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San Francisco City CarShare: Travel-Demand Trends and Second-Year Impacts

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**San Francisco City CarShare:
Travel-Demand Trends and Second-Year Impacts**

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San Francisco City CarShare: Travel-Demand Trends and Second-Year Impacts

Robert Cervero and Yu-Hsin Tsai

ABSTRACT

Two years into the introduction of carsharing in San Francisco, nearly 30 percent of members have gotten rid of one or more cars and two-thirds stated they opted not to purchase another car. By City CarShare's second anniversary, 6.5 percent of members' trips and 10 percent of their vehicle miles traveled were in carshare vehicles. Matched-pair comparisons with a statistical control group suggest that, over time, members have reduced their total vehicular travel. Because carshare vehicles tended to be small and fuel-efficient, per capita gasoline consumption and greenhouse gas emissions among members also appeared to go down. Suppressed travel likely reflected a combination of influences: reduced car ownership, more judicious and selective use of cars for particular trip purposes, and carpooling among trips made using car-share vehicles. Carsharing, however, has also enhanced mobility, allowing members to conveniently reach more destinations in and around San Francisco and to do so more quickly. Because it widens mobility choices and offers a resourceful form of automobility, carsharing is a welcome addition to the urban transportation sector in cities like San Francisco.

San Francisco City CarShare: Travel-Demand Trends and Second-Year Impacts

1. INTRODUCTION

Previous analyses of San Francisco City CarShare's impacts uncovered evidence of travel inducement.¹ Examining changes in travel several weeks before and three months as well as nine months after the introduction of carsharing, members appeared to be making more car trips than expected relative to a control group. This was not unanticipated given the make-up of early adopters. The majority of those first signing up for the program owned no cars; many were self-professed environmentalists and avid cyclists.

Might increases in vehicular travel among City CarShare's membership hold two-plus years into the program? This is less likely as the program matures and its membership becomes more mainstream, we believe. This report addresses the core question of travel inducement versus suppression two years into the program, and more broadly tracks trends and changes in travel behavior and car-ownership patterns of San Francisco's carshare program over the intermediate term. It is the third in a series of reports prepared to methodically evaluate the travel-demand impacts of carsharing in San Francisco over time. As in the study of first-year impacts, a matched pair comparison of travel patterns of members and a statistical control group of non-members is used in this second-year study. This report presents second-year findings with regard to: (1) trends and background description of travel, membership, and car ownership; (2) evaluation of travel-demand impacts; and (3) predictive models of mode choice, travel consumption, and car ownership. The interested reader is referred to earlier reports for background on the City CarShare program, discussions of survey instruments and approaches, and details on the research methodology.

2. CITY CARSHARE TRENDS AND USAGE

City CarShare was launched in the city of San Francisco in early March 2001. Figure 1 shows that the program gained steady popularity during its first year and a half — the monthly number of reservations had reached 2,350 by September 2002, up from several hundred during the program's first few months of existence. (In this paper, a "reservation" is counted as a formal lease, of unlimited duration, by a City CarShare member, marked by a member picking up and returning a car to a POD, or point-of-departure; the reader should keep in mind that multiple trips can be, and usually are, made as part of a reservation.) Appendix A provides further details on these trends (particularly Table A.1).

By the month of September 2002, over 1800 individuals had formally joined the program (representing around a quarter of one percent of San Francisco's population), and over 67,000 miles were logged on City CarShare vehicles during some 13,000 hours of usage

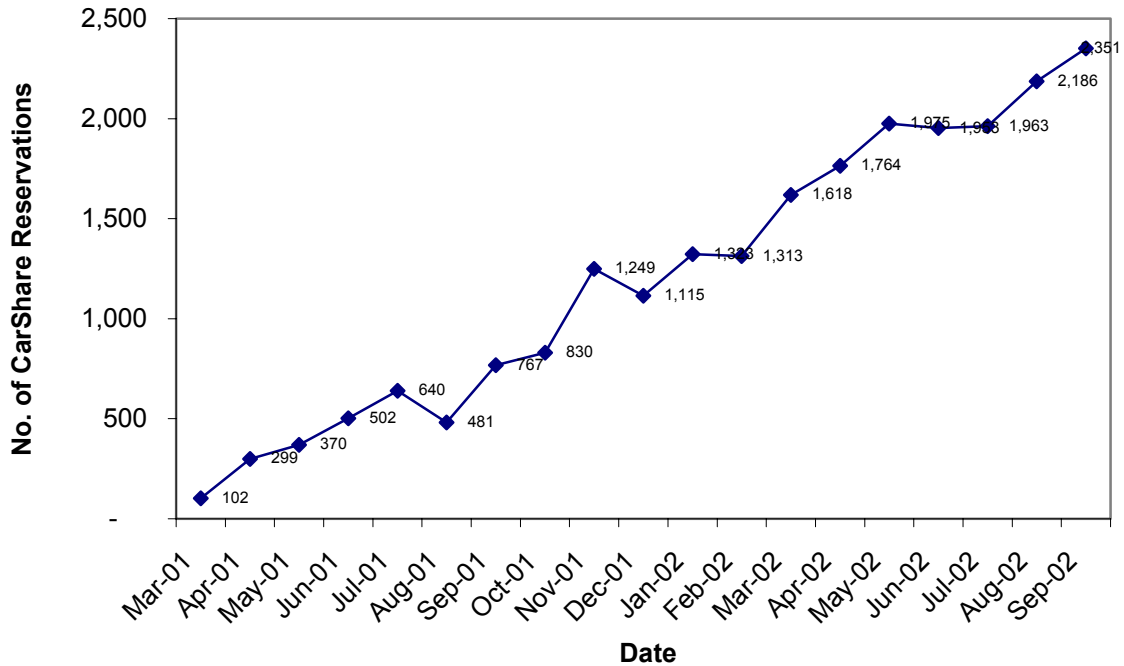


Figure 1. Trends in San Francisco City CarShare Reservations, March 2001 – September 2002

(see Figures A.1 through A.3 in Appendix A). A year and a half into the program, members averaged 28.6 miles per reservation (Figure A.4). The typical reservation was 5½ hours in length and cost \$32 (Figure A.5). Overall, vehicle productivity has risen, with the typical car leased out for some 7 hours per day by the fall of 2002 (Figures A.6 and A.7). The cancellation rate (of reservations) fell from 45 percent a half-year into the program to 35 percent at the year and a half mark (Figure A.8). Linking City CarShare reservation logs to surveyed background data revealed that males and Asian-Americans were, compared to overall membership profiles, the most frequent users of City CarShare vehicles (Tables A.2. and A.3).² There was no age pattern to relative usage (Table A.4).

During the first year and a half of the program, the typical City CarShare member could best be described as an occasional user. Figure 2 shows that slightly over a third of members reserved and used a vehicle just once a month.³ The second most frequent level of usage was once a week, associated with a little over a quarter of members. More than 15 percent of members leased a vehicle just once every three months or less.

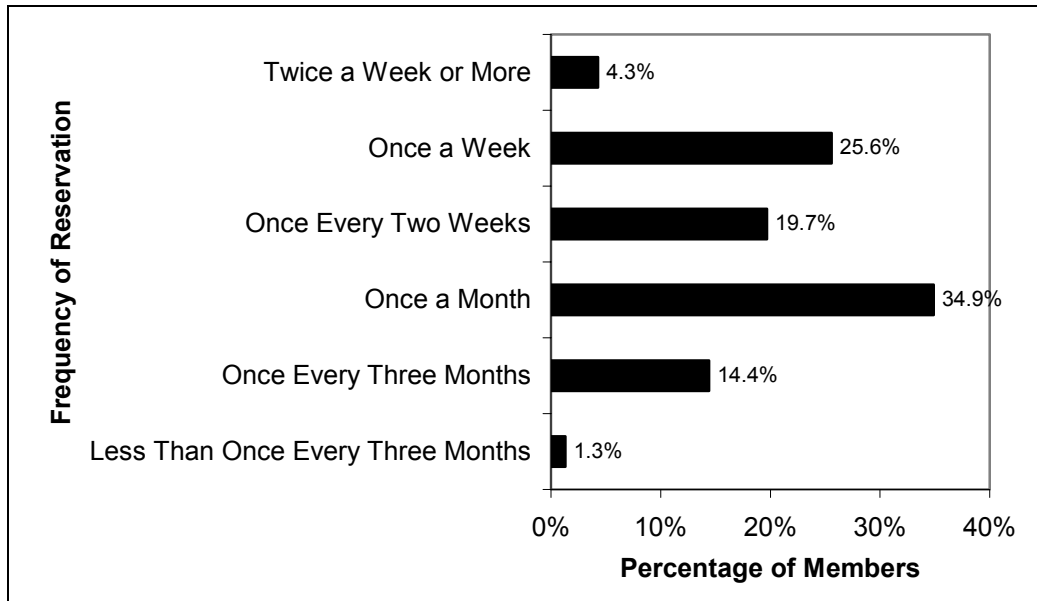


Figure 2. Frequency of City CarShare Reservations Among Members, March 2001 – September 2002

On an annual basis, the typical member leased a CarShare vehicle for a total of 222 hours, logging just over 1000 miles.⁴ This translated into an average annual cost for City CarShare leasing of \$1285 per member. The majority — 56.3 percent — of members spent less than \$1000 per year during the first year and a half of the program (see Figure A.9). Around 30 percent of members spent between \$1000 and \$2000 per year to share cars and less than 2 percent spent \$5000 or more.

The first year evaluation of City CarShare found that, while there was evidence of travel inducement, most trips were made outside of peak hours, suggesting the program was having a fairly modest impact on rush-hour traffic conditions. Figure 3 suggests this pattern has largely continued, with vehicles typically being taken out during midday and returned sometime between 6 p.m. and midnight.⁵ Any correspondence of carshare usage with rush hour generally occurs during the afternoon–evening peak. Saturday is City CarShare’s most popular day, accounting for 16.7 percent of reservations, followed by Friday (15 percent) (Figure A.10).

Lastly, the cross-linking of log files with survey background information revealed City CarShare members who owned a bicycle tended to lease carshare vehicles more than those who did not (Table A.5). This could reflect members selectively using City CarShare vehicles for particular trips and alternative modes, including their bicycles, for others. Having street parking available in one’s neighborhood also seemed to spur members to lease carshare vehicles more often (Table A.6). On the one hand, while tight parking might be expected to encourage residents to lease cars on an as-needed basis (versus

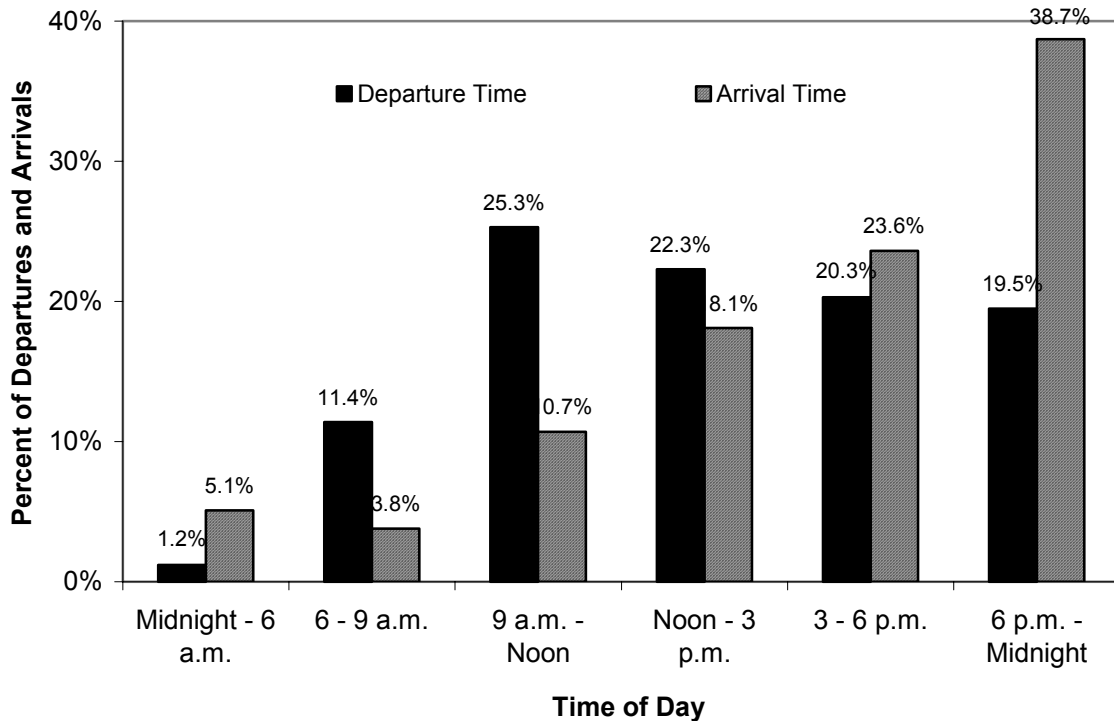


Figure 3. Distribution of Departures and Arrivals of City CarShare Vehicles, March 2001 – September 2002

owning cars), on the other hand the ability to bring a City CarShare vehicle home and park it on the street could have induced car-leasing.

3. CITY CARSHARE TRAVEL CHARACTERISTICS

To augment City CarShare’s reservation logs, a survey was conducted of usage among all 48 vehicles that were located at the 17 POD parking lots in San Francisco between September 17 and October 24, 2002. All members leasing vehicles over this period were asked to fill out a self-administered survey about their car-share usage. Members completed the one-page clipboard survey upon returning cars to PODs. (See Appendix B, Exhibits B.1 and B.2, for copies of the survey and accompanying cover letter.) In all, 351 responses were received; Table B.1 in Appendix B shows the distribution of completed survey by POD and vehicle in each POD.⁶ Survey respondents tended to be City CarShare’s most frequent customers — around half used City CarShare vehicles for half or more of times they were making the particular trip for which they were reporting. This section discusses these in-vehicle survey findings.

3.1 Trip Purposes and Destinations

For around three out of ten reservations, the main purpose for leasing a City CarShare vehicle was to shop (Figure 4), followed by personal business and recreational travel. Journeys to work constituted only around one out of ten carshare leases. Reservations for which “other” was the dominant purpose tended to be the longest: on average, 43.7 miles and 6.1 hours were logged during the lease (Figure 5). Work and school trips via carshare vehicles tended to be longer in length and duration than more discretionary trip purposes like social, recreational, and eating. Additionally, in-vehicle surveys revealed that 68.9 percent of reservations were to a single destination. Spatially, surveyed carshare trips were fairly scattered throughout the city; fewer than one out of ten were to downtown San Francisco where public transit and walking are often superior options to any form of car travel (Map 1). (See Maps B.1 through B.4 in Appendix B for desire line maps of surveyed City CarShare trips for specific purposes.)

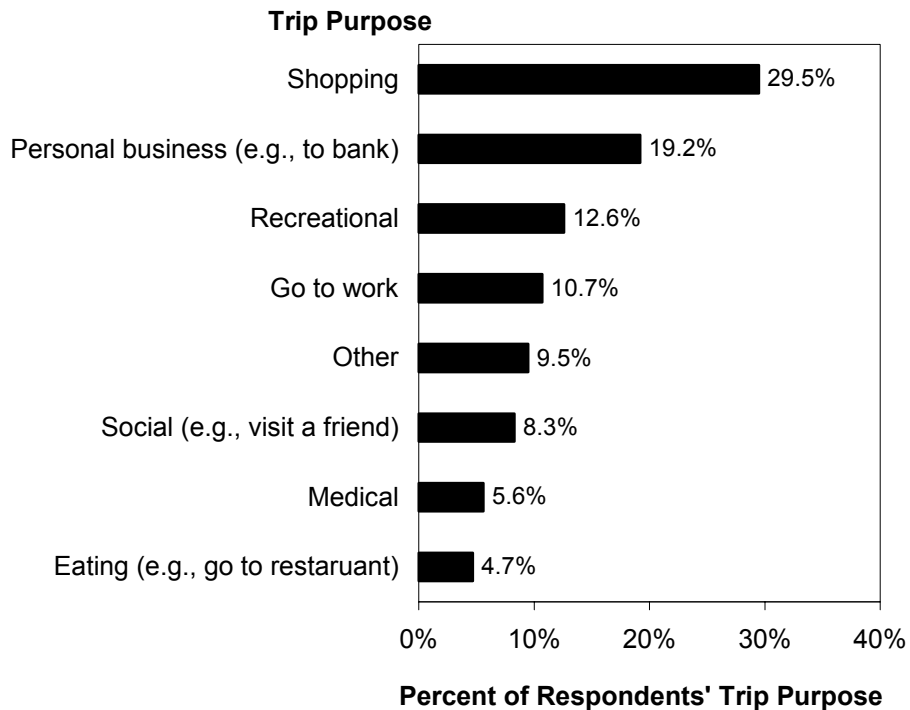


Figure 4. Distribution of Trip Purposes Using City CarShare Vehicles, September–October 2002; In-Vehicle Survey

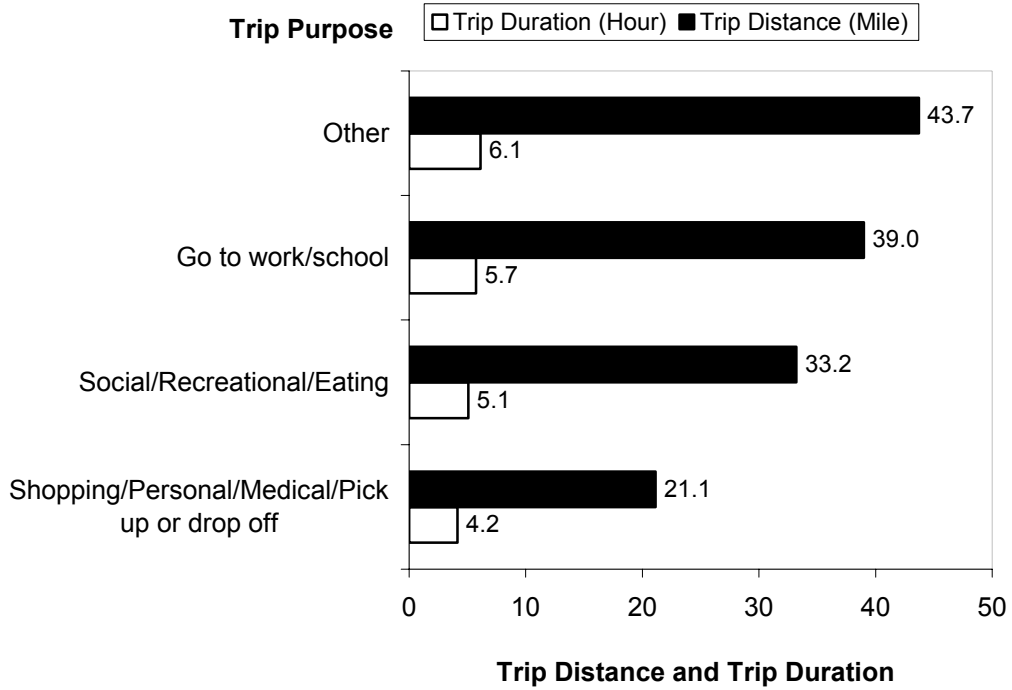
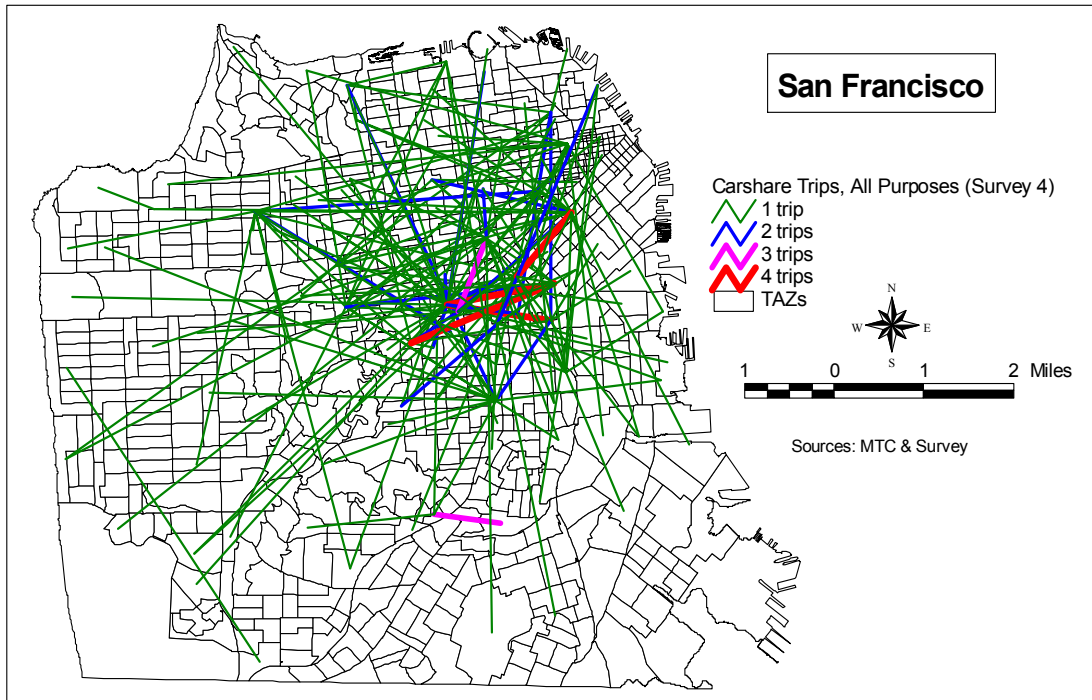


Figure 5. Average Trip Distances and Durations, by Trip Purpose, September–October 2002; In-Vehicle Survey



Map 1. Origin–Destination Patterns of All Surveyed CarShare Trips Within the City of San Francisco, September–October 2002; In-Vehicle Survey

3.2 Customer Loyalty

Around one out of five respondents of the in-vehicle survey said they always use City CarShare for the particular trip being made. Around three-quarters of respondents used carshare vehicles half of the time or more for the surveyed trip.⁷ Clearly, among those who use the service frequently, carsharing has become a vital form of mobility in their day-to-day lives.

3.3 Trip Occupancies and Modes

Among the CarShare trips surveyed, the average vehicle occupancy was 1.59 persons (including the driver).⁸ Fewer than 10 percent of City CarShare trips had children as passengers.

City CarShare users were asked what modes they previously took for the particular trip(s) they were making, prior to joining the program. Nearly half — 49.6 percent — took public transit or else walked or biked. Also, 15.6 percent said they previously carpooled/vanpooled and 3.7 percent did not make the trip before joining the program. These findings suggest that 68.9 percent of City CarShare trips added new motorized vehicles to the streets of San Francisco. The remaining shares were motorized-vehicle substitutions: 17.9 percent of trips were previously made by driving and 13.2 percent were via taxi, rental car, or borrowing someone else's vehicle.

City CarShare users were also asked how they reached PODs: 68 percent walked, 18 percent took public transit, and 9 percent biked.

3.4 Comparative Costs

Using in-vehicle survey data, it was possible to compare costs between using City CarShare vehicles and taking two other for-hire carriers: taxi or rental car. Based on compiled data on the total duration (in and out of vehicles) and miles of carshare leases, we compared what the costs would be if a taxicab or rental car were used instead. (Taxicab costs were based on San Francisco's rates for flagdrops, mileage, and idling time; car-rental estimates were based on the lowest rate in San Francisco quoted by Expedia.com, assuming unlimited mileage, a compact vehicle comparable to City CarShare's Volkswagen Beetle, insurance coverage, and outlays for regular unleaded gasoline and sales tax.)⁹ Scenarios for lease durations of one, four, seven, and ten hours were examined. (For City CarShare and rental car leases, trip durations equal the sum of in-vehicle travel time plus time spent at destinations, based on averages from in-vehicle surveys; for taxi trips, durations are only for times in vehicles but not times at destinations.)

Figure 6 summarizes the simulation results. For one-hour leases, City CarShare (at a \$3.50 per hour lease fee plus \$0.37 per mile) is consistently cheaper than taxi or rental car over all distance ranges. Given the amount of time averaged at destinations, taxis are generally cheaper for round trips of 5 miles or less that occur over a four-hour period;

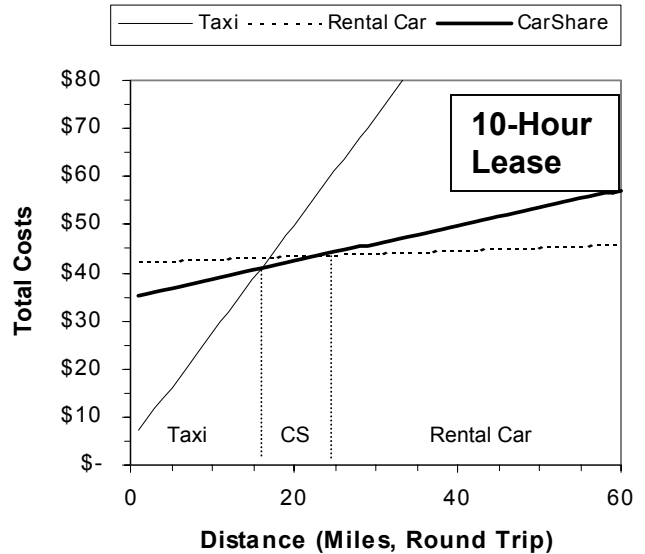
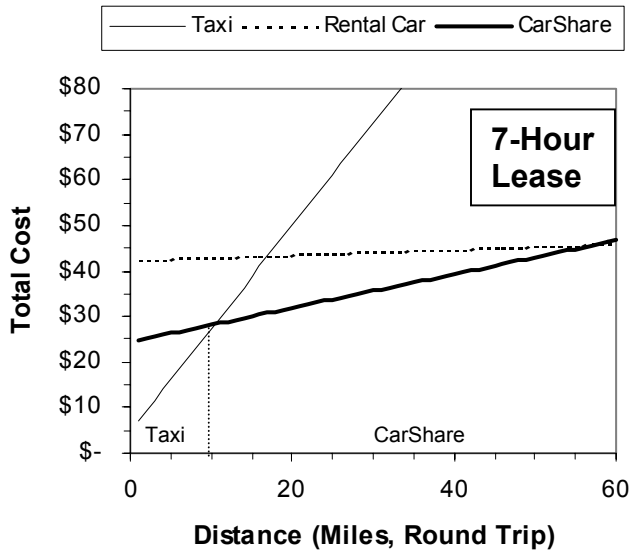
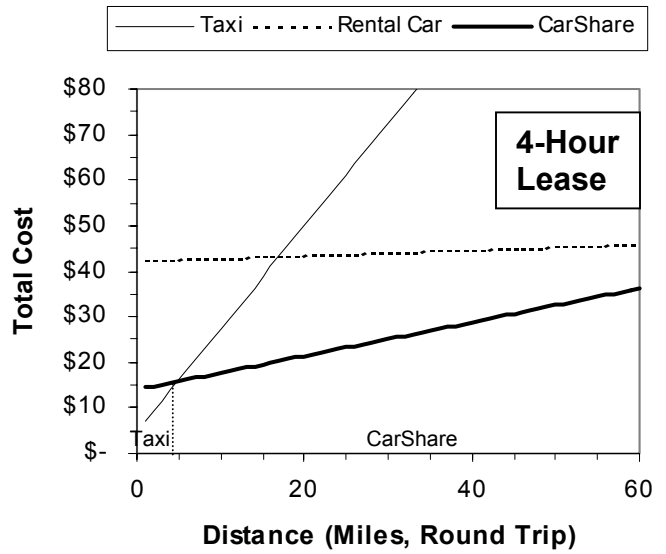
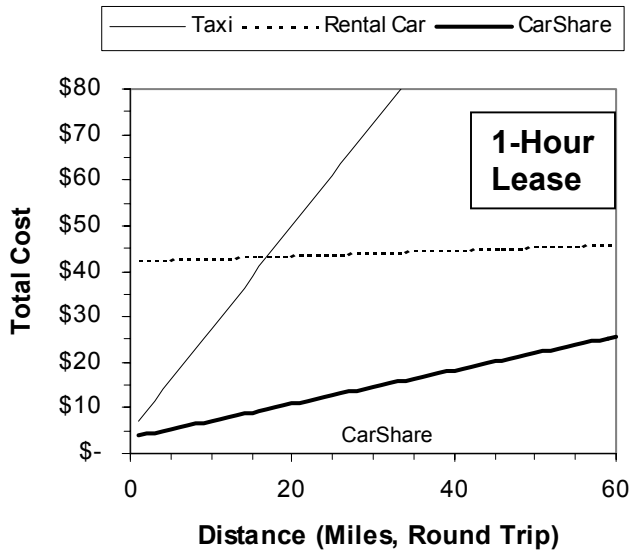


Figure 6. Comparative Costs of City CarShare Leases Versus Costs for Other For-Hire Carriers: Scenarios for Leases of 1-, 4-, 7-, and 10-Hour Durations Over Distance Ranges

when more miles are logged over this period, City CarShare costs less than taxis. For a lease of 10 hours, taxis are generally cheapest when round trips are 16 miles or less, followed by carshare (for the 16 to 24 mile range) and rental car (for the 24-plus mile range). In general, carsharing is the cheaper alternative for intermediate-distance trips and intermediate time lengths; it loses its advantage to rental car, however, as the duration of a lease lengthens.

Of the City CarShare leases that were surveyed, carsharing was cheaper than taking taxi or rental car in 84 percent of cases. For leases that would have been cheaper via taxi or rental car, 88 percent of surveyed car-sharers said that, regardless, they use City CarShare vehicles half or more of the time for the dominant purpose of their trip. Clearly, City CarShare has gained a loyal following despite such cost differentials.

4. CARSHARE MEMBERS: MARKET SHARES, BACKGROUNDS, AND CAR OWNERSHIP TRENDS

The remainder of this report draws upon the results of the fourth of a series of surveys conducted of City CarShare members and a statistical control group. Besides compiling personal, household, and car-ownership background information, the four surveys also solicited detailed travel-diary information for all trips (not just by carshare trips as was the case with the in-vehicle survey). Complete travel-diary information enabled the travel-behavior impacts of the City CarShare program to be gauged.

The first set of background and travel-diary surveys were conducted several weeks before City CarShare's March 2001 inaugural. Those who signed up to immediately join the program ("members") and those hoping to one-day become members (hereafter called "non-members" and functioning as a control group) were surveyed. (These non-members were ideal controls because they displayed comparable levels of motivation, having taken the time to sign up for the program, but had not formally joined due to factors like there not being a POD in their neighborhood.) Similar surveys were then conducted of both members and non-members three and nine months into the program. The fourth set of surveys, carried out in early-to-mid March 2003, provided insights into travel-demand and car ownership impacts two years into the program. Table 1 summarizes the scheduling and scope of background and travel-diary surveys conducted over the four time points. In all, 462 members and 54 non-members responded to the fourth survey (with response rates being 25.5% and 34.0%, respectively).¹⁰ (See the previous reports for sample information for the first three surveys as well as general discussions about the survey methodology.) Survey mail-backs and financial incentives were used to increase response rates.¹¹ Individual trip records obtained from the fourth survey totaled 2,031 (for members) and 242 (for non-members). Exhibits in Appendix C contain copies of the fourth travel-diary and background surveys as well as the accompanying cover letter that explains the purpose of the surveys. The approach used for randomly assigning members and non-members to survey days is shown in Table C.1 of the appendix.

Table 1. Chronology and Scope of Four Surveys Conducted to Date of San Francisco City CarShare Members and Non-Members

Event	Dates	Scope
Survey # 1	Feb., 2001 (Before opening of CarShare)	Travel Diary + Background Survey
<i>Opening of San Francisco City CarShare</i>	<i>Early March 2001</i>	
Survey # 2	June, 2001 (3 months)	Travel Diary + Background Survey (New members only)
Survey # 3	Oct. – Nov., 2001 (7 months)	Travel Diary+ Background Survey (New members only)
Survey # 4	Mar. – April, 2003 (2 years)	Travel Diary + Background Survey (For update purpose)

Older San Franciscans were found to represent a disproportionately large share of respondents in the control group. This was likely due to the fact many found the financial incentive (as high as \$20) to be attractive. To adjust for this over-sampling, weights were created for non-members based on the ratio of percentages of member versus non-member respondents across five age groups. Responses from non-members under 40 were up-weighted (by 1.70 to 1.72) while those from older groups were down-weighted (from 0.99 for the 40–49 age group, to 0.72 for the 50–59 group, and 0.15 for the 60-plus group).

4.1 Trip Purpose: All Trips

Figure 7 shows the distribution of all members’ and non-members’ trips as recorded in the travel-diary surveys of March–April 2003. For both groups, most trip purposes are non-discretionary, such as going to work, returning home, or taking care of personal business. These distributions of trip purposes are similar to those of earlier travel-diary surveys.

4.2 Market Shares

By the end of the second year, carsharing made up 6.5 percent of members’ total trips (Table 2). This is up from 2.2 percent three months into the program but down from 8.1 percent at the nine-month mark (suggesting the novelty effect of carsharing might have worn off over time). Adjusting for trip length, carsharing made up 10.1 percent of total vehicle miles traveled (VMT) by members at the end of year-two — again up from the 3-month mark but down from what was recorded nine months into the program. Still, the most popular form of conveyance by members — representing 45 percent of all trips in March–April 2003 — was “non-motorized transport” (i.e., walking or cycling).

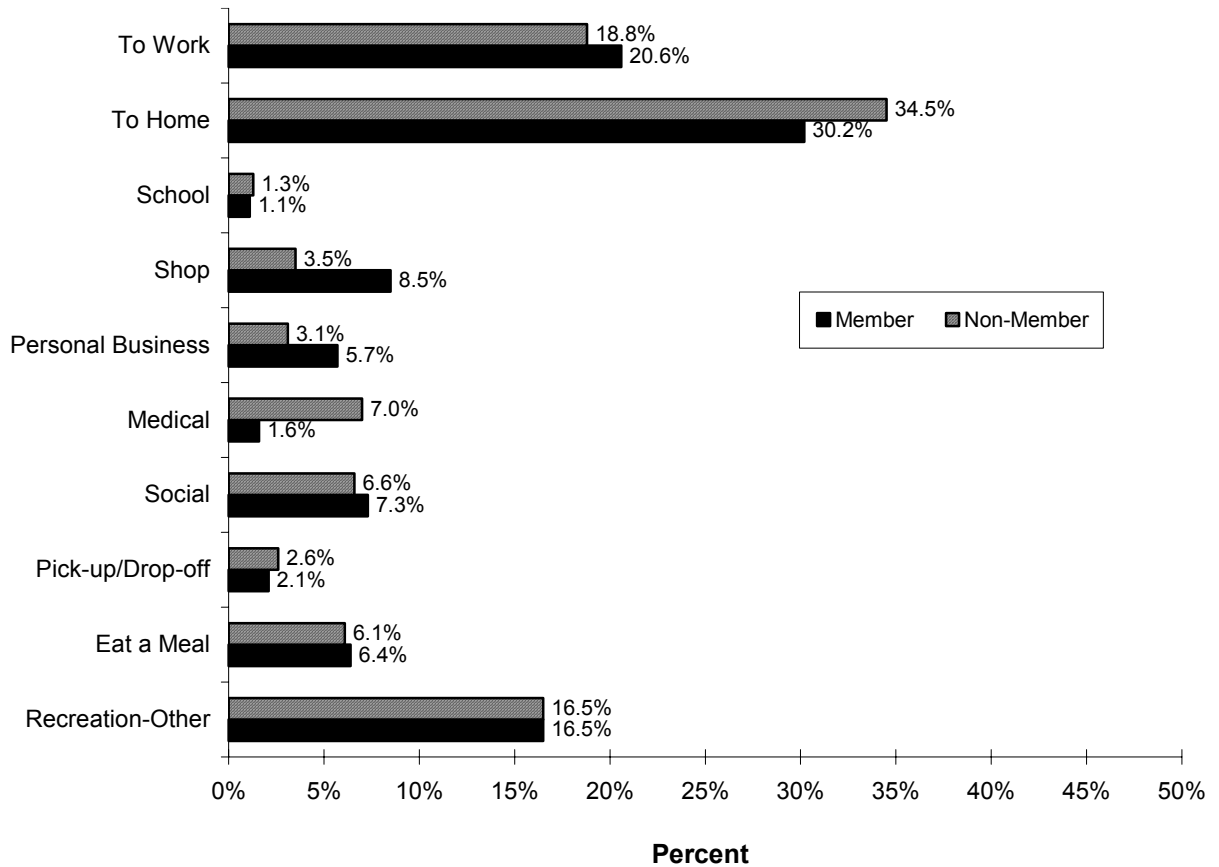


Figure 7. Trip Purposes of Trips by Members and Non-Members, Survey #4

Table 2. Modal Comparison: Percent Distribution of Mode, All Trip Purposes, City CarShare Members and Non-Members, Survey #4

	Members	Non-Members
City CarShare	6.5%	0.0%
Private Car	15.6%	24.5%
Bus Transit	16.1%	15.2%
Rail Transit	16.1%	15.2%
Walk-Bike	45.0%	45.6%
Other	2.4%	1.3%
Total	100.0%	100.0%

Among the sample trips from Survey #4, most rail-transit trips by members (56.6 percent) were via Muni (San Francisco Municipal Railway’s light-rail transit, tramways, and cable cars), followed by the heavy-rail Bay Area Rapid Transit (BART – 38.8 percent) and commuter-rail (CalTrain – 4.6 percent).¹² Among all trips (including walking and biking), Muni constituted 7.9 percent of journeys made by members, and BART constituted 5.4 percent.

Figure 8 presents summary statistics on “supply-side” factors that might have swayed mode-choice decisions among members and non-members. As found in earlier surveys, most members face parking constraints: most do not have off-street parking spaces and most have to pay to park at their workplace. As found in previous background surveys, most members have a Muni Fast Pass that allows unlimited monthly rides on the San Francisco Municipal Railway system. Most also own a bicycle. Many members clearly have options to private car travel, particularly for trips within the city of San Francisco. Predictive models presented later in this report account for the role of these factors in explaining mode choice and carshare usage.

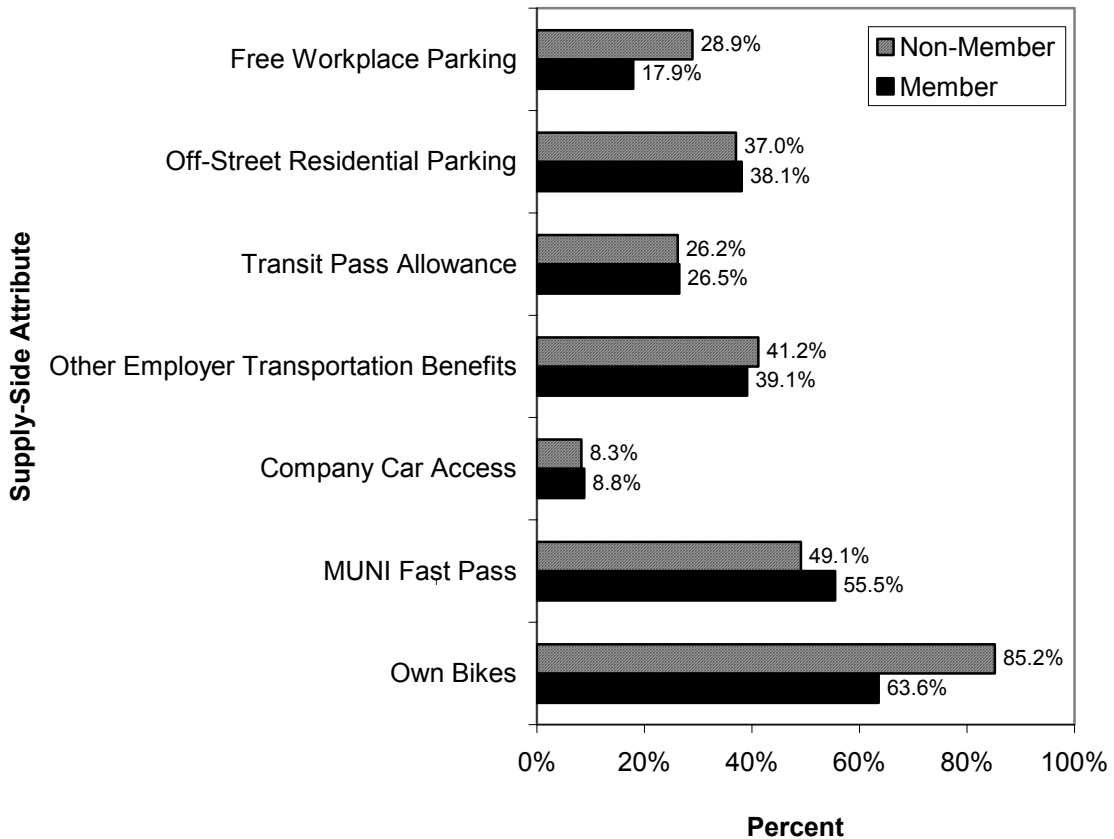


Figure 8. Shares of Members and Non-Members with Various Supply-Side Attributes Associated with Mode Choice, Survey #4

4.3 Modal Splits by Trip Purpose

Table 3 reveals the modes that were relied upon most heavily for specific trip purposes, for members and non-members. Members generally took green modes to work: 86 percent of their journeys to work were by public transit, foot, or bicycle. For social trips, private cars were relied upon to a much greater extent by both members and non-members. Compared to experiences at the 9-month mark, City CarShare vehicles were relied upon just slightly more, in relative terms, for work trips at the two-year anniversary, and comparatively less for social and personal business trips.

4.4 Rail Access and Egress

Surveys also probed how transit users reached and left rail stations. As might be expected, carshare vehicles were not used to access rail stops for any of the recorded trips. Besides the fact San Francisco has relatively few park-and-ride spots, it is highly unlikely anyone would want to incur the hourly fee to just park a City CarShare vehicle at a rail station. As found in previous surveys, a large majority of members (and a smaller share but still majority of non-members) opted to walk-and-ride. Rail access and egress model distributions in Survey #4 were similar to those recorded in the three previous surveys.

Table 3. Percent Distribution of Mode by Trip Purposes, City CarShare Members and Non-Members, Survey #4

	Member				Non-Member			
	Trip Purpose				Trip Purpose			
	Work	Return Home	Social	Personal Business	Work	Return Home	Social	Personal Business
Car Share	1.9%	4.3%	4.6%	14.2%	0.0%	0.0%	0.0%	0.0%
Private Car	8.2%	15.8%	25.4%	12.5%	13.0%	27.3%	28.1%	28.0%
Bus Transit	22.3%	18.7%	11.1%	12.5%	13.9%	13.5%	8.1%	8.1%
Rail Transit	23.6%	16.9%	15.1%	8.6%	22.9%	13.0%	15.6%	4.7%
Walk-Bike	40.1%	39.6%	38.5%	51.0%	43.9%	40.9%	40.0%	58.3%
Other	3.8%	4.5%	5.4%	1.2%	6.3%	5.3%	8.1%	0.9%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 4. Percent Distribution of Modes of Access and Egress for Rail Transit Trips, Members and Non-Members, Survey #4

	Members		Non-Members ¹	
	Access	Egress	Access	Egress
Walk	84.3%	89.2%	66.6%	67.1%
Bicycle	4.1%	5.1%	18.5%	0.0%
Bus	8.8%	5.1%	9.7%	24.7%
Other	2.8%	0.6%	5.2%	8.1%
Total	100.0%	100.0%	100.0%	100.0%

¹ Non-member data represent responses mainly from the background survey administered in March–April, 2003.

4.5 Travel Consumption

A higher share of members — 97.2 percent — responding to the survey lived in the city of San Francisco than in previous surveys. The same held for non-member respondents. Also, 87.2 and 76.1 percent of members and non-members, respectively, worked in the city of San Francisco, similar to earlier surveys. This suggests a slight trend toward City CarShare appealing to non-San Francisco residents who work in the city. In all, 86.1 percent of San Francisco residents who were City CarShare members also worked in the city, a lower share than in Survey #3. This was higher, however, than the 72 percent of employed-residents working in the city found in a survey conducted by RIDES for Bay Area Commuters in 2002.¹³

The high share of survey respondents living and working within San Francisco, coupled with the city’s relative small geographical size (49 square miles), translated into fairly short average trips, as shown in Table 5. The table presents travel statistics for all of the trips surveyed in the travel survey, broken down by member and non-member. The typical member journey of around 3 miles was less than what was recorded at the 3-month (4.5 miles) and 9-month (3.5 miles) marks of the City CarShare program. So was the mean trip time of around 21 minutes. Mean journey-to-work times among members surveyed in March–April 2003 was 29.7 minutes, close to the average for San Francisco commuters of 30.7 minutes from the 2000 census.¹⁴

Because members walked and biked a lot, the average VMT per trip was just over one mile, lower than in previous surveys. The mode-adjusted VMT, which accounts for occupancy levels of private car trips and nets out transit trips (since no new buses or rail vehicles are added to accommodate these trips), was just a half-mile, also lower than in the past. Multiplying MVMT by the engine size of private-vehicle trips yielded the “mode & engine-size adjusted VMT,” or MEVMT, metric. Because many members own small cars and used carshare vehicles which were mostly compacts (i.e., Volkswagen Beetles), their mean MEVMT was 78 percent less than that of non-members. The differential was particularly large in the case of weekday/workday travel.

**Table 5. Comparison of Travel Statistics for Individual Trips
Among Members and Non-Members, Survey #4**

	Member		Non-Member	
	Mean	Std. Dev.	Mean	Std. Dev.
Trip Distance	3.1	6.0	3.6	7.0
Trip Time	20.8	23.0	20.7	22.2
Vehicle Miles Traveled (VMT)	1.1	4.8	1.7	6.4
Mode-Adjusted VMT (MVMT)	0.5	3.0	1.2	4.7
Mode & Engine-Size Adjusted VMT (MEVMT), All trips	761.3	4,633.9	3,341.2	19,017.3

Weekday-Workday	484.3	3,028.3	5,460.0	27,124.4
Weekday-Non Workday	987.2	5,590.5	2,204.2	5,849.0
Weekend-Workday	3,526.6	11,933.5	N/A*	N/A*
Weekend-Non Workday	479.5	3,549.7	462.1	1,629.7
Gasoline Consumption, All trips	0.014	0.092	0.056	0.273

Weekday-Workday	0.009	0.051	0.086	0.384
Weekday-Non Workday	0.020	0.121	0.047	0.125
Weekend-Workday	0.077	0.250	N/A*	N/A*
Weekend-Non Workday	0.008	0.062	0.006	0.019
CO₂ (Greenhouse Gas Emissions), All trips	0.41	2.56	1.54	7.43

Weekday-Workday	0.24	1.43	2.37	10.40
Weekday-Non Workday	0.54	3.34	1.30	3.50
Weekend-Workday	2.17	7.06	N/A*	N/A*
Weekend-Non Workday	0.23	1.75	0.16	0.52

Key: * Sample size too small for meaningful statistical summary.

Travel Distance = total daily highway-network travel distance, in miles;

Travel Time = total daily highway-network travel duration, in minutes;

VMT = vehicle miles traveled over highway network [representing total miles logged in motorized vehicles; all non-vehicle (i.e., walk and bicycle) trips were assigned zero values];

MVMT = mode-adjusted VMT (representing total miles logged in motorized vehicles adjusted for occupancy levels and accounting for whether new vehicle trips are added; values for walking, bicycle, and transit are zero since none of these trips add vehicles to city streets);

MEVMT = Mode and engine-size adjusted VMT {representing an overall index of travel consumption, accounting for occupancy level and engine size of vehicle; equals [(total highway VMT)*(engine displacement in cubic centimeters)]/(vehicle occupancy) wherein engine size was estimated given the make, year, and model of vehicle used for a trip};

Gasoline Consumption = estimated gallons of gasoline consumption per day adjusted for occupancy level and fuel economy of vehicles used for each trip; equals [MVMT/miles per gallon (mpg)] wherein mpg was estimated for city highway conditions given the make, year, and model of vehicle used for a trip;¹⁵

CO₂ (Greenhouse Gas Emissions) = estimated pounds of carbon dioxide per day produced by vehicles used for travel, adjusted for occupancy level and city-highway mileage of vehicle used for each trip; equals [MVMT/(CO₂ emissions per mile based on the make, year, and model of vehicle used for a trip)].¹⁵

Table 5 also presents estimated mean levels of gasoline consumption and carbon dioxide emissions, calculated using information on fuel economy and emission levels given the make, year, and model of vehicles used for trips. Similar to the relationship found for MEVMT, energy consumption and tailpipe emission levels of typical trips by carshare members were considerably below those of non-members. The ecological footprint of travel by carshare members on Mondays through Fridays that corresponded with workdays tended to be particularly small.

Across all variables in Table 5, standard deviation statistics were fairly high compared to mean values. This suggests relatively high variation “within groups” — i.e., amongst members themselves. High “within group” variation usually translates into statistically insignificant relationships. This means very large mean differences between members and non-members will have to exist for relationships to be statistically significant.

4.6 Socio-Demographic Characteristics

Background survey data provided an update on the socio-demographic profiles of members two years into the City CarShare program. City CarShare’s first wave of members were found to be fairly unrepresentative of the Bay Area’s and even San Francisco’s population, drawn disproportionately from professional-class residents who do not own cars and who live either alone or in non-traditional households. By the end of the second year, City CarShare’s membership, while still unique in its composition, was slightly more representative of the city’s population as a whole.

In March 2003, the median age of City CarShare members was 36 years, the same as for the city of San Francisco in 2000 (from the census). Still, City CarShare tended to draw a fairly young clientele — 43.2 percent of members were between the ages of 25 and 34, compared to just 27.8 percent of the city’s population (among those 20 years and older) (Figure 9). Also, 57.1 percent of surveyed members were women (compared to 49.2 percent of San Francisco residents in 2000). Whites made up 81.2 percent of surveyed members (considerably above the 49.6 percent share for the city as a whole in 2000). The share of surveyed members who are white, however, is lower than in the first year, suggesting City CarShare is taking on a more diversified membership over time. The 9.3 percent and 1.8 percent of surveyed members who are Asian-Americans and African-Americans, respectively, are well below the city’s 2000 census shares.¹⁶ Members’ median annual personal income was \$57,000 and over 90 percent worked in professional fields, both figures being above the city’s average.

In terms of household types, City CarShare attracted a comparatively large share of individuals who lived with one or more unrelated adults — 36.3 percent of members surveyed in March 2003 versus 17.4 percent of San Francisco households in 2000. Around 42 percent of members lived alone, slightly above the citywide average. Those

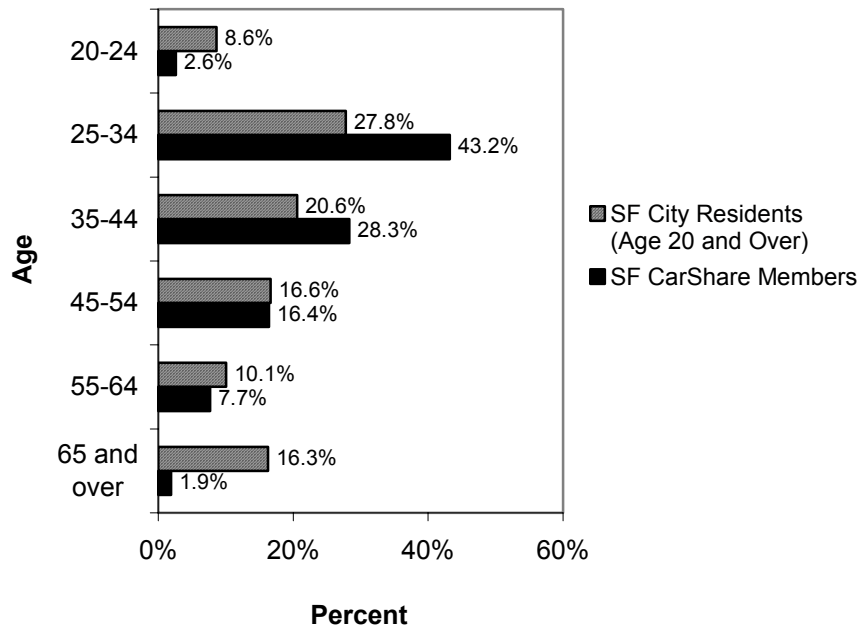


Figure 9. Comparison of Age Distributions Among Members of San Francisco CarShare (March–April 2003) and Residents (20 Years and Older) of San Francisco City (2000)

who identified themselves as Hispanic comprised 4.6 percent of the year-two surveyed members, compared to 14.1 percent of San Francisco residents in 2000.

Income and Occupational Profiles

The mean 2002 annual personal income of City CarShare members was around \$57,000, above the mean 2000 census per capita income for the city as a whole. At the extremes of the income distribution, 14 percent of members made \$80,000 or more per year while 10.4 percent earned less than \$20,000 annually.

Around three-quarters of surveyed carshare members had full-time jobs; 12.4 percent worked part-time, 2.4 percent were students, and 6.5 percent were not working. Most CarShare members (91.6 percent) with jobs worked in professional or management occupations (e.g., consultants, engineers, lawyers, planners, teachers). As in the previous surveys, a relatively large share of member respondents worked in the urban and transportation planning fields, possibly reflecting ideological leanings to progressive programs like carsharing, a greater willingness to participate in the survey, or both.

Household Profiles

Figure 10 shows that, consistent with prior surveys, City CarShare attracted a comparatively large share of individuals who lived in “non-traditional” households.

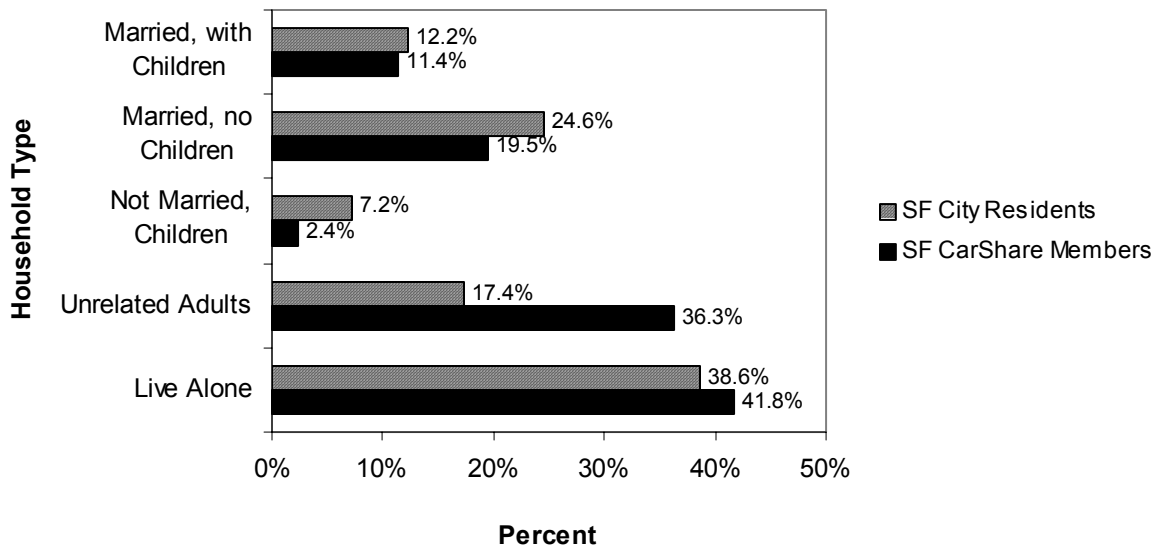


Figure 10. Comparison of Household Types Among Carshare Members (in March–April 2003) and All Residents of San Francisco (in 2000)

The proportion of City CarShare members who lived with another unrelated adult was more than twice as high as that for the city as a whole in 2000. Slightly higher shares of carshare members lived alone than was typical for the city at large. Just 14 percent of members lived in a household with children. Overall, the members’ mean household size was 1.9 compared to 2.3 for the city as a whole. Around 80 percent of members surveyed in March–April 2003 lived in one- or two-person households.

4.7 Car Ownership Patterns and Trends

By City CarShare’s second anniversary, some members might be expected to have sold personal cars. The convenience of having a fleet of vehicles available on demand, proponents contend, will prompt some carsharers to get rid of second cars and perhaps forego car ownership altogether. This section reveals the degree to which this has been the case based on second-year survey findings.

In March 2003, 56.7 percent of members were from zero-vehicle households and 33.7 percent were from one-vehicle households.¹⁷ (Motor vehicles include not just automobiles but also motorcycles, recreational vehicles, trucks, and mopeds.) Thus, around 9 out of 10 members were from 0–1 vehicle households, above the 83.3 percent share during the program’s first year and well above the year-2000 average of 70.6 percent for San Francisco households. What cars members did own tended to be fairly old — on average, their primary vehicle was 9 years old and had an odometer reading of 73,000 miles (Table 6). Second and third vehicles in the household, when they existed, tended to be used less often. The typical member’s car was a 4-cylinder medium-size sedan, like a Honda Accord (the most common car owned by members).

Table 6. Characteristics of Motor Vehicles in Households of Survey Respondents, Members and Non-Members, Survey #4

		Member		Non-Member	
		Mean	Std. Deviation	Mean	Std. Deviation
Vehicle #1:	Year	1994	7	1994	7
	Odometer Reading (miles)	73,050	82,551	84,587	68,372
Vehicle #2:	Year	1993	9	1993	6
	Odometer Reading (miles)	58,909	48,037	66,241	44,435
Vehicle #3:	Year	1991	13	N/A	N/A
	Odometer Reading (miles)	49,833	52,658	N/A	N/A

Changes in vehicle ownership levels between the first and second year of the City CarShare program are summarized in Figure 11. The figure summarizes recorded numbers of motor vehicles between surveys conducted in June–July and October–November 2001 and in March–April 2003. The share of members residing in zero-car households increased by about 15 percent over this approximately year-and-a-half period, to 56.7 percent. This was matched by drop-offs in shares of members living in one or two-plus car households.

To further probe trends in car ownership, the March–April 2003 survey asked respondents directly whether they reduced, increased, or did not change the number of vehicles in their household over the previous two years. Table 1 shows that a significantly higher share of members reduced car ownership than non-members: 29.1 versus 8.0 percent (producing an Analysis of Variance F statistic of 5.53, significant at the 5 percent probability level). Only 7.6 percent of members increased car ownership. Furthermore, 67.5 percent of members said they forewent the purchase of a motor vehicle during City CarShare’s first two years compared to 39.2 percent of non-members (F statistic and probability of 3.69 and 0.059, respectively). Thus, 73.3 percent of members reduced car ownership and/or opted not to purchase a vehicle between March 2001 and March 2003, compared to 42.9 percent of non-members (F statistic and probability of 4.18 and 0.052, respectively). Collectively, these statistics are compelling: two years into the program, participation in carsharing prompted many members to reduce their levels of car ownership. This represents a structural change in household conditions, quite likely brought on by the ability to conveniently access private cars through City CarShare. Such marked reductions in personal car ownership suggests carsharing will, over time, likely substitute for trips formerly made by personal car, and to the degree carsharers become more cognizant of the marginal cost of driving, could suppress total travel.

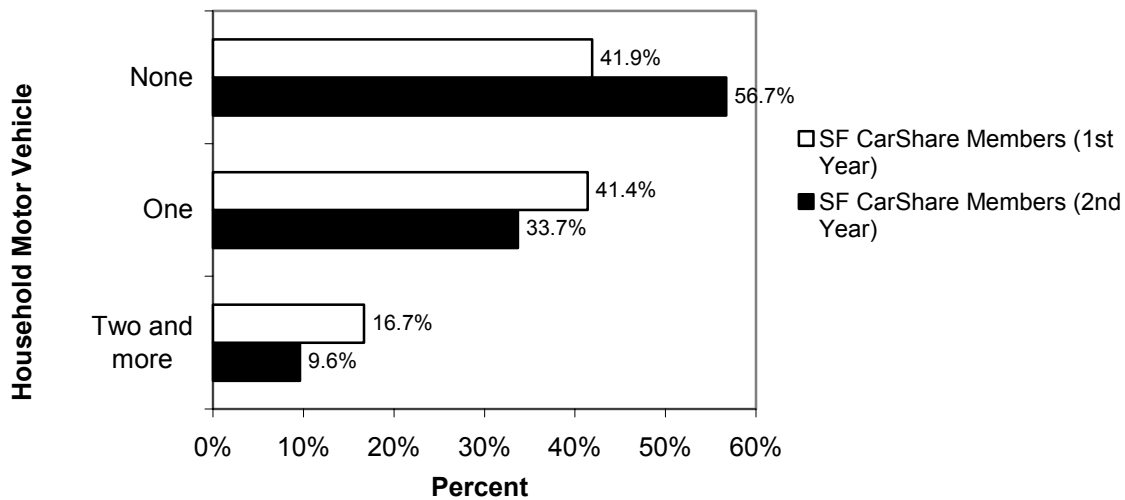


Figure 11. Comparison of Motor Vehicle Ownership Distributions Among the Members of San Francisco CarShare in 1st and 2nd Years of CarShare Program

Table 7. Change in Household Motor Vehicle Ownership Within the First Two Years of the San Francisco City CarShare Program: Members Versus Non-Members

<i>Change in Motor Vehicle Ownership</i>	Members (A)	Non-members (B)	Difference between Members and Non-members (A-B)
Reduced by Two and More	2.5%	0	2.5%
Reduced by One	26.6%	8.0%	18.6%
Did Not Change	63.2%	80.0%	-16.8%
Increased by One	7.2%	12.0%	-4.8%
Increased by Two and More	0.4%	0	0.4%
Total	100.0%	100.0%	

5. TRAVEL BY CITY CARSHARE VEHICLES VERSUS OTHER MODES

This section compares travel of City CarShare trips versus non-carshare trips made by members during Survey #4. A sample of 2,020 member trips was available for this analysis. As noted earlier, 6.5 percent of these trips, or 131 in all, were by City CarShare vehicles. The reader is reminded that the in-vehicle survey discussed earlier in Section 3 provided more in-depth information on City CarShare use, based on 351 survey responses. The value of statistics reported in this section (from the travel-diary, not the in-vehicle survey, results) is that they allow a more direct basis of comparison to travel by other modes at the two-year mark.

5.1 Trip Purpose

Some two years into the program, City CarShare vehicles were most heavily relied upon, in relative terms, for shopping, personal business, and recreation-other trips (Table 8). These results are consistent with those of the in-vehicle survey reported in Section 3. Transit's niche market was work trips, while walking and biking were favored for accessing restaurants and eateries. As noted earlier, City CarShare vehicles were not turned to very frequently for non-discretionary trips that are routinely made, such as going to and from work and school.

5.2 Travel Consumption Measures

Comparative statistics reveal that among members filling out Survey #4, those using City CarShare vehicles drove shorter distances, in less time, and logged fewer VMT than members driving private vehicles (Table 9). Adjusting for occupancy levels and engine

Table 8. Percent Distribution of Trip Purposes Among Modes for Daily Trips Made by City CarShare Members, Survey #4

Trip Purpose	City CarShare	Private Vehicle	Transit	Walk	Bike
To Work	7.7%	12.3%	27.4%	18.9%	26.0%
To Home	20.0%	30.5%	37.7%	26.3%	30.0%
School	1.5%	0.3%	1.8%	0.6%	0.9%
Shop	27.7%	8.1%	2.5%	9.1%	9.4%
Personal Business	10.0%	3.1%	4.1%	7.7%	3.6%
Medical	0.0%	3.1%	3.2%	0.8%	2.7%
Social	4.6%	10.4%	5.8%	6.5%	9.9%
Pick-up/Drop-off	4.6%	9.2%	0.6%	0.6%	0.0%
Eat a Meal	1.5%	5.6%	3.1%	11.7%	3.1%
Recreation-Other	22.4%	17.4%	13.8%	17.8%	14.4%
All	100.0%	100.0%	100.0%	100.0%	100.0%

Table 9. Comparison of Travel Statistics Among Trips by City CarShare, Private Vehicle, and All Other Modes, Members, Survey #4

	City CarShare		Private Vehicle		Other Modes	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Trip Distance (Road network miles)	4.5	10.3	5.4	9.1	2.5	4.5
Trip Time (Minutes)	11.0	18.0	13.4	17.4	23.2	23.7
Vehicle Miles Traveled (VMT)	4.5	10.3	5.4	9.2	1.9	4.65
Mode-Adjusted VMT (MVMT)	1.6	3.5	3.7	7.6	0.0	0.00
Mode & Engine-Size Adjusted VMT (MEVMT)	3,215.4	6,998.4	8,156.0	20,697.5	0.00	0.00
Gasoline Consumption (Gallons)	0.06	0.14	0.17	0.35	0.00	0.00
CO₂ (Greenhouse Gas Emission) (lbs)	1.8	3.9	4.6	9.5	0.0	0.0

Note: See Table 5 for a description of these variables.

size, the level of “travel consumption” by members for City CarShare trips was considerably below that of private cars. This is a flip-flop from the results of the third survey (some nine months into the carshare program) wherein carshare trips were longer and involved more VMT than private car trips. This about-face could reflect longer term structural adjustments: upon having sold off private cars and substituted carshare vehicles for trips previously made by second cars in the household, carshare trips tend to be more fuel efficient and environmentally conserving than those made by remaining private cars in the household.

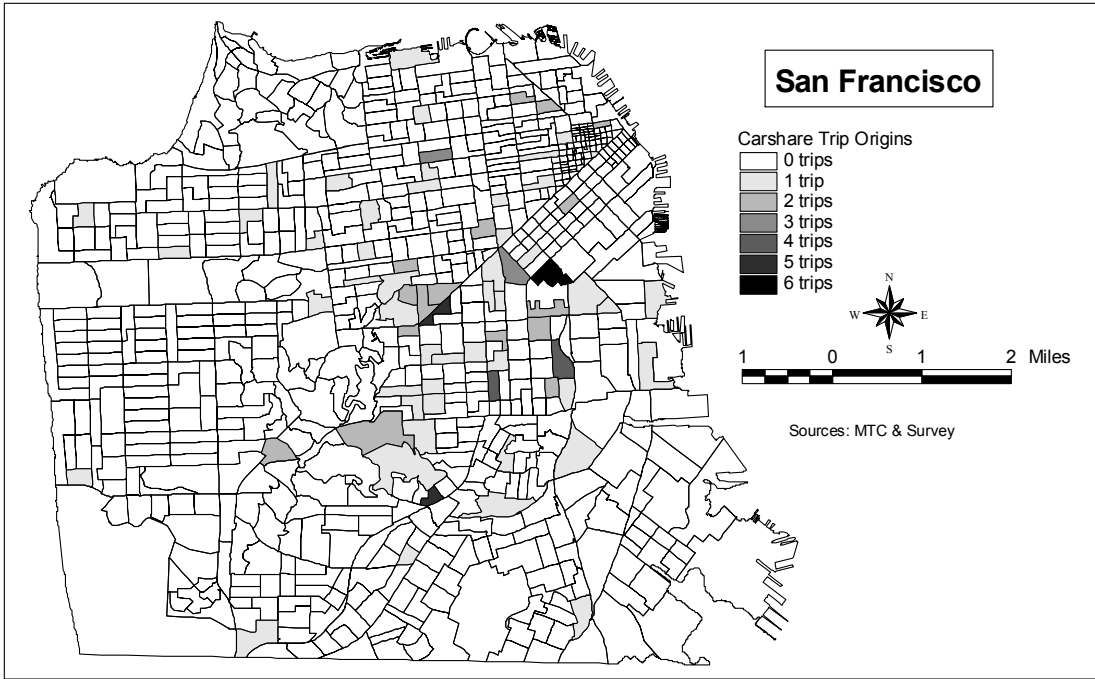
6. SPATIAL ANALYSES

This section updates the spatial analyses of previous origin–destination patterns from travel diaries. Using the March–April 2003 travel diary data, information is presented on trip origins for City CarShare trips, destination of carshare trips, and desire line patterns.

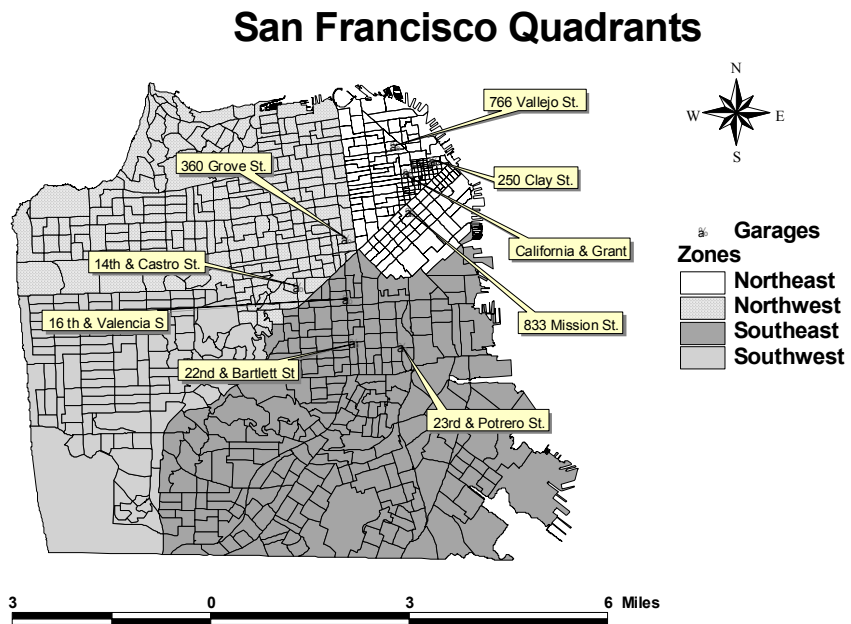
6.1 Origins and Destinations of City CarShare Trips

Map 2 shows the origins of sampled City CarShare trips, typically representing respondents’ residences, in travel-diary Survey #4. As expected, trip origins are spatially oriented toward the location of PODs. Origins for trips made by other modes, notably private car, tended to be more spatially dispersed than those made by carshare vehicles.

As in the two previous reports, destinations of trips from PODs were defined according to four quadrants of San Francisco (as shown in Map 3) as well as all destinations outside the city. Table 10 shows the largest share of surveyed carshare trips were to the



Map 2. San Francisco Traffic Analysis Zones (TAZs) of City CarShare Trip Origins, Survey #4 (March–April 2003).
Origin TAZ of City CarShare Trips shown in shade.



Map 3. Quadrants of the City of San Francisco

Table 10. Spatial Distribution of Carshare Trips by Trip Purpose, Survey #4, March–April 2003

Trip Purpose	Zones					
	Northeast	Northwest	Southeast	Southwest	Outside	Total
Work-School	33.3%	16.7%	16.7%	8.3%	25.0%	100%
Return Home	23.1%	26.9%	46.1%	3.8%	0.0%	100%
Other	12.9%	19.4%	43.0%	2.2%	22.6%	100%
All	16.8%	20.6%	41.2%	3.0%	18.3%	100%

southeastern part of the city. The southeast dominated as a destination for other (non-work) trips as well as return home travel. For journeys to work or school, most carshare travel was oriented to the northeast quadrant, representing downtown San Francisco and surrounding, highly urbanized areas. This spatial pattern was similar in earlier surveys.

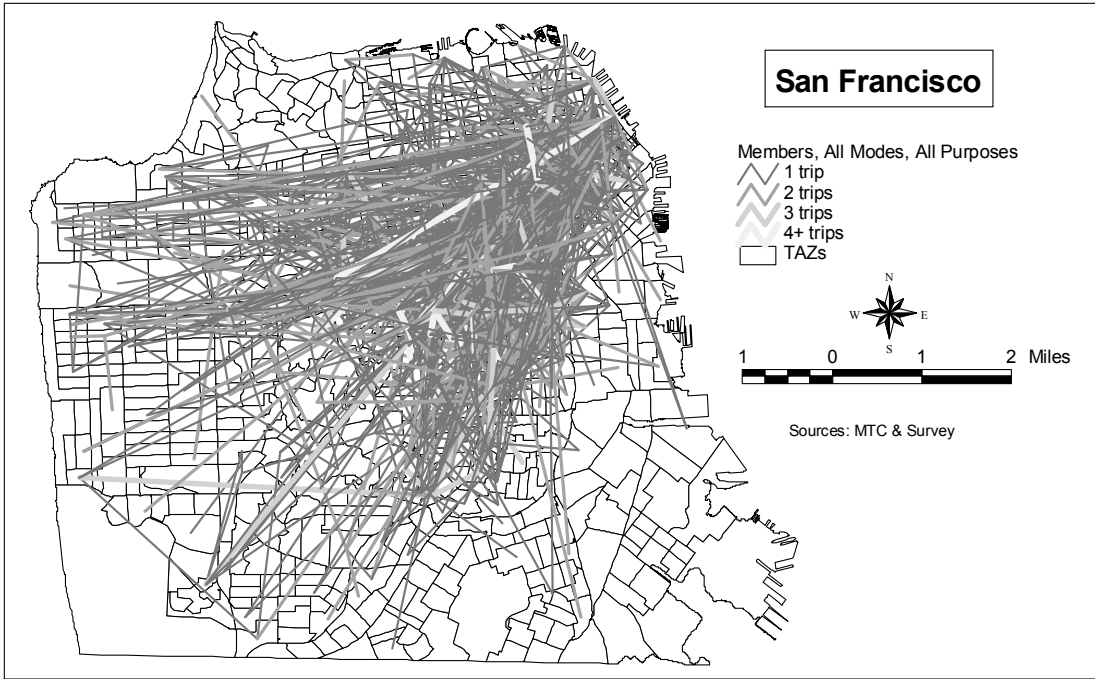
6.2 Desire Line Patterns

Maps 4 through 6 compare trip origin–destination patterns for members’ surveyed trips (in March–April 2003) for all modes, carshare travel, and private car trips, respectively. (These maps augment the previous desire line map of carshare trips from the in-vehicle survey — Map 1 — by comparing patterns across modes based on travel-diary results.) The “desire lines” — which identify the straight-line, most direct paths that people “desire” to take for each origin–destination pair — reveal a strong orientation of trips in areas with PODs. This is partly a product of self-selection: those who live near a POD were likely to join City CarShare.

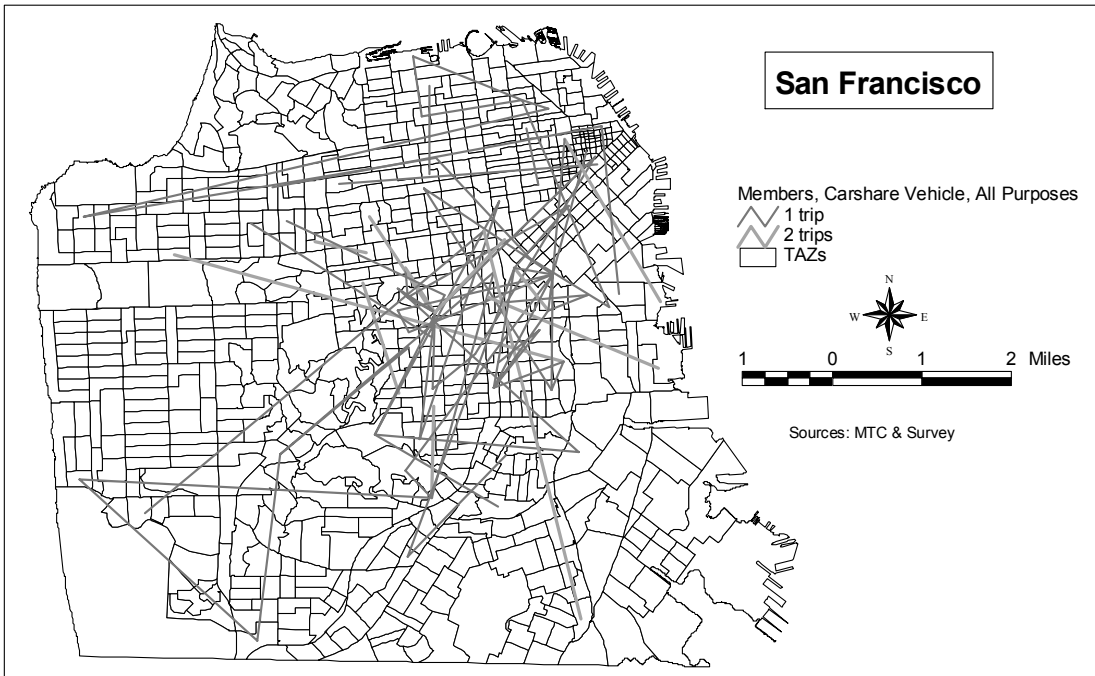
Perhaps the most that can be inferred from Map 4 is that members’ trips within the city were spatially dispersed. What degree of spatial patterning that occurs is a concentration of trip origins and destinations in the central band of the city. Recorded City CarShare trips (Map 5), while relatively few in number, were largely oriented to neighborhoods in and around PODs in the center of the city. By comparison, members’ trips by personal vehicles tended to be longer and oriented more strongly to the western part of the city.

7. EVALUATION

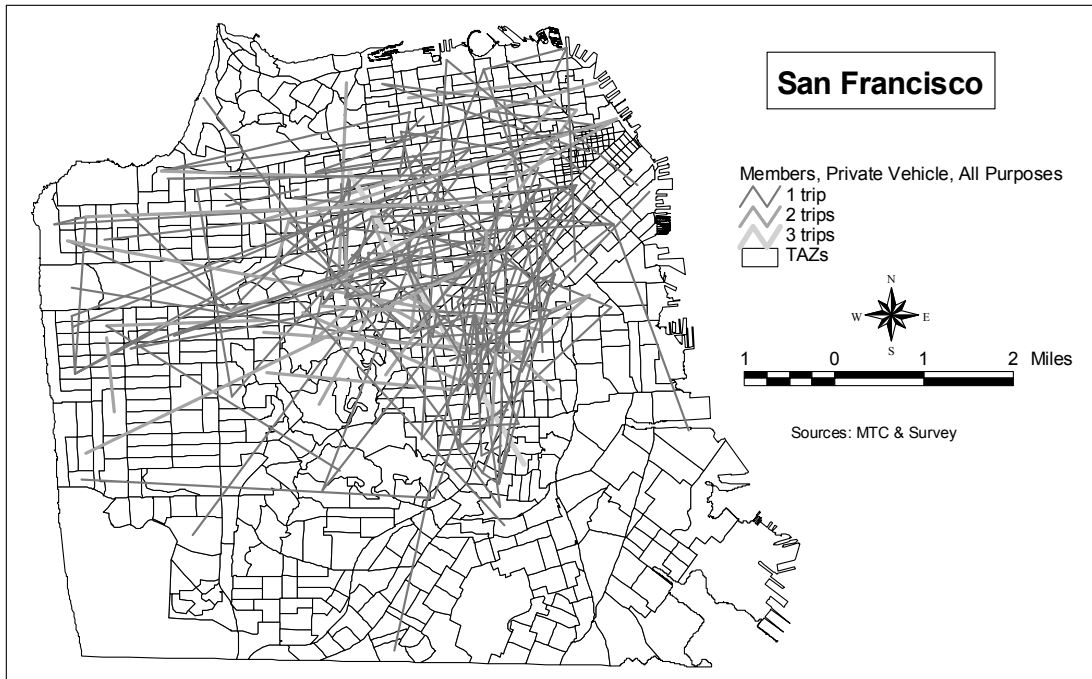
This section addresses the question of whether City CarShare, on balance, induced or reduced travel among its members during its first two years of operation. All trips made by each surveyed person are included in the analyses — what was called in the two previous reports an “aggregate analysis.” (Each person was asked to complete a 24-hour travel diary for one of two days of their choosing; the two days were randomly selected over a two-week survey period.) Sample sizes were large enough only to examine trends for weekday travel — for days that corresponded to respondents’ workdays as well as non-work days. Changes in mean trip distance, travel time, VMT, and several additional indicators of travel consumption are examined below between the period of February 2001 (several weeks prior to City CarShare’s inauguration, called Survey #1) and March 2003 (representing the program’s second anniversary, called Survey #4).



Map 4. Desire Line Map of Trips Made for All Purposes: Members, Survey #4



Map 5. Desire Line Map of City CarShare Trips Made for All Purposes: Members, Survey #4



**Map 6. Desire Line Map of Private Vehicle Trips Made for All Purposes:
Members, Survey #4**

7.1 Analysis for Weekday and Workday: Difference of Means

More travel data were compiled for weekday/workday travel than any “day type.” Table 11 summarizes results for members and Table 12 does likewise for non-members for workday travel during the Monday–Friday period. While not presented here, patterns were when comparisons were drawn between the second (June–July 2001) and fourth surveys as well as the third (October–November 2001) and fourth surveys.

Travel Distances and Times

Mean daily travel distances remained the same during City CarShare’s first two years (15.7 miles) and increased slightly among non-members, though changes were not statistically significant. Mean travel times fell for both groups, although more rapidly for non-members. Because average travel times fell while distances increased, average travel speeds rose markedly among members, in part from the substitution of City CarShare trips for travel formerly by foot and bicycle. Clearly, carsharing has enhanced mobility during weekdays/workdays, allowing members to conveniently reach more destinations in and around San Francisco and to do so more quickly.

**Table 11. Members: Trends in Daily Travel, Survey #1 to Survey #4,
Weekday/Workday**

	Survey #1 (February 2001)		Survey #4 (March 2003)		Difference of Means (S4 – S1)	T-Statistic (Sig.)
	Mean	Std. Deviation	Mean	Std. Deviation		
Travel Distance	15.7	21.2	15.7	17.7	-0.01	-0.005 (0.316)
Travel Time	114.4	120.6	108.3	77.5	-6.06	-0.480 (0.01)
VMT (Vehicle Miles Traveled)	4.50	11.32	4.40	13.10	-0.09	-0.053 (0.95)
MVMT (Mode-adjusted VMT)	2.80	7.28	1.49	4.86	-1.12	-1.626 (0.02)
MEVMT (Mode- and Engine-Size adjusted VMT)	4,313.5	14,547.1	2,641.8	9,817.4	-1,671.7	-0.946 (0.08)
Gasoline Consumption	0.074	0.231	0.047	0.167	-0.027	-0.900 (0.07)
CO₂ (Greenhouse Gas Emissions)	2.06	6.52	1.30	4.67	-0.76	-0.905 (0.07)

Key:

Travel Distance = total daily highway-network travel distance, in miles;

Travel Time = total daily highway-network travel duration, in minutes;

VMT = vehicle miles traveled over highway network [representing total miles logged in motorized vehicles; all non-vehicle (i.e., walk and bicycle) trips were assigned zero values];

MVMT = mode-adjusted VMT (representing total miles logged in motorized vehicles adjusted for occupancy levels and accounting for whether new vehicle trips are added; values for walking, bicycle, and transit are zero since none of these trips add vehicles to city streets);

MEVMT = Mode and engine-size adjusted VMT{representing an overall index of travel consumption, accounting for occupancy level and engine size of vehicle; equals [(total highway VMT)*(engine displacement in cubic centimeters)]/(vehicle occupancy) wherein engine size was estimated given the make, year, and model of vehicle used for a trip};

Gasoline Consumption = estimated gallons of gasoline consumption per day adjusted for occupancy level and fuel economy of vehicles used for each trip; equals [MVMT/miles per gallon (mpg)] wherein mpg was estimated for city highway conditions given the make, year, and model of vehicle used for a trip;

CO₂ (Greenhouse Gas Emissions) = estimated pounds of carbon dioxide per day produced by vehicles used for travel, adjusted for occupancy level and city-highway mileage of vehicle used for each trip; equals [MVMT/(CO₂ emissions per mile based on the make, year, and model of vehicle used for a trip)];

S1 = Survey #1 (February 2001 – two weeks prior to City CarShare); and

S4 = Survey #4 (March 2003 – end of City CarShare's second year of operation).

Table 12. Non-Members: Trends in Daily Travel, Survey #1 to Survey #4, Weekday/Workday

	Survey #1 (February 2001)		Survey #4 (March 2003)		Difference of Means (S4 – S1)	T-Statistic (Sig.)
	Mean	Std. Deviation	Mean	Std. Deviation		
Travel Distance	19.2	19.6	23.2	28.4	4.0	0.801 (0.03)
Travel Time	149.9	206.0	125.1	93.0	-24.78	-0.560 (0.33)
VMT (Vehicle Miles Traveled)	6.73	15.49	13.10	28.30	6.37	4.409 (0.02)
MVMT (Mode-adjusted VMT)	5.45	13.14	9.42	20.85	3.97	1.096 (0.02)
MEVMT (Mode- and Engine-Size adjusted VMT)	12,122.9	32,058.1	28,391.9	90,496.6	16,268.9	1.295 (0.01)
Gasoline Consumption	0.212	0.596	0.464	1.290	0.25	1.206 (0.02)
CO₂ (Greenhouse Gas Emissions)	5.82	16.51	12.71	34.99	6.88	1.208 (0.02)

See Table 11 key for variable descriptions.

Vehicle Miles Traveled

Did carsharing affect VMT? During City CarShare’s first two years, average daily VMT fell slightly for members yet increased for non-members for the weekday/workday period. While factors like changing fuel prices (which rose) and rainfall (which was much lower during Survey #4 than Survey #1) might have impacted VMT during survey periods, these potential confounders affected both members and non-members equally, meaning their influences are netted out when comparing trends.

Adjusting for mode and engine-size reveal even larger differentials over time. Mean MVMT fell by 47 percent for members yet increased by nearly 73 percent for non-members. Because CarShare members leased mainly Volkswagen Beetles, reductions in MVMT adjusted for engine size (i.e., the MEVMT variable) were even greater. Declines were not statistically significant, however, indicating there was a fair degree of variation in changes in travel consumption among members. Changes were not statistically significant among non-members either. Still, the evidence is persuasive: carsharing offers a fairly resourceful form of automobility to San Franciscans who have joined the program.

Energy and Environmental Metrics

Despite the fact that, upon becoming carshare members, a number of San Franciscans began driving in lieu of travel by transit, foot, or bicycle, average daily fuel consumption fell during the program's first two years. This likely reflected a combination of members reducing private car ownership, switching to more fuel-efficient City CarShare vehicles, and carrying passengers for many carshare trips (thus increasing average occupancy levels relative to private car trips). By comparison, mean fuel consumption rose among non-members over the two survey periods. Similar relationships held in terms of estimated changes in greenhouse gas emissions. Over the two-year period, members' average daily transportation-related CO₂ emissions fell by an estimated three-quarters of a pound compared to an estimated one-quarter pound increase among non-members.

Net Impacts

In striking contrast to findings on first-year impacts, by the end of City CarShare's second year, there was considerable evidence of travel suppression for the dominant period of travel, weekday/workday — i.e., carshare membership generally reduced overall travel consumption. Table 13 presents the “difference of difference of means” results — i.e., the degree to which changes in travel over the two time points differed among members and non-members. While none of the “differences of differences” were statistically significant at the 5 percent probability level, nonetheless total travel consumption during the February 2001 to March 2003 period generally went down for members and up for non-members. For example, the net change in daily VMT for members relative to non-members was -6.46 — a product of a 0.09 average decline for members and a 6.37 average increase for non-members.

While absolute differentials shown in Table 13 do not appear to be particularly large, in relative terms they were more substantial (Figure 12). For example, the percentage point differential for mode- and engine-size adjusted VMT (i.e., MEVMT) was -235 — a product of a mean 81 percent decline for members and a mean 154 percent increase for non-members.

While the sources of suppressed travel are not revealed by these statistics, we believe reduced car ownership had a substantial influence. Over time, carshare participation brings about structural adjustments like reduced car ownership and the foregoing of new purchases. Many members have also likely become more judicious in their travel habits, more conscientious of the marginal cost of driving (in light of being reminded upon receiving monthly City CarShare bills). The contention that, over time, carsharing can suppress travel through the reduction or relinquishment of private car ownership and by increasing awareness of the full cost of using a car seems to be borne out by these second-year results.

Table 13. Difference of Difference of Means: Changes of Members Minus Changes of Non-Members, Weekday/Workday, Surveys #1 to #4

	Difference of Difference of Means	T-Statistic
Travel Distance	-4.01	-0.443
Travel Time	18.72	0.414
VMT (Vehicle Miles Traveled)	-6.46	-0.829
MVMT (Mode-adjusted VMT)	-5.09	-0.888
MEVMT (Mode- and Engine-Size adjusted VMT)	-17,940.6	-0.788
Gasoline Consumption	-0.277	-0.813
CO ₂ (Greenhouse Gas Emissions)	-7.64	-0.823

See Table 11 key for variable descriptions.

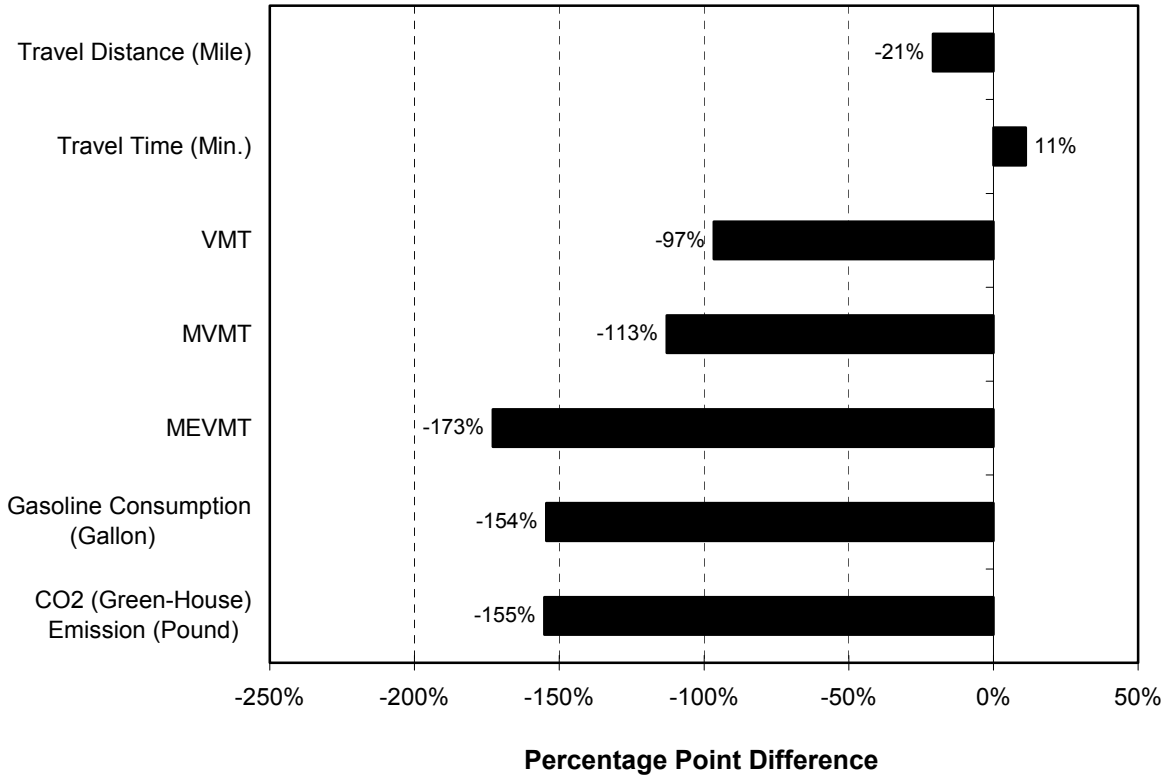


Figure 12. Percentage Point Differences in Changes in Mean Daily Travel Characteristics: Weekdays that are Workdays, Members Relative to Non-Members, Survey #1 to Survey #4

7.2 Analysis for Weekday and Non-Workday: Difference of Means

For the second-year mark of City CarShare, Tables 14 through 16 present aggregate travel results for weekdays that were non-workdays. Patterns were similar to those of weekdays/workdays, though differences between members and non-members were not as large. Accordingly, statistical relationships were even less statistically significant. Figure 13, which presents findings in proportional terms, suggests that the biggest impact for weekday/non-workday periods was from an energy-efficiency and environmental conservation standpoint: differences in changes of fuel-consumption and greenhouse gas emissions for members relative to non-members was nearly -140 percentage points.

Table 14. Members: Trends in Daily Travel, Survey #1 to Survey #4, Weekday/Non-Workday

	Survey #1		Survey #4		Difference of Means (S4 – S1)	T-Statistic (Sig.)
	Mean	Std. Deviation	Mean	Std. Deviation		
Travel Distance	16.2	25.5	11.9	15.9	-4.31	-0.993 (0.26)
Travel Time	81.4	46.4	83.7	67.5	2.36	0.149 (0.29)
VMT	9.10	26.32	5.63	15.00	-3.47	-0.821 (0.19)
MVMT	8.56	26.35	3.69	12.10	-4.87	-1.233 (0.06)
MEVMT	27,318.8	100,508.5	5,186.2	17,877.2	-22,132.6	-1.812 (0.00)
Gasoline Consumption	0.485	1.703	0.104	0.363	-0.380	-1.756 (0.00)
CO₂ (Greenhouse Gas Emissions)	13.28	46.6	2.91	10.10	-10.37	-1.746 (0.00)

Key:

Travel Distance = total daily highway-network travel distance, in miles;

Travel Time = total daily highway-network travel duration, in minutes;

VMT = vehicle miles traveled over highway network [representing total miles logged in motorized vehicles; all non-vehicle (i.e., walk and bicycle) trips were assigned zero values];

MVMT = mode-adjusted VMT (representing total miles logged in motorized vehicles adjusted for occupancy levels and accounting for whether new vehicle trips are added; values for walking, bicycle, and transit are zero since none of these trips add vehicles to city streets);

MEVMT = Mode and engine-size adjusted VMT {representing an overall index of travel consumption, accounting for occupancy level and engine size of vehicle; equals [(total highway VMT)*(engine displacement in cubic centimeters)]/(vehicle occupancy) wherein engine size was estimated given the make, year, and model of vehicle used for a trip};

Gasoline Consumption = estimated gallons of gasoline consumption per day adjusted for occupancy level and fuel economy of vehicles used for each trip; equals [MVMT/miles per gallon (mpg)] wherein mpg was estimated for city highway conditions given the make, year, and model of vehicle used for a trip;

CO₂ (Greenhouse Gas Emissions) = estimated pounds of carbon dioxide per day produced by vehicles used for travel, adjusted for occupancy level and city-highway mileage of vehicle used for each trip; equals [MVMT/(CO₂ emissions per mile based on the make, year, and model of vehicle used for a trip)].

Table 15. Non-Members: Trends in Daily Travel, Survey #1 to Survey #4, Weekday/Non-Workday

	Survey #1		Survey #4		Difference of Means (S4 – S1)	T-Statistic (Sig.)
	Mean	Std. Deviation	Mean	Std. Deviation		
Travel Distance	15.5	19.7	13.7	10.0	-1.81	-0.347 (0.11)
Travel Time	106.1	128.2	89.5	60.1	-16.62	-0.465 (0.23)
VMT	7.70	14.81	6.48	10.68	-1.22	-0.283 (0.85)
MVMT	6.97	14.65	6.06	9.68	-0.91	-0.208 (0.84)
MEVMT	17,131.0	47,226.5	12,858.1	19,437.1	-4,272.9	-0.303 (0.55)
Gasoline Consumption	0.172	0.530	0.273	0.419	0.101	0.587 (0.52)
CO₂ (Greenhouse Gas Emissions)	4.75	14.62	7.61	11.68	2.86	0.601 (0.51)

See Table 14 key for variable descriptions.

Table 16. Difference of Difference: Changes of Members Minus Changes of Non-Members, Weekday/Non-Workday, Survey #1 to Survey #4

	Difference	T-Statistic (Sig.)
Travel Distance (Mile)	-2.5	-0.252
Travel Time (Min.)	18.98	0.494
VMT	-2.25	-0.231
MVMT	-3.96	-0.673
MEVMT	-17859.7	-0.513
Gasoline Consumption (Gallon)	-0.481	-0.805
CO₂ (Green-House) Emission (Pound)	-13.23	-0.806

See Table 14 key for variable descriptions.

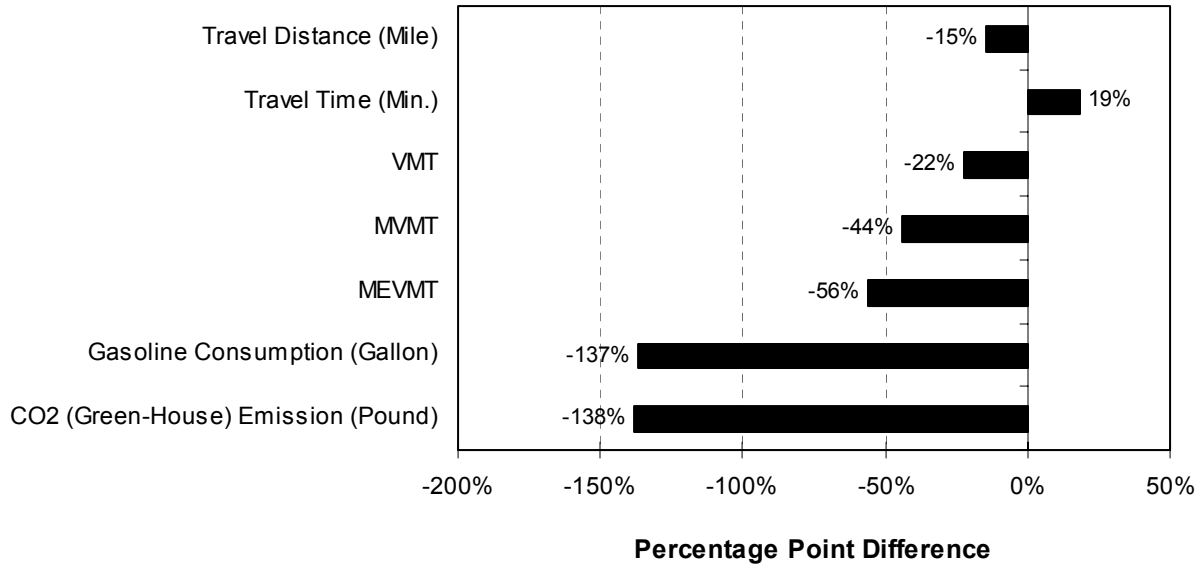


Figure 13. Percentage Point Differences in Changes in Mean Daily Travel Characteristics: Weekdays that are Non-Workdays, Members Relative to Non-Members

8. PREDICTIVE MODELS

This section presents the results of predictive models that shed additional light on City CarShare’s intermediate-term impacts. Factors that might explain changes in travel patterns are highlighted. All models are based on results of the fourth survey (from March 2003).

Reduced Car Ownership Model

Table 17 presents a best-fitting binomial logit model that predicts whether a respondent reduced one or more cars in their household and/or forewent the purchase of a vehicle over the February 2001 to March 2003 period. Controlling for several demographic variables and vehicle ownership levels, being a carshare member significantly increased the likelihood someone got rid of a car and/or opted not to purchase another one. From a sensitivity analysis, the model revealed that for the “typical” survey respondent (i.e., non-Hispanic living in an unrelated-adult household with 0.3 cars per household member), the odds of reducing car ownership or foregoing a purchase jumps from 42 percent if the person is a non-member to 69 percent if he or she is a member.

Private-Car Travel Choice Model

Again using binomial logit analysis, a reasonably good-fitting model was derived for predicting the likelihood a survey respondent chose a private car for a trip. Controlling

Table 17. Binomial Logit Model for Predicting Likelihood Respondents Reduced or Forewent Motor Vehicle Ownership; Survey #4

Variables	Coefficient Estimate	Standard Error	Probability
City CarShare Member (1 = yes; 0 = no)	1.121	0.341	0.001
Number of Vehicles Per Household Member	-1.071	0.278	0.000
Hispanic (1 = yes; 0 = no)	-1.320	0.491	0.007
Household Type:			
Married with No Children (1 = yes; 0 = no)	0.660	0.313	0.034
Unrelated Adults (1 = yes; 0 = no)	0.544	0.265	0.040
Constant	-0.025	0.345	0.942

Summary Statistics:		
Number of Cases		423
-2 \ln (c): Log Likelihood Value, Constant-only Model		520.717
-2 \ln (B): Log Likelihood Value, Parameterized Model		479.183
Model Chi-Square (Probability): -2[\ln (c) - \ln (B)]	41.534 (0.000)	
Goodness of Fit (McFadden): $1 - [\ln(B) / \ln(C)]$		0.080

for socio-economic factors (like car ownership levels), travel attributes (like trip purpose and frequency), and travel time (of transit versus car), Table 18 shows that being a City CarShare member lowered the likelihood of traveling by private car. While factors like comparative travel times, car ownership, and availability of a transit pass more strongly influenced private-car usage, belonging to City CarShare clearly sways many members to opt for other mobility options, particularly for non-work travel.

City CarShare Mode Choice Model

As a complement to the private-car travel choice model, a binomial logit equation was also estimated that predicted whether member respondents opted for carsharing for particular trips. Table 19 shows members were less likely to choose carsharing for work trips and when they had a transit pass available. In cases where public transit was relatively slow to automobile travel, members tended to opt for carshare vehicles. The model also suggests that carsharing increased when numbers of household vehicles per capita as well as children in the household rose, all else being the same.

Table 18. Binomial Logit Model for Predicting Likelihood Respondents Chose Private Car for Trip; Survey #4, All Trip Purposes

Variables	Coefficient Estimate	Standard Error	Probability
Member Status:			
City CarShare Member (1=yes; 0=no)	-.452	.249	.069
Modal and Travel Attributes:			
Total Travel Time Differential: Transit–Automobile (minutes) ^a	.063	.009	.000
Total Travel Time Differential Squared	-.002	.000	.000
Have a Transit Pass (1=yes; 0=no)	.772	.180	.000
More Than 10 Trips per Day (1=yes; 0=no)	1.189	.526	.024
Work Trip (1=yes; 0=no)	-.604	.235	.010
Socio-Economic Controls:			
No. of Vehicles per Household Member	3.997	.495	.000
No. of Vehicles per Household Member Squared	-1.882	.358	.000
Children in the Household (1=yes; 0=no)	1.276	.223	.000
Forgone Purchase of Cars over the past two years (of City CarShare operations)	-.376	.172	.029
Constant	-3.172	.339	.000
SUMMARY STATISTICS (see Table 17 for descriptions)			
Number of Cases			1583
-2 ∫ (c):			1319.2
-2 ∫ (B):			972.9
Model Chi-Square (Probability):			346.4 (.000)
Goodness of Fit (McFadden):			0.263
Notes:			
^a For transit travel, travel time consists of that occurring “in vehicle” (BART, Muni rail, or Muni bus) and “out-of-vehicle” (including walk time for access and transfers and waiting time, and driving to access transit, if any). For drive-alone travel, total time consists of in-vehicle network highway travel time.			

Table 19. Binomial Logit Model for Predicting Likelihood Member Respondents from Survey #4 Chose City CarShare for Trip, All Trip Purposes

Variables	Coefficient Estimate	Standard Error	Probability
Modal and Travel Attributes:			
Total Travel Time Differential: Transit–Automobile (minutes) ^a	.067	.009	.000
Total Travel Time Differential Squared	-.0003	.000	.000
Have a Transit Pass (1=yes; 0=no)	-.840	.191	.000
Work Trip (1=yes; 0=no)	-.482	.240	.000
Has Off-Street Parking	1.067	.202	.000
Socio-Economic Controls:			
No. of Vehicles Per Household Member	1.001	.226	.000
Has Children in the Household (1=yes; 0=no)	1.023	.242	.000
Forgone Purchase of Cars in the Past Two Years (After the Opening of CarShare)	-.424	.185	.022
Constant			
SUMMARY STATISTICS (see Table 17 for descriptions)			
Number of Cases			1399
-2 ∫ (c):			1133.6
-2 ∫ (B):			855.1
Model Chi-Square (Probability):			278.5 (.0000)
Goodness of Fit (McFadden):			0.246
Notes:			
^a For transit travel, travel time consists of that occurring “in vehicle” (BART, Muni rail, or Muni bus) and “out-of-vehicle” (including walk time for access and transfers and waiting time, and driving to access transit, if any). For drive-alone travel, total time consists of in-vehicle network highway travel time.			

Average Daily Gasoline Consumption Model

From a best-fitting multiple regression model, City CarShare membership was found to significantly reduce daily estimated gasoline consumption among survey respondents (Table 20). This was after controlling for the influences of other predictors, like type of travel day and respondents' socio-economic characteristics. All else being equal, City CarShare membership typically lowered daily gasoline consumption by nearly a quarter of a gallon. Although not presented, similar results were found in modeling various measures of VMT and estimated greenhouse gas emissions. Collectively, these results suggest that carsharing helps to shrink the urban transport sector's ecological footprint in cities like San Francisco.

Table 20. Regression Model for Predicting Respondents' Average Daily Travel Gasoline Consumption, in Gallons; Survey #4, All Trip Purposes, All Day Types

Variables	Coefficient Estimate	Standard Error	Probability
Member Status:			
City CarShare Member (1=yes; 0=no)	-.232	.091	.011
Modal and Travel Attributes:			
Weekend, Work Day (1=yes; 0=no)	.330	.132	.013
Drive Alone to Work (1=yes; 0=no)	.572	.130	.000
Socio-Economic Controls:			
No. of Vehicles Per Household Member	.436	.140	.002
No. of Vehicles Per Household Member Squared	-.153	.091	.095
Asian American (1=yes; 0=no)	.250	.099	.012
Age between 25 – 64 (1=yes; 0=no)	.224	.130	.086
Constant	-.045	.145	.758
SUMMARY STATISTICS			
Number of Cases			248
R square			.224
F Statistics (Probability)			9.962 (.000)

9. CONCLUSION

Two years into San Francisco's City CarShare program, evidence of reduced travel among members was uncovered. We believe this was substantially a product of members having sold off private cars and foregone the purchase of additional ones. Almost three-quarters of surveyed members had reduced car ownership or stated they had opted against purchasing another car over the February 2001 to March 2003 period. Evidence of travel suppression stands in stark contrast to first-year impacts wherein members' average VMT had increased. Early adopters, many drawn from the ranks of environmentalists and avid cyclists who owned no car, began logging vehicle miles on the streets of San Francisco; with time, as the program has attracted a more mainstream clientele, the novelty of carsharing has worn off, and members have shed car ownership, "induced travel" appears to have been replaced by "reduced travel."

It was not just average VMT that fell among members relative to non-members. Because carshare vehicles tended to be small, fuel-efficient, and carry several people, per capita levels of gasoline consumption and greenhouse gas emissions have also trended downwards. Mindful of the cumulative costs of driving, car-share members, we believe, have also become more judicious and selective when deciding whether to use a car, take public transit, walk, bike, or even forego a trip. These factors, coupled with reduced personal car ownership, have given rise to a more resourceful form of automobility in San Francisco's transportation sector. Members appear to be taking City CarShare up on the advice offered in its marketing brochure: "Think of car-sharing as a neighborhood-based, time-share car rental that allows people to use vehicles when needed, and pay based on how much they drive."¹⁸

Whether experiences in San Francisco can be generalized elsewhere is debatable. We believe, however, that they can be, though perhaps not quite to the extreme measured in the City by the Bay. San Francisco has many of the ingredients that make car-sharing a "natural": congested streets, limited and expensive parking, good public transit options, numerous non-traditional households, and a fairly socially progressive population. While the magnitude of impacts might vary elsewhere, the directions would likely be the same: car-sharing might initially stimulate motorized travel, however over time, it can bring about a more resourceful form of automobility, marked by a lowering of members' per capita VMT. On balance, carsharing is a welcome addition to America's offering of mobility choices.

ACKNOWLEDGMENTS

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NOTES

¹ R. Cervero, N. Creedman, M. Pohan, and M. Pai, *City CarShare: Assessment of Short-Term Travel-Behavior Impacts*. Berkeley: Institute of Urban and Regional Development, University of California, Berkeley, Working Paper 2002-01, May, 2002; R. Cervero, N. Creedman, M. Pohan, M. Pai, and Y. Tsai. *City CarShare: Assessment of Intermediate-Term Travel-Behavior Impacts*. Berkeley: Institute of Urban and Regional Development, University of California, Berkeley, Working Paper 2002-02, July, 2002; and R. Cervero, *City CarShare: Near-Term Travel-Behavior Impacts*, *Transportation Research Record*, 2003 (forthcoming).

² Females averaged slightly more miles per reservation than males, though the relationship was not statistically significant; males, on the other hand, averaged more hours and paid more per reservation.

³ These data (drawn from 1801 reservation records) are derived from the average interval of carshare members' reservations, for example 25 days. In order to classify data in the six categories of reservation frequency, the following assumptions of time intervals between reservations were applied: twice or more a week: 1-3 days; once a week: 4-10 days; once every two weeks: 11-17 days; once a month: 18-44 days; once every three months: 45-134 days; and less than once every three months: 145 days and above.

⁴ Mean annual figures (and standard deviations) were: mileage = 1028 (1247); hours = 222 (340); cost = \$1285 (\$1580). Annual CarShare Mileage = (total mileage / number of days) *365 days including only for those members acting upon 6 reservations or more during this 1.5 year period, i.e., at least once every 3 months). Annual CarShare Hours were computed similarly. Annual CarShare Cost = (total cost / number of days) *365 days + \$120 (i.e., monthly fee for one year), including only for those members acting upon reservations six times or more during 1.5 year period.

⁵ This is based on actual (versus reserved) times of departure and arrival for 22,790 cases between February 28, 2001 and October 3, 2002.

⁶ Clipboards were mounted near drivers' seats and surveys were deposited in specially marked boxes in each POD. City CarShare members received an e-mail one week prior to the survey period to explain and inform them of the upcoming survey.

⁷ Percentage breakdowns for responses on "how often do you make the trip(s) by the City CarShare vehicle" were: always – 20.8 percent; 2/3 of trips – 7.7 percent; half of trips – 46.0 percent; 1/3 of trips – 13.6 percent; and less than 1/3 of trips – 11.9 percent.

⁸ The distributions of in-vehicle surveyed carshare trips were as follows: one occupant – 53.8 percent; two occupants – 36.9 percent; and three or more occupants – 9.3 percent.

⁹ San Francisco Taxicab rates, under Section 1135 of the San Francisco Municipal Police Code, are: \$2.85 for the first 1/6th mile or flag; \$0.45 for each additional 1/5th mile or fraction thereof; \$0.45 for each minute of waiting or traffic time delay; and \$2.00 airport exit surcharge. The lowest-priced car rental for a compact in San Francisco on Expedia.com was with Enterprise Car Rental at 1133 Van Ness Avenue. The daily quoted rate (for mid-March 2003) was \$26.99, with a limit of 150 miles. Car insurance was quoted at \$11.99 per day. The average gasoline price for regular unleaded in San Francisco at the time was \$1.69 per gallon. The compact vehicle was assumed to get 30 miles per gallon for city driving conditions. State and local sales tax in the city of San Francisco is 8.5 cents per dollar.

¹⁰ Travel diary and background surveys were sent to 1,967 San Francisco residents (with valid mailing addresses in the city), composed of 1,808 San Francisco City CarShare members and 159 non-members (control group). To ensure all days of the week were represented in survey responses, each survey recipient was randomly assigned two days from which they were asked to choose one of the days for completing the travel-diary survey. However, if neither day worked for them (e.g., they were out of town), they were provided an alternative set of two days on the same days of the week.

¹¹ As an incentive, a \$1 bill was included with the survey materials, with the exception of three groups who were offered \$5 to complete the survey: non-members (i.e., the control group), those who have been members since the very beginning of City CarShare (in March 2001), and those who had completed the previous three surveys. These larger incentives were felt to be necessary to ensure adequate response rates among these groups. After the due-date for returning surveys had passed, non-respondents in the control group were offered an even larger incentive (\$20) in hopes of getting over 50 responses from this group. The higher incentive worked, for 24 percent of the responses from the control group came from the re-mailing of surveys this group.

¹² Shares for non-members were: BART – 56.8 percent; Muni – 43.2 percent. These results differ from Survey #3 wherein the largest share of trips among members was by BART.

¹³ S. Beraldo, *Commuter Profiles 2002*, San Francisco: Rides for Bay Area Commuters, 2003.

¹⁴ U.S. Bureau of the Census, *Summary Tape File 3A, 2000 Census: San Francisco*; see: <http://censtats.census.gov/data/CA/1600667000.pdf>.

¹⁵ Source: <http://www.fueleconomy.gov/feg/findacar.htm>.

¹⁶ The shares were three to four times larger for the city as a whole: 30.8 percent of San Franciscans were Asian-American and 7.8 percent were African-American in 2000.

¹⁷ Other shares were: two motor vehicles in the household – 8.0 percent of members; and three or more motor vehicles in the household – 1.6 percent.

¹⁸ City CarShare. *What Is Car-Sharing?* San Francisco: City CarShare, mimeo, 2001.

APPENDIX A

Trend Information on San Francisco City CarShare Reservation and Usage Logs

Table A.1. Numbers of CarShare Users, Trips, Operating Miles and Hours, by Month

Month-Year	Members using CarShare (% Change ³)	Number of Reservations (% Change)	Average Reservations per User ⁴ (% Change)	Revenue Miles (% Change)	Revenue Hours (% Change)	Average Miles per Reservation (% Change)	Average Duration per Reservation Hour (% Change)
Feb-01 ¹	1	1	1.0	2	1	1.9	0.6
Mar-01	88	102	1.2	3,383	703	33.2	6.9
Apr-01	287 (226%)	299 (193%)	1.0 (-10%)	9,035 (167%)	1,915 (172%)	30.2 (-9%)	6.4 (-7%)
May-01	344 (20%)	370 (24%)	1.1 (3%)	12,202 (35%)	2,506 (31%)	33.0 (9%)	6.8 (6%)
Jun-01	474 (38%)	502 (36%)	1.1 (-2%)	17,709 (45%)	3,605 (44%)	35.3 (7%)	7.2 (6%)
Jul-01	614 (30%)	640 (27%)	1.0 (-2%)	19,589 (11%)	4,304 (19%)	30.6 (-13%)	6.7 (-6%)
Aug-01	455 (-26%)	481 (-25%)	1.1 (1%)	16,267 (-17%)	3,644 (-15%)	33.8 (10%)	7.6 (13%)
Sep-01	725 (59%)	767 (59%)	1.1 (0%)	24,188 (49%)	5,737 (57%)	31.5 (-7%)	7.5 (-1%)
Oct-01	803 (11%)	830 (8%)	1.0 (-2%)	25,046 (4%)	6,196 (8%)	30.2 (-4%)	7.5 (0%)
Nov-01	1,221 (52%)	1,249 (50%)	1.0 (-1%)	33,015 (32%)	8,188 (32%)	26.4 (-12%)	6.6 (-12%)
Dec-01	1,086 (-11%)	1,115 (-11%)	1.0 (0%)	31,351 (-5%)	8,512 (4%)	28.1 (6%)	7.6 (16%)
Jan-02	1,302 (20%)	1,323 (19%)	1.0 (-1%)	32,417 (3%)	8,154 (-4%)	24.5 (-13%)	6.2 (-19%)
Feb-02	1,302 (0%)	1,313 (-1%)	1.0 (-1%)	30,180 (-7%)	7,107 (-13%)	23.0 (-6%)	5.4 (-12%)
Mar-02	1,607 (23%)	1,618 (23%)	1.0 (0%)	40,540 (34%)	8,963 (26%)	25.1 (9%)	5.5 (2%)
Apr-02	1,752 (9%)	1,764 (9%)	1.0 (0%)	46,526 (15%)	9,054 (1%)	26.4 (5%)	5.1 (-7%)
May-02	1,969 (12%)	1,975 (12%)	1.0 (0%)	54,063 (16%)	11,262 (24%)	27.4 (4%)	5.7 (11%)
Jun-02	1,951 (-1%)	1,953 (-1%)	1.0 (0%)	56,409 (4%)	10,629 (-6%)	28.9 (6%)	5.4 (-5%)
Jul-02	1,963 (1%)	1,963 (1%)	1.0 (0%)	57,837 (3%)	11,896 (12%)	29.5 (2%)	6.1 (11%)
Aug-02	2,173 (11%)	2,186 (11%)	1.0 (1%)	66,213 (14%)	13,697 (15%)	30.3 (3%)	6.3 (3%)
Sep-02	2,350 (8%)	2,351 (8%)	1.0 (-1%)	67,246 (2%)	13,051 (-5%)	28.6 (-6%)	5.6 (-11%)
Oct-02 ²	61	61	1.0	1,536	206	25.2	3.4
Mean	27%	25%	-1%	22%	22%	0%	-1%

Note:

1. February 2001 only contains data of February 28, 2001.
2. October 2002 only contains data of between 1st and 3rd of October 2002.
3. Percent change from previous month
4. Average trips per Reservation = Number of Reservations / Number of Members using CarShare
5. Data source: City CarShare, San Francisco CarShare daily logs

Table A.2. Comparison of Mean CarShare Trip Distance, Duration, and Cost, by Gender

Gender	Female		Male		F	Sig.
	Mean	S. Dev.	Mean	S. Dev.		
Mileage per Reservation	27.5	29.3	26.4	33.8	.65	.42
Hours per Reservation	5.4	9.2	6.4	7.5	7.47	.01
Cost per Reservation	\$29.5	34.6	\$32.4	38.5	3.86	.05

Table A.3. Comparison of Mean CarShare Trip Distance, Duration, and Cost, Asian American versus Non-Asian American

Race	Asian American		Non-Asian American		F	Sig.
	Mean	S. Dev.	Mean	S. Dev.		
Mileage per Reservation	32.1	27.7	26.6	32.2	4.95	.03
Hours per Reservation	8.8	9.3	5.6	8.2	24.27	.00
Cost per Reservation	\$42.8	39.3	\$29.8	36.0	21.39	.00

Table A.4. Comparison of Mean CarShare Trip Distance, Duration, and Cost, by Age Category

Age	20's		30's		40's		50's		60's and Over		F	Sig.
	Mean	S. Dev.	Mean	S. Dev.	Mean	S. Dev.	Mean	S. Dev.	Mean	S. Dev.		
Mileage per Reservation	30.3	32.2	26.6	32.0	26.0	26.9	26.7	38.7	29.4	39.8	1.08	.36
Hours per Reservation	5.1	6.1	5.8	7.4	7.1	11.2	4.5	6.8	4.2	1.5	4.50	.00
Cost per Reservation	\$29.6	29.4	\$30.3	33.6	\$34.7	44.2	\$26.2	35.1	\$25.4	18.2	2.10	.08

Table A.5. Comparison of Mean CarShare Trip Distance, Duration, and Cost, by Members' Bicycle Ownership

	Own a Bike		Do Not Own a Bike		F	Sig.
	Mean	S. Dev.	Mean	S. Dev.		
Mileage per Reservation	28.7	33.2	24.7	30.4	9.19	.00
Hours per Reservation	6.1	7.9	5.5	8.9	2.54	.11
Cost per Reservation	\$32.2	35.5	\$28.9	38.0	4.70	.03

Table A.6. Comparison of Mean CarShare Trip Distance, Duration, and Cost, by Availability of Street Parking

	Street Parking Is Available		No Street Parking		F	Sig.
	Mean	S. Dev.	Mean	S. Dev.		
Mileage per Reservation	32.9	42.8	25.9	29.4	16.60	.00
Hours per Reservation	6.2	8.4	5.8	8.4	.90	.34
Cost per Reservation	\$34.2	39.8	\$30.2	36.0	4.01	.04

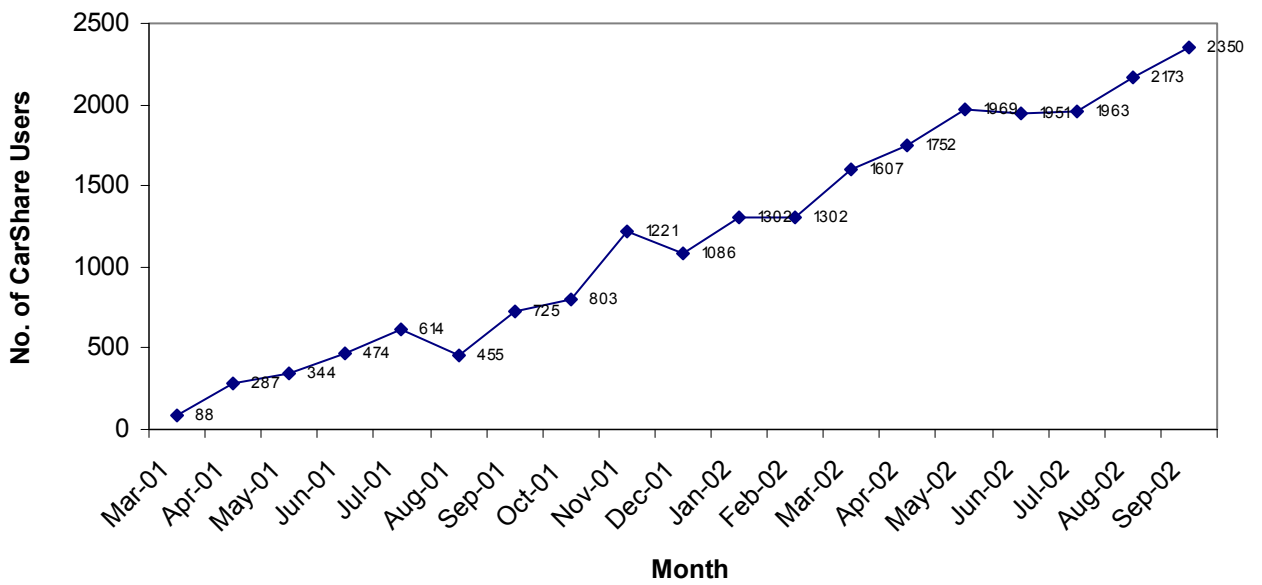


Figure A.1. Number of San Francisco CarShare Members Using CarShare Service, by Month

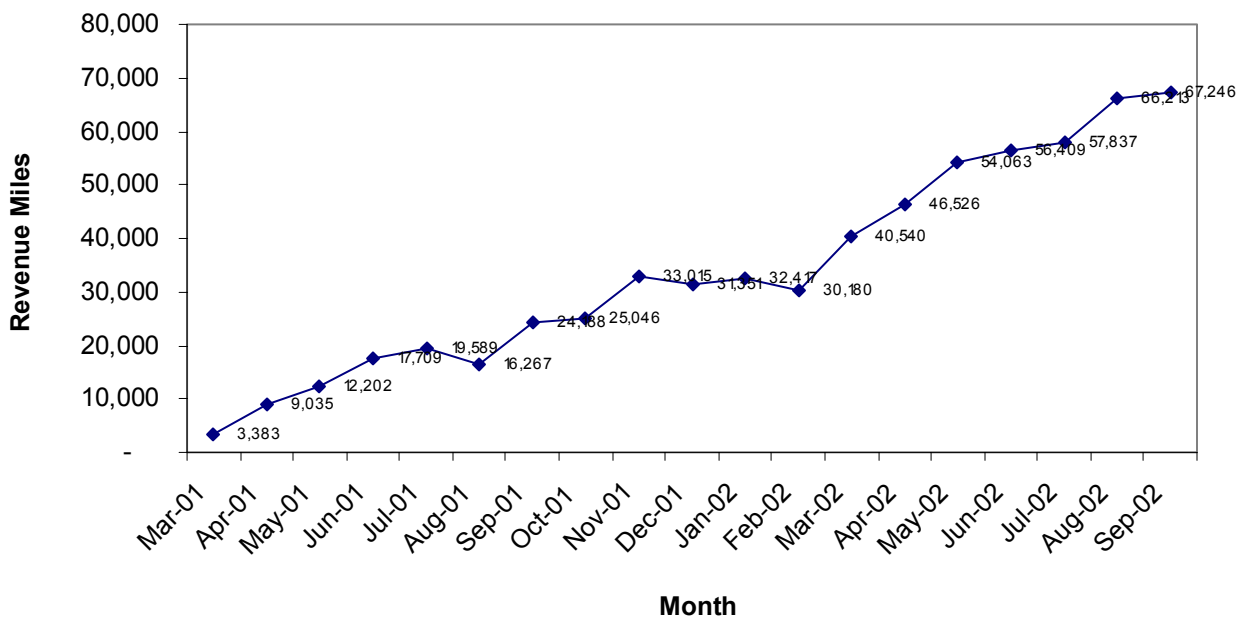


Figure A.2. San Francisco CarShare Revenue Miles, by Month

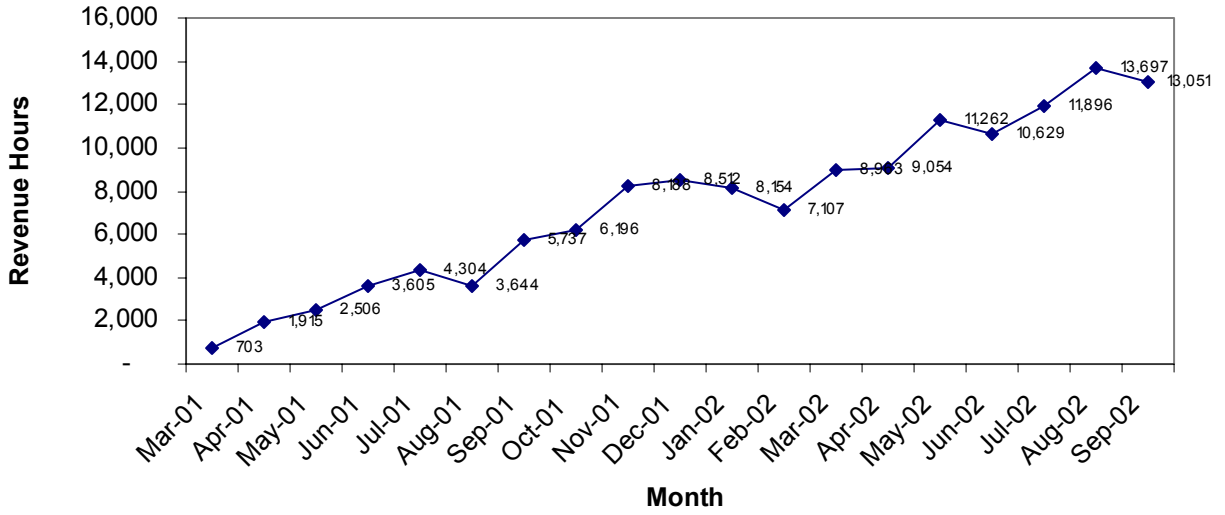


Figure A.3. San Francisco CarShare Revenue Hours, by Month

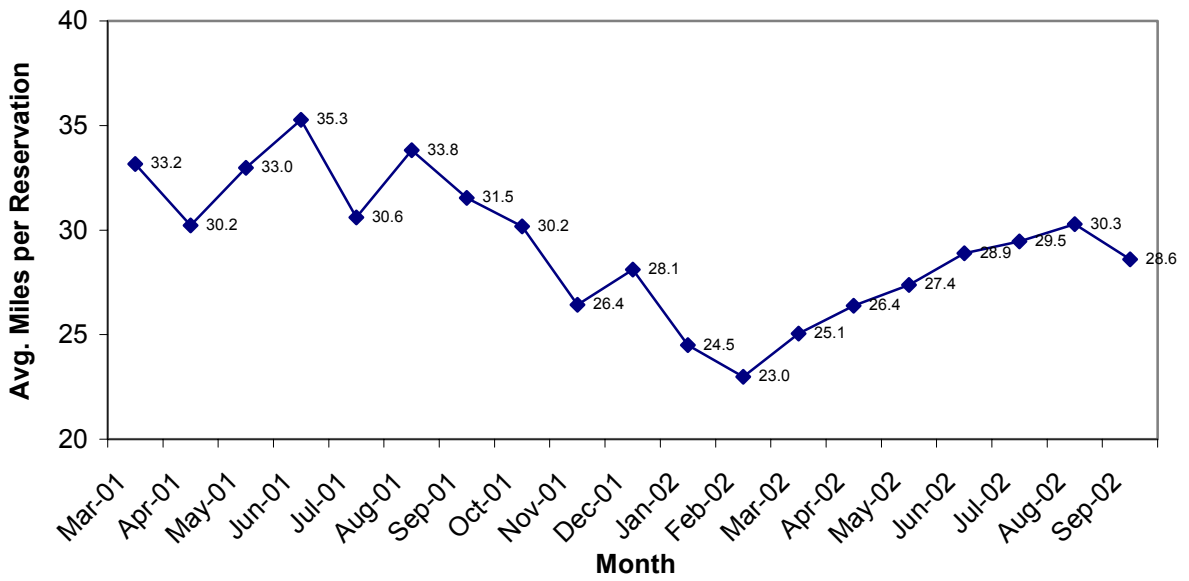


Figure A.4. San Francisco CarShare Average Miles per Reservation-Use, by Month

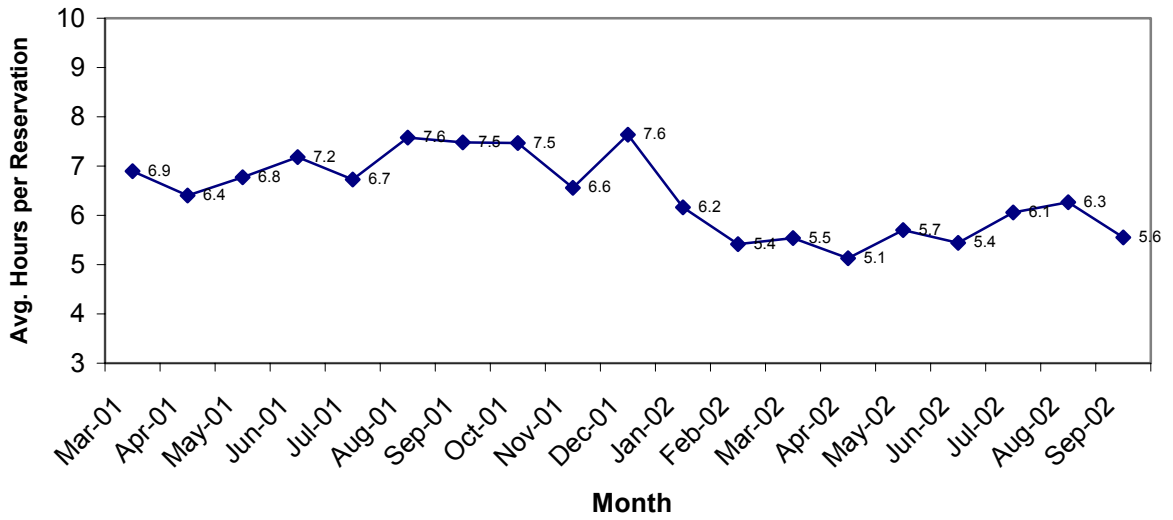


Figure A.5. San Francisco CarShare Average Hours per Reservation-Use, by Month

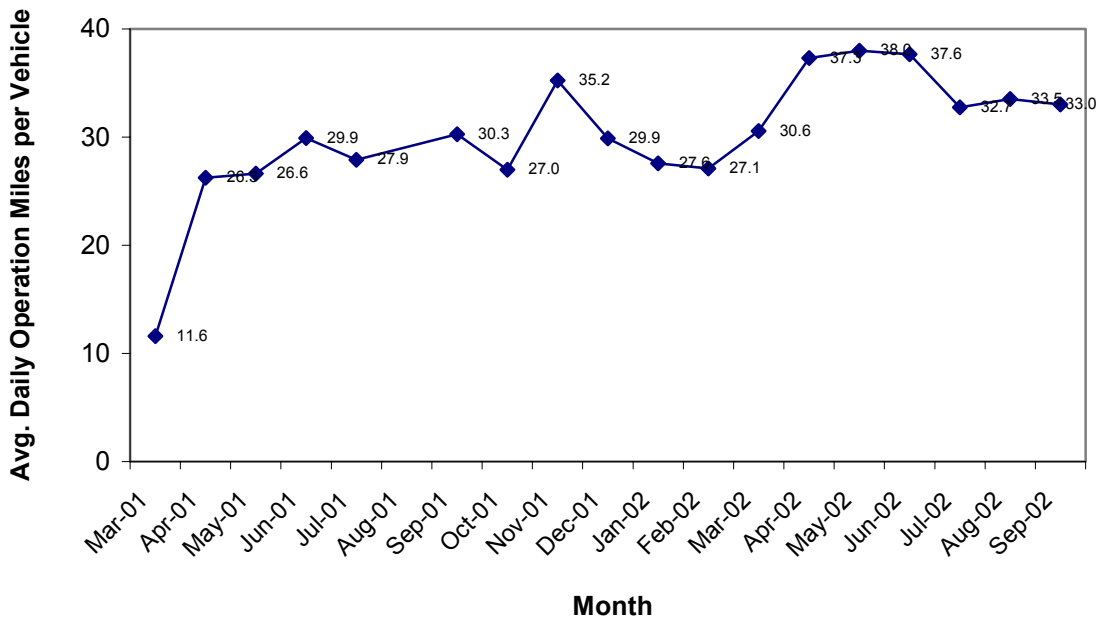


Figure A.6. San Francisco CarShare Average Daily Operation Miles per Vehicle, by Month

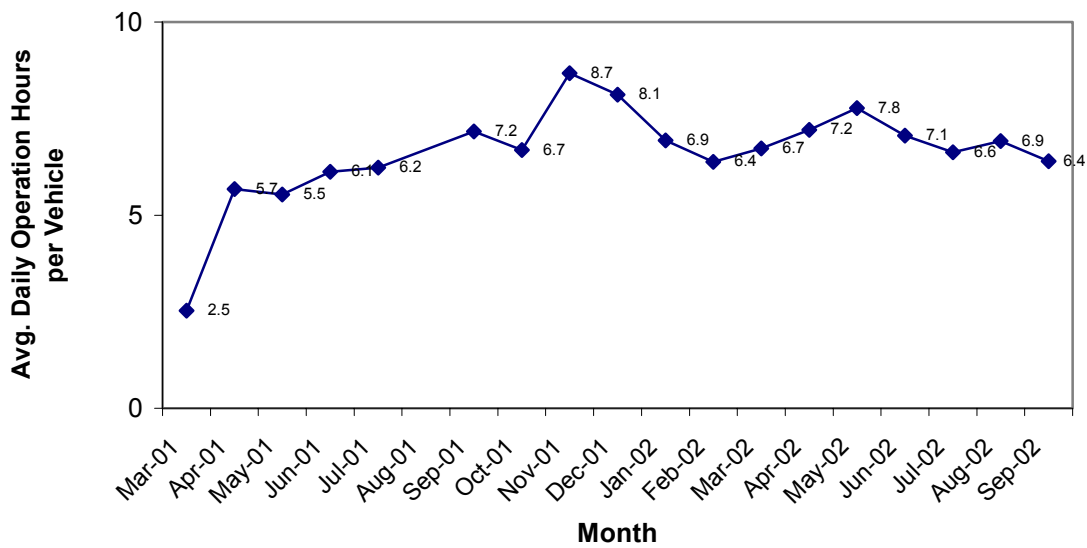


Figure A.7. San Francisco CarShare Average Daily Operation Hours per Vehicle, by Month

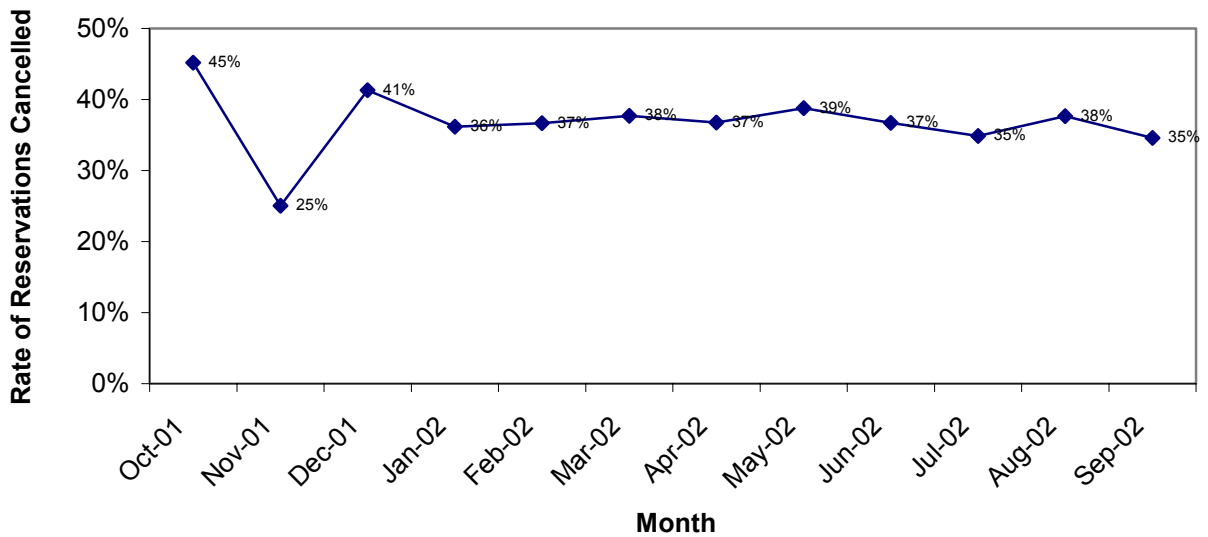


Figure A.8. Rate of Reservations Cancelled of San Francisco CarShare Trips, by Month

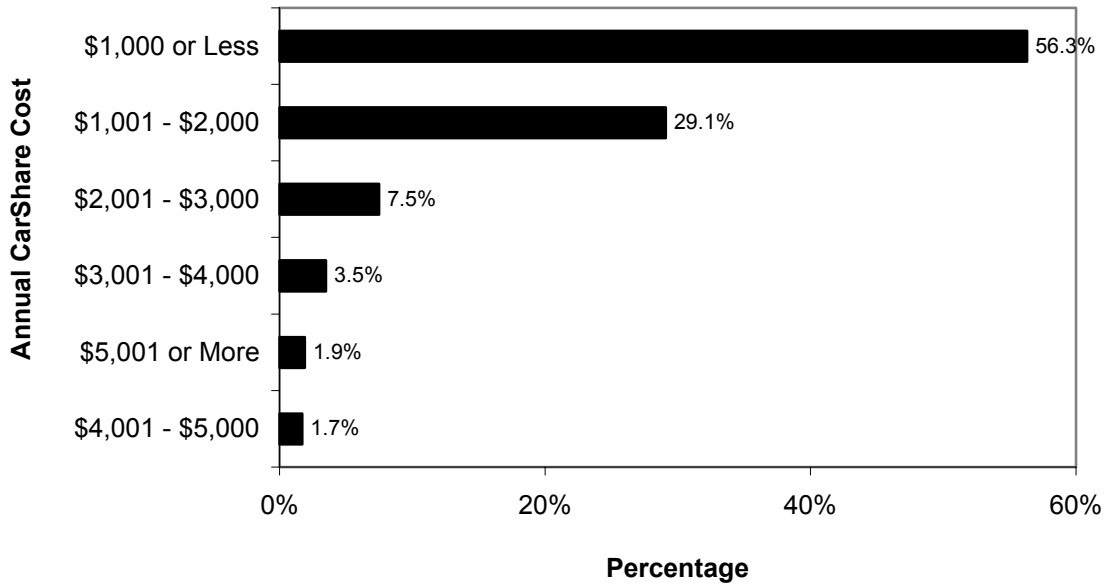


Figure A.9. Distribution of San Francisco CarShare Members' Annual CarShare Cost

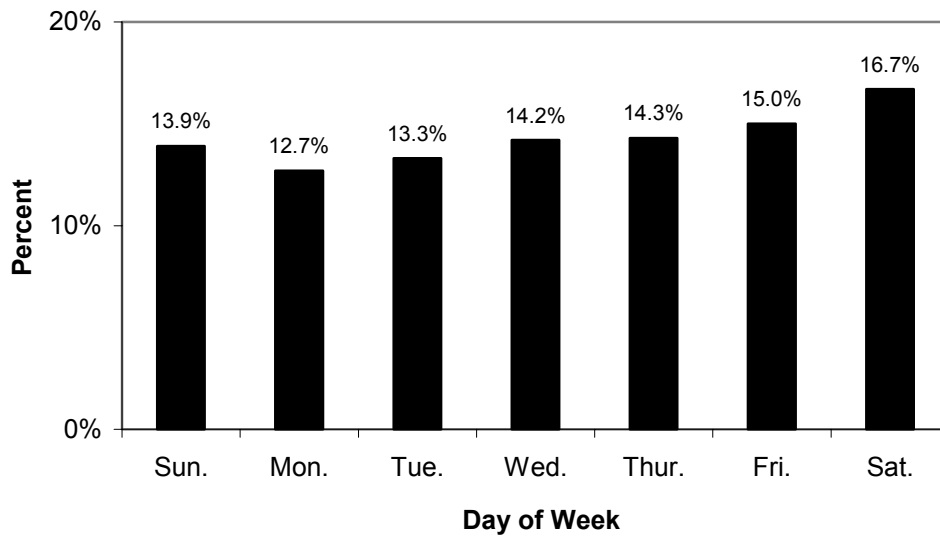


Figure A.10. Distribution of San Francisco CarShare Members' Reservation-Uses by Day of Week

APPENDIX B

In-Vehicle Survey Information on San Francisco City CarShare Usage

Exhibit B.1. City CarShare In-Vehicle Survey Instrument

CITY CARSHARE SURVEY

-- Car Use Information --

Please help us study transportation issues in San Francisco by completing this *one-page survey about your usage of a City CarShare Vehicle today*. Your responses will be strictly confidential, and will be compiled with many other responses in summary form. Your help is very much appreciated!

After you complete this survey, please put it in the drop-off envelope mounted on the back of the clipboard, or fold it in half and drop it in a mailbox within one week.

1. Today's date: _____
2. I reserved this car beginning at ____:____ AM/PM (*please circle one*)
3. How did you get to the city carshare (CCS) pod?
₁ Drive ₂ Car or Van Passenger ₃ Motorcycle ₄ Public Transit
₅ Walk ₆ Bike ₀ Other (*specify:* _____)
4. How many persons (*including yourself*) were in this CCS vehicle? ____ Adults, ____ Children
5. What was the trip purpose(s)? (*please check all that apply*)
₁ Go to Work ₂ Go to School ₃ Shopping ₄ Social (e.g., visit a friend)
₅ Personal Business (e.g., to bank) ₆ Medical ₇ Recreational
₈ Eating (e.g., to restaurant) ₉ Returning home ₀ Other (*specify:* _____)
6. Address or nearest intersection of the main destination using this CCS vehicle:

7. How often do you make the trip(s) (*not necessarily driving the CCS vehicle*)?
₁₆ 3 times a week or more ₆ 1-2 times a week
₂ Once every other week ₁ Once a month or less
8. How often do you make the trip(s) *by the CCS vehicle*?
₃ Always ₂ 2/3 of trips ₁ Half of trips ₁ 1/3 of trips ₁ Less than 1/3 of trips
9. Before you joined the CCS program, what transportation did you use for the trip(s)? (*Please check all that apply*)
₁ Drove ₂ Car or Van Passenger ₃ Motorcycle ₄ Public Transit
₅ Walked or Biked ₀ Other (*specify:* _____)
10. Your gender: ₀ Female ₁ Male
11. Your age? _____
12. Your Race: ₁ Hispanic/Latino ₂ White/Caucasian ₃ African-American
₄ Pacific-Islander ₅ Asian-American ₆ Native-American
₀ Other (*Please specify:* _____)
13. Your personal Annual Income (year 2001, rounded to nearest \$1,000): _____
14. Your household type: ₁ Married or equivalent, with children ₂ Married or equivalent, no children
₃ Not married, with children ₄ unrelated adults
₅ Live alone ₀ Other (*specify:* _____)

***** *Thanks for your time and assistance* *****

Exhibit B.2. Cover Letter on In-Vehicle Survey

UNIVERSITY OF CALIFORNIA, BERKELEY

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO



SANTA BARBARA • SANTA CRUZ

INSTITUTE OF URBAN AND REGIONAL DEVELOPMENT
BERKELEY, CALIFORNIA 94720-1870
104 WHEELER HALL # 1870
(510) 642-4874
(510) 643-9576 FAX

August 16, 2002

Dear Sir or Madam:

We'd appreciate your help in our continuing study of car sharing in San Francisco. Between late August and September, City CarShare members will be asked to fill out a one-page survey about trip(s) made by using a City CarShare vehicle. We request your participation in this survey.

Surveys will be in the City CarShare vehicle (i.e., the side-pocket on the driver's side). We ask that you complete this survey after you've finished your trip. Return the completed survey to the drop-off envelope on the back of the clipboard. You can also mail back the survey. Just fold it in half and drop in a mailbox. We would appreciate your mailing it back to us within one week of your trip(s).

Your participation is entirely voluntary. Completion of the survey should take about 3 minutes. To protect the confidentiality of your responses, we will keep all completed surveys in a locked file accessible only to the research team, and will use all responses for statistical analysis only. If you have any questions, please phone Yu-Hsin Tsai at (510) 642-4874.

Thanks for your help and support.

Sincerely,

Robert Cervero, Professor
Institute of Urban and Regional Development

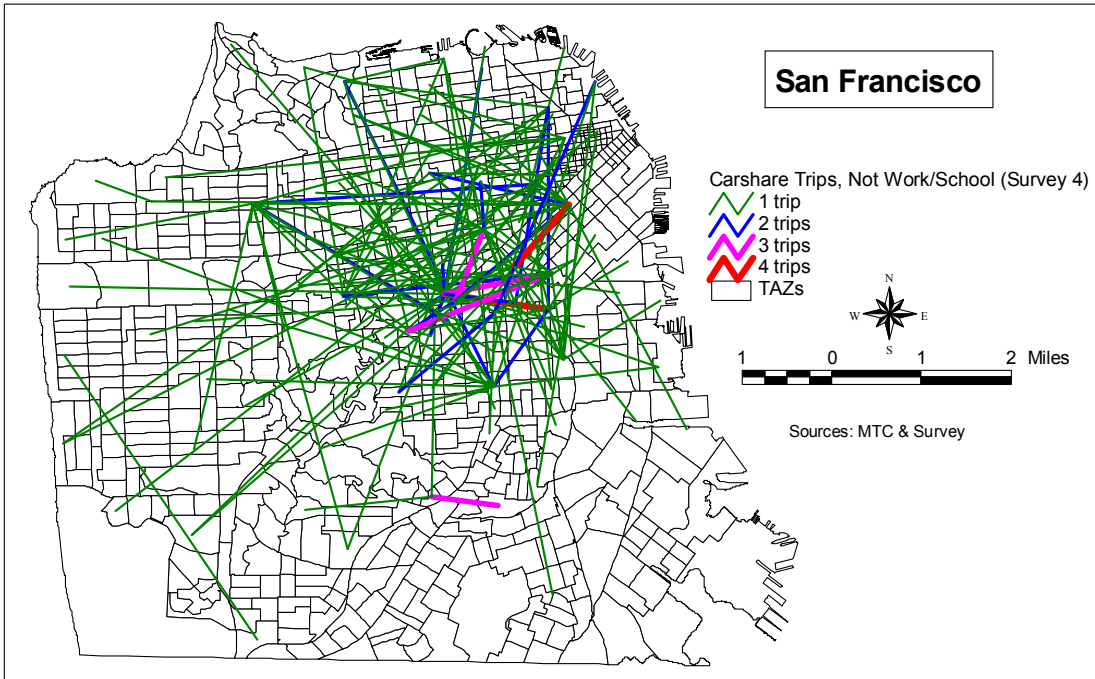
Elizabeth Sullivan, Executive Director
City CarShare

**Table B.1. Distribution of Completed City CarShare In-Vehicle Surveys,
by POD and Vehicle**

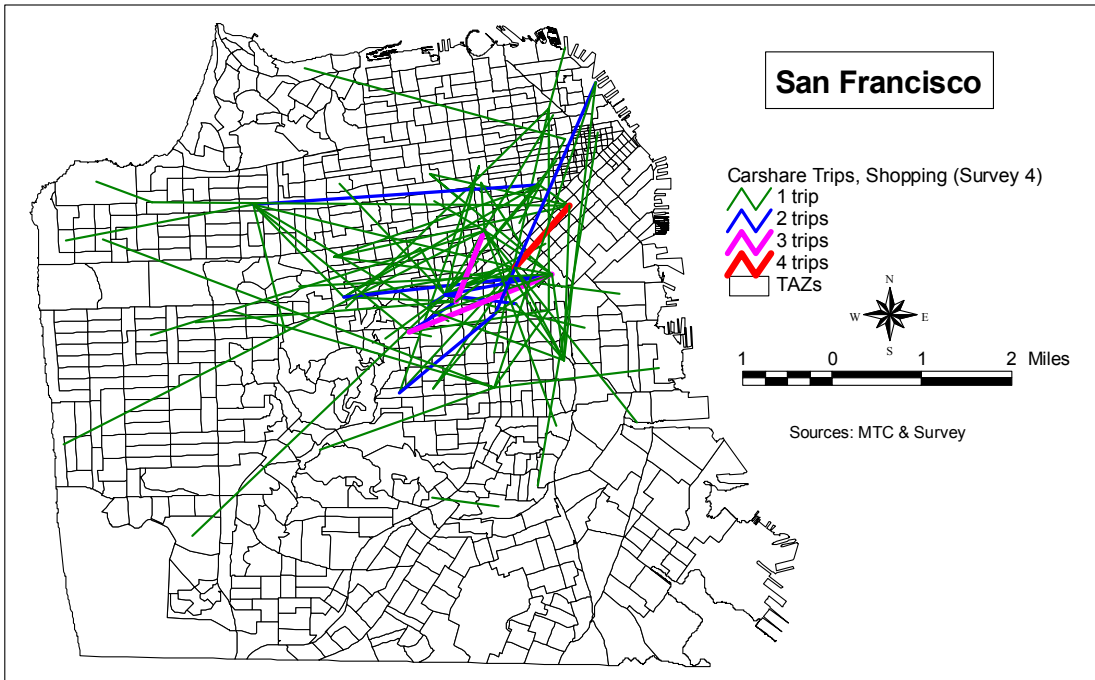
POD	CarShare Vehicle No.						Total
	1	2	3	4	5	6	
1. 5 th & Mission (4*)	7	10	5	13			35 (4**)
2. Golden Gateway (3)	4	1	3				8 (3)
3. Performing Arts (3)	11	8	13				32 (3)
4. Vallejo (4)		4	5	13			22 (3)
5. St. Mary's Square (3)	2	7	7				16 (3)
6. New Mission Bartlett (5)	9	9	4	6	8		36 (5)
7. Davies (6)	6	9	8	9	12	10	54 (6)
8. 16 th & Hoff (2)	6	11					17 (2)
9. General Hospital (2)	7	7					14 (2)
10. Kezar (3)	12	5	5				22 (3)
11. California & Fillmore (3)	4	1	6				11 (3)
13. Castro (2)	11	7					18 (2)
16. 8th Ave & Clement (2)	12	5					17 (2)
20. Lombard Gate (1)	5						5 (1)
21. Ocean View Village (1)	1						1 (1)
25. Glen Park BART (2)	9	7					16 (2)
26. Saint Mary's Medical Center (2)	6	4					10 (2)
Total (48)	112		56	41	20	10	334 (47)

Note: * Number of CarShare vehicles in the POD during the October 2002 in-vehicle survey period.

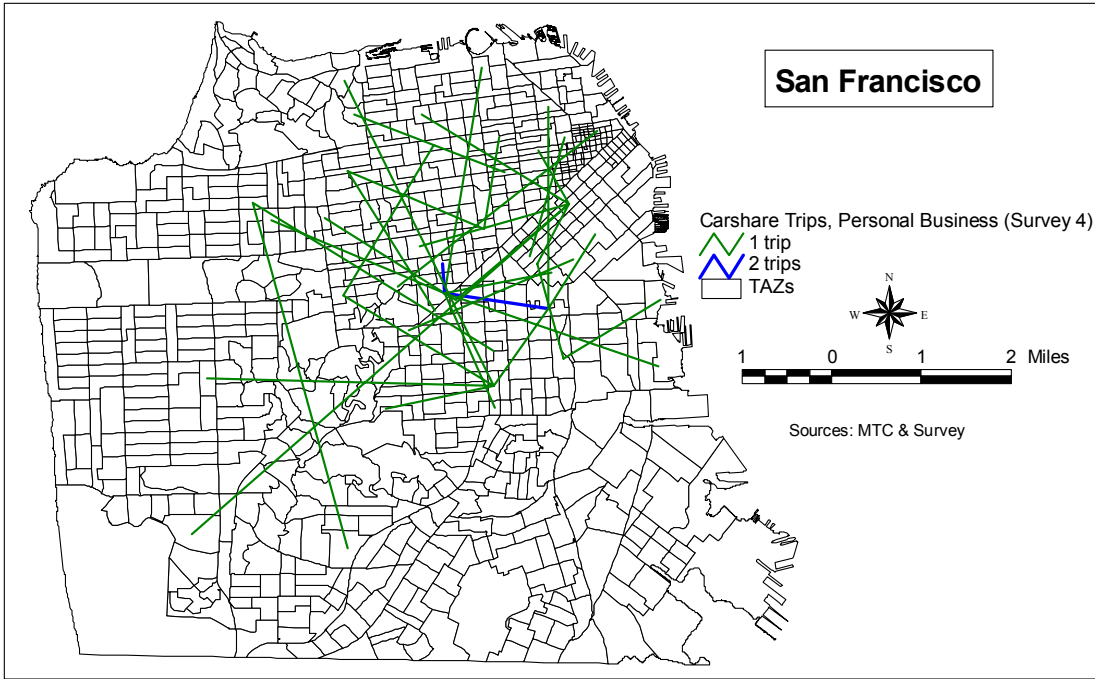
** Number of CarShare vehicles with responses.



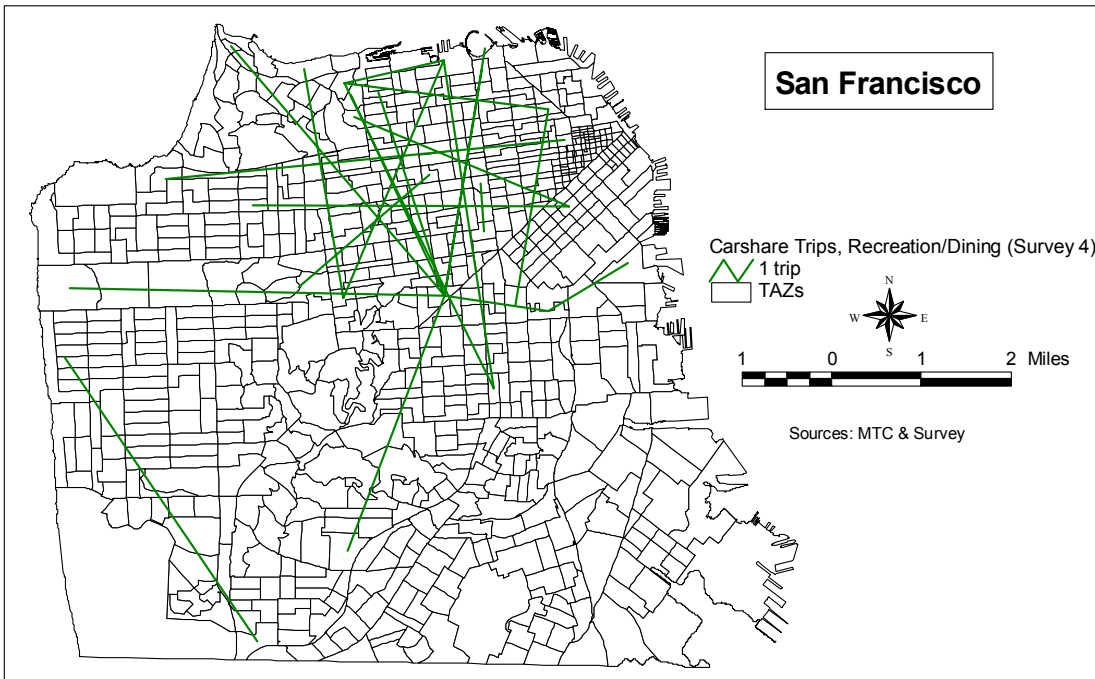
Map B.1. Origin–Destination Patterns of Non-Work CarShare Trips Within the City of San Francisco; September–October 2002, In-Vehicle Survey



Map B.2. Origin–Destination Patterns of Shopping CarShare Trips Within the City of San Francisco; September–October 2002, In-Vehicle Survey



Map B.3. Origin–Destination Patterns of Personal Business CarShare Trips Within the City of San Francisco; September–October 2002, In-Vehicle Survey



Map B.4. Origin–Destination Patterns of Recreation/Dining CarShare Trips Within the City of San Francisco; September–October 2002, In-Vehicle Survey

APPENDIX C

Travel Diary and Background Survey Information

Exhibit C.1. Background Survey

CITY CARSHARE SURVEY

- Background Information -

Please help us study transportation issues in San Francisco, including car-sharing, by completing this survey. Your responses will be strictly confidential and will be compiled with many other responses in summary form. Your help is very much appreciated!

YOUR NAME: _____

TODAY'S DATE: _____

I. PLEASE TELL US ABOUT YOU

1. Age: _____

2. Gender: Male Female

3. Race: African-American Asian-American Native American Pacific Islander White Other: _____

4. Ethnicity: Do you identify yourself as Latino/Hispanic? Yes No

5. Home address: _____

6. Work status: Full-time employed occupation: _____ Part-time employed occupation: _____ approx. # of hours you work per week: _____ Student (check one): college undergraduate student college graduate student other (specify): _____ Not working Other (specify): _____

7. Personal annual income (for year 2000, rounded to the nearest \$1,000): _____

8. Highest level of education you have completed: Grade school High school College (Associate's, Bachelor's, etc.) Graduate/Professional Other (specify): _____

9. Are you self-employed? Yes No If Yes, do you mainly work at home? Yes No

10. If you work outside your home: a) How many days per week do you typically go to work? _____ b) What is the address of your main workplace (or nearest intersection to it): _____

c) What type of business do you work for? _____

d) Approximately how many other people work there? _____

11. Travel to work: a) What is the usual time you: leave from home to go to work? _____ (circle one) AM / PM leave from work to return home? _____ (circle one) AM / PM

11. b) How do you usually get to work? (check the main mode)

Drive alone Drive with other passengers Passenger in car or van Motorcycle Bus (specify service & route): _____ Rail Transit (specify service & route): _____ Walk Bicycle Other (specify): _____

12. If you take rail transit (e.g., BART, Muni, CalTrain) to get to and from work, how do you usually access the station or stop? Also, what is the approximate access distance?

a) From Home to Rail Stop (check one): Walk Bicycle Bus Other (specify): _____ Access distance (indicate if in feet or miles): _____

b) From Work to Rail Stop (check one): Walk Bicycle Bus Other (specify): _____ Access distance (indicate if in feet or miles): _____

13. How many minutes does it typically take to commute from your residence to your workplace? _____

14. Does your employer provide: a) free parking? Yes No If No, how much do you typically pay? (specify if per day, per week, or per month): _____

b) a parking discount? Yes No If Yes, how much is the discount? (specify if per day, per week, or per month): _____

15. Does your employer provide you: a) a transit pass or allowance? Yes No b) access to a company car? Yes No c) any other transportation benefits? Yes No If Yes, please specify: _____

16. Do you: a) own a bicycle? Yes No b) have a Muni Fast Pass or other transit pass? Yes No c) have off-street parking at your residence? Yes No If Yes, do you pay for it? No Yes How much? (specify if per day, per week, or per month): _____

II. PLEASE TELL US ABOUT YOUR HOUSEHOLD

1. Number of persons living in household: _____
2. Household type: Married, with children
 Not married, with children
 Married, no children
 Unrelated adults
 Live alone
 Other (specify): _____
3. Are any other members of your household signed up or planning to enroll in City CarShare?
 Yes No
 If **Yes**, who is the person and what relationship is this person to you? _____

III. MOTOR VEHICLES AT YOUR RESIDENCE

Please provide information on the motor vehicles at your residence (*including cars, trucks, pick-ups, vans, SUVs, RVs, motorcycles, and mopeds*) and specify whether you own the vehicle, someone else owns it but it is available for your use, or someone else owns it and it is not usually available for your use. If there are no motor vehicles at your residence, leave this section blank.

VEHICLE 1
Make:
Model:
Year:
Number of cylinders (4, 6, 8)*:
Engine size (in centimeters)*:
Odometer reading (in miles):
Check One: <input type="checkbox"/> I own this vehicle <input type="checkbox"/> Someone else owns this vehicle but I can use it <input type="checkbox"/> Someone else owns this vehicle and it is usually not available for my use

VEHICLE 2
Make:
Model:
Year:
Number of cylinders (4, 6, 8)*:
Engine size (in centimeters)*:
Odometer reading (in miles):
Check One: <input type="checkbox"/> I own this vehicle <input type="checkbox"/> Someone else owns this vehicle but I can use it <input type="checkbox"/> Someone else owns this vehicle and it is usually not available for my use

VEHICLE 3
Make:
Model:
Year:
Number of cylinders (4, 6, 8)*:
Engine size (in centimeters)*:
Odometer reading (in miles):
Check One: <input type="checkbox"/> I own this vehicle <input type="checkbox"/> Someone else owns this vehicle but I can use it <input type="checkbox"/> Someone else owns this vehicle and it is usually not available for my use

VEHICLE 4
Make:
Model:
Year:
Number of cylinders (4, 6, 8)*:
Engine size (in centimeters)*:
Odometer reading (in miles):
Check One: <input type="checkbox"/> I own this vehicle <input type="checkbox"/> Someone else owns this vehicle but I can use it <input type="checkbox"/> Someone else owns this vehicle and it is usually not available for my use

* Information on the make, model and year is the most important. Information on the number of cylinders and engine size would also be useful, particularly if the engine is a non-standard option for the model. This information can sometimes be found in the owner's manual. If not, you can determine the number of cylinders by counting the number of black rubber spark-plug cables going into the engine block (4, 6 or 8 in most cases). You can determine the size of the engine (displacement) from the engine specification plate located on the underside of the hood.

NOTE: If there are more than 4 motor vehicles at your residence, please record information for these other vehicles on additional pages.

1 CITY CARSHARE SURVEY

—Travel Diary: Day 1—

Name: _____

Date of recorded trips: _____ (12:01am to midnight)

Please help us study transportation issues in San Francisco by completing this survey about all of your 24-hour travel, **including trips made by private or City CarShare car, transit, bike, foot, or other means.**

You do not need to own or drive a car to fill out the travel diary; we are collecting information on all travel.

Your responses will be strictly confidential and will be compiled with many other responses in summary form. Your help is very much appreciated!

1ST: Please provide as much information as possible on the private motor vehicles you used to make trips on this date. Include all vehicles used, even if you do not own them. You **DO NOT** need to include this information for City CarShare cars.

MOTOR VEHICLES		
VEHICLE 1	VEHICLE 2	VEHICLE 3
Make:	Make:	Make:
Model:	Model:	Model:
Year:	Year:	Year:
Number of cylinders (4, 6, 8)*:	Number of cylinders (4, 6, 8)*:	Number of cylinders (4, 6, 8)*:
Odometer reading (in miles):	Odometer reading (in miles):	Odometer reading (in miles):

* Information on the make, model and year is the most important. Information on the number of cylinders would also be useful, particularly if the engine is a non-standard option for the model.

If you used more than 3 motor vehicles, please record information about these other vehicles on additional pages.

THANK YOU
—For Your Time & Assistance—

2ND: Are there any **OTHER** motor vehicles at your residence (including cars, trucks, vans, SUVs, RVs, motorcycles, and mopeds) not listed on the previous page?

MOTOR VEHICLES	
VEHICLE A	VEHICLE B
Make:	Make:
Model:	Model:
Year:	Year:
Number of cylinders (4, 6, 8)*:	Number of cylinders (4, 6, 8)*:
Odometer reading (in miles):	Odometer reading (in miles):
VEHICLE C	VEHICLE D
Make:	Make:
Model:	Model:
Year:	Year:
Number of cylinders (4, 6, 8)*:	Number of cylinders (4, 6, 8)*:
Odometer reading (in miles):	Odometer reading (in miles):
* Information on the make, model and year is the most important. Information on the number of cylinders would also be useful, particularly if the engine is a non-standard option for the model.	
If there are more than 4 motor vehicles at your residence, please record information about these other vehicles on additional pages.	

3RD: Please use the following pages to record information for each trip made on this date. For each trip made with a private motor vehicle, indicate the vehicle number that was used for that trip (i.e., VEHICLE 1, VEHICLE 2, or VEHICLE 3, etc., as listed on the FRONT of this booklet).

- Pages are provided for you to record up to 9 trips.
- Consider a trip to be any journey that is over 300 feet (the length of a football field) in distance by any means (walk, drive, bike, transit, etc.). Count every segment of a journey as a separate trip—e.g., from work to grocery store and then to home is 2 trips.

TRIP 9. Fill in or check all that apply.

- Trip began at (address or nearest intersection):

 City: _____
- Trip ended at (address or nearest intersection):

 City: _____
- Time of departure: _____ AM / PM (circle one)
- Time of arrival: _____ AM / PM (circle one)
- Main mode of transportation (check one):
 - City CarShare vehicle. Indicate original parking location (pod) vehicle was taken from: _____
 - Private motor vehicle (specify vehicle number as indicated on front of diary): _____
 - Were you: _____ the driver _____ a passenger
 - Including yourself, how many people were in the vehicle? _____
 - Bus (specify bus route, if known): _____
 - Rail transit (specify type of service): _____
 (specify route number, if known): _____
 - Walk
 - Bicycle
 - Other (specify): _____
- Purpose of trip:

<input type="checkbox"/> Go to work	<input type="checkbox"/> Go to school
<input type="checkbox"/> Return home	<input type="checkbox"/> Go shopping
<input type="checkbox"/> Social (e.g., visit a friend)	<input type="checkbox"/> Personal business (e.g., to bank)
<input type="checkbox"/> Eat a meal	<input type="checkbox"/> Medical
<input type="checkbox"/> Recreational	<input type="checkbox"/> Other (specify): _____
- If you paid for any of the following, record the amount paid:
 - \$ _____ parking
 - \$ _____ transit fare
 - \$ _____ toll
 - \$ _____ other (specify): _____

* If you made more than 9 trips on this date, please record this information for these other trips on additional pages.

Exhibit C.3. Cover Letter for Background and Travel Diary Surveys



UNIVERSITY OF CALIFORNIA, BERKELEY
INSTITUTE OF URBAN AND REGIONAL DEVELOPMENT
316 WURSTER HALL #1870
BERKELEY, CALIFORNIA 94720-1870
(510) 643-9103
(510) 642-0908 FAX



410 JESSIE STREET SUITE 503
SAN FRANCISCO, CA 94103
(415) 995-8588
(415) 415-8589 FAX

March 5, 2003

Dear Sir or Madam:

We would like your help in our continuing study of transportation issues in San Francisco, with a focus on car-sharing. As you might know, a group of us at the University of California has been studying travel trends in San Francisco since the initiation of the City CarShare program in 2001. We would very much appreciate your help with this continuing study.

Enclosed are two surveys — (1) a *Background Survey*; and (2) a *Travel Survey*. The *Background Survey* collects socio-economic and car ownership information about you and your household. The *Travel Survey*, in booklet form, collects information on your travel activities for a particular 24-hour period. We ask that you complete this survey for **one of the following days: March _____ OR _____, which ever is most convenient. Again, please fill it out for just one of the two days, at your choosing.** Should neither of these two days work for you, please contact Dr. Yu-Hsin Tsai (phone: 510-642-4874; e-mail (ytsai@uclink.berkeley.edu), or Christina Ferracane (cferra@uclink.berkeley.edu) to choose a different day.

Enclosed is \$1, a small token of our appreciation for your completing the surveys. Please mail back the surveys within **one week** of when you completed the one-day travel diary. A self-addressed, stamped envelope is provided for returning the surveys. Your responses will be treated **confidentially** and pooled together with many other responses in carrying out the study.

Again, should you have any questions, please contact Dr. Yu-Hsin Tsai or Christina Ferracane. Thank you for your help and support!

Sincerely,

Robert Cervero, Professor
Institute of Urban and Regional Development

Larry Magid, Executive Director
City CarShare

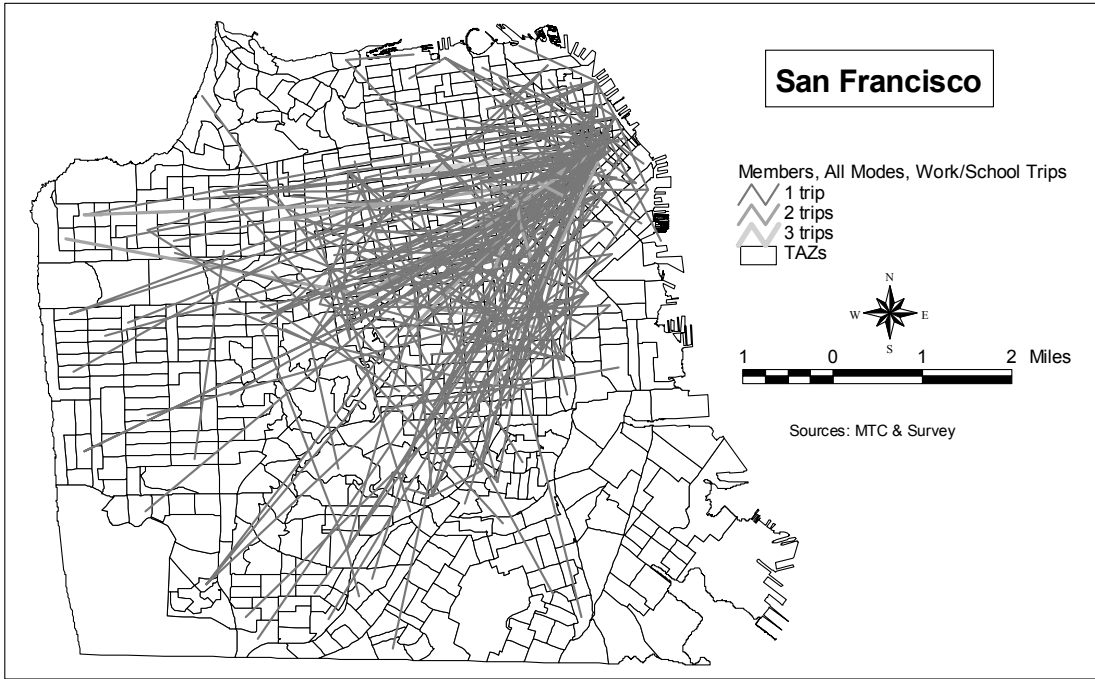
Table C.1. Randomly Assigned Days for Background and Travel Diary Surveys, Survey #4

Survey Day Option	Dates (Between March 17–30, 2003)	Percentage of Cases (Randomly*) Assigned
1	March 17 (Mon.) or 18 (Tue.)	7.1%
2	March 17 (Mon.) or 19 (Wed.)	5.8%
3	March 18 (Tue.) or 20 (Thurs.)	7.3%
4	March 19 (Wed.) or 21 (Fri.)	6.3%
5	March 20 (Thurs.) or 22 (Sat.)	7.2%
6	March 21 (Fri.) or 23 (Sun.)	8.4%
7	March 22 (Sat.) or 24 (Mon.)	6.7%
8	March 23 (Sun.) or 25 (Tue.)	7.6%
9	March 24 (Mon.) or 26 (Wed.)	6.3%
10	March 25 (Tue.) or 27 (Thurs.)	6.8%
11	March 26 (Wed.) or 28 (Fri.)	7.5%
12	March 27 (Thurs.) or 29 (Sat.)	6.6%
13	March 28 (Fri.) or 30 (Sun.)	9.4%
14	March 29 (Sat.) or 30 (Sun.)	6.8%
Total		100%

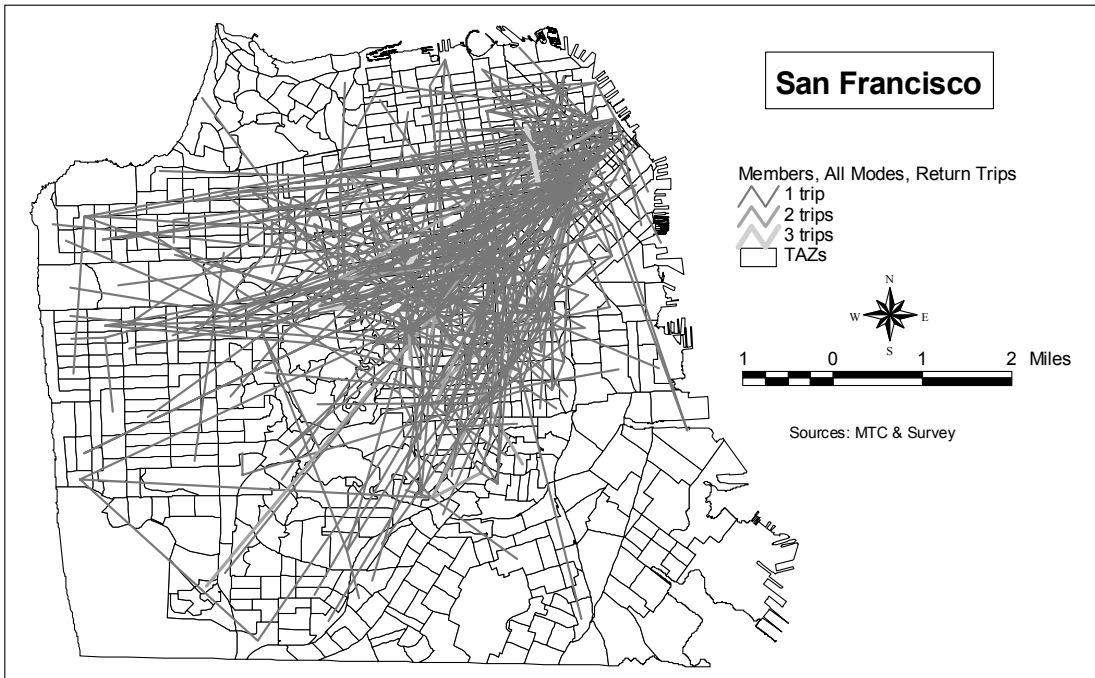
* Each surveyor was randomly assigned with a survey day option with an Excel function (i.e., $\text{int}(\text{rand()}*14+1)$)

APPENDIX D

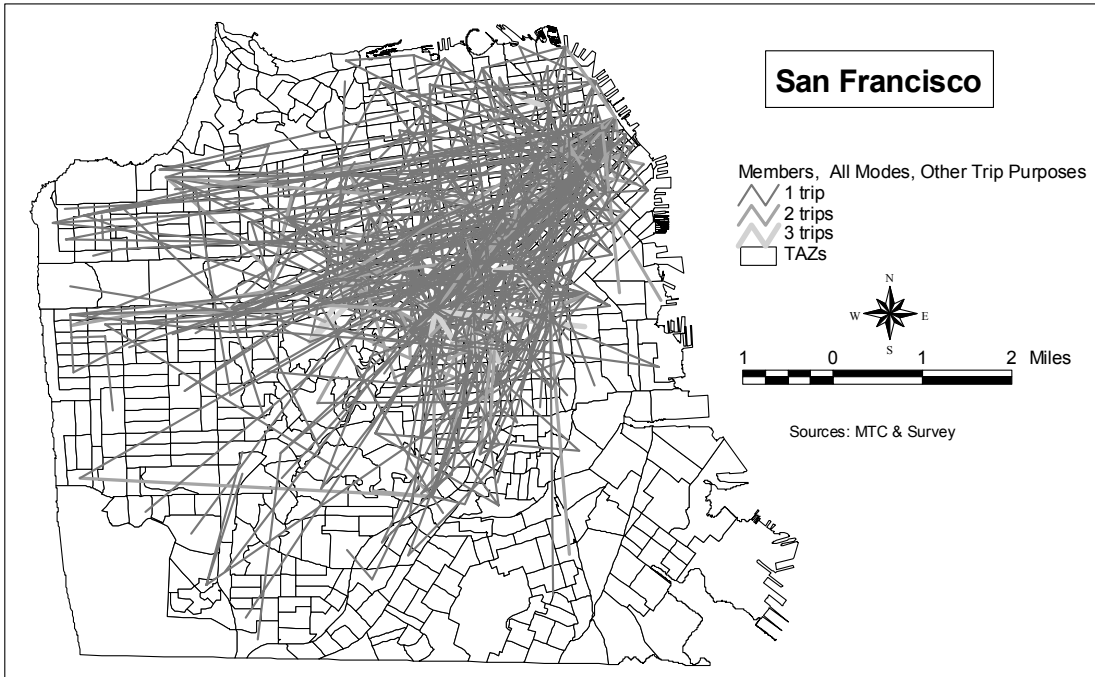
Desire Line Maps from Travel Diary Survey



Map D.1. Desire Lines of Trips Made For Work or School Purposes, Members, Survey #4



Map D.2. Desire Lines of Trips Made For Return Home Trips, Members, Survey #4



Map D.3. Desire Lines of Trips Made For Other Trip Purposes, Members, Survey #4