

MEMORANDUM

To: Nate Baird, City of Mountain View

From: Adrian Witte and Rae-Leigh Stark

Date: February 8, 2019

Project: Mountain View Bike Share Study

Subject: Dockless Bikeshare Pilot Project Evaluation

INTRODUCTION

The City of Mountain View created a dockless bikeshare permit program in Spring 2018 to allow vendors to apply for and provide dockless bikeshare services for a 12-month pilot period. Two vendors, Lime and ofo, were issued permits and started operating in May 2018. Ofo ceased operations in North America in Summer 2018 and their bikes were removed from the City of Mountain View on July 29, 2018. Lime operated throughout the pilot period.

Toole Design was asked to evaluate the pilot program and review ridership trends, usage rates, and spatial trip patterns. Ridership data was provided by both vendors for the period from May 8, 2018 to August 29, 2018 (113 days or approximately 4 months). For each trip the following information was provided:

- Trip ID number,
- Trip start date and time,
- Trip end date and time,
- Trip start latitude and longitude,
- Trip end latitude and longitude,
- Trip distance, and
- Trip duration.

User information, GPS locations of the bikes when not being used, and GPS locations of the bikes during trips were not provided, so trip routes could not be studied. Moreover, bike ID numbers were not provided with the trip data which limited the ability to study the spatial patterns of bike availability and parking. To identify these patterns, knowing whether subsequent trips are made on the same or different vehicles is critical. Bike availability was only available on an aggregate level by provider each day. It is recommended that these data be required as part of any future dockless micro-mobility program.

The data from the pilot program was “cleaned” to remove any unusual trips including:

- Trip durations under 30 seconds (2,112 trips removed): these are thought to be aborted trips that could have been completed so quickly because of a maintenance issue with the bike, a decision not to take the trip, or some other reason.
- Speeds over 20 miles per hour (mph) (314 trips removed): these are not realistic trip speeds and are assumed to be when a bike was being transported in a vehicle, bus, or train.
- Trips with both an origin-to-destination distance and a total traveled distance under 150-feet (3,004 trips removed): these are also thought to be aborted trips. Note that only trips where both the distance between the origin and destination and the reported travel distance were less than 150-feet were removed because some trips could have a total traveled distance of greater than 150-feet but were round trips (i.e., the origin and destination were the same location). There were also some trips with a reported total travel distance of approximately zero, despite these trips occurring between origins and destinations separated by more than 150-feet. These trips were removed.

Out of the 37,050 trip records provided by the dockless bikeshare vendors, a total of 3,518 trips (9.5%) were removed resulting in a total of 33,532 trips taken on dockless bikeshare during the pilot period. During this period there were an average of 230 Lime bikes and 128 ofo bikes available to the public each day.

The following sections analyze this data in more detail.

RIDERSHIP ANALYSIS

TOTAL TRIPS

For the period from May 8, 2018 to August 29, 2018, there were 33,532 trips taken on Lime and ofo bikes in Mountain View. **FIGURE 1** displays the daily distribution of these trips and shows that in general, ridership on Lime increased during the first two months of operations and then steadied and slightly decreased towards the end of the pilot program. Ofo ridership was lower than Lime and remained relatively consistent throughout the pilot program until the bikes were removed on July 29, 2018. Peak usage occurred on the Fourth of July holiday when approximately 500 trips were taken on Lime bikes and 100 trips on ofo bikes.

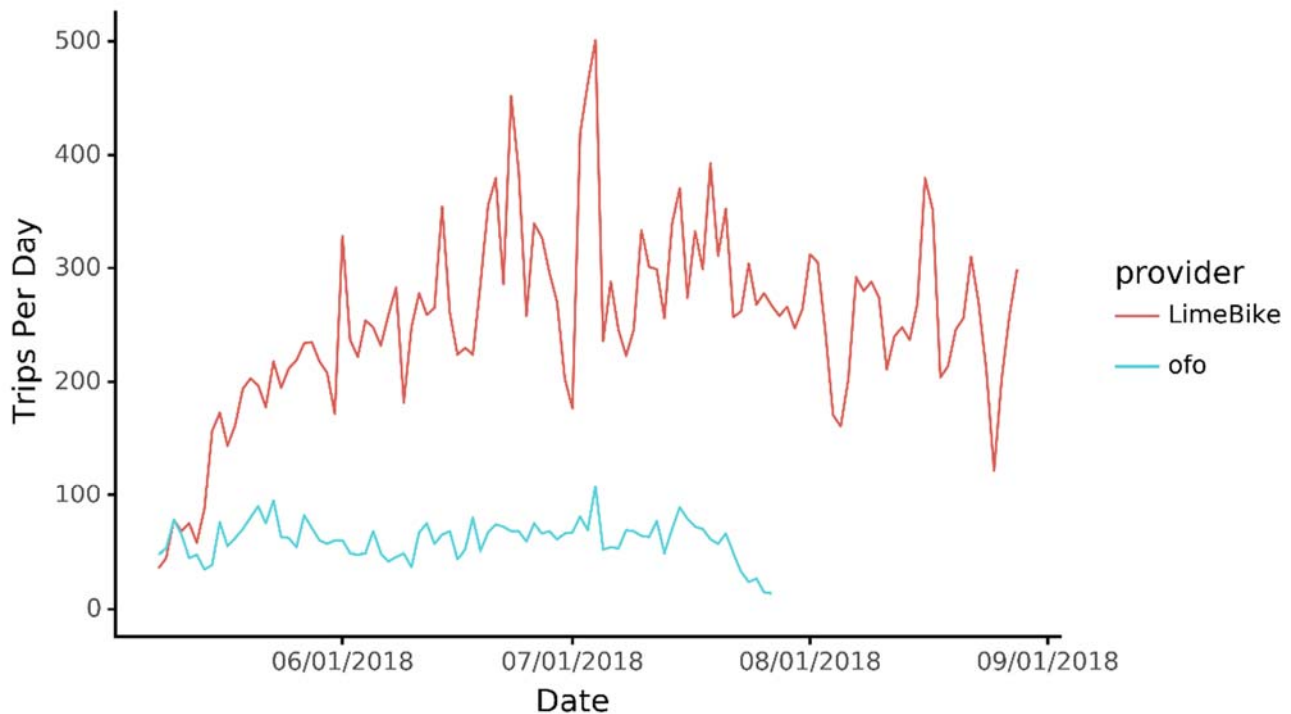


FIGURE 1: Total trips by day.

The number of bikes available each day varied throughout the pilot period.

FIGURE 2 shows that both vendors ramped up quickly to get to almost 300 Lime bikes and over 150 ofo bikes by mid-May. The number of Lime bikes fluctuated more dramatically than ofo. For example, the number of Lime bikes reduced steadily during May and early-June before being increased with an influx of bikes in mid-June and then a steady reduction again through to early August and another influx of bikes through August. The number of ofo bikes remained fairly steady until their bikes were removed on July 29, 2018 following the closure of ofo's North American operations.

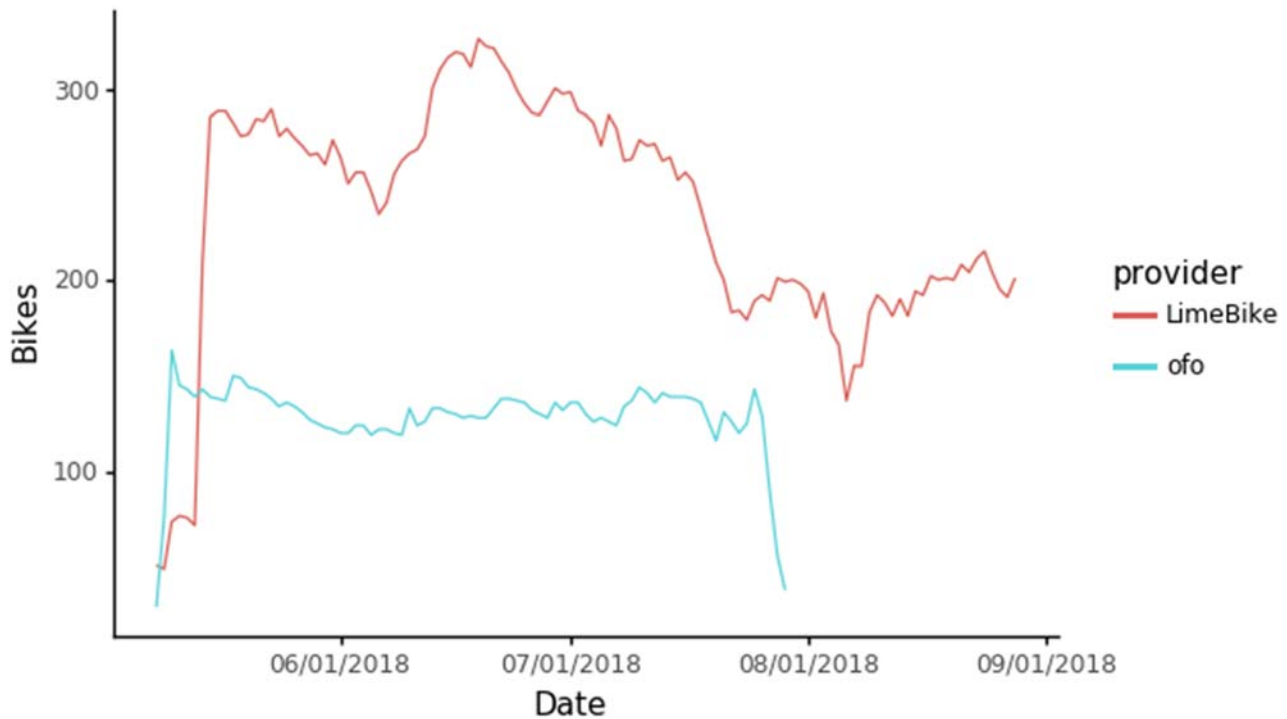


FIGURE 2: Daily bike availability.

A common metric to evaluate bikeshare utilization is the number of trips per bike per day. The average of this metric for the pilot period was 0.84 trips per bike per day for both vendors combined with Lime recording 1.10 trips per bike per day and ofo recording 0.47 trips per bike per day. The change in bike utilization during the pilot program is shown on **FIGURE 3**. The points on the graph represent the utilization for that day and the lines represent the seven-day moving average (i.e., it shows the average value for the seven-day period surrounding a given day and is intended to help visualize trends).

In general, the utilization rate for the Lime bikes increased from the start of the pilot through to mid-August when it experienced the pilot program’s single highest usage day with almost 2 trips per bike per day before usage generally declined through to the end of the pilot. For ofo, the number of trips per bike per day stayed relatively consistent at around 0.5 trips per bike per day.

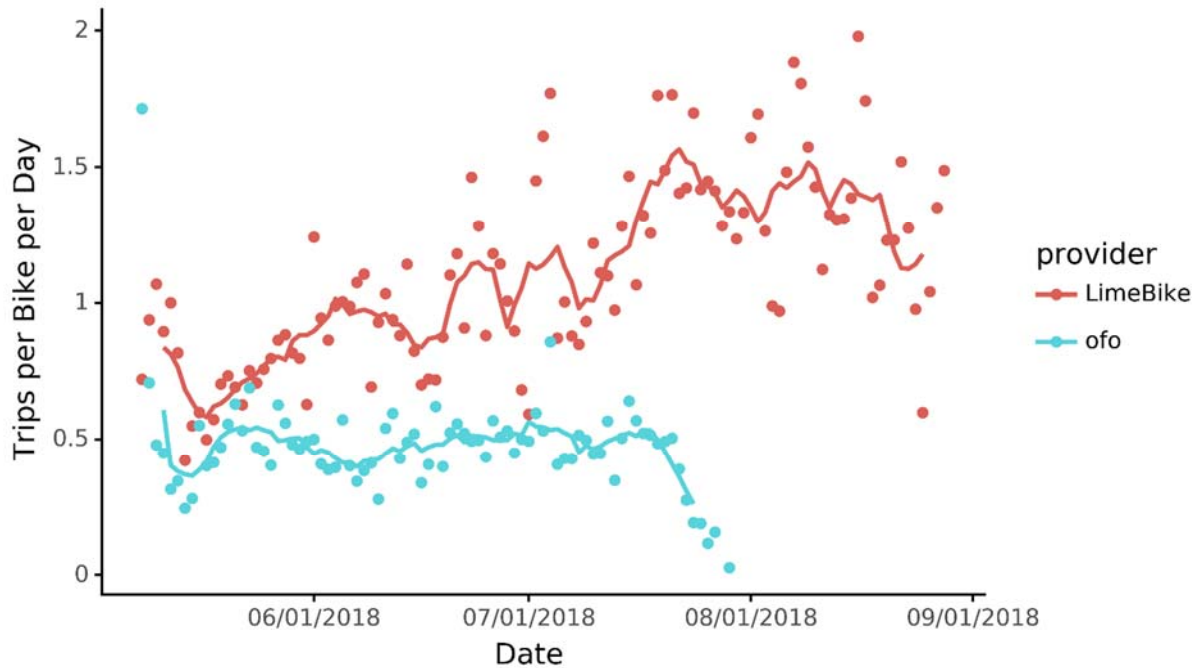


FIGURE 3: Daily usage per bike.

FIGURE 4 plots bike availability (cyan line) alongside utilization (red line) for the entire fleet. It shows that utilization steadily increased while at the same time the number of bikes was slightly declining through to mid-July. After this time the number of bikes significantly reduced and resulted in significant jumps in utilization. This suggests that the remaining bikes were more efficiently used during that period.

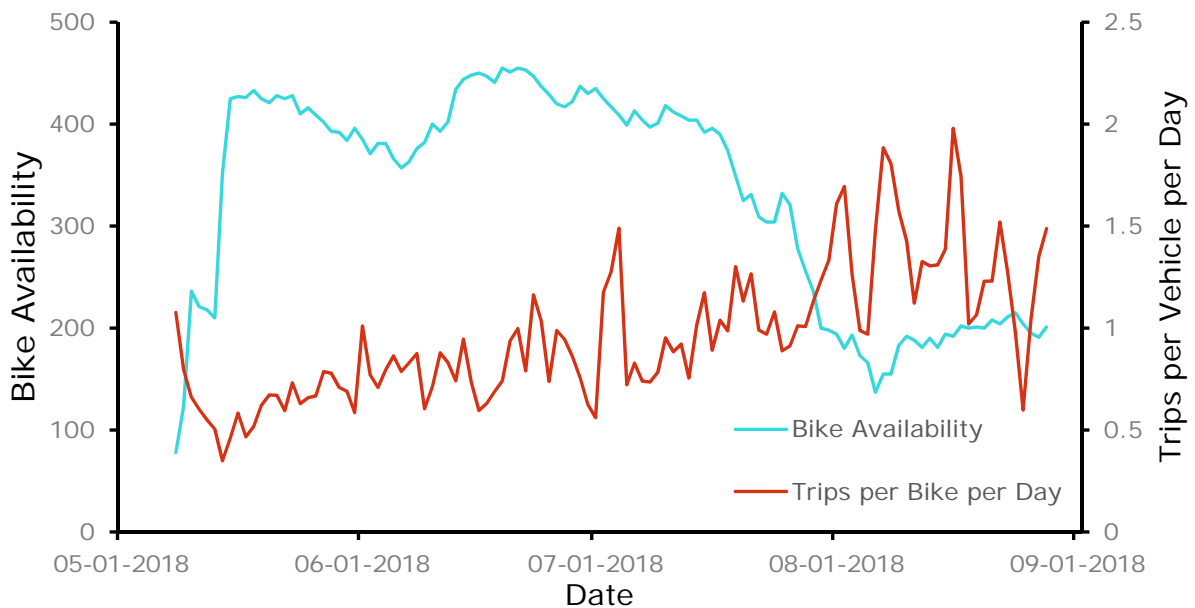


FIGURE 4: Total daily usage per bike and bike availability.

PATTERNS BY TIME OF DAY, DAY OF WEEK

FIGURE 5 shows the distribution of trips by day of the week. It shows that the system is approximately 10% to 15% busier during the mid-week than on the weekends, suggesting that the system is used for both utilitarian trips and recreational trips. Ridership is particularly high Tuesday, Wednesday, and Thursday, which is consistent with typical commuter patterns.

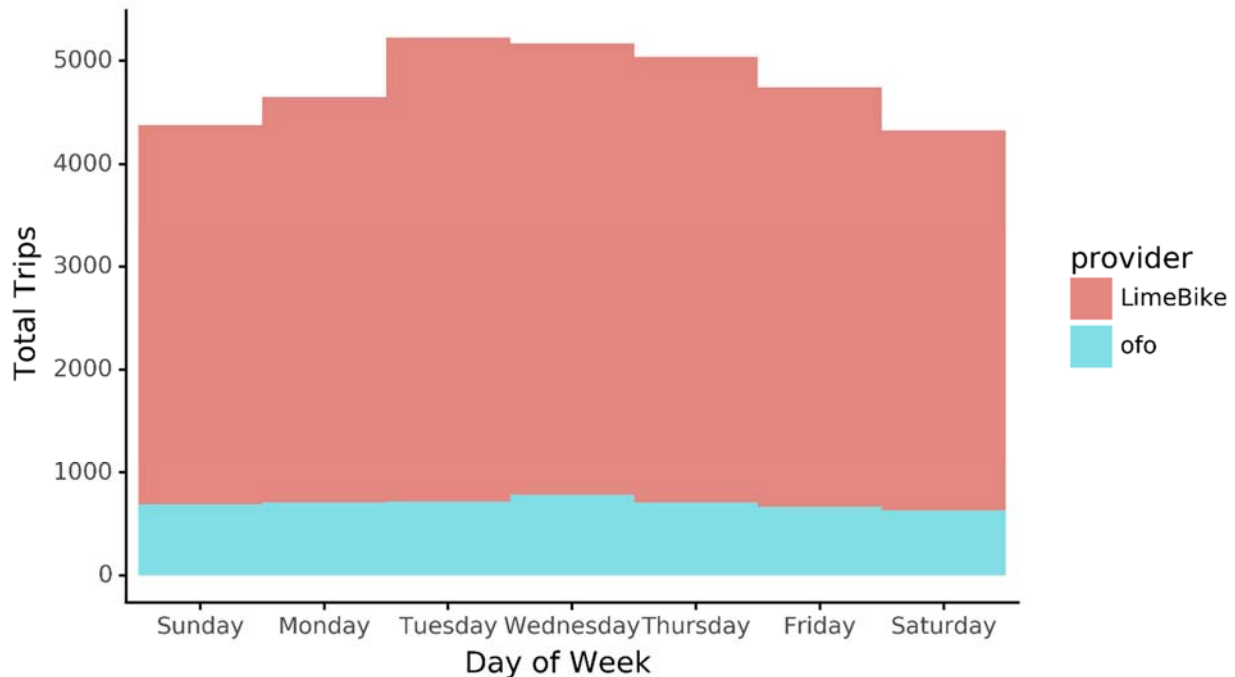


FIGURE 5: Trips by day of week

Weekday and weekend trip patterns are shown in **FIGURE 6** and **FIGURE 7** respectively. **FIGURE 6** shows that both Lime and ofo's ridership followed typical commuter trends with a (smaller) morning peak around 7:00 AM and a larger afternoon major peak occurring around 5:00 PM.

Weekend ridership shown on **FIGURE 7** shows ridership building up to around 11:00 AM weekend ridership peaked through the afternoon and early evening starting at 11:00 AM and then staying high through to around 6:00 PM before reducing. Nevertheless, there were also quite a few trips taken late into the evening and even the early morning, which suggests bikeshare may have been used to get home from restaurants, bars, and other entertainment uses.

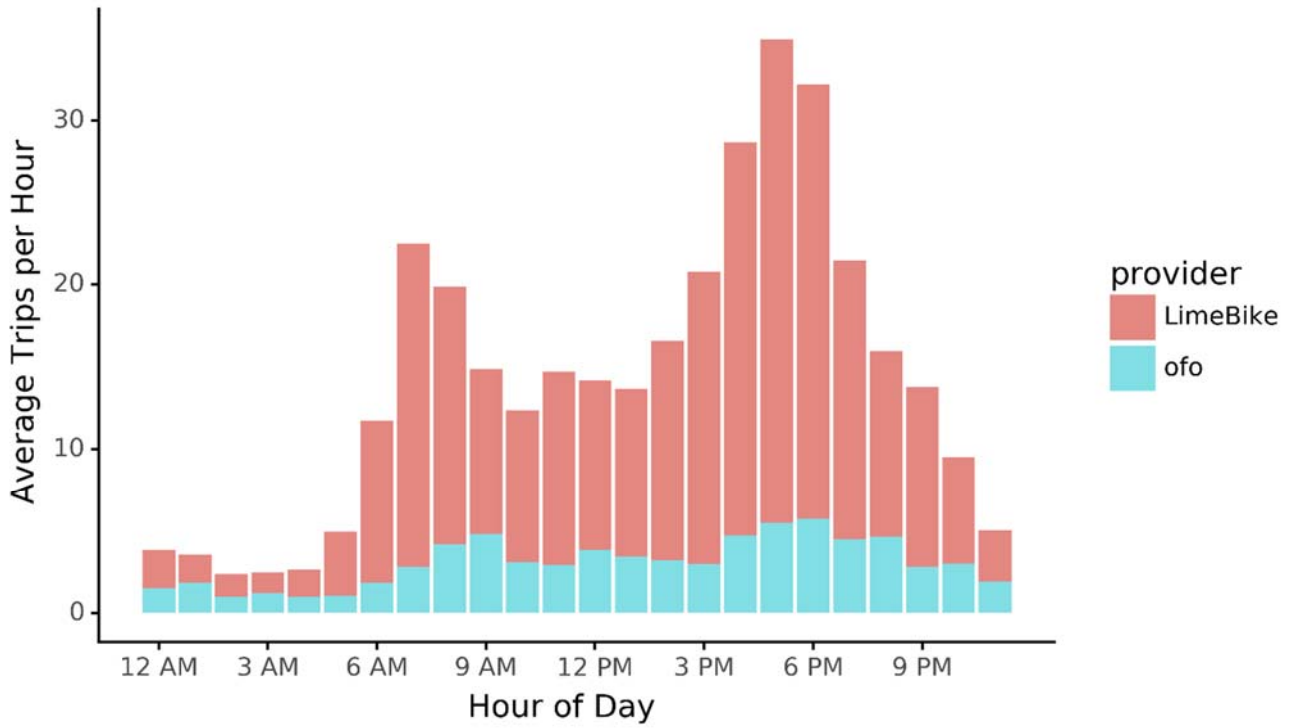


FIGURE 6: Average trips by hour of day (Weekdays).

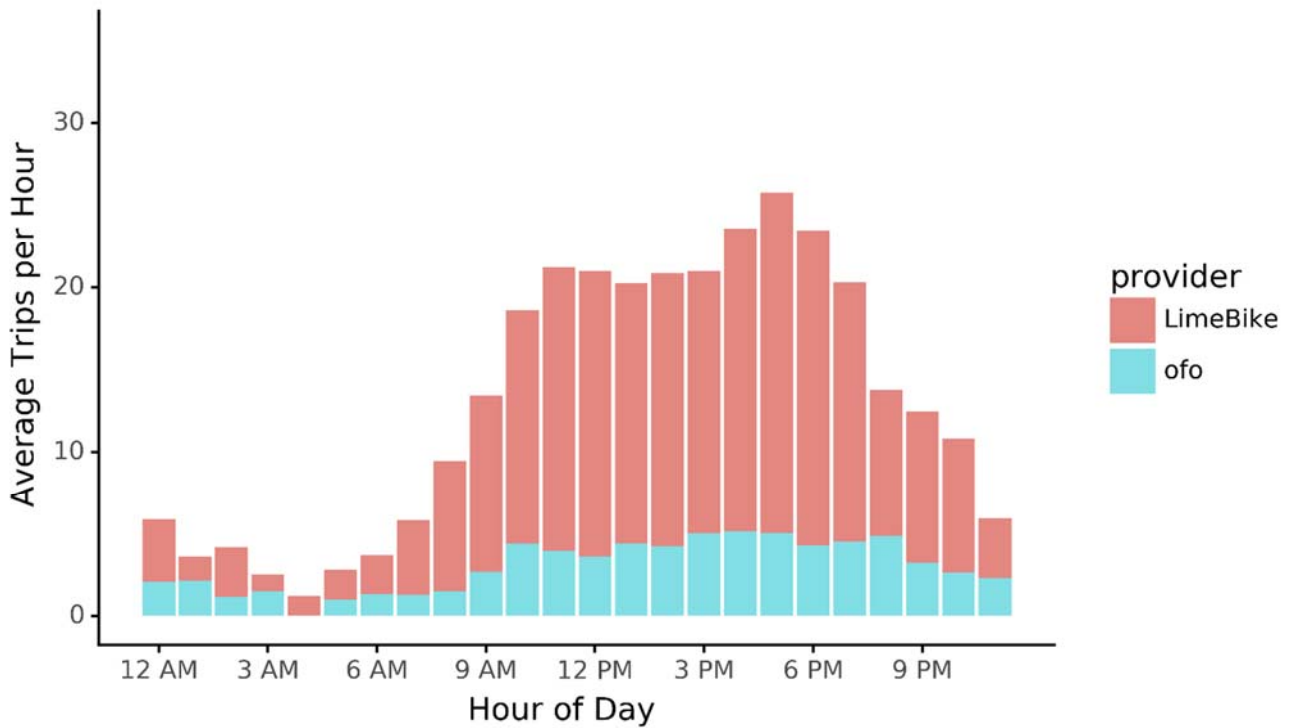


FIGURE 7: Average trips by hour of day (Weekends).

TRIP DURATION

FIGURE 8 plots the frequency of trip durations and shows that nearly all trips are under 1 hour (approximately 96%), 79% are less than 20-minutes long, and 49% are less than 10 minutes.

Thirty-one percent (31%) of trips taken on dockless bikeshare are between 5 and 10 minutes long, which is approximately the time it takes to bicycle 0.5 to 1 mile. This is consistent with the average distances people are riding (**FIGURE 9**) and the distances between the major destinations in Mountain View (**FIGURE 10**).

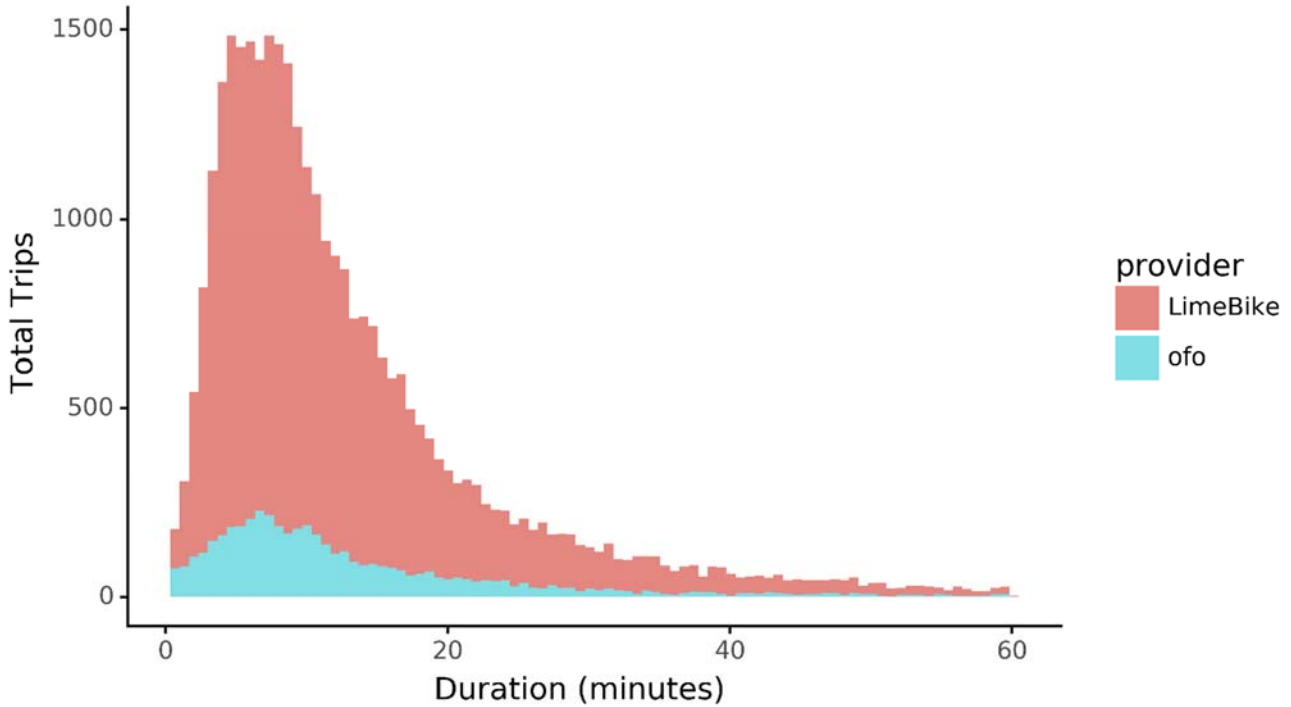


FIGURE 8: Frequency of dockless bikeshare trip durations.

TRIP DISTANCES

FIGURE 9 plots the frequency of trips by straight-line distance and shows that the majority of trips are less than 3 miles (97%), 91% are less than 2 miles, and 64% are less than 1 mile.

The most common trip distances are between 0.5 and 1.0 miles, which represents approximately 31% of trips. These distances are consistent with the duration of trips and common destinations in Mountain View. It is noted that there are a high number of trips less than a tenth of a mile long. It is not certain if these were utilitarian trips but did not fall within the parameters of those removed for data cleaning.

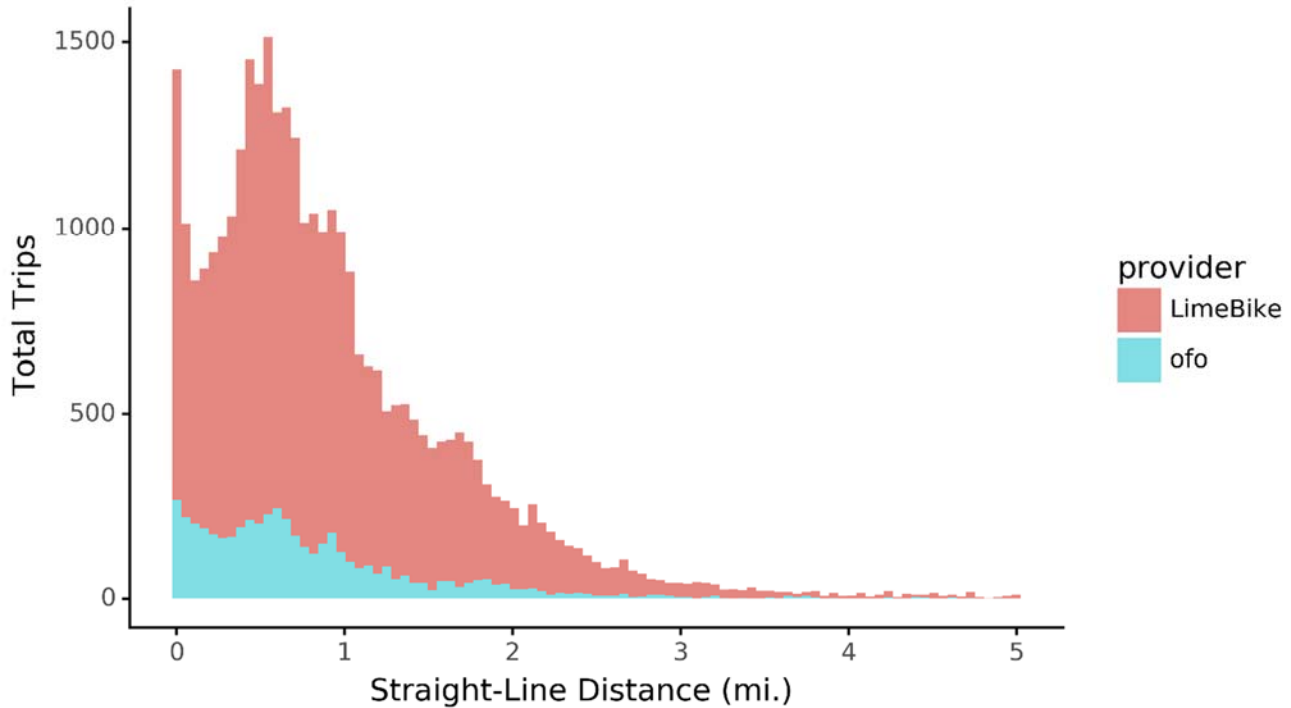


FIGURE 9: Distance of trips by mile.

SPATIAL PATTERNS

ALL TRIPS

The 32,075 trips taken in Mountain View were plotted on **FIGURE 10** to view spatial patterns. The vast majority of trips started or ended within the City of Mountain View. However, Sunnyvale had 1,028 trips start or end in that city (3% of all trips), Los Altos had 991 trips (3%), and Palo Alto had 817 trips (2%).

During the pilot period, some of the most popular origins and destinations were:

- Downtown Mountain View: approximately 15,900 trips started or ended in the area bound by the Central Expressway and El Camino Real, and S Shoreline Boulevard and Calderon Avenue. This represents approximately half (50%) of all trips,
- Mountain View Station: 6,408 trips started or ended here, which represents 20% of all trips,
- Google Campus: 5,274 trips started or ended here, which represents 16% of all trips, and

- Shoreline Amphitheatre: 1,143 trips started or ended in this area, which represents 5% of all trips.

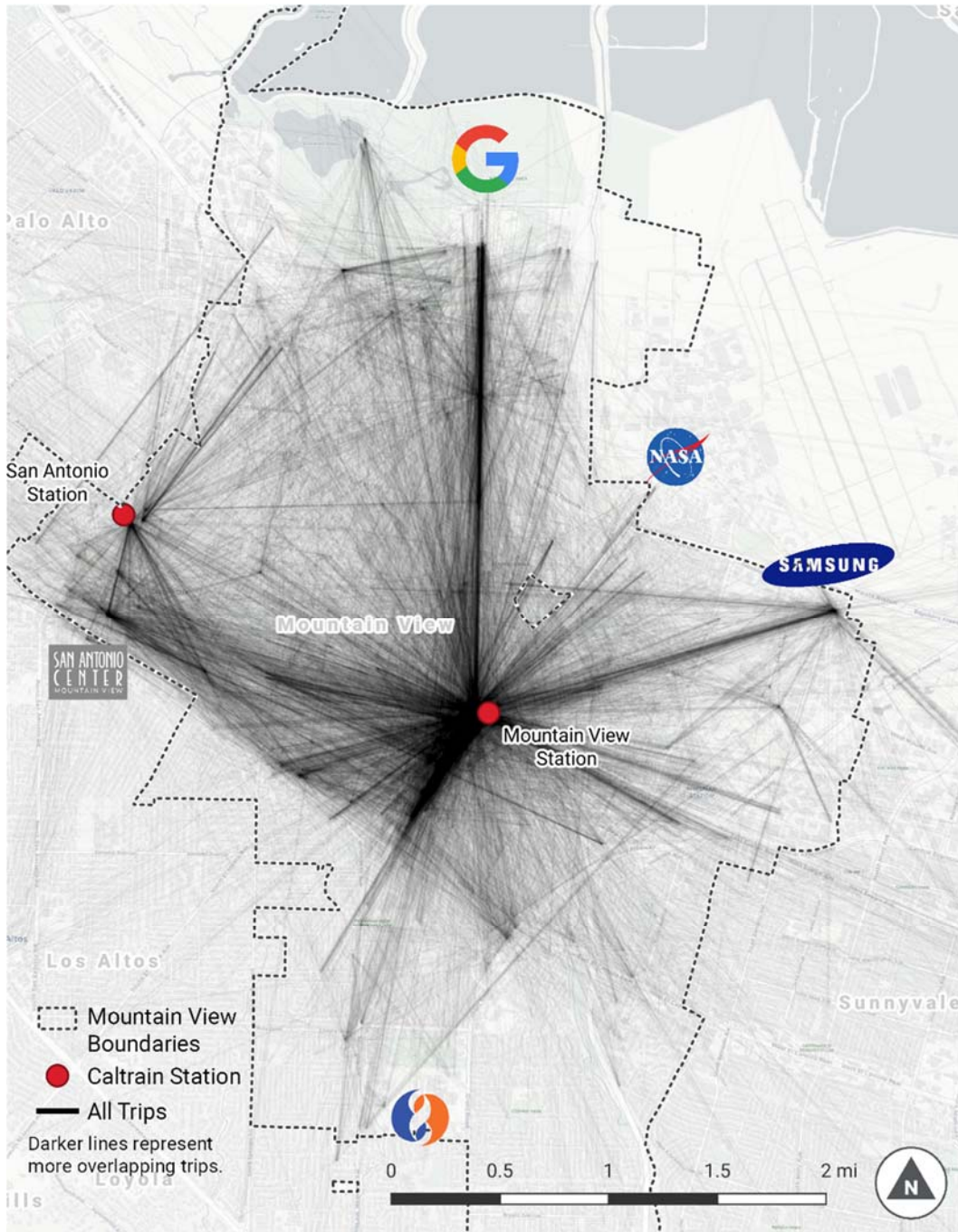


FIGURE 10: Spatial patterns of all bikeshare trips.

Other areas with high activity were the neighborhoods located southwest of the Mountain View Caltrain Station (likely making trips to and from the train station), other large employers including Samsung and NASA, and the San Antonio Station area.

Approximately 750 trips, or 2.4% of all trips, started or ended in areas designated as Communities of Concern (CoC). These communities represent approximately 1.8% of the city's land area and 4.9% of the city's population so are over-represented by land area and under-represented by population in terms of the number of bikeshare trips made in these areas.

The density of trip start and end points is shown in **FIGURE 11** and shows that the majority of trips start or end in Downtown Mountain View, at the Mountain View Caltrain Station, or along the El Camino Real / California Street and Shoreline Boulevard corridors.

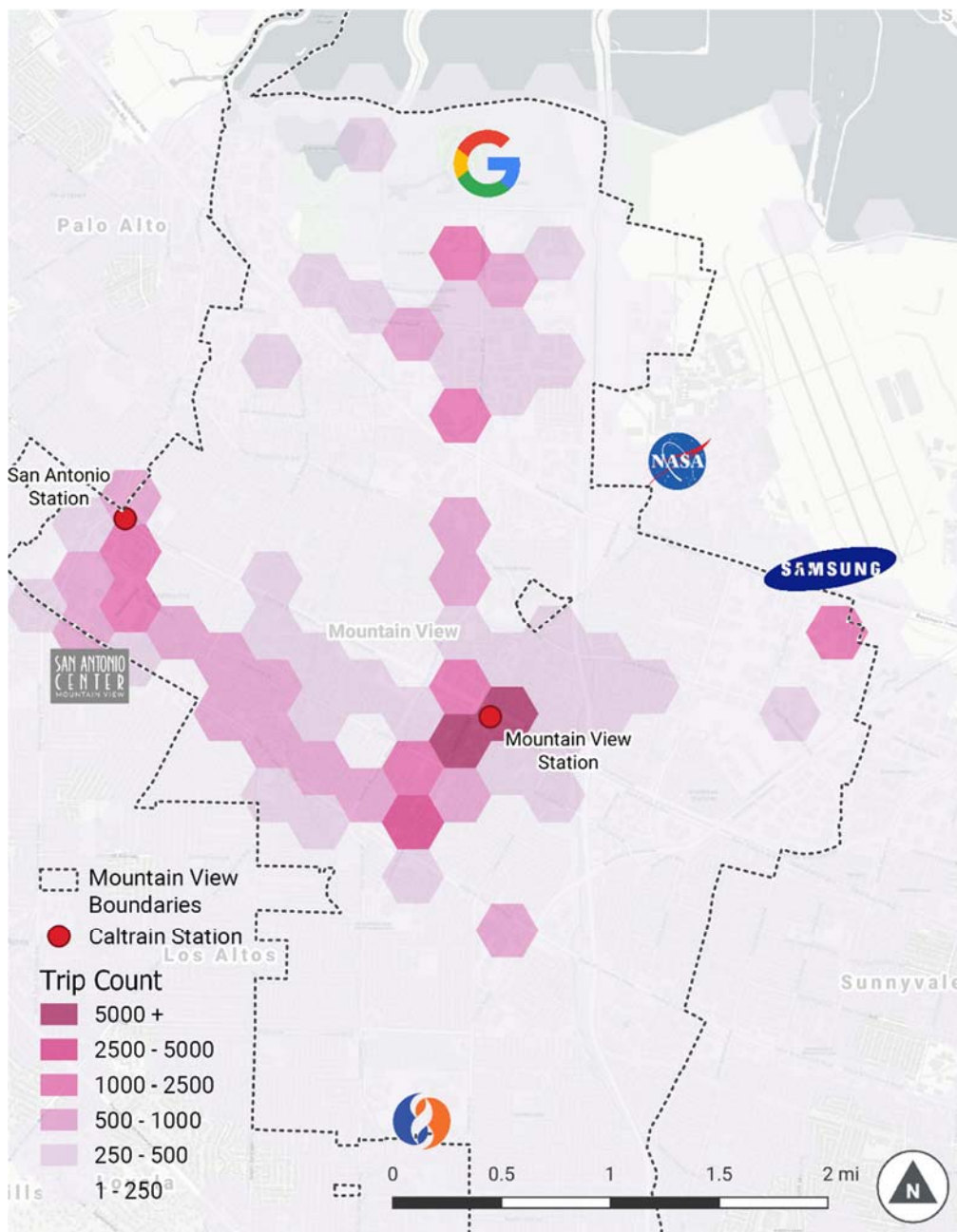


FIGURE 11: Density of total trips (all trip starts and ends).

SPATIAL PATTERNS BY TIME OF DAY, DAY OF WEEK

Bikeshare peak times are from 7-9 AM and 4-6 PM during weekdays. Ridership during these four hours is almost as many as are made during the rest of the day and are shown on **FIGURE 12**. The morning peak consists of people traveling to and from the neighborhoods southwest of downtown, destinations on El Camino and California Street, and the Mountain View Caltrain Station. The evening peak consists mostly of people traveling from Google to the Mountain View Caltrain Station and from the Mountain View Caltrain Station to Shoreline Amphitheatre, which typically holds events that start from 4-7 PM.

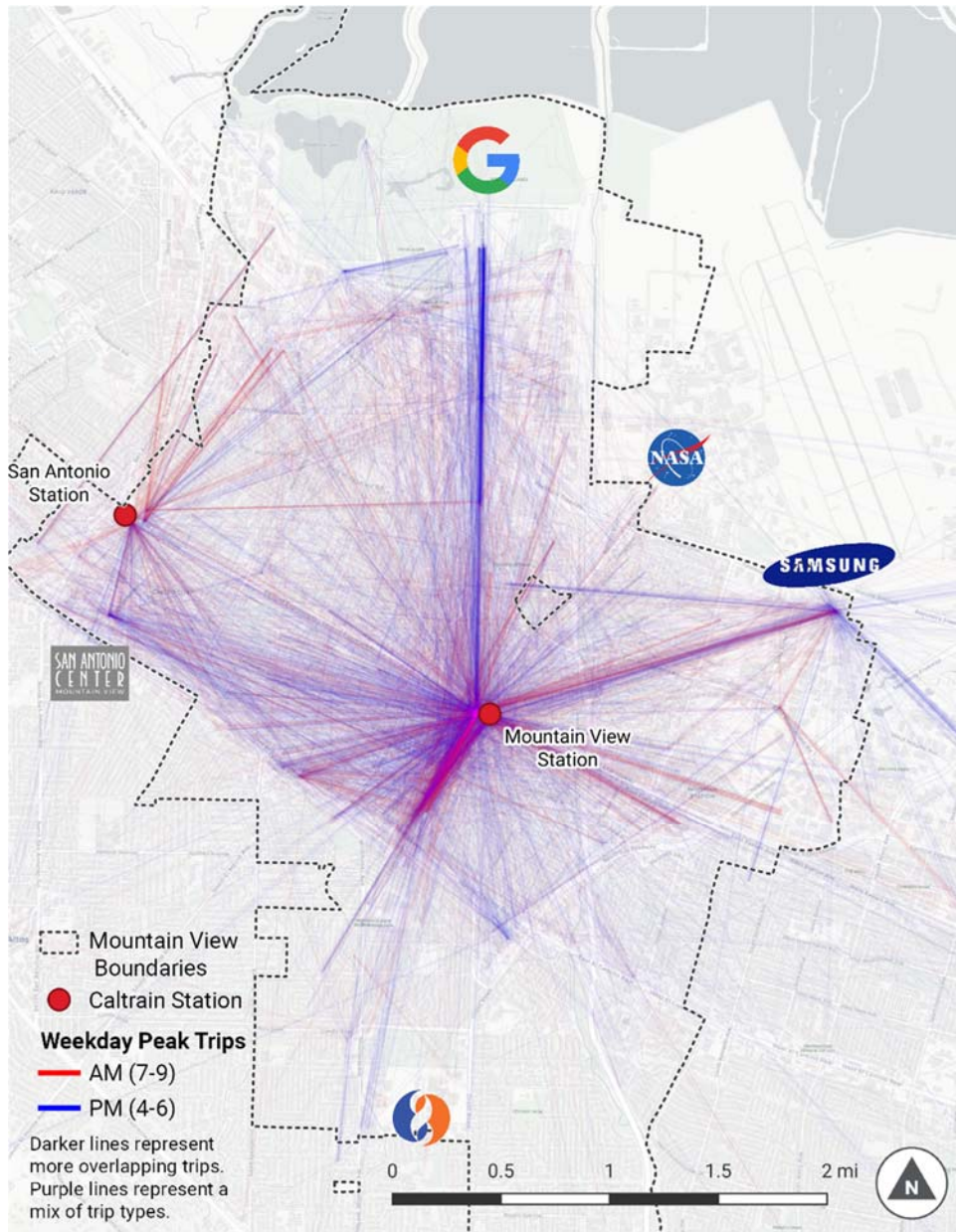


FIGURE 12: Spatial patterns of weekday peak trips.

The spatial pattern of weekend peak trips are mapped on **FIGURE 13** and shows that trips to and from Google and the Mountain View Caltrain Station are well represented, however there is a greater diversity in destinations compared to the weekday peak hours and include more recreational and entertainment destinations such as the San Antonio Shopping Center, Downtown Mountain View, the Shoreline Amphitheatre and park, and residential neighborhoods.

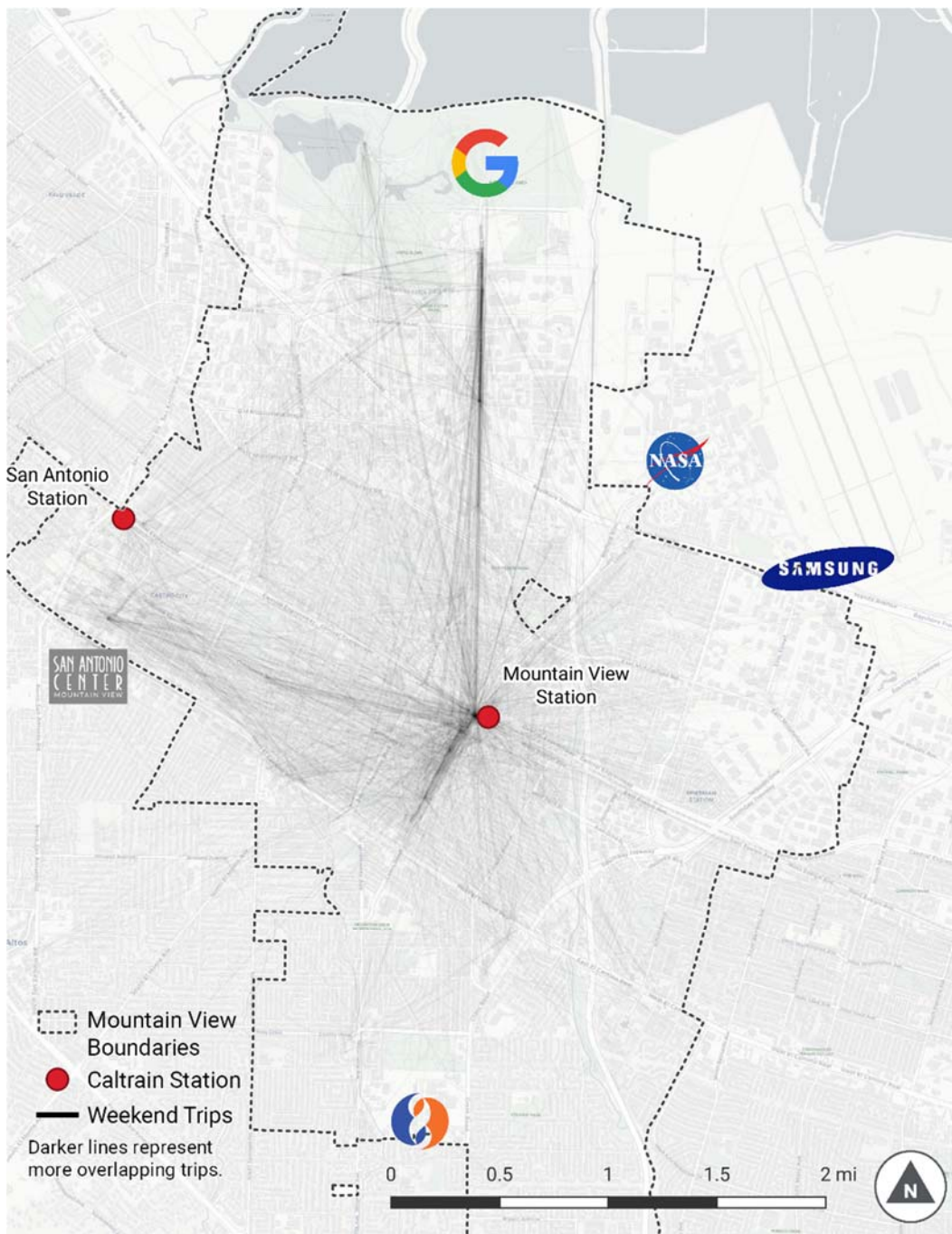


FIGURE 13: Spatial patterns of weekend peak trips.

CONCLUSION

In Mountain View, dockless bikeshare is used for both utilitarian and recreational trips including commuting trips connecting to major employment centers and connecting the first and last mile to and from transit. Approximately 33,500 trips were taken over the 4-month period of the pilot program, representing approximately 250 trips per day or an average of 0.80 trips per bike per day. The below metrics were used to measure the effectiveness of the program and identify opportunities for improvement:

- **Utilization:** the program had an average 0.80 trips per bike per day. This is higher than the ridership observed by the previous Bay Area Bike Share docked bikeshare program and higher than the 0.3 trips per bike per day that the National Association of City Transportation Officials (NACTO) determined as the average utilization for dockless bikeshare systems in 2017.¹
- **Trip patterns:** the trends patterns observed by the system show that weekday trips are slightly higher than weekend trips, however, the system appears to be used for both utilitarian trip-making such as commuting to work as well as for recreation and entertainment. Most trips are short, less than 20-minutes and less than 1-mile.
- **Key destinations:** the system recorded significant trip starts and ends in Downtown Mountain View, at the Mountain View Caltrain Station, along the El Camino and California Street corridors, along Shoreline Boulevard, and at the Google campus and Shoreline Amphitheatre as well as other large employers in Mountain View. Some trips (less than 10%) crossed the city boundaries into neighboring cities.
- **Community comments:** there was good levels of support amongst online comments reviewed as part of this study. However, there were concerns raised about how and where bicycles were being parked and the response times of operators to remove obstructing bikes. There was also some misunderstandings or lack of knowledge regarding the pilot program and the regulations that vendors are required to follow suggesting greater public education may be useful for any future program.
- **Missing data:** several data elements including user information, bike identification numbers, GPS locations of the bikes when not being used, and GPS routing information were not provided and limited the analyses that could be conducted. Including this data in future data requirements from bikeshare operators will allow routing, parking, and bike availability analyses of the program in the future.

¹ <https://nacto.org/bike-share-statistics-2017/>