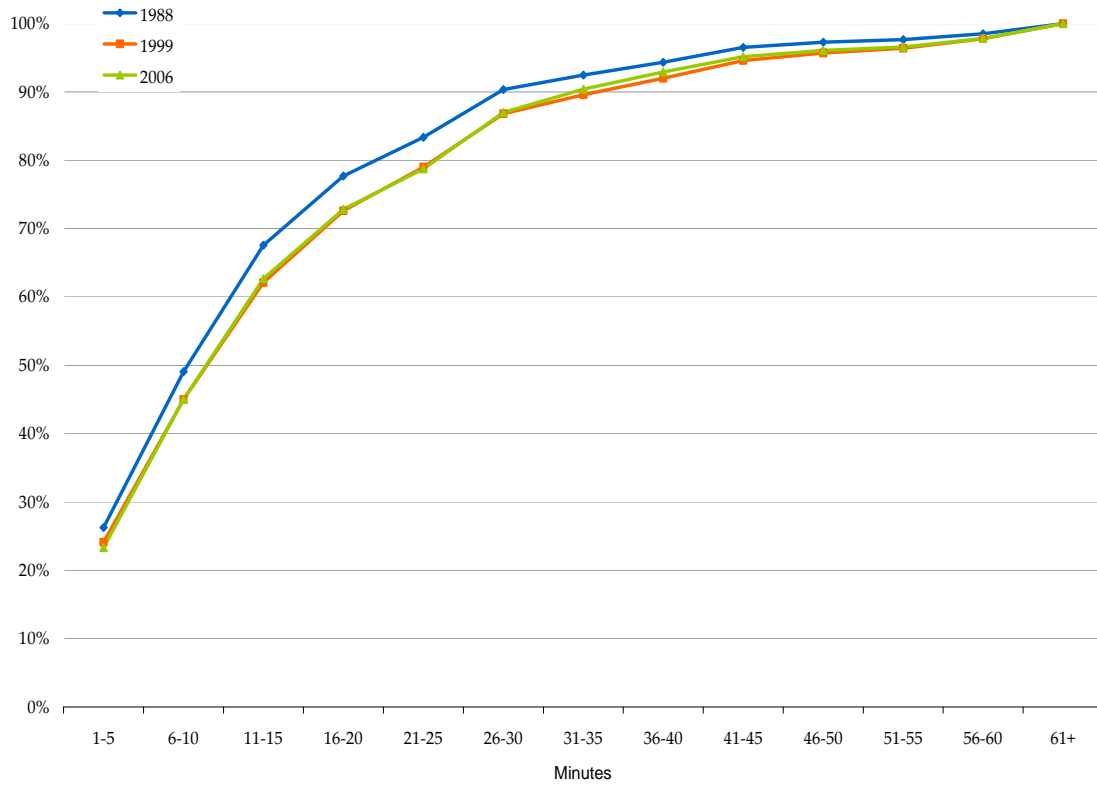


Figure A-18. Cumulative Distribution of NHB Trip Length by SOV

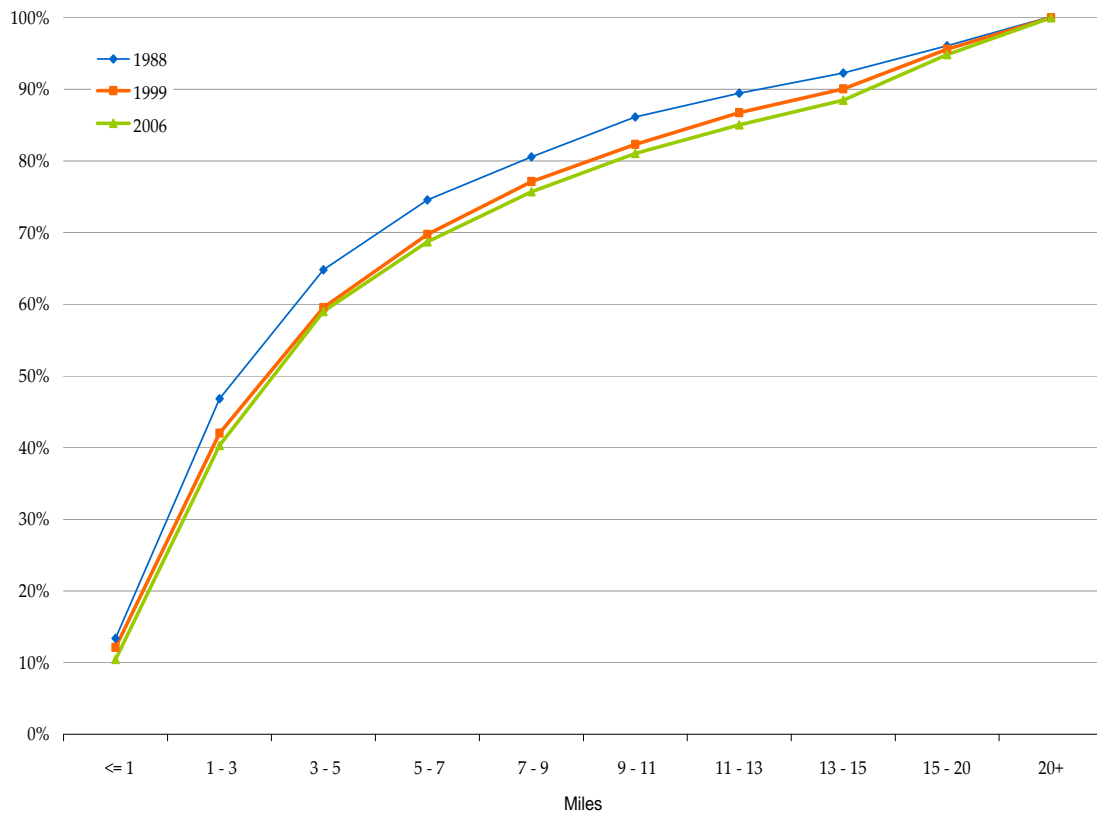


Figure A-19. Cumulative Distribution of NHB Trip Time by HOV

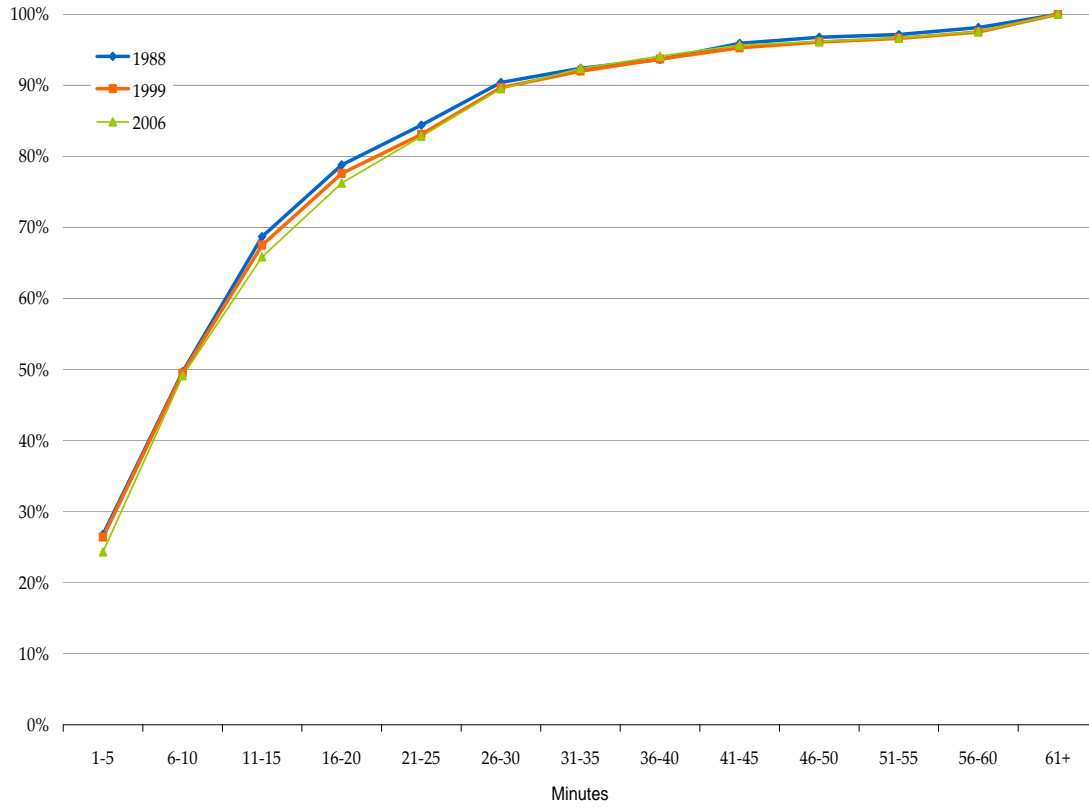


Figure A-20. Cumulative Distribution of NHB Trip Length by HOV

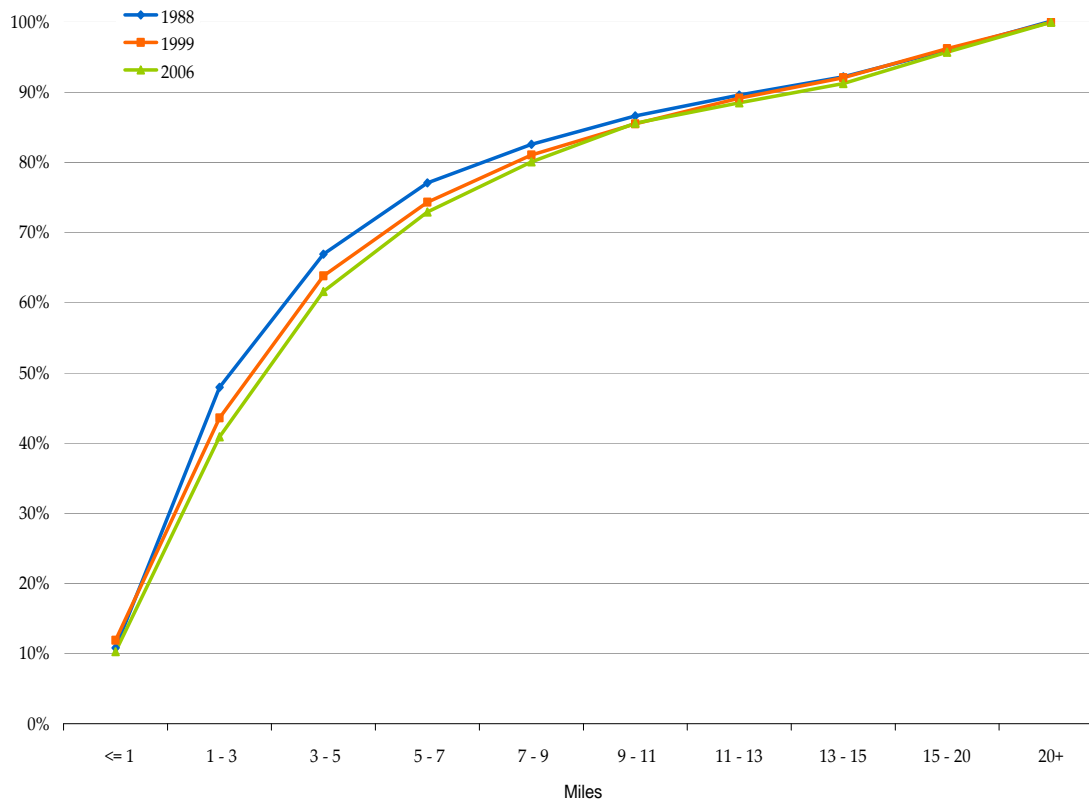


Figure A-21. Cumulative Distribution of NHB Trip Time by Transit

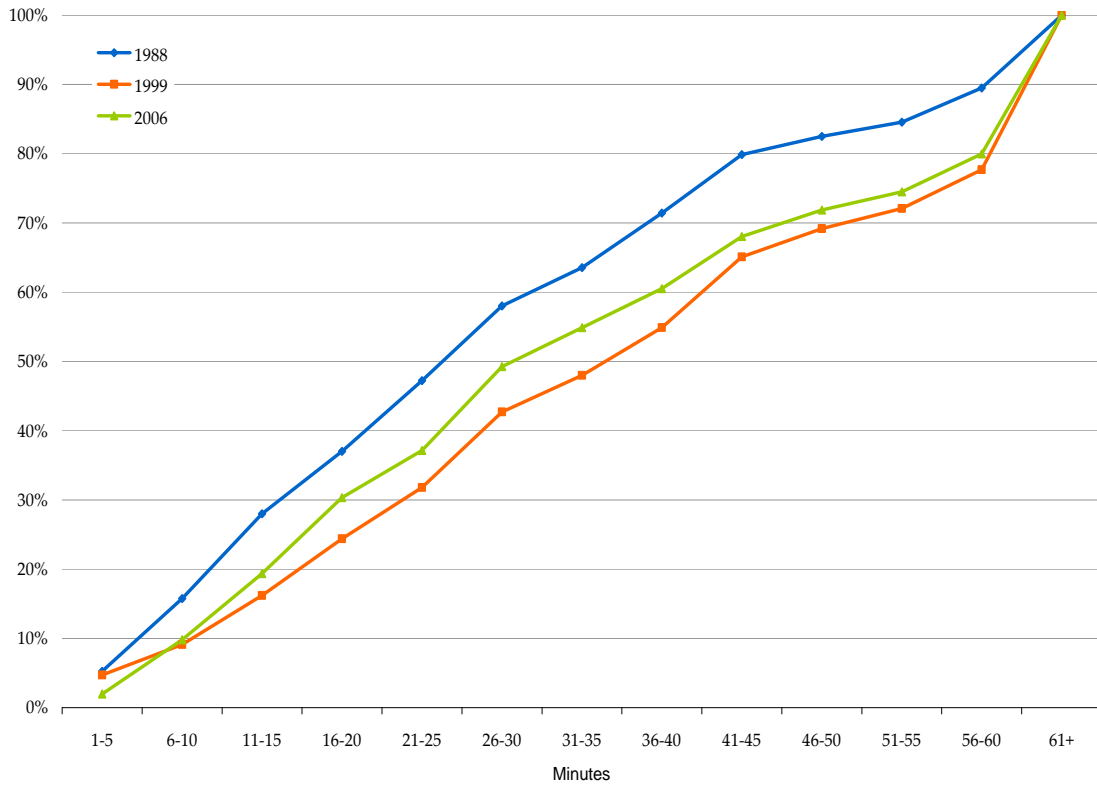


Figure A-22. Cumulative Distribution of NHB Trip Length by Transit

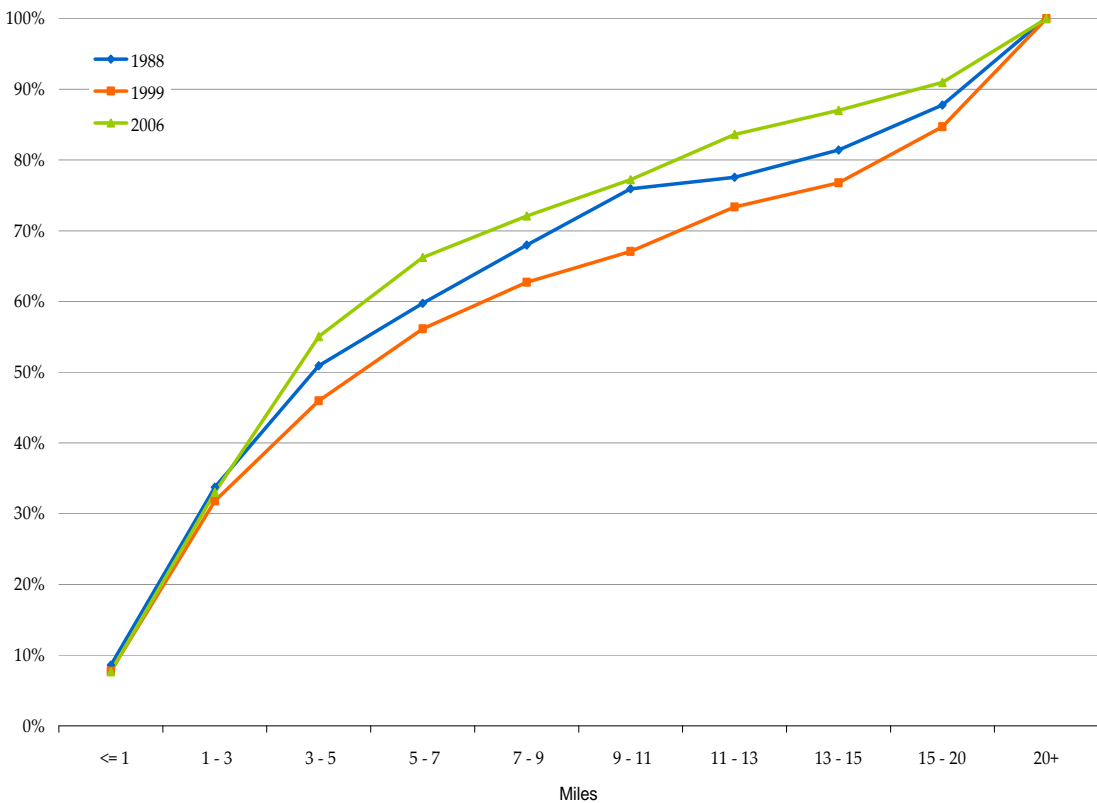


Figure A-23. Cumulative Distribution of NHB Trip Time by Walk

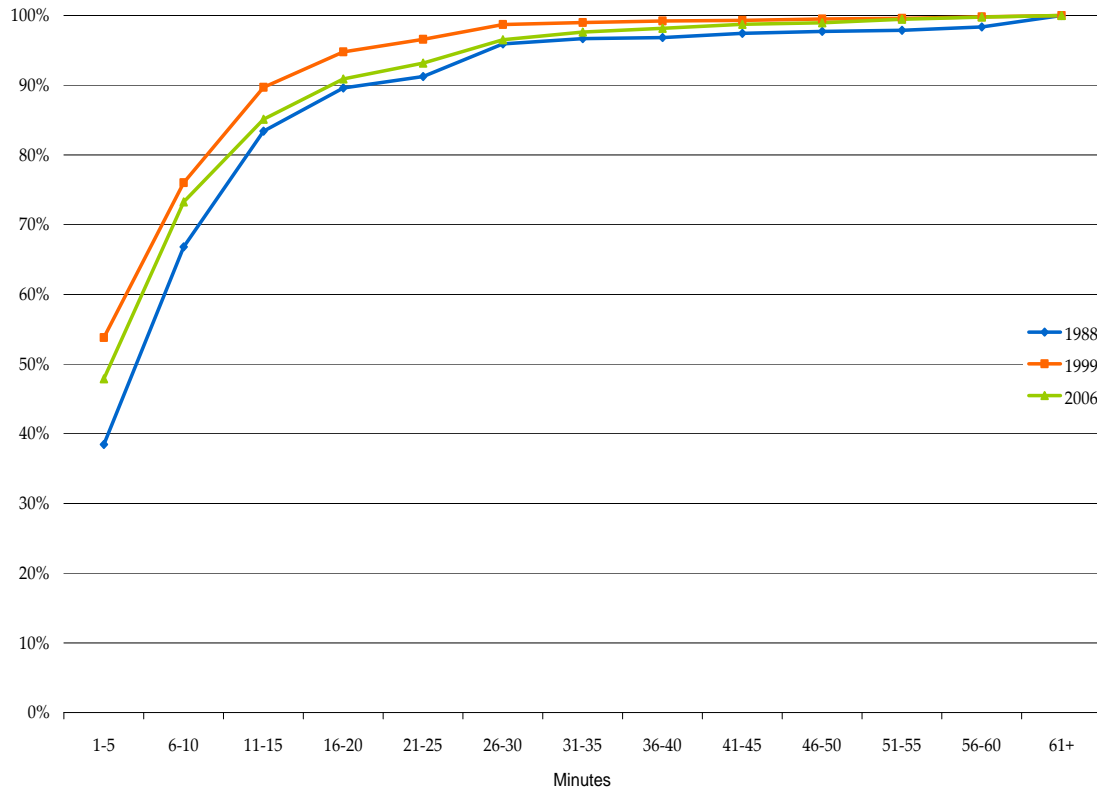
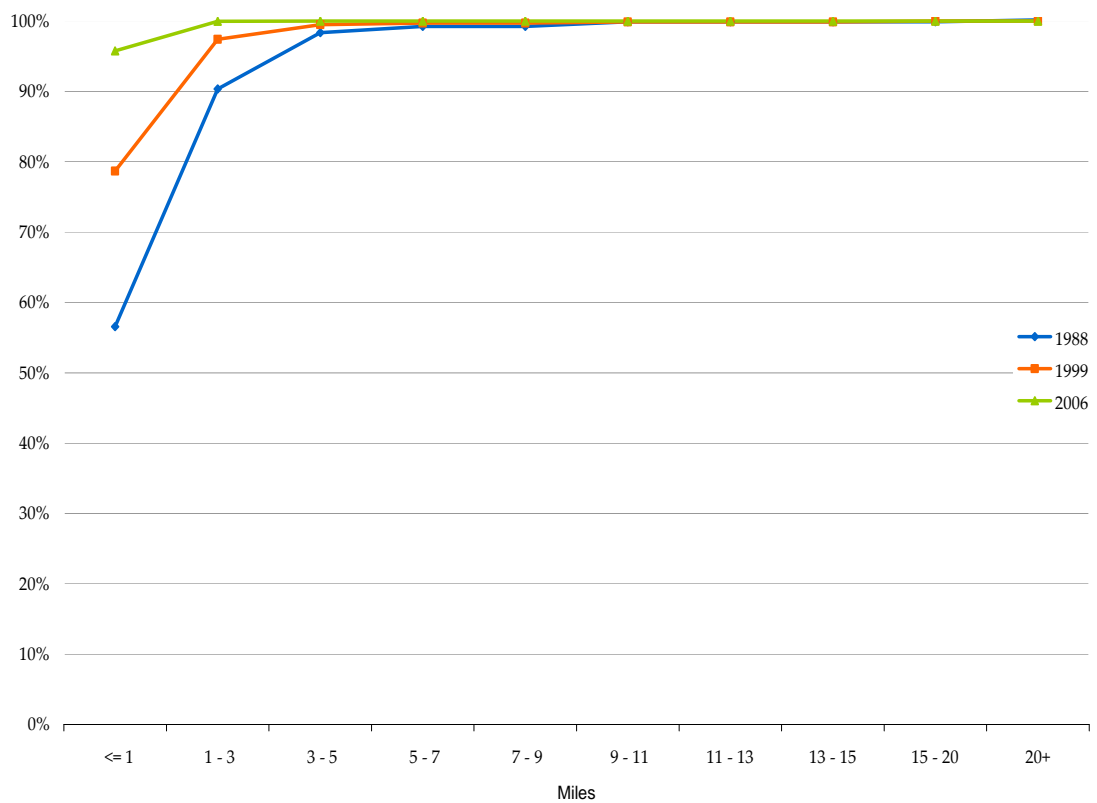


Figure A-24. Cumulative Distribution of NHB Trip Length by Walk



Appendix B: 1961/1971 Household Surveys

In 1961, the regional MPO at the time, the Puget Sound Governmental Conference, initiated the Puget Sound Regional Transportation Study (PSRTS) to provide a description of travel in the region. This project, done with state and federal assistance, was designed to investigate the factors relating to the movement of persons and goods, and the distribution and intensity of various land uses. It included analyses of the interrelationships of these factors.

A home interview survey was conducted as part of the PSRTS to collect base year travel characteristics to input into a travel demand model. A statistically selected sample of residents in the four-county region were interviewed at their homes about their travel activity. This involved requesting information about all trips made by persons in the household on the day before the in-house interview, including:

- a) The time and place each trip began and ended.
- b) How the trip was made (car, bus, taxi, etc.).
- c) The purpose of the trip.

The PSRTS also included a truck/taxi survey, ferry passenger interviews, and land use inventories.

The travel forecasting developed from the 1961 data assumed that trip generation rates would remain constant over time. By the end of the decade, the PSGC decided to update the 1961 travel inventories to check the stability of trip rates and the underlying relationships upon which the earlier rates were developed.

The 1970-71 Home Interview Survey was conducted using a 0.4 percent sample of households in the urbanized portions of King, Pierce, and Snohomish counties.

Interviewers recorded basic household information on one form (household income, vehicles, number of occupants, occupations of each occupant) and on a separate form, the trips made by each person on the assigned travel day.

Appendix C: 1985-1988 Household Travel Surveys Methods

Overview

Two previous regional household travel surveys had been conducted by earlier incarnations of the Puget Sound Regional Council -- one in 1961 and another in 1971. The six surveys during the 1985 to 1988 period represented an effort to update the data from the earlier surveys for use in the agency's travel forecasting and planning programs, by providing a scientifically valid snapshot of household travel patterns in the 1980s.

Travel surveys conducted in the 1950s and 1960s were very large and expensive projects, perhaps involving 5 percent of all households, and probably using an in-home interview to collect the information on daily travel. These large samples were used to prepare zone-to-zone trip tables. In the 1980s the trend was toward smaller samples, usually less than 1 percent of all households, and using either a mail-out/mail-back, or mail-out/telephone-back method for data collection. The goal became to collect travel data to calibrate trip generation, trip distribution, and mode choice, rather than attempting to establish accurate zone-to-zone trip tables, as well as to establish a current data set on travel behavior of households in the region, for purposes of informing the process of public policy development.

The Puget Sound Council of Governments (PSCOG, predecessor to the current Puget Sound Regional Council) used Michael E. Smith's approach for "Small-Sample Home Interview Travel Surveys" (TRR 701, 1979) in designing the first of six surveys. This was done in Kitsap County and would serve as a test for the household travel surveys to be conducted in the remaining three counties. It would also be the first time a household travel survey had been conducted in Kitsap County.

In the end, approximately 4,500 households, or about 0.5 percent of all households in the Puget Sound region, were surveyed between 1985 and 1988. Six separate surveys were conducted, three in King County conducted jointly with the Municipality of Metropolitan Seattle (Metro), and one each in Kitsap, Pierce and Snohomish counties.

Sample Selection

For the first sample in Kitsap County, a random selection from listed phone numbers was used. In 1985, the primary local telephone service provider (Pacific Northwest Bell, now Qwest) estimated that about 12 percent of households in Oregon and Washington had unlisted numbers. It was assumed that the percentage of unlisted numbers in Kitsap County would be lower due to the rural nature of the county. The remaining samples were obtained using random digit dialing.

In Kitsap, Pierce and Snohomish counties, all persons in the household age 5 and above were asked to complete a one-day diary on a weekday. For the diaries collected in King County, persons age 16 and above were asked to keep three and four-day diaries, including both weekdays and weekends. The weekend travel was not included in the analysis report.

Survey Method

Before 1980, a home-interview survey was not uncommon, but the costs of conducting such a survey became prohibitive except in very small samples, or very large budgets. The more common methods used have been:

1. Telephone screen/mail-out of forms/phone-back
2. Telephone screen/mail-out of forms/mail-back

The first method, collection of trip-making records on a phone-call back to respondents, was used in the Kitsap County study in 1985. All subsequent samples used a mail-out/mail-back method.

Mail-out/phone-back

The phone-back method was used in Kitsap County rather than a mail-back form to avoid erroneously reporting multimode trips, e.g., drive-to-ferry, car passenger-to-ferry. On the "mainland" side, this was less of a problem, although accurate reporting of such trips as "drive to Park-and-Ride" was necessary. The average telephone interview to collect the trip information took 20 minutes. Many of those interviewed on the phone had not completed the trip diary and proceeded to relay their trip-making by recall. These interviews were accepted, but a better method would have been to have re-assigned them another day for which to record their trips on the diary forms, and to have called them back again. In many cases, all members were not present at the time of the phone call, which made it difficult to collect trip information for each household member without many phone calls.

Mail-out/mail-back

The first of the joint PSCOG-Metro travel diary surveys was conducted in 1986. Metro had agreed on a mail-back method, and PSCOG concurred in this approach. This eliminated the expensive and time-consuming costs of a lengthy telephone interview to collect the data.

Mail-out package

The package mailed out to all those who agreed to complete diaries included:

- Introductory letter, signed by elected official from the appropriate jurisdiction
- Description of the marketing research company
- Instruction sheet (1 page, 2-sided)
- Sample diary form
- Diary forms for each person
- Postage-paid return envelope

Incentive

Monetary incentives have been used increasingly in survey research in part to offset lower response rates. Incentives in public sector research in transportation have included special lotteries (Vancouver, B.C.), and free bus tickets (Municipality of Metropolitan Seattle). Completion of a one-day diary for all household members was not felt to be "too burdensome," and so all PSCOG surveys with a one-day diary were offered no financial incentive. However, the three, multi-day

diary surveys in King County, conducted with Metro, provided a \$10 incentive, paid to households after return of the completed diaries.

Completion rates were similar between the samples with one-day and no incentive, and three-days and a \$10 incentive. The completion rate for Kitsap County was not available.

Completion rate (those who accept diary)

Kitsap Co.	1-day, no incentive	n.a.
Pierce Co.	1-day, no incentive	54.2
Snohomish	1-day, no incentive	56.3
East King	3-day, \$10	53.9
So King	3-day, \$10	58.6
Seattle	4-day, \$10	50.7

Further work on incentives and multi-day diaries was conducted in the first wave of the Puget Sound Transportation Panel (1989), and show that a smaller monetary incentive provided pre-completion is as effective as a larger sum provided post-completion. (Murakami & Watterson, TRR 1285, 1990).

Diary and Instruction Sheet Design

Trip Reporting Format

For the first survey, Kitsap County in 1985, the diary form was a one-page (legal size) form with one line per trip. Trip purpose and mode were in the form of check-off boxes. While the concept of check-off boxes is simple, having too many categories printed on the page made it look complex.

Subsequent diary forms have also been one page per day, in a horizontal format, and are primarily open-ended, thus, the forms appear very clean, and require very little reading (e.g. respondents don't have to read through 10 different trip purpose categories). While this format makes it easier for the respondents – they don't have to decide if returning books to the library is "recreation" or "personal business" - it requires that the information be coded to appropriate categories upon receipt of the diaries. Making the form as easy as possible for the respondent is more important to us than the added cost of coding each response.

Number of Diary Days

Traditionally, household travel surveys in cross-sectional studies have used a one-day trip diary for weekday travel. Because of the joint efforts with Metro, the three surveys in King County were multi-day trip diaries and covered both weekdays and weekends. For the PSCOG surveys, all household members age 5 and above kept a one-day diary. For those conducted with Metro, persons age 5 to 15 completed a one-day diary only, and those aged 16 and above completed multi-day diaries.

Persons who Make No Trips

From the work conducted in Kitsap County, it was impossible to distinguish people who made no trips on the reporting day from those people who neglected to fill out the forms.

Subsequent diaries had an additional box for people to specifically mark if they did not go anywhere.

Trip Information Collected

The type of information collected on the form included location, trip purpose, mode, time started and time ended, and who was traveling with the person. All trips, including walk, school bus, taxi, and ferry, were to be reported.

Instruction Sheet and Sample Diary

A two-page instruction sheet and a sample diary were mailed with each set of diaries. It included examples of acceptable formats for location reporting, as well as instructions on how to report carpool trips, and multimodal trips, e.g., driving to the park-and-ride and taking the bus.

Survey Recruitment

All surveys were conducted under contract with local marketing research firms. These firms had phone banks with a trained corps of telephone interviewers. Many firms now have computer-assisted telephone interviewing software that can be used for different aspects of a household travel survey. Computers can assist with the initial phone contact, with controlling call-back routines, and even with automatic dialing. Data entry from either a phone-collect of trip making or from surveys returned in the mail can use this type of software.

Understanding call-back routines set up by the research firm was seen as critical. While some recommended up to 15 call-backs per observation, eight call-backs were considered more realistic.

Diary Completion Rates

All surveys began with a phone contact. Each household successfully contacted on the phone was asked to complete trip diaries. About 62 percent of those contacted on the phone agreed to receive trip diary forms. Of those who were mailed trip diaries and given follow-up reminder calls, about 55 percent returned complete, useable trip diaries.

Sample Bias

Two populations are easily identified as those with high non-response in travel surveys. These are: one-person households who make very few or no trips and one-persons households who make a large number of trips. Persons who make very few or no trips often feel that information about their trip making "isn't important." Persons who make many trips aren't at home to be contacted, or if they are contacted, feel that it is too burdensome to fill out all trips on a diary form.

The average household size of the sample is higher than estimated regionally. However, since the correct proportion of households by household size is unknown, the data was not weighted to account for this bias.

Appendix D: 1999 Household Travel Survey Methods

NuStats Research and Consulting conducted the 1999 Puget Sound Household Travel Survey on behalf of the Puget Sound Regional Council (PSRC). The purpose of the study was to provide data for the continuing development and refinement of the Regional Travel Demand Forecasting Model, as well as to provide a better understanding of travel behavior in the Puget Sound region. The resultant data set has been used to fulfill the model's functions of estimating trip generation and distribution, mode choice, and assignments. The study consisted of a 48-hour personal travel diary for all household members, a phone interview to collect household and person characteristics, and an "attitude" survey about transportation and land use issues given to household members 16 years and older.

This section describes the sample methods used to conduct the study, including sample design, generation and final sample composition. The response rate and identification of sample bias are also discussed in this section.

Survey Universe

The universe for the survey was defined as households located in the four-county study area. According to 1999 estimates, the study area contained 1,313,463 households. The distribution of households by county and by three King County sub-areas is shown in Figure D-1. The sub-areas were the same as those used for the 1987-88 surveys.

Figure D-1. 1999 Estimated Number of Households in Study Area by County and King County Sub-Area

County	Number of Households	Percent of Total
King	718,427	55%
East Side King	182,096	25% of King County
Seattle/Shoreline	279,703	39% of King County
South King	256,628	36% of King County
Kitsap	110,578	8%
Pierce	262,425	20%
Snohomish	222,033	17%
TOTALS	1,313,463	100%

Source: The Sourcebook of Zip Code Demographics, Ninth Edition, CACI Marketing Systems, 1994.

Sample Size

The survey resulted in a sample size of 6,000 randomly selected households, with an overall accuracy of ± 1.3 percentage points at the 95 percent confidence level. Figure D-2 shows the proportional allocation of sampled households by county and King County sub-areas.

Figure D-2. Sample by County and King County Sub-Area

County	Sub-Area	1999 Estimated Households	% of Total	% of King	Survey Distribution	Sub-Area Distribution
King		718,427	55%		3,282	
	East Side	182,096		25%		832
	Seattle/Shoreline	279,703		39%		1,278
	South	256,628		36%		1,172
Kitsap		110,578	8%		505	
Pierce		262,425	20%		1,199	
Snohomish		222,033	17%		1,014	
TOTALS		1,313,463	100%		6,000	

Source: The Sourcebook of Zip Code Demographics, Ninth Edition, CACI Marketing Systems, 1994.

To ensure proper model calibration, there was a sample size goal for each household size and automobile ownership cell stratum. These were goals and not specific quotas. It is not cost-effective to set minimum quotas; certain types of households are typically harder to find in a random selection process because there are so few of them in the general population. The types of households hardest to find are those with no car and those that have a large number of members. The estimated number of households in the study area, by household size and auto ownership, is shown in Figure D-3.

Figure D-3. 1990 Estimated Percentage of Households: Household Size by Auto Ownership

Auto Ownership	Household Size				Totals
	1	2	3	4+	
0	5%	1%	1%	1%	8%
1	17%	8%	3%	3%	31%
2	3%	18%	7%	11%	39%
3+	1%	6%	6%	9%	22%
Totals	26%	33%	17%	24%	100%

Source: Census Transportation Planning Package (CD-ROM) — Bureau of Transportation Statistics, U.S. Department of Transportation.

Based on the household size by auto ownership distribution (shown in Figure D-3) and the minimum number of completes (6,000), the recommended sample size per cell goal is shown in Figure D-4. For analysis purposes, the zero-car by 3 and 4+ person household cells will be combined (highlighted in table) since these are the cells that are typically the hardest to fill.

Figure D-4. Total Sample Distribution by Household Size and Auto Ownership

Auto Ownership	Household Size				Total
	1	2	3	4+	
0	312	80	62		454
1	1,008	482	190	182	1,862
2	194	1,085	420	651	2,350
3+	50	388	358	538	1,334
Totals	1,564	2,035	999	1,402	6,000

Sample Selection

The survey employed a probability sample selection process to select households for inclusion in the study. The major requirement for probability sampling is that the relative probability that any given household in the universe will be included in the sample is known. Once the sampling procedure is determined, selection of specific households for inclusion in the sample is left entirely to chance.

The type of probability sample used was a stratified sample in which the sample elements were drawn proportionately to households within the four counties. The sample was randomly generated across all telephone exchanges within the study area.

The 1990 Census revealed that the overall percentage of households with telephones in the study area was 97 percent to 98 percent. Figure D-5 shows the percentage of households with telephones by county. It was determined that the study area had very high levels of telephone coverage and that non-telephone household coverage was not an issue for this survey effort.

Figure D-5. Study Area Telephone Coverage

Area	Percentage of Households w/Phone
King	98%
Kitsap	97%
Pierce	97%
Snohomish	98%

Source: County and City Data Book, Bureau of the Census, 1994.

Sample Frame Generation

The sampling frame for the survey included listed and unlisted telephone numbers. A listed telephone number is a telephone number for which a household address can be identified; an unlisted telephone number is one for which a household address cannot be identified.

Both the listed and unlisted telephone numbers were generated using random digit dial (RDD) procedures. Using *ProPhone*, a CD database that contains listed telephone numbers for the entire U.S., NuStats identified all the working exchange/block combinations for each county in the study area. The percentage of residential telephone numbers (out of a possible 100 telephone numbers) assigned to an exchange/block combination was calculated. A “percent residential” cutoff, usually 70 percent, was used to eliminate from the sample frame the block/exchange combinations that had fewer than 70 percent residential phone numbers assigned. NuStats then generated all the possible combinations of telephone numbers within these working exchanges and blocks. All of these numbers comprised the listed sampling frame for the listed telephone numbers.

The unlisted telephone numbers were generated based on the telephone exchange/block combinations identified from the listed sample generation. Telephone numbers were randomly generated from these exchanges and blocks and then compared to all phone numbers listed in *ProPhone* for the four counties. All unlisted telephone numbers generated that were listed in *ProPhone* were purged from the sample frame. Approximately 75 percent of phone numbers in the four-county study area were listed.

A recruitment goal of 9,000 households assumed a retrieval rate (that is, percentage of recruited households that will be completed) of 67 percent. This recruitment sample size and retrieval rate produced a minimum of 6,000 completed surveys. NuStats typically completes about 2 percent additional surveys to accommodate for surveys that may later be deemed unacceptable during post-processing.

A completed household survey is a survey for which all household, person, vehicle and trip data are collected. The key statistics for determining sample quotas are household size and automobile ownership.

Sample Preparation

The generated telephone numbers were prepared for administration by organizing them into replicates. A replicate is a systematically selected sub-sample of the universe. The main benefit of using replicated samples is that the interviewers do not need to call the entire sample frame in order to ensure proper representation of the study area. When the quota of completed households is accomplished, it is only necessary to call telephone numbers that are in replicates that have already been released or opened.

Advance calls were made to each unlisted telephone number in order to elicit a home address. Advance calls were also made to each listed telephone number to verify that the telephone number

was assigned to a household rather than a business. Since listed telephone numbers do not have an apartment or unit number attached, the advance call also served to verify this piece of information, which was critical to the mailing procedure. Once addresses were verified, an advance letter and brochure were mailed to home addresses for each record in the sample file that had been geocoded. For this survey, a 60 percent recruitment rate or a mailing of 15,000 advance letters (9,000 recruits divided by 0.6) was assumed. During the course of the survey, advance calls were terminated so that focus could be placed on recruitment. Toward the end of the project, it was necessary to focus on recruiting those households that met the necessary household size by vehicle ownership sample strata. Therefore, “cold call” recruitment was necessary (the advance call was skipped and the first contact with some households was during recruitment).

During survey administration, progress on advance calls, advance letters, and recruitment, were tracked daily by NuStats’ Continuous Data Flow staff.

From the sampling frame, NuStats randomly selected 60,896 telephone numbers for inclusion in the study. As shown in Figure D-6, 19,168 telephone numbers were found to be ineligible for the study (disconnects, business/government, computer/fax, over quota and out of area). This left an effective sample of 41,728 telephone numbers (60,896 minus 19,168) that formed the basis of the advance calling effort. Of these 41,728 telephone numbers, 9,985 (23.9%) resulted in a household that was willing to receive an advance letter with more information about the study. At the same time, 5,628 (13.5 percent) refused to receive any materials.

Figure D-6. Advance Call Outcomes

Call Outcome	Frequency	Percent
Agreed to receive letter	9,985	16.4%
Refused to participate	5,628	9.2%
*Disconnected number	12,077	19.8%
No answer	15,074	24.8%
*Business / Government	3,806	6.3%
Answering machine	4,375	7.2%
*Computer I fax line	3,073	5.0%
Busy	1,636	2.7%
*Out of area	78	0.1%
Call Back	5,030	8.3%
*Over Quota	134	0.2%
Total	60,896	100.0%

* Sample pieces in these categories were found to be ineligible for participation in the study, as they did not result in contact with a study area residence or were in sample strata that were already filled.

Response Rate

The sampling plan is but a means to an end, because it is the response of the actual sample that matters. The responses of those who completed the survey comprise the data set, and an acceptable response rate is critical. Overall response rate is one guide to the representation of the sample respondents. The 1999 Puget Sound Household Travel Study used a multistage survey process (i.e., household recruitment and household retrieval). In this case, a rate is calculated for each survey stage, then the overall response rate is determined by multiplying the rates together.

The participation rate is determined by reviewing the outcomes of the recruitment calls. As shown in Figure D-7, the recruitment call outcomes yielded two types of sample dispositions: eligible and ineligible. The small percentage of ineligible calls resulted from the advance calls performed earlier in the process with the purpose of identifying and purging non-working numbers from the sample prior to the recruitment effort. The advance call sample (9,985 households agreed to receive an advance letter as shown in Figure D-6) was not sufficient to support a recruitment of over 9,000

households; households could decide to refuse to participate at any phase of the project. As mentioned previously, additional “cold calling” recruitment was conducted (i.e., non-advance-called sample was generated) to reach the recruitment goal.

Figure D-7. Recruitment Call Outcomes

Category	Sample Outcome	Frequency	Percent
Eligible Sample			
	Recruited	9,028	22.0%
	Refused	5,342	13.0%
	Unable to re-contact	26,717	65.0%
Sub-total Eligible		41,087	100.0%
Ineligible Sample			
	Disconnected numbers/numbers changed	10,276	17.6%
	Language barrier	810	1.3%
	Business/Government number	2,768	4.7%
	Computer/Fax	1,983	3.3%
	Over Quota	1,419	2.4%

The recruitment rate is calculated as the number recruited divided by the sum of recruits, refusals and a portion of the total eligible sample (a percentage of these can be allocated as refusals). Using this method, the recruitment rate is 45.8 percent [or $9,028 / (9,028 + 5,342 + 5,343^5)$].

The completion rate reflects the rate at which recruited households complete the survey process. It is a measure of sample attrition, which influences sample bias. The rate is calculated by dividing the total number of completed (retrieved) surveys by the total number of recruited households. Of the total 9,028 recruited households, 6,000 completed their surveys for a retrieval completion rate of 66.5 percent. To summarize:

Recruitment rate = 45.8 percent

Completion rate = 66.5 percent

Overall response rate = 30.5 percent ($0.458 * 0.665$).

This rate is comparable to recent 48-hour travel studies conducted using similar methods. The response rate calculation uses the same formula prescribed by the Council of American Survey Research Organizations (CASRO).

Final Sample Composition

Figure D-8 summarizes the final distribution of households for the entire region. At the conclusion of data collection, the distribution of households by size and vehicle ownership closely approximated the sample objectives as laid out in Figure D-9 (final distribution pending). Cells in

⁵ Based on the percentage of refusals to the sum of recruits and refusals [$9,028 / (9,028 + 5,342)$], we can assume that 20 percent of the “unable to re-contact” sample would also end up as refusals if contacted. Applying this 20 percent to the total “unable to re-contact” (20 percent of the 26,717 = 5,343) brings the total denominator to 19,713 eligible contacts.

which the goals were not met are historically problematic (zero-car households and large households).

Figure D-8. Final Distribution of Households

HH Vehicles	Household Size				Total
	1 Person	2 Person	3 Person	4+ Person	
0 Vehicles	200	46	14		260
1 Vehicles	1,017	403	117	67	1,604
2 Vehicles	210	1,102	352	542	2,206
3+ Vehicles	59	407	332	389	1,187
Total	1,486	1,958	810	1,003	5,257

Figure D-9. Final Distribution of Households as a Percentage of the Goal

HH Vehicles	Household Size				Total
	1 Person	2 Person	3 Person	4+ Person	
0 Vehicles	64%	58%	23%		57%
1 Vehicles	101%	84%	62%	37%	86%
2 Vehicles	108%	102%	84%	83%	94%
3+ Vehicles	116%	105%	93%	72%	89%
Total	95%	96%	81%	72%	88%

For modeling purposes, it is important to maintain an equal distribution of travel days across the week. However, this goal was secondary to the achievement of the sampling goals (it was more important to approximate the distribution of household size and household vehicles than day-of-week distribution). Although obtaining an even day-of-week distribution was a secondary goal, a final distribution across the five weekdays was achieved as shown in Figure D-10. (Note: the total number of cases in the goal column adds up to 12,000 since each of the 6,000 households traveled for two days. The travel-day pairs were Monday/Tuesday, Tuesday/Wednesday, Wednesday/Thursday, Thursday/Friday, and Friday/Monday).

Figure D-10. Distribution of Households by Day-of-Week

Day-of-Week	Goal	Frequency	Percent
Monday	2,400	1,839	17%
Tuesday	2,400	2,233	21%
Wednesday	2,400	2,265	22%
Thursday	2,400	2,179	21%
Friday	2,400	1,998	19%
Total	12,000	10,514	100%

Identification of Sample Non-Response Bias

Non-response bias in a survey data set occurs when certain individuals selected in a sample do not participate in the survey. The concern is that “*non-respondents will differ from respondents with regard to the survey variables, in which case the survey estimates based on the respondents alone will produce biased estimates of the overall population parameters.*”⁶ The purpose of this section is to examine the extent to which non-response bias is an issue in the survey.

With an overall response rate of 30.5 percent, it is evident that a sizable portion of eligible households did not participate in the study. A recent study of non-responding households

⁶ Kalton, Graham. *Introduction to Survey Sampling*. (Sage Publications: Beverly Hills, CA, 1987), p. 63.

conducted by NuStats for the Federal Highway Administration indicates that households with the following characteristics are less likely to participate in travel studies:

- Households with four or more persons
- Households with no workers or more than two workers
- Households with no vehicles
- Households earning less than \$20,000
- Households earning between \$60,000 and \$75,000

It is important to note that the sampling design used in this study (household size by household vehicles) did help to control non-response bias by household size and household vehicles.

To ensure the reliability of the inferences drawn from this sample, it is useful to compare the sample statistics with known population parameters as expressed in the 1990 Census. This comparison is shown in Figure D-11. As indicated above, household size and vehicles track fairly well with the census data, given that these were the main variables monitored during data collection.

Figure D-11. Comparison of Sample Data with 1990 Census Data

Household Characteristic	Survey Data	1990 Census Data
Household Size		
1 person	28%	26%
2 persons	37%	34%
3 persons	16%	17%
4+ persons	19%	23%
Totals	100%	100%
Household Vehicles		
0 vehicles	5%	8%
1 vehicle	30%	31%
2 vehicles	42%	39%
3+ vehicles	23%	22%
Totals	100%	100%

Another tool used to assess data quality is analyzing descriptive statistics such as the standard deviation for key variables. The standard deviation measures the “spread” of the data from the sample mean. The formula for calculating the standard deviation is:

$$S = \sqrt{\frac{1}{n-1} \sum (xi - \bar{x})^2}$$

where,

n = sample size

xi= observed value of the variable

\bar{x} = sample mean of the variable

Figure D-12 summarizes the statistics for key variables at the household level. The household size and vehicle ownership variables have a standard deviation of just over 1; variability among responses relative to the sample mean within each parameter is small. The standard deviation of the trip rate has a higher variability since some households do not travel much (e.g., retirees), while others may travel quite a bit (more active, younger households).

Figure D-12. Descriptive Statistics of Key Variables

Household Characteristic	Minimum Value	Maximum Value	Mean	Standard Deviation
Household Size	1	10	2.34	1.26
Vehicle Ownership	0	8	1.95	1.12
Trips	0	56	9.34	6.72

Survey Methods

This section reviews the methods used to conduct the survey, starting with an overview of data collection activities, by a discussion of the various components of data collection.

Data Collection Overview

The 1999 Puget Sound Household Travel Survey was a multistage study, as it involved three telephone interviews and two mailings to the households. The procedures and materials used in the conduct of the study are discussed in the next section. The study itself was administered from late July to the first week in November 1999, with no travel days assigned on Labor Day (September 6) and Columbus Day (October 11). Prior to the start of data collection, a pilot test was conducted. The objectives of the pilot test were to refine the survey materials and to fine-tune the processes and programs that were used to carry out the travel behavior survey.

The principal component of the pilot test was a complete run-through of survey procedures for a small sample of households. “Complete” data from 25 households were collected. Pilot test households were recruited, received mail packages, traveled, and were re-contacted to report their travel activities.

As a result of the pilot test, the following modifications were made prior to implementing the full study. Suggested changes were categorized into one of two areas: survey process and survey materials.

Survey Process

There were no significant changes made to the process as a result of the pilot test. There were two suggestions to the administrative aspects of the process, including printing household size and auto ownership directly on the sample page for ease of tracking, and printing the date and time of recruitment so that subsequent phone calls could be targeted during those times as the chance of contact might be higher.

Survey Materials

Two suggestions were made regarding the diaries. The first suggestion was to add the sentence “Record Vehicle Odometer Readings” to the checklist on the back page. The second suggestion was

to add a paragraph on the diary that stated, "If you would like to call us to provide your diary information, please call Monday through Friday between 3:00 p.m. and 8:00 p.m. or Saturday between 11:00 a.m. and 4:00 p.m. PST."

Survey Procedures

The survey process followed an eight-step plan. 1) First, advance calls were made to households to confirm working condition and obtain/confirm a mailing address. 2) Following this call, an introductory letter and brochure were mailed to each household. 3) The recruitment call secured the household's participation in the study and obtained demographic information. 4) This information was used to prepare personalized travel diaries for all household members and an attitude survey for those respondents 16 years of age or older. 5) The diaries were mailed to each member of a household and used during their assigned travel days to record all of their travel. 6) In addition, a reminder call was made to confirm receipt of the packet and answer any last minute questions prior to the assigned travel days. 7) Following the assigned travel day, a retrieval call was made to obtain the recorded information. 8) The retrieved data was edited and processed, then reported locations were geocoded to x/y coordinates. More detail about each stage is contained below.

1. **Advance Calls.** The purpose of the advance call was to confirm or obtain a name and mailing address for each sampled household. Advance calls were made using a CATI script to walk the interviewer through the interview. Data on household size and number of household vehicles were collected at this time to efficiently meet sample goals. For example, the 2-person, 2-vehicle household sample cell was the first to fill up. When this happened, the advance call helped to filter out these households so that other household types that were needed could be targeted.
2. **Advance Mailing.** The day following the advance call, any new addresses were sent to geocoding. For all households where a definite location could be determined, an advance notification packet was prepared. This packet included a personalized letter on customized PSRC/NuStats letterhead, as well as a brochure explaining the study. Letters were prepared and mailed by NuStats' Fulfillment Department from Austin, Texas.
3. **Recruitment Interview.** The purpose of the recruitment interview was to secure household participation in the study. The interview was also conducted using CATI. The questionnaire introduction was specifically designed to obtain agreement on participation. The other objectives of the recruitment questionnaire were to collect information on the characteristics of the household and the individual people in the household.
4. **Respondent Material Mailing.** The day following recruitment, the demographic information was used to prepare personalized diaries to send to each member of the household. A personalized cover letter was also prepared and included in the packet, along with an example of how to complete the diary. These materials are included in Appendix E of this report. Packets were also mailed by NuStats' Fulfillment Department from Austin, Texas.
5. **Reminder Call.** The night prior to the assigned travel day, a reminder call was made to each household to confirm receipt of the packet and answer any last minute questions. If the packet was not received by this time, the address was re-confirmed, new travel dates were assigned, and the diary packet re-sent.

6. Retrieval Interview. Using CATI, the interviewers collected all travel information recorded by respondents for the designated 48-hour travel diary period. The CATI program prompted interviewers to gather all pertinent information, as well as reference the same trips made by other household members. A look-up table of frequently visited locations aided with the retrieval process.

Several techniques were employed during the retrieval interview to help ensure that all trips were accounted for. These included a simple question of “did you make any stops along the way” as each new location was reported. Tracking whether any other household members also went on a given trip helped to ensure consistency within the household records, as well as provide a method for ensuring that each household member reported the shared trip. Proxy reporting and diary usage were also tracked for each respondent.

7. Data Editing and Processing. The data collected were subjected to a rigorous edit check program, which performed electronic edits of the data. These edits included both within-file checks (intrafile) for consistency, as well as cross-file checks (interfile) for logic and compatibility. For example, the edit check program confirmed that all responses were appropriate (e.g., if a household reported not having a car, all vehicle variables should be blank). Additionally, if the household reported having four vehicles, the program checked to confirm that there were four vehicle records in the vehicle file. A list of selected edits follows:

Across all Files:

- Range of values for each data item is valid, including values for non-response (logic: responses cannot be outside range).

Household File:

- Compare number of persons in household with number of person records in person file for that household.
- Compare number of vehicles in household with number of vehicle records in vehicle file for that household.

Person File:

- Check to see if the number of persons indicated in the household file matches the number of person records.
- Check to see if persons traveled on travel days. If not, reason must be provided.
- If person is not licensed, check to make sure there are no trips in which he/she was a driver.

Vehicle File:

- Check year of vehicle. Verify if year is 1960 or earlier.
- Check make and model. Flag if blank.

Trip File:

- Verify that each person has at least one place per day.
 - Verify that household and person records exist for each sample number in the trip file.
 - Check the travel times. Arrival at place (n) must be after departure from place (n-1). Arrival at place (n+1) must be after departure from place (n).
 - Place numbers must be sequential and inclusive.
 - Check to see if the person returned home at the end of each day. If not, flag as potential missing trip.
 - Verify that each place has address and trip data associated with it.
 - Ensure that activities are consistent with reported location.
8. Geocoding. All locations were geocoded using Arc View 3.1 against a 1998 street coverage file for the four-county region obtained from PSRC. Home addresses were geocoded soon after sample generation. Home addresses that did not geocode were investigated and corrected during the recruitment interview. Each of the 6,000 household addresses was geocoded (100 percent match rate).

Work and school addresses for all household members were collected during the recruitment interview. Those addresses that did not geocode were investigated and corrected during reminder and retrieval calls. Ninety-five percent of the work and school addresses traveled to are geocoded. All other addresses (non-home, non-work and non-school) were forwarded to PSRC for geocoding.

Quality Control

Quality control procedures to check the accuracy of the geocoding were performed by NuStats. The main procedure involved sorting geocoded locations by county, then displaying all geocoded points for a particular county using the county coverage file. Any points falling outside the county boundaries were verified and re-geocoded if necessary. The final data file contains a geocoding quality control variable that identifies the action taken on a particular record, the quality control check performed, and/or the outcome of the check.

Appendix E: 2006 Household Travel Survey Methods

The 2006 PSRC Household Activity and Travel Survey was undertaken to obtain information on regionwide household activities and the travel these activities generate. PSRC will use the data to update, develop, and calibrate statewide and urban travel demand models. The primary use of the models is to estimate future travel demand and travel patterns. Other uses include air quality conformity, alternatives analysis, and detour analysis.

In the design of the 2006 survey, basic demographics, activities, and tour and travel characteristics were collected for every member (including children) of 4,746 households during a consecutive 48-hour travel period. Vehicle GPS data were collected from a subsample of 220 of these households, with completed activity/travel diaries also collected for each household member. (Up to three vehicles per household were equipped with GPS units).

Finally, a follow-up attitude perception and stated preference (SP) survey was conducted with a subsample of 916 respondents whose revealed trips fit criteria of interest for possible public transit and highway toll alternatives. A customized preference/choice survey instrument was generated using actual origin-destination data taken from trips reported in the household activity survey.

Sample Design and Selection

The minimum sample size for the base household activity survey was set at 4,600 households. This was divided between a main sample and transit rider and transit access oversamples. A two-day activity/travel diary was collected for all members of sampled households. The sample size for the SP survey was set at a minimum of 800 individuals sampled from the 4,600 households who completed the household survey. See Sampling Technical Document Attachment A1.

Rationale for Using Multiple Sample Frames

Ideally, a household travel/activity survey would be conducted using a single, geographically stratified random digit dial (RDD) sampling frame. One problem with this approach is the number of transit riders sampled is usually too small for analysis. Transit riders would fall into the RDD sample according to their incidence in the overall population. For example, if transit ridership in the PSRC area is 5 percent or less, the number of transit riders coming from the household survey (n=4,600) would be 230 or fewer. Moreover, using a regionwide RDD frame to oversample transit riders, particularly if they represent less than 10 percent of the total area households, is not very efficient.

Another strategy for increasing the number of transit riders in a sample was needed. Therefore, the sampling design provided for oversampling of households within defined 4-plus zip codes where transit options (access) are currently available. Within this transit access oversample, small oversamples of households whose member(s) used ferry service or park-and-ride lots were included.

Sampling Targets and Results

The sample size for the main RDD household activity survey was set at 3,600 households; for transit access households, the sample target was 1,000. Regardless of survey activity, a two-day activity/travel diary was collected for all members of sampled households. By definition, a completed household was a household where two-day travel inventories and related information

were retrieved from every member. The sample for the SP survey was set at 800 individuals sampled from the 4,600 households who completed the household survey. Figure E-1 shows the recommended and completed sample sizes by survey activity.

Figure E-1. Recommended and Completed Sample Sizes by Survey Activity

Survey Activity	Sample Size	Completed No. of Households
Household Survey – Main Sample (Random Digit Dial)	3,600	3,937
Household Survey – Transit Rider & Transit Access Oversamples	1,000	809
Stated Preference Survey	800	916

While the completed transit rider and transit access oversample was somewhat less than the target, an additional 742 households of the completed RDD sample (18.8 percent) reported at least one trip by public train or bus during their 48-hour assigned travel period, and 196 RDD households (5 percent) reported at least one trip by ferry. Thus, overall the number of transit rider and transit access households completed will be sufficient for robust transit rider activity and travel analysis.

For the main RDD survey, the region was divided into five geographic sampling areas. Each sampling area was defined by counties, or within King County, by the City of Seattle and those areas within King but outside Seattle. For the most part, the types of travel patterns and behaviors generated by households within each of these areas were similar. The five sampling areas were the following:

1. King County outside Seattle
2. City of Seattle
3. Kitsap County
4. Pierce County
5. Snohomish County

To ensure both representation by household density across the region, and adequate statistical validity within less populated counties, the RDD sample required the completion of 48-hour activity/travel diaries in each sampling area from the number of households as in Figure E-2:

Figure E-2. Recommended and Completed RDD Sample Sizes by Geographic Area

Counties	Sample Size	Completed # of Households
King Without Seattle	900	1,054
City of Seattle	900	982
Kitsap County	400	589
Pierce County	750	624
Snohomish County	650	688
TOTAL	3,600	3,937

Again, while Pierce County response rates were somewhat low, the completed sample size was sufficient for robust statistical analysis. Regional RDD results were weighted by geographic area

household density, proportional to the 2004 American Community Survey⁷ Census data shown below.

Figure E-3. 2004 American Community Survey Data for Number of Households by Sampling Area

Counties	Number of Households	Percent of Households
King Without Seattle	469,354	34.8%
City of Seattle	266,569	19.8%
Kitsap County	89,978 ⁸	6.7%
Pierce County	281,307	20.9%
Snohomish County	240,563	17.8%
Total	1,347,771	100.0%

Variables of household size, number of vehicles available to a household, and the number of workers per household have been found to be highly correlated with travel behavior and travel patterns. Therefore, a final modeling concern for the RDD sample design was the degree to which, for completed sample size within the region, the number of autos available to a household matched household size, again as documented by the 2004 American Community Survey. Independently, the number of workers per household was also to be representative of Census data for the region.

The stratification of households by household size and autos available identified 16 potential cells for sample monitoring. (Autos by 0 autos, 1 auto, 2 autos, and 3+ autos; household size by 1-person, 2-persons, 3-persons, and 4+-persons; 4 x 4). Upon inspection, improbable cells were removed from the tables where the number of autos was greater than household size. A comparison of the sample design to the completed number of households, as stratified by number of autos and household size, is shown in Figure D-4.

Figure E-4. Recommended and Completed Number of RDD Households by Number of Autos and Household Size

	No Vehicles	1 Vehicle	2 Vehicles	3+ Vehicles	Totals
1-person HH	184/130	718/875	113/162	41/57	1,056/1,224
2-person HH		312/236	621/826	244/361	1,224/1,443
3-person HH	75/26	98/73	260/233	202/208	577/518
4+ person HH		66/47	352/398	316/305	743/752
Totals	259/156	1,193/1,231	1,346/1,619	802/931	3,600/3,937

Key: Recommended Sample Size/Completed # of Households

The completed sample size was very representative by household size and by number of vehicles, with the exception that the number of zero-vehicle households completed was only 60 percent of recommended RDD sample size. However, zero-vehicle completes totaled 220 when 64 zero-

⁷ Source: U.S. Census Bureau, 2004 American Community Survey

⁸ 2004 American Community Survey data not available for Kitsap County. PSRC 2004 estimate is cited.

vehicle households collected as a part of the oversample of transit rider and transit access sample were added.

Likewise, the completed RDD sample was representative regionwide by the number of workers per household as shown in Figure E-5.

Figure E-5. Recommended and Completed RDD Households by Number of Workers

	No Workers	1 Worker	2 Workers	3+ Workers	Totals
Region Sample Model	24.2%	43.6%	26.8%	5.5%	100.0%
RDD Completed Sample	25.9%	40.6%	29.2%	4.3%	100.0%

Response Rates

In terms of overall 2006 PSRC Household Activity/Travel Survey response rates, based on the American Association for Public Opinion Research’s (AAPOR) Response Rate 3 (RR3) calculation method, the overall recruitment response rate (including oversamples) was 36.7 percent. The participation rate (fully completed household retrievals/recruitments) overall was 54.1 percent.

Transit Access and Transit Rider Oversample

This frame consisted of directory-listed sample from targeted geographic areas. Areas were selected based on their geographic proximity to specific transit-supported corridors. Households were randomly sampled from this frame. PSRC staff identified the transit access geography according to the following procedure.

1. "Transit density," from PSRC’s modeling network, was mapped using percent workers by block group.
2. Zip+2 geographic coverage was purchased from a private vendor.
3. "Transit density" was then overlaid onto the Zip+2 maps and a subset of Zip+2 areas were selected. (See map of transit access areas on the following page.)

Various criteria were used to select the Zip+2 areas including different "density" levels and the amount of overlap between the "density" geography and the Zip+2 geography. A total of 1,724 Zip+2 areas were selected. The distribution of the targeted Zip+2 geography across the region is presented in Figure D-6.

Figure E-6. Distribution of Transit Access Targeted Zip+2 Areas

County	Total ZIP+2 Areas in a County	Zip+2 Areas In Targeted Transit Access Area	Percent of County	Percent of Total Targeted Zip+2 Areas
King	4,381	1,382	31.55%	80.2%
Kitsap	905	10	1.10%	0.6%
Pierce	2,882	183	6.35%	10.6%
Snohomish	2,218	149	6.72%	8.6%
Total	10,386	1,724		100.0%

Park-and-Ride Transit Rider Intercept Oversample

Park-and-ride transit users represent a unique subgroup from a sampling perspective. Their incidence is too low to expect enough for analysis purposes from the RDD or transit access frames.

Therefore, an intercept process at selected park-and-ride lots was used to supplement this frame. Interviewers were placed at these lots to solicit names, phone numbers, and addresses from commuters waiting to board transit buses. Those who agreed to participate were contacted at a later time by telephone when the standard recruitment interview was administered. While sampling design called for 150 households completed by this method, actual completes were only 92. However, for analysis this oversample of park-and-ride user households can be supplemented by 205 RDD or other transit access/ferry user households who had at least one member reporting use of a park-and-ride lot during his or her 48-hour travel period.

Frame 4: Ferry Rider Intercept Oversample

Like park-and-ride transit users, ferry riders also represent a unique subgroup from a sampling perspective.

Therefore, an intercept process at selected ferry debarking locations was used to supplement this frame. Interviewers were placed at these locations to solicit names, phone numbers, and addresses from commuters waiting to board ferries. Those who agreed to participate were contacted at a later time by telephone when the standard recruitment interview was administered. While sampling design called for 50 ferry user households to be completed by this method, actual completes were only 18. For analysis this small oversample of ferry user households can be supplemented by 185 RDD or other transit access/park-and-ride user households who had at least one member reporting use of a ferry during his or her 48-hour travel period.

GPS Tracking

GPS tracking was designed as a subcomponent of the Household Activity/Travel Survey. The objective was to compare data results from GPS tracking of a sample of household vehicle(s) trips with the diary trips reported by household members. The research assumption is that respondents frequently underreport trips, and that GPS tracking of a subsample of household vehicles can help identify the types of trips that are most frequently underreported in diaries, as well as profile the respondents most likely to underreport trips. GPS tracking was not deployed with the entire sample since the cost would be prohibitive. For the 2006 survey, 220 households completed both 48-hour diaries for each of their household members, and GPS tracking for up to three of their household vehicles. These households were recruited randomly from the RDD Household Activity/Travel Survey sample.

Attitude and Stated Preference Survey

The attitude and stated preference survey was conducted as a follow-up to the 2006 Household Activity/Travel Survey. A total of 1,400 respondents were selected based on their revealed trips, which met criteria for length of trip and location of origin and destination points, within defined geographic corridors of transit access and/or potential toll alternatives. Approximately one-third of the sample was provided with transit alternatives choice experiments, one-third received choice experiments related to toll usage, and the final third received choice exercises related to both.

Overall, completed interviews were obtained from 916 respondents for a response rate of 65.4 percent.

2006 Survey Methodology

There were nine program components to the 2006 Household Activity/Travel Survey: These were:

1. Sample design and monitoring
2. Designing materials and instruments
3. The pilot
4. Data collection and monitoring
5. GPS tracking for a subsample
6. Geocoding or all origin and destination points
7. Data checking and quality control
8. Design and conduct of the attitudinal and stated preference survey
9. Analysis and reporting

For quality control, interim datasets and reports were scheduled after the completion of 30 (the pilot), 1,500 and 4,600 households. The delivery schedule was adhered to throughout the data collection period with travel days starting the first of April 2006 and ending in mid-June 2006.

In addition to a detailed Work Plan, a Sampling Technical Plan Document, Quality Control Manual, and a Geocoding Procedures Manual were developed. These protocols defined criteria for determining whether a completed household would be accepted. All documents were approved prior to use in the main survey by PSRC.

Design and Implementation of Survey Materials and Instruments

The months of February and March 2006 were devoted to development of data collection materials and instruments, and to a pilot survey. There was a minimum of two iterations and reviews of each item before final drafts were approved.

Pre-Recruitment Letter

A pre-recruitment informational letter was developed and released to replicates (randomly selected portions) of the sample on a scheduled basis. This was done so that respondents did not receive the letter too far in advance of the recruitment phone call.

The households that received pre-recruitment letters were flagged in the data file. All undeliverable mailing was monitored and flagged in the data file. An attempt was made to correct the address through the United States Postal Service (USPS) website. A log was also kept of phone calls to the 1-800 number, to Internet help, and of any mail responses. Any non-routine responses were referred to PSRC. Undeliverable mailings were monitored, logged, and flagged in the data file.

Recruit Script

The telephone recruit script introduced the purpose of the study and secured the agreement of the household to participate. Demographics including the number of persons in the household, number, make, model, and year of vehicles, number of workers, and income were collected. Two

consecutive travel days were randomly assigned to a household by the CATI system, which kept travel day assignments even by eligible days over the interviewing period.

In addition, to enhance activity and land-use modeling capabilities, households were asked in the recruit for additional information about their current and previous residence (if they had moved within the last 10 years). Questions asked for both current and previous address were: rent or own, type and age of structure, length of residency, and street address, city, county, and state. The contact person for the household was also asked for the reasons they chose their current residence.

The CATI screens displayed counts of recruited and retrieved households by data cells within sample areas and by socioeconomic attributes, which were then compared with the Sampling Plan Technical Document on a daily basis. Initial recruitment-to-retrieval ratios were low for certain populations, such as 4+-person and zero-vehicles households. To compensate, PSRC and its partners implemented five responsive interviewing design strategies⁹ over the course of the data collection period. Each of these strategies used a series of different or successive recruitment and response techniques. These modifications included:

- Adjusting recruitment sample targets based on the varying actual retrieval rates for different data cells.
- Introducing portions of low-income targeted random digit dial (RDD) samples into the traditional RDD sampling frames.
- Introducing differential incentives (\$20-\$30--not paid for by PSRC) for zero-vehicle and 4+-person households, if all members of the household completed the activity/travel inventories.
- Introducing RDD-listed sample targeted by income and household size.
- Conducting refusal conversion interviews for all households recruited in rare population data cells that did not initially complete the travel inventories (retrievals).

Diary Cover Letter and Diary Format

To reduce respondent burden, particular attention was paid to the diary format to ensure that all modeling data requirements were met and that the flow and construction of questions and instructions were clear.

This design captured only two types of activities within the home: (1) home-not working and (2) home-working. Primary and secondary activities at each location were collected; however, the timing of these activities at any one location was collected as a block without differentiating among activities. Activities were collected via closed-ended categories. Thus, respondents were required to self-code their activities into pre-set categories using the list and examples in the diary. The diary questions were designed to flow in conjunction with the Computerized Assisted Telephone Interviewing (CATI) customized program, taking the respondents through their activities/locations and travel in chronological order.

Included with the diary was a person information sheet for each member of the household. This information was not included in the recruit since data requested for each member about work and school were extensive. The diary, cover letter, instructions, and person information sheet were thoroughly tested in the pilot, which was conducted in March 2006.

⁹ Steven Heeringa and Robert Groves, "Responsive Design for Household Surveys" in the 2004 Proceedings of the American Statistical Association, Survey Research Methods.

The activity-travel diary (retrieval interview) format consisted of eight parts:

1. Collecting any changes in or missing data, in regard to number of persons in the household, number and type of vehicles, and number of workers.
2. Collecting person attributes, including age, gender, relationship to contact person, driver's license status, education level, use of transit during the last 30 days, transit pass and rate information, disability status, use of Internet and frequency of watching DVDs (activities which substitute for travel).
3. Collecting person attributes in regard to school and/or work activities.
4. Information about work characteristics, including shifts worked, hours per week, flexibility, and availability of compressed work week.
5. Usual mode of getting to work and times of travel.
6. Information on previous job location (if changed job location within the past 10 years), including reasons for change in location or job.
7. Modes used for each trip, parking information for car, routes, transfers, and fare for public transit and taxi/shuttle modes, and information about which household member(s) traveled with respondent and (if traveling by car) what household vehicle was used.
8. A series of attitudinal questions asked of the first person interviewed within a household. These questions included:

- Transit options to work or school
- Importance of delays
- Road and bridge maintenance
- Importance of transportation system
- Levels of state and local funding
- Population expansion and land use
- Freight movement and the economy
- City or neighborhood composition
- Paying for tolls
- Truck traffic
- Importance of predictable travel
- Affordable transportation costs
- Comfort while traveling
- Privacy while traveling
- Importance of flexibility
- Importance of quickest travel time
- Effect of travel delays

The extent of questions asked for modeling and transit option alternatives resulted in a retrieval interview that averaged 17 minutes in length. Nevertheless, sampling completion targets were met.

Personal labels were applied to diaries with the name, ID #, and travel days for each respondent. A business reply envelope was included with the household packet. A full mailing log was maintained electronically in the database. In total, diary packets were sent to 8,816 recruited

households. Any undeliverable mailings were fully explored and the household was re-contacted by phone for corrected information. The data file was continually edited with these changes by an assigned assistant programmer.

Reminder Call Script

The evening before the first assigned household travel day, the recruited household was called to remind household respondents to start recording their locations and travel at 3:00 a.m. (and to install the GPS units in their vehicles before traveling). Any questions regarding the process or the diaries were answered. Re-mailings and rescheduling of travel dates were edited into the data file on a daily basis by the assistant programmer. Hard refusals at this point were recorded and reviewed by a supervisor for possible refusal conversion.

Retrieval CATI Script

The CATI retrieval script followed the flow of the diary. Respondents did not have to provide a previously reported address. Trips taken jointly were recorded and then confirmed in each relevant household member's activity/trip file. Household retrieval phone interviews were scheduled by the Computer Assisted Telephone Interviewing (CATI) system for the evening following the assigned travel days. Retrieval interviews continued to be scheduled for the following five days until the CATI recorded that all members had completed the travel inventory. Phone messages were left with persons or on answering machines. Respondents were asked for the most convenient time to call them back. Attempts were also made during the day and on weekends.

Respondents who were reluctant to complete the person information sheet and activity/travel inventories by phone were asked if they would do so by mail. If mail was indicated, the household was reminded that a postage-paid envelope was provided with the diary package for the return of all completed materials. Difficult-to-reach respondents were asked to call the toll-free number provided. The CATI system provided all of the real-time tallies specified for the recruit, by person and household as appropriate. The data file was edited daily with any corrected information that was received from respondents. Finally, callbacks were made for home or work address information when an address was found to be non-geocodable. All corrected information was entered into or edited into the CATI data file.

Preference Survey Instrument

The preference survey instrument was designed by PSRC in consultation with the project's modeling subconsultants, Cambridge Systematics and Mark Bradley. The survey instrument consisted of a series of rotated attitudinal questions and four choice exercises. One third of the sample was provided with transit option choices and one third was provided with toll choices. The final third received both choice set exercises.

Appendix F: Survey Weighting

The six samples from the 1985-1988 surveys have not been weighted. The samples in Kitsap, Snohomish and Pierce counties were randomly collected, and should approximate the counties as a whole. The three samples in King County conducted with Metro were collected with efforts at stratification by geographic location. However, the specification for stratification was for an in-depth market segmentation study conducted by phone, and not the diary portion, which can be treated the same as the samples for the other three counties.

Regional figures for analysis were weighted using estimated household totals for each county and city (i.e., Seattle), prepared by Washington State Office of Financial Management.

Post-stratification weights for both the 1999 and 2006 surveys were generated through iterative proportional fitting (IPF, also known as “raking”) to simultaneously approximate regional control totals in five demographic dimensions: household size, number of vehicles per household, number of workers per household, lifecycle (i.e., eight categories ranging from young children at home to older adult), and income range. Regional control totals were taken from the 2000 Decennial Census and the 2005 American Community Survey. The 2006 weights used an additional dimension to compensate for the transit oversample, which did not exist in the 1999 survey.

To utilize IPF, non-response (null) values must be imputed. This is of particular note for the income category, which respondents often refuse to provide. For the 2006 dataset, consultants used a “pseudo-random” income assignment method for absent values. The 1999 imputation also used an adjusted random method, utilizing household characteristics and block group income distributions.

MEMBERSHIP

Counties

King County
Kitsap County
Pierce County
Snohomish County

Cities and Tribes

Algona
Arlington
Auburn
Bainbridge Island
Beaux Arts Village
Bellevue
Black Diamond
Bonney Lake
Bothell
Bremerton
Buckley
Burien
Clyde Hill
Covington
DuPont
Duvall
Eatonsville
Edgewood
Edmonds
Enumclaw
Everett
Federal Way
Fife
Fircrest
Gig Harbor
Granite Falls
Hunts Point
Issaquah
Kenmore
Kent
Kirkland
Lake Forest Park
Lake Stevens
Lakewood
Lynnwood
Maple Valley
Marysville
Medina
Mercer Island
Mill Creek
Milton
Monroe
Mountlake Terrace
Muckleshoot Indian Tribal Council
Mukilteo

Newcastle
North Bend
Orting
Pacific
Port Orchard
Poulsbo
Puyallup
Redmond
Renton
Ruston
Sammamish
SeaTac
Seattle
Shoreline
Skykomish
Snohomish
Snoqualmie
Stanwood
Steilacoom
Sultan
Sumner
The Suquamish Tribe
Tacoma
Tukwila
University Place
Woodinville
Woodway
Yarrow Point

Statutory Members

Port of Bremerton
Port of Everett
Port of Seattle
Port of Tacoma
Washington State Department of Transportation
Washington Transportation Commission

Associate Members

Port of Edmonds
Daniel J. Evans School of Public Affairs
Island County
Puyallup Tribe of Indians
Snoqualmie Tribe
Thurston Regional Planning Council
The Tulalip Tribes

Transit Agencies

Community Transit
Everett Transportation Service
Kitsap Transit
Metropolitan King County
Pierce Transit
Sound Transit



Puget Sound Regional Council
PSRC

1011 Western Avenue, Suite 500
Seattle, Washington 98104-1035
206-464-7090 • psrc.org