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City CarShare: Assessment of Short-Term Travel-Behavior Impacts

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1. INTRODUCTION

One of the more innovative and potentially resourceful urban transportation initiatives in recent times is car-sharing. The sharing of motorized cars through cooperative arrangements is a market-based strategy that, proponents maintain, is suited to urban settings where parking is in short supply and good public transit and easy walking access make car ownership less imperative.

If it works as its advocates hope, car-sharing can be expected to reduce car ownership and potentially participants' annual car travel by promoting judicious use of vehicles and making consumers more mindful of the cumulative costs of automobility. On the other hand, it could induce motorized travel by increasing access to fleets of private cars, especially if members are drawn from the ranks of car-less individuals accustomed to walking, cycling, and transit riding. Because impacts on travel behavior are largely speculative, empirical research is needed to assess the likely broader public-policy implications of car-sharing.

In this report, the short-term travel-behavior impacts of car-sharing in the city of San Francisco are evaluated. San Francisco's program, City CarShare, was launched in early-March 2001 and has steadily gained popularity as more and more residents as well as non-residents have voluntarily joined the program. For purposes of studying "before-and-after" changes in travel demand, data were compiled both prior to program implementation and three to four months into the program. To remove the influences of other factors that could explain changes in travel demand besides car-sharing itself, a controlled experimental framework was adopted. This involved comparing changes in travel demand between City CarShare participants and an otherwise comparable group of non-participants over time. Besides evaluating impacts, car-sharing is profiled in terms of trip purposes, travel durations, spatial patterns of trip-making, and other attributes.

Car-sharing has been practiced in Europe for some 15 years; however, surprisingly few evaluations of impacts on travel behavior have been carried out.[1] One study estimated that car-sharers in Switzerland who previously owned cars but sold them when they switched to car-sharing reduced their average annual vehicle miles traveled (VMT) from 13,200 km to 11,000 km, an 18 percent decline.[2] Even larger reductions have been recorded in the Netherlands and Germany.[3] A British study found a high economic rate of return from car-sharing in the United Kingdom because members formed carpools mainly during peak hours, thus relieving traffic congestion.[4] Whether experiences from Europe are applicable to the United States is not yet known. Besides historical and cultural differences, the fact that the cost of auto-motoring and parking is considerably higher in Europe than in the United States, in addition to the much higher population densities and transit service levels found there, casts doubt on the transferability of European lessons.

1.1 Concept

The City CarShare organization calls its program "an innovative mobility service that makes vehicles available to people on a per-use basis." City CarShare's marketing brochure states: "Think of it as a neighborhood-based, time-share car rental that allows people to use vehicles when needed, and pay based on how much they drive."[5] Notes Board member Gabriel Metcalf: "The idea behind car sharing is to approximate the convenience of private ownership while spreading the large fixed capital costs of a car over multiple individuals."[6]

An advantage of car-sharing is that customers only use the service when they need it. As a member of the "cooperative," they need not make a reservation through an independent rental car agency every time they want access to a car. Rather, they can reserve a car over the Internet, months or minutes in advance, and pick it up at a nearby garage knowing the rate will be the same — $3.50 per hour and $0.37 per mile, in the case of City CarShare. Besides these use-based charges, City CarShare members also pay a $10 monthly fee that covers insurance and administrative overhead. Becoming a member also requires a $300 deposit, part of which goes to the cost of a "smart key" that allows a member to open and start any one of the fleet of City CarShare vehicles.

1.2 Organization and Equipment

City CarShare is a non-profit, public benefit corporation dedicated to implementing the practice of car-sharing in the San Francisco Bay Area. The organization is staffed by an Executive Director, administrators, and sub-contractors and is overseen by a decision-making Board of Directors. The program has gained steady popularity. The goal was to attract 500 members in the first year; however, by December 2001 (eight months into the program) there were already over 900 members who shared 31 cars. These vehicles are predominantly Volkswagen Beetles, distinguished by their chartreuse green exteriors and City CarShare emblem on the side door. In December 2001, cars were parked at 12 "PODs," or home locations, in different parts of the city. At the time survey data were compiled in mid-2001, the only type of vehicle available to City CarShare members was the Volkswagen Beetle and only nine PODs were in existence. For further background information on City CarShare, visit the organization's web site at www.citycarshare.org.

2. SURVEYING TRAVEL DEMAND

To support the short-term evaluation, surveys were compiled from members and non-members over two time periods. The first, which largely corresponded to a "before" survey, was compiled mainly over the period of February 18 to March 5, 2001, roughly two to three weeks before the City CarShare program was formally launched.[7] Data from the second survey, representing a time point three to four months into the program, were compiled principally over the period of June 4 to July 2, 2001.[8]

For each survey period, two different questionnaire instruments were designed and administered. One collected background information on the sample domain, such as personal socio-demographics, car-ownership, and household attributes. The second survey compiled travel information for all trips made over a two-day period, such as addresses of trip origins and destinations, mode of travel, occupancy levels, trip purpose, time of departure and arrival, and expenditures. All responses were self-reported. Both questionnaires were pre-tested and revised based on suggestions from pre-testers. A cover letter provided telephone numbers and e-mail addresses for contacting the research group in the event respondents had questions or needed clarifications. Also, a website (www-iurd.ced.berkeley.edu/citycarshare.htm) was created that explained the purpose of the research, provided answers to Frequently Asked Questions (FAQs), and allowed individuals to key-in survey information on-line. Because of the complexity of recording travel-diary information and the difficulty of recalling the specifics (e.g., departure time) of trips made earlier in a day, most respondents opted to complete and mail in hard-copies of the questionnaire. Copies of the background survey (*City CarShare Survey: Background Information*), travel-diary survey (*City CarShare Survey: Travel Diary*), and cover letter for the first survey are presented in Appendix A.

Surveys were administered by first obtaining master lists of individuals who had signed up to join City CarShare. These individuals were divided into two groups: (1) *Members:* those who officially became members by paying a full membership fee and had been formally accepted by the City CarShare program; and (2) *Non-Members:* those who had signed up but had yet to formally join the program.

2.1 Survey #1

For the first survey, called Survey #1 throughout this report, every member and non-member received, via mail, a package that included an instructional cover letter, a background questionnaire, and two travel-diary questionnaires. Also, e-mails were sent out to all City CarShare members one week before the mailings to alert them that surveys would soon be arriving and to encourage them to complete questionnaires.

The cover letter asked each person to complete and return both the background survey and two travel-diary surveys (thus providing travel data over two consecutive days). To obtain a balance of responses (spanning all days of the week over a two-week survey period), survey participants were given two sets of two consecutive days from which they could choose a single pair of days to record their travel behavior.[9] In all, 780 sets of surveys were initially mailed to all members and non-members on the original City CarShare list of interested individuals. Non-respondents received a second round of surveys and were given wider latitude on selecting days for recording travel diaries. A total of 298 surveys were received from the initial list of 780 individuals for a response rate of 38.2 percent. Background data were compiled from all 298 respondents; however, not everyone completed travel diaries, resulting in 170 sets of travel records.

2.2 Survey #2

For the second survey, conducted three to four months into the program, all of those who returned the first set of surveys were mailed second sets of surveys. Non-respondent members from Survey #1 were given the opportunity to complete Survey #2; however, because they provided only a single time-point of information, their responses were not used in making short-term "before-and-after" comparisons. (They were surveyed regardless under the premise that, if they completed the second survey, they could thus enlarge the sample size for studying longer term impacts in the future.) Individuals were asked to complete travel diaries for similar types of days as they did in Survey #1. "Day-types" were distinguished in terms of whether the day of recorded travel was a weekday or weekend, and whether it was a day that respondents worked (workdays) or not (non-workdays). Thus, there were four day-types: weekdays/workdays; weekdays/non-workdays; weekends/workdays; weekends/non-workdays. The sampling frame followed this same order: the largest number of travel diaries was obtained for weekdays/workdays, followed by weekdays/non-workdays and then weekends/workdays, and the fewest obtained were for weekends/non-workdays.

After initial mailings and mail-backs, 199 surveys were returned (including on-line submittals) out of the 575 individuals who received questionnaires, for a response rate of 34.6 percent.[10] A total of 147 individuals completed both Survey #1 and Survey #2, providing a panel for conducting the before-and-after survey. Non-members comprised the majority of panel responses.

Between the first and second surveys, new members joined City CarShare. These individuals received both background surveys and travel-diary surveys. While their responses did not contribute to the short-term before-and-after analysis, they did provide cross-sectional records of travel among City CarShare members that are reported later in this report.

3. RESEARCH CONTEXT AND METHODOLOGY

Car-sharing is often heralded as a progressive initiative that promotes sustainable transportation. This could take the form of individuals selling personal cars and, mindful of the hourly cost of leasing a car-share vehicle, reducing overall vehicle miles of travel over time. However, the program might also have some unanticipated consequences — such as prompting some participants to give up transit riding and carpooling in favor of leasing cars, or inducing more chained trip-making (e.g., taking bus-transit to reach a City CarShare vehicle, perhaps increasing vehicle-miles-traveled in the process).

This section first presents several propositions about the travel-demand impacts of car-sharing. This is followed by discussions on the methodology used to evaluate impacts and draw larger policy inferences.

3.1 Propositions on Travel Impacts

The effects of car-sharing on travel behavior remain somewhat speculative. Group-sharing of vehicles could exert countervailing influences whose net results are unclear. One impact could be *travel efficiency*, which should translate into an overall reduction in travel. An opposite effect could be *travel inducement*, resulting in a net travel increase. These two opposing impacts are outlined below.

> *Travel Efficiency*: Paying a regular fee for access to and use of a car could spawn cost-conscious behavior. With an automobile, many expenses, such as annual insurance payments, capital outlays, and debt service, are treated as "foregone" or "sunk" costs. Cognitively, motorists are thought to "write-off" such costs, almost as if they are subscription fees in order to participate in American society. By making the cost of car use transparent and conspicuous, participants might be more conscientious about the full opportunity cost of each trip, money that could go to other purposes. They are also more apt to be judicious and selective in their choice of mobility options — such as foregoing motorized trips that are viewed as non-essential and offering low utility or choosing a subcompact for in-neighborhood travel and a large vehicle for weekend excursions (although in this particular analysis, members only had one vehicle from which to choose). Such responses should bring about more efficient and resourceful travel.
>
> *Travel Inducement*: An opposite reaction might be the stimulation of more travel. Economic theory suggests that by increasing the "supply" of urban mobility, car-sharing might increase motorized trips. This will particularly be the case when members are drawn from the ranks of non-car-owning individuals and zero-car households. Trips that previously were not made might now be made — presumably in the form of more discretionary travel like single-purpose convenience shopping. Or trips that were made by bike, bus, or walking might now be made by single-occupant cars.

3.2 Evaluation Design

From a research design standpoint, the greatest challenge in evaluating an initiative like car-sharing is *attribution*. Upon implementation, vehicle ownership levels might fall and local traffic conditions might improve; however, this does not mean that car-sharing *caused* these outcomes. Other factors, like rising real gasoline prices or a slow-down in economic growth, might be more influential. Thus, the challenge of any evaluation effort is to effectively and unambiguously separate out the effects of the policy of interest (i.e., car-sharing) from all the other events going on in the world that might shape outcomes. One of the best ways of doing this is to include statistical controls. This approach, called matched-pair testing, is not unlike what a medical researcher does when trying to gauge the success of a drug — e.g., the health status of members of a "test" group (that receive the drug) and of a "control" group (that unknowingly receive a placebo) are compared over at least two time points. In medical research, this is done by randomly assigning

target populations into "test" and "control" groups. Since this is not possible with non-clinical studies, a "quasi-experimental" approach is often adopted. In the case of car-sharing, this means sampling among car-sharing participants and non-participants (who, rather than being randomly assigned, have self-selected into their respective groups). Any differences in travel patterns between the "test" and "control" cases over time can be attributed to the car-sharing scheme as long as any other changes that occur (e.g., rising fuel prices) are comparable across both groups, which generally should be the case.

In the first-year analysis, the control group used to compare trends in travel behavior represented individuals who had registered to join City CarShare but had not yet formally joined, for reasons like a POD where car-share vehicles are parked is not located near their residence. Thus, they represent people inclined to car-share and who hope to one day participate. The advantage of using these non-participants as the "control" group is that they have comparable levels of motivation as participants — i.e., they have taken the time to sign up for the program. This means factors like level of motivation and level of interest, as well as possibly factors such as ideological leanings (e.g., the support of environmentally "green" modes of transportation), are potentially controlled for by using non-participants as the control group. A second advantage of this sampling approach is that it allows for resource efficiencies. This is because while "non-participants" fall into the "control-group" category at one time point, when they later formally participate, they then fall into the "test-group" category. This allows us to "kill two birds with one stone" — we are able to use non-participants as cross-sectional controls and are also able to later measure "before-and-after" changes in travel behavior as these individuals switch from the "control-group" to the "test-group" category.

The analytical framework used in assessing impacts was as follows:

$$\textit{Impact} = (T_{t,a} - T_{t,b}) - (T_{c,a} - T_{c,b}), \text{ where:}$$

T = trip or impact measure;
t = "test" (car-sharing) cases;
c = "control" (non-car-sharing, but otherwise comparable) cases;
a = later time point; and
b = early time point (ideally, before project implementation).

Statistically, this amounts to a "differences in difference of means" test. If car-sharing exerts real and meaningful impacts on, say, travel behavior, then this approach should reveal statistically significant "differences" across the two "different" groups.

For this research, an example of why the introduction of controls was important were the marked differences in weather conditions over the two survey periods. For the three-week period of February 18 to March 5, 2001, when people were asked to record travel-diary information for Survey #1, the total rainfall recorded in downtown San Francisco was 5.39 inches — a particularly heavy period of precipitation. For the period of June 4 to June 24, 2001, when the bulk of responses from Survey #2 was recorded, there was no measurable rainfall in downtown San Francisco. Rainy conditions could have dissuaded

people from walking and cycling in Survey #1 and perhaps forego some trips altogether, whereas dry and warmer weather conditions likely invited more foot and bicycle travel in Survey #1 and perhaps added trips. Of course, there is no way to predict the whims of Mother Nature, thus the introduction of controls become essential in examining changes over time. As long as weather conditions affected members and non-members equally (which there is no reason to believe they should not), then the effects of rainfall are netted out in a "difference of difference of means" analysis.

3.3 Metrics

Various metrics of travel consumption were created from survey responses. They are defined below.

> *Vehicle Miles Traveled (VMT)* equals total miles logged on roadways in motorized vehicles.[11] In calculating VMT, all non-vehicle (i.e., walk and bicycle) trips were assigned zero values. In the analyses presented later in this report, VMT was measured as the mean daily VMT per person, averaged over the two days of travel as recorded in travel diaries.
>
> *Mode-adjusted Vehicle Miles Traveled (MVMT)* represents total miles logged on roadways in motorized vehicles, adjusted for the occupancy level of vehicles. Mathematically, MVMT equals (total highway VMT)/(vehicle occupancy) where values for transit, walking, and cycling equal zero. If someone drives alone for 30 miles, this represents a MVMT of 30. If instead they drive 30 miles with someone else, the MVMT is 15 (30/2). And if the trip is made by public transit, wherein no new vehicles are added to the streets, the MVMT is zero.
>
> *Mode and Engine-Size adjusted Vehicle Miles Traveled (MEVMT)* is an overall index of transportation resource consumption. It measures total miles logged on roadways in motorized vehicles, adjusted for the occupancy level and engine size of vehicles. MEVMT = [(total highway VMT)*(engine displacement in cubic centimeters)]/(vehicle occupancy) wherein engine size was either recorded in surveys or estimated based on the most common engine size given the make, year, and model of vehicle used for a trip. MEVMT is thought to provide a multi-factor gauge of resource consumption as reflected by engine sizes and vehicle occupancy levels. Trips with low MEVMT values can generally be expected to correspond to ones with low levels of fuel consumption and exhaust emissions; trips with high values are likely the most resource-consuming ones.

3.4 Measurement of Travel Impedance and Consumption

All measures of travel impedance (e.g., trip distance, travel times) and travel consumption (e.g., VMT) were estimated using "network path" travel times between centroids of traffic analysis zones (TAZs) maintained by the city of San Francisco. The

city's TAZs are considerably smaller in land area than those of the typical regional transportation planning organizations, including the Metropolitan Transportation Commission (MTC). The city has more than 300 TAZs (for a land area of 49 square miles) compared to MTC's 1,099 TAZs (over a land area of some 3,200 square miles covering nine counties). Thus, impedance and travel-consumption estimates made for surveyed trips are considered to be more accurate than those estimated from regional travel networks. While errors invariably creep into the estimation process when calculating centroid-to-centroid values, there is no reason to believe estimates are in any way systematically biased.

For all modes, including walking and cycling, all distance-related estimates were derived over highway networks, except in the case of transit trips on fixed-guideway rail systems (e.g., BART, San Francisco Muni), in which case estimates were derived over rail-networks. Travel-time estimates accounted for mode of transportation; for example, bike trips were estimated to take more time than automobile trips based on assumed differences in mean travel speeds between any two points on a road network. For transit trips, means of access and egress (e.g., walk-and-ride, bike-and-ride, park-and-ride) were weighed in deriving travel-time estimates.

We note that survey respondents self-reported estimated travel times of each trip. Since recalling travel times of trips previously made is prone to considerable errors, it was felt that estimated travel times based on the mean TAZ-to-TAZ times for the mode used provided more reliable estimates.

4. COMPARATIVE ATTRIBUTES OF CITY CARSHARE MEMBERS

Characteristics of those completing the background Survey #1 and who were at the time just about to become members were compared to those of approximately 950 randomly sampled San Francisco residents who participated in a survey conducted for RIDES for Bay Area Commuters, Inc. during 1998–2000. The aim was to reveal the degree to which those signing up for City CarShare differed from a "typical" San Francisco adult resident, as reflected in the RIDES survey, who regularly commutes.

Comparisons could only be drawn for those variables which were similarly collected across the two independent surveys. The following were the most notable differences among the two groups:

- *Age.* City CarShare members tend to be in their 30s; comparatively few are over 50 (Figure 1).
- *Household Income.* City CarShare members tend to have lower household incomes and relatively few are in the highest income brackets; however, they also are not as likely to fall in the lowest-income bracket, perhaps a product of screening applicants to ensure they have the financial means to join the program (Figure 2).

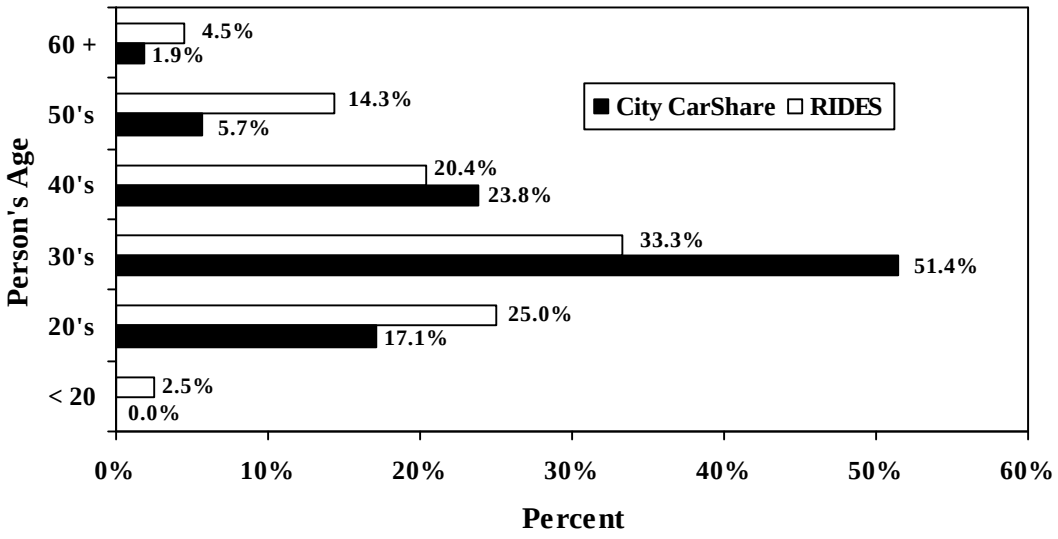


Figure 1. Comparison of Age Distributions Among Members of City CarShare and San Francisco Commuters

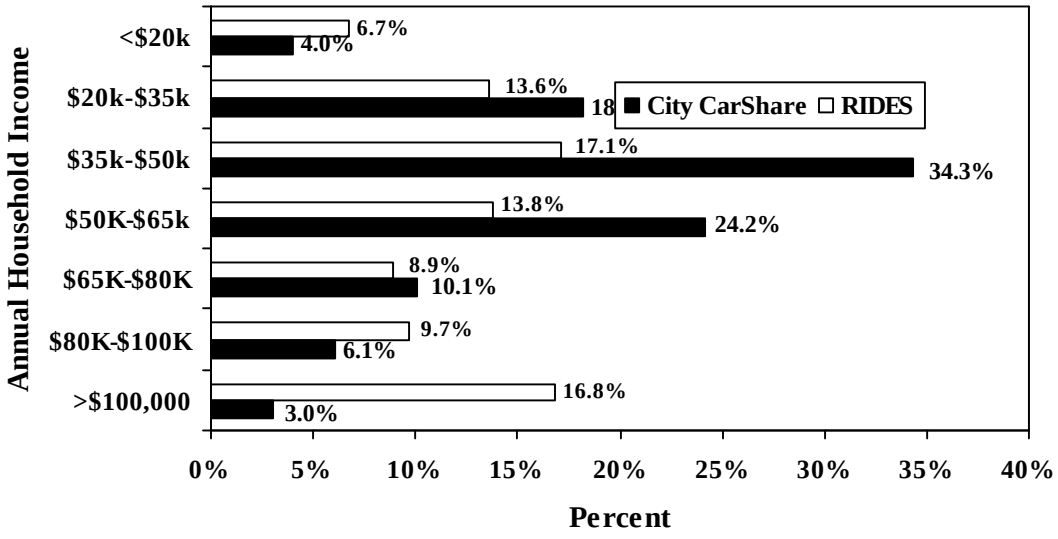


Figure 2. Comparison of Household Income Distributions Among Members of City CarShare and San Francisco Commuters

- *Commuter Pattern.* City CarShare members tend to be intra-city commuters, living and working in San Francisco: 85.3 percent live and work in the city, compared to 73.0 percent of the RIDES respondents.
- *Commute Distance.* Because of the high rate of intra-city commuting, City CarShare members tend to travel shorter distances to work: the mean highway network commute distance of car-share members was 3.8 miles, compared to 11.6 miles for RIDES respondents.
- *Mode Choice.* Means of getting to work are strikingly different between the two groups: City CarShare members are much more likely to commute by non-auto and non-drive-alone modes — particularly, walking, cycling, and rail transit (Figure 3).
- *Travel Duration.* Despite shorter commute distances, the mean travel time spent getting to and from work are comparable for City CarShare members and the typical San Franciscan (29 minutes versus 31 minutes), reflecting the greater reliance on transit and non-motorized modes.

5. SHORT-TERM TRAVEL PATTERNS AND MEMBER PROFILES

This section summarizes travel behavior three to four months into the City CarShare program, based on results from Survey #2. Also, member attributes from background surveys are presented.[12] Comparisons are made between City CarShare members and non-members, providing a cross-sectional portrait of how car-sharers differ from

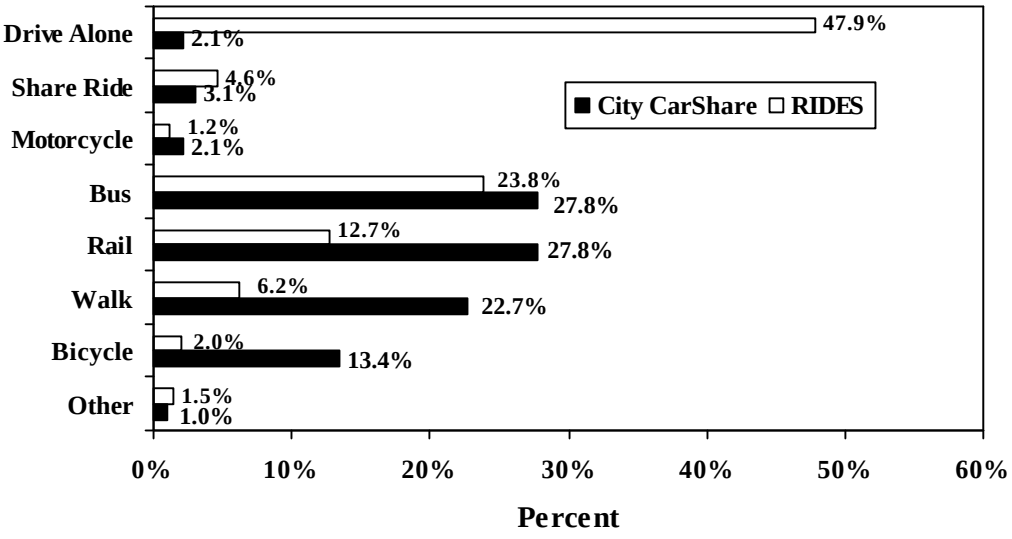


Figure 3. Comparison of Mode Choice Distributions Among Members of City CarShare and San Francisco Commuters

non-members. As previously noted, "non-member" represents individuals who have expressed an interest in joining City CarShare but have yet to do so. They serve as a statistical control-group for drawing comparisons. Information on 1,799 and 1,161 trips were obtained from Survey #2 for non-members and members, respectively. The numbers of people recording this information were 694 non-members and 466 members, respectively.

5.1 Mode of Transportation

Table 1 presents modal shares for all trip purposes recorded by City CarShare members and non-members who were surveyed. The table reveals that members were generally more inclined to use transit than non-members. The most common means of getting around San Francisco among members and non-members alike was foot or bike.

City CarShare trips made up a little over 2 percent of all surveyed member trips in June–July 2001. While modest, this figure understates the relative importance of car-sharing in terms of VMT. Since City CarShare trips tended to be longer than non-carshare trips made by members (5.8 miles versus 1.8 miles), car-share trips constituted an estimated 7 percent of total VMT logged by members.[13]

Among the sample trips from Survey #2, considerable shares of rail-transit trips were by the heavy-rail Bay Area Rapid Transit (BART): 50 percent among members and 56.1 percent among non-members. Among all trips (including walking and biking), BART constituted 6.3 percent of total journeys made by members and 7.0 percent made by non-members. Muni light-rail captured the second highest share of rail trips — around 38

Table 1. Modal Comparison: Percent Distribution of Mode, All Trip Purposes, City CarShare Members and Non-Members, Survey #2

	Members	Non-Members
City CarShare	2.2%	0.0%
Private Car	16.9%	27.2%
Bus Transit	18.6%	11.7%
Rail Transit	14.6%	13.1%
Walk-Bike	43.5%	43.4%
Other	4.2%	4.6%
Total	100.0%	100.0%

percent among members and non-members alike. CalTrain commuter services handled the remaining shares of rail travel.

Figure 4 presents summary statistics on "supply-side" factors that might have swayed mode-choice decisions among members and non-members. Members often face parking constraints, both at their workplaces and residences. Most have to pay for parking at their work sites and have no off-site residential parking. Parking constraints could explain high levels of employer allowances for transit and ownership of Muni Fast Passes. The majority of members and non-members also own bikes. The strong orientation of members, and those registered to one day become members, toward transit and bike travel suggests that car-sharing could substitute for trips made by these "green" modes. In section 8.4 of this report, a predictive model is presented that accounts for the role of these factors, along with City CarShare membership, in explaining mode choice.

5.2 Modal Splits by Trip Purpose

Breaking modal statistics down by trip purpose reveals transit was used heavily by members to get to and from work, though walking and biking were even more popular (Table 2). Early into the program, City CarShare vehicles were used most frequently for

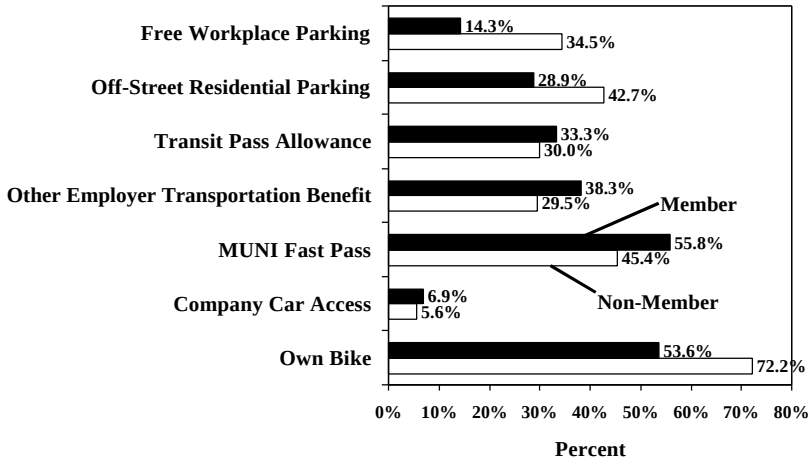


Figure 4. Shares of Members and Non-Members with Various Supply-Side Attributes Associated with Mode Choice

Table 2. Percent Distribution of Mode by Trip Purposes, City CarShare Members and Non-Members, Survey #2

	Member				Non-Member			
	Trip Purpose				Trip Purpose			
	Work	Return Home	Social	Personal Business	Work	Return Home	Social	Personal Business
Car Share	4.3%	5.0%	6.7%	10.3%	0.0%	0.0%	0.0%	0.0%
Private Car	2.9%	11.4%	26.7%	20.5%	16.3%	29.7%	20.0%	33.8%
Bus Transit	26.1%	17.9%	6.7%	7.7%	11.6%	9.9%	10.0%	3.1%
Rail Transit	15.9%	14.3%	23.3%	12.8%	19.0%	10.8%	20.0%	4.6%
Walk-Bike	42.0%	47.9%	33.3%	43.6%	50.3%	42.8%	50.0%	58.5%
Other	8.7%	3.6%	3.3%	5.1%	5.4%	6.8%	0.0%	0.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

personal business (10.3 percent) and (not shown) recreational trips (20.8 percent). For members and non-members alike, walking and biking were the most common means of getting to and from work for all trip purposes.

5.3 Rail Access and Egress

Among members who patronized rail transit, 78 percent got from their homes to the rail station by foot (Table 3). Bus transit was the second most popular access mode for members and non-members.

Around 90 percent of members who commuted by rail transit walked from the station to their workplace (representing an "egress" trip). Significant shares of non-members transferred to buses to reach their destinations.

Table 3. Percent Distribution of Modes of Access and Egress for Rail Transit Trips, Members and Non-Members, Survey #2

	Members		Non-Members	
	Access	Egress	Access	Egress
Walk	78.1%	89.6%	66.7%	71.4%
Bicycle	3.4%	3.5%	12.9%	9.1%
Bus	13.5%	1.7%	14.6%	19.6%
Other	5.0%	5.2%	5.8%	0.0%
Total	100.0%	100.0%	100.0%	100.0%

5.4 Travel Consumption

Around 91 percent of the members responding to the survey resided in the city of San Francisco (compared to 81 percent of non-members). Also, 77.2 percent of surveyed members worked in San Francisco (compared to 67.8 percent of non-members).[14] In all, 76.6 percent of members and 66.1 percent of non-members worked in the same city in which they resided.[15] High shares of intra-city commuting bode favorably for car-sharing as a viable candidate for journeys to work.

High rates of intra-city travel also translate into fairly short average trips, as shown in Table 4 for all trip purposes combined. While trips were fairly short by urban standards, given that high shares were by foot and bicycle, average travel times were close to the San Francisco Bay Area norm of around 25 minutes. Because of the large share of non-motorized trips, mean VMT was less than mean trip distance — i.e., zero values for walk and bike trips lowered the average VMT statistic considerably. 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 even lower — 1.2 for members and 1.5 for non-members. Lastly, multiplying MVMT by the engine size of private-vehicle trips yielded the "mode & engine-size adjusted VMT," or MEVMT, which as an index of "private travel consumption," yielded mean values that were 20 percent higher for members than non-members. This suggests the substitution of City CarShare Volkswagen Beetles for members' private cars could be expected to substantially reduce the index of private travel consumption (and in parallel, factors like energy consumption). For members, MEVMT was the lowest on non-workdays, particularly those falling on weekdays. This reflects the higher rates of transit usage for trips made during these periods. The highest "travel resource consumption" (i.e., MEVMT) was generally for trips made on weekends, often corresponding to social-recreational travel.

Across all variables in Table 4, 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. Based on these statistics alone, we cannot expect much in the way of statistically significant differences in travel demand among members and non-members.

5.5 Socio-Demographic Characteristics

In mid-2001, around half of surveyed members were in their thirties (Figure 5).[16] The seemingly greater proclivity of "thirty-somethings" to join car-sharing was also found in a survey of Portland's car-sharing program.[17] Most of the surveyed City CarShare members, 63 percent, were women (compared to 54.5 percent of non-members). Whites made up 85.5 percent of surveyed members, Asian-Americans 12.2 percent, and African-Americans 2.3 percent; shares were comparable for non-members. Those who identified

themselves as Hispanic or Latino comprised 1.5 percent of surveyed members and 7 percent of non-members.

Table 4. Comparison of Travel Statistics for Individual Trips Among Members and Non-Members, Survey #2

	Member		Non-Member	
	Mean	**Std. Deviation**	**Mean**	**Std. Deviation**
Trip Distance (Road network miles)	4.5	8.8	4.2	7.5
Trip Time (minutes)	28.0	41.1	25.5	36.2
Vehicle Miles Traveled (VMT)	3.4	7.8	1.8	6.0
Mode-Adjusted VMT (MVMT)	1.2	5.5	1.5	5.2
Mode & Engine-Size Adjusted VMT (MEVMT)**: All trips**	2622.1	9621.0	2101.3	10,710.1
MEVMT: Weekday-Workday	3172.9	11614.9	2660.2	8315.2
MEVMT: Weekday-Non Workday	1678.0	8505.4	1726.5	7339.0
MEVMT: Weekend-Workday	4023.2	7729.2	3055.2	7982.1
MEVMT: Weekend-Non Workday	3097.1	14729.5	2267.2	8041.7

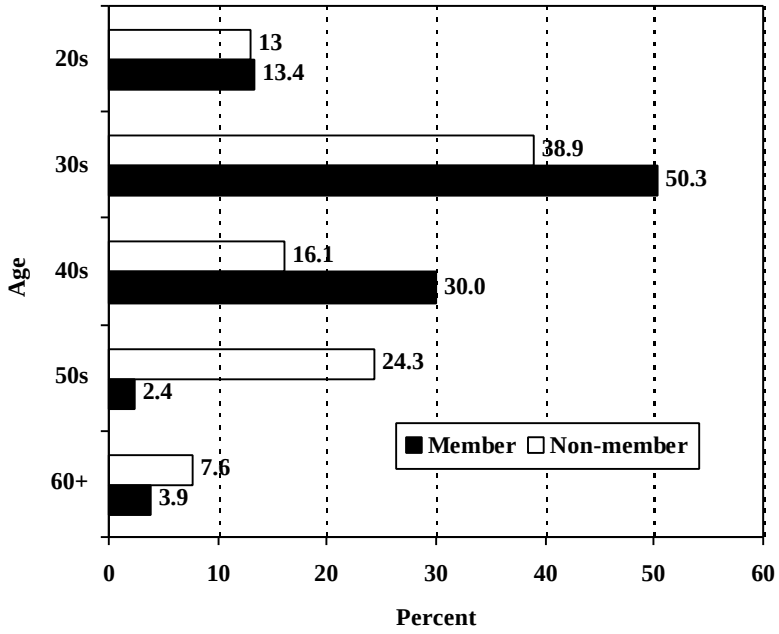


Figure 5. Age Distribution, City CarShare Members and Non-Members

Income and Educational Profiles

Figure 6 shows non-members generally averaged higher household incomes than members — the medians for both groups were $50,500 and $40,600, respectively.[18] Higher income levels appear to be associated with higher levels of graduate education among non-members (Figure 7). Both groups are well-educated, with well over 90 percent having graduated from college.

Occupational Profiles

Most survey respondents — 82 percent of members and 66 percent of non-members — had full-time jobs. Higher shares of non-members worked in professional occupations (e.g., consultants, engineers, lawyers, planners) — 87 percent versus 75 percent for members. The most common occupation, for both members and non-members, was urban planning: 9 percent of surveyed members and 5.5 percent of non-members worked as planners, suggesting professional affiliation might have prompted some to join a progressive program like car-sharing. Moreover, 5.5 percent of members worked as transportation planners or transit professionals, further suggesting a predisposition of some members toward the idea of car co-ops. Around 3 percent of members were full-time students. Also, 21.3 percent of members and 16.4 percent of non-members were self-employed, suggesting an appreciable number of existing and future car-sharers work at home.

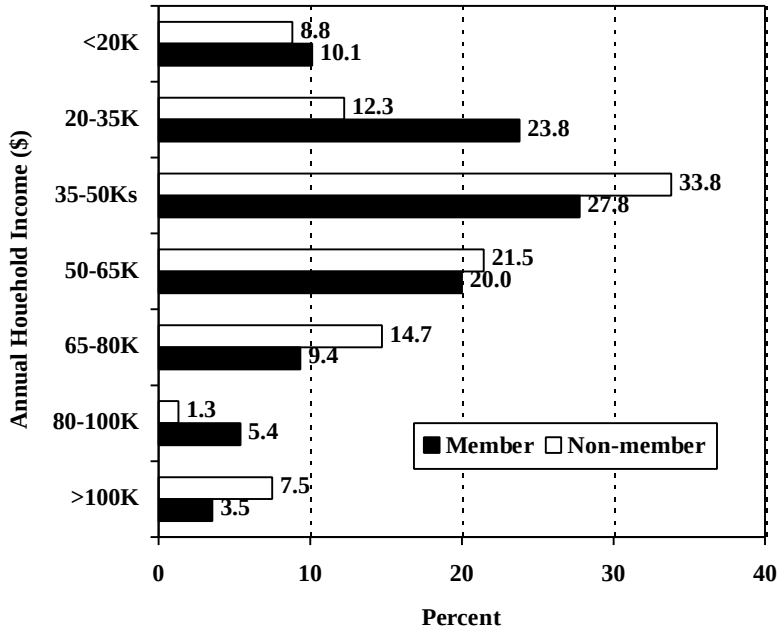


Figure 6. Household Income Distribution, City CarShare Members and Non-Members

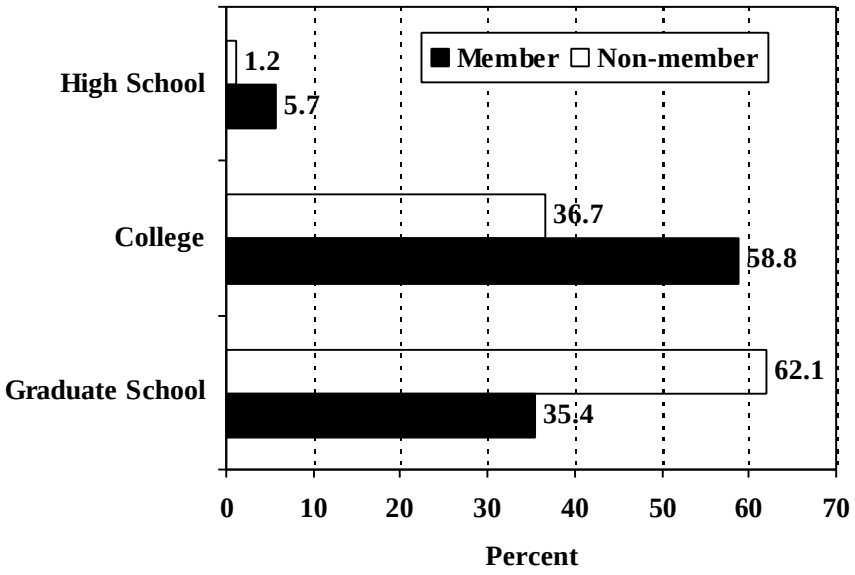


Figure 7. Highest Level of Education, City CarShare Members and Non-Members

Household Profiles

Most surveyed City CarShare members were from what can be called "non-traditional" households, reflecting the unique demographics of the city of San Francisco (Figure 8). Over a third lived alone and one-quarter lived with other non-related adults. Around three times as many married members had no children as married members with children. The one out of 15 members living in "Ozzie and Harriet" households — i.e., married with children — was only slightly more than the share of those raising children on their own. Larger shares of members lived in group-quarters (e.g., dormitories, short-term residential occupancy hotels) than in households with a spouse and children.

The relatively small average household sizes — 1.87 for members and 2.24 for non-members — reflect the high shares of live-alone and non-traditional household arrangements among the sample. Over 80 percent of members and 73 percent of non-members live in one- or two-person households.

City CarShare participation often runs across household members. Among members responding to the survey, 31.9 percent lived in a household with another adult who was also a member; for non-members who were registered to one day become a member, the share of adults in the household also signed-up to eventually join the program was 12.5 percent. These high shares bode well for the prospects of carshare-pooling: members from the same household riding together in City CarShare vehicles.

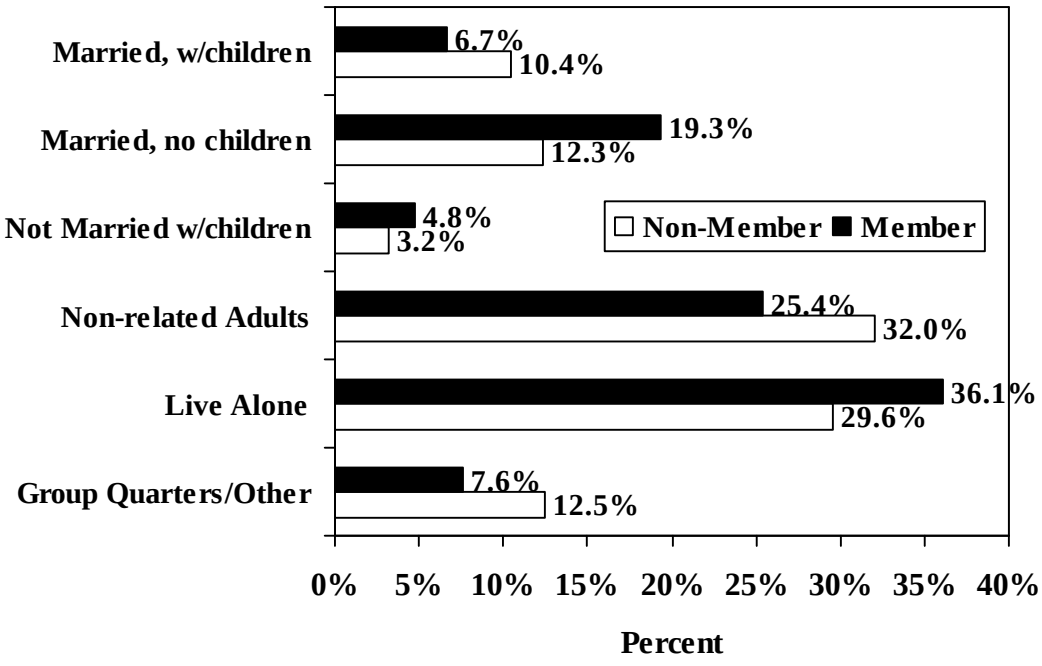


Figure 8. Household Types, City CarShare Members and Non-Members

Car Ownership

One of the expected longer-term impacts of car-sharing is to reduce vehicle ownership. The convenience of having a fleet of vehicles available, almost on-call, can be expected to prompt some member-households to give up a second car and perhaps relinquish car ownership altogether. Establishing a profile of car ownership patterns early into the program is thus important.

From the background data compiled in the first and second surveys, 71.5 percent of members were from zero-car households and 21.2 percent were from one-car households. Thus, well over 90 percent of members were from households with 0–1 cars, a statistic that is well above the national and Bay Area average. The share of member households that are car-less is even well above the 59 percent figure found in Portland during its program's first year.[19] Non-members tended to have higher levels of car availability — 35.4 percent were from zero-car households and 34 percent were from one-car households. No member households had more than two cars; 5 percent of non-member households had three or more cars. In general, the high share of car-less households, especially among members, suggests that car-sharing will induce some degree of motorized travel.

While some members came from households with cars, often they themselves did not own these cars. In all, 44.3 percent of household cars were owned by members, and 8.8 percent were not owned by but were available to members; all other household cars — around 47 percent — were unavailable to members. Non-members owned and had access to larger shares of household cars.[20]

Among cars in surveyees' households, the most common types of vehicle were 4-cylinder medium-size sedans like Toyota Camry, Toyota Corolla, Honda Accord, and Honda Civic. These four makes and models alone comprised 28 percent of members' and 38 percent of non-members' cars. Relatively few large vehicles — e.g., recreational vehicles, sport utility vehicles, vans, or minivans — and hardly any motorcycles were reported by survey respondents.

For the most part, members and non-members lived in households with older, well-used cars. Table 5, organized in order of the household vehicles listed by survey respondents, shows the typical member's car was more than a decade old and had been driven, on average, 5,500 to 6,000 miles a year.

6. 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 #2. A sample of 1,161 member trips was available for this analysis. The small number of trips made by City CarShare vehicles makes comparisons to non-carshare travel somewhat problematic. While one cannot draw statistical inferences from these results, nonetheless, comparisons offer insights into pattern of usage of City CarShare vehicles in the short-run.

Table 5. Characteristics of Motor Vehicles in Households of Survey Respondents, Members and Non-Members, Surveys #1 and #2

	Member		Non-Member	
	Mean	**Std. Deviation**	**Mean**	**Std. Deviation**
Vehicle #1: Year	1989	3	1988	4
Engine Size (cubic centimeters)	2000	1100	1500	840
Odometer Reading (miles)	65,200	58,600	90,800	52,300
Vehicle #2: Year	1989	2	1991	3
Engine Size (cubic centimeters)	1000	100	900	750
Odometer Reading (miles)	72,500	10,300	62,800	47,300
Vehicle #3: Year	--	--	1986	5
Engine Size (cubic centimeters)	--	--	700	80
Odometer Reading (miles)	--	--	73,600	43,800

6.1 Trip Purposes

Of the few City CarShare trips recorded three to four months into the program, the most common trip purpose was to return home, followed by recreational trips, personal business, going to work, socializing, and attending to medical needs. Partly because of age restrictions (members must be 25 years of age or older), no recorded trips were for purposes of going to school.

Compared to other modes, trips made by City CarShare vehicles were oriented more toward personal business, shopping, and recreation (Table 6). In general, City CarShare vehicles were not turned to for essential, non-discretionary trips, such as going to and from work and school.

6.2 Travel Consumption Measures

Comparative statistics reveal that among members filling out Survey #2, those using City CarShare vehicles drove farther, longer and, when adjusting for occupancy levels, logged more VMT than members driving private vehicles (Table 7). This suggests some degree of travel inducement, to the degree City CarShare travel substituted for private cars as well as walking, cycling, or transit usage.

Table 7 shows member trips via City CarShare Volkwagens were on average 46 percent longer than private-car trips and almost twice as long as trips by transit, walking, cycling, taxi, and other modes. The average distance of City CarShare trips in San Francisco, however, was less than one-third the length of car-share trips recorded in Portland, Oregon, during its first-year program, which could be partly explained by San Francisco's smaller and more compact geographic area.[21] Compared to private-car

Table 6. Percentage Distribution of Trip Purposes Among Modes for Daily Trips Made by City CarShare Members, Survey #2

Trip Purpose	City CarShare	Private Vehicle	Transit	Walk	Bike
To Work	11.5%	9.3%	27.1%	14.8%	27.3%
To Home	26.9%	37.2%	42.1%	36.1%	50.0%
School	0.0%	2.3%	6.5%	7.7%	13.6%
Shop	7.7%	0.0%	1.9%	1.3%	0.0%
Personal Business	19.2%	18.6%	8.4%	11.0%	0.0%
Medical	3.8%	2.3%	1.9%	12.9%	0.0%
Social	11.5%	18.6%	8.4%	5.8%	4.5%
Recreation-Other	19.2%	11.7%	5.6%	10.3%	4.5%
All	100%	100%	100%	100%	100%

Table 7. Comparison of Travel Statistics Among Trips by City CarShare, Private Vehicle, and All Other Modes, Members, Survey #2

	City CarShare		Private Vehicle		Other Modes	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Trip Distance (Road network miles)	6.3	12.5	4.3	7.6	3.3	5.4
Trip Time (minutes)	14.5	22.6	11.9	15.0	26.1	27.6
Vehicle Miles Traveled (VMT)	6.3	12.5	4.3	7.6	0.2	1.3
Mode-Adjusted VMT (MVMT)	4.2	8.1	2.9	4.5	0.2	1.3
Mode & Engine-Size Adjusted VMT (MEVMT), **All trips**	4,200	620	11,333	36,685	128.5	1,852.3

driving, City CarShare trips were also of a longer duration — on average, around two and a half minutes longer. (Adding the access time involved in picking up a City CarShare vehicle and egress time of returning home, the mean durations of City CarShare trips compared to private car trips were likely even larger.)

Because most City CarShare trips were drive-alone and thus of a lower occupancy than the typical (especially non-work) private-car trip, the mode-adjusted VMT of car-share travel was also high relative to private-car travel: 4.2 versus 2.9. Since the only form of mode-adjusted VMT for "other modes" was by taxi or other commercial services, the VMT statistics for this category were close to zero. When adjusting for engine size in addition to mode (in the MEVMT statistic), City CarShare trips are seen to be less "resource-consuming." This reflects the fact all City CarShare trips were via sub-compact vehicles — Volkswagens — whereas many other private-car trips were made by larger cars with bigger engines. Whether this relationship holds as City CarShare diversifies its fleet over time to include larger vehicles remains to be seen.

7. EVALUATION: AGGREGATE ANALYSES

We now shift to evaluating impacts. The evaluation presented in this section is aggregate in the sense individual trip records were summed for each surveyed person to produce a 24-hour total. Thus, the unit of analysis is the person (instead of trip) and the focus is on overall travel consumption over 24-hour periods. The sample size was considerably reduced for the aggregate analysis because respondents needed to complete questionnaires for at least one of two survey days for both Survey #1 and Survey #2.[22] Sample sizes were large enough only to examine trends for weekday travel — both for days that corresponded to respondents' workdays and to non-workdays. For weekdays/workdays, 100 person records were available from non-members and 74 records from members for the analysis. For the weekdays/non-workdays, there were 52 person records for members and 79 for non-members. There were insufficient weekend responses to tabulate aggregate statistics and compare changes over time. We noted that

there appears to be an under-sampling of weekend travel since trip records reveal a fair amount of car-share use on Saturdays and Sundays as well as evenings.

The technique of Difference of Means (DOM) was used to examine impacts. (Pairwise sample comparisons were also produced, however since they yielded nearly identical results, they are not presented.) Results presented in this section are stratified by day type.

7.1 Analysis for Weekday and Workday: Difference of Means

As noted, more travel diaries were recorded for weekdays that were also workdays than any day type. Impacts on VMT, MVMT, MEVMT, and travel times are summarized in Table 8 for members and Table 9 for non-members. First, however, overall trends (between surveys #1 and #2) in these four outcome variables are summarized for all recorded cases — i.e., members and non-members combined. This is followed by breakdowns and the analysis of impacts for members versus non-members.

Vehicle Miles Traveled (VMT)

There was a general decline in daily Vehicle Miles Traveled (VMT) for both members and non-members between the two surveys — on average, daily VMT went down from 6.92 to 5.08 (with large standard deviations of 17.72 and 12.22, respectively).[23] (This represented miles logged on all forms of motorized transportation, unadjusted for occupancy levels.) The decline represented the effects of seasonal variation (e.g., between winter and summer months), random-sample variation, modal shifts, or a combination of these factors. As noted earlier, heavy rainfall during Survey #1 could have induced more car travel whereas the dry conditions during Survey #2 likely encouraged more walking and cycling (which add zero VMT and thus depress the mean statistic). In theory, the effects of seasonal and random-sample variation should have been similar between the members and non-members.

Mode-adjusted and Engine-Adjusted VMT (MVMT and MEVMT)

There was a general decline in daily mode-adjusted Vehicle Miles Traveled (MVMT) for both members and non-members between the two surveys — on average, daily MVMT went down from 5.63 to 4.54 (again, with values for non-members tending toward the higher end; standard deviations were 15.68 and 11.70, respectively). The smaller numbers reflected the high share of City CarShare members and prospective members who own no car and travel by foot, bike, or transit. Adjusting for engine size, the mean MEVMT (for both members and non-members combined) similarly went down, from 10,424 to 8,150 (standard deviations of 35,809 and 22,683, respectively).

Total Trip Travel Time (for drive trips)

For both groups combined, total travel time for drive trips fell noticeably between Survey #1 and Survey #2 — from 116.5 minutes (nearly two hours) to 108.8 minutes. Travel times fell faster than VMT, suggesting a decrease in average travel speeds. For trips made by driving mode, total travel time remained fairly constant — on average, 36.9 minutes in Survey #1 and 36.0 minutes in Survey #2.

Net Impacts and Statistical Significance

When travel statistics are stratified by members and non-members, insights into impacts can be gained. Tables 8 and 9 show there was a decline in mean VMT for both groups, suggesting seasonal influence (e.g., between work months February/March to the summer months June/July, when schools are out of session, some take vacation leave and nicer weather promotes walking and cycling instead of driving). Rising fuel prices — from a mean of $1.76 per gallon for medium-octane unleaded gasoline in February 2001 to $2.01 in June 2001 — could also explain the overall decline over this 3–4 month period.[24] However, VMT went down more for non-members than members, as summarized in Table 10. This hints at possible travel inducement among members, though the effects were neither strong nor statistically significant. The stimulation of motorized travel among members is consistent with the findings of a Swiss study that, through pre- and post-membership surveys, found a 118 percent increase in total kilometers traveled by previously car-less households.[25] Given that around three-quarters of surveyed City CarShare members come from zero-car household, a similar pattern could very well emerge in San Francisco.

Table 8. Members: Trends in Daily Travel, Survey #1 to Survey #2

	Survey #1		Survey #2		Difference of Means (S2 – S1)	T-Statistic
	Mean	Std. Deviation	Mean	Std. Deviation		
VMT	4.79	13.34	3.17	7.09	-1.62	-0.387
MVMT	2.98	7.42	2.42	5.42	-0.56	-0.202
MEVMT	2177.8	8377.0	3323.1	11981.5	1145.3	0.235
Travel Time (min.)	112.2	104.0	89.4	54.2	-22.8	-0.676

Key: VMT = vehicle miles traveled; MVMT = mode-adjusted VMT; MEVMT = Mode and engine-size adjusted VMT; S2 = Survey #2; S1 = Survey #1.

Table 9. Non-Members: Trends in Daily Travel, Survey #1 to Survey #2.

	Survey #1		Survey #2		Difference of Means (S2 – S1)	T-Statistic
	Mean	Std. Deviation	Mean	Std. Deviation		
VMT	8.44	20.29	6.03	14.14	-2.41	-0.427
MVMT	7.53	19.43	5.60	13.79	-1.93	-0.354
MEVMT	16565.2	45998.4	10391.9	26116.3	-6173.3	-0.523
Travel Time (min.)	119.5	128.3	117.8	127.4	-1.7	-0.039

Key: VMT = vehicle miles traveled; MVMT = mode-adjusted VMT; MEVMT = Mode and engine-size adjusted VMT; S2 = Survey #2; S1 = Survey #1.

Table 10. Difference of Difference of Means: Changes of Members Minus Changes of Non-Members

	Difference	T-Statistic
VMT	+0.79	0.079
MVMT	+1.37	0.166
MEVMT	+7381.6	0.438
Travel Time (minutes)	-21.1	-0.274

On a mode-adjusted basis, mean VMT among City CarShare members fell over the two survey periods (by 0.56), though this was less than the decline for non-members (of 1.93 miles). This further hints at "travel inducement" — the availability of City CarShare vehicles stimulated travel via motorized vehicles with low occupancy levels. MEVMT fell less for members because, at the margin, there were low-occupancy City CarShare trips that in the past were made by non-motorized travel (walk and bike) or high-occupancy motorized travel (bus). Based on the mean difference-of-difference (shown in Table 10), changes in MVMT were still statistically insignificant. Because of the small number of surveyed City CarShare trips made by members, it would be hard to attribute this gain entirely to car-sharing itself. One possibility is an "echo effect;" cognizant of some of the mobility advantages of cars, members might have unconsciously become predisposed toward a pattern of "automobility" and thus begun driving their own cars or those of friends more.

Adjusting for engine-size yielded the largest difference in VMT patterns among members and non-members. Notably, the mean mode- and engine-size adjusted VMT of members rose (by 1145) compared to a mean decline (of 6173) among non-members. The positive change for members is thought to reflect lower occupancy levels of motorized trips made using City CarShare vehicles as opposed to a trend toward the use of larger-engine cars. Still, when comparing Tables 8 and 9, it is clear that non-members generally drive much bigger cars than members, with a mean MEVMT in Survey #2 that was more than three times higher — i.e., more than three times the amount of resource consumption per person-trip.

Lastly, members enjoyed an overall reduction in average daily travel time, possibly reflecting the faster travel provided by City CarShare vehicles (versus walking, cycling, and transit), and the reductions were larger than those experienced by non-members. (Given that the summer months represent vacation season and public schools were out of session, reduced congestion levels could be expected to lower travel times for both groups; however, the declines were greater for City CarShare members, suggesting some slight benefits from access to car-share vehicles.)

Table 10 summarizes the "difference of difference" results — e.g., the degree to which changes in travel differed among members and non-members. Two of the barometers of automobility — VMT and MVMT — decreased less over the two time points for City CarShare members than non-members, thus yielding a positive difference of difference. Mean MEVMT increased for members while dropping for non-members. While these findings hint at travel inducement, none of the differences were large enough relative to within-group sampling variation to infer statistically significant relationships.

While in absolute terms impacts were marginal, in relative terms they were more substantial. Figure 9 compares the percentage point difference in relative changes for mean travel statistics of members versus non-members. The biggest difference was in terms of mode- and engine-size adjusted VMT — it increased by 52.6 percent for members and decreased by 37.3 percent for non-members, resulting in almost a 90 percentage point differential.

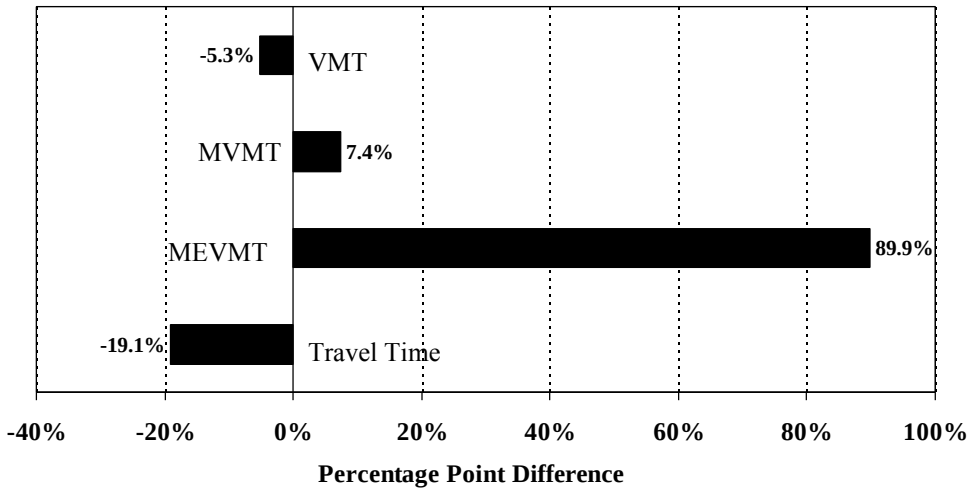


Figure 9. Percentage Point Differences in Changes in Mean Daily Travel Characteristics: Weekdays that are Workdays, Members Relative to Non-members

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

Tables 11 through 13 and Figure 10 present aggregate results for weekdays that were non-workdays. A different set of relationships emerged from this analysis, although small sample sizes among members for Survey #1 hampered the analysis. In the case of weekdays, in contrast to the results for days that people worked, travel on non-workdays tended to go down more for members (Table 11) than non-members (Table 12). While the differences of differences (Table 13) were not statistically significant, differences were more pronounced than in the case of workdays. On Mondays through Fridays when people did not work, VMT in every form (including mode- and engine-size adjusted) tended to decline faster for members than non-members. And while total travel times by members went up, they did not increase as fast as they did for non-members. Thus, as opposed to travel inducement, the findings for weekdays/workdays show a trend toward more resourceful automobility — i.e., members' motorized resource consumption declined faster than that of non-members. Thus, while members appeared to be driving more on non-workdays, there is evidence this involved small-engine and resourceful vehicular travel. Overall, there was a stronger trend toward more judicious travel among members on non-workdays than workdays, Mondays through Fridays.

Table 11. Members: Trends in Daily Travel, Survey #1 to Survey #2

	Survey #1		Survey #2		Difference of Means (S2 – S1)	T-Statistic
	Mean	Std. Deviation	Mean	Std. Deviation		
VMT	15.52	27.71	4.67	8.53	-10.85	-0.854
MVMT	12.37	24.16	4.19	8.28	-8.18	-0.715
MEVMT	23250.0	59950.6	4055.0	10993.7	-19195.0	-0.664
Travel Time (min.)	92.98	63.78	127.71	146.59	+34.73	0.612

Key: VMT = vehicle miles traveled; MVMT = mode-adjusted VMT; MEVMT = Mode and engine-size adjusted VMT; S2 = Survey #2; S1 = Survey #1.

Table 12. Non-Members: Trends in Daily Travel, Survey 1 to Survey 2

	Survey #1		Survey #2		Difference of Means (S2 – S1)	T-Statistic
	Mean	Std. Deviation	Mean	Std. Deviation		
VMT	12.21	22.28	6.74	13.70	-5.47	-0.854
MVMT	9.36	15.76	5.74	12.79	-3.62	-0.723
MEVMT	23187.8	56539.4	9714.8	25076.2	-13473.0	-1.032
Travel Time (min.)	87.76	91.64	136.75	133.91	+48.99	1.259

Key: VMT = vehicle miles traveled; MVMT = mode-adjusted VMT; MEVMT = Mode and engine-size adjusted VMT; S2 = Survey 2; S1 = Survey 1.

Table 13. Difference of Difference of Means: Changes of Members Minus Changes of Non-Members

	Difference	T-Statistic
VMT	-5.38	-0.278
MVMT	-4.56	-0.277
MEVMT	-5722.0	-0.136
Travel Time (minutes)	-14.26	-0.149

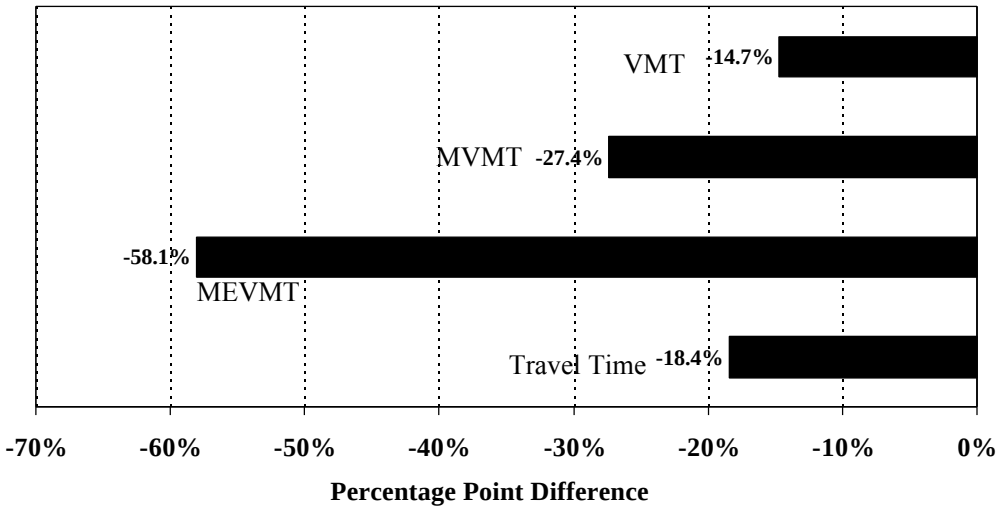


Figure 10. Percentage Point Differences in Changes in Mean Daily Travel Characteristics: Weekdays that are Non-Workdays, Members Relative to Non-Members

8. EVALUATION: TRIP-LEVEL ANALYSES

Expressing travel at the trip level provided more in-depth insights into changes in travel consumption and behavior among members and non-members. The analyses in this section separate trip-level statistics by trip purpose rather than by day-type.[26] We note that breaking down data by trip purposes reduced sample sizes (especially for infrequent purposes like medical trips), thus such disaggregations are more prone to sampling errors.

8.1 Modal Splits

How did modal split distributions vary over the short-term among members versus non-members? This section summarizes statistics showing changes in the shares of daily trips among modes, broken down by trip purpose. (City CarShare is not included as a mode in this distribution since non-members did not have this service as a modal option, precluding the ability to measure differences in modal distributions among the two groups over the two time points.)

Table 14 presents proportional changes in shares of trips by private car, transit, walking, and cycling between Survey #1 and Survey #2, broken down by trip purpose. Overall, excluding City CarShare trips, there was a trend away from motorized to non-motorized trips made over the two time points for both members and non-members. We note that this could have had a lot to do with differences in weather conditions. As noted earlier, February–March 2001 was a period of particularly heavy rainfall in San Francisco whereas the survey period of June–July was largely dry. Of course, the entire reason for introducing a "control" group is to remove the influences of such factors. Weather conditions likely affected members and non-members similarly. Thus, a difference-of-difference comparison nets out such extraneous factors.

From the table, we see the most statistically significant relationships were for the most non-discretionary trips: going to work and returning home. For work trips, there was a significant reduction in car and transit trips and a significant increase in walk travel. A

Table 14. Differences in Proportion of Trips by Modes Among Members and Non-Members, Between Survey #1 and Survey #2

Trip Purpose	Status	Private Car	Transit	Walk	Bike
To Work	M	-0.076**	-0.128*	+0.080*	+0.090*
	NM	+0.002*	-0.123*	+0.093*	+0.125*
To Home	M	0.179	-0.024	+0.081	+0.086
	NM	0.064*	-0.093	+0.009*	+0.055*
School	M	-0.075	-0.179	+0.095	+0.238
	NM	-0.086	-0.126	+0.106	+0.151
Shop	M	-0.018	-0.036	+0.089	+0.054
	NM	+0.197	-0.156	-0.151	-0.229
Personal Business	M	+0.036	+0.094	-0.149	-0.280
	NM	+0.141	-0.121	-0.057	-0.020
Medical	M	-0.329	-0.034	+0.325	+0.325
	NM	-0.023	-0.323	+0.288	+0.320
Social	M	+0.112*	-0.033	-0.082	-0.071
	NM	-0.138	+0.065	-0.042	+0.191
Recreation	M	-0.267	-0.080	+0.167	+0.197
	NM	-0.265	+0.031	+0.194	+0.250
Other	M	+0.216	+0.083	-0.180	-0.245
	NM	-0.037	+0.109	-0.204	-0.188
All	M	-0.051	-0.034	+0.043	+0.039
	NM	-0.017	-0.074	+0.024	+0.066

Key: M = member; NM = non-member; ** = statistically significant T-statistic at the 5 percent probability level; * = statistically significant T statistic at the 10 percent probability level.

very small amount of the decline in private car usage might be attributed to City CarShare, however most of it is likely due to drier weather conditions during the second survey period. For both members and non-members, motorized travel tended to increase the most for personal-business trips, though the relationship was not statistically significant. Besides work trips, walking and cycling seemed to gain favor, for both members and non-members, for medical, recreation, and school trips.

While revealing, Table 14 does not express the relative differences in modal-split changes among members and non-members. Figures 11 and 12 do so. The figures summarize the "difference of difference" results, broken down between motorized modes (Figure 11) and non-motorized modes (Figure 12). None of the "differences of difference" were statistically significant at the 10 percent probability level, however several patterns do stand out. Again, an advantage of taking such differences is that the influences of possible confounding factors, like weather conditions or gasoline price increases, are removed.

Relative to non-members, City CarShare members decreased the share of private-car trips when: going to work, returning home, shopping, on personal business, and attending to medical needs. Relationships were generally opposite for transit: members either increased their reliance on transit relative to non-members or rates of decline in transit usage were less for members than their counterparts. For medical, personal business, and shopping trips, transit seemed to substitute for car travel more for members than non-members.

Figure 12 shows that relative to non-members, members became less reliant on non-motorized (walk and bike) travel for journeys to work, personal business, social purposes, and recreational purposes. On the other hand, City CarShare members tended to walk and bike more for shopping and when returning home. While it would be a stretch to associate any of these trends to the City CarShare program, reductions in automobile ownership within households of car-share members could have, at the margin, spurred more walking and cycling. The absence of data on changes in car-ownership levels preclude any exploration into this question; however, this is the kind of trend that should be monitored over the longer run as time series information on car-ownership levels among members accumulates.

8.2 Travel Times and Distances

Mean travel times fell for both members and non-members between the first and second surveys, and Table 15 shows this held across most trip purposes. Declines were most probably due, at least in part, to seasonal factors, such as reduced traffic volumes during summer months when many schools are out of session and some residents are on vacation. For City CarShare participants, the table reveals significant declines in mean travel times for school trips, attending to personal business, and recreational activities.

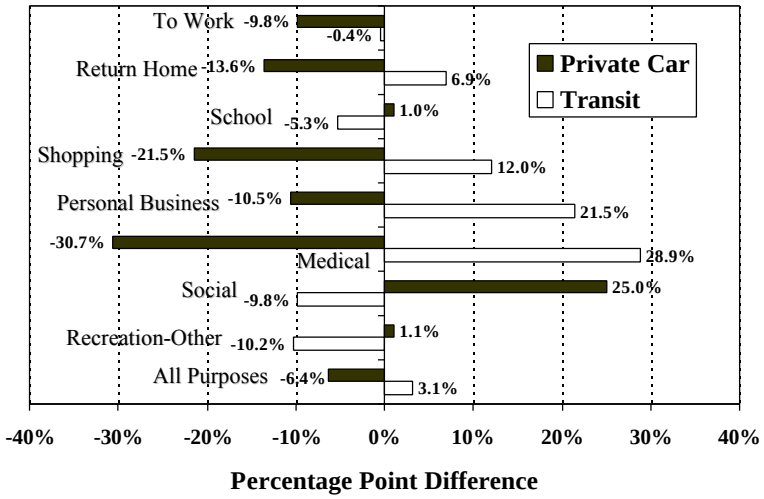


Figure 11. Relative Changes in Motorized Modal Distributions Among Trip Purposes. Represents percentage point difference in share of trips by private car and transit between Survey #1 and Survey #2, Members relative to Non-Members.

For the "control group," declines were generally of a different order of magnitude, and mean durations actually rose for shop, personal business, and social trip purposes. Difference-of-means were statistically significant for all trip purposes, with probabilities of obtaining such large differences from samples (if there were no differences in the population of all trips) falling well below 5 percent in most instances.

Less of a consistent and statistically significant pattern was found for mean trip distances. For both groups, average distances increased for work trips (presumably because of changes in home or workplace locations) and personal business trips; they went down for recreational and other trips. For all purposes combined, mean distances went down slightly for both groups, though relationships were not statistically significant.

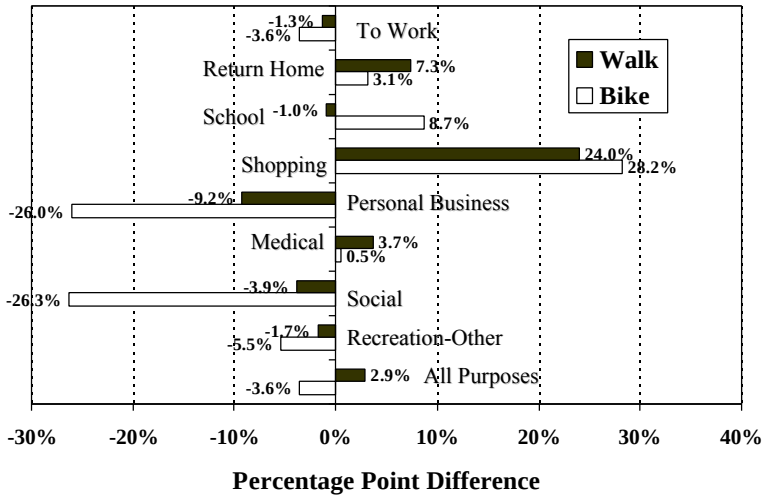


Figure 12. Relative Changes in Non-Motorized Modal Distributions Among Trip Purposes. Represents percentage point difference in share of trips by walking and cycling between Survey #1 and Survey #2, Members relative to Non-Members.

Figure 13 summarizes the "difference of difference" results by trip purpose. Mean travel times declined less for members than non-members for three trip purposes: work, return home, and medical trips; for all other purposes, they fell more sharply. Overall, mean times declined around 3 minutes more for members than non-members. Given the small numbers of trips made by City CarShare vehicles, very little of this is likely due to the phenomenon of car-sharing.

With regards to trip distances, differences were less pronounced. In general, trip distances fell slightly more among members than non-members. The largest relative declines among car-share members were for school and recreational trips. Again, attribution is difficult given the infrequency of recorded car-share trips.

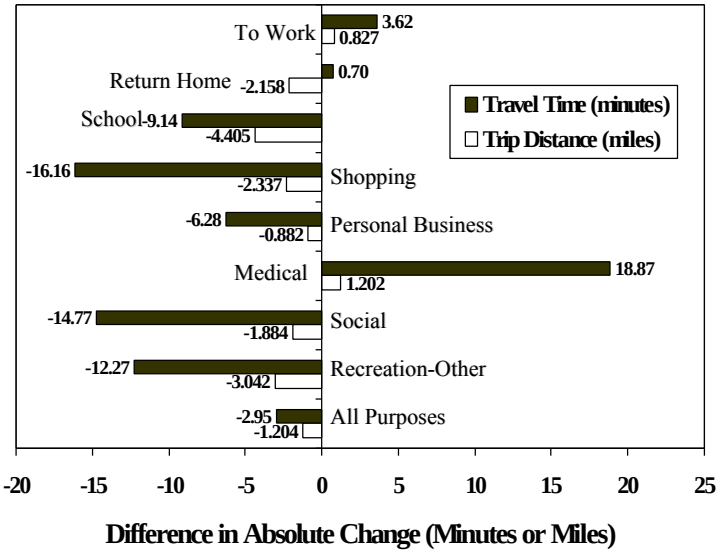


Figure 13. Relative Changes in Mean Travel Times and Trip Distances Across Trip Purposes. Represents absolute difference in mean travel times and trip distances between Survey #1 and Survey #2, Members relative to Non-Members.

8.3 Mode-Adjusted Vehicle Miles Traveled

Table 15 shows mean mode-adjusted VMT fell among car-share members for all trip purposes except work and personal business. For non-members, the figure fell for social, medical, and recreational trips, and rose for other purposes.

Difference-of-difference results are summarized in Figure 14. Relative to non-members, the mean mode-adjusted VMT of members fell faster for medical and recreational trips, or fell while rising for non-members for return home, school, shopping, and recreational-other trips. For work and personal business trips, mean mode-adjusted VMT increased for both groups, but less for members than non-members (thus producing a negative difference-of-difference). Only in the case of social trips was the mean difference of difference positive — specifically, the decline was larger for non-members than members. Overall, the trip-level analysis found a larger decline in average mode-adjusted VMT for City CarShare members than the control group, but the difference was modest (about one daily mile) and not statistically significant.

Table 15. Differences in Mean Travel Times, Trip Distances, and MVMT Among Members and Non-Members, Between Survey #1 and Survey #2

Trip Purpose	Status	Travel Times	Trip Distances	MVMT
To Work	M	-1.925*	+1.006	+0.181
	NM	-5.541**	+0.179	+0.565
To Home	M	-3.984**	-2.085	-1.519
	NM	-4.687**	+0.073	+0.600
School	M	-13.582**	-4.052**	-1.494
	NM	-4.448**	+0.353**	+1.376
Shop	M	-5.080**	-1.931**	-1.785
	NM	+11.083**	+0.406**	+1.291**
Personal Business	M	-10.630**	+0.492	+0.510
	NM	+3.887**	+1.374	+1.682
Medical	M	-3.301**	-1.143	-1.178
	NM	-22.168**	-2.345	-0.541
Social	M	-5.489**	-0.950**	-0.680
	NM	+9.282**	+0.935**	-1.754
Recreation	M	-14.056**	-4.531	-2.681
	NM	-1.137**	-1.346	-1.181
Other	M	-6.183**	-0.823	-0.341
	NM	-12.760**	-1.607	-0.657
All	M	-6.376**	-1.402	-0.878
	NM	-3.426**	-0.198	+0.138

Key: M = member; NM = non-member; MVMT = mode-adjusted vehicle miles traveled;
** = statistically significant T statistic at the 5 percent probability level;
* = statistically significant T statistic at the 10 percent probability level.

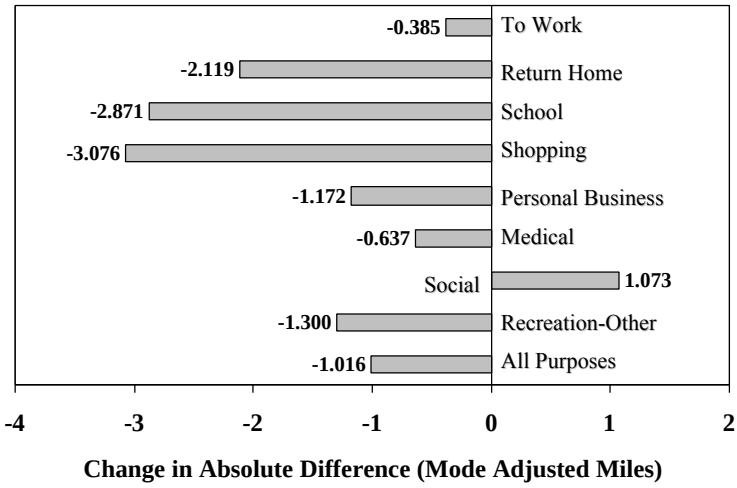


Figure 14. Relative Changes in Mean Mode-Adjusted Vehicle Miles Traveled Across Trip Purposes. Represents absolute difference in mode-adjusted vehicle miles traveled between Survey #1 and Survey #2, Members relative to Non-Members.

We note that this finding differs from the aggregate analysis presented earlier, wherein mode-adjusted VMT increased for members compared to declines for non-members. The aggregate analysis, however, was conducted for weekday travel only whereas the statistics presented at the trip level are for all days of the week — weekdays and weekends. Besides the effects of using different units of analysis (persons versus trips), differences suggest some degree of travel inducement on weekdays and travel suppression on weekends.[27] The absence of statistically significant results means one cannot read too much into these findings. Regardless, it will be interesting to see if such patterns hold over the longer term.

8.4 Explanatory Analysis

Efforts to estimate models that attributed travel behavior and trends in trip-making to City CarShare usage proved unsuccessful, mainly due to the relatively small share of car-share trips. Trying to predict variation in travel as a function of membership status also generally proved unsuccessful. An exception, however, was the analysis of car mode-choice. Using binomial logit analysis, a reasonably good-fitting model with interpretable

and intuitive coefficients was predicted. Table 16 summarizes the maximum-likelihood estimation results.

Those who were signed up to become City CarShare members prior to the program were more likely to drive a private car; however, if they stayed a member 3 to 4 months into the program, this probability declined. Owning a bicycle lowered the probability even more. These results hint at a receptivity of City CarShare members to reduce personal-car consumption (though as noted earlier, this is not necessarily matched by reduced travel consumption).

Table 16 contains several variables related to modal attributes. Consistent with most utility-based mode-choice analyses, the odds of driving increased when the travel time via transit exceeded that of the automobile. Having a Muni or BART transit pass substantially lowered the likelihood someone would opt to drive.

The socio-economic control variables defined other attributes of City CarShare members and non-members (who hope to one day become members) who tended to drive. The probability of driving rose with income and vehicles per household and among males and non-whites, all else held constant. Traveling on weekdays and days one had to work lowered the odds of taking a car.

Figure 15 presents a sensitivity analysis, revealing the responsiveness of private-car travel to changes in three variables: membership status, bicycle ownership, and travel-time differential (functioning as a covariate control). In the analysis, all other variables are set at their modal or mean values, representing the "typical" survey respondent. The figure shows that for a trip that took as long by transit as by driving, there was a 33 percent chance that a "typical" non-member without a bicycle would travel by private car, *ceteris paribus*. If everything remained the same but the person was a City CarShare member, the odds fell by around 10 percent, to 23 percent. And if this member had a bicycle available, the odds dropped even more, to around 12 percent. Membership status and bicycle ownership were strongly associated with reduced private-car travel, lowering the overall odds of driving by around one-fifth.

Overall, these results suggest bicycle ownership, transit passes, speedy transit services, low car ownership, and City CarShare membership are associated with reduced private automobile usage. The limited number of trips made by City CarShare vehicles would lead one to believe that car-sharing itself had a modest impact on restricting private-car usage. Regardless, the mode-choice modeling results suggest that membership suppressed private car travel, whether through encouraging people to reduce car ownership, making members cognizant of alternative mobility options, car-sharing itself, or some combination of these factors.

Table 16. Binomial Logit Model for Predicting Likelihood Respondent from Survey #2 Chose Private Car for Trip, All Trip Purposes

Variables	Coefficient Estimate	Standard Error	Probability
MEMBER STATUS:			
City CarShare Member in Survey #1 (1=yes; 0=no)	1.316	0.485	.007
City CarShare Member in Survey #2 (1=yes; 0=no)	-0.542	0.380	.154
City CarShare Member and owns a bike (1=yes; 0=no)	-0.765	0.485	.115
MODAL ATTRIBUTES:			
Total Travel Time Differential: Transit– Automobile (minutes)[a]	0.018	.0.003	.000
Have a Transit Pass (1=yes; 0=no)	-0.605	0.189	.001
SOCIO-ECONOMIC CONTROLS:			
Annual Household Income ($000s)	0.012	-0.001	.000
No. of Vehicles in Household	0.402	0.131	.002
Gender (0 = Male; 1 = Female)	-0.576	0.189	.002
White (1=Yes; 0=No)	-0.849	-0.849	.001
DAY TYPE:			
Weekday (1=Yes; 0=No)	-0.882	0.200	.000
Workday (1=Yes; 0=No)	-1.104	-0.192	.000
Constant	0.127	0.399	.750
SUMMARY STATISTICS:			
Number of Cases			912
-2L(c): Log Likelihood Function Value, Constant-only Model			1146.6
-2L(*B*): Log Likelihood Function Value, Parameterized Model			964.0
Model Chi-Square (Probability): -2[L(c) - L(*B*)]			182.6 (.0000)
Goodness of Fit (McFadden)			ρ^2 =.162

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.

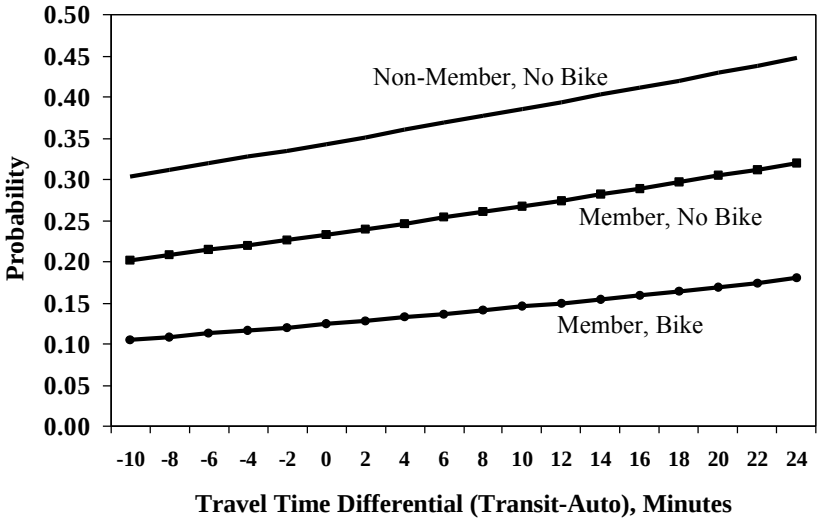


Figure 15. Sensitivity of Private Car Travel to City CarShare Membership and Bicycle Ownership as a Function of Travel Time Differential. All probabilities based on the mean or modal attributes of survey respondents, assuming: no transit pass; female; white; one car in the household; weekday and workday travel; and annual household income of $50,000.

9. SPATIAL ANALYSES

This section summarizes the results of studying spatial differences in trip-making between Survey #1 and Survey #2. The section is divided into descriptions of: POD locations; origins of City CarShare trips; destinations of City CarShare trips; and origin-destination patterns.

9.1 POD Locations

The term "POD," sometimes used as an acronym for "point of departure," has become the accepted name for parking-lots where customers pick up and return car-share vehicles. Figure 16 shows the location of nine PODs that existed by the time of the second survey in the summer of 2001. Most were located in the most urbanized eastern half of San Francisco.

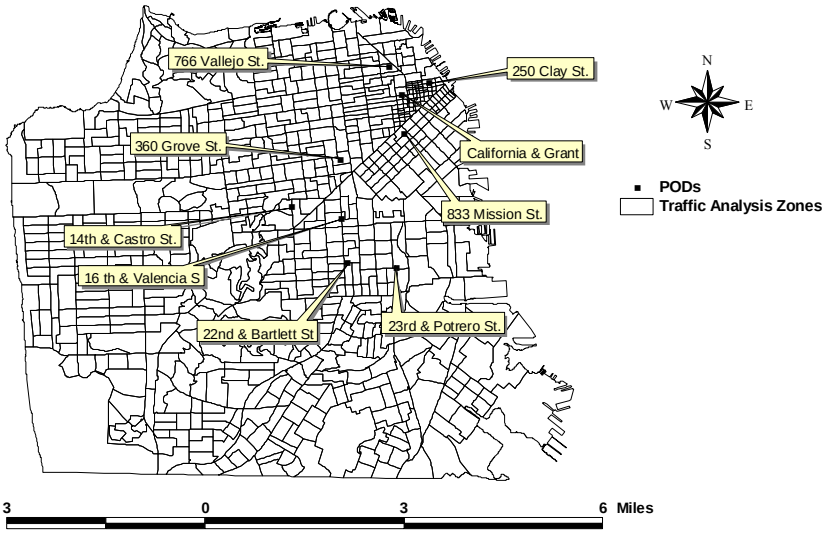


Figure 16. Location of POD Garages in San Francisco at Time of Survey #2

Based on the residential addresses of City CarShare members in Survey #2, Table 17 shows which PODs tended to be closest, in terms of road-network travel distances, to potential customers. For each POD, the share represents the percentage of City CarShare members who reside closest to that POD. The 14th and Castro Streets POD and the Civic Center POD were the closest to the largest share of City CarShare members in the summer of 2001. The least accessible PODs to members' residences were in and around downtown San Francisco.

Table 17. Relative Proximity of PODs to City CarShare Members' Residences

Name	Address	No.	Share
Duboce Triangle – CPMC Davies Campus Garage	14th & Castro St.	1	15.6%
Civic Center/Hayes Valley – Performing Arts	360 Grove St.	2	15.5%
North Mission – Hoff & 16th Street Garage	16th & Valencia St.	3	12.9%
South Mission – New Mission Garage	22nd & Bartlett St.	4	10.1%
Potrero Hill – SF General Hospital Lot	23rd & Portrero	5	8.7%
SOMA – 5th & Mission Garage	833 Mission St.	6	11.2%
Chinatown – Saint Mary's Park Garage	California & Grant Sts.	7	9.6%
Embarcadero – Golden Gateway Garage	250 Clay St.	8	7.7%
North Beach – Vallejo Street Garage	766 Vallejo St.	9	8.6%

Figure 17 shows the distribution of car-share pick-up locations among the sample of City CarShare trips compiled in Survey #2. Because only 2.2 percent of all surveyed trips were by City CarShare vehicles, this represents a small sample and should therefore not be considered necessarily representative of car-share activities among PODs. Among sample cases, the most frequently used PODs were along the 45^{o} axis aligned along Market Street: 14th & Castro; 360 Grove Street; 16th & Valencia Street; and 833 Mission Street. The least used PODs among sampled members were in and around downtown. In general, the pattern of usage from Figure 17 matches the relative proximity of PODs to members' residences from Table 17, suggesting that convenient access could be important in encouraging City CarShare usage.

Among the City CarShare trips made that involved members traveling from their homes to a POD to access a car, the average access distance was one-half mile. Access distances ranged from less than 100 feet to 1.5 miles.

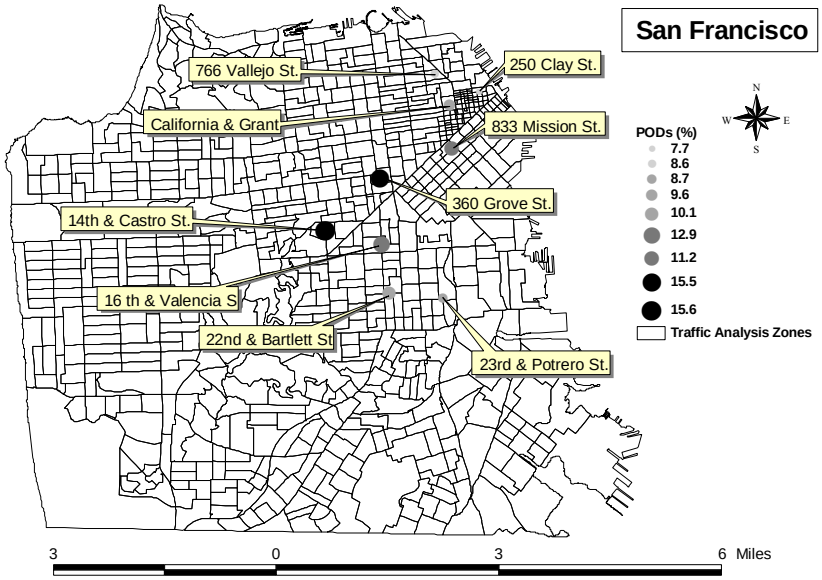


Figure 17. Percentage of City CarShare Trips Originating in Each POD

9.2 Origins of City CarShare Trips

Figure 18 shows the origins of sampled City CarShare trips in Survey #2, spanning June–July 2001. As expected, trip origins were spatially oriented toward the locations of PODs. There was little spatial clustering of car-share trip origins, revealed by a low spatial autocorrelation statistic (based on Moran's I) of 0.07.[28] As a basis of comparison, Figure 19 shows the origins of all work trips made by private car (excluding City CarShare vehicles) among members in Survey #2. The figure suggests stronger spatial clustering, which is supported by a larger Moran's I spatial autocorrelation of 0.21.

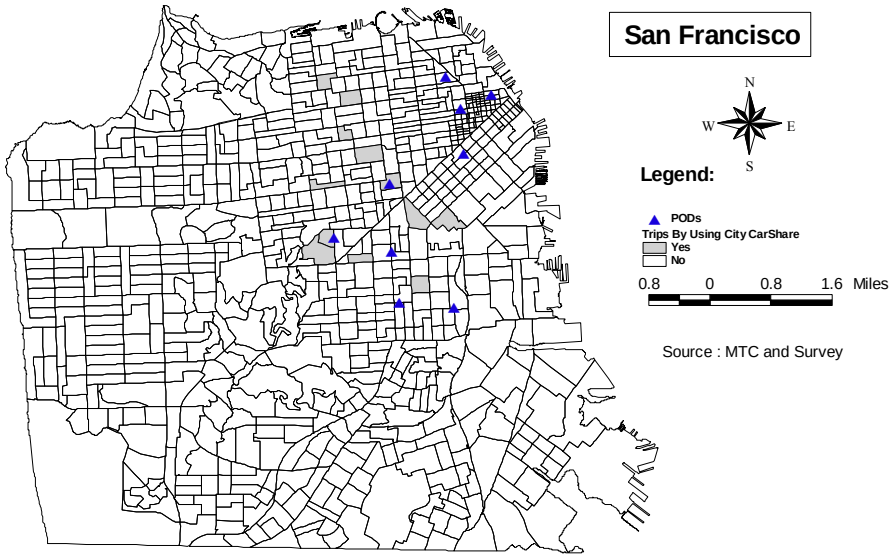


Figure 18. San Francisco Traffic Analysis Zones (TAZ) of City CarShare Trip Origins, Survey #2. Origin TAZ of City CarShare trips shown in shade.

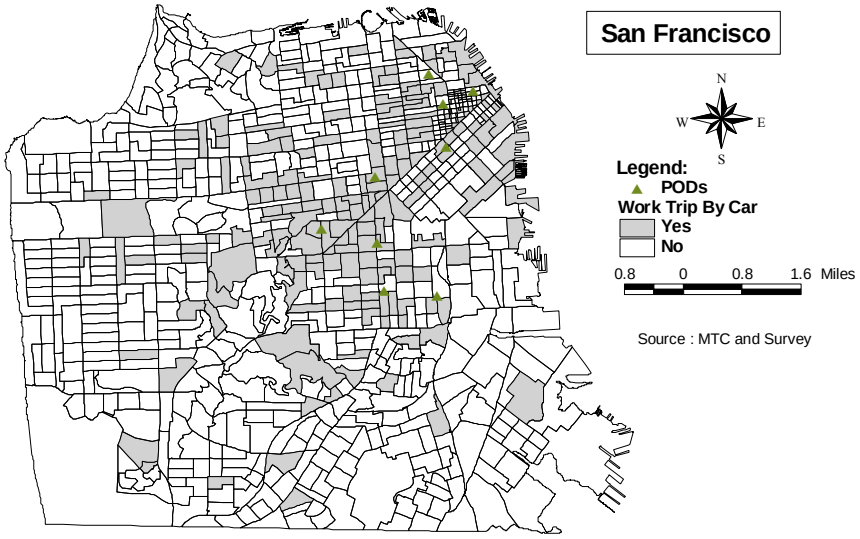


Figure 19. San Francisco Traffic Analysis Zones (TAZ) of Trip Origins of Private Car Trips, Excluding City CarShare Vehicles, Survey #2.
Origin TAZ of trips shown in shade.

9.3 Destinations of City CarShare Trips

For purposes of further defining the spatial nature of City CarShare trips, destination of trips from PODs was defined according to four quadrants of the city of San Francisco as well as all destinations outside the city (Figure 20). These were compared to the trip destinations of all trips made by members in Survey #1 (prior to the City CarShare program) who used City CarShare vehicles in Survey #2. The small sample size of City CarShare trips again diminishes the statistical validity of comparisons.

Table 18 shows the comparison results. Work trips are seen to be more spatially distributed during the periods covered by Survey #2. Spatial patterns of return-home trips were similar across the two surveys. For social trip purposes, whereas the carshare-using members made all trips to destinations outside the city in Survey #1 (prior to program initiation), in the second survey they were all within the city, specifically to the northwest quadrant. The small sample size makes drawing any inferences from this difficult; however, this is the kind of trend that would suggest that car-sharing encourages more localized non-discretionary trips. Lastly, the destinations of personal business travel seemed to be unaffected by City CarShare trip-making.

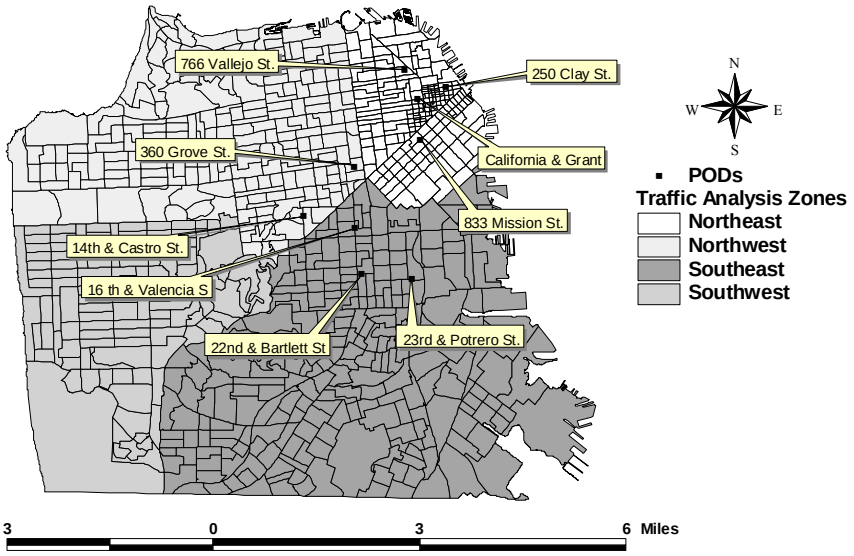


Figure 20. Quadrants of the City of San Francisco

Table 18. Spatial Percentage Distributions of All Trip Destinations by Trip Purpose, Members Who Were Car-Sharers in Survey #2: Survey #1 (Prior to Car-Sharing) and Survey #2

		Zones				
	Trip Purpose	**Northeast**	**Northwest**	**Southeast**	**Southwest**	**Outside**
Survey # 1	**Work**	100.0%	0.0%	0.0%	0.0%	0.0%
	Return Home	21.4%	57.1%	7.1%	0.0%	14.3%
	Social	0.0%	0.0%	0.0%	0.0%	100.0%
	Personal Business	25.0%	75.0%	0.0%	0.0%	0.0%
Survey # 2	**Work**	33.3%	33.3%	0.0%	0.0%	33.3%
	Return Home	0.0%	40.0%	20.0%	0.0%	40.0%
	Social	0.0%	100.0%	0.0%	0.0%	0.0%
	Personal Business	50.0%	50.0%	0.0%	0.0%	0.0%

Enlarging the sample to include trips by members and non-members over the two survey time periods produced the distributions shown in Table 19. For work and school trips, there is predictably a strong orientation of travel to downtown San Francisco (northeast quadrant), both among members and non-members and over both survey periods. Other trip purposes have more even distributions of trip destinations, save for the southwest sector. The small share of trips to the southwest quadrant likely reflects the current absence of PODs in this area, which is apt to reduce membership among those living in this area. Since the "non-members" are those who are signed up to one day become members, the absence of PODs in the southwest area could have suppressed people to register as well.

9.4 Origin-Destination Patterns

Figure 21 and 22 compare changes in trip origin-destination patterns between Survey # 1 and Survey #2, respectively, among members, for all trip purposes combined. The "desire line" maps — which identify the straightline, most direct paths that people "desire" to take for each origin-destination pair — show a strong orientation of trips in areas with PODs, both prior to and after the launching of the City CarShare program. The denser pattern of desire lines in Figure 21 simply reflects the larger sample of members' trips obtained from Survey #1.

Table 19. Spatial Percentage Distributions of All Trip Destinations by Trip Purpose, Member and Non-Member, Survey #1 and Survey #2

			Zones					
	Membership	Trip Purpose	Northeast	Northwest	Southeast	Southwest	Outside	Total
Survey #1	Member	Work-School	61.9%	11.0%	12.3%	4.5%	10.3%	100.0%
		Home	30.1%	36.5%	25.6%	3.7%	4.1%	100.0%
		Other	35.7%	21.6%	30.5%	1.6%	10.5%	100.0%
	Non-member	Work-School	41.6%	16.4%	20.6%	4.7%	16.8%	100.0%
		Home	15.4%	38.8%	29.8%	8.0%	8.0%	100.0%
		Other	21.7%	29.7%	30.4%	5.0%	13.2%	100.0%
Survey #2	Member	Work-School	57.3%	8.7%	9.7%	3.9%	20.4%	100.0%
		Home	29.9%	30.6%	26.4%	2.8%	10.4%	100.0%
		Other	26.8%	28.8%	26.8%	1.0%	16.6%	100.0%
	Non-member	Work-School	39.5%	13.3%	12.8%	4.6%	29.7%	100.0%
		Home	12.1%	35.0%	22.0%	7.0%	23.8%	100.0%
		Other	24.9%	30.3%	16.1%	5.4%	23.4%	100.0%

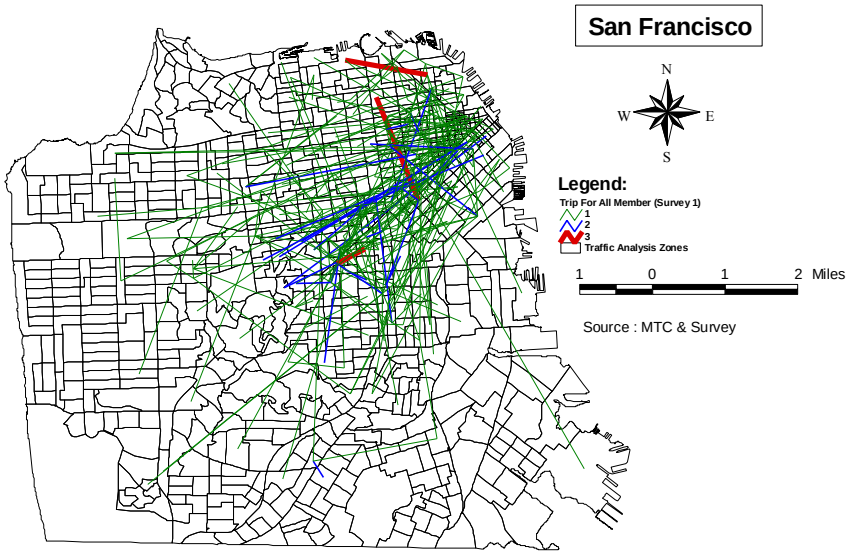


Figure 21. Desire Line Maps of Trips Made for All Purposes: Members, Survey #1

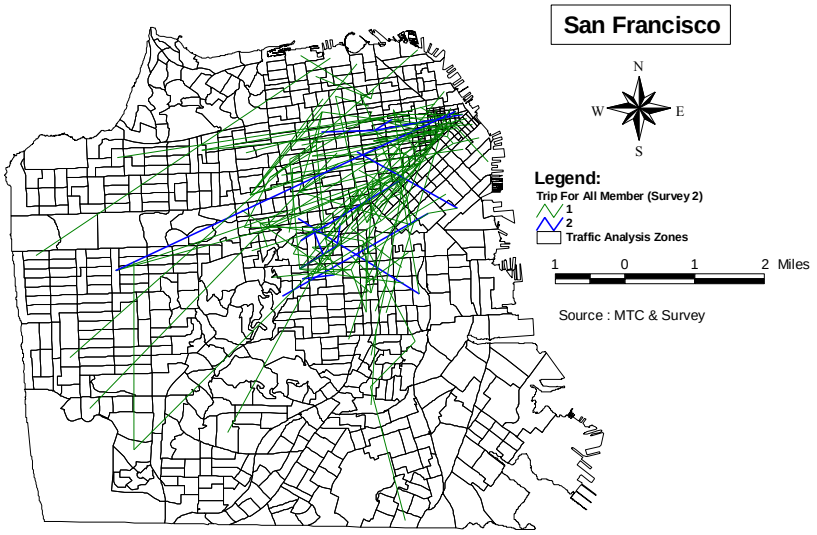


Figure 22. Desire Line Maps of Trips Made for All Purposes: Members, Survey #2

Figures 23 and 24 present the equivalent maps for non-members. Because non-members resided in a wider array of neighborhoods in the city, correspondingly there was a wider array of desire-line paths for this group, both for Survey #1 and Survey #2. Of course, the reason for this is circular. Non-members were less inclined to join City CarShare because of an absence of PODs in their neighborhoods. The limited number of PODs throughout the city meant non-members' residences were more geographically distributed, leading to more dispersed desire-line patterns.

The desire-line maps are for all trip purposes combined. Appendix B presents maps with desire-lines stratified by trip purpose. While discretionary trips, such as for social and recreational purposes, tend to be somewhat more geographically distributed, in general the spatial patterns for stratified trips paralleled those of all trip purposes combined.

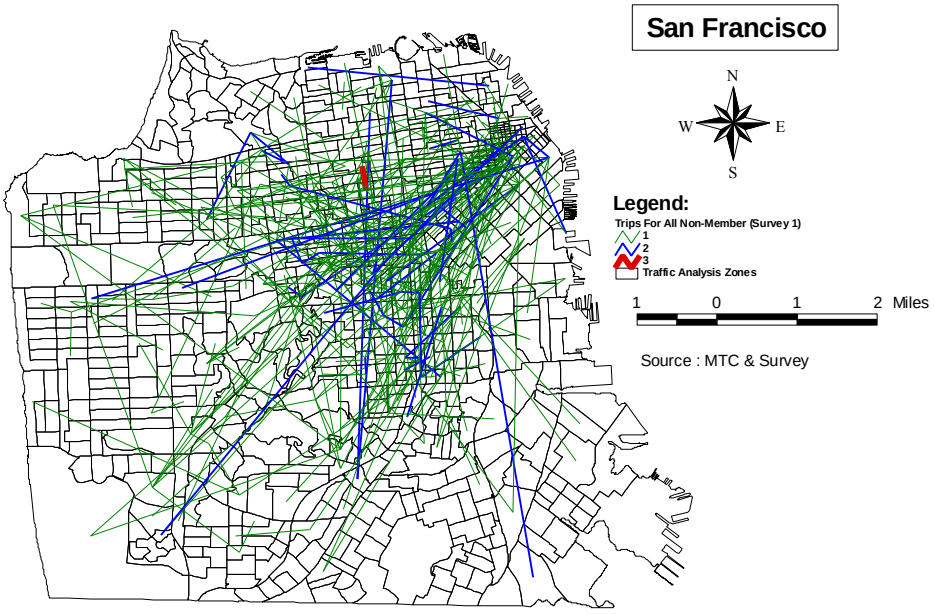


Figure 23. Desire Line Maps of Trips Made for All Purposes: Non-Members, Survey #1

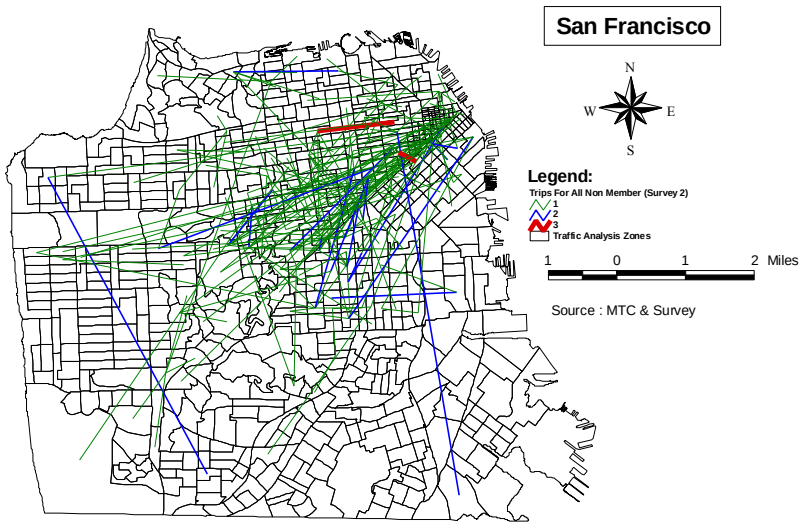


Figure 24. Desire Line Maps of Trips Made for All Purposes: Non-Members, Survey #2

10. CONCLUSION

Overall, City CarShare had a negligible impact on travel demand over the very near term. Only around 2 percent of all trips made by members were via City CarShare vehicles; however, since these trips tended to be longer than other trips, they constituted around 7 percent of VMT. There is slight evidence of travel inducement, but the small number of City CarShare trips recorded three months into the program precludes any firm inferences from being drawn. Increased VMT and mode-adjusted VMT recorded for weekdays could have been partly due to car-sharing, however, it also could have been due to an echo effect. Cognizant of some of the mobility advantages of cars, members might have become more predisposed toward the idea of "automobility" and unconsciously begun driving their own cars or those of their friends more often. For weekdays that were non-workdays, there was some evidence of "resourceful automobility" in that the mode- and engine-sized adjusted VMT of members fell faster than that of non-members. These inferences are only speculative; however, they hint at some of the behavioral adjustments that might be tracked over time as the program matures and participants settle in to more permanent patterns of travel behavior.

Statistically, little can be said about the travel-behavioral impacts of car-sharing in San Francisco with any degree of confidence. There tended to be as much variation in travel distances, durations, mode choice, and various indices of VMT among members as between members and non-members. In most instances, changes in mean values of these variables over the two survey periods did not vary significantly between members and non-members. Also, there were some conflicting signals, such as evidence of travel inducement in the study of aggregate 24-hour travel compared to some instances of travel suppression in the trip-level analysis. In these instances, restricted sample sizes required that analyses be stratified differently — such as the partitioning of results for limited day-types in the case of the aggregate analysis versus the pooling of data across all day-types in the trip-level analysis. Thus, differences in sample frames could have explained some of the inconsistencies. Restricted sample sizes and the limited incidence of car-sharing unavoidably blurred research insights.

It is perhaps presumptuous to expect any significant recordable impacts only three to four months into the City CarShare program. It very well could take several years before significant effects begin to surface. Notably, any appreciable reductions in travel might only happen through reductions in private car ownership. Alternatively, car-sharing might induce car ownership — those who did not own a vehicle when entering the program (which was the overwhelming majority of City CarShare members who were surveyed) might eventually decide to buy their own car once they experience first-hand some of the benefits of automobility. Regardless of the directionality of impacts, changes in car ownership likely take time to unfold. It is in this spirit that a companion report will follow, presenting intermediate-term impacts 8 to 10 months into the program.

NOTES

[1] For further discussions on car-sharing in both Europe and North America, see: T. Beatley, *Green Urbanism: Learning from European Cities*, Washington, DC, Island Press, 2000; C. K. Orski, Car Sharing Revisited, *Innovation Briefs*, Vol. 13, No. 1, p. 1.

[2] Peter Muheim & Partners, *CarSharing: The Key to Combined Mobility*. Berne: Swiss Federal Office of Energy.

[3] S. Shaheen, D. Sperling, and C. Wagner, Car-sharing in Europe and North America: Past, Present, and Future. *Transportation Quarterly*, Vol. 52, No. 3, 1998, pp. 35–52.

[4] N. T. Fellows and D. E. Pitfield, An Economic and Operational Evaluation of Urban Car-sharing, *Transportation Research D*, Vol. 5, 2000, pp. 1–10.

[5] City CarShare. What is Car-Sharing? San Francisco: City CarShare, 2001 (mimeo).

[6] G. Metcalf, New Car-sharing Options, *Urban Land*, Vol. 61, No. 2, p. 84.

[7] For Survey #1, questionnaires were distributed from the period of January 10 to May 21, 2001, although 96.8 percent of the responses were from the periods of February 13 to March 5. Surveyees were assigned dates spanning February 18 through March 5 to fill out travel diaries. Some earlier responses were compiled as part of pre-testing the survey instrument. Some responses from April and May were also obtained as part of the orientation process wherein new members were asked to complete surveys prior to joining the program. Since this represented a time-point prior to new members using City CarShare vehicles (even though data were compiled following the March 7, 2001, inauguration date), the responses were treated as "before" data observations.

[8] Responses were obtained as early as May 29, 2001, and as late as August 9, 2001, however, 92.2 percent of the questionnaires were sent out and returned over the periods of June 4 to July 2, 2001. Surveyees were assigned dates spanning June 4 through June 17 to complete the second travel-diary surveys. Questionnaires asked for responses over the June 4 to June 17 period, however, delayed responses (possibly because of increased vacation and recreational travel) resulted in responses being accepted into July and as late as early August.

[9] Most respondents opted to complete surveys on weekdays, not weekends. Hardly any respondents completed surveys on Sundays; thus, there was an under-sampling of weekend travel.

[10] For Survey #2, an incentive was introduced, in the form of a brand-new, crisp one-dollar bill that was included in each mailed package, offered as a "small token of appreciation" for individuals taking the time to complete the surveys. Concerns over collecting detailed sample data within three to four month's time of the initial survey, a possibly "wearing down" of surveyees, prompted the research team to introduce this incentive. While there is no way to know whether the incentive increased response rate, the respectably high rate of return suggests it did have some marginal effect. The response rate did decline from the first survey, however, this could have been expected since the second survey was less of a novelty and could have been perceived as more of a burden coming relatively soon after the initial survey.

[11] Information on roadway travel distance as well as travel time was obtained from computer-generated matrices that recorded typical travel distances and times (depending upon mode) for every origin and destination combination. The Transportation Department of the City of San Francisco provided the travel time estimates based on the corresponding traffic analysis zone (TAZ) of trip origin and destination.

[12] Background survey results are drawn from Survey #1 and Survey #2.

[13] Among the sampled City CarShare trips, 156.6 miles were logged in City CarShare vehicles, compared to 2,224 miles logged on motorized vehicles. Thus, 156.6 / (156.6 + 2244), or 7 percent, of total VMT occurred in City CarShare vehicles.

[14] This is based on background survey information drawn from Survey #1 and Survey #2. These results differ from those presented in Section 4, which are based on Survey #1 only.

[15] In most cases, this meant living and working in San Francisco; however, not all members were from San Francisco and in several instances members living outside the city worked at home.

[16] Statistics presented in this sub-section differ from those in Section 4 in that the former are drawn from Survey #2 and the latter from Survey #1 (prior to program implementation).

[17] R. Katzev, Car-sharing Portland: An Analysis of its First Year. Paper presented at the Annual Meeting of the Transportation Research Board, Washington, DC, January 2001.

[18] Standard deviations for annual household incomes were $35,939 for non-members and $28,418 for members.

[19] R. Katzev, 2000, *op cit*.

[20] Among non-member surveyees, 58.3 percent of household cars were owned by the respondents, 20.4 percent were not owned but were available, and 21.3 percent were not available.

[21] R. Katzev, 2000, *op cit*.

[22] In cases where respondents provided two days of travel diary information, a single 24-hour estimate was derived by averaging over the two days. If respondents completed a survey for just one day, that single-day recorded was used in the analysis.

[23] Mean VMT levels were suppressed by the large share of respondents who made no private vehicle trips, producing a 0 value. Removing cases with no private-vehicle trips reduced the sample size considerably, but increased mean VMT levels.

[24] Source: California Energy Commission, *Estimated 2001 Gasoline Price Breakdown & Margins Details*, http://www.energy.ca.gov/fuels/gasoline/margins/2001.html.

[25] K. Steininger, C. Vogl, and R. Zettl. Car-Sharing Organizations: The Size of the Market Segment and Revealed Change in Mobility Behavior. *Transport Policy*, Vol. 3, No. 4, 1996, pp. 177–185.

[26] Separation by day-type was not considered necessary as long as purposes were stratified, since for example, there is no reason to believe that factors influencing medical trips differ between weekdays and weekends.

[27] In the aggregate analysis, the unit of analysis is the person, and the metric is the daily sum of mode-adjusted VMT for all purposes, averaged over the two-day travel-diary period. In the trip-level analysis, the unit of analysis is the individual trip, and the metric is the mode-adjusted VMT for each trip, again averaged over the two-day travel-diary period.

[28] Moran's I was estimated using the TransCAD GIS software package. The statistic was calculated as:

$$I = \frac{n \sum_i \sum_j w_{ij} (y_i - y') (y_j - y')}{[\sum_i (y_i - y')^2] (\sum \sum_{i?j} w_{ij})}$$

where y_i is the variable of interest, y' is the global mean, i and j subscripts index traffic zones, and w_{ij} is a spatial weight. The weight, w_{ij}, was based on the degree of "shared-boundary" adjacency of super-districts, ranging in value from zero (non-adjacency) to one (only when one super-district totally envelops another, which is not the case with Bay Area super-districts). Like a Pearson-Product moment correlation, Moran's I ranges in values between –1 and +1, with a high positive value indicating spatial clustering and agglomerations, a high negative value revealing a "patchy," alternating spatial pattern, and a zero value suggesting pure spatial randomness.

ACKNOWLEDGMENTS

We thank Joseph Castilogne and others in the Transportation Department of the City of San Francisco for matching address information on trip records to determine the origins and destinations of trips for purposes of estimating highway network trip distances and durations. We also thank Elizabeth Sullivan, Executive Director of City CarShare, for making directories of members and applicants available to us and helping with other phases of the research, such as e-mailing members to encourage them to complete questionnaires. Also, we thank Chris Amado of the Institute of Urban and Regional Development (IURD) for setting up the website used to compile survey data and explain our survey instruments to respondents. She and others from IURD also provided valuable assistance in copying questionnaires, stuffing envelopes, and mailing the surveys. Our thanks also go to Forest Atkinson who helped in the early phases of the research with designing and administering questionnaires, compiling records, and conducting preliminary analyses of the results from the first survey.

APPENDIX A:

BACKGROUND SURVEY, TRAVEL-DIARY SURVEY, AND EXAMPLE OF COVER LETTER

Survey Cover Letter

UNIVERSITY OF CALIFORNIA, BERKELEY

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

INSTITUTE OF URBAN AND REGIONAL DEVELOPMENT
104 WHEELER HALL
(510) 642-4874
(510) 643-9576 FAX

BERKELEY, CALIFORNIA 94720-1870

Dear Sir or Madam:

The Institute of Urban and Regional Development (IURD) at the University of California, Berkeley, is conducting an important study of transportation issues in San Francisco with a focus on car-sharing. We need your help to successfully carry out this work.

Enclosed are two sets of surveys plus a Business Reply Mail envelope for returning the surveys. Alternatively, you can complete these surveys electronically by going to the following web site: http://www-iurd.ced.berkeley.edu/citycarshare.htm. You can also visit this site to get answers to possible questions you might have or to e-mail us.

The first survey — **City CarShare Survey: *Background Information*** — is the long single-page questionnaire that folds out. It requests needed background information about yourself, your household, and vehicles in your household.

Also enclosed are two surveys in booklet form that are paper-clipped together — **City CarShare Survey: *Travel Diary Day 1*** and **City CarShare Survey: *Travel Diary Day 2.*** The booklet surveys collect information on your daily travel activities for a particular 24-hour day (12:01 a.m. to midnight). We need travel data for a consecutive two-day period, thus two booklets are enclosed

We would appreciate it if you could either mail back these surveys or complete them on-line within ***one week*** of the last day you completed a travel diary. Your responses will be treated **confidentially** and will only be used by pooling together data across many other responses. No individual responses will be reported or cited in the research report. Data responses will be kept in a locked cabinet drawer and on a computer disk that is only accessible to members of the research team.

Should you have any questions, please visit our web site or contact by phone (510-642-4874) or e-mail either Forest Atkinson (foresta@uclink.berkeley.edu) or Nina Creedman (creedman@uclink.berkeley.edu).

Please sign the consent line below and return this cover page with your survey response. Your time and assistance is greatly appreciated!

Sincerely,

Robert Cervero, Professor
Institute of Urban and Regional Development

Elizabeth Sullivan, Executive Director
City CarShare

CONSENT: I have read this consent form and agree to take part in this research by completing the survey.

_____ _____

Your Signature Date

City Carshare Survey: Background Information

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: (check all that apply) ❒ 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?_____ AM / PM (circle one)

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: ❒ I own this vehicle ❒ Someone else owns this vehicle but I can use it ❒ 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: ❒ I own this vehicle ❒ Someone else owns this vehicle but I can use it ❒ 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: ❒ I own this vehicle ❒ Someone else owns this vehicle but I can use it ❒ 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: ❒ I own this vehicle ❒ Someone else owns this vehicle but I can use it ❒ 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.

• • • • • • • • Thank you for your time and assistance • • • • • • • •

City Carshare Survey: Travel Diary

THANK YOU
—For Your Time & Assistance—

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.

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 tripÑe.g., from work to grocery store and then to home is 2 trips.

TRIP 9. Fill in or check all that apply.

1. Trip began at (address or nearest intersection):
   _____
   _____City:_____
2. Trip ended at (address or nearest intersection):
   _____
   _____City:_____
3. Time of departure:_____ AM / PM (circle one)
4. Time of arrival:_____ AM / PM (circle one)
5. 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): _____
6. Purpose of trip:
   - ❒ Go to work
   - ❒ Return home
   - ❒ Social (e.g., visit a friend)
   - ❒ Eat a meal
   - ❒ Recreational
   - ❒ Go to school
   - ❒ Go shopping
   - ❒ Personal business (e.g., to bank)
   - ❒ Medical
   - ❒ Other (specify): _____
7. 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.

TRIP 8. Fill in or check all that apply.

1. Trip began at (address or nearest intersection):

   _____

   _____City:_____

2. Trip ended at (address or nearest intersection):

   _____

   _____City:_____

3. Time of departure:_____ AM / PM (circle one)
4. Time of arrival:_____ AM / PM (circle one)
5. 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): _____
6. Purpose of trip:
   - ❒ Go to work
   - ❒ Return home
   - ❒ Social (e.g., visit a friend)
   - ❒ Eat a meal
   - ❒ Recreational
   - ❒ Go to school
   - ❒ Go shopping
   - ❒ Personal business (e.g., to bank)
   - ❒ Medical
   - ❒ Other (specify): _____
7. If you paid for any of the following, record the amount paid:
   - $_____._____ parking
   - $_____._____ transit fare
   - $_____._____ toll
   - $_____._____ other (specify):_____

TRIP 1. Fill in or check all that apply.

1. Trip began at (address or nearest intersection):

   _____

   _____City:_____

2. Trip ended at (address or nearest intersection):

   _____

   _____City:_____

3. Time of departure:_____ AM / PM (circle one)
4. Time of arrival:_____ AM / PM (circle one)
5. 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): _____
6. Purpose of trip:
   - ❒ Go to work
   - ❒ Return home
   - ❒ Social (e.g., visit a friend)
   - ❒ Eat a meal
   - ❒ Recreational
   - ❒ Go to school
   - ❒ Go shopping
   - ❒ Personal business (e.g., to bank)
   - ❒ Medical
   - ❒ Other (specify): _____
7. If you paid for any of the following, record the amount paid:
   - $_____._____ parking
   - $_____._____ transit fare
   - $_____._____ toll
   - $_____._____ other (specify):_____

TRIP 2. Fill in or check all that apply.

1. Trip began at (address or nearest intersection):

   _____

   _____City:_____

2. Trip ended at (address or nearest intersection):

   _____

   _____City:_____

3. Time of departure:_____ AM / PM (circle one)
4. Time of arrival:_____ AM / PM (circle one)
5. 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): _____
6. Purpose of trip:
   - ❒ Go to work
   - ❒ Return home
   - ❒ Social (e.g., visit a friend)
   - ❒ Eat a meal
   - ❒ Recreational
   - ❒ Go to school
   - ❒ Go shopping
   - ❒ Personal business (e.g., to bank)
   - ❒ Medical
   - ❒ Other (specify): _____
7. If you paid for any of the following, record the amount paid:
   - $_____._____ parking
   - $_____._____ transit fare
   - $_____._____ toll
   - $_____._____ other (specify):_____

TRIP 7. Fill in or check all that apply.

1. Trip began at (address or nearest intersection):

   _____

   _____City:_____

2. Trip ended at (address or nearest intersection):

   _____

   _____City:_____

3. Time of departure:_____ AM / PM (circle one)
4. Time of arrival:_____ AM / PM (circle one)
5. 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): _____
6. Purpose of trip:
   - ❒ Go to work
   - ❒ Return home
   - ❒ Social (e.g., visit a friend)
   - ❒ Eat a meal
   - ❒ Recreational
   - ❒ Go to school
   - ❒ Go shopping
   - ❒ Personal business (e.g., to bank)
   - ❒ Medical
   - ❒ Other (specify): _____
7. If you paid for any of the following, record the amount paid:
   - $_____._____ parking
   - $_____._____ transit fare
   - $_____._____ toll
   - $_____._____ other (specify):_____

TRIP 6. Fill in or check all that apply.

1. Trip began at (address or nearest intersection):

   _____

   _____City:_____

2. Trip ended at (address or nearest intersection):

   _____

   _____City:_____

3. Time of departure:_____ AM / PM (circle one)
4. Time of arrival:_____ AM / PM (circle one)
5. 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): _____
6. Purpose of trip:
   - ❒ Go to work
   - ❒ Return home
   - ❒ Social (e.g., visit a friend)
   - ❒ Eat a meal
   - ❒ Recreational
   - ❒ Go to school
   - ❒ Go shopping
   - ❒ Personal business (e.g., to bank)
   - ❒ Medical
   - ❒ Other (specify): _____
7. If you paid for any of the following, record the amount paid:
   - $_____._____ parking
   - $_____._____ transit fare
   - $_____._____ toll
   - $_____._____ other (specify):_____

TRIP 3. Fill in or check all that apply.

1. Trip began at (address or nearest intersection):

   _____

   _____City:_____

2. Trip ended at (address or nearest intersection):

   _____

   _____City:_____

3. Time of departure:_____ AM / PM (circle one)
4. Time of arrival:_____ AM / PM (circle one)
5. 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): _____
6. Purpose of trip:
   - ❒ Go to work
   - ❒ Return home
   - ❒ Social (e.g., visit a friend)
   - ❒ Eat a meal
   - ❒ Recreational
   - ❒ Go to school
   - ❒ Go shopping
   - ❒ Personal business (e.g., to bank)
   - ❒ Medical
   - ❒ Other (specify): _____
7. If you paid for any of the following, record the amount paid:
   - $_____._____ parking
   - $_____._____ transit fare
   - $_____._____ toll
   - $_____._____ other (specify):_____

TRIP 4. Fill in or check all that apply.

1. Trip began at (address or nearest intersection):

   _____

   _____City:_____

2. Trip ended at (address or nearest intersection):

   _____

   _____City:_____

3. Time of departure:_____ AM / PM (circle one)
4. Time of arrival:_____ AM / PM (circle one)
5. 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): _____
6. Purpose of trip:
   - ❒ Go to work
   - ❒ Return home
   - ❒ Social (e.g., visit a friend)
   - ❒ Eat a meal
   - ❒ Recreational
   - ❒ Go to school
   - ❒ Go shopping
   - ❒ Personal business (e.g., to bank)
   - ❒ Medical
   - ❒ Other (specify): _____
7. If you paid for any of the following, record the amount paid:
   - $_____._____ parking
   - $_____._____ transit fare
   - $_____._____ toll
   - $_____._____ other (specify):_____

TRIP 5. Fill in or check all that apply.

1. Trip began at (address or nearest intersection):

   _____

   _____City:_____

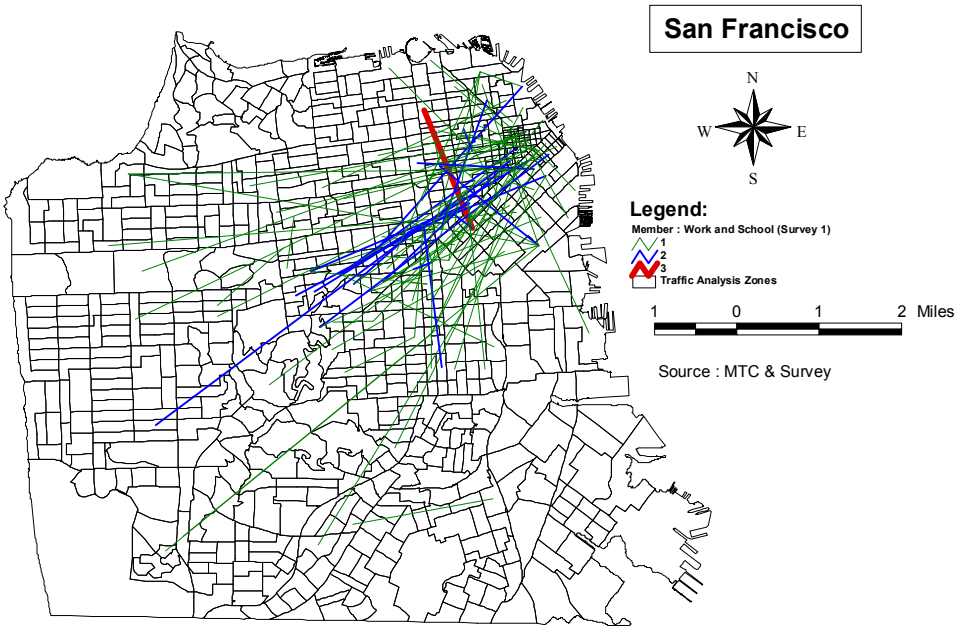
2. Trip ended at (address or nearest intersection):

   _____

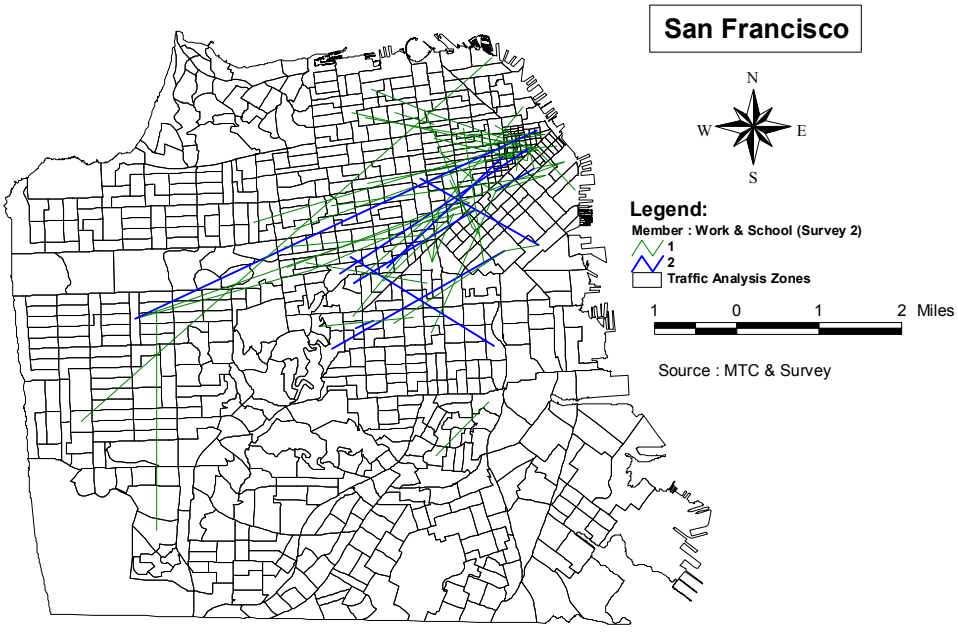
   _____City:_____

3. Time of departure:_____ AM / PM (circle one)
4. Time of arrival:_____ AM / PM (circle one)
5. 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): _____
6. Purpose of trip:
   - ❒ Go to work
   - ❒ Return home
   - ❒ Social (e.g., visit a friend)
   - ❒ Eat a meal
   - ❒ Recreational
   - ❒ Go to school
   - ❒ Go shopping
   - ❒ Personal business (e.g., to bank)
   - ❒ Medical
   - ❒ Other (specify): _____
7. If you paid for any of the following, record the amount paid:
   - $_____._____ parking
   - $_____._____ transit fare
   - $_____._____ toll
   - $_____._____ other (specify):_____

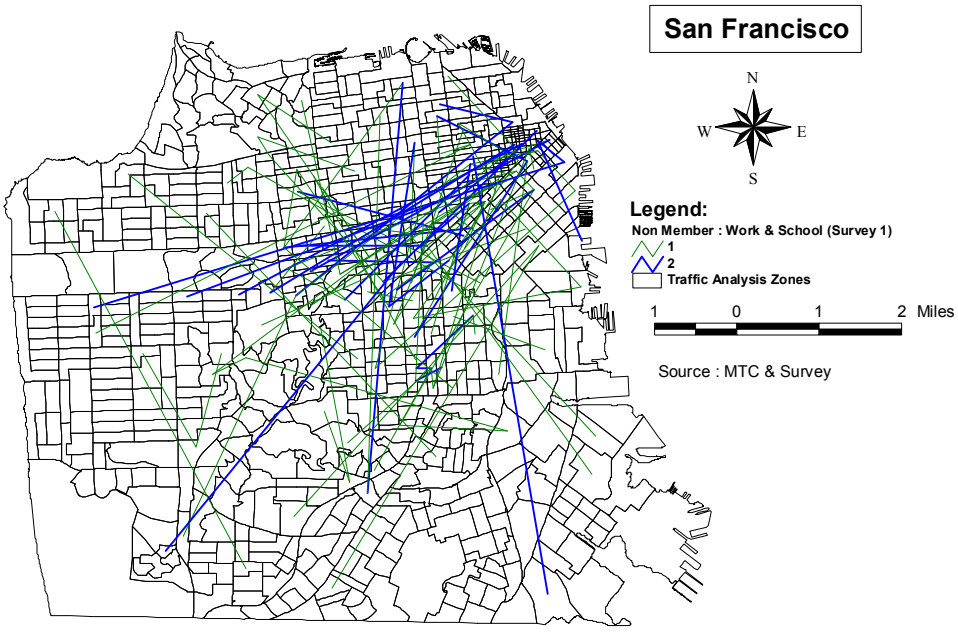
APPENDIX B: DESIRE LINE MAPS OF TRIPS BY PURPOSE, MEMBERS AND NON-MEMBERS



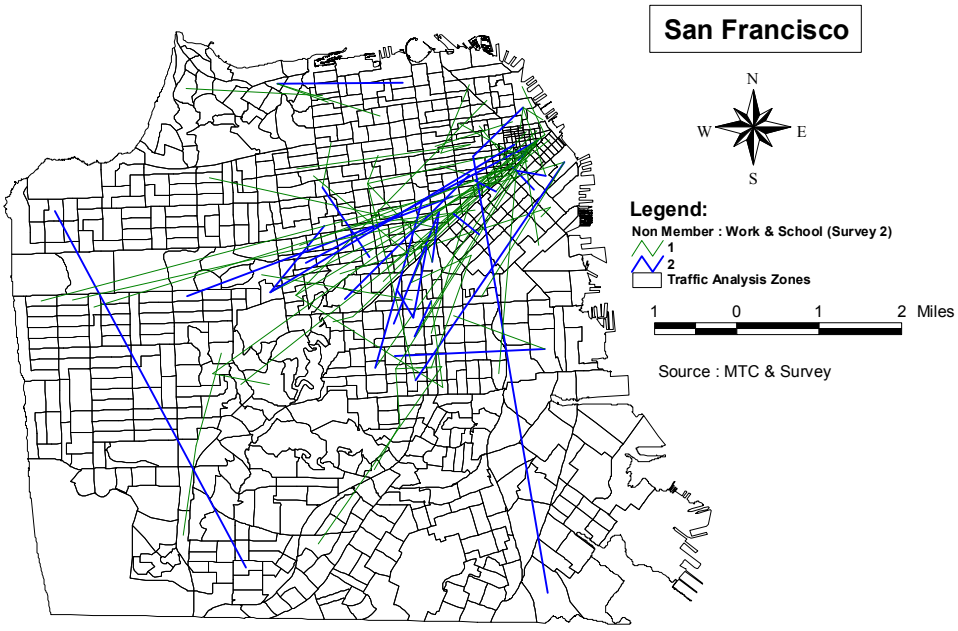
Member: Work or School Trip (Survey 1)



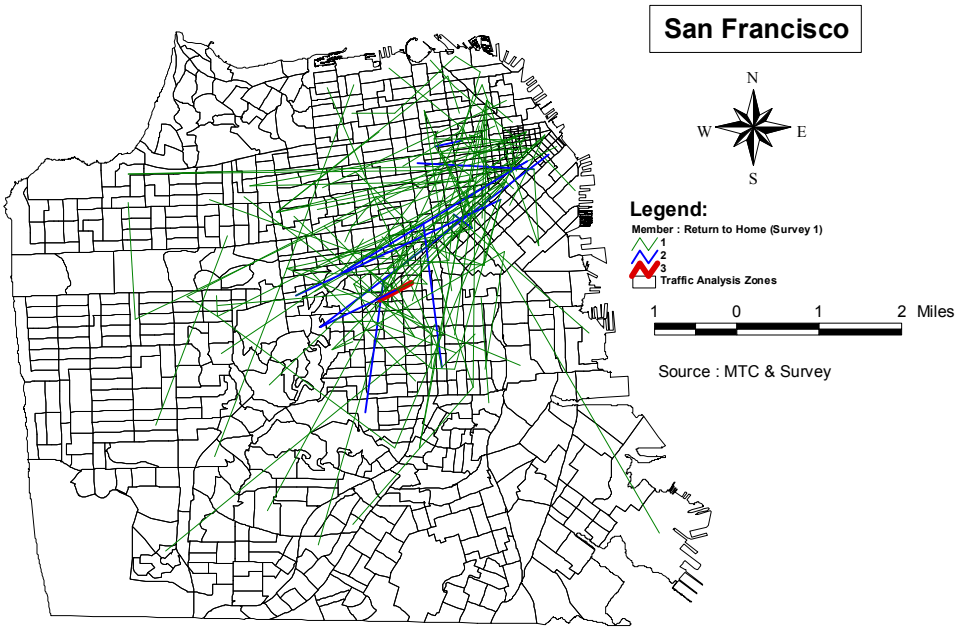
Member: Work or School Trip (Survey 2)



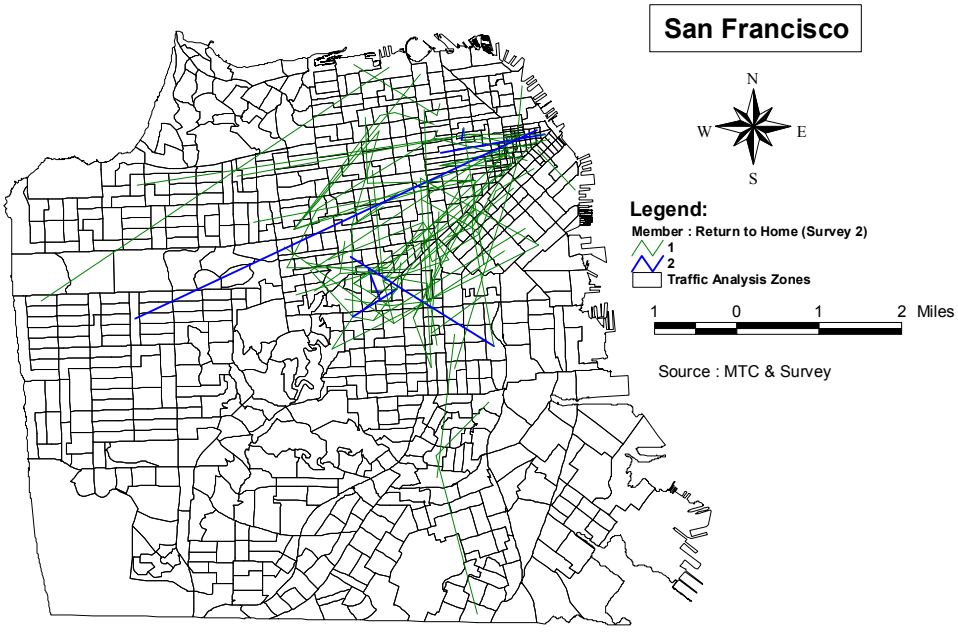
Non-Member: Work or School Trip (Survey 1)



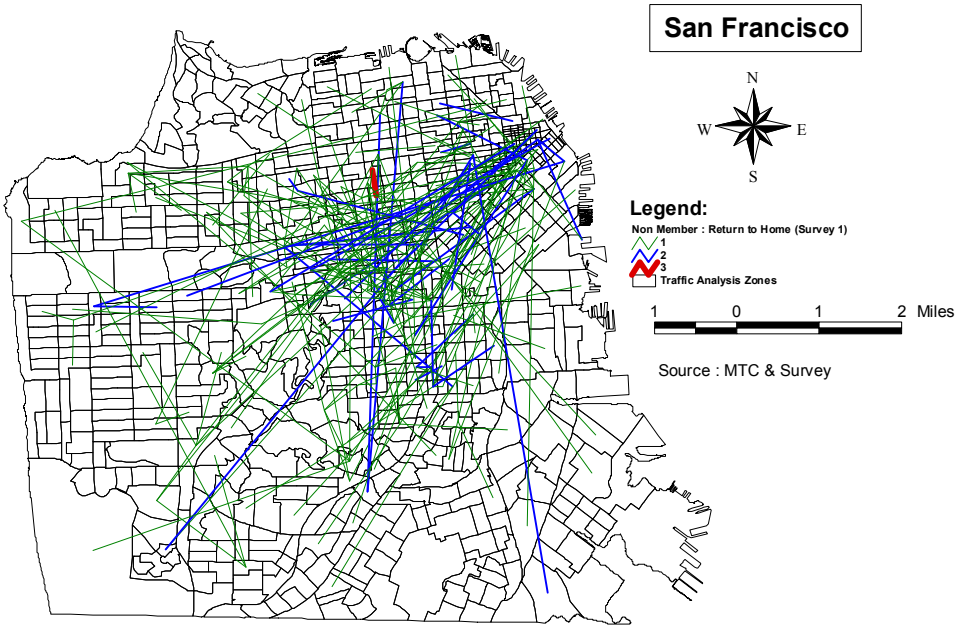
Non-Member: Work or School Trip (Survey 2)



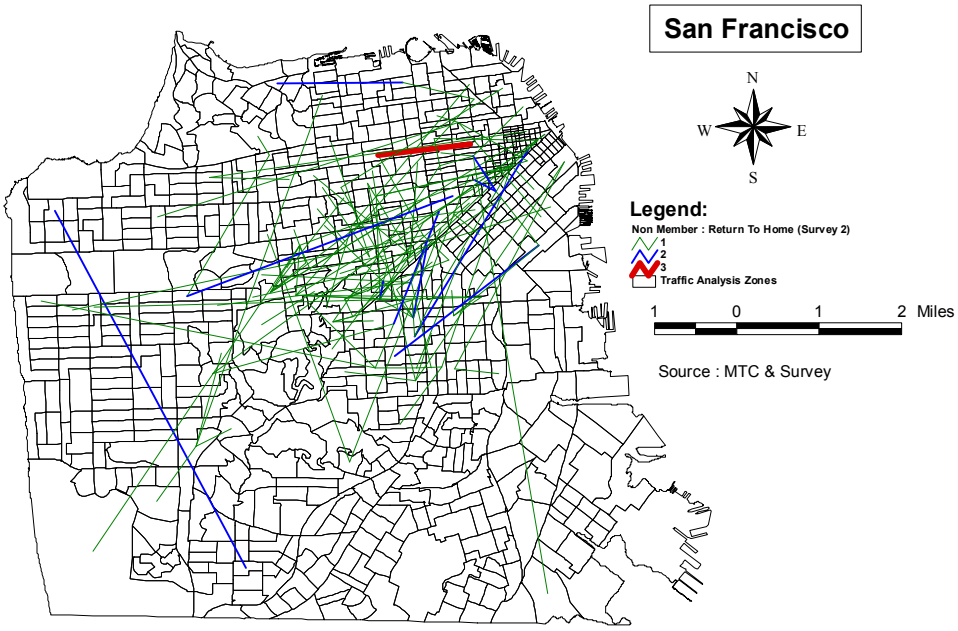
Member: Return to Home (Survey 1)



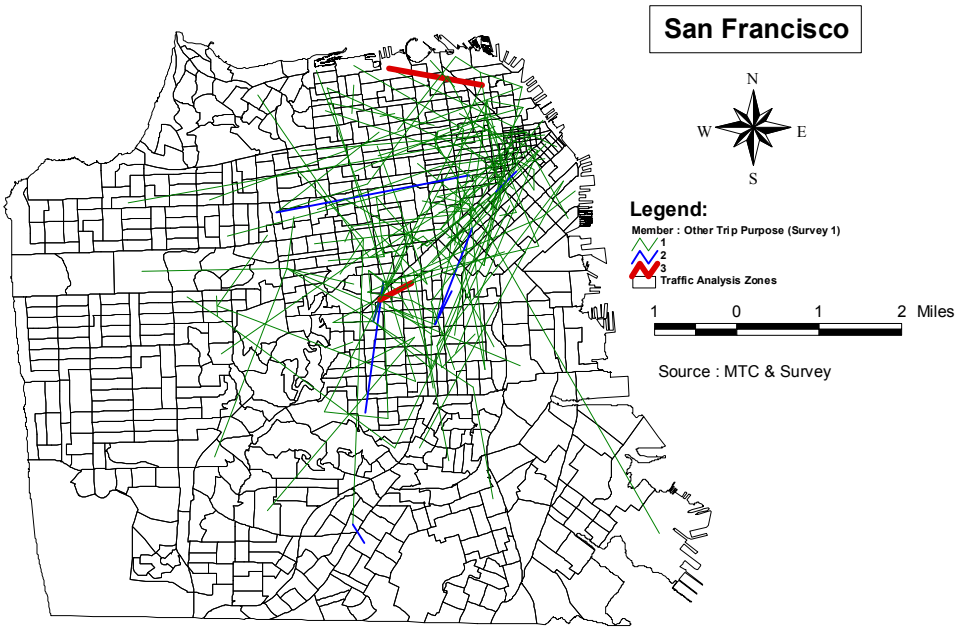
Member: Return to Home (Survey 2)



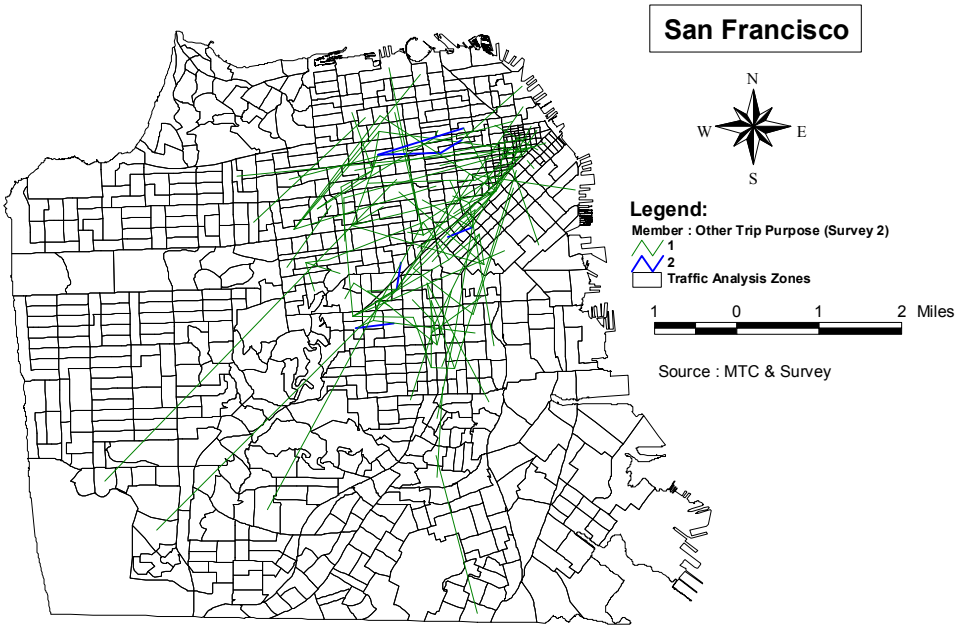
Non-Member: Return to Home (Survey 1)



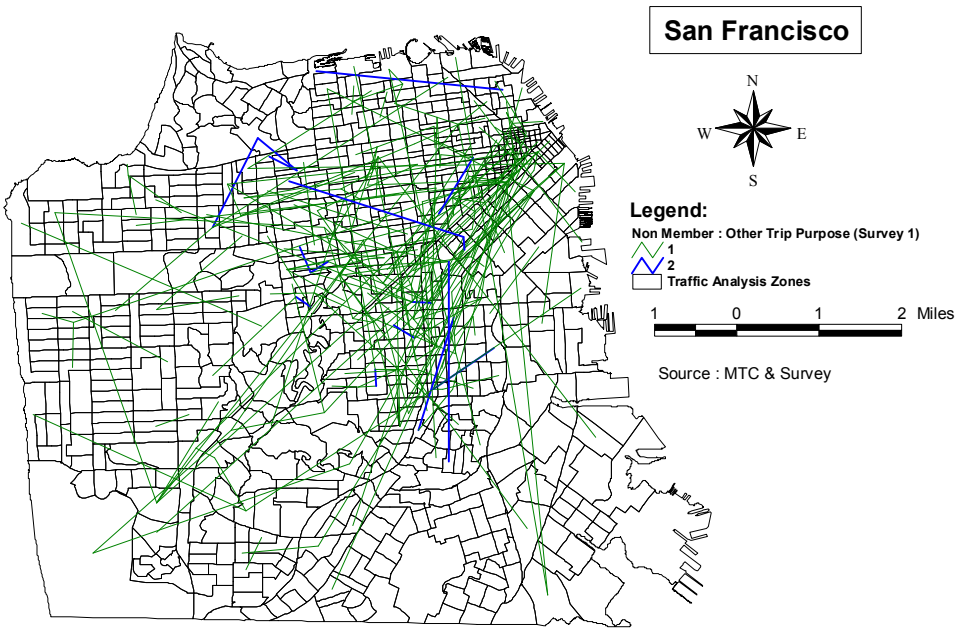
Non-Member: Return to Home (Survey 2)



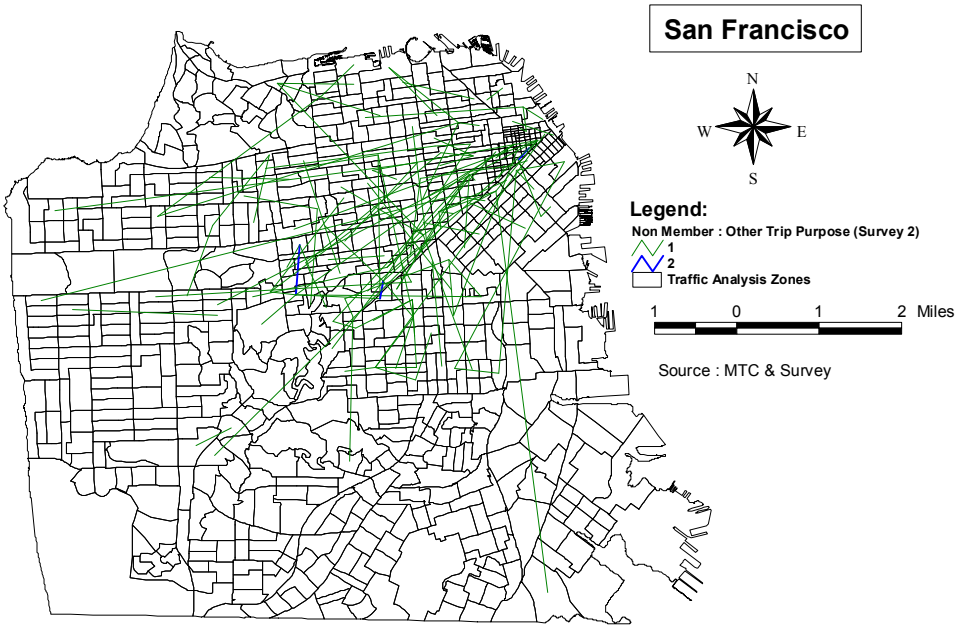
Member: Other Trip (Survey 1)



Member: Other Trip (Survey 2)



Non-Member: Other Trip (Survey 1)



Non Member: Other Trip (Survey 2)