Effectiveness of Green Commuter Incentives at UCDMC

2016 SURVEY RESULTS

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Commuting CO_2 Emissions at UCDMC

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1 Introduction

The University of California, Davis Medical Center (UCDMC) in Sacramento has a large population of commuters, resulting in significant annual carbon emissions. The population of the campus is approximately 13,500, most of which commute via personal occupancy vehicle (POV). The goal of this report was to determine the effectiveness of the incentives offered by the Green Commuter Program (GCP) at changing the commute mode of UCDMC affiliates. We distributed a survey among GCP participants and the results were used to calculate the CO_2 reduction as a result of the incentives program. Given the budget of the program, this will allow calculation of $kgCO_2$ averted/$.

The need for this analysis rose from the issue that simply counting members of the GCP did not necessarily mean a reduction in commuting CO_2 emissions. It was entirely possible that the majority of the members of the program were already 'green commuters' who simply signed up for the program to make the transit passes they were already buying cheaper. Or maybe they were already cycling to campus, but signed up for the program for the free parking permits so they could drive to campus on rainy days. But the true goal of the program was to 'convert' those who drive alone into carpoolers or bikers or convince them into taking public transit.

There were two possible ways to evaluate which, or what combination, of the above to scenarios was taking place. The first, and ideal, way would have been to take a campus wide travel survey with a reasonably high response rate before the implementation of the program. Note that the UCDMC travel survey from 2014 had a response rate of 32% [4]. Then kickoff the GCP, and perform surveys of campus again to determine any changes in mode share of green commuting methods. This would likely need to be done over several years, as it may take time for people to become aware of the program.

The second method, and the way that was done here, was to distribute a survey to those in the GCP, and ask them how the program has changed their commuting behavior [Appendix 7.2]. The inherent issues with asking program members about the program, is that they may be more likely to say that the program got them to switch, such that program coordinators believe that the program is more effective and keep subsidizing their transit passes. However, since many respondents did not switch their transportation mode, the results of the survey suggested that *most* of the respondents were likely being honest, so this effect was neglected.

1.1 The Green Commuter Program

The Green Commuter Program at UCDMC is a combination of several incentives to entice commuters to consider alternate modes of transportation [1]. The goal of the program is to reduce the carbon footprint of the UCDMC by reducing the number of vehicles on the road. The program includes those commuters who are willing to commute by carpooling, Sacramento Regional Transit (RT), UCDMC shuttles, Amtrak, ZipCar, vanpools, walking, or biking.

1.1.1 Carpools

For those who commute by carpool at least 3 days a week, discounted parking permits are available. The minimum number of people in a carpool is 2, and at least one of them must be an affiliate of the UCDMC. Non-UCDMC affiliates are allowed to count towards a carpool if their commute destination is within five miles of the UCDMC.

For carpools with 3 or more members, access to special "CP3" parking spots on campus is granted. This is a strong incentive for this community due to limited parking availability near the inner campus buildings. All carpoolers are given a free Temporary Ride Share Permit, which allows them to dive alone to campus 24 times per fiscal year [1]. Should they desire, this permit can be 'refilled,' at a cost, once with an additional 24 uses [2].

Additionally, carpoolers can enroll, at no cost, in the Guaranteed Ride Home Program, which allows them six free rides home per year in case of emergencies. This includes, but is not limited to: the carpooler or a family member becomes sick, the carpool driver left or the carpooler was unable to leave at the regular time, etc. [2]. The method of the ride home is a function of the commuter's distance from campus. Should they live less than 20mi from campus, a taxi will be provided, otherwise a rental car will be provided.

1.1.2 Vanpools

Vanpools are organized through Enterprise Vans and paid for by the vanpoolers, but each person in the vanpool receives a $65 monthly subsidy on the cost of the van. The cost of the van is a function of the distance it is driven. To start a vanpool requires that six or more employees of UCDMC commute together from at least 15 miles from campus and all six must live in neighboring zip codes. As with carpools, they must commute at least three times a week.

1.1.3 Transit (Shuttle, Sacramento RT, and Amtrak)

The UCDMC provides a shuttle service that operates both intra-campus and inter-campus. There are several lines for traveling around campus as shown in Figure 1. As shown, the Green Line also stops at a light rail stop to connect to Sacramento Regional Transit (RT). There is also a shuttle service connecting the UCDMC to the main UC Davis campus in Davis, CA. The previous report showed that the vast majority of commuters who utilize the shuttle as their primary commute mode take the inter-campus shuttle from UC Davis. Commuters who take the shuttle are offered similar benefits to those who vanpool.

RT and Amtrak monthly passes are both discounted at $65/month. The RT monthly pass, at the time of writing, cost $100 per month, making this a 65% subsidy. Amtrak passes vary in price depending on the commute length, but the subsidy is a smaller percentage of the cost of the Amtrak pass. Those who sign up for the GCP for taking transit are also offered a Rideshare Permit which allows them to drive alone 24 times per fiscal year.

1.1.4 All Green Commute Mode Benefits

Regardless of the commute mode, so long as it is not 'drive alone', UCDMC affiliates can join the GCP. The benefits for all include the 24 day Rideshare Parking permit which allows parking in any "B" parking spot. Emergency rides home are guaranteed six times a year for whatever the user may consider an urgent need for a ride home. Depending on the distance from campus, they will either be given a taxi pass, or a rental car. Additionally, members of the program can register for the ZipCar program for free,

but still need to pay for the use of the vehicles. Green Commuters can register with the Sacramento Regional Commuter Club [sacregioncommuterclub.org], which allows them to log their commutes for a chance to win various prizes including gift cards.

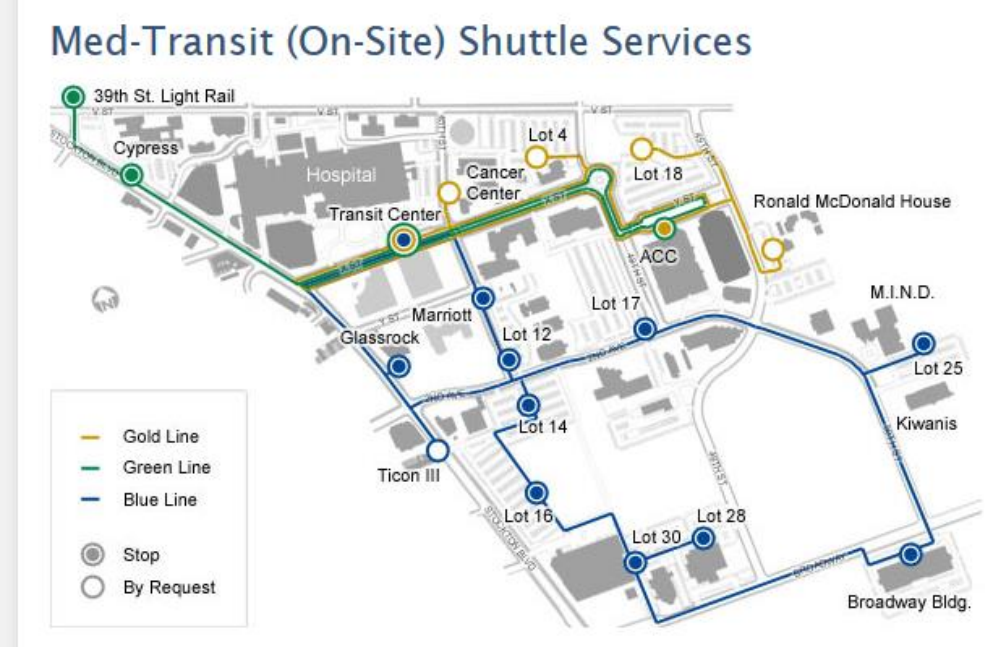

Figure 1: Map of the on campus shuttle service at UCDMC [3].

2 Methodology and Data Analysis

2.1 Assumptions

Despite noting that respondents might have a reason to overstate the program's effectiveness, it was assumed that respondents were honest. Some justifications for this were found in the responses. 8% of the green commuters admitted that driving alone was their primary method of commuting, which they are not supposed to do. Additionally, more than half of them said that the program does not influence their commute mode.

We also assumed that the survey respondents are representative of all GCP members, i.e. the results obtained with the survey would be the same if all GCP members responded to it.

2.2 Methods and Analysis

2.2.1 The Survey

Data for the analysis was collected by a survey (shown in appendix 7.2) that was distributed to members of the Green Commuter Program by an email listserv. The email sent to the program members (appendix 7.1) gave the recipients notice of what to expect from the survey, and informed them that they would be offered the chance to win one of ten $20 Amazon.com gift cards for their participation. This email was modeled after the email used by the UC Davis Institute for Transportation Studies to solicit replies to the UC Davis Campus Travel Survey [5].

The survey itself consisted of 11 questions (including the 'feedback' and email address requests). The question at the end of section one asked the respondents if the GCP affected their commute mode.

Depending their answer to this question, they were directed down one of two paths of the survey, making the number of questions that any individual responder would need to answer 9 at most. The goal was to keep the survey short so people would be more likely to complete it. Based on the number of parking permits distributed through the Green Commuter Program, there were 1528 members of the program, 327 of which responded to the survey, a 21% response rate, higher than the response rate achieved by the UCD ITS Campus Travel Survey [5]. This may not be surprising since those who signed up for the GCP may be more engaged commuters than average, resulting in them being more likely to respond to the survey.

2.2.2 Survey Response Analysis

The responses from different groups at UCDMC are shown in Table 1. Response rates for each group were not calculated, since it was unknown how many of each group were actually members of the GCP.

Role	*# @ UCDMC*	*% of UCDMC*	*% of Responses*
Faculty	**1506**	**11.3%**	**7.3%**
Staff	**10155**	**76.2%**	**74.6%**
Student	**800**	**6.0%**	**10.5%**
Other	**872**	**6.5%**	**7.6%**

Table 1: Percent of responses and % of total population for people with various roles at UCDMC.

Responses were validated manually by sorting them to catch those who provided inconsistent answers. An example of this includes 11 bikers, 7 carpoolers, 7 who listed driving alone, 1 vanpooler, and 2 walkers who said that the GCP changed how they commute, yet listed the same commute mode both before and after the program. Based on some of their responses to the question "*What incentive was your primary motivation to switch commuting modes?"*, it seemed likely that they had actually changed their commute mode, but misread the question, so picked the same commute mode twice. Still, these responses did not provide useful information, so were disregarded in evaluating the effectiveness of the GCP.

The non-multiple-choice answers were manually grouped with similarly intentioned statements. Questions that required this treatment included:

1. What incentive was your primary motivation to switch commuting modes?
2. What incentive was your primary reason for joining the program?
3. If you drive alone, what incentive would make you consider other modes?
4. Suggestions for Improvements to the Program
5. Feedback

Also, if respondents did not pick one of the canned responses for their commute mode, they had the option to input a commute mode, these were also manually changed to allow for better sorting. For example "UCD/UCDMC Shuttle" and "Campus Shuttle" were both changed to "Shuttle".

After cleaning up the data, travel distance distributions were taken found for those who said the GCP changed their commute mode and for those who said that it did not change their commute mode. The commute distances reported were binned into the bins [1, 2, 3, 5, 7.5, 10, 15, 25, 30, 40, 50] using Matlab R2014a. The goal was to determine if the GCP was more or less effective and convincing people to change their commute mode based on how far from campus they were.

Another survey (the campus travel survey (CTS)) was previously distributed by Nelson/Nygaard Consulting Associates to all campus population groups with a response rate of 32%. The survey consisted of 18 questions related to survey respondent travel to/from campus. Responses our survey were compared to the CTS [4] in the results section.

2.2.3 CO_2 Calculations

To determine the reduction in CO_2 emissions at UCDMC thanks to the Green Commuter Program, a baseline and final case were needed. The baseline case was given by the respondents who said that they switched due to the incentives offered by the program, and the commute mode they said they did/would have used if the program did not exist. The current, reduced CO_2 emissions were calculated, again only from those who said they switched commute modes, but using the transportation mode they said they switched to.

Calculations were done using the same sets of parameters used for the general UCDMC analysis done previously. Each respondent's reported commute distance was multiplied by $kgCO_2$/gal fuel and divided by fuel economy then multiplied by the commute days per year, and by 2 to account for commuting home. The difference between the before and after GCP cases was the commute mode, and hence the MPG, and depending on the mode, the number of people in the vehicle. The results were scaled to the fraction of the respondents who said that the GCP had influenced their commute mode, and then scaled again based on the survey response rate to match the total GCP population.

3 Results

3.1 Overall Conversion Effectiveness

After weeding out the ambiguous answers, the fraction of those who said that they had changed their commute mode to a greener method as a result of the GCP was 37%. Given the population of the GCP, this was 560 commuters. However, this is not very enlightening in terms of determining how effective the GCP was at reaching its goal of reducing CO_2 emissions. If everyone switched to carpooling, this would mean that the 560 commuters were producing 280 commuters worth of carbon. But if they all switched to biking, they would have completely eliminated the carbon footprint of all 560 of them. To determine this, we needed to know what mode of transportation those who switched would have used if not for the GCP.

3.2 Mode Split Changes

Using the 37% of respondents who indicated that they had changed their commute mode, the fraction of them that switched from/to each mode was calculated. Figure 2 shows how, of those who changed their commute mode, how the commute modes changed. For the lines showing no change in commute mode, this indicates that the person changed between modes in a category. For example, changing from bus to light rail. Table 2 shows the percentage of those who switched, who switched to each mode.

Bike	Transit	Shuttle	Carpool	Walk
28%	28%	2.5%	38%	3.4%

Table 2: Percentage of those who switched modes who went to the indicated mode.

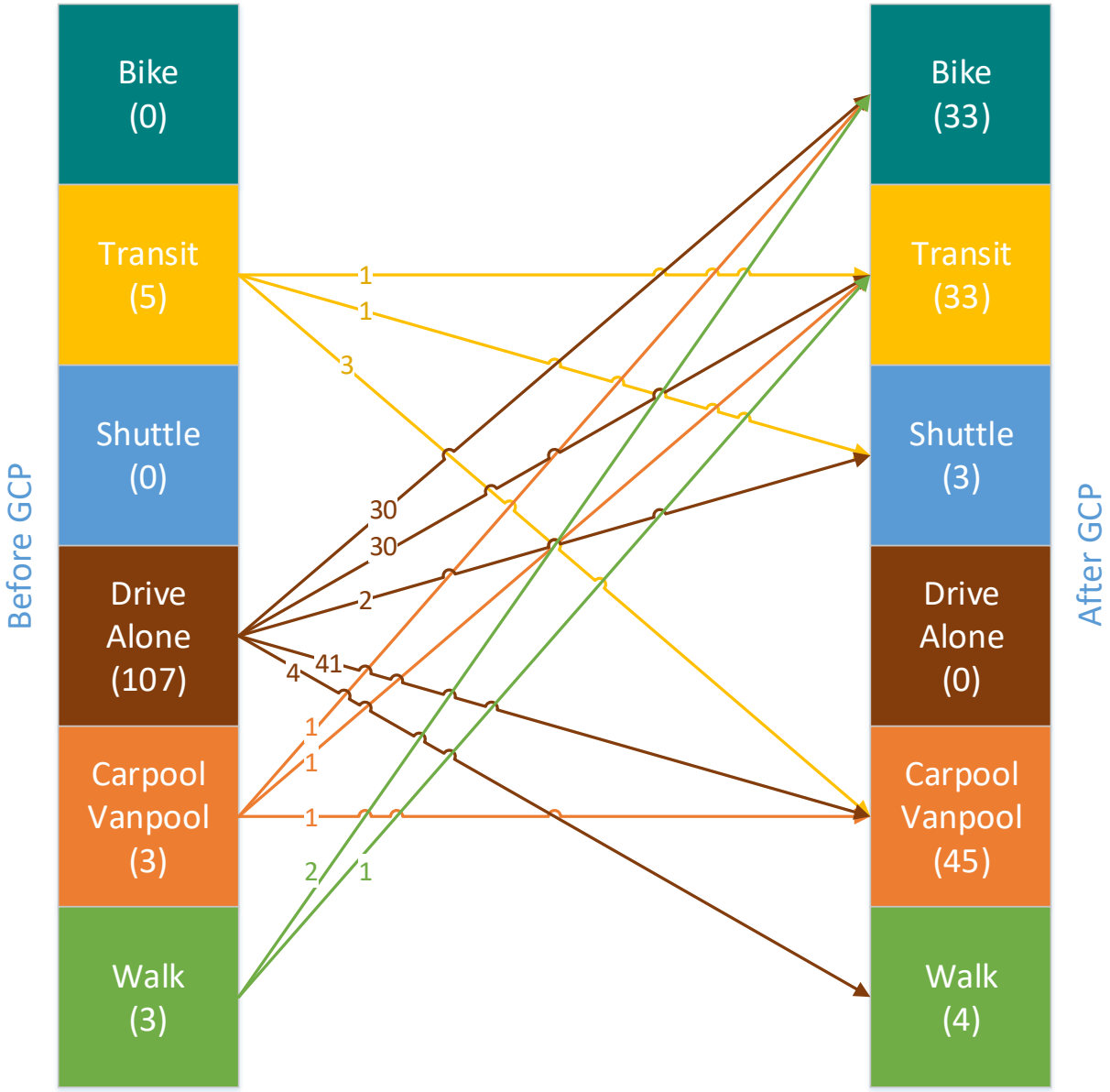

Figure 2: Diagram showing how people changed their commute mode as a result of the Green Commuter Program.

3.3 The Effect of Commute Distance

It was found that commute distance was a very good predictor as to what mode a person switched to, and whether or not they switched at all. **Error! Reference source not found.** shows the average commute distance, in miles, of the commuters who switched to each mode. Predictably, the commuters who switched to carpooling had the longest commutes, while the commuters who switched to walking had the shortest commutes. Those who switched to biking had reasonably short commutes, while those who took public transit had, still long, but not as long commutes as those who carpooled. As

expected, those who took the shuttle had a commute distance consistent with taking the inter-campus shuttle between UC Davis and UCDMC.

Mode	Bike	Transit	Shuttle	Carpool	Walk	Drive Alone
Switched	3.6	21.7	19.7	25.4	1.0	-
Didn't Switch	2.9	18.2	22	18.6	0.92	13.2

Table 3: Average commute distance (miles) of those who switched modes to the indicated mode compared to those who did not change their commute mode.

When compared with the commute distance of those who did not switch modes, it can be seen that those who switched tended to have longer commutes. This was to be expected, since if it was already convenient to bike, walk, carpool or take transit, they were likely already doing so. Given extra incentives, people for whom it was less convenient to switch commute modes were finally convinced to change.

The commute distance distribution in shown in Figure 3 for both those who did not switch and those who did, and compared against the overall commute distance distribution for UCDMC. It shows that many in the GCP live closer to campus than the overall population of campus. This is not surprising since they were more likely to already be commuting 'greenly', and joined the program to get the benefits, or they did not have to make a large sacrifice in convenience or time to join the program. It also illustrates how distance affected why a commuter joined the GCP, or conversely, how the effective the GCP was.

It seems that what the Green Commuter Program does is to extend the range at which people view alternate commute modes as viable. It can be clearly seen in Figure 3 that for commutes less than 10 miles, there were more members of the GCP who did not switch commute modes. This represents those who were already commuting by a green method, and now enjoy the benefits of the program 'for free'. For free in the sense that they are not reducing UCDMC's CO_2 emissions further by joining the program, but are getting the benefits of it. Of course, it would be unfair to only apply the benefits to those who switch commute modes after signing up for the program. For commutes greater than 10 miles, it can be seen that commuters were more likely to change their commute mode as a result of the GCP.

Figure 4 shows similar information to Figure 3, but relative to the overall commute distribution, as opposed to the number of commuters in their own category, as in Figure 3. In Figure 3, the percentages are fractions of the commuters who switched or didn't, whereas in Figure 4, it is the percentage of the total population living at a given distance that switched or didn't. What Figure 3 shows then is if you switched, what is the likelihood that you commute distance x. Figure 4 shows for any distance x, how many commuters did or did not change their commute mode. The result is that in Figure 4, for longer distances [more than 7.5 miles], the 'did not switch' category is larger than the 'switched' category. This is because even though the people who switched lived farther away, there were still more people who didn't switch that lived at those distances [they were already green commuters]. Now it is not until 35 miles that those who switched commute mode begin to outnumber those who didn't switch.

It was interesting that almost 45% of the UCDMC community who lives approximately 3 miles from campus was a member of the Green Commuter Program. While this was a large fraction of the

total commuters, at distances that short, a much higher percentage of the community should be capable of joining the program and switching their commute mode to something a little greener.

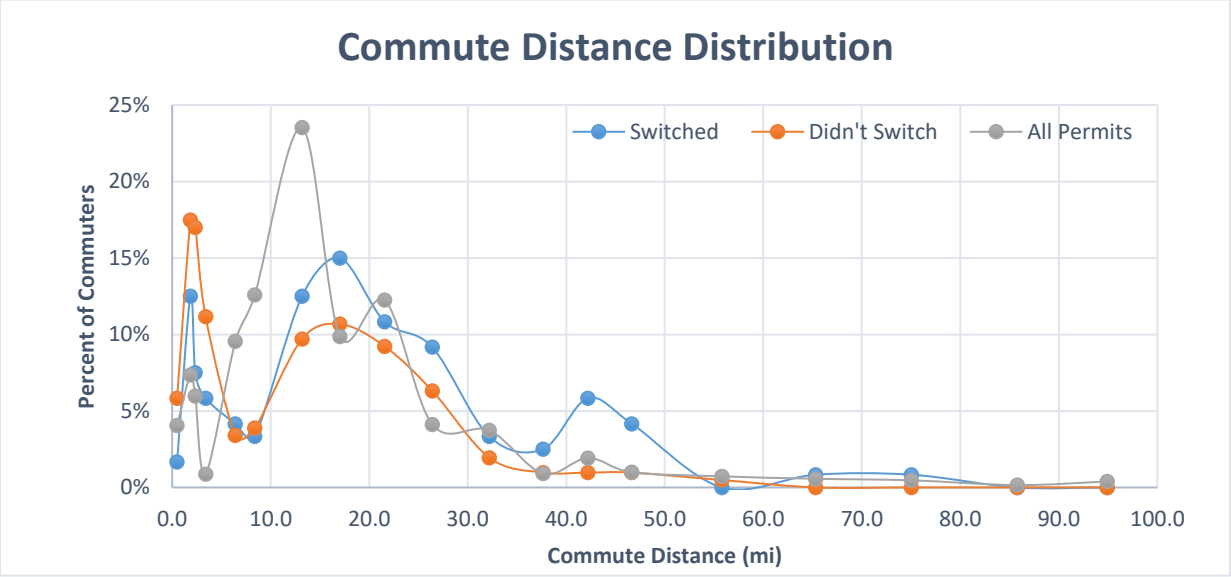

Figure 3: Commute distance distribution comparing all parking permit data with those in the GCP, broken out into those who switched modes and those who did not.

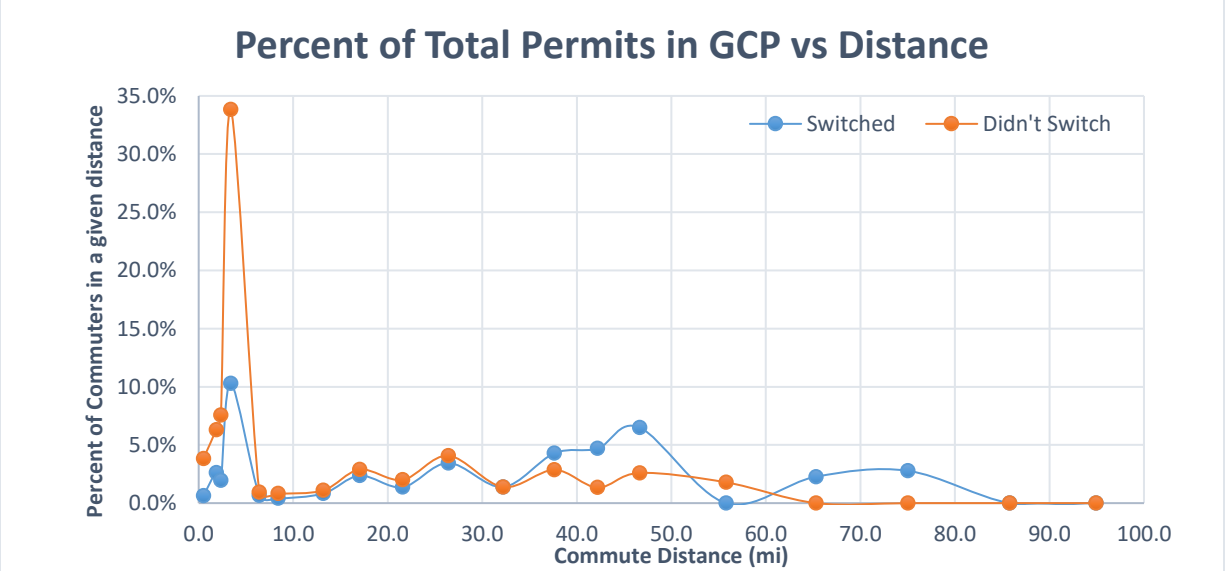

Figure 4: Percentage of all commuters at a given distance who are in the GCP, split by whether or not they switched commute modes.

3.4 CO_2 Reductions as a Result of Green Commuter Program

The reductions in CO_2 emissions as a result of the GCP are thanks to those who switched commute modes to a greener mode. There were some, but not many, who switched from greener modes to more carbon intensive modes. As a baseline case for CO_2 calculations, the commute modes respondents said

they would use if the program did not exist were used. Then the reduced CO_2 was calculated using the mode they specified actually using to commute to UCDMC.

	Baseline CO2 (kg)	Total GCP CO2 (kg)	CO2 Reduction (kg)
Sample	276,440	115,480	160,960
Population	1,471,778	614,822	856,956

Table 4: Calculations of the CO_2 reductions as a result of the Green Commuter Program.

Table 4 shows the results of the yearly CO_2 production by the members of the GCP who changed their commute mode. This does not include CO_2 emissions by those in the GCP, but who did not change their commute mode, and therefore does not measure the total carbon footprint of the GCP. It does measure the CO_2 emissions of those who were commuting "however they wanted", then switched when they joined the program because of the incentives.

The "sample" row in Table 4 shows the carbon emissions calculated from the data reported by the respondents to the survey before and after they switched commute modes. The "population" row shows the same data, scaled to the population of the Green Commuter Program. The resulting percentage reduction of CO_2 emissions from those who switched was 857,000 kg CO_2, or a 58% reduction. In terms of the entire population of the GCP, including those who did not change their commute mode, this is an overall reduction in the carbon footprint of all members of the program by 43% (Table 5). This reduction assumes that GCP members are not using their complementary parking days when they can drive alone to campus [24 days per year]. If we assume that GCP members use 50% of these free parking days, the reduction would be instead 34.6% (Table 5).

Even though green commuters who switched modes made up only 37% of the members of the program, they accounted for 73% of the baseline CO_2 for all members of the program. Again, this makes sense since those who were already in the program were already green, while those who switched were mostly driving alone before joining. This then is a measure of the effectiveness of the program at reducing UCDMC's carbon footprint, giving the total amount of CO_2 reduction due to the GCP. In terms of the total campus population's commuting emissions, this was a 3% reduction due to these members joining the program.

	Baseline CO2 (kg)	After Incentives CO2 (kg)	CO2 Reduction (kg)	% Reduction
Sample	376,839	215,879	160,960	43%
Population	2,006,304	1,149,348	856,956	43%
Assuming GCP members use 50% of their free parking days [24 days / year]				
Population	2,006,304	1,312,837	693,467	34.6%

Table 5:CO2 reductions based on entire population of green commuter program, unlike table 4 which only included those who switched.

Of course, it is difficult to reduce carbon emissions further if a green commuting method is already being used, which is why the overall percentage is lower for the whole program, and higher for those who did change.

4 Recommendations

The Green Commuting program achieved a reduction of 34.6% in the CO2 emissions of GCP participants. This number would be higher if all GCP members switched their transportation mode after joining the program, but many were already green commuters and only joined the program to enjoy its benefits. This reduction corresponds to 2.7% of total commuting emissions of UCDMC (estimated to be around 25.9 $MtCO_2$ / year)

Below is a list of recommendations to improve the Green commuting program and reduce UCDMC carbon emissions. These recommendations were derived from the relevant literature, the travel survey previously distributed on campus, the survey we conducted for this study and our interactions with Sarah Janus.

4.1 Better data analysis [Read: Hire a data analyst to assist Sarah]

Sarah Janus plays a large role in creating a Green commuting community at UCDMC and motivating people to be part of the program. She would strongly benefit from the work of a data analyst that could help her better target her efforts. Some of the data analysis tasks she could most benefit from are:

- Knowing exactly where everybody lives and how they commute
    - Analyzing drivers' behavior would be easier if the campus had better tracking mechanisms, such as License plate recognition or Fastrack technology
- Creating a system to help carpoolers find each other
- Integration of the UCDMC GCP transit passes with the Sac RT transit app, allowing electronic distribution of passes and easier payment while riding transit. This was requested several times in the survey we distributed to the members of the GCP.
- Targeting incentives to different groups of commuters, depending on their zip code:
    - Less than 5 miles away from campus: Incentives to walk and bike
    - From 5 to 20 miles: Incentives to public transit, carpool and vanpool
    - More than 20 miles: Identify popular zip codes and provide shuttles, along with carpools and vanpools.
- Investigating if there is a link between wage and distance. If this link exists, provide incentives to people move closer to campus (housing subsidies to poor people that live far away, etc.).
- Extra help in the office or with advertising at campus events.

4.2 Feel it in the pocket (daily parking and other financially painful strategies)

Financial mechanisms are among the best incentives that can be used to shape commuting behavior. Based on the CTS, the UCDMC community is much more receptive to positive incentives (i.e. rewards for not driving) than they are for negative incentives (punishment for driving) (Figure 6)Figure 6. The CTS respondents indicated that only 6% of the population said that more expensive parking would make them more likely to change commute mode. It should be noted though, that some people have avoided this response to not give administrators the idea that increasing the parking fees was a good idea so that they wouldn't have to pay more for parking. Also, it is possible that commuters *would*

change because of higher prices, they just don't *think* they would. Regardless, there are methods of using monetary incentives without actually increasing the absolute price of parking.

Gates (2015) suggested that removing monthly or annual parking permit payments and replacing them with daily ones would remind drivers more often of the cost of driving. The advantage to this is that it does not actually make parking more expensive, but reminds people that they are paying for it. Gates also suggested providing a bonus to paychecks if the employees do not apply for parking permits. The GCP already effectively does this by offering discounts and other benefits to those who do not apply for parking permits. Petrunoff et al. (2015) reported a successful case of a hospital that discouraged driving alone by implementing a "parking management plan" that significantly reduced the number of parking spots on campus, and began charging ~$4/day via permit to use these parking spots. An offsite parking garage with regular shuttles was used to allow others to drive, but still discourage it. Another advantage of daily parking permits is that it allows commuters to choose on a daily basis whether or not they will drive. With a monthly permit, they have already paid for parking the whole month, so get maximum value out of their permit by driving every day. With a daily permit, this 'incentive' to drive is not there.

Another strategy could involve 'tiered' pricing for parking permits, where the parking permit cost is a function of commute distance. The idea would be that people who live closer would pay more for parking, since it would be easier for them to take an alternate mode of transportation, which would be discounted by the GCP, effectively doubling the incentive to change commute modes. On the other hand, this would mean those who drive further, and this produce more CO2 emissions, would be incentivized to drive more, and it is possible this could offset the CO2 reductions by those who live close to UCDMC. Also, if the price difference were too high, it may have the effect of incentivizing people to live further from campus, have the opposite effect as intended. UCDMC should try to incentivize employees to live closer to campus, both reducing driving distance (and hence CO2), and increasing the likelihood that they will make use of an alternate mode of transportation.

A positive incentive to stop driving to work could be a one-time cash out of parking spots. If an employee who has been driving decided to change commute mode, they could be offered a sum (eg. $200) for no longer driving to campus. The CTS found that 36% of UCDMC commuters said cash subsidies such as this would be effective at enticing them to change their commute mode. There would have to be safeguards put in place to prevent them from going back to driving, then stopping again to claim another cash-out.

An optimization of Green Commuting funds may also increase the effectiveness of the program. This is another area were hiring a data analyst would help. Each incentive offered by the GCP should be evaluated on a CO2 reduction/$ basis, and those that have the highest value should get a larger share of attention and investment. Also, all subsidies are currently $65, but not all commute modes cost the same, for example, this is 65% of an RT monthly pass, but only ~40% of an Amtrak monthly pass. However, 50% of UCDMC survey respondents said that free RT passes would entice them to change their commute mode, at least part of the time (Figure 6). This may be an extremely effective way to significantly reduce the commuting CO2 emissions at UCDMC.

4.3 Encouraging Carpooling

For people living further than 10 miles from campus, walking or biking is normally not an option. When transit is not available, carpooling and vanpooling are the best options of green commuting. Petrunoff et al. (2015) reported several strategies that were successful at increasing the rate of carpooling, including: Providing parking discounts to carpoolers, a service to match employees to carpools, and e-bikes for getting around campus. Another strategy reported by Petrunoff consisted of providing guaranteed rides home for carpoolers. Dong et al., 2015 found that parking fees were the most effective at increasing the number of workers carpooling. Brownstone and Golob (2015) analyzed commuter data in the Los Angeles area to determine the effect on worker's commuting habits that various incentive programs had. Their analysis resulted in a prediction that providing reserved parking and guaranteed rides home increased the rate of carpooling by ~40%.

It should be noted that UCDMC is already implementing some of these measures, but as discussed below, has an awareness problem. Members of the GCP strongly requested that more carpool parking spots be made available, and closer to campus, with some requesting that they be allowed access to the 'premium' parking in the garages. If the GCP continues to expand, the number of CP parking spots should proportionally increase. Members also suggested that two person carpools be granted access to designated carpool parking spots. The more carpool spots, the easier it is for people to carpool and the harder to drive, further increasing that incentive.

The current limits on vanpool eligibility are shown in section 1.1.2, and it may be a good idea to relax those constraints a little. The minimum distance should be lowered, maybe to 10 miles. Another factor that may increase the vanpool adoption is allowing members who live in non-neighboring zip codes, so long as they all live along a commute corridor to UCDMC from the furthest member's commuting address. Implementation of this requires both validation of commuting zip code data, and more heavy analysis of the individual commutes, something hiring a data analyst to help Sarah with would make significantly easier. Several respondents to the survey that was distributed to members of the GCP requested that the minimum number of people required to start a vanpool be lowered to four. In principle, these people could simply carpool, but they may not own cars, may own small cars, or not want to increase the millage on their vehicles. (This was a significant motivation for not driving for many in the GCP.)

Yet another where a data analyst, who should be an accomplished programmer, could help would be targeting drivers by zip code. This would be valuable, since 17% of respondents to the CTS said the reason they do not carpool is that they don't know how to join a carpool, while another 16% said they don't know how to find more passengers for their carpool. A system could be created, based on parking permit data, to group commuters by address if available, or zip code if not available. These commuters could then be contacted about carpooling, telling them that there are a large number of people in their immediate area. For zip codes with a very high concentration of UCDMC commuters, a UCDMC shuttle to that area could be created, with a limited schedule.

4.4 Increasing biking adoption

Yang et al. (2015) found that the availability of bike racks and distance from work were strong factors affecting bicycle commuting. Petrunoff et al. (2015) reported that bike sharing programs and increasing the number of bike locks can also contribute to the reduction of emissions from commuting. Both of these suggestions agree with the results of our survey and the CTS. One of the most popular

suggestions for our survey (Figure 5) was more bike lockers (especially) and bike racks. Many were concerned about the security of the bike racks, and wanted more secure places to park their bikes. In the CTS, “more secure bike lockers/cages” was the top requested ‘feature’ to improve the campus environment for alternate modes of transportation. Bike racks should be retrofitted, or built, to standout, and make people *want* to use them. Bike racks would also be excellent places for signage advertising the Green Commuter Program.

Another requested amenity for bikers were showers. Sacramento gets hot during the summer, and bikers who need to come to work in formal attire feel this prevents them from being able to bike to work. Providing showers they would be able to use, as a benefit of the Green Commuter Program, could increase the number of workers who are willing to bike to campus. To facilitate this, providing a building similar to the Bike Barn at UC Davis which contained the showers, but also served as a hub for all biking activities, events, and a social space could “make biking cool”. Staff at this location could provide free inner-tube replacement and chain oiling. These services should be limited to members of the Green Commuter Program. Upon joining the GCP as a biker, they could be offered a free bike lock. Bike repair stations should also be made wide-spread throughout campus, including air pumps and tools required to adjust bike tuning and inner tube replacement. These would also be ideal places to place advertising for the GCP.

4.5 Learn to love transit

One study in Beijing (Bopp et al., 2015) found that it was possible to encourage workers to use public transit (subway) more by incentivizing them to take it when it was less crowded. This was achieved by offering free or discounted breakfast at locations near work, and discounted subway fares. This caused workers to leave home before rush hour, increasing satisfaction with public transit and getting them cheap food. An additional benefit was found by implementing flexible working hours, thus allowing workers to leave after rush hour then stay at work longer, for those not willing to wake up earlier.

Yang et al. (2015) found that distance to bus stops at home and work, as well as public transit incentive programs were strong factors related to taking public transit. Based on the CTS, 42% of respondents said that bus stops were too far away from home, while another 42% said that taking transit was too slow. Another study (Dong et al., 2015) using data from the 2011 Oregon Household Activity Survey found that either discounted or free transit passes were the most effective at increasing the number of workers taking transit. This also corresponds to the results of the CTS, and to responses to our survey.

16% of responses to the CTS said that they did now know how to take transit, or what line to take. Combining free transit passes with increased advertising of methods for how to easily determine and find transit routes could significantly increase the UCDMC mode share of public transit.

4.6 Gamify On

Gates (2015) suggested that creating a gamified dashboard that tracks employee commuting methods, ranks employees relative to one another, and rewards the best preforming of them. This could serve as a strong motivational factor for some commuters, both because of the competition and the rewards. One of the most popular pieces of feedback from the GCP survey (Figure 5) was “more prizes”, with several members suggesting those were the reason they joined the program in the first place.

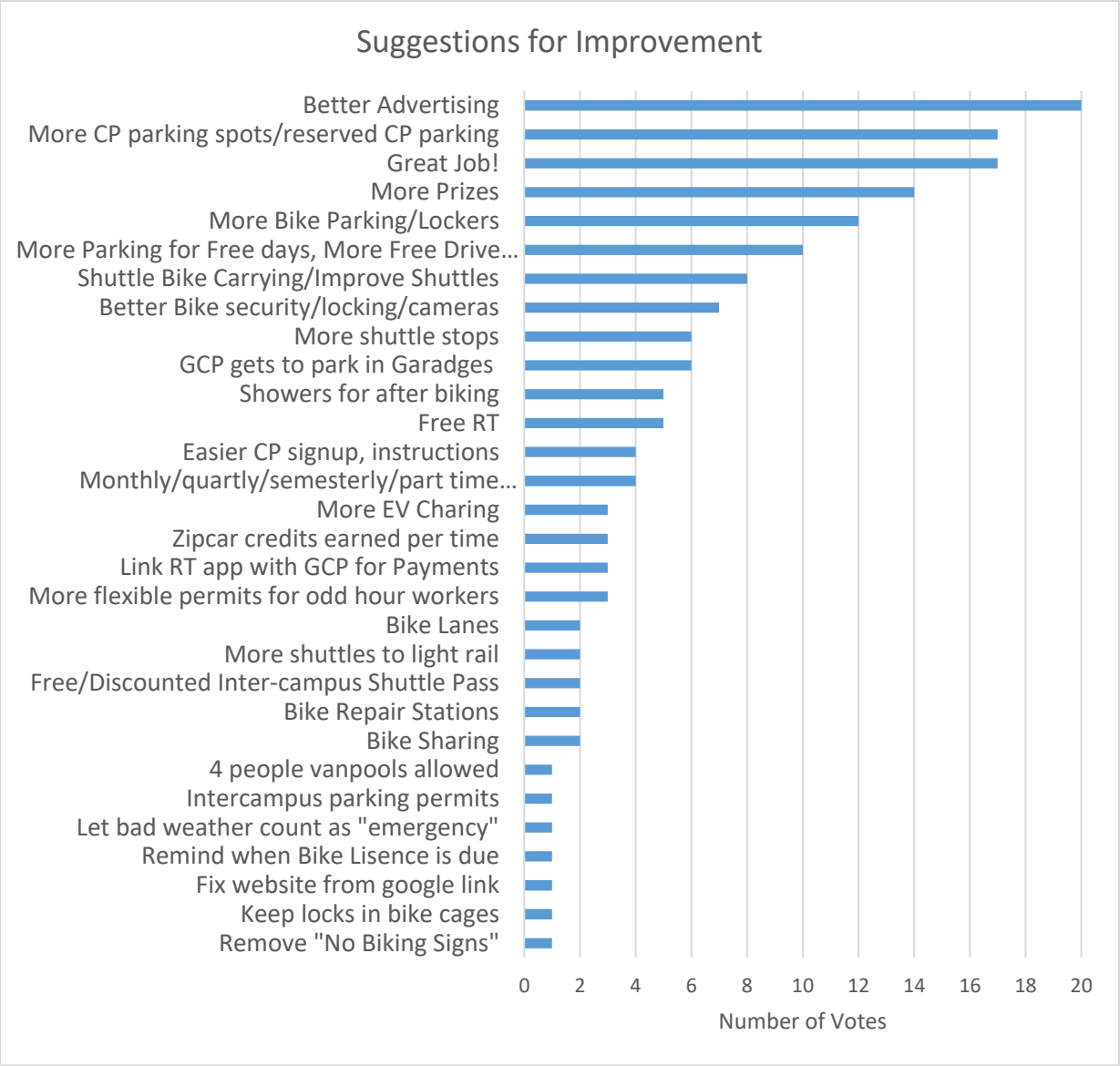

Figure 5: Suggestions for improvements to the GCP based on responses from the survey distributed to members of the program.

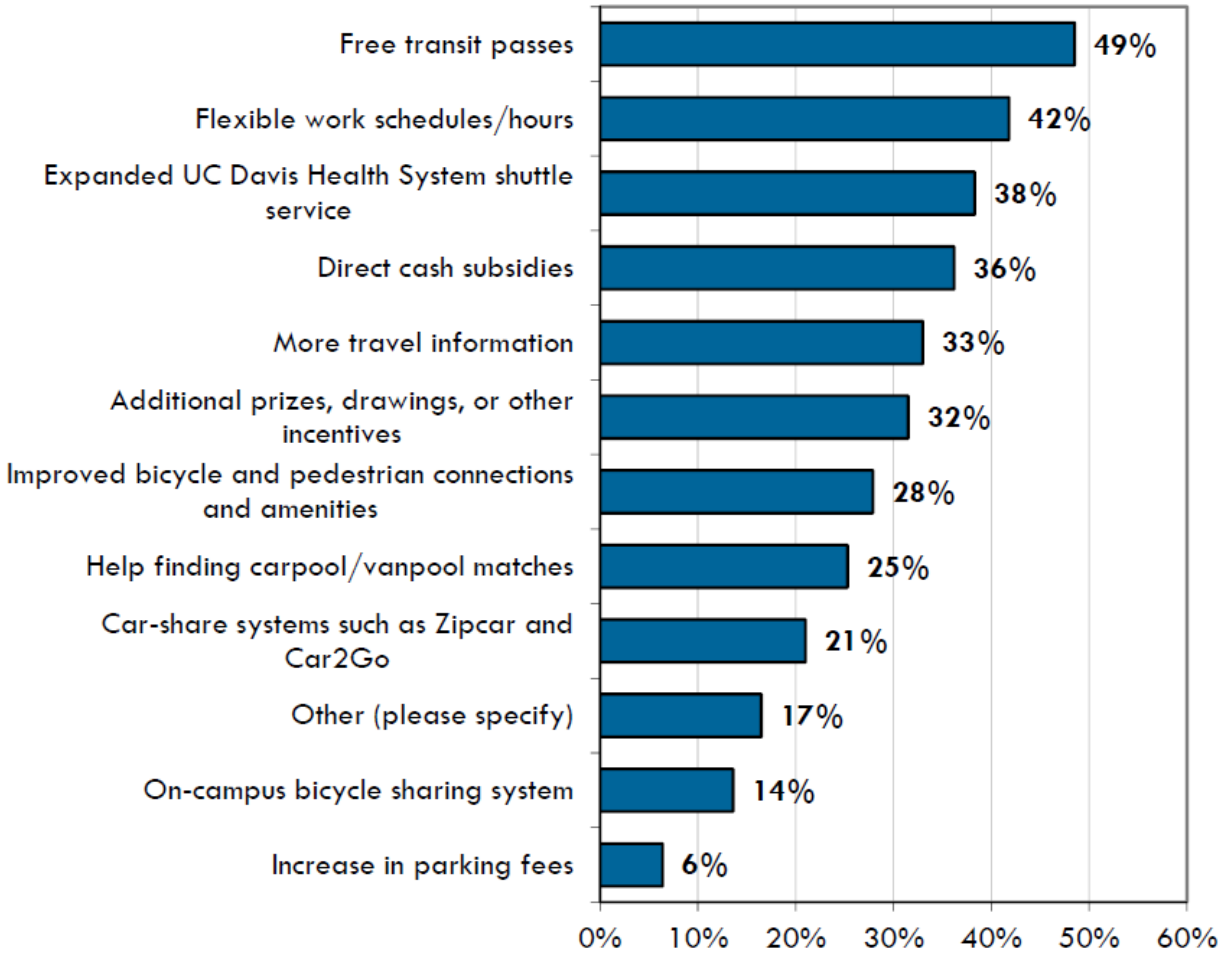

Figure 6: Responses to the campus travel survey, 'what would get you to stop driving alone?'

4.7 Advertisement

Gates (2015) also suggests that all green commuting programs should be sufficiently advertised to the target workforce. This is not news to UCDMC, as it was well known that the GCP has an awareness problem. The members of the program know this as well, as many of them said it took them years to hear about the program after they came to UCDMC. This can be seen by the fact that this was the number one piece of feedback we received on the green commuter survey in Figure 5. The CTS found, as can be seen in Figure 6, that several of the items on that list are already offered by the GCP. The CTS also found under "reasons for driving alone" that 26% of respondents said that they needed to be able to get home in case of emergency, which the GCP provides to all members. 7% said they do not know how to find a carpool was their primary reason for driving alone. As seen in section 4.3, advertising carpooling more could result in significant CO_2 reductions (the exact number is completely dependent on how far from campus those 7% of commuters live).

Clearly many people at UCDMC don't know the benefits of the Green commuter program. Better advertisement of the program is a key for its success. All employees should be made aware of the

community of Green Commuters so they can feel the desire to be part of it. Some ideas for better advertisement of the program:

- Target different types of advertisement depending on the zip code.
- Provocative ads in parking lots, featuring testimonials of carpoolers and bikers
    - “Are you tired of looking for a parking spot? If you carpooled this would be much easier “
    - “I can take a nap on my way home, can you?”
    - “Tired of sitting in traffic? Play Candy Crush on the bus instead!”
    - Testimonials of carpoolers and vanpoolers who became close friends
- Build Bike racks that look and cool attract people’s attention
- 'Bumper stickers' for bikes
- Badges and wearables that identify GCP members
- Fix the GCP website. Searching it from Google results in a broken link (Figure 7).
    - It appears that the website changed from www.**ucdmc.ucdavis**.edu/parking/**green_commuter/green**_links/ to www.**ucdmc.ucdavis**.edu/parking/**green**, but the old site does not forward to the new site.

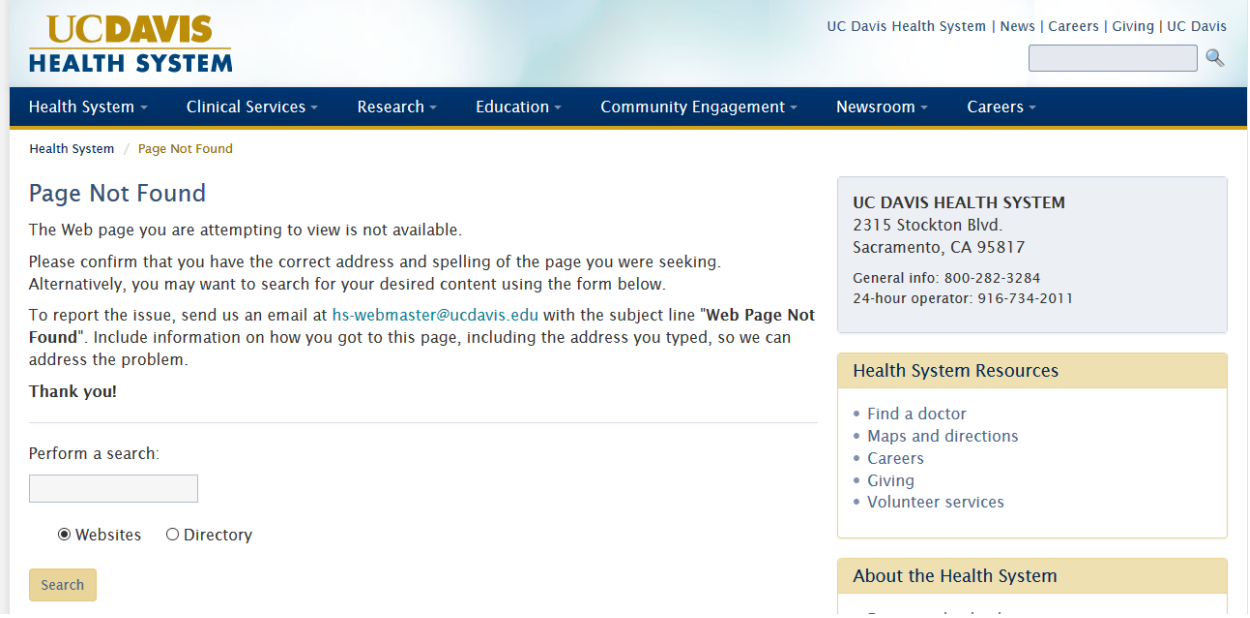

Figure 7: Broken website from the first result of a Google search for "UCDMC green commuter".

4.8 Other measures

- Strict parking permit application: request primary vehicle model when users apply to permit and restrict permit to one vehicle

- Increase the number of shuttles and shuttle stops
- Accommodations for those with odd working hours. This is very important, since UCDMC is a hospital and has employees commuting 24/7. The campus travel survey found that 33% of respondents said that their primary reason for driving alone was their irregular working hours. Several respondents to our survey to members of the GCP expressed a desire to allow late-night call-ins not count against their 24 free parking days, especially if they had already taken transit or biked to work earlier that day. Also, the campus travel survey found that 42% of respondents said they would be more likely to take alternate commute modes if their working hours were more flexible.

5 Conclusions

The Green Commuter Program was found to have changed the commute mode of ~41% of its members, resulting in a 35% reduction in CO2 production from all members of the program, and a 3% reduction in overall commuting emissions for the entire UCDMC campus. The program has the potential to significantly reduce the total emissions of the campus, given sufficient awareness. The primary problem for the program is that the UCDMC community does not know it exists. To alleviate this situation, the GCP requires more staff to help with data analysis and advertisement, as well as to implement, or convince the campus to implement, some of the suggestions provided above.

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7 Appendix

7.1 Green Commuter Program Survey Email

Dear Valued Green Commuter,

You are invited to participate in this Green Commuter Program Survey. This survey will provide campus planners with valuable feedback on how people get to campus and their use of the Green Commuter Program. It is intended for everyone who regularly travels to the UC Davis Medical Center for school or work.

Your feedback helps improve the campus!

The UC Davis Medical Center Parking and Transportation Services will use the results of this survey to:

Determine the effectiveness of the Green Commuter Program
Make improvements to the Green Commuter Program
Estimate CO_2 emissions
Increase membership of the Green Commuter Program

Participating in this research survey should take **less than 5 minutes** to complete. Doing so is voluntary, and we assure you that **all responses are confidential** and the results will only be published in the aggregate, without connection to any individual. Your email address will be recorded to enter in the drawing described below. You must be at least 18 years old to complete this survey.

We're going to ask you questions in the following areas:

Your role at the UC Davis Medical Center

How you travel to (or from) campus
Your membership in the Green Commuter Program

In appreciation for your time, we're offering anyone who completes the survey a chance to **win one of 10 $20 Amazon.com gift cards!**

To start the survey, click on the link below:

Thanks for your participation in this year's survey!

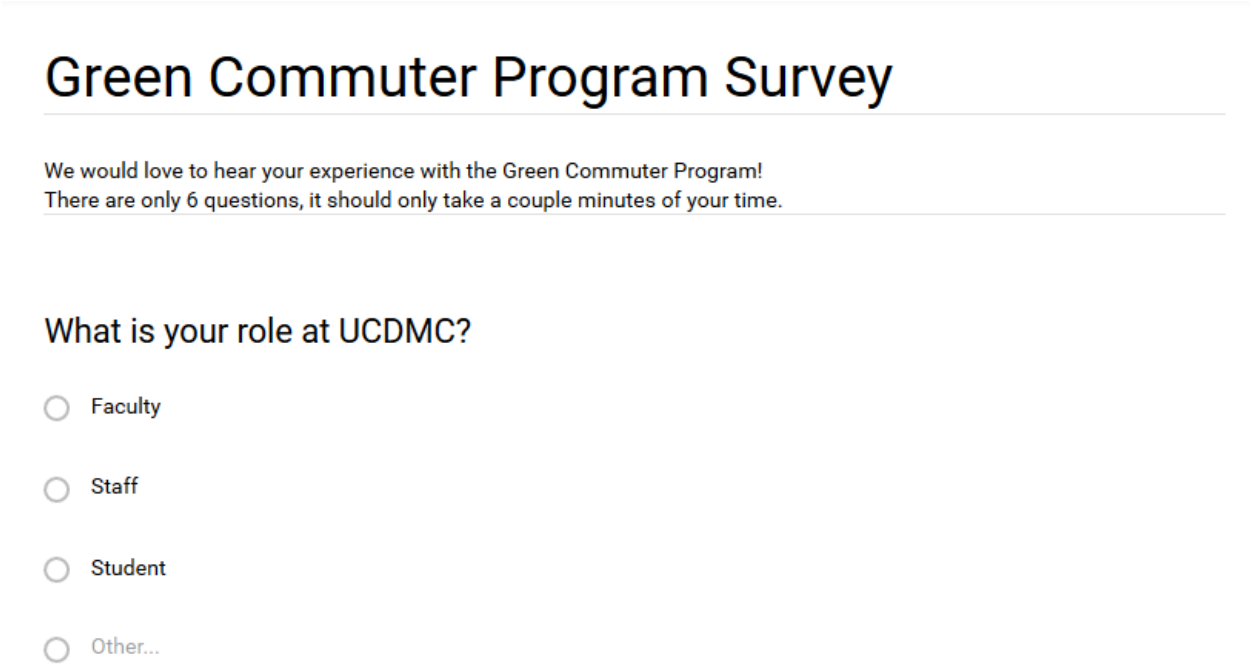
Best regards,

UCDMC Parking and Transportation Services

7.2 The Green Commuter Program Member Survey

Below is the list of questions distributed to the members of the GCP to obtain the data used in the above analysis.

Section 1:



How do you primarily commute to UCDMC?

- ○ Drive Alone
- ○ Carpool
- ○ Bus/lightrail
- ○ Bike
- ○ Walk
- ○ Train
- ○ Other...

How many miles is your commute (1 way)?

Short answer text

Is your commuting method influenced by the green commuter program incentives? (Did you change how you commute?)

- ○ Yes
- ○ No

If the respondent answered “yes” to the above question, they were directed to section 2, and if they answered “no”, they were sent to section 3. Sections 2 and 3 were mutually exclusive. Both tracks merged again in section 4.

Section 2:

Section 2 of 4

How Does the Program Influence Your Commute?

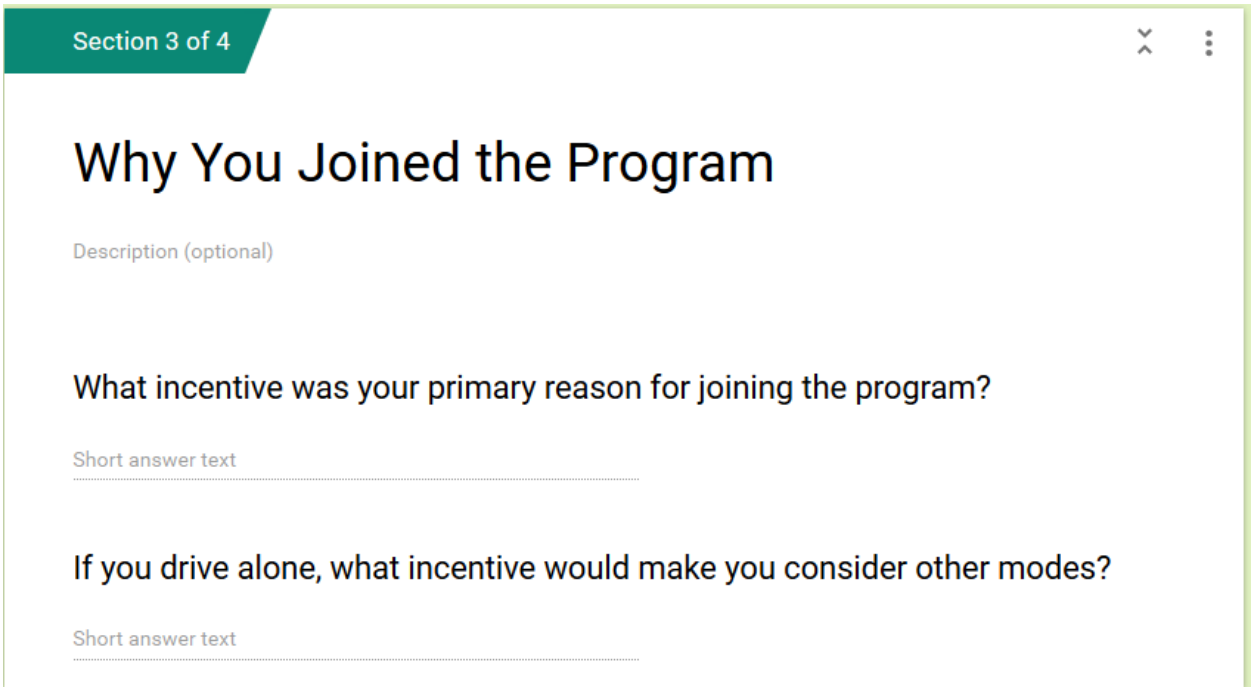
If not for the incentives program, how would you be commuting?

- ○ Drive Alone
- ○ Carpool
- ○ Bus/lightrail
- ○ Bike
- ○ Walk
- ○ Train
- ○ Other...

What incentive was your primary motivation to switch commuting modes?

Short answer text

Section 3:



Section 4: