RESULTS OF THE FALL 2007 UC DAVIS CAMPUS TRAVEL ASSESSMENT

INSTITUTE OF TRANSPORTATION STUDIES
AND
TRANSPORTATION AND PARKING SERVICES
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1 Introduction

For both transportation planners and travelers, collective issues such as traffic and parking congestion, sprawl, air quality, oil dependence, global warming, and more recently obesity, have become important concerns. These collective problems are all exacerbated by increasing suburbanization and the accumulation of individuals' choices to predominantly use automobiles. In the U.S., "walking and cycling for transportation has declined by about 40 percent since 1977, to approximately 6 percent of total trips, while nearly 65 percent of Americans are currently either overweight or obese" (SACOG 2008). In the Sacramento Metropolitan Region, daily peak period congestion has grown from 17 percent of the region's urban freeways in 1993 (27 out of 160 miles), to 38 percent in 2006 (61 miles) – the trend is only projected to increase (SACOG 2008). Though automobiles and suburbanization may confer high benefits to the individuals who choose to utilize them (Deakin 2008), they have also produced large unanticipated social costs which has led planners, advocates, and governments worldwide to consider and promote "Lower Impact Modes" [p.66] (OECD 1996).

Lower Impact Modes (LIMs) include biking, busing, carpooling, taking a train, walking, telecommuting, and any combination of these. They are low impact modes by virtue of their relative per capita energy consumption, pollution production, road and parking footprint, and safety risks vis a vis single occupant automobiles. These impacts are often external to the private costs and benefits of choosing between different modes, so they must be addressed through public policy and/or collective action, not just in the market place. The City of Davis and the University of California have become increasingly concerned about these problems and so are promoting LIMs and seeking support, cooperation, and participation from community members.

Previous research about the future of UC Davis campus travel has noted that "many of the negative side effects of exclusive dependence on automobile travel, such as air pollution, congestion, and parking stress, would be reduced as more people shift some of their trips to lower impact modes"(TAPS 2002). However, this purported shift is contrary to current trends. In recent years an opposite shift has occurred – the number of people using bikes in the city has reportedly been on the decline for over a decade (Bicycle Advisory Commission and Public Works Department 2006). Even international scholars studying the anomalous success of Davis have noted that the car continues to be more convenient than lower impact modes in Davis:

> "Barriers to walking and cycling in Davis are…lack of a safe infrastructure, particularly safe crossings Downtown…The Davis City Council has not been able (wanted?) to implement pedestrian streets, parking restrictions or other measures, which are regarded as negative towards the car. Secondly, the alternative modes available and the time, cost and ease of using these, govern mode choice. The car is a superior mode for most people for most journeys, even in Davis."
> -- Anders Langeland, "Sustainable Transport in Davis"
> World Transport Policy and Practice, Vol.13-2 (Langeland 2007)

Yet in spite of this, Davis remains a special city, in no small part because of the university, and in large part because of the collective mobilizations of its active citizenry over the last half century (Buehler 2007). For those who have heard of Davis and its bicycles, the city stands as lighthouse above the sea of U.S. bicycle usage (Moritz 1997; Pucher, Komanoff et al. 1999), yet as we have demonstrated, its role as a guiding light is in danger. The majority of cycling in Davis is done by students, faculty, and staff of UC Davis, as they represent around 40% of the population of the city. The university is the largest employer in the city - in fact, it's the largest employer in Yolo County. People travel from disparate parts of northern California to work at UC Davis, some from the Bay Area, many from all corners of the Sacramento region. At present, more than half of those employed at the university live outside of Davis, while almost 20% of the undergraduate students travel to campus from outside of Davis. Because the university continues to grow rapidly according to the directives of the state while the city has adopted a slow growth policy, the portion of campus affiliates who commute from outside of Davis is projected to rise. This report is a snapshot of the commute patterns of UC Davis campus affiliates in the fall of 2007. It is the best available picture we have to illustrate, understand, and scrutinize our community's current travel choices.

The initiation of this project is partly the outgrowth of efforts by the California Student Sustainability Coalition, which lobbied for the UC system to have a comprehensive sustainability policy. As a result, the University of California has developed such a policy, the *UC Policy on Sustainable Practices*, within which the university adopted specific policies to pursue more sustainable transportation. In this document, the UC Office of the President called for campuses to collect average vehicle ridership data (AVR)[1] with the aim of reducing fuel consumption, and to collect data on mode split and commute distance in order to analyze the effect of location on mode choice. The policy also calls for ongoing involvement of graduate and undergraduate students in efforts toward achieving sustainable campus transportation. This project spawned our local effort to meet those goals at UC Davis, while also aiming to provide valuable data about and for the UC Davis community. It is hoped that the report will inform policy decisions to improve access to UC Davis while reducing dependence on fossil fuels and emissions of greenhouse gases.

This is the first annual survey of UC Davis campus travel, following a pilot effort in spring 2007. The ongoing project is a collaborative effort of the Sustainable Transportation Center (STC) of the Institute of Transportation Studies (ITS), Transportation Parking Services (TAPS), and the Office of Resource Management and Planning (ORMP) at UC Davis. This assessment of campus travel provides a baseline measurement of the campus Mode Split for academic year 2007-2008, and is conducted on an annual basis by students, under the guidance of Professor Susan Handy.

[1] Average vehicle ridership (AVR) is a measure of the proportion of travelers using modes other than driving alone. It is calculated by dividing the total number of people arriving on campus by the number of private automobiles arriving on campus. It is therefore the average number of people traveling per private vehicle to campus. Increased use of carpools would increase AVR for a given community of travelers.

2 Methods

2.1 Survey Design

We sampled the campus population using a stratified sample of email addresses in order to represent the following groups: freshmen, sophomores, juniors, seniors[2], Masters students, PhD and post-docs (taken together as a group), faculty, staff, and administration. The target population was all people affiliated with UC Davis who traveled regularly to the central campus. Travelers were contacted via e-mail during the spring quarter and invited to a web-based survey. Survey invitations were distributed by the UC Davis postmaster via email and included a link to an online survey. Survey reminders were sent to non-respondents once a week for two weeks following the survey.

2.2 Sampling Plan

The total initial sample size was 13,770 people (10,539 students and 3,231 employees). We used a disproportionate random sample, meaning a different share of the population was included in the sample of each stratum. This approach produces close to a +/-5% confidence interval with a 95% confidence level for each strata. An ideal sample size for each strata subpopulation was calculated using a standard sample size formula including a finite population correction. Because response rates can reduce sample sizes significantly, a majority of administrators was included in the sample.

The survey was completed by 1438 employees and 2411 students, yielding of a response rate of 44.5% for employees, 22.9% for students, and 28.0% overall.

Table 2-1 Sample Size and Response Rate

Role	invited	responses	response rate
Freshmen	1808	476	26.3%
Sophomores	1765	384	21.8%
Juniors	1805	386	21.4%
Seniors	1830	369	20.2%
Masters Students	1570	300	19.1%
PhD & Post-Docs	1761	496	28.2%
Faculty	1340	496	37.0%
Staff	1448	724	50.0%
Administration	443	218	49.2%
Students (summed)	10539	2411	22.9%
Employees (summed)	3231	1438	44.5%
Overall	13770	3849	28.0%

[2] We added all the "other" undergraduates (Post Baccalaureates, etc.), numbering 362 in total, to the population of senior students.

Table 2-2 Campus Population and Confidence Interval

Role	Population[3]	Confidence Interval
Freshmen	4527	4.25%
Sophomores	4891	4.80%
Juniors	5703	4.82%
Seniors	8547	4.99%
Masters Students	1873	5.19%
PhD & Post-Docs	3660	4.09%
Faculty	2073	3.84%
Staff	8888	3.49%
Administration	430	4.67%
Students (summed)	29201	0.76%
Employees (summed)	11391	1.46%
Overall	40592	1.50%

The confidence levels listed in Table 2-2 mean that our survey statistics for each of the groups are within +/- the percent of whatever measurement we report from the survey[4]. For example, we later reveal that our survey indicates that 37.64% of the overall campus population rides a bike to campus as their primary means of transport – looking up at Table 2-2, we see that the confidence interval is 1.5% for "Overall", which means that our results suggest the actual percentage of people biking lies somewhere between 36.15% and 39.15% (37.64-1.5=36.15% and 37.64+1.5=39.15%).

2.3 Population Weighting

Sample weights were calculated by dividing the number of employee and student respondents by the total numbers of employees and students estimated to commute to the main campus. Weights varied by the number of cases available for each analysis. For our AVR, Mode Split, and most other estimates, we used the following weighting scheme.

Table 2-3 Sample Weights

Role	Population	Respondents	Weight
Freshmen	4527	476	10.35927
Sophomores	4891	384	10.70241
Juniors	5703	386	13.41882
Seniors	8547	369	22.37435
Master's Students	1873	300	6.022508
PhD's Students	3660	496	8.061674
Faculty	2073	496	4.327766
Staff	8888	724	7.635739
Administration	430	218	6.056338
Total	**40592**	**3849**	**10.54612**

[3] Employee counts come from ORMP, student totals come from the Registrar.

[4] To be precise, the number we measure would be between these numbers at least 95% of the times that we would perform the survey, since they are at the 95% confidence level.

The employee population figure from which we drew our weighting factors for the AVR and mode split figures come from ORMP's official population statistics for the on-campus population, but for student strata, we used information from the campus registrar's office.

Table 2-4 On-Campus Population5

Category	2006/07	Fall 2007
Faculty[6]		
Ladder Rank	1,459	1,486
Faculty-other (not ladder rank)	653	587
Total	**2,111**	**2,073**
Staff[7,8]		
Academic Support[4]	2,120	2,068
Senior Management	28	24
MSP	414	406
SSP[9]	6,811	6,820
Total	**9,372**	**9,318**
Total Employees	**11,483**	**11,391**
Students[10]		
Undergraduates	22,059	23,067
Post-baccalaureate	132	126
Graduate Academic and Professionals	5,411	5,556
Total Students	**27,602**	**28,749**

Revision date: December 3, 2007

The survey attempted to target travelers to the main campus, as opposed to UC Davis affiliates who travel to other locations such as the UCD Medical Center or other research locations outside of Davis. To make sure that our sample only includes these types of folks, we included a screener as the first question in our survey. The results of the screener indicate that we were largely successful in our targeting (see Table 2-5).

[5] Campus and Davis area only. Data is consistent with annual publication *UC Davis Total On- and Off-Campus Headcount Population Annual Averages* distributed by the UC Davis Office of Resource Management and Planning.
[6] Includes without salary designations. Annual averages for faculty and staff represent averages of October and April snapshot figures.
[7] Includes "Affiliated" such as co-op extension (in Davis), ANR (in Davis), etc.
[8] Such as Academic Administrative Officers, Librarians, Research, Post-Docs, etc.
[9] Includes most staff categories and job titles.
[10] Annual averages for students represent Fall-Winter-Spring quarter averages (or in the case of Law, Fall-Spring semester averages).

Table 2-5 Main Campus Travel Screener

	Regularly work or go to classes in Davis?	
Role	**No**	**Yes**
Freshman	3.20%	96.80%
Sophomore	0.43%	99.57%
Junior	1.17%	98.83%
Senior	0.26%	99.74%
Master's	2.24%	97.76%
PhD	1.75%	98.25%
Faculty	1.69%	98.31%
Staff	1.98%	98.02%
Administrator	4.19%	95.81%

2.4 Primary Research Questions

1. ***How does the campus community get to campus?***

In Section 4, we explore survey questions related to the *how* of campus travel, to gain an understanding of the overall picture of the campus community's travel choices. We report and discuss the following measurements: Average Vehicle Ridership (AVR), mode split, and travel during peak travel periods vs off-peak periods, compare travelers from within Davis and outside of Davis, and analyze the relationship between distance and mode choice in general.

2. ***What are the main barriers for people to walk, bike, bus, and carpool more to get to campus?***

In this survey, we sought to explore bicycling in Davis more thoroughly. We included a set of questions for all Davis residents related to bicycling, which we report in Section 5. Given the group of campus travelers who live in Davis, what are the differences between those who drive alone and those who use lower impact modes?

3. ***Are people trying to make a difference through their transportation choices?***

As in the spring 2007 survey, we asked questions about how mobilized the campus community was regarding community-level transportation-related problems. Since the spring survey did not break down responses by role categories except students and employees, a few select questions were repeated to observe differences between campus roles. The results are presented in Section 6.

4. ***How do people feel about the campus' transportation programs?***

Every year, we hope to measure awareness and usage of TAPS programs, as the university continues to adapt and improve its programs in response to feedback from the survey and campus planning groups. The results of these questions are presented in Section 7.

3 How does the campus community get to campus?

3.1 Average Vehicle Ridership

AVR is an index of what share of people are using alternative modes of travel. It is a measure of the total number of people traveling to the campus divided by the number of personal vehicles traveling to the campus (the personal vehicles category doesn't include buses, but does include single occupancy vehicles, carpools, vanpools, and motorcycles). If everyone drove alone to the campus, the AVR would be 1. The more people carpool, take the bus, walk, or bicycle to campus, the larger the AVR becomes.

The AVR calculation was performed according to *"Rule 2202 – On Road Motor Vehicle Mitigation Options: Compliance Forms"* from the South Coast Air Quality Management District's website.[11] Adjustments to the raw numbers were made only for the number of telecommuting trips, the number of Zero Emission Vehicle trips, and compressed work week scheduling in a manner consistent with the compliance form. No off-peak or other credits were included for the calculation of the UC Davis AVR. Because carpooling respondents may or may not be part of the same carpool, we estimated the "total" number of carpoolers by multiplying the number of carpool trips by the average carpool size. Students living on campus were excluded from the analysis to match the methodology used by other UC campuses.

Figure 3-1 AVR Calculation Summary

To calculate our AVR, we followed the instructions from the SCAQMD AVR compliance forms used by the southern UC Campuses. For inputs into these forms, we used data from questions 3.0.1.1 (Time of Day), 3.0.1.2 (Daily Travel Mode), 3.0.1.3 (Reason Not Traveled), 3.1.2.1 (Carpool Size), and 3.1.3.1 (Type of Vehicle).

We exclude all of our cases who **do not work/go to class** in Davis and all who **live on campus**[12] from the analysis (**15.7%** of total travelers were excluded).

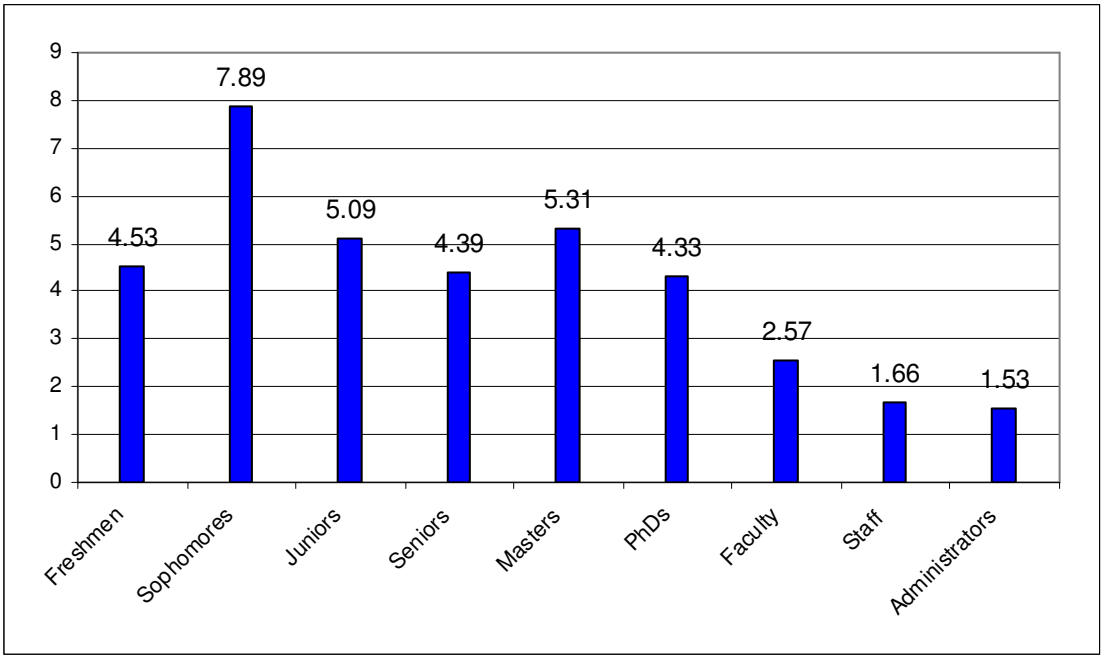
For FACULTY, STAFF, and ADMIN we adjusted for compressed work week and other days off. Students' AVR are not adjusted.

Lastly, we applied weighting by role when calculating the overall AVR.

[11] Specifically, "Section IV-1. AVR Verification Process" starting on page 5. See: http://www.aqmd.gov/trans/doc/regform/all_registration.pdf

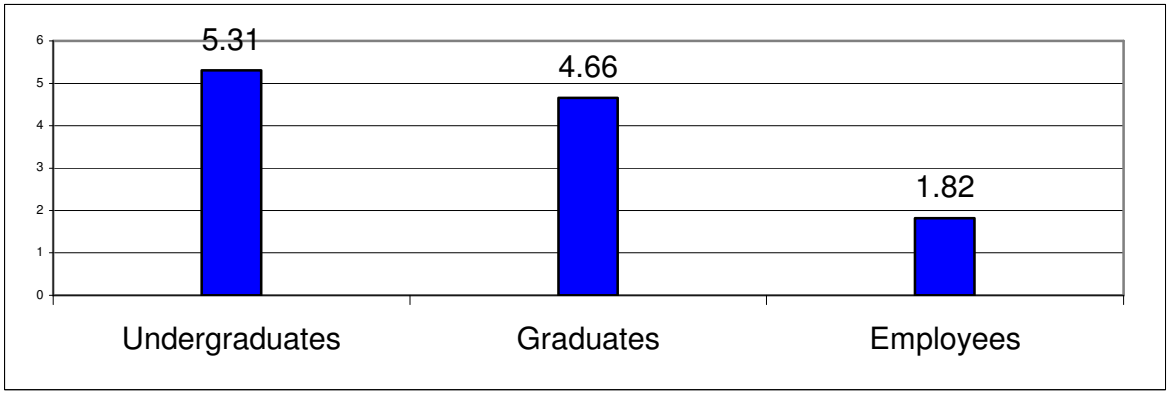
[12] We exclude those on campus because that is the preferred method at other UC Campuses. However, since the purpose of AVR is to show the success of alternative transportation and one strategy to achieve this is on-campus housing, we believe AVR should include students, faculty, and staff living on campus.

Figure 3-1 AVR by Roles



Campus-wide peak AVR is 4.17 passengers per vehicle, indicating that over three quarters of trips made to campus are made using an alternative mode, a slight improvement from the spring quarter's estimate (3.87).

Figure 3-2 AVR by Roles (Condensed)



For undergraduate students AVR was 5.31, and for graduate students it was 4.66. For employees, the AVR of 1.82 indicates that just over half of employee trips are drive alone trips, a slight improvement over the spring quarter's assessment (1.72). While AVR is a common measure for the success of alternative transportation programs, it is less informative than mode split (explained below).

3.2 Mode Split

Bicycling, driving, busing, etc. are all different *modes* of travel, and *mode split* (also called mode share) is the breakdown of commute choices in a population. We will look at the mode split of UC Davis as the proportion of the total number of commute trips to campus estimated to be made by each mode of travel. These estimates are based on reported modes of travel to campus over a five day period, with respondents being asked to report their first trip to the campus[13] for each day of the previous week of travel.

Figure 3-3 Primary Mode Split

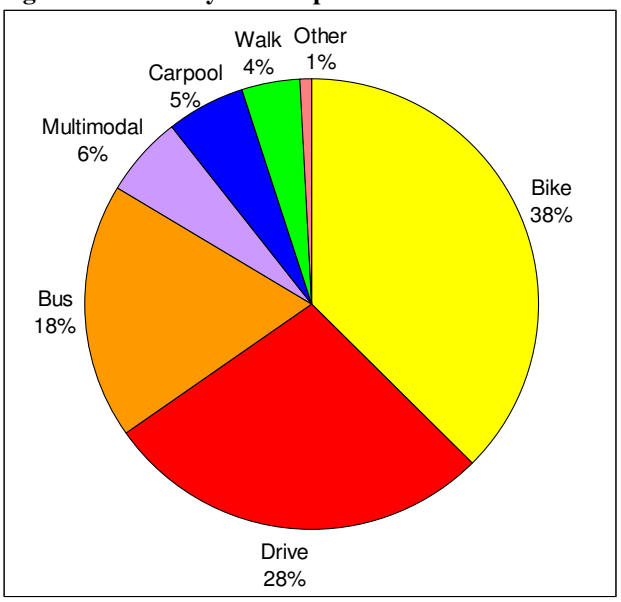


Table 3-1 UC Davis Mode Split by Affiliation Fall 2007

Role	Drive	Bus	Bike	Walk	Carpool	Other	Multi-modal
Freshman	3.74%	7.24%	74.08%	8.41%	1.40%	0.92%	4.20%
Sophomore	10.53%	44.96%	31.15%	2.62%	3.73%	0.66%	6.35%
Junior	18.40%	32.08%	33.73%	4.71%	3.53%	0.70%	6.84%
Senior	21.99%	27.23%	32.99%	4.97%	4.97%	0.53%	7.33%
Master's	28.70%	6.82%	47.92%	5.20%	3.25%	1.30%	6.82%
PhD	20.33%	6.48%	57.82%	4.68%	4.02%	1.33%	5.34%
Faculty	43.74%	1.69%	39.10%	2.95%	7.30%	1.45%	3.77%
Staff	58.24%	3.63%	20.19%	2.07%	10.61%	0.95%	4.32%
Administrator	63.49%	2.79%	18.37%	0.00%	11.16%	1.40%	2.79%
Undergraduate	15.31%	28.31%	40.52%	5.07%	3.69%	0.67%	6.42%
Graduate	23.16%	6.60%	54.47%	4.86%	3.76%	1.32%	5.84%
Employee	55.79%	3.24%	23.57%	2.15%	10.03%	1.06%	4.16%
Campus-wide Overall	**27.76%**	**18.32%**	**37.64%**	**4.22%**	**5.48%**	**0.87%**	**5.70%**

[13] Students often return home several times a day.

In terms of the number of trips, bicycling continues to be the most popular form of transportation at UC Davis, followed by the automobile, the bus, multimodal travelers, carpooling, and walking. Students bike the most, with over 40% of them bicycling, almost 30% taking the bus, 15% driving, 5% walking, and 4% carpooling. The student biking contingent is led by freshmen at 74%, followed by a wide margin by PhD students at almost 60%, master's students at almost 50%, and the rest of the undergraduates are relatively close to one another at just above 30%.

Out of the employees, faculty bike the most at nearly 40% (more than most undergraduates), followed by staff at 20%, and the administration at around 18%. As far as driving alone, the administration tops out at over 60%, followed closely by staff with just under 60%, while less than 45% of faculty drive alone. Carpooling, however, is led by the administration (11.1%), holding a slight lead over staff (10.6%), and faculty (7.3%). We discuss the mode split in greater detail in the conclusion (p.42).

3.3 Peak Periods vs Non-Peak Period Travel

The majority of travelers come to UC Davis during the hours of 6 and 10am (over 60% for all roles), with the administration and staff being the most regular. Monitoring peak vs non-peak travel is mostly of concern for mitigating traffic congestion and parking congestion.

Table 3-2 Timing of First Trip to Campus Based on Weekly Trips

Role	Monday through Friday		
	Not scheduled this day	**Between 6am and 10am**	**Before 6am and after 10am**
Freshman	4.8%	63.4%	31.8%
Sophomore	3.2%	67.9%	28.9%
Junior	7.2%	70.4%	22.4%
Senior	7.4%	60.7%	31.9%
Master's student	16.8%	60.6%	22.6%
PhD student	10.9%	71.4%	17.8%
Faculty	9.1%	80.9%	10.1%
Staff	5.4%	88.7%	6.0%
Administration	3.1%	93.0%	3.9%
Total	**6.9%**	**71.7%**	**21.4%**

3.4 Where are travelers coming from?

3.4.1 Which travelers are coming from within Davis and outside of Davis?

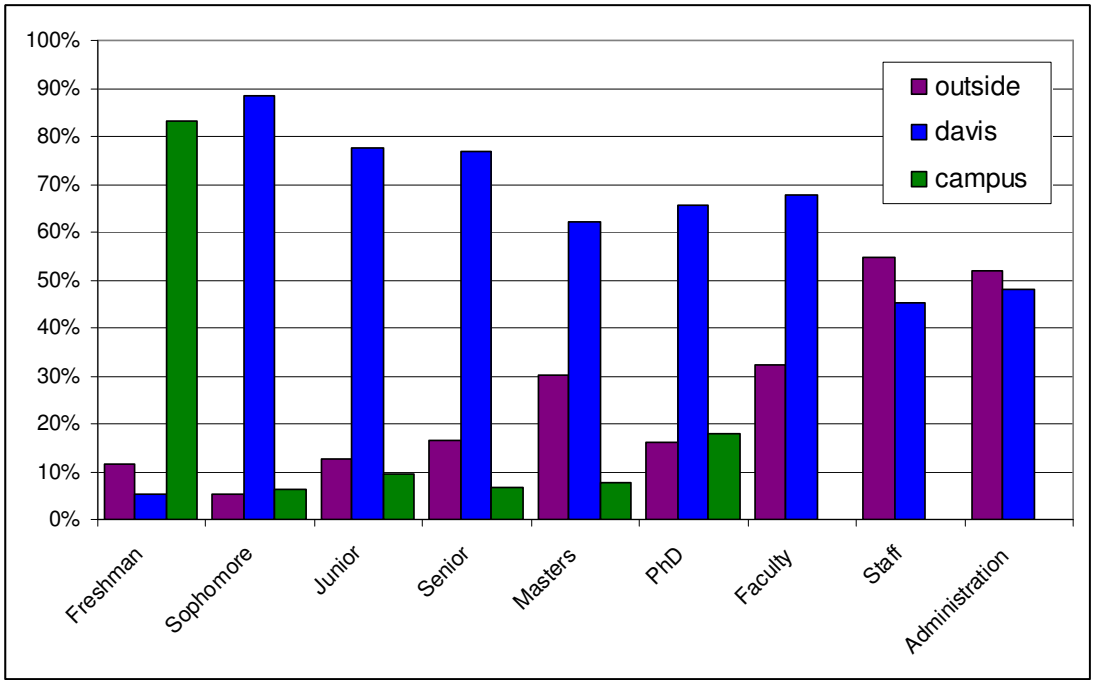
For the following analyses, we distinguish between travelers on campus, within Davis, and outside of Davis. Around 75% of the campus population lives on campus or within Davis, with almost 15% on campus and around 60% within Davis. The 25% commuting from outside of Davis are mostly staff. Over half of staff and administrative commuters live outside of Davis, while the majority of all other commuters live predominantly in

Davis. Over 80% of undergraduate students live within Davis (including on-campus), over 60% of graduate students and faculty, and over 40% of staff and administration.

Table 3-3 Number of Commuters Living in Davis, On Campus, and Outside of Davis

Role	Live in Davis		Live on Campus		Live Outside of Davis	
	Number	Percent of Total Population	Number	Percent of Total Population	Number	Percent of Total Population
Freshman	239	5.3%	3760	83.1%	529	11.69%
Sophomore	4324	88.4%	310	6.3%	259	5.30%
Junior	4428	77.6%	550	9.6%	725	12.71%
Senior	6578	77.0%	559	6.5%	1410	16.50%
Master's student	1162	62.0%	145	7.7%	566	30.24%
PhD student	2402	65.6%	661	18.1%	596	16.30%
Faculty	1402	67.6%	0	0.0%	672	32.42%
Staff	4009	45.1%	0	0.0%	4880	54.91%
Administration	206	47.9%	0	0.0%	224	52.11%
Total[14]	**24750**	**61.0%**	**5985**	**14.7%**	**9866**	**24.31%**

Figure 3-4 Percent of Travelers Living on Campus, with Davis, and Outside of Davis



[14] These counts slightly underestimate the real total, as these are counts of only those cases which could be geocoded (about 90% of all cases).

3.4.2 How are within Davis travelers traveling compared to their out of town counterparts?

The bicycle is the most used form of travel for all roles of Davis residents except sophomores and the administration (Table ; Figure 3-). It is interesting to note that bicycling rates go up from sophomores to seniors after the initial drop-off in the rate from freshmen moving off campus. Future surveys will show whether this is a cohort effect, due to younger people cycling less on average, or perhaps reveal that students that stay in Davis tend to bike more every year they stay on past sophomore year.

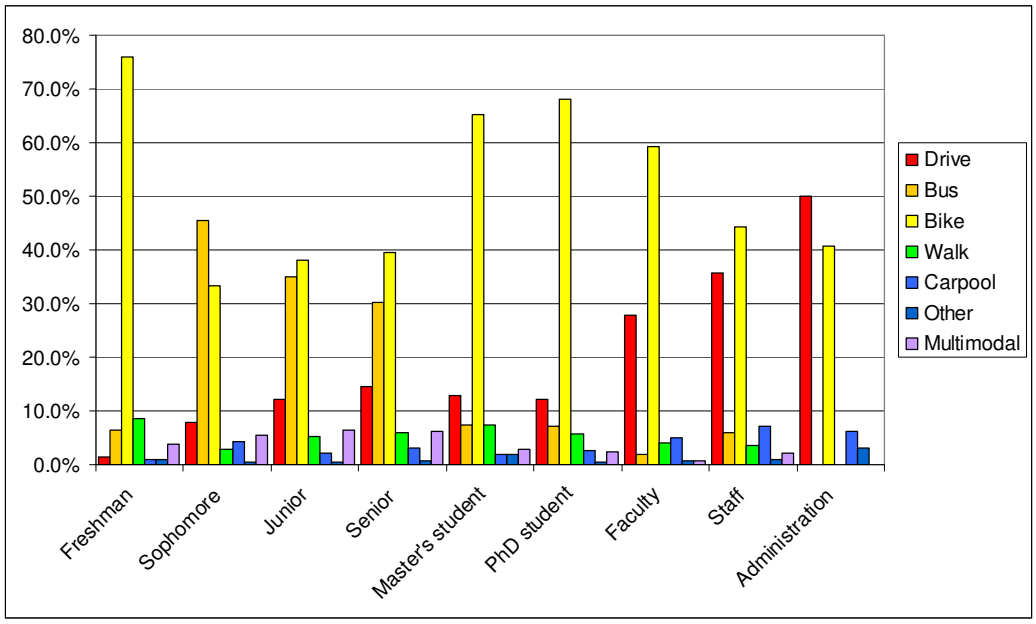
Table 3-4 Number of Commuters by Mode within Davis (Includes On-Campus)

Role	Drive	Bus	Bike	Walk	Carpool	Other	Multi-modal	Total
Freshmen	52	249	2963	331	41	41	145	3905
Sophomores	321	1852	1359	118	171	21	225	4078
Juniors	564	1610	1758	242	94	27	295	4603
Seniors	940	1969	2573	380	201	45	403	6511
Master's students	157	90	789	90	24	24	36	1210
PhD students	339	202	1919	161	73	16	64	2814
Faculty	359	26	766	52	65	9	9	1290
Staff	1306	221	1626	130	260	31	76	3665
Administration	97	0	79	0	12	6	0	194
Total	**4135**	**6219**	**13832**	**1504**	**941**	**220**	**1253**	**28270**

Table 3-5 Mode Split of Residents within Davis (Includes On-Campus Housing)

Role	Did Not Travel	Drive	Bus	Bike	Walk	Carpool	Other	Multi-modal
Freshman	2.1%	1.3%	6.4%	75.9%	8.5%	1.0%	1.0%	3.7%
Sophomore	0.3%	7.9%	45.4%	33.3%	2.9%	4.2%	0.5%	5.5%
Junior	0.3%	12.3%	35.0%	38.2%	5.3%	2.0%	0.6%	6.4%
Senior	0.0%	14.4%	30.2%	39.5%	5.8%	3.1%	0.7%	6.2%
Master's student	0.0%	13.0%	7.4%	65.2%	7.4%	2.0%	2.0%	3.0%
PhD student	1.4%	12.0%	7.2%	68.2%	5.7%	2.6%	0.6%	2.3%
Faculty	0.3%	27.8%	2.0%	59.4%	4.0%	5.0%	0.7%	0.7%
Staff	0.4%	35.6%	6.0%	44.4%	3.5%	7.1%	0.8%	2.1%
Administration	0.0%	50.0%	0.0%	40.7%	0.0%	6.2%	3.1%	0.0%
Undergrads	0.6%	9.8%	29.7%	45.3%	5.6%	2.7%	0.7%	5.6%
Grads	1.0%	12.3%	7.3%	67.3%	6.2%	2.4%	1.0%	2.5%
Employees	0.4%	34.2%	4.8%	48.0%	3.5%	6.5%	0.9%	1.7%
Overall	**0.6%**	**14.6%**	**22.0%**	**48.9%**	**5.3%**	**3.3%**	**0.8%**	**4.4%**

Figure 3-5 Mode Split of Residents within Davis (Includes On-Campus Housing)



The uniqueness of Davis can be seen in Figure 3-5 below with over 15,000 people biking to work or classes on campus, over 6500 taking the bus, and only around 4500 driving. Within Davis, over 40% of commuters primarily use a bicycle to get to campus and over 25% use the bus (Figure 3-6).

Figure 3-6 Number of Commuters by Primary Mode and Location

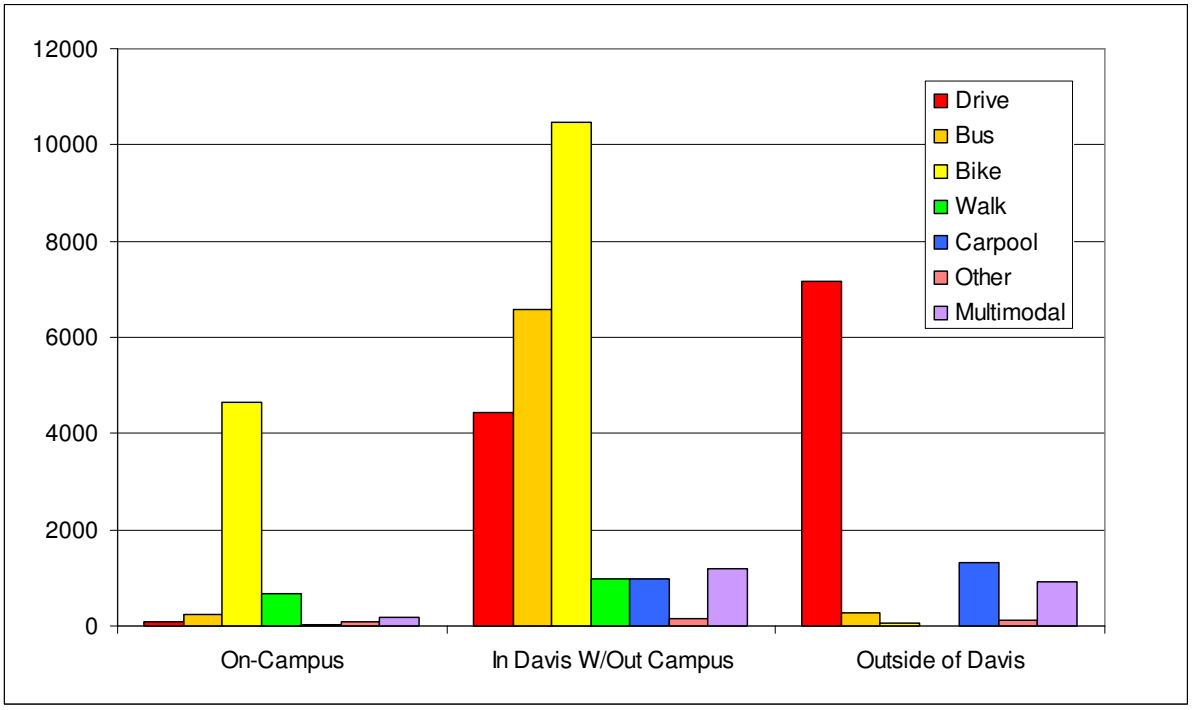
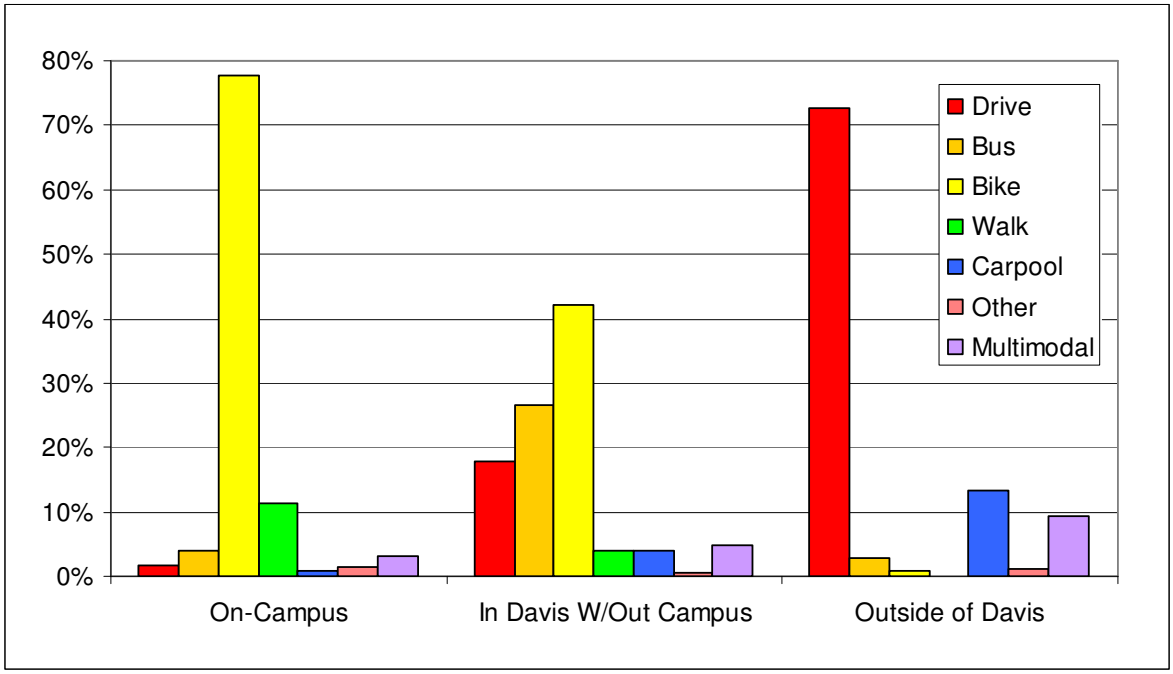


Figure 3-7 Mode Split by Location



3.5 What is the relationship of distance to mode choice?

Distance estimates come from those respondents in our sample who selected their home location on a map, provided an address or cross street, or lived on campus. For those off-campus, we calculated the geocode-based network distance for each, whereas those on campus were simplified to a distance of zero. When they are weighted to represent the whole population they sum to about 90% of the total. As a result, while the following graphs of distances are representative, the total number of travelers is slightly underestimated on the graphs.[15]

As shown in Figure 3-8, the majority of travelers within Davis who live off campus commute less than four miles. Cyclists and bus riders average around two miles away from the campus. Walkers live just over a mile on average from campus, with no walkers beyond three miles. Most carpoolers and those who drive alone to campus within Davis live between two and three miles away.

[15] We double checked the cases missing geocoding by using their own estimates of how far from campus they live, and role and modesplit distribution patterns closely resemble the geocoded cases.

Figure 3-8 Number of Travelers by Mode by Mile – Within 6 Miles of Campus16

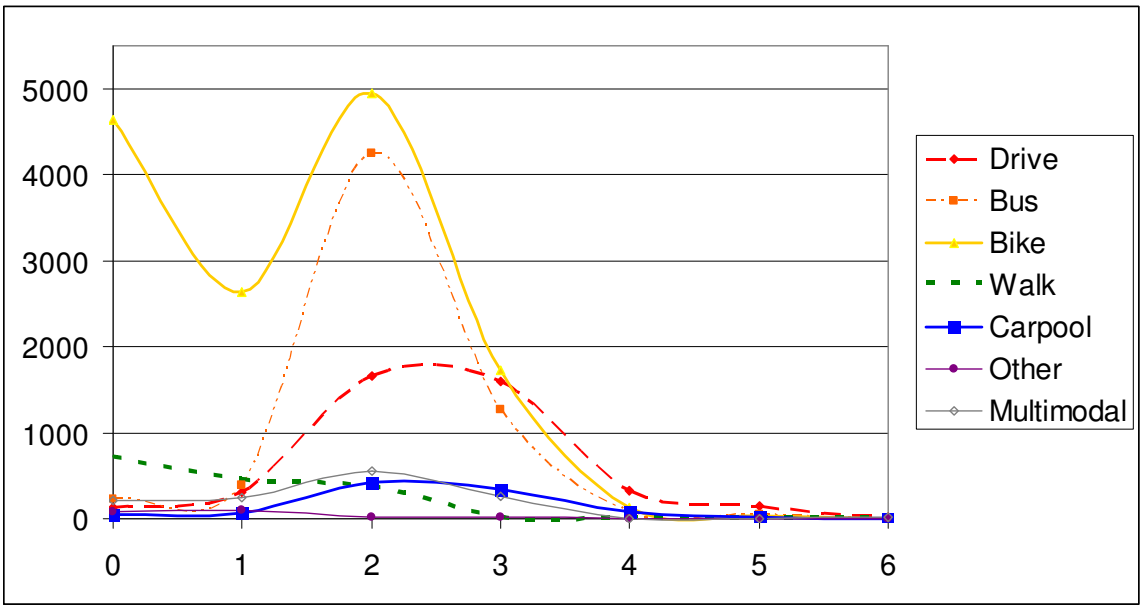
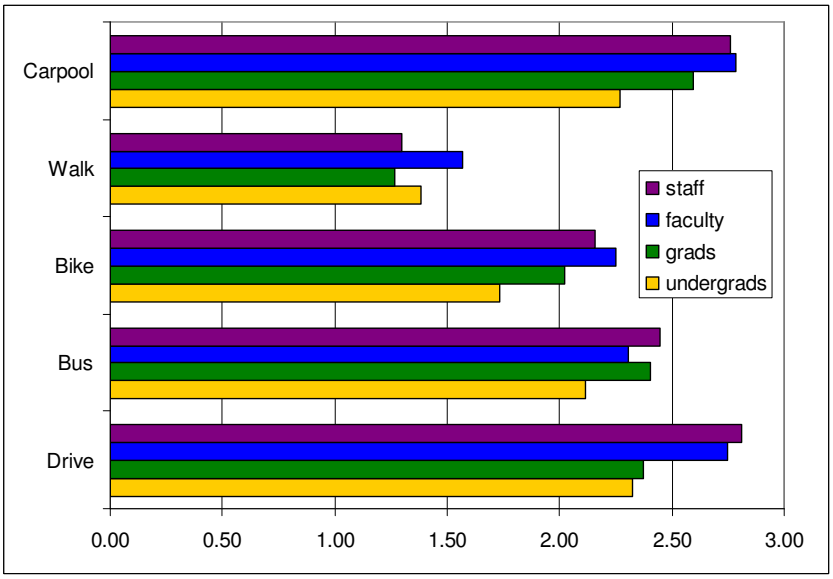


Figure 3-9 Average Miles from Campus by Mode and Role (in Davis)

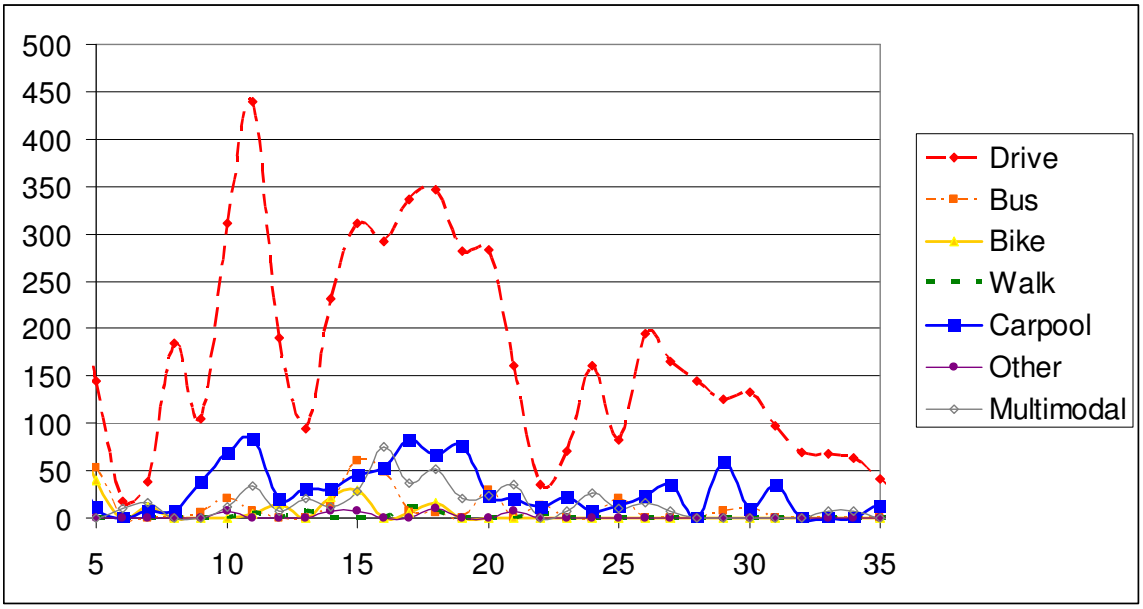


[16] The trend lines in the following charts are for illustrative purposes only, the area under the curves are not equal to the total number of travelers by each mode – this would be found by summing the measurements from each mile marker.

Table 3-6 Average Miles from Campus by Mode and Role (in Davis, All Travelers)

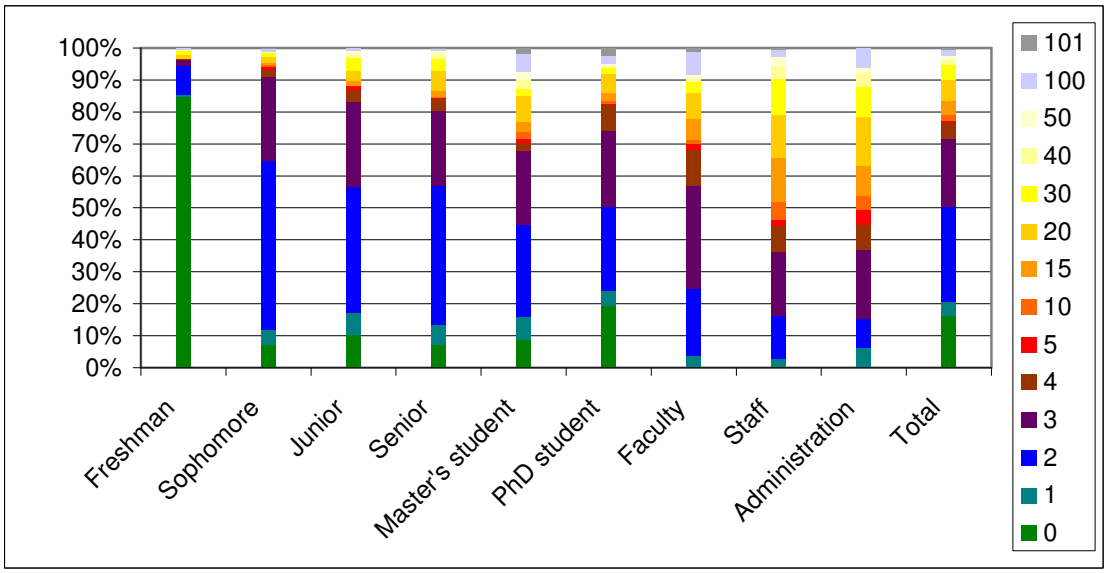
	Other	Multimodal	Drive	Carpool	Bus	Bike	Walk
Distance (miles)	**18.47**	**18.13**	**15.63**	**14.72**	**3.18**	**1.48**	**0.79**

Figure 3-10 Number of Travelers by Mode by Mile: Outside of Davis (5-35 miles from Campus)



Most travelers outside of Davis live within 10-20 miles away, in nearby cities. However, there are also a non-significant number traveling around 100 miles (see gray segments in Figure 3-11), most commuting from the Bay area; a large number of these commuters use multiple modes such as BART and Amtrak.

Figure 3-11 Distribution of Residential Distance in Miles by Role[17]



[17] In the following two graphs, 0 indicates on campus, 1 indicates 0 to 1, 2 is 1 to 2, etc. up to 100. However, 101 indicates 101 up to 156.

Figure 3-12 Distribution of Residential Distance in Miles by Role (Condensed)

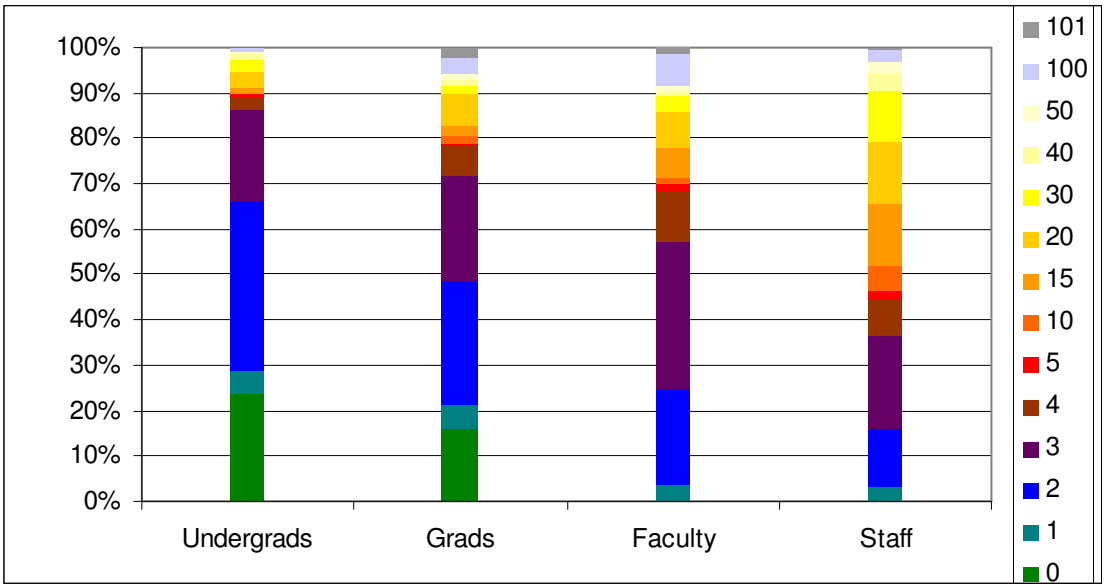


Figure 3-13 Number of Travelers within 5 Miles of Campus by Role

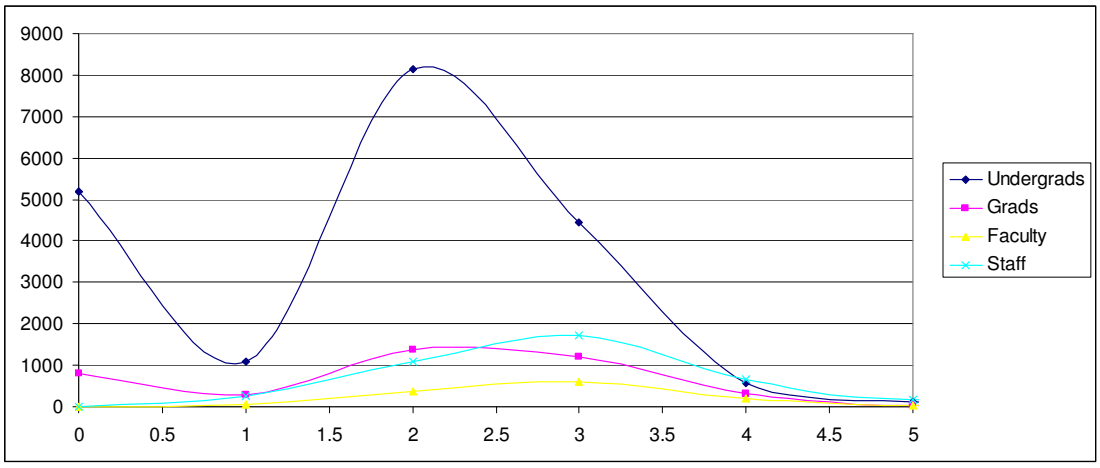
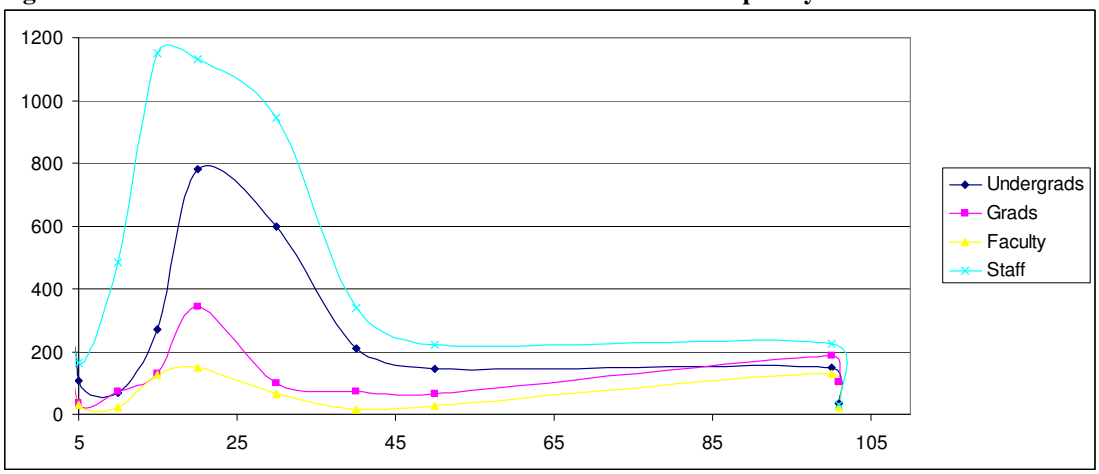


Figure 3-14 Number of Travelers Greater than 5 miles from Campus by Role

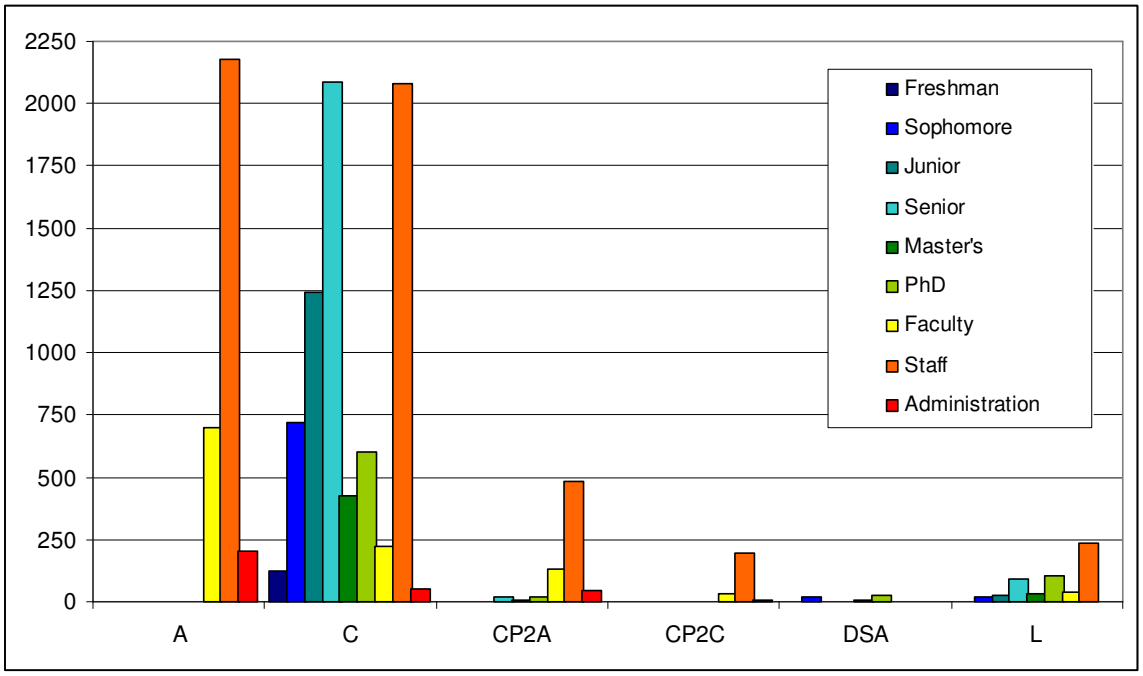


3.5.1 Parking Demand

Parking on Campus

Figure 3-15 suggests that more than 500 additional undergraduates choose to purchase a C-Permit every year starting after their freshman year, however this may partly be an artifact of cohort size. Adjusting for this, we see that 1 out of every 36 freshmen has a permit, 1 out of every 6.4 sophomores, 1 out of 4.5 juniors, and 1 out of every 4 seniors has a permit (Table 3-7). These ratios are not far off from the AVR measures calculated in Section 3.1.

Figure 3-15 Type of Long-Term Parking Permit Purchased by Each Role



Permit Types

A (Faculty and staff)
C (Faculty, staff, and students)
CP2A (Two person carpool, A permit)
CP2C (Two person carpool, C permit)
CP3A (Three or more person carpool, A permit)
CP3C (Three or more person carpool, C permit)
DSA (Disabled)
GP (Vanpool)
K (Cuarto resident exception)
L (Remote lot)
M (Motorcycle)
N (Night)
RT (Retiree)
V (Vendor)
Visitor

Table 3-7 Odds Against Purchasing a Permit by Role

Frosh	Soph	Junior	Senior	Master's	PhD	Faculty	Staff	Admin
35.9	**6.4**	**4.5**	**3.9**	**4.0**	**4.9**	**1.8**	**1.7**	**1.4**

There were over 13,000 long-term parking permits being used during Fall 2007, according to our survey. Staff purchased the most long-term permits, followed by undergraduates, then faculty, grad students, and admin (Figure 3-16).

Figure 3-16 Number of Parking Permits Purchased by Each Role

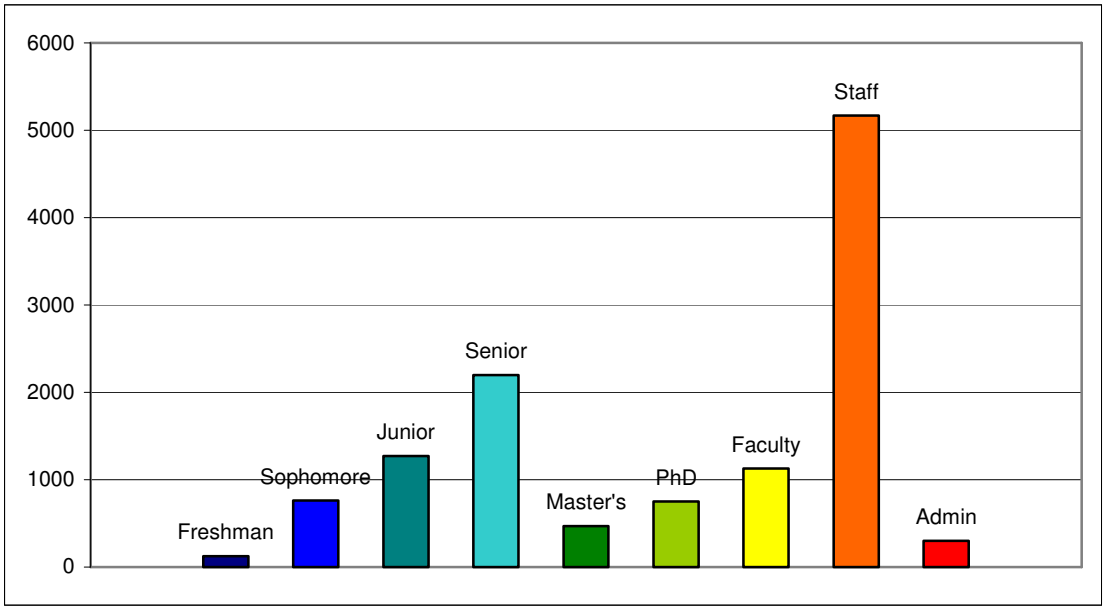
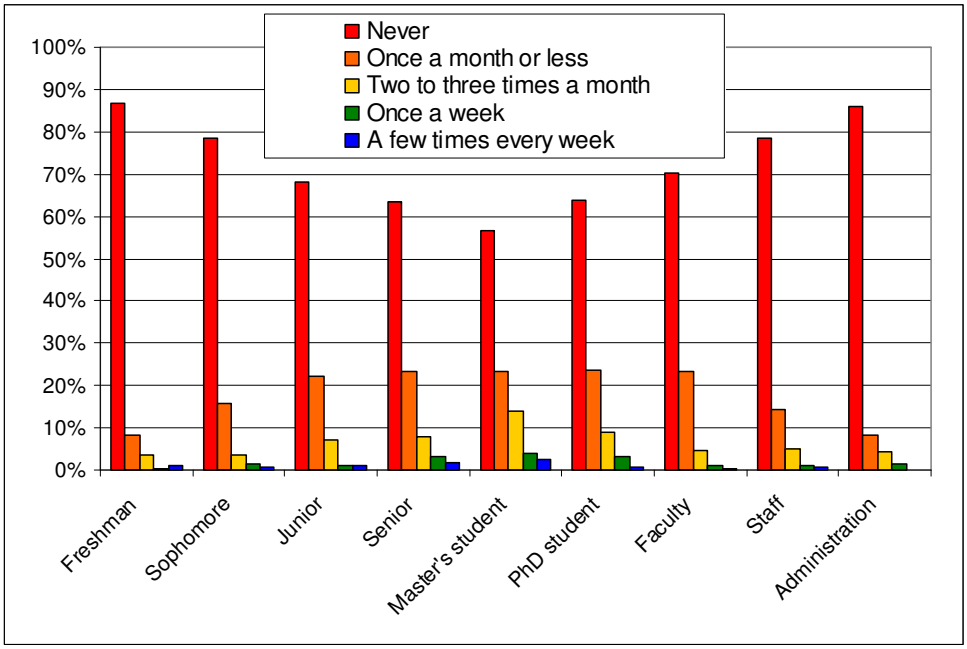


Table 3-8 Number of Long-Term Parking Permits Purchased by Each Role

	Frosh	Soph	Juniors	Seniors	Master's	PhDs	Faculty	Staff	Admin	Total
A	0	0	0	0	0	0	699	2175	200	3074
C	126	719	1241	2084	424	602	221	2082	49	7549
CP2A	0	0	0	23	6	16	131	483	43	702
CP2C	0	0	0	0	0	0	35	195	6	236
DSA	0	21	0	0	6	25	0	0	0	52
L	0	21	27	92	31	107	39	234	0	552
Total	**126**	**761**	**1269**	**2199**	**467**	**750**	**1125**	**5169**	**299**	**12166**

(Plus 845 additional respondents who purchased permits but didn't specify which kind.)

Figure 3-17 How often have you bought a single-use parking permit ($6) in the last 6 months?



For undergraduates, purchase of single-use parking permits increases with year in school. Master's students purchase the most single-use permits per capita. What a beautifully symmetric bar chart! We leave it an exercise for the reader to divine the reasons for the mysterious symmetry.

Parking Location

The most popular parking zones for all commuters are zones 3, 4, 5, and 6 (Figures 3-19 and 3-20). For those from outside of Davis is zone 4, followed by zone 6, zone 3, and zone 5. For commuters in Davis, parking zones 5 and 6 are both largely utilized, zones 3 and 4 slightly less.

Figure 3-18 Parking On-Campus vs Off-Campus

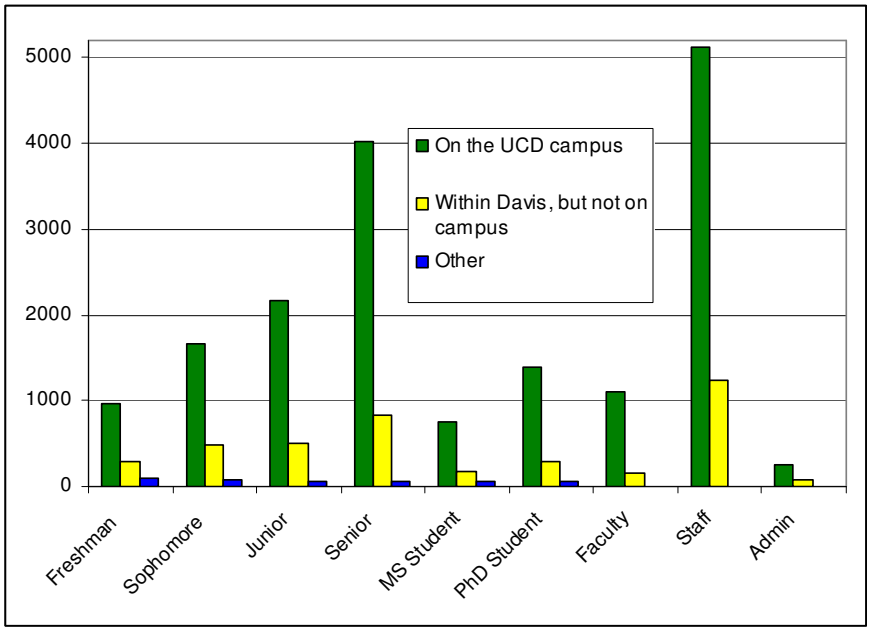


Figure 3-19 On-Campus Parking Location

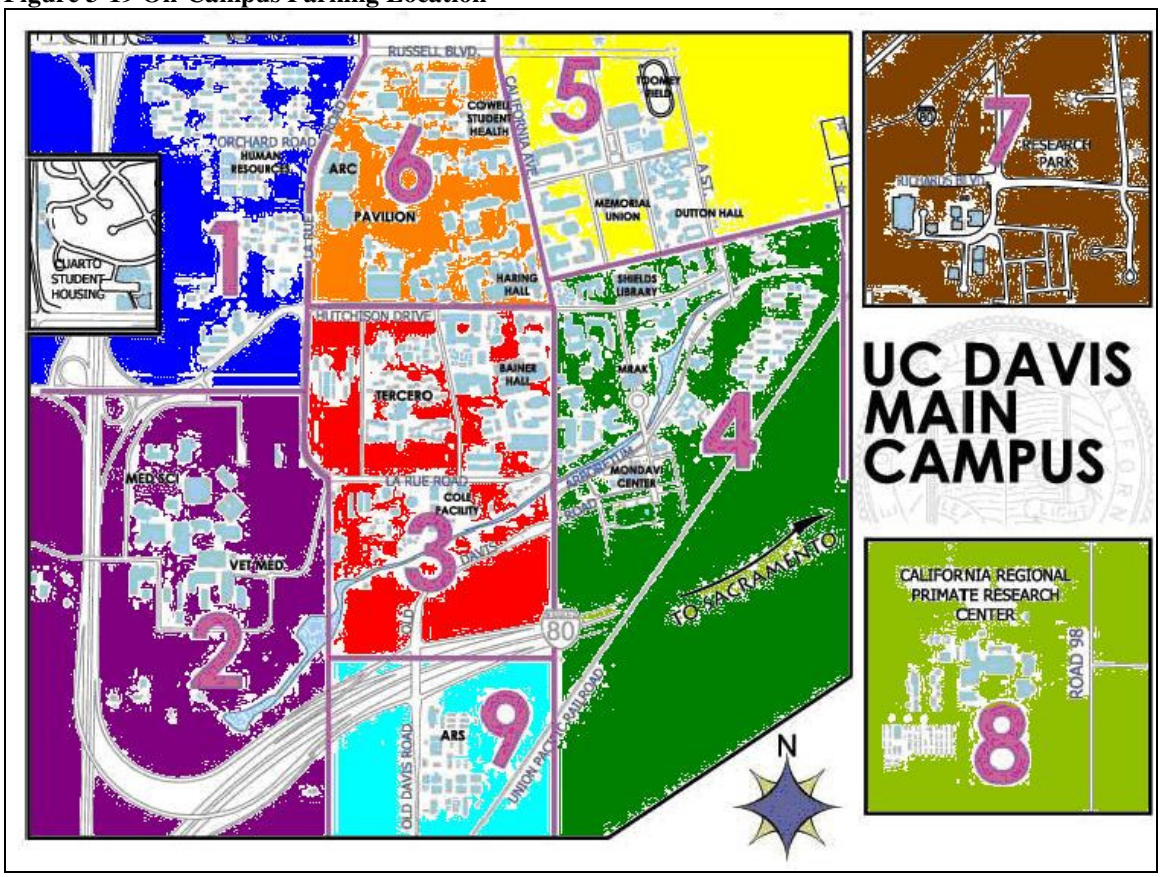
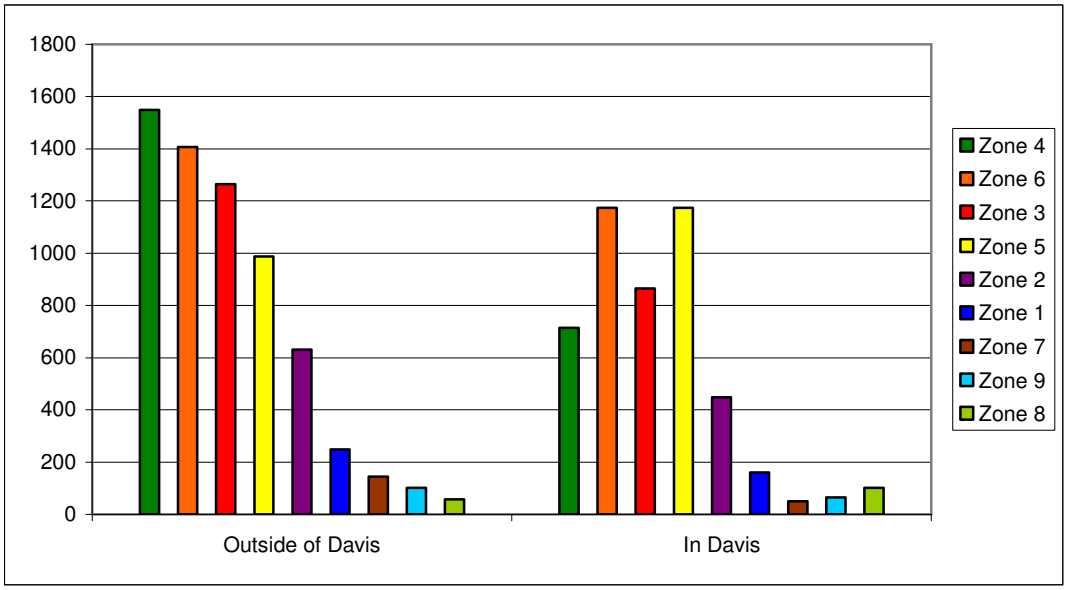


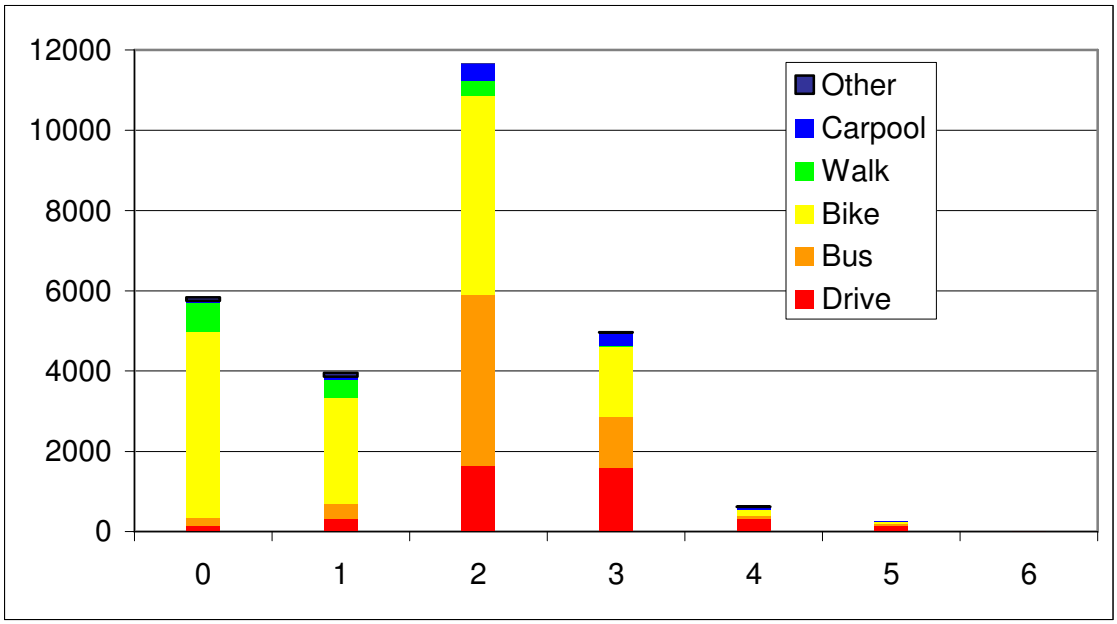
Figure 3-20 On-Campus Parking Location Breakdown by Commute Location



4 What are the main barriers for people to walk, bike, bus, and carpool more to get to campus?

In this year's survey, we focused a section of the survey towards biking in Davis – those respondents who lived within Davis were prompted with additional questions about their opinions regarding bicycling. In this section, we focus on **travelers who live within Davis**, and the differences between those who use lower impact modes and those who drive alone. We compare the means of different roles' answers to questions in the survey to uncover differences that may prove important to their commute choices.

Figure 4-1 Total Number of Travelers by Mode by Mile (including On-Campus Residents): Davis



Recalling our analysis from Section 3, around 75% of campus travelers live within Davis, with around half of these bicycling and over 20% taking the bus, with a large number of these living close to two miles from campus.

Table 4-1 Number of working bicycles available in household

(1,2,3, 4=4 or more)	Walk	Bike	Bus	Carpool	Drive	Other
Employee	1.8	2.7	1.5	1.7	1.7	2.0
Student	1.4	2.0	1.6	1.6	1.3	1.8

LIM users have more working bicycles than drivers, with cyclists not surprisingly topping the list. However, it is interesting that employees have more bicycles per household in general than students.

Table 4-2 Number of working motor vehicles available to household

(1,2,3, 4=4 or more)	Walk	Bike	Bus	Carpool	Drive	Other
Employee	1.4	1.5	0.9	1.8	1.9	1.5
Student	1.1	1.0	1.0	1.6	1.7	1.3

Likewise, drivers have more motor vehicles than LIM users, with students have less vehicles in general.

Table 4-3 Distance between home and campus (in miles)

	Walk	Bike	Bus	Carpool	Drive	Other
Employee	1.31	2.24	2.53	2.70	2.98	7.92
Student	.72	1.26	2.64	2.17	2.79	2.51

Table 4-3 is the geocode-based network distance between people's homes and the campus (not the subjective estimates from question 2.4 of the survey). Drivers travel about half a mile further to campus than LIM users on average, an expected difference since most of the on-campus population does not drive.

Table 4-4 Average commute time (in minutes)

	Walk	Bike	Bus	Carpool	Drive	Other
Employee	18.04	12.53	18.58	10.08	9.59	18.50
Student	12.85	9.38	13.09	12.02	8.90	11.46

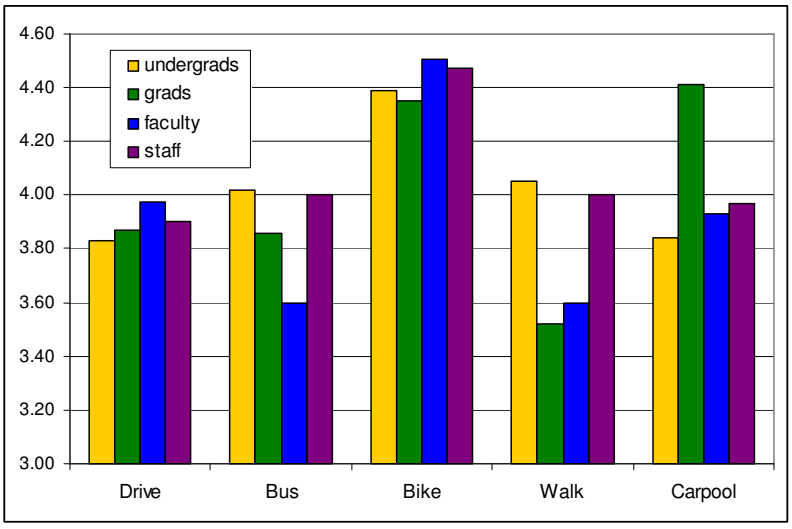
While drivers live a half mile further than LIM users on average, they arrive on campus several minutes sooner than their counterparts do. It is unknown whether this includes time spent looking for parking, so further research could be done to verify this.

Table 4-5 I am very skilled at riding a bike

{1= Strongly Disagree, 5=Strongly Agree}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	3.9	4.5	3.9	3.9	3.9	4.5
Student	3.7	4.4	4.0	4.0	3.9	4.1

Most travelers believe they are skilled bike riders (around 80%), with drivers feeling less skilled on average than their lower impact mode using counterparts. Comparing perceived cycling skill more closely across roles, we find the following:

Figure 4-2 Cycling Skill



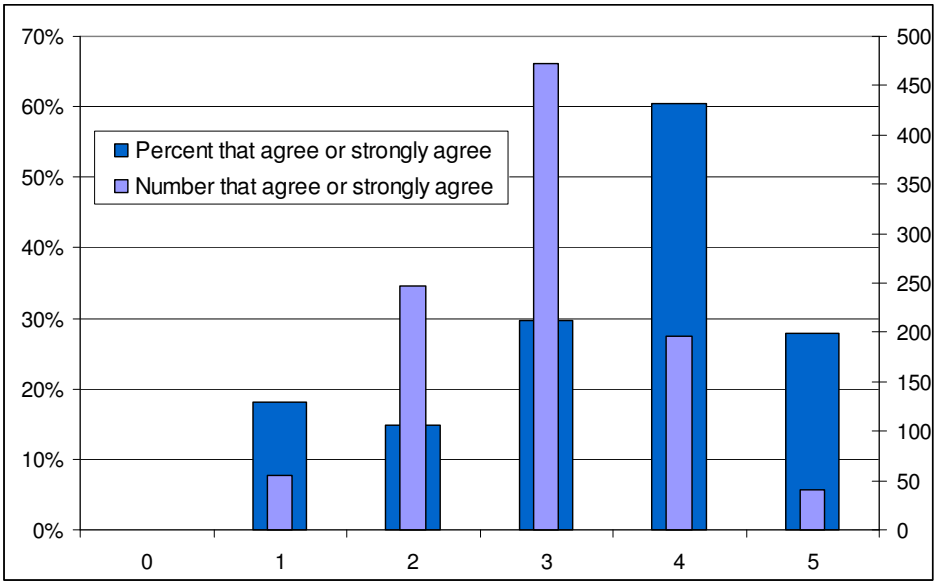
Cyclists feel they are the most skilled at bike riding, with faculty who take the bus and walk as well as grad students who walk think they are the least skilled.

Table 4-6 I live too far from campus to ride a bike

{1= Strongly Disagree, 5=Strongly Agree}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	1.2	1.2	1.6	2.5	2.4	1.6
Student	1.2	1.3	2.5	2.6	2.7	1.8

Most travelers that live within Davis don't believe they live too far from campus to ride a bike. Some drivers do think that distance inhibits them from choosing to ride a bike, which we explore more in detail in Figure 4-3.

Figure 4-3 Number of Drivers within Davis Who Live Too Far Away to Bike by Distance from Campus



The above graphs shows that of the 3,586 people who drive three miles or less to campus, 774 believe it is too far to bike. If they shifted to other modes besides driving alone, this would represent a two percent reduction in drive alone trips overall for the campus. If *all drivers within 3 miles* of campus shifted to other modes, this would result in an *eight percent reduction in drive alone trips* overall.

Table 4-7 I regularly need more cargo capacity than a bike can provide

{1= Strongly Disagree, 5=Strongly Agree}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	1.9	1.8	2.6	3.3	3.4	2.5
Student	2.0	2.2	2.7	3.0	3.5	2.5

Table 4-7 illustrates that LIM users generally disagree with this statement, while drivers are more likely to agree slightly.

Table 4-8 I don't ride a bike when it's raining

{1= Strongly Disagree, 5=Strongly Agree}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	3.4	2.6	4.1	4.2	4.4	3.8
Student	3.7	2.7	4.2	4.0	4.3	3.8

Table 4-9 I don't ride a bike when it's hot outside

{1= Strongly Disagree, 5=Strongly Agree}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	2.1	1.5	3.2	3.2	3.1	2.4
Student	2.4	1.7	3.1	2.9	3.2	2.5

Table 4-10 I don't ride a bike when it's cold outside

{1= Strongly Disagree, 5=Strongly Agree}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	2.1	1.6	3.1	3.3	3.3	2.5
Student	2.8	1.8	3.2	3.0	3.3	2.7

Table 4-11 I don't want to arrive on campus sweaty

{1= Strongly Disagree, 5=Strongly Agree}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	3.4	2.6	3.8	3.3	3.9	2.8
Student	3.6	3.0	3.8	3.6	3.8	3.6

Both LIM users and drivers answered as expected in response to these statements. The two groups have more differences regarding temperature (hot/cold).

Table 4-12 My job requires that I wear professional clothing

{1= No Impact,6=Very Large Impact}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	2.6	2.3	3.3	2.9	3.6	2.8
Student	2.2	1.9	2.4	2.3	2.4	2.2

Table 4-13 The style of clothing I prefer is inconvenient for biking

{1= Strongly Disagree, 5=Strongly Agree}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	2.2	1.8	2.8	2.7	3.1	2.5
Student	2.2	2.0	2.4	2.5	2.8	2.4

LIM users have less impact on biking from clothing preferences, with employee drivers being the most impacted from professionalism – less than 20% of most campus roles are concerned about biking in their preferred attire – the only exception is that around 40% of the administration find it hard to bike in their preferred attire.

We also looked at perceived safety of biking on various types of infrastructure: on-campus, on streets with no bike lane, on streets with a bike lane, and on grade-separated bike paths. These results are found in Table 4-14 to Table 4-17.

Table 4-14 Riding a bike on campus

{1=Very Unsafe, 5=Very Safe}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	3.3	3.9	3.6	3.8	3.7	4.0
Student	3.7	4.0	3.8	3.9	3.9	3.8

Table 4-15 Riding on a road with no bike lane

{1=Very Unsafe, 5=Very Safe}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	2.3	2.5	2.2	2.0	2.3	2.4
Student	2.2	2.5	2.3	2.4	2.4	2.5

Table 4-16 Riding on a road with a bike lane

{1=Very Unsafe, 5=Very Safe}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	3.6	3.9	3.8	3.6	3.7	4.2
Student	3.6	3.9	3.7	3.7	3.6	3.7

Table 4-17 Biking on a bike path

{1=Very Unsafe, 5=Very Safe}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	4.1	4.6	4.3	4.4	4.4	4.6
Student	4.4	4.5	4.3	4.4	4.3	4.3

Non-cyclists feel consistently less safe biking across all types of infrastructure. Only around 10% of drivers found it safe or very safe on roads without bike lanes. Around 60-70% of drivers found it safe or very safe to ride on a street with a bike lane as well as riding on campus. Lastly, bike paths were seen as safe or very safe by the most people – 85-90% of each group.

We looked at a number of changes to the biking program at UC Davis to gauge what impact such programs might have on travelers' decisions to ride a bike. The results are shown in Table 4-18 to Table 4-22.

Table 4-18 More bicycle-friendly dress code

{1=No Impact, 6=Very Large Impact}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	1.9	1.9	2.2	2.6	2.3	2.1
Student	1.7	1.9	1.9	2.1	1.9	1.9

Table 4-19 Locked box on campus in which I can store my bike

{1=No Impact, 6=Very Large Impact}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	2.1	2.0	2.8	2.3	2.2	2.0
Student	2.3	2.3	2.6	2.4	2.3	2.4

Table 4-20 Low cost emergency rides home

{1=No Impact, 6=Very Large Impact}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	2.1	2.4	3.0	2.8	2.7	2.9
Student	2.8	2.8	3.1	3.2	2.7	2.7

Table 4-21 After hours emergency flat tire repair

{1=No Impact, 6=Very Large Impact}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	2.0	2.7	3.1	2.6	2.7	3.2
Student	2.8	3.1	3.1	3.3	2.8	2.9

Table 4-22 Bike racks on Unitrans

{1=No Impact, 6=Very Large Impact}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	1.9	2.4	3.6	2.7	2.2	2.4
Student	3.2	3.4	4.1	3.4	3.2	3.4

It is clear that certain programs particularly encourage drivers to bike more while others particularly encourage LIM users to bike more. Bus users seem the most encouraged by various interventions to get them to use bikes. It also looks as if students may be interested in flat tire repair for their bicycles on campus during non-business hours. This could be explored more accurately in future surveys.

Lastly in this comparison of different modes related to bicycling within Davis, we look at some household traveler characteristics that may be important to different modes: the

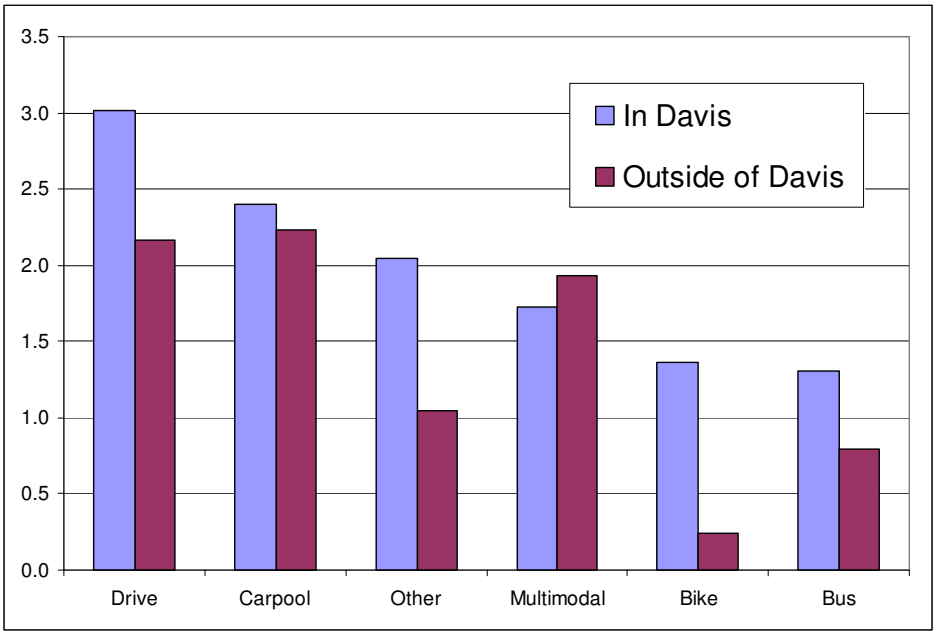
frequency of errands, household lifecycle characteristics, and number of years at UC Davis. People were prompted with a list of errands which included work-related business, dropping off/picking up other family members, meals, social activities, exercise/working out, grocery shopping, visiting/caring for family members, and medical/dental appointments.

Table 4-23 Average Frequency of Errands

{0= Not at all, 1= Once a week or less, 2= Once every few days, 3= Once a day, 4= A few times a day}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	1.4	1.4	1.3	1.8	1.8	1.2
Student	3.4	3.1	1.1	1.6	1.8	2.1

Drivers run errands more often during their commutes than LIM users on average, yet student walkers and bikers as a group run more errands on their way to classes than other groups.

Figure 4-4 Average Frequency of Commute Errands per Person per Week by Mode



Travelers who live in Davis run more errands on average during their commute, led by drivers and carpoolers.

Different lifecycle stages are likely to have an effect people's mode choice, so demographic variables related to lifecycle were included in the survey.

8.2: Number of people of each category below are in your household?

Table 4-24 Children, age under 6

{0, 1, 2, 3, 4, 5=5 or more}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	.10	.24	.09	.33	.13	.22
Student	.04	.03	.01	.03	.02	.04

Table 4-25 Children, age 6-15

{0, 1, 2, 3, 4, 5=5 or more}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	.11	.28	.22	.30	.43	.55
Student	.03	.03	.02	.02	.07	.03

Table 4-26 Youth, age 16-17

{0, 1, 2, 3, 4, 5=5 or more}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	.00	.06	.00	.03	.10	.16
Student	.09	.07	.04	.01	.01	.11

Table 4-27 Total Adults, age 18-65

	Walk	Bike	Bus	Carpool	Drive	Other
Employee	1.7	1.9	2.0	2.0	1.7	1.8
Student	2.7	2.8	3.2	3.0	2.7	2.9

Table 4-28 Elderly, age 65 or older

{0, 1, 2, 3, 4, 5=5 or more}	Walk	Bike	Bus	Carpool	Drive	Other
Employee	.00	.06	.00	.08	.07	.11
Student	.02	.01	.00	.02	.01	.02

LIM users' households mainly consist of adults. In comparison, drivers' households have more non-adults, particularly children 6-17 years old. There also seems to be some preliminary evidence that people who have children under 6 may be more likely to bike or carpool than drive alone. This relationship could be looked at in more detail in future analyses.

The last variable of interest is the number of years employed or enrolled at UC Davis. In general, drivers have been employed or enrolled at UC Davis for a slightly longer time, as seen in Table 4-29.

Table 4-29 Number of Years at UCD

	Walk	Bike	Bus	Carpool	Drive	Other
Employee	9.6	9.4	6.0	10.5	11.0	9.4
Student	2.2	2.1	2.3	2.4	2.6	2.3

Within this section, we have compared different commute attributes, attitudes, lifestyle patterns, and some demographic characteristics and how they related to travelers mode choices within Davis. We found that travel time, distance, weather, perceived safety of cycling, chauffeuring children, and the duration of time at UC Davis all had a relationship to which mode travelers chose. Below, we summarize some of the main findings and questions.

Drivers within Davis tend to live half a mile further away than their lower-impact mode counterparts yet for employees their commute time is three minutes faster than biking, eight minutes faster than walking, and nine minutes faster than taking the bus on average. For students driving is also the fastest way to get campus - although only a minute faster than biking, four minutes shorter than walking and taking the bus.

Somewhere around 80% of the population would say that they are skilled bike rider. Those who think they are the least skilled at riding bikes are graduate students who walk to campus, faculty who walk to campus, and faculty who take the bus.

Around 3,500 people drive 3 miles or less to get campus, and almost 800 perceived that this is too far to bicycle. People who generally drive or take the bus don't ride their bikes when it's raining, when it's hot outside, or when it's cold outside. People who generally walk are less averse to inclement weather, however. Almost everyone doesn't want to arrive on campus sweaty, though cyclists are the least averse to this of all the groups. Less than 20% of the campus has trouble bicycling in their preferred attire, though 40% of the administration does.

Regardless of the mode chosen, campus travelers agree that they perceive the grade-separated bike path as the safest form of infrastructure, followed by roads with a bike lane, and regular roads. For those who bike, riding on campus is about as safe as riding on the road with a bike lane. The fact that people who don't regularly cycle perceived all types of cycling infrastructure as less safe than those who regularly bike suggests that perceived safety, and possibly a lack of experience with cycling is a major barrier.

Student cyclists, bus users, and student carpoolers may be interested in emergency flat tire repair after regular business hours. This suggests a few things. First, it suggests that bicycle maintenance and repair is a barrier to students riding bikes. Secondly, it suggests a need for bicycle maintenance facilities available on campus at all hours.

It appears that employees who have children tend to drive more when their children are between the ages of six and fifteen, likely due to chauffeuring children for school and other activities on the way to and from work. The fact that people who drive to UC Davis tend to have worked longer than those who use lower impact modes is curious. Could it just be a factor of age? It is a cohort effect, where younger generations are more likely to use LIMs? Or is it that the longer one works or goes to school at UC Davis, the more likely one is to drive?

5 Are people trying to make a difference through their transportation choices?

Mode choice isn't just a decision about travel time and associated travel costs; it is also understood as a lifestyle choice for some people. For example, bicycling for many isn't just a form of travel, it also enables and articulates an alternative lifestyle and vision of a more sustainable culture (Horton 2006). Standard economic theory currently used for transportation planning and most policy-making begins with the assumption that people are "selfish robots", and proceeds from there to form prescriptive policies and predictions. This has worked well enough for looking at human behavior in market settings in the last few hundred years, but it isn't an accurate or appropriate model of human behavior for many other settings (Henrich, Boyd et al. 2005). When looking to solve community-scale collective problems in transportation, planners may not only need to call upon their

fellow community members to rise above myopic self-interest; we may also need to call upon *our models* to account for the same possibility (Congleton 2008).

Theories of collective action have been used in sociology and political science to explain protest behavior and social movement participation, including the environmental movement, efforts to improve air quality, and efforts to reduce global warming (Klandermans 1984; Finkel 1989; Gibson 1997; Muller 1998; Lubell 2002; Lubell, Vedlitz et al. 2006; Lubell, Zahran et al. 2007). We have adapted these models to study collective action in the mode choice setting.[18]

This section compares this fall's survey responses to the Spring Quarter 2007 survey responses about collective problems related to transportation choices at UC Davis. Problems addressed in the fall survey include local air pollution, local traffic congestion, global warming, and national dependence on non-renewable energy. We measure level of concern for these problems, belief in one's ability to affect them through personal action, and belief in the UC Davis community's ability to affect them through collective action.

There is the potential for a prosocial bias in people's answers to survey questions about collective issues, which can reduce the variance of the answers (Sjostrom and Holst 2002). Survey questions themselves can generate a norm simply by querying about norms, so we changed the format of the fall survey relative to the spring survey to minimize this effect, following the work of Sterngold, et al. (Sterngold, Warland et al. 1994).

We provided introductory questions to each collective interest-related query, as follows:

> 7.3.1: Are you concerned about any of the following transportation related issues in your community or do you feel that they are not really a problem?
> (Air pollution, Traffic congestion, Global warming, Dependence on non-renewable energy)
>
> *No, they are not really issues to me.*
> *Yes, I am concerned about one or more of these issues.*
>
> 7.3.3: Do you think your personal actions could improve any of the following transportation issues by driving less?
>
> *No, my personal action cannot improve any of these issues by driving less.*
> *Yes, my personal action can improve one or more of these issues by driving less.*
>
> 7.3.4: Do you think UC Davis travelers can improve the following transportation issues by driving less?
>
> *No, UC Davis travelers cannot improve any of the issues by driving less.*
> *Yes, UC Davis travelers can improve one or more of these issues by driving less.*

If respondents chose "Yes" for these questions, they were queried further about the extent to which they were concerned, thought their personal action mattered, or believed that the group could make a difference. For further background we recommend reviewing Section 7 of the spring 2007 report[19].

[18] See Chris Congleton's dissertation for discrete choice model using the survey questions in this section: Congleton, C. (2008). The Collective Calculus of Mode Choice: Are Drivers Free-Riding on Lower Impact Modes? Davis.

[19] found at http://taps.ucdavis.edu/surveys/results/Spring_07_Travel Assessment_UCD.pdf

5.1 Level of Concern

The community is generally very concerned about collective problems related to transportation. Over 70 percent of all travelers are concerned or very concerned about local air pollution, local traffic congestion, global warming, and national dependence on non-renewable energy.

Table 5-1 Concern about Air pollution

{0=Not at all Concerned, 3=Very Concerned}	Walk	Bike	Bus	Carpool	Drive	Other
Employees	2.19	2.45	2.33	2.45	2.24	2.35
Students	1.99	1.96	1.88	1.94	1.94	1.90

Table 5-2 Concern about Traffic congestion

{0=Not at all Concerned, 3=Very Concerned}	Walk	Bike	Bus	Carpool	Drive	Other
Employees	2.09	2.15	2.17	2.25	2.18	2.32
Students	1.73	1.70	1.67	1.97	1.87	1.68

Table 5-3 Concern about Global warming

{0=Not at all Concerned, 3=Very Concerned}	Walk	Bike	Bus	Carpool	Drive	Other
Employees	2.11	2.47	2.39	2.30	2.08	2.23
Students	1.97	2.00	1.96	1.99	1.95	1.91

Table 5-4 Concern about Dependence on non-renewable energy

{0=Not at all Concerned, 3=Very Concerned}	Walk	Bike	Bus	Carpool	Drive	Other
Employees	2.32	2.55	2.46	2.41	2.25	2.39
Students	1.94	2.04	1.89	1.99	1.99	1.86

Employees are more concerned in general than students, with LIM users more concerned than drivers. However, employee LIM users and drivers are almost equally concerned about congestion. All groups have a relatively high level of concern on all issues.

5.2 Personal Actions

Perceptions of one's ability to affect community-level policies and problems may be important in determining one's mode choice. For example, concern and ability to affect changes in local air pollution or local congestion may motivate people to choose alternatives rather than drive alone.

Table 5-5 Personal Efficacy to Reduce Air pollution

{0=No Improvement, 3=Large Improvement}	Walk	Bike	Bus	Carpool	Drive	Other
Employees	1.54	1.93	2.36	1.89	1.67	1.93
Students	1.71	1.68	1.45	1.50	1.41	1.34

Table 5-6 Personal Efficacy to Reduce Traffic congestion

{0=No Improvement, 3=Large Improvement}	Walk	Bike	Bus	Carpool	Drive	Other
Employees	1.68	1.92	2.34	1.89	1.62	1.98
Students	1.85	1.79	1.55	1.46	1.45	1.35

Table 5-7 Personal Efficacy to Reduce Global warming

{0=No Improvement, 3=Large Improvement}	Walk	Bike	Bus	Carpool	Drive	Other
Employees	1.25	1.72	2.31	1.73	1.46	1.74
Students	1.49	1.49	1.39	1.36	1.32	1.16

Table 5-8 Personal Efficacy to Reduce Dependence on non-renewable energy

{0=No Improvement, 3=Large Improvement}	Walk	Bike	Bus	Carpool	Drive	Other
Employees	1.34	1.81	2.27	1.80	1.59	1.87
Students	1.33	1.50	1.32	1.28	1.31	1.09

While most travelers are concerned about collective problems, few think they can personally do something about it. Employees are more likely to believe they can make a difference than students, while LIM users are more optimistic than drivers.

5.3 Actions of UC Davis Travelers as a Group

Perceptions of group efficacy may play a role in shaping people's mode choice. The following question measures this concept. Questions are focused on what extent UC Davis travelers would improve the following transportation issues by driving less than they do now:

Table 5-9 Group Efficacy to Reduce Air pollution

{0=No Improvement, 3=Large Improvement}	Walk	Bike	Bus	Carpool	Drive	Other
Employees	2.23	2.55	2.81	2.38	2.16	2.48
Students	2.41	2.39	2.21	2.25	2.03	2.05

Table 5-10 Group Efficacy to Reduce Traffic congestion

{0=No Improvement, 3=Large Improvement}	Walk	Bike	Bus	Carpool	Drive	Other
Employees	2.70	2.81	2.96	2.55	2.28	2.60
Students	2.53	2.72	2.53	2.36	2.28	2.41

Table 5-11 Group Efficacy to Reduce Global warming

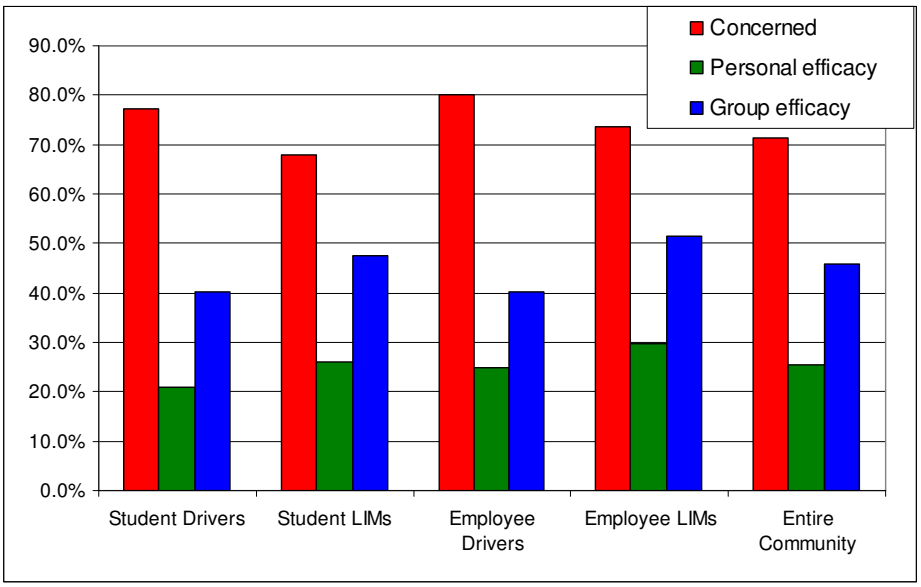
{0=No Improvement, 3=Large Improvement}	Walk	Bike	Bus	Carpool	Drive	Other
Employees	1.77	2.22	2.67	2.05	1.87	2.18
Students	1.96	1.91	1.84	1.98	1.71	1.59

Table 5-12 Group Efficacy to Reduce Dependence on non-renewable energy

{0=No Improvement, 3=Large Improvement}	Walk	Bike	Bus	Carpool	Drive	Other
Employees	2.13	2.37	2.67	2.07	2.02	2.33
Students	1.98	1.99	1.88	2.03	1.74	1.59

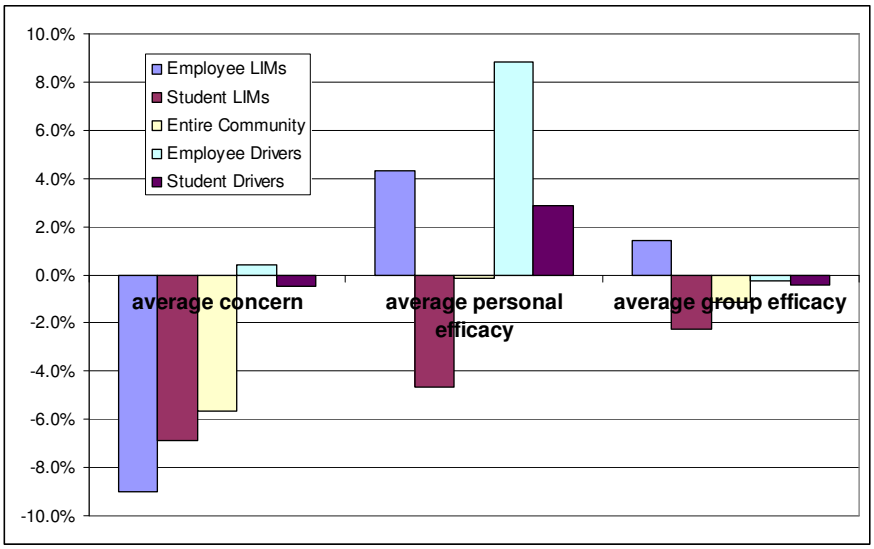
The pattern here is similar to personal action, but there is more optimism for improvement across all segments. LIM users are more confident in the group's impact, and employees are more confident in the group's impact except for air pollution and traffic congestion, where students and employees answers are more similar.

Figure 5-1 Fall 2007 Summary Statistics for Collective Action on Transportation Related Problems



71.4% of the entire community is moderately or very concerned about collective problems posed by transportation. Translating this concern into personal action, only 25.6% believe a medium or large improvement is possible to problems by their individual choice to drive less. However, almost half (45.8%) of the community believes that all UC Davis travelers working together to drive less can make a medium or large improvement to collective transportation problems.

Figure 5-2 Summary of Changes between the Spring '07 Survey and the Fall '07 Survey



Compared to the spring '07 survey, answers changed slightly. The percentage of people concerned or very concerned dropped by almost 6%, possibly in part due to the changes we made to the survey to reduce bias. Interestingly, more employees believe they can make a difference personally than spring '07, with a 4.3% increase for LIM users and an 8.8% increase for employees who drive alone. Proportionately less student LIM users are optimistic about their personal ability to make changes – a 4.6% decrease from spring '07.

6 Evaluation of Existing Programs

Overall Knowledge and Usage of Various TAPS Programs

Almost 80% of all undergraduates have never heard of many of TAPS alternative transportation programs. Almost half of all administration, staff, and faculty are also relatively unaware. However, knowledge and usage of TAPS programs does increase the longer one stays at UCD. It is mainly non-students who utilize the programs. Below, we analyze the awareness level (percentage of people who have heard of each program), the success rates for those who have heard of the program (of those who have heard of the program, what percentage use it currently?), and lastly, the success rate for those who have tried it (of those who have previously used the program, what percentage are still using it?).

Figure 6-1 TAPS Carpooling Program: Awareness, Usage, and Experience

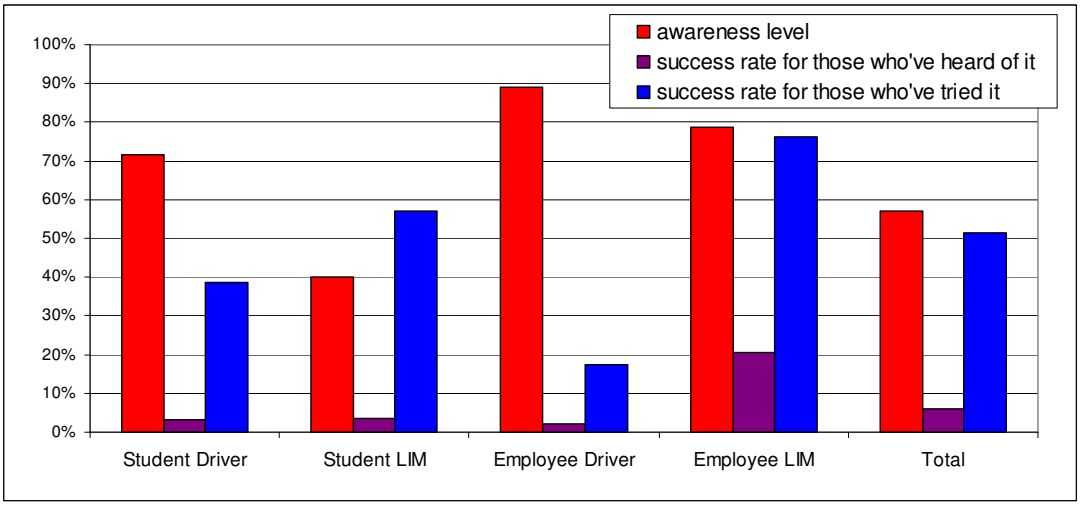


Figure 6-2 Discounted transit passes (transit pool program)

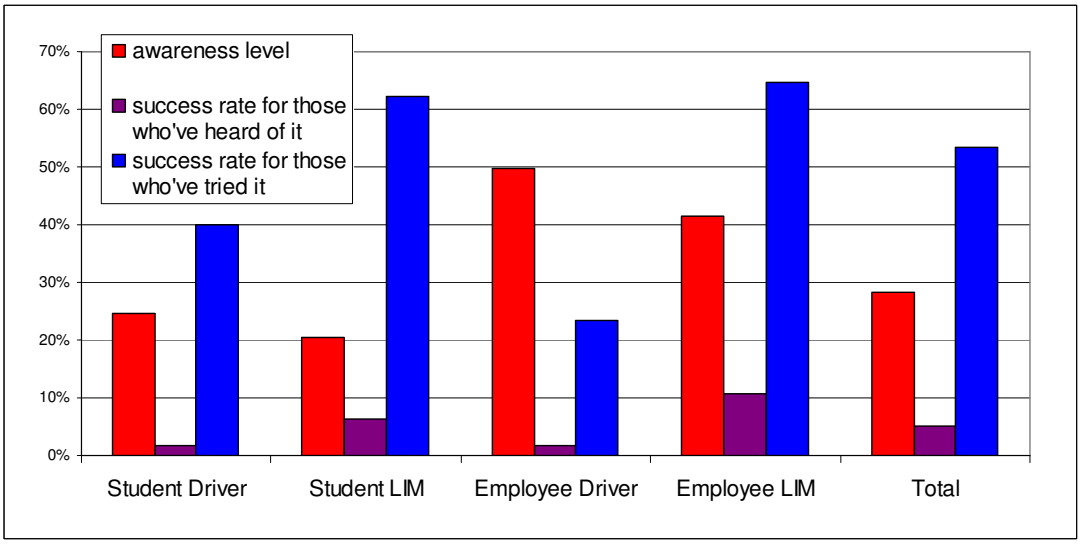


Figure 6-3 Emergency ride home service for carpool and transit/train users

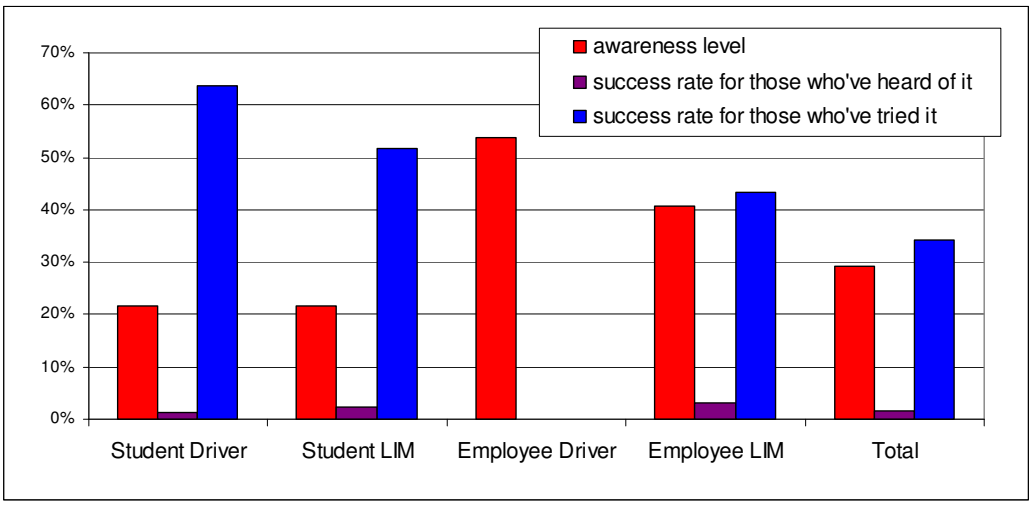


Figure 6-4 24 free daily parking days (per year) for carpoolers, trainpoolers, and transitpoolers

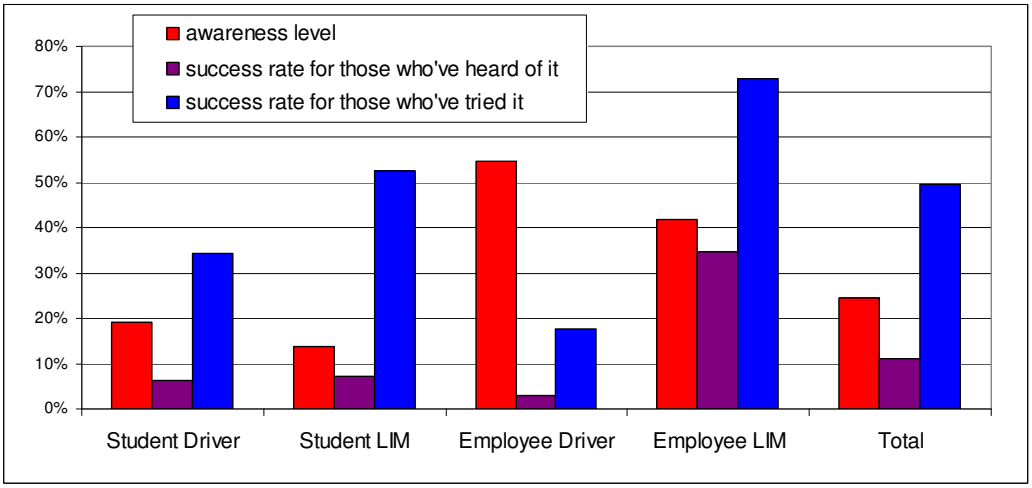


Figure 6-5 Online Ridematching (find a carpool partner) Service

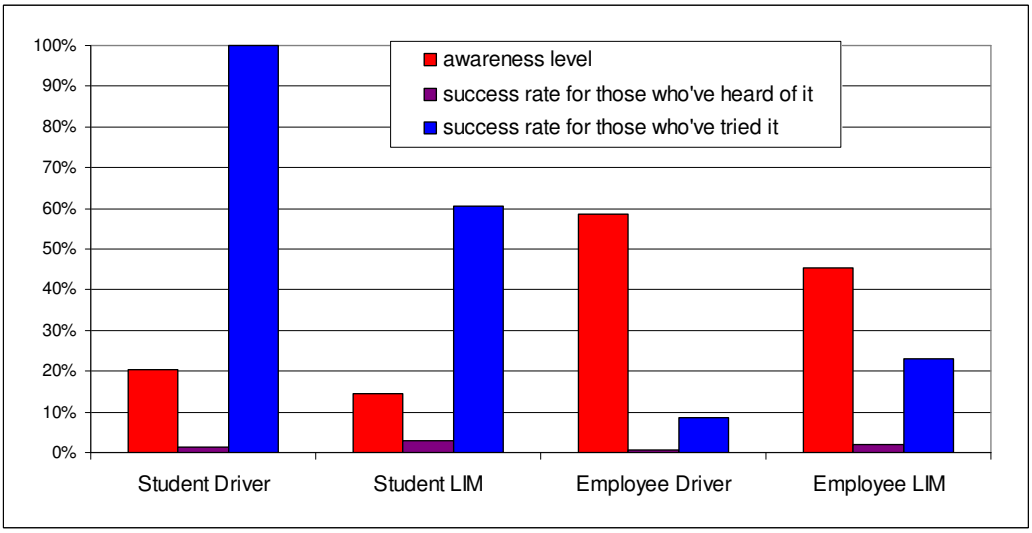


Figure 6-6 Trainpool

Figure 6-7 Transitpool

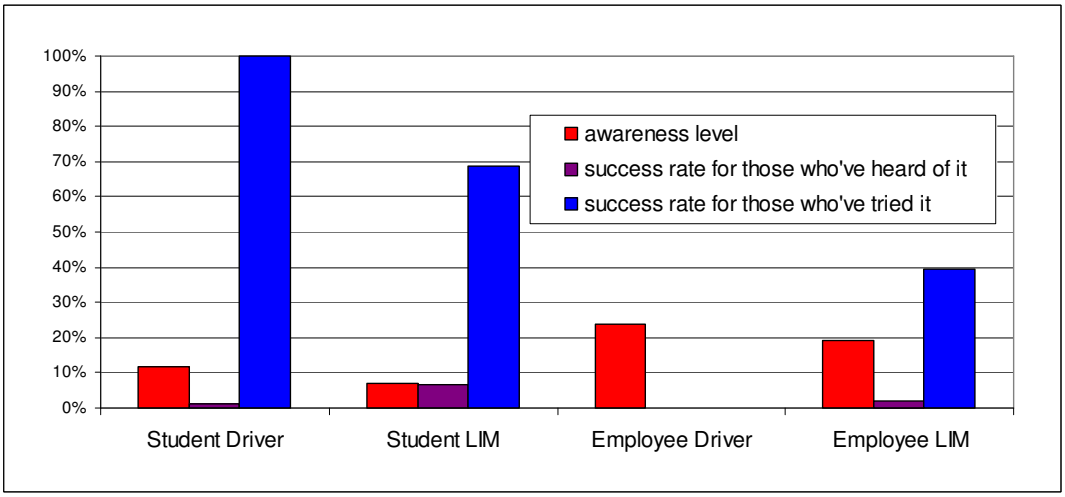


Figure 6-8 Yolo TMA Commuter Club

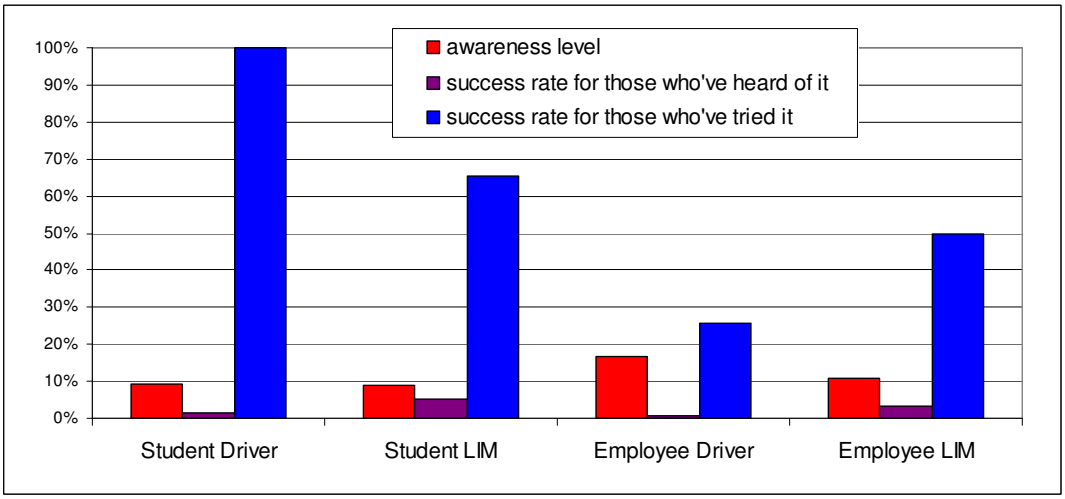
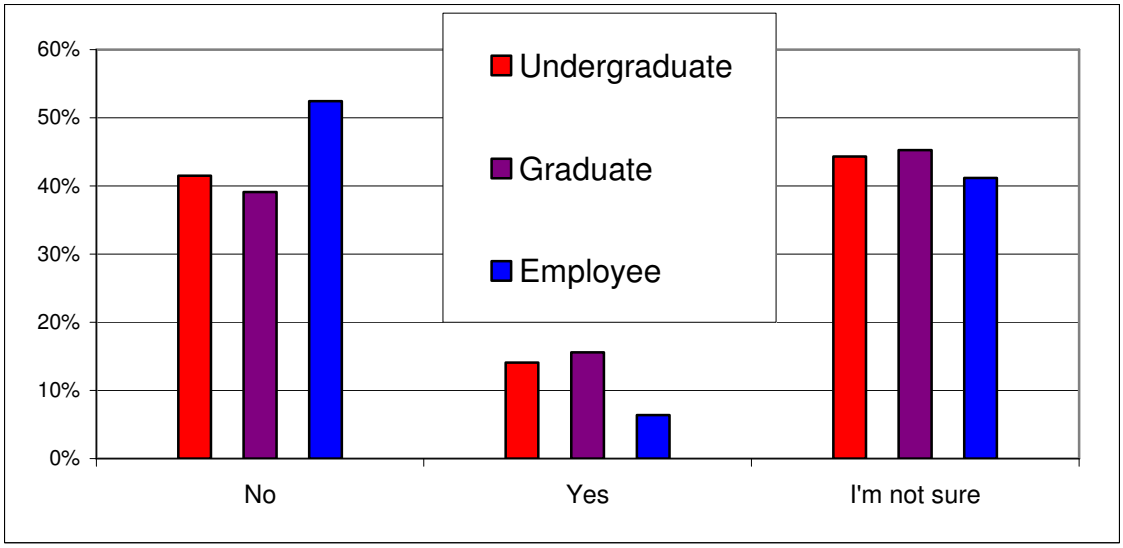


Figure 6-9 www.sacregion511.org

We also queried respondents about their interest-level for in-vehicle parking meters that charge by the minute, as well as their interest-level for automobile rental by the hour.

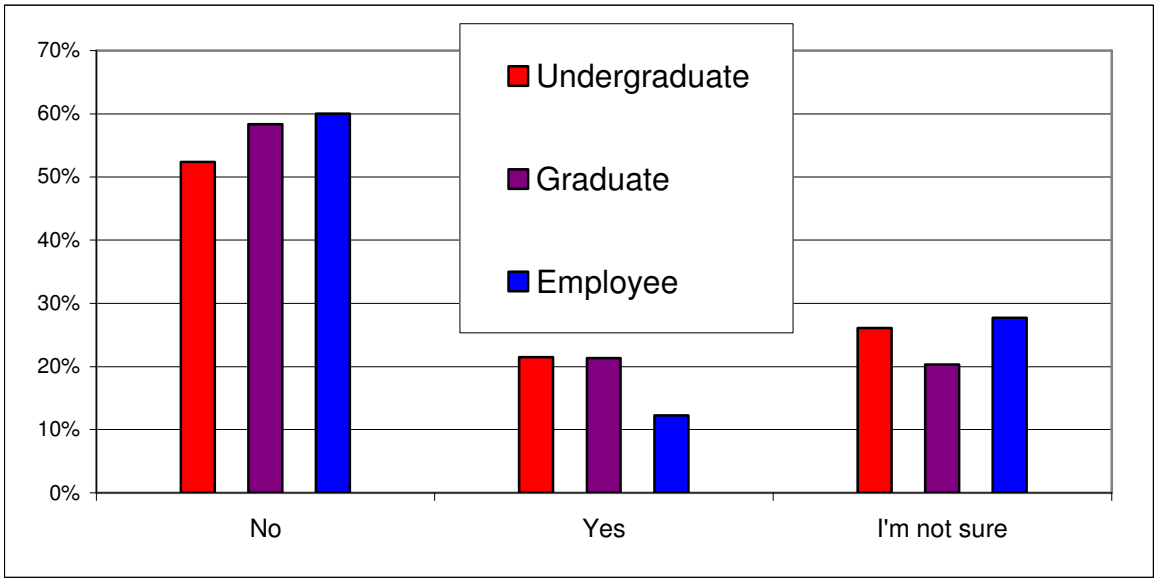
Figure 6-10 Interest in In-Vehicle Parking Meters that charge by the minute



Few campus travelers are interested in trying in-vehicle parking meters (less than 15%), but over 40% are not sure if they are interested in the service. The details of the service would probably need to be stated to gauge interest more accurately.

7.4b Hourly car rental

Figure 6-11 Interest in Hourly Car Rental

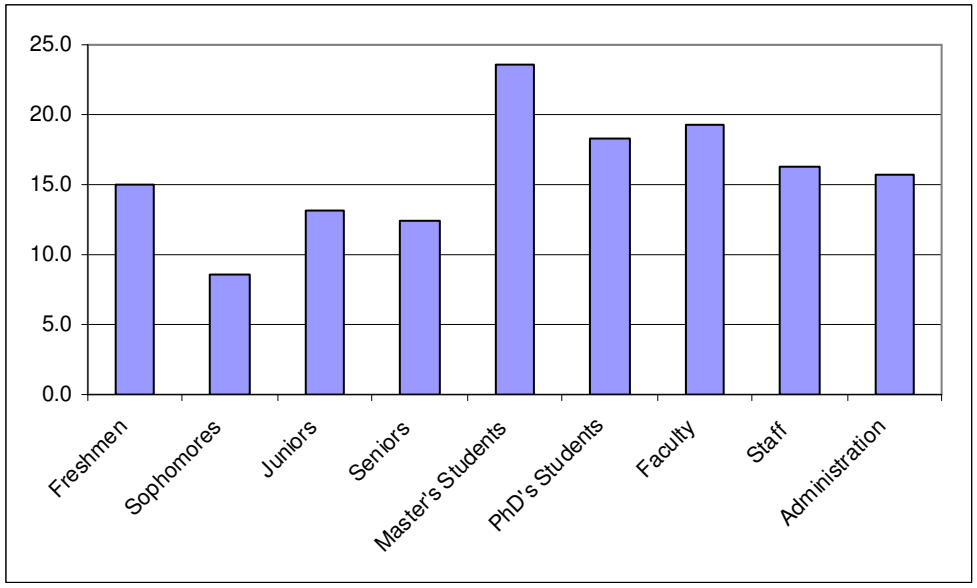


Automobile rental by the hour was of interest to more travelers – over 20% of students and over 10% of employees. An additionally 25% were not sure, probably also because the details of the service would be important to their interest level.

7 Greenhouse Gas Emissions from the Daily Commute

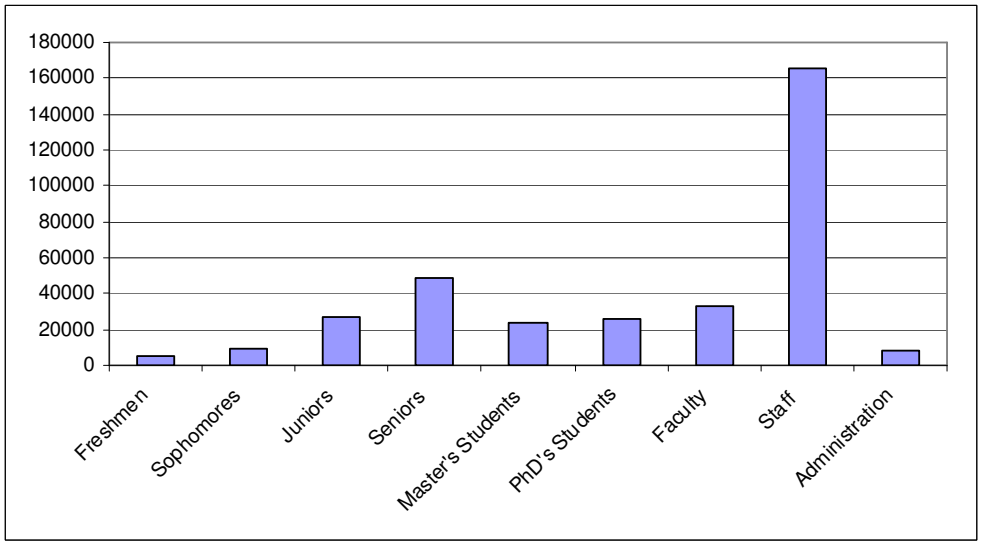
We provide a rough comparative estimate of greenhouse gas emissions generated by different campus roles. We use the distance each commuter travels from home to campus and their primary mode[20] to make an estimate of their daily commute emissions.

Figure 7-1 Average Commute Distance for Single Occupancy Vehicle (SOV) Users by Role



In the following figure we report the total sum of commute miles by single occupancy vehicle drivers for each role.

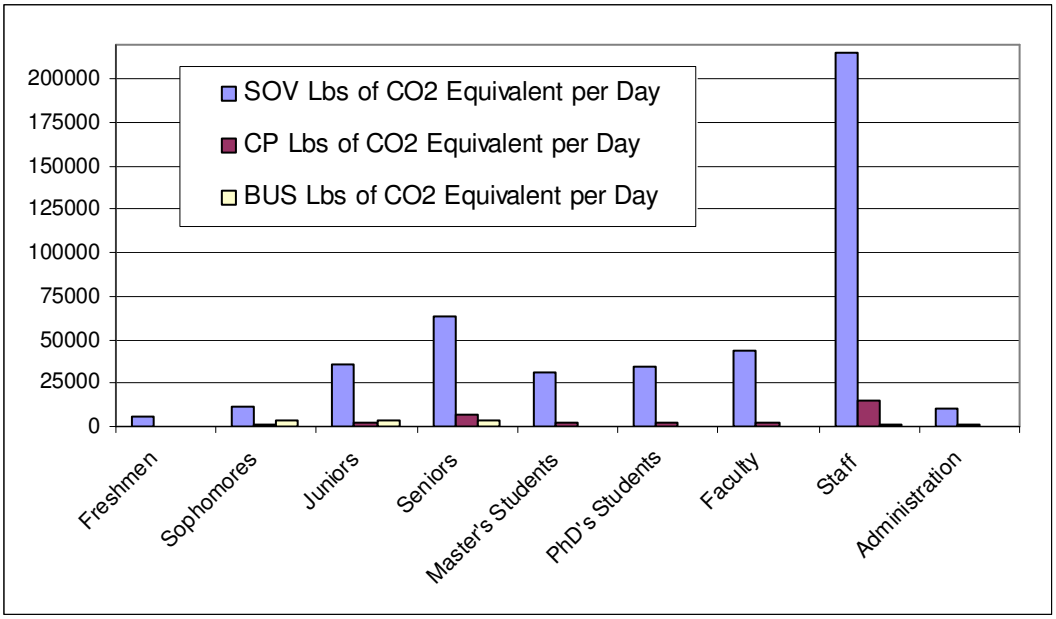
Figure 7-2 Total Daily Commute Miles for Single Occupancy Vehicle (SOV) Users by Role



[20] This introduces a small amount of error for commuters who use different modes of transport on different days of the week, but was done in this fashion in the interest of time. Mode split calculated using primary mode vs the actual number of trips per week closely approximated one another, so we expect that the error with this substitution should also not be too significant.

In order to estimate the greenhouse gas (GHG) emissions from different roles, we must use estimates of emissions per mile for different modes. For single occupancy vehicles, we use 1.3 Lbs of CO_2 equivalent per mile, for carpools we use the SOV estimate divided by our average carpool size (2.56 people per car) to get 0.51 Lbs of CO_2 equivalent per mile, and for the bus we use an estimate for a relatively full transit bus around 0.3 Lbs of CO_2 equivalent per mile[21].

Figure 7-3 Total Daily CO_2 Equivalent Emissions for SOV, Carpool (CP), and Bus Users by Role

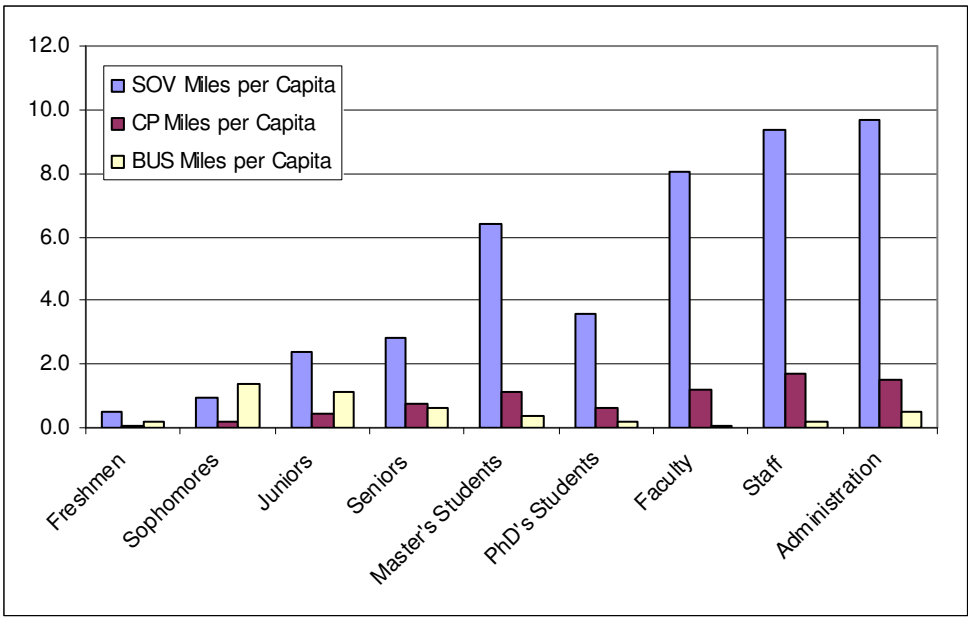


Staff commuters provide the largest share of emissions by far (over 47%), followed by senior students (at 15%). This is partly due to the large number of staff and the fact that over half of them live outside of Davis.

If we compare roles by emissions per capita (see Figure 7-4), we find that Administrators have the highest emissions per person, followed closely by Staff, Faculty, and then Master's students.

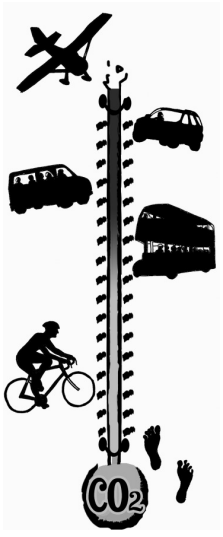
[21] All GHG emission per mile estimates are adapted from calculations made by the Sightline Institute: http://www.sightline.org/maps/charts/climate-CO2byMode

Figure 7-4 Per Capita Daily CO_2 Equivalent Emissions for SOV, Carpool (CP), and Bus Users by Role



Overall, we estimate that campus commuters to the main campus emit a total of 488,321 lbs (222 metric tons) equivalent of CO_2 per travel day, with over 90% of this coming from single occupancy vehicle drivers traveling to the campus from outside of Davis. We estimate that the total annual emissions from campus commuters is on the order of 50,000 metric tons per year.

Lastly, we note that air travel is a large and unaccounted for contributor to the campus carbon footprint, including faculty and student travel to conferences and research sites, as well as administrative travel associated with the university. While not part of the daily commute to campus, these travels are university-related and as such deserve to be measured and accounted for in the campus carbon footprint.



8 Target Areas for Reducing Carbon Emissions and Increasing AVR at UC Davis

This concluding section begins with a forecast of campus growth over the next 7 years and its effect on the carbon footprint of the campus. **We introduce commute miles rather than trips as the appropriate metric for measuring the success of travel demand management programs**. With this metric in mind, we list three broad target areas to reduce the carbon footprint of UCD travelers, outlined in Table 8-1:

1. increase the proportion of travelers living in Davis or on campus,
2. increase the use of alternatives to driving outside of Davis, and
3. increase the use of lower impact modes within Davis.

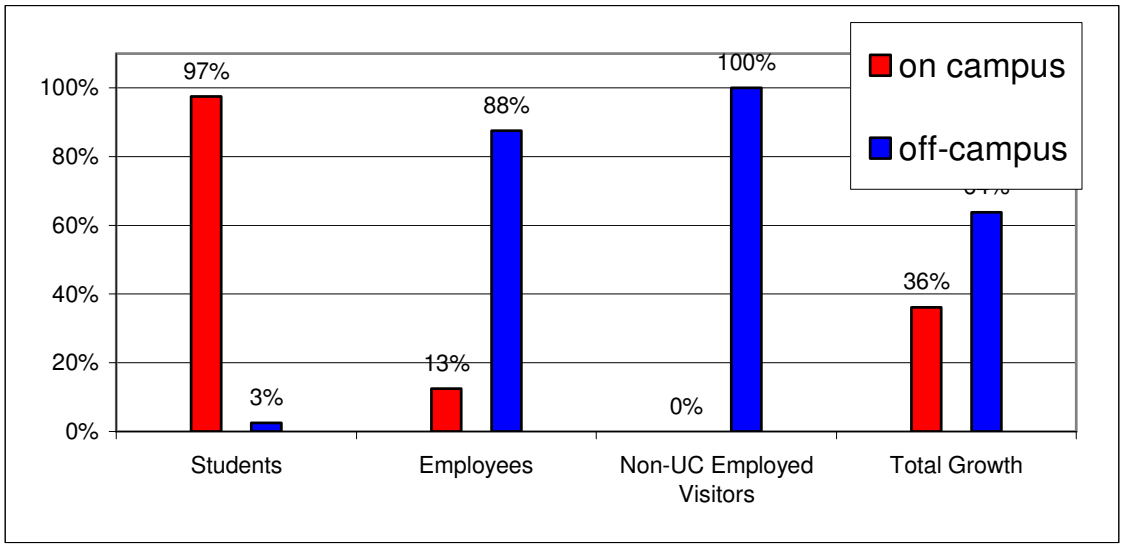
We suggest potential strategies within each target area, based on relevant data from our survey to determine existing barriers and levers for change.

8.1 Campus Growth Will Likely Lead to Increased Carbon Emissions Without Intervention

In this report, we have examined the travel choices and some of the opinions of current UC Davis affiliates. While a majority of those coming to the main campus currently commute from within Davis or on campus, the university anticipates more growth in the coming years as mandated by the state. Additionally, the Sacramento Area is home to about a million people and is expected to double in population by 2035, which amounts to another 34,000 people a year (SACOG 2008).

Given the current planning scenario, we estimate that over 64% (9,700) of the additional 15,200 travelers to UC facilities in Davis by 2016 will live off-campus (Mohr 2008) and probably outside of Davis as well (see Figure 8-1 below). If they do, the resulting growth would change the overall mode split of the campus to increase driving alone by 4%, reduce bus use by 4%, and bicycling by 2% (assuming mode splits remain the same as they are now on campus, within Davis, and outside of Davis).

Figure 8-1 Additional Commuters to UC Davis between 2001 and 2016[22]



While we do not calculate the estimated carbon emissions from this growth, it is clear that increases in driving alone and reductions in biking and busing will also increase the carbon emitted. Unless the new growth is on or near campus, unless the proportion of driving trips decreases, the collective carbon emissions from campus commuters will only increase.

8.2 The UC Davis Community is Concerned about Collective Transportation Problems

The vast majority of people are concerned about global warming and other collective problems related to personal travel. Over 71% of the entire community is moderately or very concerned about collective problems posed by their transportation choices. However, most do not think they can personally or collectively have a significant effect on these problems, but some do: over 25% believe a medium or large improvement to problems is possible by their individual choice to drive less, and almost half (46%) of the community believes that all UC Davis travelers working together to drive less can make a medium or large improvement to collective transportation problems. Why not more than this? In transportation, there is a gap between exercising a personal choice, largely based on personal convenience (travel times, travel costs, etc.), and communities exercising a collective choice, based on social costs and benefits. This gap is determined by the ability of social institutions or groups to incentivize and coordinate collective action.

Our survey provides evidence that most travelers do not believe that their personal decisions have an effect on other peoples' decisions when it comes to commuting; i.e. they do not perceive that their choice of mode is a strategic decision. Yet as transportation analysts we know that it is – the costs of transportation, both private and social (such as parking costs, transit fare, congestion delays, bicycle and pedestrian safety, etc.) are all affected by the proportion of people choosing each mode. Coordinating these

[22] These numbers include West Village.

choices on a collective basis has a have huge effect on the convenience of each choice. But how does this coordination happen?

Social institutions are the bridge between the individual and the collective, and rational collective choices leading to socially optimal outcomes are possible when social institutions are able to coordinate individual behaviors in such a way that individual choices can make a difference to collective outcomes. When the private costs and benefits of personal choices are equal to the social costs and benefits of those choices, an economically efficient and socially optimal outcome will occur. Our social institutions are the arbiters of these private costs and benefits in transportation, and it is up to these institutions to determine what these costs should be. In the context of campus travel, the university is the primary social institution to make changes in the private costs and benefits that travelers see, although governance from the federal government down can affect these costs and benefits also.

8.3 LIM convenience is the gold standard of goals, across jurisdictions

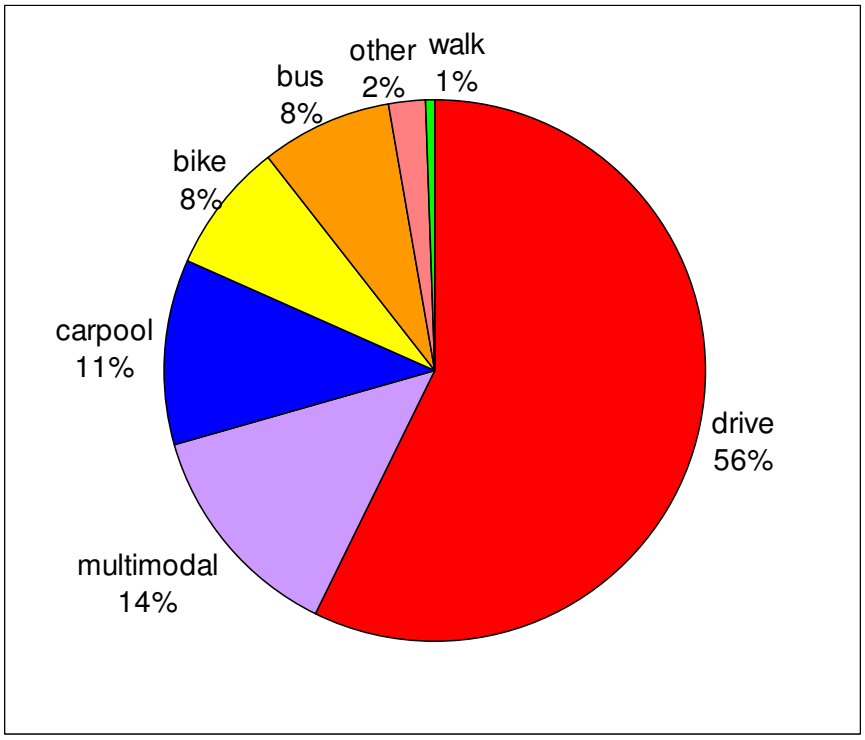
According to modeling using our survey data (Congleton 2008), the overall convenience of different choices largely determines their use by people, while collective considerations represent a significant yet much smaller fraction of determinants of the choice. Thus, the relative convenience of mode choices is incredibly important for achieving transportation policy goals. For this reason, **we recommend all relevant jurisdictions cooperate in a coordinated fashion to achieve a single long term goal: make the convenience of lower impact modes equal or greater to that of driving.** The collective public vision at each jurisdiction will determine how this can be accomplished, with the SACOG BluePrint Project being a principle example of how this vision can be constructed on a community-level within local jurisdictions. These jurisdictions include but are not limited to the federal government, the State of California (and the California Department of Transportation), regional Metropolitan Planning Organizations (the Sacramento Area Council of Governments is our local MPO), the University of California, Yolo and adjacent counties, the City of Davis, and UC Davis respectively.

8.4 The Future of the UCD Commute Carbon Footprint

Right now, near 50,000 metric tons of CO_2 per year, UC Davis probably has a smaller per capita carbon footprint than many other universities of its size in the US. This is in large part due to its high share of bicycle commuters (38% of total trips) and transit users (18%). The car-free campus, the bike infrastructure of the city, the incredible success of the student-run Unitrans local transit system, all are likely to contribute greatly to making the UC Davis mode split what it is. But as we saw in the last chapter on greenhouse gas emissions, the campus's commute carbon is a function of the distance people live from campus and the emissions per mile of their commute choice.

If we look at how *commute miles* are distributed by mode (Figure 8-2), rather than just *commute trips*, we find that **56% of the total commute miles to UC Davis are miles driven alone, with only 16% of total miles being traveled by bus or bicycle.**

Figure 8-2 Mode Split –in terms of miles traveled by mode at UC Davis



If we really want to reduce carbon emissions of the campus commute in the long term, we would do better to pay attention to increases in the percentage of *lower impact mode miles*, not just the percentage of lower impact mode *trips*, as a metric of our success. This provides a more accurate measurement of our success in reducing our collective carbon emissions from commuting.

Currently, over half of the commute miles to UC Davis are driven alone, 14% are multimodal, meaning that people use a combination of modes to get to campus[23], 11% are in carpools, and bike and bus are tied around 8% of overall miles, other and walking together account for the remaining 3%. What if taking the bus, riding the bike, walking the foot, and carpooling together accounted for 50% of total commute miles? What would that look like for the City of Davis and the campus? We leave it to the reader to imagine such a world. Right now, we live in a world where lower impact modes total to 28% of commute miles to UC Davis.

If we are to increase the share of lower impact mode miles, how are we to get from this world of 28%, to that potential world of 50% or more in the future? That question must be answered by the UC Davis community. We suggest the three different target areas in Table 8-1 as a starting point, and provide some beginning discussion points on these target areas below.

[23] In this survey, this includes train riders and UCD Medical Center and UCD-UCB shuttle riders, but it also includes people who drive a pickup truck to Davis and pull a bike out of the back and ride it onto campus. Further post-hoc research will distinguish between these different users in our survey, but we don't perform this above.

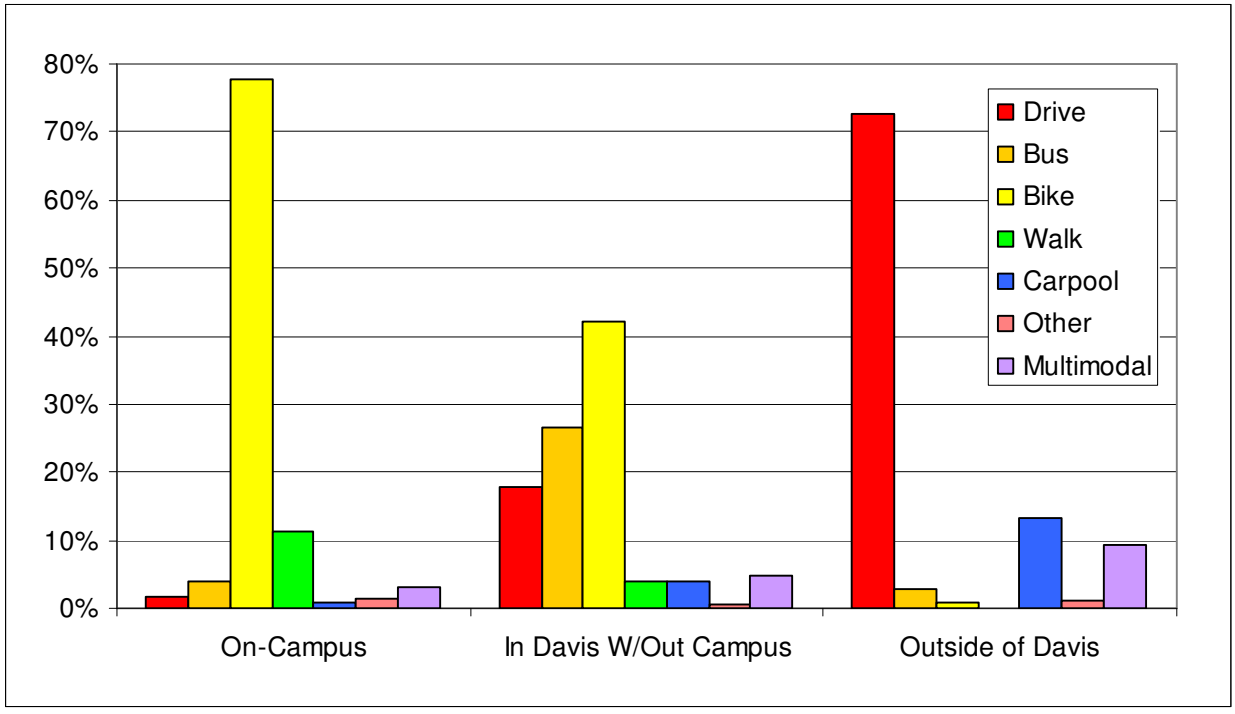
Table 8-1 Target Areas for Reducing Green House Gas Emissions and Potential Strategies

Targets	Possible Strategies
Get more people living within Davis, preferably close to or on-campus	• West Village project (UC Davis) • Incentives for residential infill projects downtown and in Central Davis (Davis) • Mileage-based Employee Relocation Incentives (UCD, SACOG, CA, Fed)
Get more people who live outside of Davis to use transit/carpool/vanpool instead of driving alone	• TAPS Individualized Marketing Programs (TAPS) • Increasing Partnership with Yolo Bus, SacRT, Amtrak, etc. (TAPS) • Aggressive Travel Demand Management (TAPS, Davis, SACOG) • Regional Lower Impact Mode Network Development (Yolo County, SACOG, DOT, Davis, Woodland) • Educational Programs on Travel Costs and Land-Use/Transportation • Increase walking and cycling access to transit (MPOs) • Bike Stations at Transit Centers (Davis, MPOs) • Increasing Regional Park and Ride Lots and Express Bus Service targeting UCD Travel Clusters (TAPS) • Increase Train Incentives to reduce train cost to that of auto (UC, TAPS) • Increase(Begin?) Funding of Educational and Promotional Programs (Federal government, State of California, UCD)
Get more people within Davis to walk/bike /bus	• Education/Training Programs (UCD, Davis, SACOG) • Cultural/Promotional Programs (UCD, Davis, SACOG) • Financial incentives (e.g. unlimited bus passes for employees and grad students) (UCD) • Reduced or complimentary parking passes for occasional drivers who bicycle (TAPS)

8.5 Get more people living within Davis, preferably close to or on-campus

Increasing the proportion of people who work and study at UC Davis and live in Davis or on-campus is an effective long-term strategy for reducing the University's commute carbon. Why? The competitiveness of LIMs increases as the distance between a traveler's residence and the main campus decreases. Since commute times within Davis are relatively similar for most modes (Remember from fig x that the commute times for driving, busing, biking, and walking, only vary from 12 to 18 minutes, respectively), other cost/benefit considerations can come into play besides time. Conversely, few considerations are as important as time when looking at options when travelers live further away from campus. Recalling Figure 3-6 (Duplicated in Figure 8-3, below), we can see the difference in the practical choices available to people based on where they live. This underscores the importance of distance from campus and the relative travel times of different choices available to community members.

Figure 8-3 Mode Split by Location



For most people who live outside of Davis, walking and cycling are not an option, although a surprising number of people still bike from outside of Davis to the campus (we estimate at least 40 people currently bike 7 miles or more from outside of Davis, including faculty, staff, graduate, and undergraduate students)[24]. What this means is that getting a greater proportion of UCD affiliates to reside on or near campus will translate directly into reducing the carbon footprint of the campus.

[24] See http://www.davisbicycles.org/ for information about a locally made film about bicycle commuting between Davis and Sacramento called "Zen and the art of Bicycle Commuting".

The UC's sustainable transportation policy pledges that UC Campuses will *"continue their strong commitment to provide affordable on-campus housing, in order to reduce the volume of commutes to and from campus. These housing goals are detailed in the campuses' Long Range Development Plans".* The West Village Project is a prime example of dense housing development right on campus, and along with additional dorm infill, will result in accommodating 97% of the anticipated student growth at UC Davis to 2016 right on campus. However, West Village will only accommodate 12.5% of anticipated staff growth at UC Davis as noted in Figure 8-1 above. Unless additional housing is provided on-campus or within Davis somehow, UC Davis affiliates will likely contribute to significant growth in transportation-related problems. This housing development could be driven by policy, whether incentives for residential infill projects downtown and in Central Davis, or whether UC Davis follows its sustainable transportation policy, not just with its growing student population, but also with their associated staff and research affiliates. Another strategy for the campus might be to create a mileage-based employee relocation incentive package. This would provide employees who commute the furthest to get to campus an incentive to move closer to campus, thus significantly reducing their commute distance. This program could also be done through SACOG or at state level in cooperation with other large employers in the region.

8.6 Get more people who live outside of Davis to use transit/carpool/vanpool instead of driving alone

Another strategy for reducing the carbon created by campus commuters is to get a greater proportion of people who live outside of Davis to carpool, vanpool, and take transit, including the train where applicable.

While 95% of those who live in Davis report they live near a bus stop, only 44% of those who live outside of Davis do. Unitrans only provides local service, so bus usage drops severely for affiliates who reside outside city limits. Besides the lack of availability for many people, another one of the reasons for this seems fairly straightforward. According to our survey, those who are able to take the bus to get to campus from outside of Davis have to travel times 1.7 times longer on average than if they had driven the same distance. This time cost likely prohibits most people from choosing anything but driving when they live far away.

The UC's official sustainable transportation policy states,

> "By January 2009, each campus will implement a pre-tax transit pass program to facilitate the purchase of transit passes by University employees, or will establish a universal access transit pass program for employees.", and campuses must "engage in advocacy efforts with local transit districts to improve routes in order to better serve student and staff ridership."
>
> --Policy Statement and Guidelines for Implementation

Just like within Davis, the competitiveness of regional lower impact mode options increases as the difference in travel time between a LIM and driving decreases. In the case of regional travel, this could be accomplished by transit with express service to UC Davis from common employee residence clusters. Using the geocoded data from this

survey, TAPS can identify clusters of campus commuters that could be served by a vanpool, express bus to campus, and/or regional park and ride lots for Amtrak and other transit. This information could be communicated with Yolo Bus, SacRT, Amtrak, SACOG, etc. to improve the coordination of services offered by these groups.

Another innovation that could be attempted is to initiate a morning carpool/vanpool "parade" where all carpools and vanpools could follow designated one-way routes through the central campus between 7am and 7:30am to drop off their members close to their place of work before the driver parks the vehicle. This makes sense in the morning because there is significantly less bicycle and foot traffic at this time, and the "door to door" service could make carpooling more competitive.

8.6.1 Aggressive Travel Demand Management

Another part of the UC's sustainable transportation policy's purpose is to *"Incorporate alternative means of transportation to/from and within the campus to improve the quality of life on campus and in the surrounding community."* Likewise, SACOG plans to invest in educational and promotional programs for Travel Demand Management to reduce the region's vehicle miles traveled by 10% (SACOG 2008). Travel Demand Management (TDM) is a huge field of strategies and techniques with various degrees of implementation in practice. UC Davis, the City of Davis, SACOG, and cities with UC Davis affiliates reside must determine what TDM measures are appropriate in their jurisdiction and how they are to be applied. At the same time, it is likely that coordination across/through these jurisdictions could play a key role in determining how successful any of them are. With these two ideas in mind, we present a number of TDM strategies that could be discussed within stake-holder communities for each jurisdiction.

Price commute options correctly

As a first step, get pricing information to travelers about social costs and benefits of different commute choices, as a second, the community can work towards moving policies so that actual prices of different commute choices reflect their true costs. While this means adjusting revenue streams for different modes and therefore different agencies responsible for their conveyance to campus (Unitrans~bus, TAPS~autos), these adjustments can be made incrementally over time so that large unpredicted changes can be avoided.

Increase Train Incentives to reduce train cost to that of auto

Train costs could be further reduced for UC affiliates and eventually included as part of a more general and integrated transit pass, just as UCD undergraduates can use their student IDs to take Yolobus. This makes sense for a number of UC, California State University, and Community College schools, as well as other large employers seeking to reduce their carbon footprint.

Fund Educational and Promotional Programs

For regions and cities, there has been a trend towards federal and state funding of "shovel ready" infrastructure projects rather than educational/cultural/market based approaches (Conversation with Tara Goddard, Nov. 2008). However, both the City of Davis and

SACOG have educational programs as goals, and UC Davis has several educational programs in nascent stages of development, some of which are in cooperation with Yolo County and the local police. These types of programs could have financial support at the state and federal level through the same process as infrastructure projects. These programs could educate the community about community-level problems in transportation, the external costs and benefits of their private travel choices, how to move to more sustainable lifestyles, etc. Programs could support trainings, events, and creative mass media such as films, theatre, and art more generally.

Individualized Marketing Programs
When people come to TAPS to purchase a long-term parking pass and provide their starting commute location and regular commute times (where applicable), TAPS can identify the nearest open carpools, vanpools, and transit routes to their home, thus beginning an individualized marketing process to enroll them in alternatives, monitor their satisfaction and use of these programs. This type of program allows for all parkers to be informed about programs, allows those disinterested to opt out with little cost or hassle, and those interested to learn more about and participate in programs. This type of program could also be performed at any workplace or location where parking is sold by a human representative.

8.6.2 Development of Lower Impact Mode Networks

SACOG, Yolo county, Woodland, Davis, and UC Davis are all working together to research the feasibility of a Neighborhood Electric Vehicle (NEV) path alongside the already planned bicycle path between Woodland and Davis. For Woodland commuters to UC Davis, NEVs are currently not an option, there is simply not a legal route to take a NEV between Woodland and Davis. In this respect, the proposed NEV route creates a new commute option, it provides people a new choice which they do not currently have.

For most Woodland commuters, the average travel distance is around 12.8 miles. Based on self-reported travel times, average travel time for Woodland commuters is 18 minutes, and the average travel speed would then be 44mph. If we assume that car drivers end up taking a NEV, and we then assume their average travel speed would drop to say, 20mph-24mph, and their average travel time to 32-39 minutes. While this is around double the commute time, it is still a fairly normal commute time for many people and still faster than taking the bus. It is not implausible that some will find the benefits of taking a NEV between Woodland and Davis to outweigh the saved travel time of driving on the freeway.

Separating regional and local travel
Without separation from fast heavy vehicles, walking, biking, and using NEVs will always be more dangerous on roads that prioritize the movement of cars and allow them to travel at speeds much higher than walking or biking speeds. The Lower Impact Mode Network (LIMnet) in existing cities is simply the collection of roads where legal travel speeds are 25 mph or less. Paying specific attention to such roads and the network they create between homes and activity centers, working to separate trunks of these networks from high speed arterials, and prioritizing LIM traffic where possible on these roads improves the local travel of LIM users. Most of Davis is a LIMnet already, although

there are notable exceptions, such as the 5th St. corridor. This corridor is perceived as dangerous and unpleasant to cross by many pedestrians and cyclists in Davis.

Without prioritizing and improving the safety and convenience of Lower Impact Vehicles, they will continue to present less private utility to the majority of travelers than their higher impact counterparts. We therefore recommend developing separate networks or even just designating a strategic subset of existing roads to prioritize LIMs, especially between residential streets and activity centers.

8.6.3 Implement Bike Stations at Transit Centers (Davis, MPOs)

The City of Davis has been discussing having a bike station, similar to stations in several cities across the U.S.[25], and has been actively researching this option but to date no bike station exists in Davis or on-campus. This station could be a place for secure overnight storage of bicycles, a place to purchase bicycle parts and accessories, receive and/or perform repairs, and could even teach bicycle repair to the public. It is likely to encourage more travelers to commute by bike and train rather than drive. Other cities along the Capitol Corridor route could consider doing the same, including Sacramento, Fairfield/Suisun, Martinez, Richmond, and Berkeley.

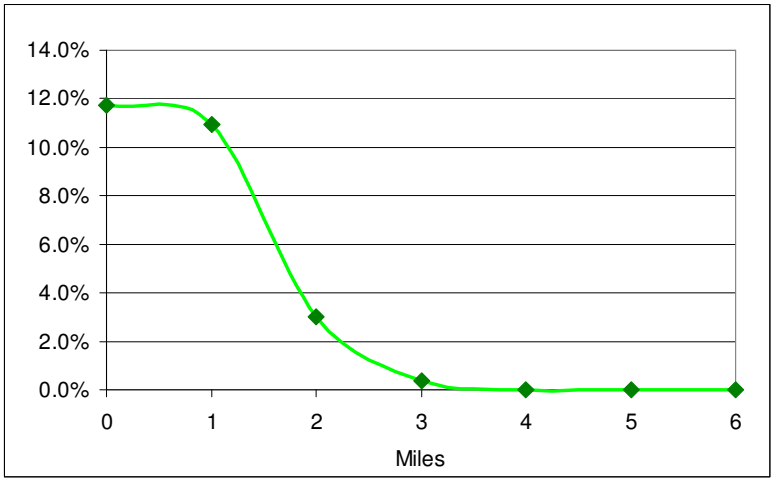
8.7 Get more people within Davis to walk/bike/bus

We saw that living within Davis significantly increases the competitive edge of lower impact modes. Yet even within Davis, distance has a strong role to play.

Walking

A five minute walk for most people is about a quarter of a mile. UC Davis has many pedestrians that walk much further than a quarter of a mile to get to work or classes on campus, but none indicated that they walk more than 3 miles from campus. The walking modesplit is highest on campus, at almost 12%, and remain relatively high right off campus, then quickly drops off above a mile away.

Figure 8-4 Percentage of Travelers Walking by Distance from Campus



[25] the nearest one being at the Downtown Berkeley BART station.

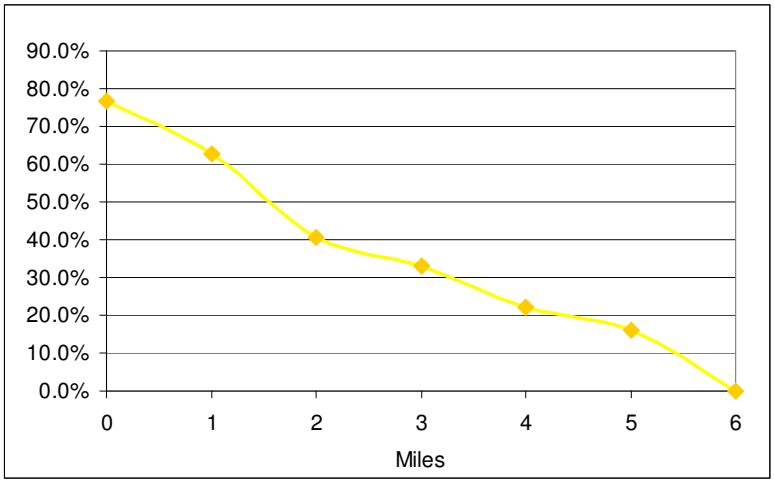
This means that the more people who live within a mile of campus, the greater the share of trips by walking will be overall. Denser housing close to campus would accomplish this.

8.7.1 Education/Training Programs

Bicycling

For cyclists, we see from Figure 8-5 that the share of biking trips is highest on campus at over 75%, and the percentage drops about 12% for every mile away from campus, almost linearly.

Figure 8-5 Percentage of Travelers Biking by Distance from Campus



In our introduction, we noted that bicycling has declined in the city in recent years. The Bicycle Plan for the City of Davis has recently been updated with a new goal of increasing bicycle trips within the City of Davis to 25% of all trips by 2012 (Davis 2008). In addition, education has been identified as an important goal of the city: "It is apparent that the City of Davis must still continue to work hard, particularly by education and encouragement to increase the level of bike ridership if it is to remain 'America's Best Cycling City.'" (Bicycle Advisory Commission and Public Works Department 2006) [p3]. Another goal includes maintaining "an education program to promote bicycle use and safety," and investigating "development and promotion of a monthly 'riding tips' clinic aimed at new riders." (Bicycle Advisory Commission and Public Works Department 2006) [p6]. Most of the new riders coming into Davis every year appear in September, about 5,000 of them on average. Most of them have bikes, and no formal training on how to use or maintain one, and most of them will leave UC Davis within four to five years, still with no training on how to safely use or maintain a bicycle.

Our survey showed that **freshmen have the highest cycling rate at almost 75%, and it appears that this may decline by over 40% by the time they begin the new school year as sophomores**. If so, this is a huge attrition rate! This phenomenon is worth investigating more in the future and points very clearly towards the need for a cycling training and maintenance program during the freshmen year, perhaps even a UC Davis

"core class" in the first quarter of enrollment about safe cycling and basic bike maintenance. Of those students that stop riding their bicycles before or during their sophomore year, common reasons the author has heard include having their bike stolen or having their bike "stop working". Hundreds of bikes are abandoned annually on campus, in city bicycle parking, or stashed behind a bush somewhere in Davis.

Additionally, as seen in Figure 4-2, drivers, bus users, and walkers feel less skilled at riding bikes than those who bike regularly to campus do. This raises the question, if there were classes offered on how to safely ride a bicycle on-campus and within Davis, would more people use bicycles to get to campus? Further, would the 75% of freshmen who are riding between classes remain cyclists for the duration of their stay at UC Davis if they were provided training on how to cycle effectively on regular roads off-campus, provided with ASUCD-subsidized rain gear, a rear bike rack, and waterproof bike bags that could carry their books, laptop, and other gear? A small research study answering this question would be very useful.

Also, while our survey did not ask about bicycle maintenance issues, anecdotal evidence over eight years points towards the hypothesis that a lack of training in both the use and maintenance of the bicycle is partly responsible for the attrition rate between the freshman and sophomore year. Many students stop riding their bikes at the first major maintenance issue, whether a flat tire, a stuck brake, or a warped wheel, either as freshmen, or sophomores. It also seems that in this process their attitude towards biking may change negatively also. This could be studied and understood more clearly in the future, but perhaps more expediently, it could be avoided through education and training.

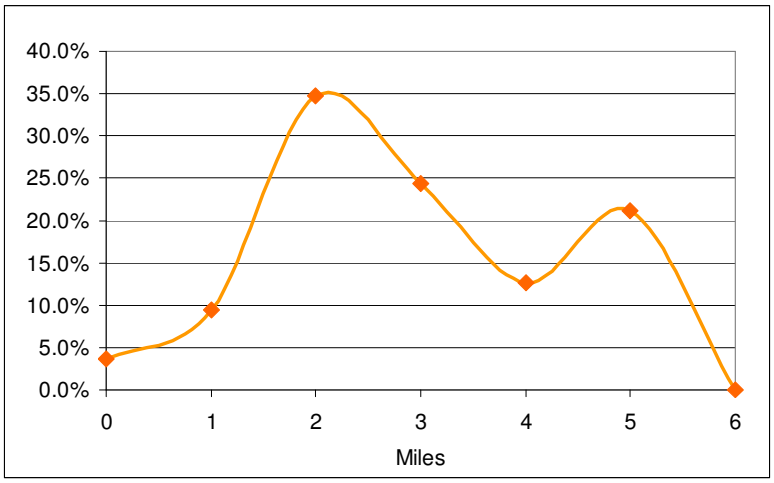
The scope of teaching around 5000 new people how to safely ride a bicycle is well within the abilities of an educational institution like UC Davis. The American League of Bicyclists Road I training course takes about 9 hours, and the recommended number of students in a class is 10, so that means the teaching load for instructors is about 1 hour and 7 minutes of training per student, and for 5000 students, that's 5556 hours. This translates to about 14 full-time cycling instructors during the fall quarter in order to meet the demand. This could easily be translated into 28 part-time student jobs(at $10/hr), all of whom would become certified League Instructors, at an estimated annual cost well under $60,000, and possibly as low as $30,000 (If class sizes were doubled; the American League of Bicyclists is flexible on class size for institutions), costs could be cut up to half.. If funded through ASUCD, this program, **educating all freshman about how to ride a bike safely and make basic roadside repairs, would be an additional annual cost of around $1.25-$2.50 per student**, and seems likely have a tremendous impact on campus modesplit.

This discussion points towards the need for an **on-campus learning center, possibly student-run, training students and community members how to safely operate their bicycles, and additionally how to repair their bicycles.** This center could also organize and oversee a large training program for incoming freshmen every fall. Why does the bicycle campus in the "bicycle city" not have such a program already?

Unitrans Bus Ridership

For bus, the peak usage is at around two miles, and another peak occurs at 5 miles from campus via the road network. Geographic analysis needs to be done to see more clearly where these trips originate from, but it is clear that the bus is only a minor threat to walking and bicycling within a mile from campus.

Figure 8-6 Percentage of Taking the Bus by Distance from Campus



The UC's official sustainable transportation policy states,

> "By January 2009, each campus will implement a pre-tax transit pass program to facilitate the purchase of transit passes by University employees, or will establish a universal access transit pass program for employees." --Policy Statement and Guidelines for implementation

It is unclear what impact this policy will have at UC Davis. It will be interesting to monitor staff bus ridership after the policy change.

8.7.2 Cultural/Promotional Programs

The campus and the city already have a number of successful events both annually and more intermittently that celebrate, encourage, or otherwise help people to use lower impact modes, especially the bicycle. However, few of these existing programs specifically target people who currently drive. The campus could provide bike buddy programs where experienced bike commuters were partnered with a neighbor less skilled and/or less seasoned who wanted to commute by bike, simply by providing an online matching system similar to the current rideshare program provided by TAPS. This "bikeshare" program could be advertised and assembled effectively during the Sacramento Region's Bike Commute Month (during May), in addition to simply being available year-round. Additionally, the alternative transportation coordinator at TAPS, the bicycle coordinator, and student environmental and transportation groups can cooperate more closely on specific campaigns. One example in which this has worked well in the past was to have student volunteers table in front of parking structures to earn pledges of drivers to not drive at least one day during the month of May. This type of program can **focus on voluntary changes by those who can have the greatest impact on transportation problems**, single occupancy drivers, especially those living outside of Davis. It also puts interested drivers directly in touch with those who have the information and support they need to experiment with not driving, whether for a single day, or as a more permanent lifestyle goal.

9 Appendix II: Differences between the Spring '07 and Fall '07 Surveys

Spring 07					Fall 07					
Section	Question number	Content	Version Applied (e/s, blank=both)	Type	Section	Question number	Content	Version Applied (ne/ns, blank=both)	Type	Other Changes/ Comments
2.0 Available Travel Options	2.0	Regular Travel to Campus?	s	Y/N	2.0 Available Travel Options	2.0	Regular Travel to Campus?		Y/N	
	2.0.1	Boilerplate (No need to complete survey if N on 2.0)		-		2.0.1	Boilerplate (No need to complete survey if N on 2.0)		-	
	2.1	Number of working motor vehicles		MC		2.1	Number of working motor vehicles		MC	
	2.2	Live on campus?	s	Y/N		2.2	Live on campus?	ns	Y/N	
	2.3	Bus service nearby?		MC		2.3	Bus service nearby?		MC	
	2.4	Distance of commute		Num		2.4	Distance of commute		MC	
	2.4.1	Name of on-campus residence	s	Num		2.4.1	Name of on-campus residence	ns	Num	
						2.5.0	Screener for 2.5.0a		Y/N	
	2.5	Special conditions		MC		2.5.0a	Special conditions		MC	
	2.5.3	Accommodation suggestions		Text						
3.0 Your most recent week of travel between home and the UC Davis campus	3.0.0	Boilerplate for Section 3.0		-	3.0 Your most recent week of travel between home and the UC Davis campus	3.0.0	Boilerplate for Section 3.0		-	
	3.0.1	Form(s) of travel used last week [switch board for conditional questions]		MC (Multiple Answer)		3.0.1	Form(s) of travel used last week [switch board for conditional questions]		MC (Multiple Answer)	Eliminates "motorcycle" and "train"
	3.0.1.1	Time of Travel (peak or non-peak?)		MC array		3.0.1.1	Time of Travel (peak or non-peak?)		MC array	Eliminates "Saturday" and "Sunday"
						3.1.1.2	Multi-modal?		Y/N	Now condition for 3.0.1.4 to show up
	3.0.1.2	Form of travel by day		MC array		3.0.1.2	Form of travel by day		MC array	Eliminates "Saturday" and "Sunday"
	3.0.1.3	Reason for not traveling to work	e	MC array		3.0.1.3	Reason for not traveling to work	ne	MC array	Eliminates "Saturday" and "Sunday"
	3.0.1.4	Details of multi-modal travel		Text		3.0.1.4	Details of multi-modal travel		Text	
	3.0.1.5	Number of trips avoided through telecommuting	e	Num		3.0.1.5	Number of trips avoided through telecommuting	e	MC	
	3.0.2.4	Length of commute time		Num		3.0.2.4	Length of commute time		MC	
	3.0.5	Primary work/first class location		Text		3.0.5	Primary work/first class location		Text	
	3.0.6.0-3.0.6.4	Commute time estimation for various forms of travel		MC						
3.1 Driving	3.1.2.1	Carpool Size		Num	3.1 Driving	3.1.2.1	Carpool Size		MC	
	3.1.3	Type of motor vehicle		MC						
	3.1.3.1	Alternative vehicle		MC		3.1.3.1	Alternative vehicle		MC	Eliminates "Other"
	3.1.4	Gas mileage		Num						
3.1b Parking	3.1.5	Drop-off location		MC		3.1.5	Drop-off location		MC	
	3.1.6	Specific location (Parking lot Number/Street&Cross-Street)		Text		3.1.6	Specific location (Parking zone, with zone map)		MC	Shows up only when answered "on-campus" on 3.1.5
	3.1.7- 3.1.8	Maps of Parking Location on Campus		-						
3.2 Biking	3.2.3	Type of bike		MC	3.2 Biking	3.2.3	Agree/Disagree Statement on biking constraints		5-pt scale array	
	3.2.4	Brand of bike		Text		3.2.4	Level of Impact of dress code on biking		6-pt scale	
	3.2.5	Bike gear(s) used		MC (Multiple Answer)		3.2.5	Bike gear(s) used		MC (Multiple Answer)	
	3.2.6	Incidents of bike stolen		Num		3.2.6	Level of safety on various bike facilities		5-pt scale array	
						3.2.7	Incidents of bike accidents		MC	
						3.2.9	Level of Impact of various programs on Biking		6-pt scale array	
3.3 The Bus				MC (Multiple Answer)	3.3 The Bus				MC (Multiple Answer)	
	3.3.4	Bus system(s) used				3.3.4	Bus system(s) used			Eliminates "Other"
	3.3.5	Bus route(s) used		Text						
3.5 The Train	3.5.2	Train station where commute begins		Text						
3.7 Errands	3.7.1	Type(s) of routine errands		MC (Multiple Answer)	3.7 Errands	3.7.1	Screener for 3.7.1.1		Y/N	
	3.7.1.1	Frequency of running errands		5-pt scale array		3.7.1.1	Frequency of running errands		5-pt scale	No distinction on errand types
6.0 Travel during your work day/ average day on campus	6.0	Frequency of travel during workday/ on campus		5-pt scale	6.0 Travel during your work day/ average day on campus	6.0	Frequency of travel during workday/ on campus		5-pt scale	Now a condition for 6.1 to show up (except answering "Not at all")
	6.1	Form(s) of travel used during workday/ on campus		MC (Multiple Answer)		6.1	Form(s) of travel used during workday/ on campus		MC (Multiple Answer)	
	6.3.3	Keep bike at work/ on campus?		MC		6.3.3	Keep bike at work/ on campus?		Y/N	Eliminates "I don't know"
	6.6	Frequency of purchasing single-use parking permits		5-pt scale		6.6	Frequency of purchasing single-use parking permits		5-pt scale	
	6.7	Purchased long-term parking permit this year?		MC		6.7	Purchased long-term parking permit this year?		Y/N	Eliminates "I don't know"
	6.7.1	Type of parking permit purchased		MC		6.7.1	Type of parking permit purchased		MC	
					7.0 Campus Transportation Programs	7.4.0	Knowledge of TAPS related programs		MC array	
						7.4a – 7.4b	Opinion on two specific TAPS programs		MC	
						7.4c	Other TAPS programs used, but not listed		Text	
					7.1 Social Aspect of Travel				MC/MC (Multiple	
						3.8.1	Type(s) of people who know about your travel pattern		Answers)	Mixed-up between ns and ne
						3.8.2	Number of known person who travel with you		Num	
						3.8.3	Household members who travel with you		Num	
7.1 Your Views on Travel Choices	7.1.1	Level of convenience in using various forms of travel		6-pt scale array						
	7.1.2	Level of safety in using various forms of travel		5-pt scale array						
	7.1.4.1.1	Level of stress in using various forms of travel		5-pt scale array						
	7.1.4.1.2	Level of excitement in using various forms of travel		5-pt scale array						
	7.1.4.2	Reasons of inconvenience in alternative forms of travel		Text						
	7.1.5.0	Boilerplate for 7.1.5.1- 7.1.9		-						
	7.1.5.1	Would try bus service if available		5-pt scale						
	7.1.6- 7.1.9	Level of pride in using various forms of travel		5-pt scale						
7.2 Your Community, UC Davis, and Potential Policies	7.2.1	Boilerplate for 7.2.1b- 7.2.1j		-						
	7.2.1b – 7.2.1j	Agree/Disagree Statement on travel options and views		5-pt scale						
	7.2.1.k	Policy Suggestions		Text						
	7.2.3.1	Advocacy for form(s) of travel		MC (Multiple Answer)						
	7.2.3.1.1	Advocacy activity/activities		MC (Multiple Answer)						
7.3 Your Views on Potential Transportation Problems		Level of Concern for various transportation related			7.2 Your Views on Transportation Policies and Issues	7.3.1	Screener for 7.3.1a		Y/N	
	7.3.1	issues		5-pt scale array		7.3.1a	Level of Concern for various transportation related issues		4-pt scale array	Eliminates "Not sure what it is"
	7.3.2	Additional Issue not listed		Text						
	7.3.3	Perceived Impact of Personal Action		5-pt scale array		7.3.3	Screener for 7.3.3a		Y/N	
						7.3.3a	Perceived Impact of Personal Action		5-pt scale array	
	7.3.4	Perceived Impact of Collective Action		5-pt scale array		7.3.4	Screener for 7.3.4a		Y/N	
						7.3.4a	Perceived Impact of Collective Action		5-pt scale array	
						7.3.5	Additional Issue not listed		Text	
						7.20.1k	Policy Suggestions		Text	
7.4 Your Views on Others and Governance	7.4.1	Agree/Disagree Statement on governance		5-pt scale array						
	7.4.2	Environmental Protection vs Economics		MC						
8.0 Demographic Information	8.1	Household Size		Num	8.0 Demographic Information	8.1	Household Size		Num	
	8.2	Breakdown of age group in household		Num		8.2	Breakdown of age group in household		MC array	Further breaks down to child, youth, teenager, adult, elderly.
	8.2.1	Number of employed adults		Num		8.2.1	Number of employed adults		MC	
	8.3	Gender		MC		8.3	Gender		MC	Adds "Other"
	8.4	Age		Num		8.4	Age		Num	
	8.4.1	Ethnicity		Text		8.4.1	Ethnicity	ne	Text	
	8.5	Driver license?		Y/N						
	8.6	Year(s) employed/studied at UC Davis		Num		8.6a	Primary Role in UC Davis		MC	Difference answer choices between ns and ne
						8.6a.1	Transfer student?	ns	Y/N	
						8.6b	Year(s) employed/studied at UC Davis		Num	
						8.6c	Have a Campus Email Address? (Switchboard for 8.6d and 8.6e)		Y/N	
						8.6d	UC Davis Email Address for contact		Text	
						8.6e	UC Davis ID Number for contact		Text	
	8.7	Local Residence ZIP		Num		8.7	Local Residence ZIP		Num	
	8.8	Local Residence Address (Street&Cross-Street)		Text		8.8	Local Residence Address (Geocode or Street&Cross-Street)		Interactive map or text	
	8.10	Type of Housing		MC						
	8.11	Own/Rent		MC		8.11	Own/Rent	ne		
	8.12	Highest Level of Education		MC		8.12	Highest Level of Education	ne	MC	
	8.13	Percentage of Income Spent on Housing and Travel Cost		MC						
	8.14	Total Household Income		MC		8.14	Total Household Income	ne	MC	
9.0 Choose Your Incentive	9.1	Choose your incentive		MC	9.0 Choose Your Incentive	9.1	Choose your incentive		MC	
	9.2	Interested in Survey Results?		Y/N		9.2	Interested in Survey Results?		Y/N	
	9.3	Interested in Follow-up Research?		Y/N		9.3	Interested in Follow-up Research?		Y/N	
	9.4	Comments for survey		Text		9.4	Comments for survey		Text	

10 References

Bicycle Advisory Commission and Public Works Department, C. o. D. (2006). City of Davis Comprehensive Bicycle Plan. C. o. D. B. A. C. a. t. C. o. D. P. W. Department. Davis, CA, USA, City of Davis.

Buehler, T. (2007). Fifty Years of Bicycle Policy in Davis, CA. Institute of Transportation Studies. Davis, UC Davis. **MS:** 159.

Congleton, C. (2008). The Collective Calculus of Mode Choice: Are Drivers Free-Riding on Lower Impact Modes? Davis.

Davis, C. o. (2008). Minutes of the City of Davis Bicycle Advisory Commission, Monday, June 16, 2008. P. Works. Davis, CA, USA.

Deakin, E. a. C., Robert (2008). The Challenge of Urban Transportation in California. Access, University of California Transportation Center. **32:** 10-17.

Finkel, S. E. E. N. M. K.-D. O. (1989). "Personal Influence, Collective Rationality, and Mass Political Action." The American Political Science Review **83**(3): 885-903.

Gibson, J. L. (1997). "opposition to the Soviet putsch of August 1991: Collective action, rational choice and democratic values in the former Soviet Union." American Political Science Review **91**: 671-684.

Henrich, J., R. Boyd, et al. (2005). ""Economic Man" in cross-cultural perspective: Behavioral experiments in 15 small-scale societies." Behavioral and Brain Sciences **28**(06): 795-815.

Horton, D. (2006). "Environmentalism and the bicycle." Environmental Politics **15**(1): 41 - 58.

Klandermans, B. (1984). "Mobilization and participation: Social-psychological expansions of resource mobilization theory." American Sociological Review **49**: 583-600.

Langeland, A. (2007). "Sustainable Transport in Davis." World Transport Policy & Practice **13**(2): 8-22.

Lubell, M. (2002). "Environmental activism as collective action." Environment and Behavior **34**(4): 431-454.

Lubell, M., A. Vedlitz, et al. (2006). "Collective action, environmental activism, and air quality policy." Political Research Quarterly **59**(1): 149-160.

Lubell, M., S. Zahran, et al. (2007). "Collective Action and Citizen Responses to Global Warming." Political Behavior **29**(3): 391-413.

Mohr, K. (2008). Planning for Growth: People (projected growth at UCD from 2001-2016). C. Congleton. Davis, CA.

Moritz, W. (1997). "Survey of North American Bicycle Commuters: Design and Aggregate Results." Transportation Research Record: Journal of the Transportation Research Board **1578**(-1): 91-101.

Muller, F. S. E. E. N. (1998). "Rational Choice and the Dynamics of Collective Political Action: Evaluating Alternative Models with Panel Data." The American Political Science Review **92**(1): 37-49.

OECD (1996). OECD Proceedings: Towards Sustainable Transportation. Towards Sustainable Transportation, Vancouver, British Columbia, OECD.

Pucher, J., C. Komanoff, et al. (1999). "Bicycling renaissance in North America?: Recent trends and alternative policies to promote bicycling." Transportation Research Part A: Policy and Practice **33**(7-8): 625-654.
SACOG (2008). Metropolitan Transportation Plan for 2035. S. A. C. o. Governments. Sacramento, CA, Sacramento Area Council of Governments**:** 1.1, 11.6, 11.7, 11.9, 5.6.
Sjostrom, O. and D. Holst (2002). "Validity of a questionnaire survey: response patterns in different subgroups and the effect of social desirability." Acta Odontologica Scandinavica **60**(3): 136 - 140.
Sterngold, A., R. H. Warland, et al. (1994). "Do Surveys Overstate Public Concerns?" The Public Opinion Quarterly **58**(2): 255-263.
TAPS (2002). Long Range Access Plan Options Study. Davis, CA, Transportation and Parking Services, UC Davis.