SANDAG

SAN DIEGO REGIONAL TRANSPORTATION STUDY

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VOLUME I: TECHNICAL REPORT

PREPARED FOR:
SAN DIEGO ASSOCIATION OF GOVERNMENTS

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the science of insight

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ACKNOWLEDGEMENTS

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GLOSSARY OF ACRONYMS

AB:	Activity-based
ABS:	Address-based sample
BG:	Block Group (Census)
CBO:	Community-based organizations
CDS:	Computer Delivery Sequence file
FAQ:	Frequently asked questions
HH:	Household
HTS:	Household Travel Survey or Household Travel Study
MSG:	Marketing Systems Group
PMP:	Project Management Plan
NDS:	National Data & Surveying Services
NHTS:	National Household Travel Survey
RDD:	Random Digit Dialing
SANDAG:	San Diego Association of Governments
USPS:	United States Postal Service

1.0 EXECUTIVE SUMMARY

1.1 OBJECTIVES

The San Diego Regional Transportation Study began in 2016 and ended in 2017. The household travel survey (HTS) data are collected about every ten years to update, improve, and maintain the SANDAG travel demand forecast models, which support planning and policy development. The project's primary goal was to deliver a dataset of the highest quality for activity-based (AB) modeling. The last comparable study conducted by SANDAG used notably different methods and began in 2006 and ended in 2007.

1.2 METHODOLOGY

The study employed innovative methods and produced a higher-quality and higher-quantity dataset than similar previous studies in the region. Methodology highlights include the following:

- Used an address-based sample (ABS)—compared to a random digit dialing (RDD) sample for the prior study in 2006—with significant oversampling of populations of interest (e.g., bike riders)
- Conducted a two-part survey; part one (the "recruit" survey) gathered data about households' demographic composition and typical travel behaviors; part two (the "travel diary") gathered individual travel data during a specified travel period for all members of the household
- Leveraged smartphone-based travel diaries as the primary means of travel data collection; households with smartphones participated using the smartphone-based GPS travel diary and survey app, rMove™, for one week
- Accommodated participating households without smartphones by allowing them to complete their one-day travel diary online or by calling the study call center
- Leveraged advanced technologies and methods to improve the dataset, Google Maps API to help capture and validate location, and travel data and machine-learning algorithms to clean and prepare data accurately and efficiently

1.3 OVERALL RESULTS

The study **obtained complete surveys from 6,199 households, exceeding the project goal of 5,500** households completing their surveys. These households completed 22,598 days where all household members provided all travel details. This dataset compares favorably to the 2006 SANDAG household travel study. Complete households increased by 70% (6,199 vs. 3,651 households) and travel days increased by more than 500% (22,598 vs. 3,651 complete travel days). The dataset collected more than 282,000 trips and nearly 31 million GPS points to detail the origins, destinations, and travel paths of trips. More than 193,000 trips were collected on days with complete data for the household, an increase of 460% compared to the 2006 study. Figure 1-1 visualizes trip destinations for each of the 1,795 census Block Groups (BGs) within San Diego County (for reference, the 2006 study averaged fewer than 20 trips per census BG, while the 2017 study averaged more than 150 trips per census BG). Figure 1-2 and Figure 1-3 summarize the trips by travel mode and purpose by time of day.

Across multiple demographic measures, the data collected were representative, especially after RSG applied a rigorous data weighting process using data from the American Community Survey (ACS). Overall, the study applied innovative methods to capture a higher-quality and higher-quantity dataset.

FIGURE 1-1: UNWEIGHTED COUNTS OF TOTAL TRIP DESTINATIONS WITHIN SAN DIEGO COUNTY, BY BLOCK GROUP

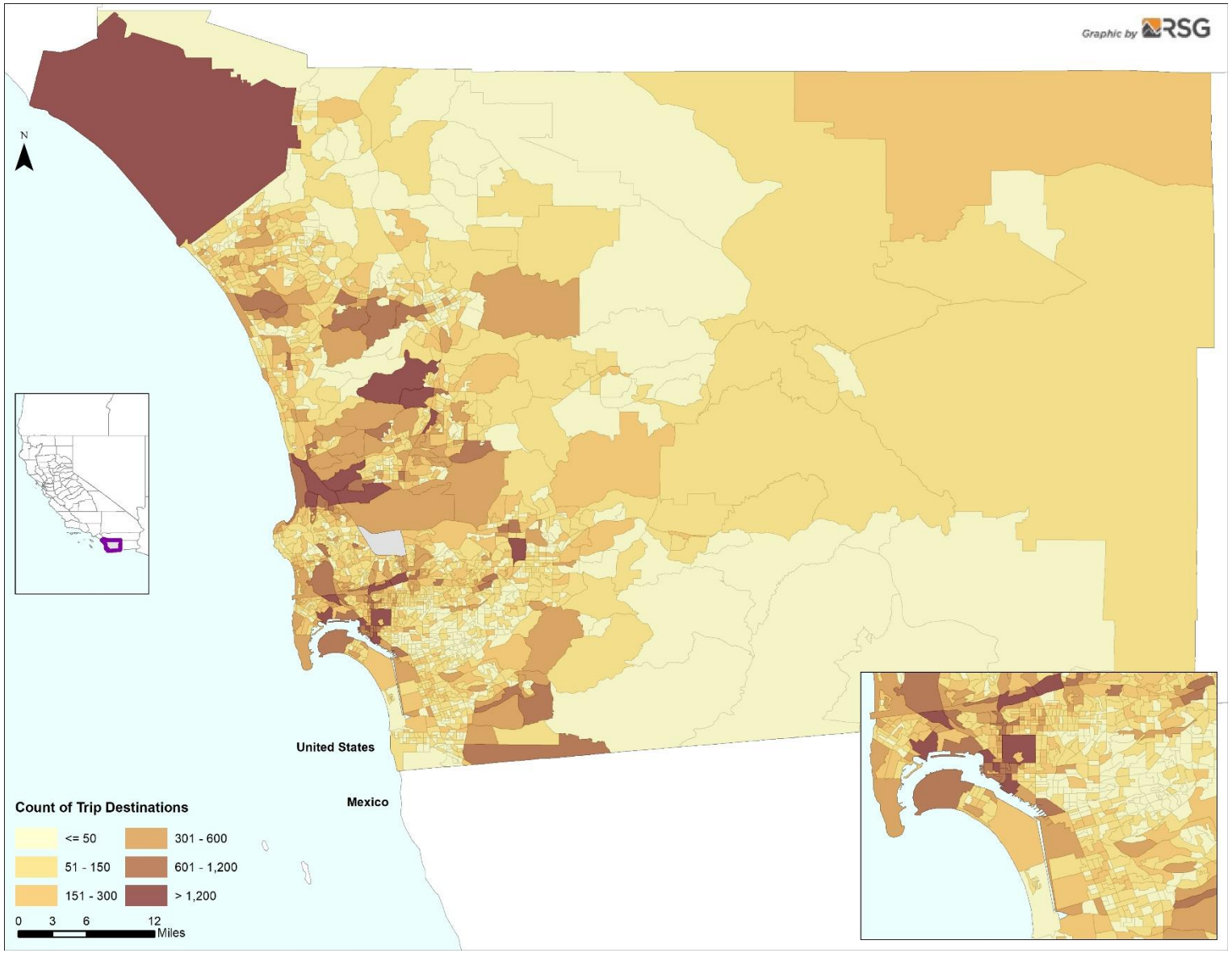


FIGURE 1-2: DESTINATION PURPOSE BY HOUR OF DEPARTURE (MIDNIGHT TO 11:00 P.M.) (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)

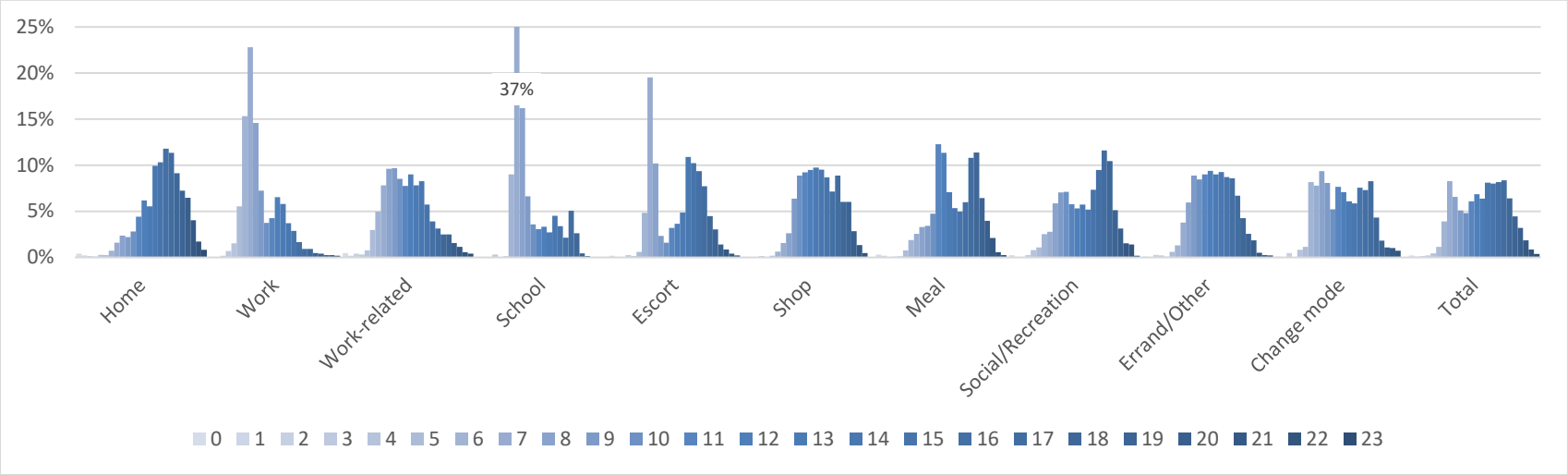
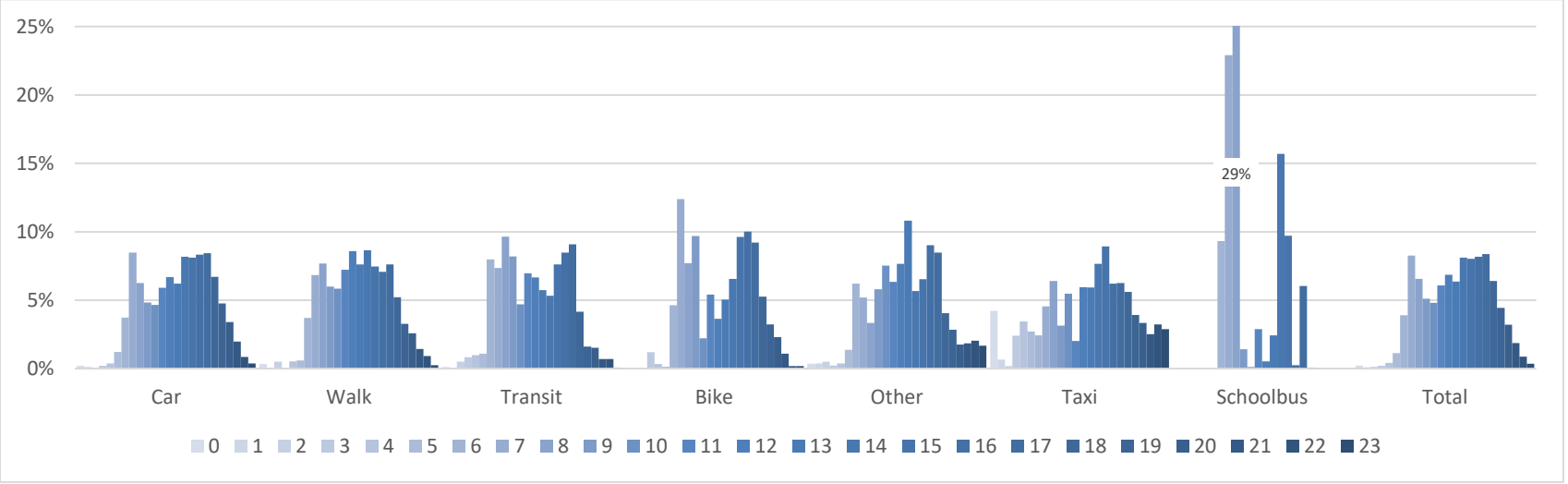


FIGURE 1-3: TRIP MODE BY HOUR OF DEPARTURE (MIDNIGHT TO 11:00 P.M.) (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



1.4 OVERVIEW OF TRAVEL BEHAVIOR RESULTS

OVERALL TRAVEL BEHAVIOR

Several key figures regarding the travel behavior captured in this dataset are shown below using weighted data. The weighted data (as described in detail later in the report) excluded weekend days and was adjusted by data collection mode to account for households reporting multiple travel days and those only reporting a single travel day. The mode shares and destination categories shown in Figure 1-4 and Figure 1-5 are summarized to higher-level categories. More detailed categories are shown in Table 1-1 and Table 1-2. The detail in these tables is often partially confounded by inconsistency in participants' responses to detailed answer choices. As such, many of the charts in this report use aggregated categories (e.g., "transit" vs. each specific transit option).

In addition, this dataset is a primary input to future transportation modeling at SANDAG. Certain figures reported here, such as travel mode shares, may differ from future travel demand modeling scenarios. Transit and walk mode shares, in particular, are likely to be different between this report and future modeling scenarios for several reasons. These reasons include the use of linked versus unlinked trips and the incorporation of additional data into the SANDAG models (such as the regional transit on-board survey). This dataset reflects the travel of residents of San Diego County and does not necessarily reflect the travel of visitors or nonresidents, which is an additional reason for possible differences between the figures in this report and future modeling scenarios.

Cars represent 83.1% of all weekday trips, up from 81.7% in 2006. Walking represent 11.5% of all trips, transit represents 3.3%, and all other travel modes are approximately 2%.[1]

Figure 1-4 shows the overall mode share breakdown for trips made by the survey respondents.[1]. Cars represent 83.1% of all weekday trips, up from 81.7% in the 2006 report. Walking trips represent 11.5% of all trips, transit represents 3.3%, and all other modes total approximately 2%.

[1] Survey respondents did not include visitors or non-residents. These numbers are based on unlinked trips. For example, walking to a transit station, riding a bus, and transferring to another bus counts as three unlinked trips.

FIGURE 1-4 OVERALL TRAVEL MODE (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)

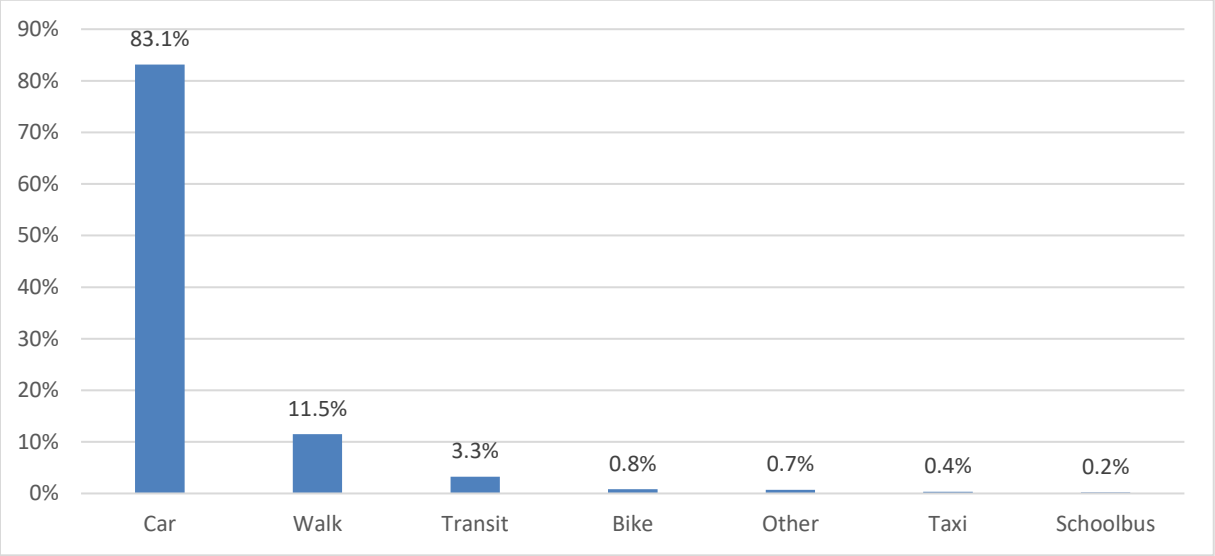


Figure 1-5 shows the overall destination purpose breakdown. Home trips represent nearly 30% of all weekday trips. Work and work-related trips comprise just under 15% of trips, while escort trips come in at 12.8% of trips.

FIGURE 1-5 OVERALL DESTINATION PURPOSE (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)

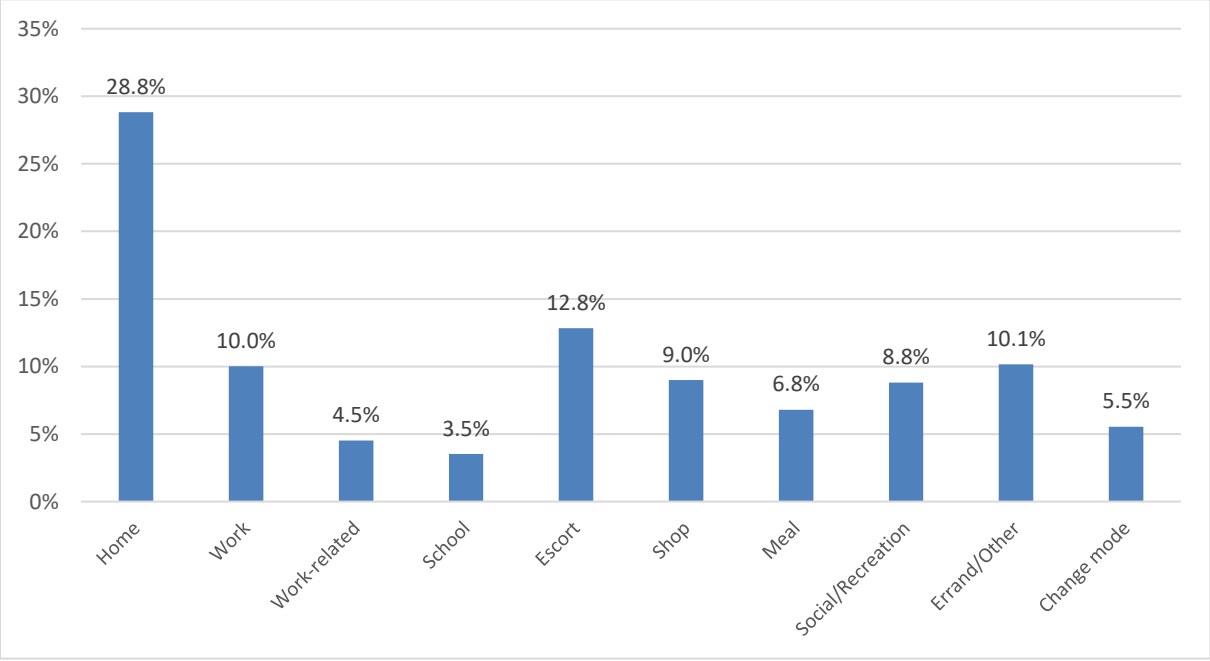


TABLE 1-1 DETAILED DESTINATION PURPOSE (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)

TRIP DESTINATION PURPOSE	TRIPS PER DAY (AS WEIGHTED)	%	CUMULATIVE %
Home	3,551,953	28.8%	28.8%
Primary workplace	1,233,735	10.0%	38.8%
Restaurant	837,989	6.8%	45.6%
Change travel mode	683,894	5.5%	51.2%
Drop someone off (rMove only)	677,884	5.5%	56.7%
Grocery	538,815	4.4%	61.0%
Exercise	526,936	4.3%	65.3%
Pick someone up (rMove only)	523,793	4.2%	69.6%
Other purpose	505,548	4.1%	73.7%
Work-related	476,976	3.9%	77.5%
Routine shopping	409,509	3.3%	80.9%
Errands without appointment	286,227	2.3%	83.2%
Drop-off, pick up, accompany person (Online diary only)	285,294	2.3%	85.5%
School/Class	210,773	1.7%	87.2%
Medical	210,114	1.7%	88.9%
Social (rMove only)	185,406	1.5%	90.4%
Social/leisure/vacation activity (Online Diary only)	153,187	1.2%	91.7%
Gas	131,464	1.1%	92.7%
Other errand	113,575	0.9%	93.7%
Errands with appointment	105,476	0.9%	94.5%
K-12 School	99,100	0.8%	95.3%
College/University	90,987	0.7%	96.1%
Leisure/entertainment (rMove only)	88,109	0.7%	96.8%
Family activity (rMove only)	61,542	0.5%	97.3%
Multiple: pickup, drop-off, accompany (rMove only)	59,459	0.5%	97.8%
Other work	56,243	0.5%	98.2%
Religious/civic (rMove only)	38,525	0.3%	98.5%
Accompany someone (rMove only)	35,775	0.3%	98.8%
Vacation/travel (rMove only)	31,217	0.3%	99.1%
Shopping for a major item	29,559	0.2%	99.3%
Other leisure (rMove only)	28,366	0.2%	99.5%
Other education-related (e.g., field trip)	25,086	0.2%	99.7%
Traveling for work (e.g., going to airport)	16,243	0.1%	99.9%
Volunteer work	8,634	0.1%	99.9%
Vocational education	7,582	0.1%	100.0%
Total	**12,324,980**	**100.0%**	

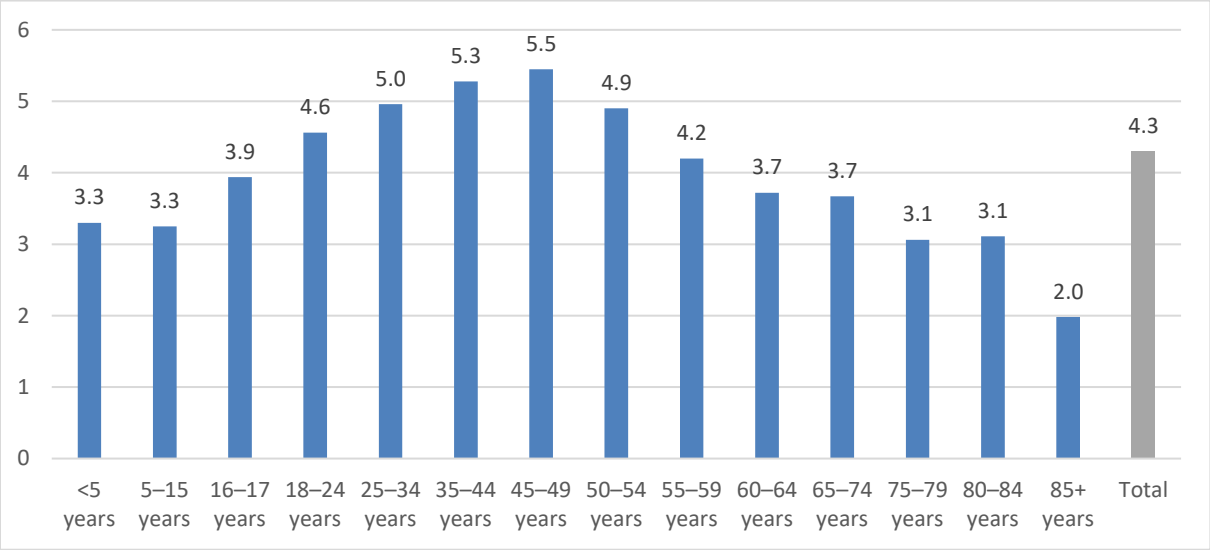
TABLE 1-2 DETAILED TRIP MODE SHARE (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED) [1]

TRAVEL MODE 1	TRIPS PER DAY (AS WEIGHTED)	%	CUMULATIVE %
Any household vehicle or motorcycle	9,526,507	77.3%	77.3%
Single occupancy vehicle	*4,874,163*	*51.2% of subtotal*	-
Double occupancy vehicle	*2,511,924*	*26.4% of subtotal*	-
3+ occupancy vehicle	*2,140,420*	*22.5% of subtotal*	-
Walk/jog/wheelchair	1,055,900	8.6%	85.9%
Bus	474,272	3.8%	89.7%
Friend's car	282,751	2.3%	92.0%
Work car	266,866	2.2%	94.2%
Rail - Light	191,424	1.6%	95.7%
Personal bike	101,093	0.8%	96.5%
Other auto	81,660	0.7%	97.2%
Rental car	67,315	0.5%	97.8%
Other mode	50,417	0.4%	98.2%
School bus	48,842	0.4%	98.6%
Taxi - Rideshare	34,234	0.3%	98.8%
Express Bus/Rapid	30,722	0.2%	99.1%
Shuttle bus	21,822	0.2%	99.3%
University bus or shuttle	14,027	0.1%	99.4%
Vanpool	11,546	0.1%	99.5%
Skateboard	10,326	0.1%	99.6%
Airplane	9,630	0.1%	99.6%
Taxi - Regular	8,940	0.1%	99.7%
San Diego COASTER Line	8,567	0.1%	99.8%
Golf cart	7,388	0.1%	99.8%
Carshare	4,910	0.0%	99.9%
Other bus	4,071	0.0%	99.9%
Rail - Intercity	3,823	0.0%	99.9%
Ferry or water taxi	3,329	0.0%	100.0%
Borrowed bike	1,359	0.0%	100.0%
ATV	761	0.0%	100.0%
Paratransit	638	0.0%	100.0%
Rail - Other	622	0.0%	100.0%
Intercity bus	478	0.0%	100.0%
Subway	445	0.0%	100.0%
Rental bike	295	0.0%	100.0%
Total	**12,324,980**	**100%**	

[1] Participants using rMove could select multiple modes for a single trip, but only “Mode 1” is reported here. Fewer than 1% of trips had multiple modes reported.

Figure 1-6 shows the total number of linked trips for weekdays by age, with a total of 4.3 trips per person per weekday; which represents the number of trips for an "average person." The equivalent figure for the "average household" is 11.3 trips per weekday. The details behind these numbers are covered in Section 7.0 Expansion and Weighting.

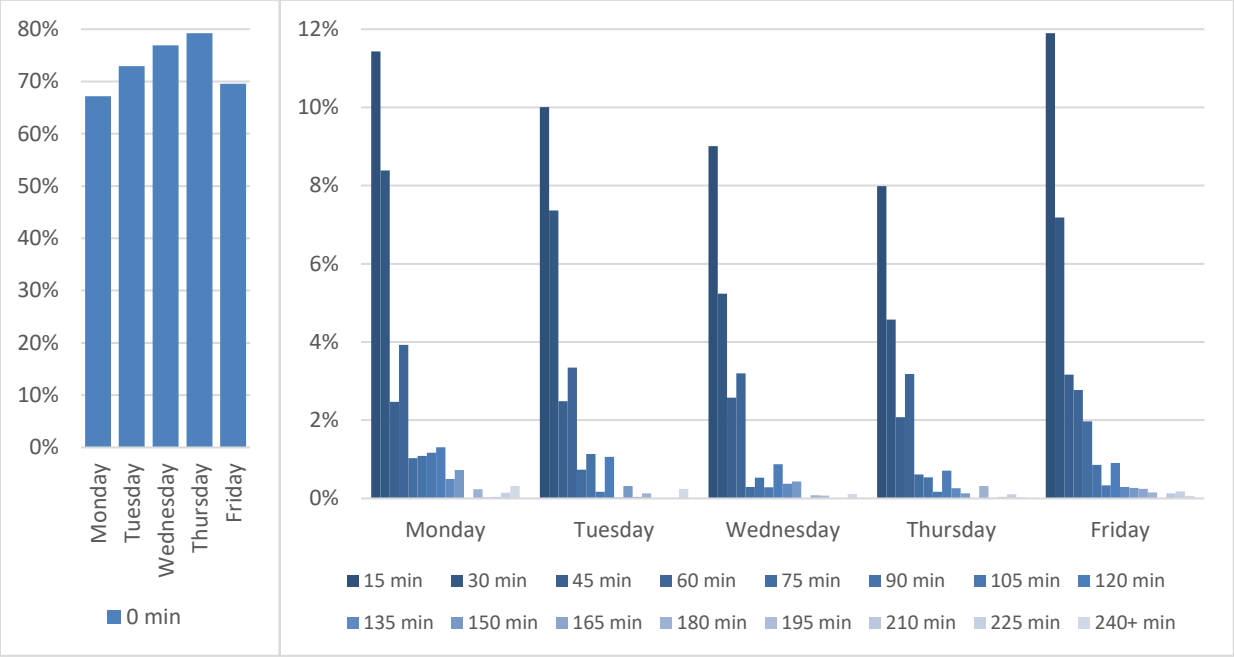
FIGURE 1-6: AVERAGE LINKED TRIPS PER WEEKDAY, BY AGE GROUP ADJUSTED (COMPLETE HOUSEHOLD DAYS, WEIGHTED, TRIP-RATE-ADJUSTED, TRIPS FROM THE HTS DATASET AS DELIVERED)



The study asked questions about online shopping and telework for each day, which are analyzed in Figure 1-7 and Figure 1-8. Because these distributions are so heavily skewed to the low end of the spectrum, two charts are provided for each topic. The left-most charts show the percentage of people reporting no time doing these activities, while the right-most charts show the distribution for people reporting any time doing these activities. Because these charts use the weighted data, they do not analyze activity on weekends.

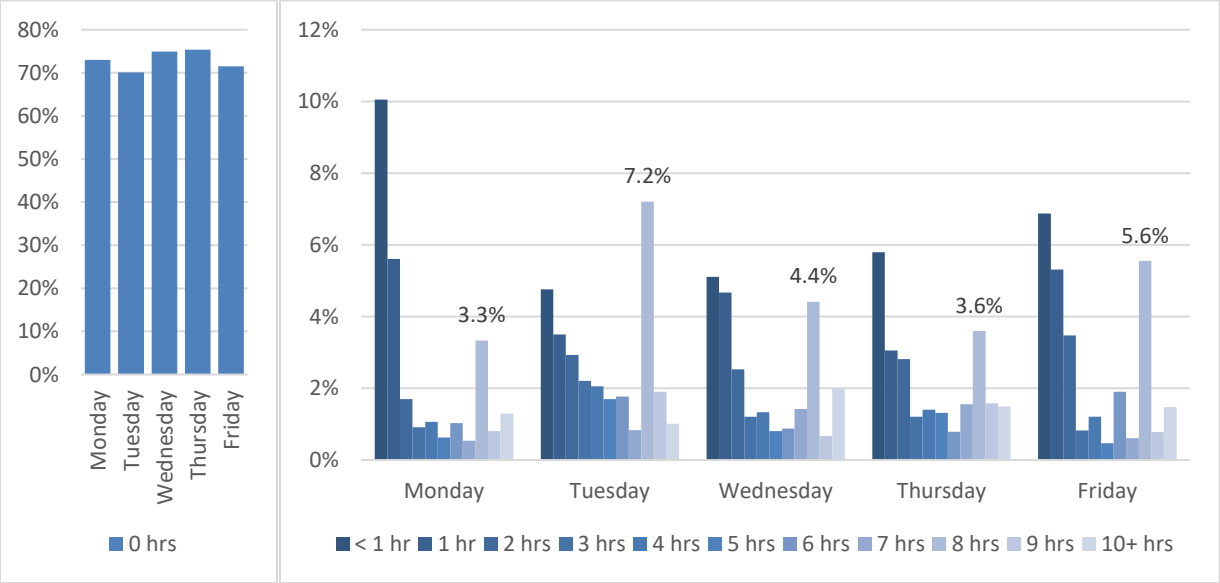
Across weekdays, 21-33% of participants report some level of online shopping activity. The distribution of online shopping time is similar across days with an overall decrease in time from Monday to Thursday and a peak on Friday. It may also be possible that many respondents round to the nearest half-hour, given the shape of each curve.

FIGURE 1-7: ONLINE SHOP TIME BY DAY OF WEEK (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



Across weekdays, 25-30% of participants reported some kind of teleworking. Among survey participants who reported teleworking, the most frequent telework days were Tuesday and Friday with slight decreases at the start and middle of the week. Across all days, the most frequent lengths of telework time were short intervals (e.g., 15-30 minutes) or full work days of eight hours.

FIGURE 1-8: TELEWORK TIME BY DAY OF WEEK (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



WORK TRIPS

While work trips (i.e., trips with a destination purpose of “work” or “work-related”) exhibit many of the same patterns as trips overall, some patterns are only apparent when broken out separately. For example, car and bike trips exhibited similar distributions while taxi, walk, and “other” modes were used more sporadically throughout the day. The car, bike, and total mode shares all peak at the 7AM departure house, while and taxi peak at the 8AM hour, ‘other’ peaks at 6AM, and school bus peaks at 2PM.

It should be noted that transit trips are not included here, given that this is an “unlinked” dataset, implying that most the transit trips are given a destination purpose of “change mode” rather than “work” in this dataset. (Figure 1-9). The distribution of work-related trip times and distances was found to vary slightly across income levels and MSAs, however further analysis can more clearly differentiate “commutes” from all work and work-related trips. (Figure 1-10).

FIGURE 1-9: WORK TRIPS: TRIP MODE, BY DEPARTURE HOUR (12 A.M. TO 11 P.M., COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)

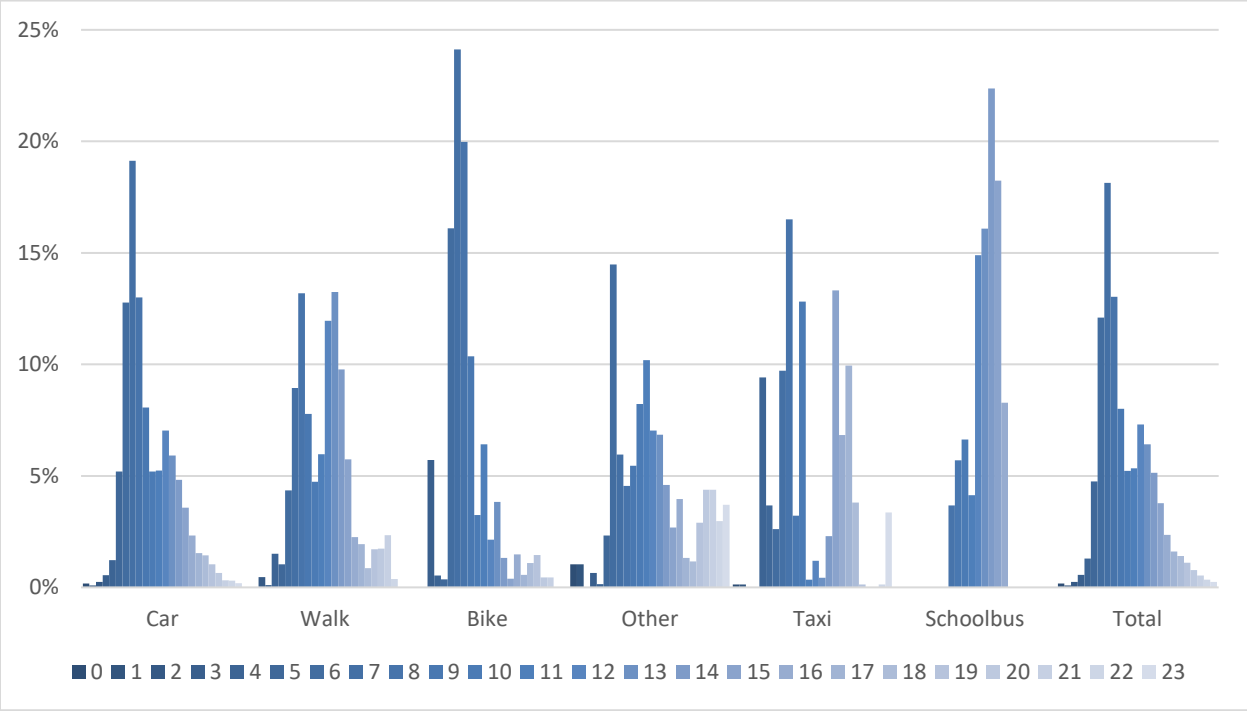
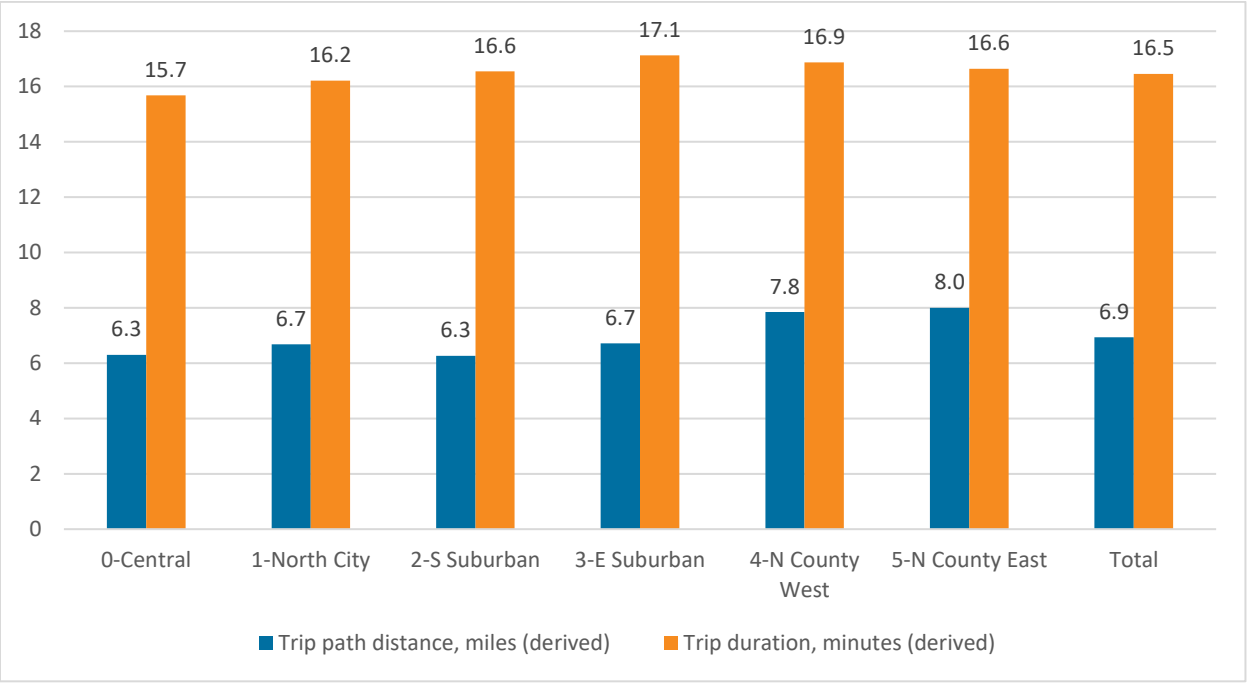


FIGURE 1-10: WORK TRIPS: AVERAGE TRIP DURATION AND DISTANCE BY MSA (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



2.0 INTRODUCTION

2.1 STUDY OBJECTIVES

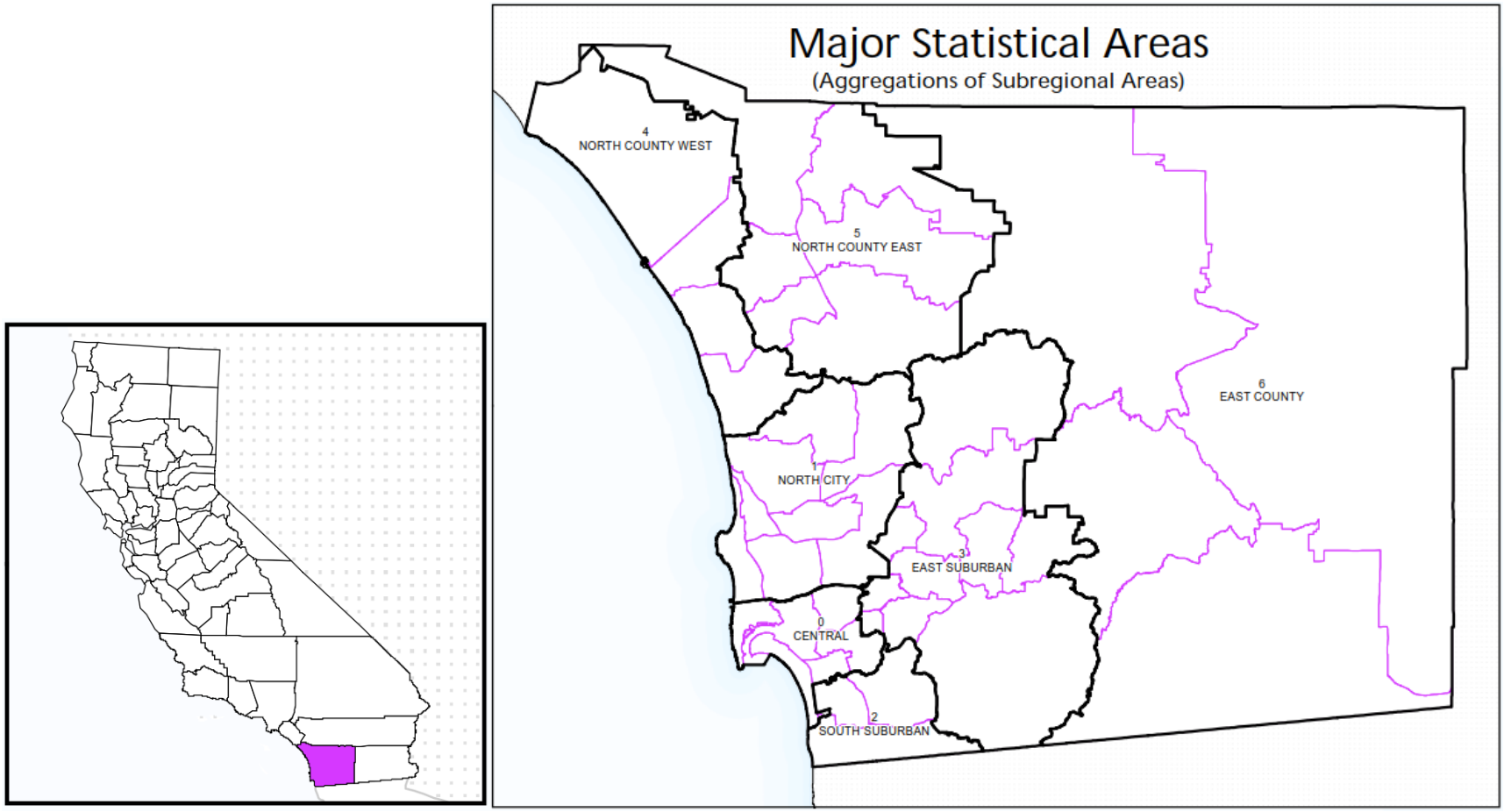
The San Diego Regional Transportation Study began in 2016 and ended in 2017. The collected HTS data are used to update, improve, and maintain the SANDAG travel demand forecast models, which support planning and policy development. The project's primary goal was to deliver a dataset of the highest quality for AB modeling. The last comparable study conducted by SANDAG used notably different sampling and data collection methods and began in 2006 and ended in 2007.

2.2 STUDY AREA

The study was conducted within San Diego County (Figure 2-1). The county includes 1,795 census BGs with 3,223,096 people and 1,094,157 households.[2] The county contains several noteworthy considerations that affected the study design, including multiple large military installations, numerous colleges and universities, and several high-volume border crossing locations between the United States and Mexico. San Diego County also includes myriad land uses, from dense urban environments to sparsely populated areas.

[2] Data from the 2011–2015 American Community Survey (ACS) for San Diego County.

FIGURE 2-1: MAP OF STUDY AREA—SAN DIEGO COUNTY AND ITS MAJOR STATISTICAL AREAS (PROVIDED BY SANDAG)



2.3 STUDY TIMELINE

The scope of work for this project included three discrete travel surveys:

- The core household travel diary survey through which most households participated via a seven-day smartphone-based GPS travel survey
- An add-on survey comprising a one-day military travel diary
- An add-on active transportation study that included both an intercept survey and seven-day smartphone-based GPS travel survey

Table 2-1 documents the project's tasks and associated deliverables.

TABLE 2-1: STUDY TIMELINE

TASK DESCRIPTION	DELIVERABLES	SCHEDULE
Task 1: Project Management	• Conduct project kickoff meeting • Draft Project Management Plan (PMP) and project schedule • Final PMP and project schedule • Draft Work Plan • Final Work Plan	**January 2016**
Task 2: Survey Methodology and Instrument Design	• Data variables master list • Invitation materials • Recruit survey questionnaire • Web implementation of survey questionnaire • Reminder email and telephone scripts • Travel diary questionnaire • Web/app implementation of travel diary questionnaire • Estimated response rate and sample size • Documentation and summary of survey procedures	**February 2016–March 2016**
Task 3: Sample Design	• Pilot survey sample plan • Main survey sample plan	**February 2016 and July 2016**
Task 4: Pilot Survey	• Copies of questionnaires used in pilot survey • Website access for SANDAG to monitor survey and data collection efforts • Pilot survey dataset • Pilot survey dataset user guide • Memo of recommended changes for the main study • Finalized survey materials for main survey (including other language materials, as needed) • New estimate for response rate and sample size	**April 2016–August 2016**

TASK DESCRIPTION	DELIVERABLES	SCHEDULE
Task 5: Outreach	• Communications and public outreach plan (includes stakeholder list) • Printed survey materials • Project web page (includes FAQs) • Outreach and media materials (e.g., press releases) • Summary report of all outreach efforts	**August 2016– September 2016** **January 2017– March 2017**
Task 6: Survey Implementation and Unweighted Survey Dataset	• Regular/timely progress updates during survey fielding • Main survey dataset data preparation, cleaning, and quality control procedures • Main survey dataset (unweighted) • Main survey dataset user guide	**August 2016– October 2016** **January 2017– March 2017***
Task 7: Analysis and Weighted Dataset	• Draft weighting and expansion plan • Final weighting and expansion plan • Weighted and expanded dataset	**March 2017– July 2017**
Task 8: Final report and Data Delivery	• Draft report • Final report • Final survey datasets (weighted) • Final and comprehensive data documentation • Final copies of all study materials • Documentation that study data and materials were removed from consultant systems (re: confidential info. policy)	**May 2017– September 2017**
Task 9/10: AT/Intercept Add-on	• Pretest (August 2016) • Pretest results and analysis • Intercept plan • Conduct intercepts (February 2017) • Conduct rMove follow-up survey • Conduct household demographic follow-up survey • Final weighted dataset	**August 2016– February 2017**
Task 11: Military Add-on	• Distribute recruitment postcards to Naval bases • Conduct social media outreach for San Diego bases • Conduct media relations in military publications • Provide final datasets	**January 2017– March 2017**

Task 6's midstudy break sought to lessen the effect of November 2016 national elections on regional survey response. This break occurred following the first three travel weeks, including the additional "extra" week in October 2016. (This significantly smaller travel week was added to capture those households who recruited too late to participate in the second travel week, but who would have otherwise needed to wait until the study resumed in January 2017.)

2.4 PILOT STUDY OVERVIEW

RSG conducted a pilot study from April 4, 2016 through May 6, 2016. The pilot study comprised two travel weeks, each seven days long, starting on Tuesday, April 19 and Tuesday, April 26. The initial fielding period sought to evaluate the following components:

- Questionnaire/online survey
- Study materials
- Administration process
- Response rates
- Data quality
- Respondent burden

The pilot study aimed to collect data from approximately 150 households in select areas of the region representing certain household types and obtained 135 complete households. The project team included lessons learned from the pilot study in the development of the sampling plan for the main study. The following primary changes were made between the pilot study and the main study:

- Increased Spanish language text on the project web page and print materials
- Provided more thorough Spanish translations for both online surveys (rMove had already been translated)
- Updated list of travel planning and navigation tools about which households were asked (e.g., removing Strava as an option)
- Added more email and phone reminders for households before, during, and after their travel periods
- Updated the industry and occupation options about which households were asked
- Dropped the use of loaner smartphones tested during the pilot study; instead, collected additional samples from those that own smartphones
- Improved rMove user interface
- Improved rMove proxy trip reporting
- Improved rMove in-app trip editing (splitting, merging, and adding trips)

3.0 SURVEY SAMPLING

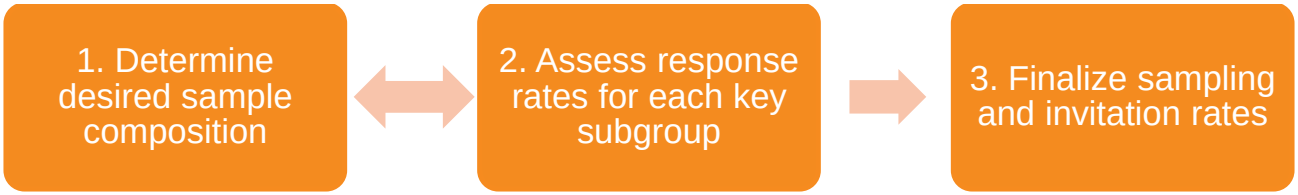
3.1 SAMPLING GOALS

The main study aimed to sample 5,500 completed household surveys, which equates to a 0.50% sample rate according to data from the 2011-2015 ACS, the data that was used at the time of sampling. However, beyond achieving the overall sample target, an objective was to ensure the sample was representative across key demographics and behaviors, as discussed below.

$$0.50\%\ \text{sample rate target} = \frac{\text{complete households}}{\text{total households in the study area}} = \frac{5{,}500}{1{,}094{,}157}$$

Figure 3-1 illustrates the sampling plan development process. The first step, determining the desired sample composition, depends heavily on the study area and the overall goals of the study. Step two, assessing response rates, is primarily based on experience from previous surveys (and from the pilot study for the current project). Step three is derived from calculating final sampling rates from steps one and two.

FIGURE 3-1: BASIC STEPS TO DETERMINE THE SAMPLING PLAN



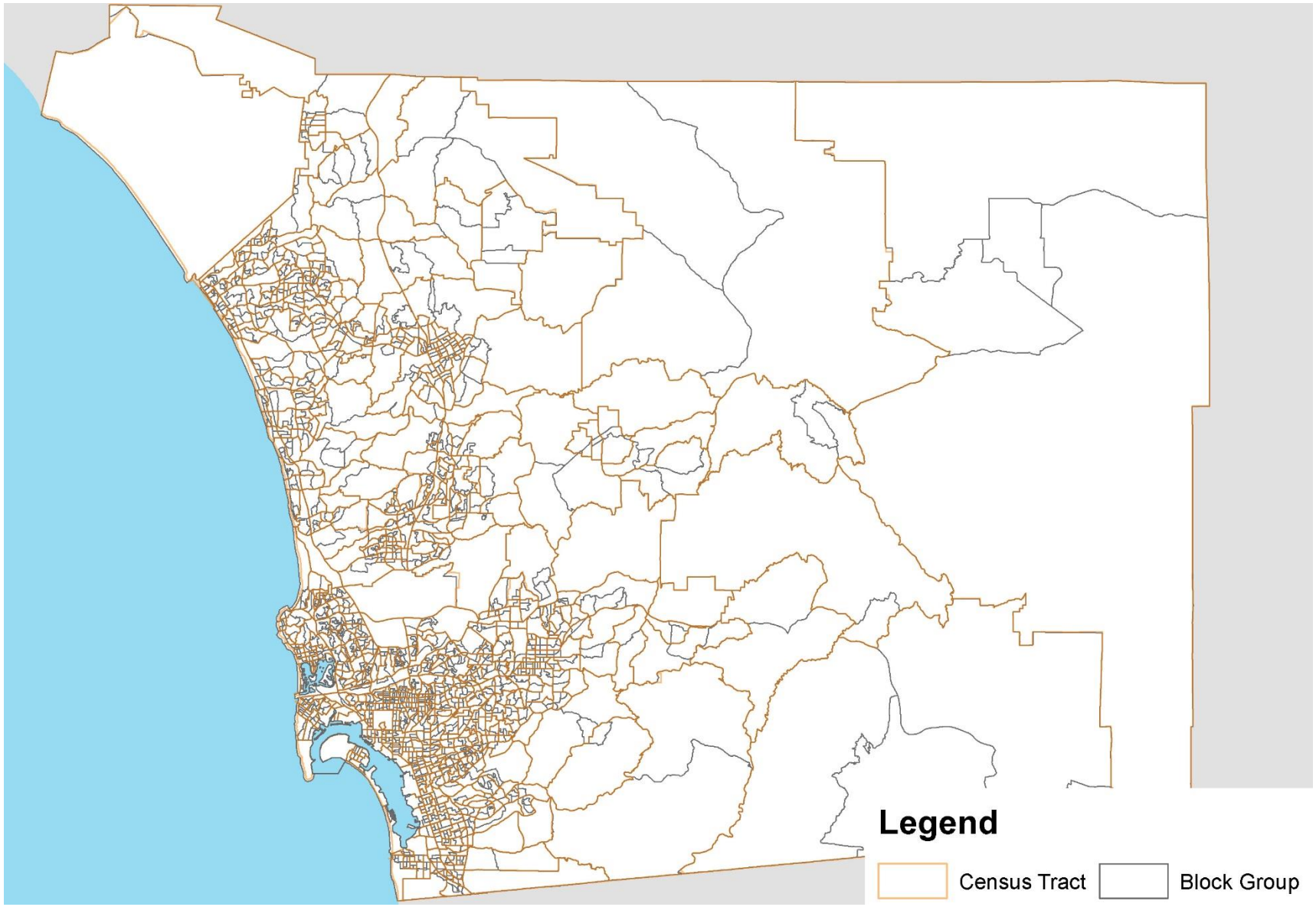
Section 9.0 Additional Surveys includes details on the sampling methods used for the two add-on studies.

3.2 SAMPLING METHODS

SAMPLING FRAME

The sampling frame was the list of all households in San Diego County (the study region). RSG used ABS to select households for the study. This method involves drawing a random sample of addresses from all the residential addresses in that area such that all households in each area have an equal chance of selection for the sample. The final household mailing addresses were purchased from Marketing Systems Group (MSG), which maintains the Computer Delivery Sequence (CDS) file from the United States Postal Service (USPS). RSG stratified the sample using census BGs and ACS data. The study region included 1,795 BGs, with a total population of 3,299,521 people in 1,113,610 households, as of the 2015 single-year ACS data, data and totals which were used in the final data weighting on this project. Of the 1,795 BGs, six had no households living in them, per the census. Figure 3-2 shows the extent of the study area, delineated by census BGs and census tracts. Each census tract encompasses one or more BGs.

FIGURE 3-2: STUDY AREA OF SAN DIEGO COUNTY



OVERSAMPLE CONSIDERATIONS

Based on the results of the pilot study, RSG identified certain populations and behaviors, such as transit users or Spanish-speaking households, as groups that would need to be oversampled (or over-invited) to meet the project's objectives. The top 2.5%, 5%, or 10% of BGs that represented the identified behavior (e.g., transit users) or demographic (e.g., Spanish-speaking) were selected to be oversampled. For example, the top 5% (listed as the "95th percentile") of BGs that contained bike commuters were selected to be oversampled.

The rate at which RSG oversampled each group was based on several factors:

- Expected completion rates for each region (informed by the pilot study)
- Degree of concentration of that behavior within certain BGs
- Relative rarity of finding the desired population

For example, Hispanic or Spanish-speaking households completed the pilot study at approximately half the rate of the general population, so increasing the sample rate helped to counteract the lower completion rates of these households. Conversely, the BGs that contained bike commuters participated in the pilot at a normal rate, but because finding bike commuters was still rare within these BGs, this behavior required a higher oversample rate to strengthen the number of bike commuters captured in the study. Furthermore, bike commuters are concentrated within a small number of BGs, so oversampling was an efficient way to obtain that extra data.

Finally, significant overlap often exists between these oversample criteria. For example, the Hispanic and Spanish-speaking households demonstrate a strong positive correlation, meaning that a BG that qualifies for one oversample criteria is also likely to qualify for the other. Conversely, some criteria, such as active duty military or bike commuters, are less likely to be correlated with any other criteria, meaning that those BGs are more likely to be oversampled for a distinct and unique reason. Because each BG can qualify for more than one oversample criteria, RSG applied the highest oversample rate for which each BG qualified. In practice, this meant that if a BG qualified for a quadruple rate for one criterion *and* a double rate of oversampling for a second criterion, then it was sampled at the quadruple (higher) rate. In other words, the sample rates listed in Table 3-1 represent the *minimum* rates at which behaviors were oversampled.

Figure 3-3 maps the resulting sample rates by BG for a portion of San Diego County. Block groups with the highest sample rates are shown in dark red, those with the lowest rate are shown in gray, and those in between are in shades of pink. The most intensive oversampling occurred in and around the densest areas across the county, particularly Downtown San Diego.

FIGURE 3-3: MAP OF SAMPLE RATES BY BLOCK GROUP FOR PART OF SAN DIEGO COUNTY

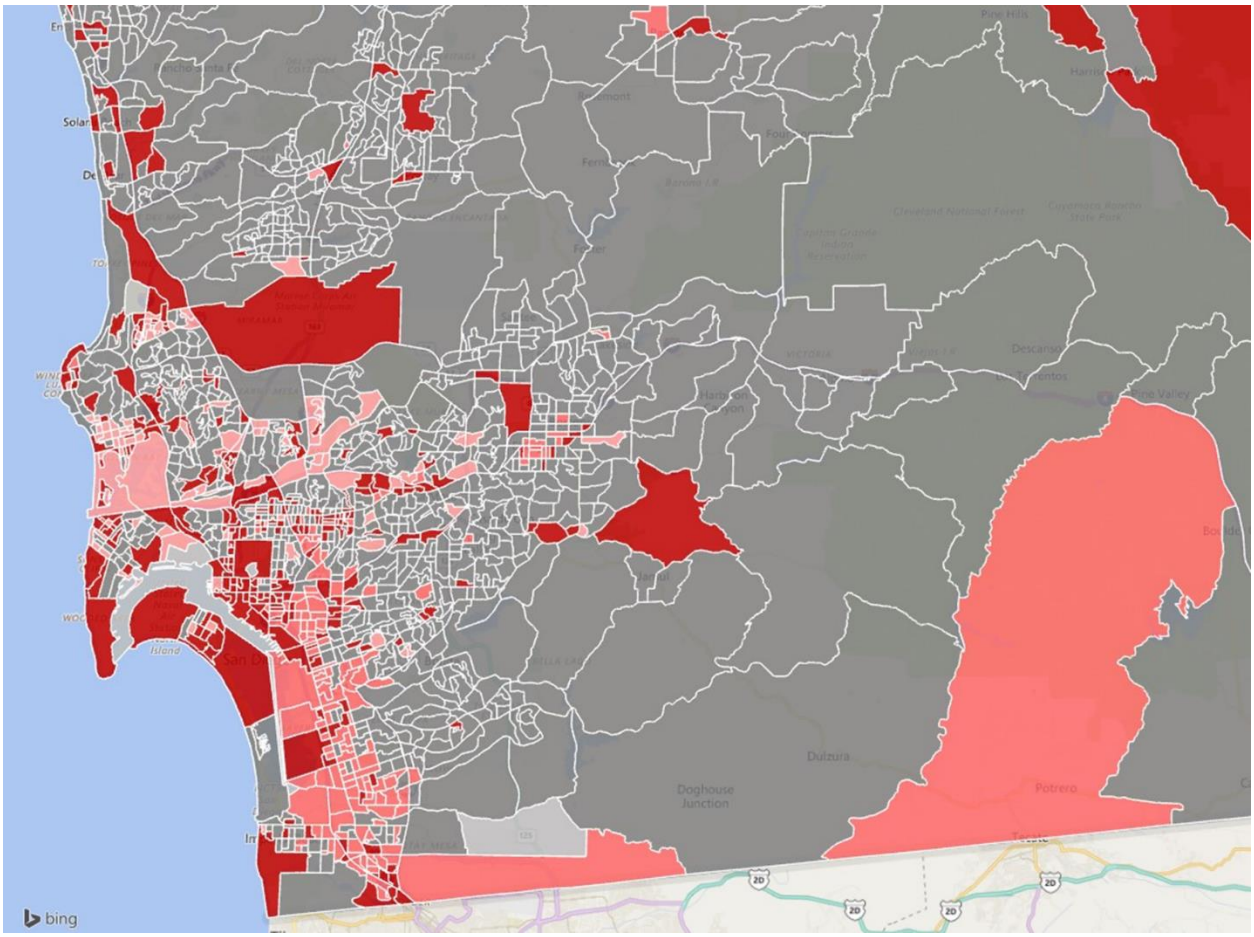


TABLE 3-1: SPECIFICATION OF SAMPLING STRATA AND OVERSAMPLE RATES (FROM SAMPLING PLAN)

	SAMPLE CRITERIA	DEFINITION OR MEASURE USED TO IDENTIFY THE POPULATION	PERCENTILE CUTOFF FOR OVERSAMPLE	BEHAVIOR THRESHOLD	OVERSAMPLE RATE (RELATIVE TO GEN. POP.)
TRANSPORTATION OVERSAMPLE	Bike Commuters	% of workers in BG with commute mode = bike	95% (90 BGs)	4.5% or higher	4.0x
	Walk or Bike Commuters	% of workers in BG with commute mode = bike or walk	95% (90 BGs)	13.0% or higher	4.0x
	Transit Commuters	% of workers in BG with commute mode = public transit	95% (90 BGs)	12.1% or higher	4.0x
	Zero-Vehicle HHs	% of HHs in BG with no vehicles available	95% (90 BGs)	22.1% or higher	4.0x
HISPANIC, SPANISH, AND LOW-INCOME OVERSAMPLE	Hispanic Ethnicity HHs	% of HHs in BG of Hispanic ethnicity	90% (180 BGs)	71.4% or higher	2.5x
	Spanish-Speaking HHs	% of HHs in BG speaking Spanish (regardless of whether they speak English)	90% (180 BGs)	59.5% or higher	2.5x
	Low-Income HHs	% of HHs in BG with annual income <$25K per year	90% (180 BGs)	37.6% or higher	2.5x
OTHER OVERSAMPLE	Active Duty Military	% of population age 16 or older in BG who are active military	97.5% (45 BGs)	9.6% or higher	2.0x
	College Student Enrollment	% of population in BG enrolled in higher education	95% (90 BGs)	19.7% or higher	2.0x
	Young, Nonfamily HHs	% of HHs with age of householder under 35 and is a nonfamily HH	95% (90 BGs)	36.2% or higher	2.0x
	Downtown San Diego	Defined as a 15-BG region	15 BGs	N/A	1.0x
	General Population	All other BGs	N/A	N/A	1.0x

3.3 SAMPLE MONITORING AND ADJUSTMENTS

The project separated data collection into two discrete time periods, primarily to avoid the November 2016 election and possible impacts on response rates. Two weeks of invitations were mailed in August and September 2016, and the remaining seven weeks of invitations were mailed in January and February 2017. In early February 2017, the project team decided to increase the number of households invited to

the study to counteract what appeared to be lower-than-expected completion rates, again possibly due to impacts on response rates following the presidential election in the United States. Due to the lead time required to send those additional mailings without extending the overall data collection schedule, this decision was made after only finishing two complete travel weeks in 2017, which added some uncertainty to the projected sample totals. As evidenced by the final sample counts, the additional invited households—and other factors—contributed to the project far exceeding the 5,500-household sample target.

3.4 SAMPLE PLAN EFFECTIVENESS

The effectiveness of the sample plan can be evaluated in three ways:

1. How well does the dataset represent the region overall?
2. Was the compensatory oversampling effective?
3. Was the targeted oversampling effective?

This report's sections on data weighting and analysis address the first question. The following subsections assess the effectiveness of the project's compensatory and targeted oversampling elements of the sample plan.

EFFECTIVENESS OF COMPENSATORY OVERSAMPLING

Table 3-2 identifies the main results of the sample plan. A total of 6,199 households completed the study, with 6,139 households meeting the criteria to be weighted (60 households were not weighted, as they only had complete travel days on weekends).

Each sample segment includes the initial expansion weight required to match the count of total households for each sample segment, per the 2011–15 ACS data. Higher expansion rates correspond to lower sample rates. The final column (from left to right) of Table 3-2 provides the response rate for each segment relative to the Regular (or "General Population") segment.

As estimated in the sample plan, the Hispanic oversample saw sample rates of approximately half the General Population. Thus, the 2.5x sample rate effectively overcame the response bias for those BGs, as evidenced by the lower initial expansion weight when compared to the General Population sample. As also noted in the separate weighting memo (Appendix D), overcoming the response bias does not guarantee that the recruited households from the Hispanic oversample BGs were Hispanic. However, those BGs achieved greater overall representation than BGs in the General Population sample. The evaluation of the participation of Hispanic persons is described in the separately provided weighting memo (Appendix D) and Section 7.0 Expansion and Weighting.

TABLE 3-2: RESULTS OF INITIAL EXPANSION WITHIN SAMPLING STRATA (FROM THE WEIGHTING MEMO)

SAMPLE SEGMENT	OVERSAMPLE RATE	ACS 2011-15 HOUSEHOLDS	COMPLETE HOUSEHOLDS IN SAMPLE	INITIAL EXPANSION WEIGHT	RESPONSE RATE RELATIVE TO REGULAR SAMPLE
Regular (General Population) sample	1.0x	754,772	2,952	255.6816	100%
Transportation oversample	4.0x	171,083	2,221	77.0297	83%
Hispanic oversample	2.5x	103,561	490	211.3490	48%
Other oversample	2.0x	64,741	476	136.0105	94%
Total		**1,094,157**	**6,139***		

Another 60 households completed the study but were not included in the weighting, as their only complete travel days were on weekend days.

The Transportation and Other oversample segments were primarily designed as targeted oversample regions and are evaluated in the next section. The Other oversample saw comparable response rates to the General Population sample; however, the Transportation oversample saw slightly lower response rates, at 83% of the General Population sample response rate. This is likely due to the overlap between the two regions, as 113 out of 294 Transportation oversample BGs also qualified for Hispanic oversample. These BGs were counted as part of the Transportation oversample in Table 3-2 and were sampled at the higher sample rate.

EFFECTIVENESS OF TARGETED OVERSAMPLING

The Transportation and Other oversample segments sought to capture more data on behaviors and demographics. The Transportation oversample focused on commute behaviors, while the Other oversample focused on demographics that often have interesting or unique travel patterns (e.g., military, young nonfamily households, and college students). Table 3-3 presents the percentage of trips (by travel mode) for each sample segment. The modes in this table are recoded to a simplified list and sorted from highest to lowest overall mode share. At the bottom, the cumulative share of all nonauto trips is shown (all but household auto and other auto). Nonauto mode share is much higher for the targeted oversample regions, at 26.9% of Transportation oversample and 21.9% for the Other oversample, compared to 12.7% for the Regular (General Population) sample.

TABLE 3-3: REPORTED TRIPS BY MODE (RECODED) FOR EACH SAMPLE SEGMENT (COMPLETE HH DAYS ONLY) (UNWEIGHTED)

TRAVEL MODE	REGULAR SAMPLE	TRANSPORTATION OVERSAMPLE	HISPANIC OVERSAMPLE	OTHER OVERSAMPLE	TOTAL
Household auto	82.0%	67.6%	77.6%	70.6%	76.2%
Walk	8.8%	16.0%	8.5%	15.2%	11.6%
Other auto	5.3%	5.5%	6.7%	7.6%	5.6%

TRAVEL MODE	REGULAR SAMPLE	TRANSPORTATION OVERSAMPLE	HISPANIC OVERSAMPLE	OTHER OVERSAMPLE	TOTAL
Transit	2.1%	7.3%	5.6%	3.7%	4.1%
Bike	0.8%	1.6%	0.4%	1.3%	1.1%
Taxi	0.4%	1.2%	0.4%	1.0%	0.7%
Other	0.5%	0.7%	0.7%	0.5%	0.6%
Airplane	0.2%	0.2%	0.1%	0.3%	0.2%
Total %	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Total trips	**102,708**	**62,227**	**13,674**	**14,981**	**193,590**
Nonauto trips	***12.7%***	***26.9%***	***15.7%***	***21.9%***	***18.2%***

It is difficult to ascertain what the dataset would have looked like without targeted oversampling; however, some basic calculations and assumptions imply that the overall rate of nonauto trips would have dropped from approximately 18% to around 15%, or approximately 3,500 fewer nonauto trips. This combined evidence suggests that targeted oversampling was effective at increasing the number of nonauto trips. Further analysis shows that the presence of those currently affiliated with the military or enrolled in higher education were also increased due to oversampling, although to different degrees. Current military affiliation in the travel survey included the following: self-reported current active duty, U.S. Army Reserve or National Guard, and Department of Defense civilian workforce or contractor. Current higher education enrollment captures those who self-reported being in vocational/technical school, two-year college, four-year college, or graduate or professional school. In both cases, the oversample segments comprise a higher share of the targeted demographics than the regular sample, so oversampling those regions produced a higher overall share of those demographics (military affiliation and enrollment in higher education) (Table 3-4).

TABLE 3-4: PERCENTAGE OF PERSONS WITH MILITARY OR HIGHER EDUCATION ENROLLMENT, BY SEGMENT

PERSONAL STATUS	REGULAR SAMPLE	TRANSPORTATION OVERSAMPLE	HISPANIC OVERSAMPLE	OTHER OVERSAMPLE	TOTAL
Current military affiliation	2.1%	2.8%	2.3%	3.6%	2.4%
Current higher education enrollment	5.4%	8.2%	7.3%	7.7%	6.6%
Total persons in segment	**6,442**	**3,902**	**1,063**	**830**	**12,237**

OVERALL SAMPLE PLAN EFFECTIVENESS

Overall, the sample plan far exceeded its goals for overall sample size (113% of target) and the compensatory and targeted oversampling helped to significantly increase the representativeness and quality of the dataset delivered to SANDAG. Further evaluation of these topics occurs in Section 7.0 Expansion and Weighting and Section 8.0 Survey Results.

4.0 SURVEY DESIGN

4.1 SURVEY DESIGN OVERVIEW

The study employed a mix of data collection methods, including smartphone, online, and telephone. The study design balanced the strengths of innovative technologies with pragmatic best practices derived from traditional market research.

Study design highlights include the following:

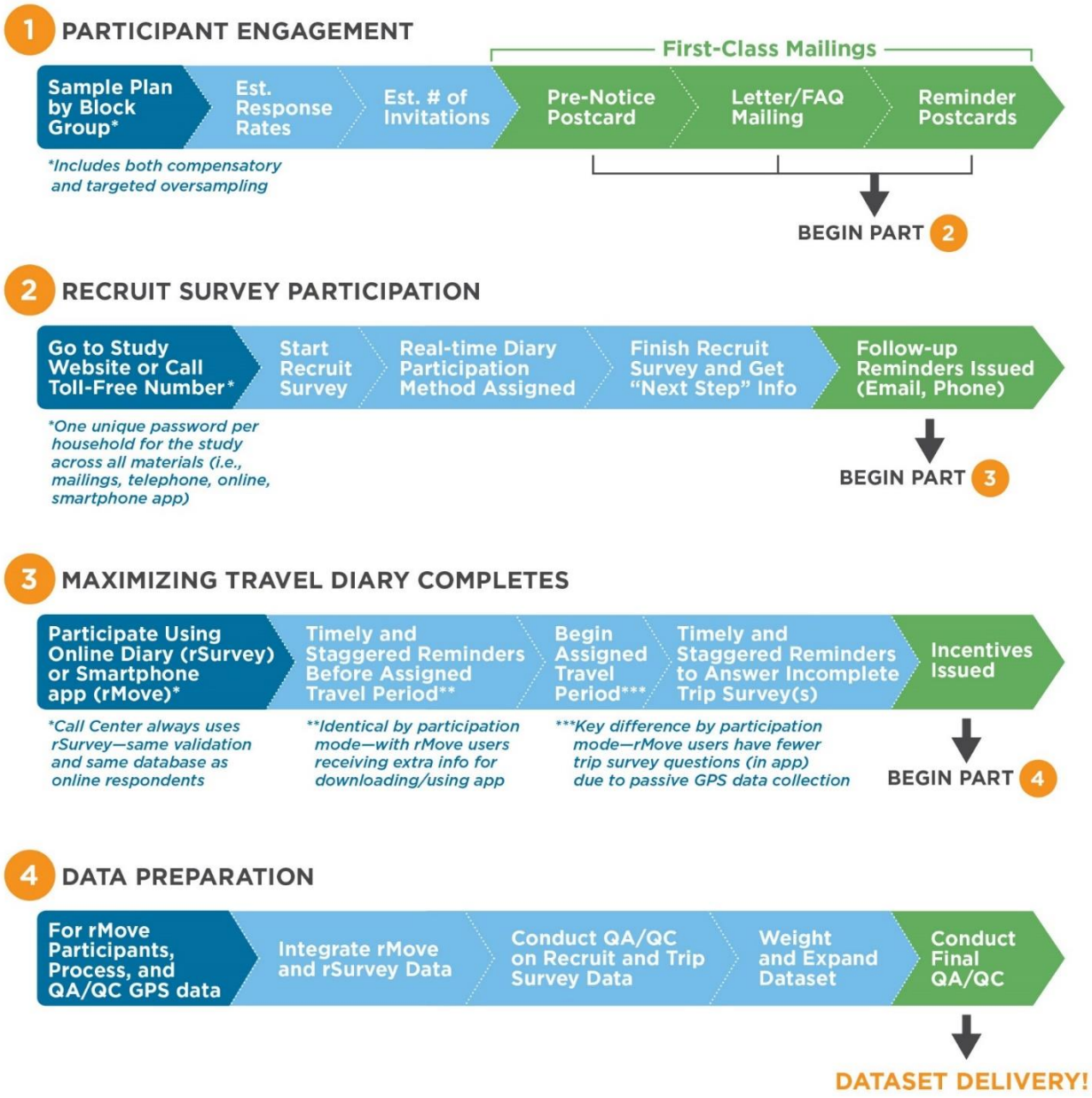
- Used an ABS (described in Section 3.0 above) and mailed study invitations
  - The ABS included compensatory and targeted oversampling to improve the representativeness and quality of the final dataset.
  - Invited households received a "prenotice" postcard, an invitation envelope with complete study details, and a "reminder" postcard (described in Section 5.0).
  - The study provided a choice of gift card incentives to households that completed the study; this was done to improve the response rate (and thereby lower the overall cost) and representativeness (described in this section).
- Conducted a two-part survey:
  - Part one (the "recruit survey") gathered data on each household's demographic composition and typical travel behaviors.
  - Part two (the "travel diary") gathered travel data for everyone in each household during a designated travel period.
- Provided multiple modes of data collection:
  - Household participants with smartphones used rMove, the smartphone-based GPS travel survey app, for a travel period of one week (always starting on a Tuesday, to align with the online travel diary administration).
  - Household participants without smartphones completed their travel diary online or by calling the study call center. Call center operators used the same online travel diary instrument. These households were assigned a travel period of one day (a Tuesday, Wednesday, or Thursday to capture typical weekday travel behavior).
    - For a portion of the study, households with partial smartphone ownership (i.e., not all adults owned smartphones) could "split" their participation, with some participants using rMove and others using the online travel diary.
- Leveraged advanced technologies and methods to improve the approach:
  - Used rMove, which offers numerous benefits for data quality and quantity, as the primary means of travel diary data collection.
  - Leveraged the Google Maps API to capture and validate (in real time) different types of location and travel data.
- Minimized respondent burden and increased engagement through an integrated approach to project participation and communication:

- RSG provided outgoing customized, targeted, and well-timed reminders to study respondents by email, telephone, or within the rMove smartphone app to ensure nearly real-time completion of travel surveys.
- Provided user support to respond to study respondent requests for assistance via telephone, email, or within the rMove smartphone app. Responses were typically provided within one business day.
- An engaging project brand, logo, and web page legitimized the study and encouraged response.

4.2 SURVEY STAGES AND PARTICIPATION METHODS

The study had two stages and used multiple methods to ensure that nearly all populations could participate in the study. The overall participation process is shown in Figure 4-1 and described in the sections that follow.

FIGURE 4-1: STUDY PARTICIPATION PROCESS

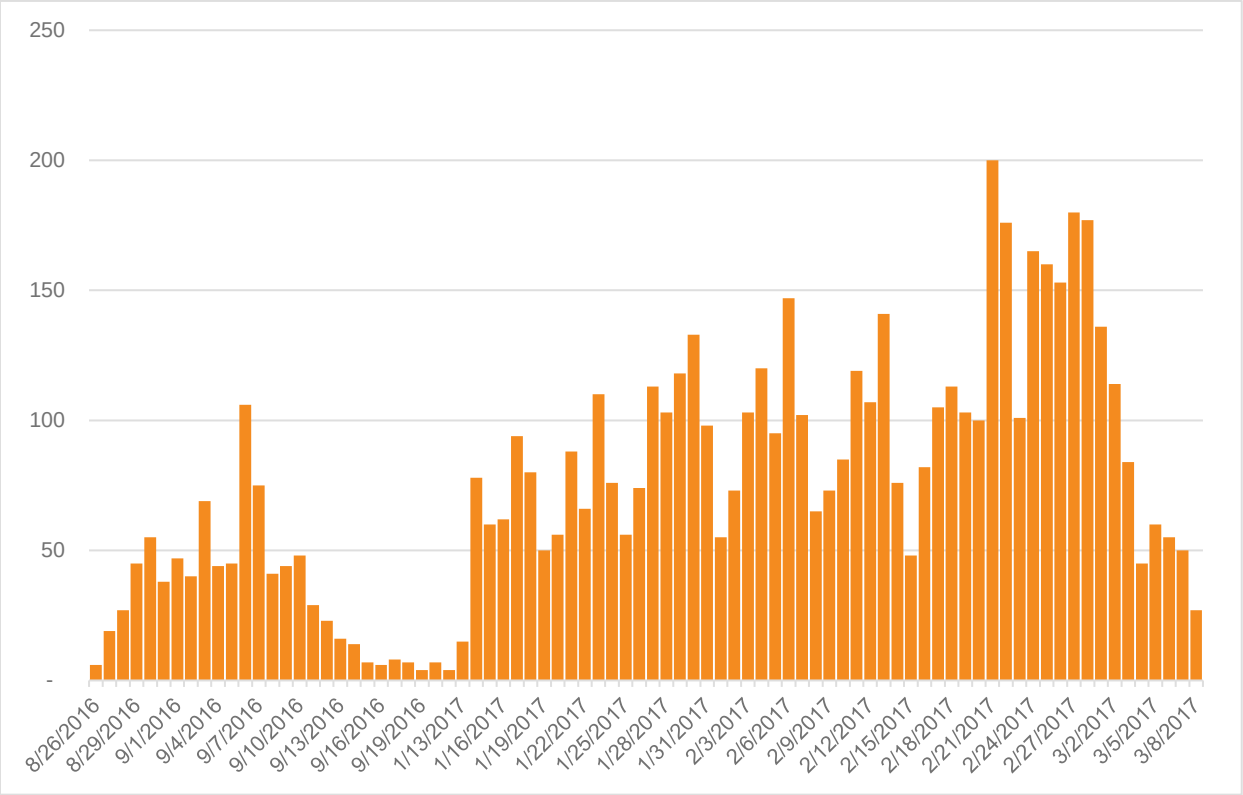


RECRUITMENT

Participants were recruited using a series of invitations mailed to their home addresses (shown in Section 5.2 Study Invitation Materials). Each mailing contained information about the study and a unique password for their household to use to begin the study. Interested households could visit the study web page or contact the study call center to begin their participation. Invitations were mailed more than nine weeks; however, invited households could recruit at any time during the data collection period. The two waves of recruitment took place from August 26, 2016 to September 21, 2016, and from January 13, 2017 to March 8, 2017 (Figure 4-2). Among the final dataset, 8.8% of households began their

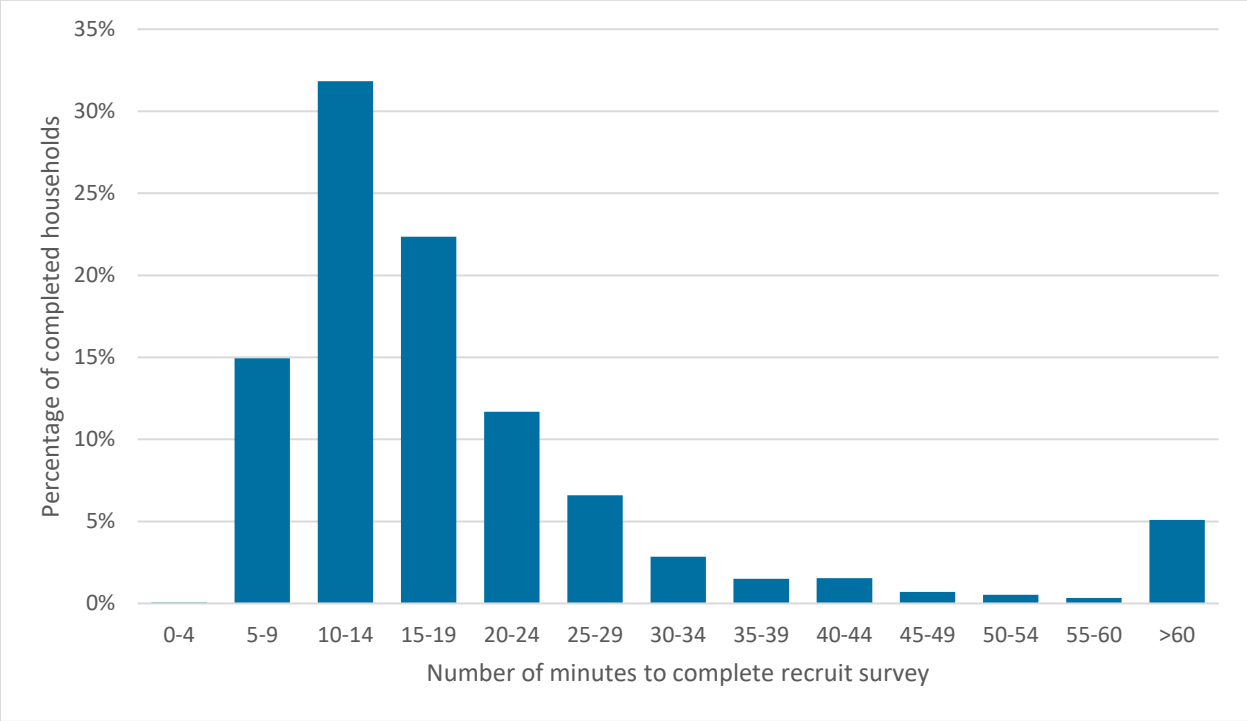
participation (“recruited”) via the call center and the remainder (91.2%) recruited through the online recruit survey.

FIGURE 4-2: COUNT OF COMPLETE HOUSEHOLDS, BY DATE RECRUITED



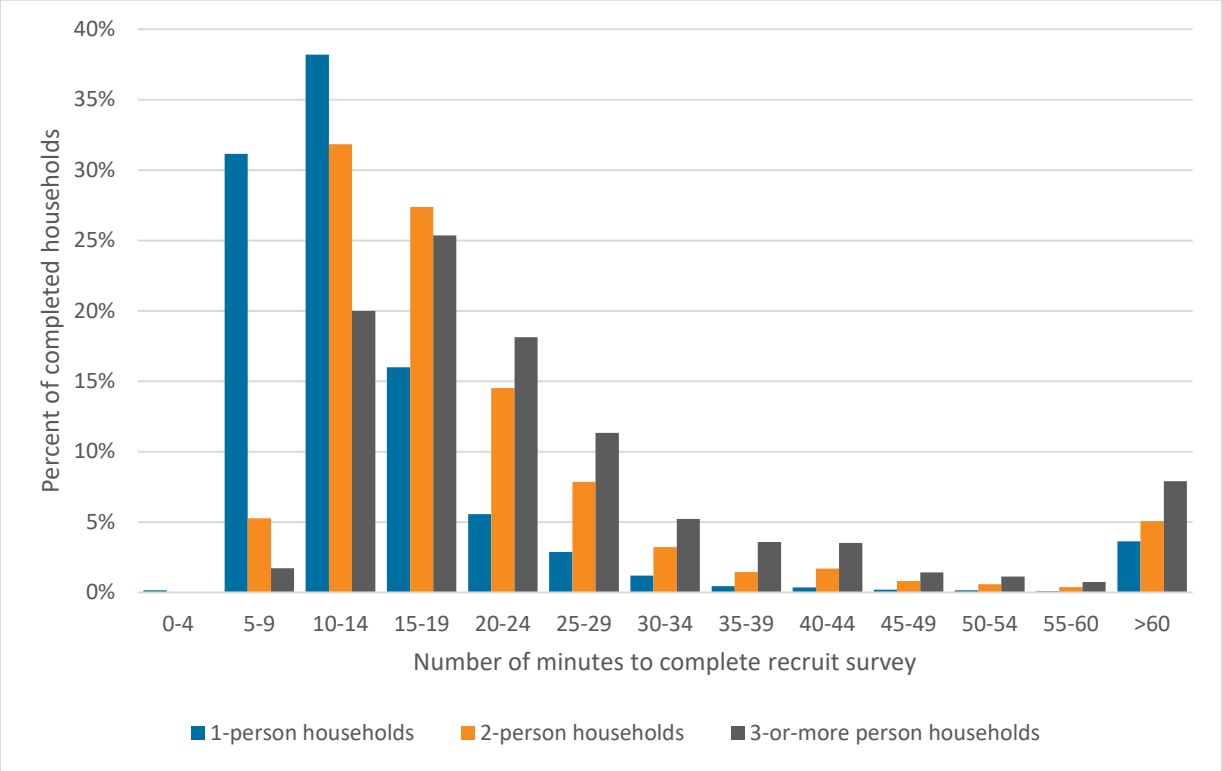
Among complete households, the median length of time required to complete the recruit survey was 15 minutes; however, there was a large distribution in time, as shown in Figure 4-3. Based on more detailed analysis, many of the times greater than 60 minutes reflect people pausing or stepping away midway through the survey and leaving their web browsers open. Some particularly long times reflect people returning to the online survey the following day.

FIGURE 4-3: PERCENTAGE OF COMPLETE HOUSEHOLDS, BY NUMBER OF MINUTES TO FINISH RECRUIT SURVEY



The length of time required to complete the recruit survey varied by household size. Single-person households had a median complete time of 11 minutes, two-person households had a median complete time of 17 minutes, and three-or-more-person households had a median complete time of 20 minutes. Figure 4-4 provides the full complete time distributions.

FIGURE 4-4: PERCENTAGE OF COMPLETE HOUSEHOLDS BY NUMBER OF MINUTES TO FINISH RECRUIT SURVEY BY HOUSEHOLD SIZE



TRAVEL DIARY GROUP ASSIGNMENT

The first part of the study required participants to complete the "recruit" survey, which gathered data about each household's demographic composition and typical travel behaviors. Near the end of the recruit survey, a series of questions about smartphone ownership determined if each household was eligible to complete part two of the study using their smartphones (or by using the online travel diary, which also allowed those households to report their travel using the call center).

Households with smartphone ownership among all persons aged 18 and older were assigned to solely use rMove. Approximately 70% of recruited households fell into this category. Children between the ages of 16 and 17 with their own smartphones in these households were given the option to use their own device *or* to be proxy reported by their parents (described in more detail later in this section). Only 1.4% of persons in the final dataset were between the ages of 16 and 17 and almost 45% of these participants used their own devices when given the option.

Households that did not have complete smartphone ownership among adults were accommodated in two ways. First, for 8 of the 11 travel weeks offered in the study, households with partial smartphone ownership among adults could split their participation so that adults with smartphones used rMove and all other family members used the online travel diary. Approximately 10% of recruited households qualified for this method of participation when it was offered. Due to complexities and coordination challenges, the project team dropped this approach after the eighth travel week, and instead asked those households to entirely use the online travel diary approach. Second, all other households—approximately 20% of

recruited households—qualified to use the online travel diary only, which also allowed households to report their travel via the call center.

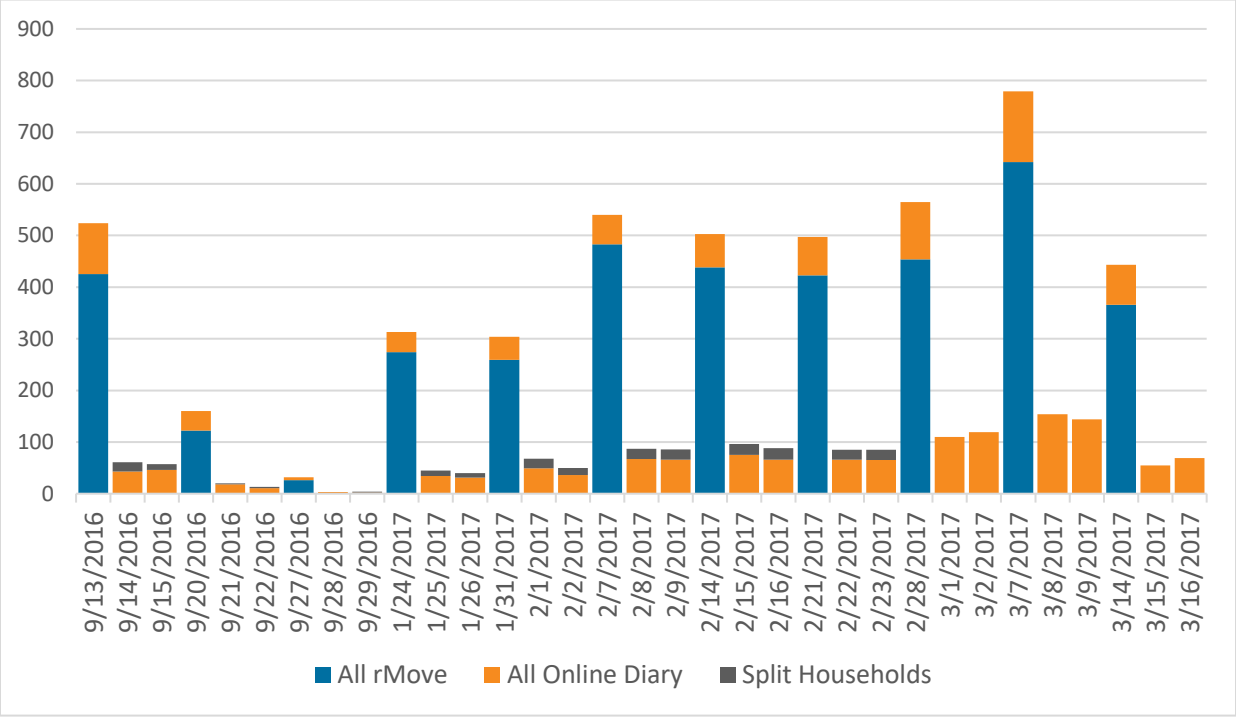
TRAVEL DATE ASSIGNMENT

After determining the method of participation for the travel diary, RSG assigned each household a travel period. Households using rMove had a travel period of one week—set 6 to 12 days in the future—that always began on a Tuesday and ended on a Monday. Trip surveys in rMove were technically available to answer indefinitely after their initial appearance; however, respondents answered most surveys in rMove within 24 hours.

Households that used the online travel diary had a travel period of one day, with households uniformly distributed among Tuesdays, Wednesdays, and Thursdays. The travel diary survey itself was available to these households the day after their travel day; the survey also was available to be completed for up to seven days. After seven days, RSG closed the online travel diaries to prevent poor or incomplete recall among participants.

Households with split participation used a combination of these approaches. Participants who used rMove were assigned an entire travel week that started on a Tuesday; the other members of their households were assigned a Wednesday or Thursday during that week for which they reported their travel online. Figure 4-5 summarizes the 11 weeks when travel diaries were recorded. The largest travel period began on March 7, 2017, primarily due to the arrival of the invitations for the additional sample that was added near the end of the data collection period.

FIGURE 4-5: COUNT OF COMPLETE HOUSEHOLDS, BY START DATE OF TRAVEL DIARY PERIOD



Households that did not activate the rMove app for their assigned travel week were periodically reinvited to participate during future travel weeks. This occurred four times during data collection—once in 2016 and three times in 2017.

LANGUAGE OPTIONS

The study was offered in English and Spanish. Spanish language support and translation efforts included the following:

- A complete set of translations for the invitation letter and FAQ, along with other Spanish messages on the postcard mailings
- Full translations for rMove
- Full translations for the recruit survey and online travel diary for participants in 2017
- Spanish language call center support
- Communications and outreach efforts, as detailed in Section 5.0; included Spanish language media relations, a press release, media coverage to support the study, and a significant door-to-door outreach effort in Hispanic communities
- Additionally, RSG integrated the Google Translate toolbar into the online surveys and project web page to support approximately 100 other foreign languages

Section 5.4 Public Outreach describes the effects of some of these outreach efforts.

4.3 SURVEY INCENTIVES

Gift card incentives were offered to invited households. Many surveys, including most HTSs and the National Household Travel Survey (NHTS), offer incentives for a few reasons:

- Incentives increase response rates significantly, often doubling participation rates.
  - Incentives help reduce participant bias.
  - Historically low response rates in the United States and abroad mean that incentives are now often required to obtain sufficient sample.
- By increasing study response rate, incentives help save the project money overall and encourage the most cost-effective use of public research funding.
  - Incentives are only provided to households that complete the study in its entirety, so households with partially completed surveys do not quality for incentives.

The study offered gift cards from Walmart and Amazon.com as incentives; participants also could waive their right to an incentive. These vendors were chosen for their nearly universal availability, wide selection of products, widespread name recognition, and administrative ease of use to obtain and send gift cards to study participants.

Households that used the one-day online travel diary were offered either a $10 Walmart gift card mailed to their house or an Amazon or Walmart e-gift card emailed to them. Households that used rMove were offered e-gift cards of $20 *per adult rMove participant* because they participated for seven days (instead of just one). Thus, if a household had three rMove participants (each at least 16 years or older), then they received $60 in gift cards. In households where participants used a combination of these criteria—rMove

participants received $20 incentives and the rest of the household received $10 incentives. Table 4-1 shows the frequency with which each option was chosen by participants.

TABLE 4-1: INCENTIVE OPTIONS PROVIDED TO PARTICIPANTS AND THEIR RATE OF USE

INCENTIVE TYPE	PERCENTAGE OF SENT INCENTIVES
Amazon.com e-card	70.3%
Walmart mailed card	14.3%
Walmart e-card	13.7%
Waived incentive	1.7%
Total	**100%**

This incentive structure was designed to encourage larger households to participate via rMove, which required more effort on behalf of each participant and which collected data for a greater number of days (seven travel days vs. one travel day).

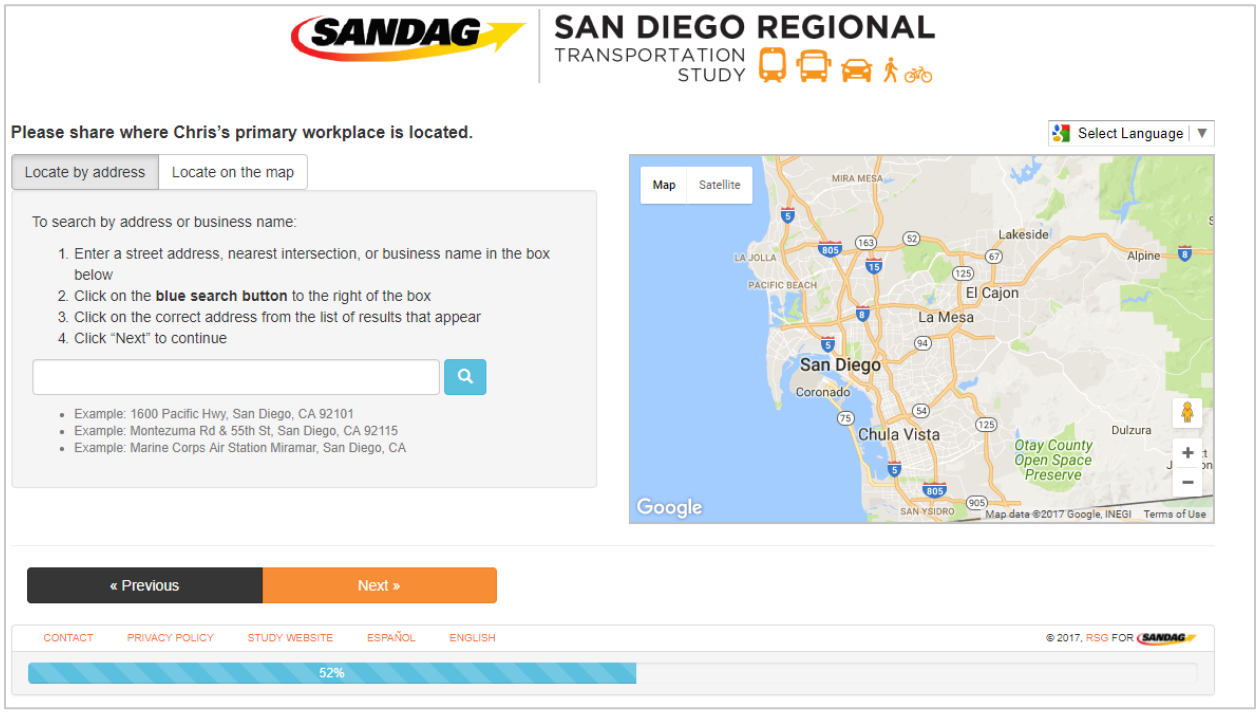
4.4 ONLINE SURVEY PLATFORM

The recruit survey and the online travel diary were both built using rSurvey™, RSG's online survey platform used in public and private sector market research. The recruit survey is the main source of household, person, and vehicle data collected in the survey. The recruit survey left the exact details to the survey questionnaires and dataset codebooks, and was organized into the following ordered categories of questions:

1. Language preference (English, Spanish, or other)
2. Vehicle and bike ownership
3. Household membership details (e.g., age, relationship, employment status)
4. Typical transportation behavior
5. Work and school information
6. Home details and household income
7. Crossborder travel (USA-Mexico border)
8. Smartphone ownership
9. Incentive and communication preferences
10. Instructions for completing the travel diary

Portions of the survey required using a real-time geocoder to specify home, work, school, or other locations on the map. Figure 4-6 provides a screenshot of the geocoder for a person's primary work location. Geocoders required participants to select specific addresses to ensure that general entries, such as "San Diego" were not allowed.

FIGURE 4-6: PRIMARY WORK LOCATION GEOCODER (RECRUIT SURVEY SCREENSHOT)



The survey collected details on the make, model, model year, and fuel type of each household vehicle. To facilitate this data capture, an up-to-date reference database of vehicles provided a comprehensive set of drop-down lists from which participants could select their vehicle details.

QUALITY CONTROL

For both online surveys, rSurvey uses multiple methods to ensure data consistency and minimize respondent burden. Key examples include the following:

- Web respondents and telephone retrieval operators both used the rSurvey interface to ensure that all data underwent the same logic, validation, and real-time checks. RSG could review which data were collected via the call center or by respondents on their own.
- Superior validation and logic checking, such as real-time geocoding of addresses, intersections, businesses, and points on a Google map. Nonspatial data, such as travel times, travel party size, household vehicle used, and many other questions were automatically customized for the respondent based on previous answers. For example:
  - Questions about employment and school were only shown to persons employed or enrolled in school, respectively.
  - A respondent could not report a trip that started prior to the arrival time at the destination of their previous trip. Custom prompts were provided to respondents if they reported that they began and ended their travel day in different locations.
- Respondent burden (and error) was reduced by logic checks that minimized the need to re-enter data. For example, if the household member earlier recorded their school location, then the school location was geocoded and referenced for all subsequent trips to school. Another example is that

household members could select and copy information already reported by other household members if they indicated that multiple household members traveled together (rather than having to re-enter the same trip information).

- Responsive web design ensured that the survey showed properly on smartphones, tablets, and other devices, although not all questions showed or performed equally well on all devices. Geocoders are difficult to use on small screens and devices.
- Metadata collection permitted passive collection of data like survey duration (in total and by each question), screen resolution, browser type (e.g., Internet Explorer or Firefox), default language of web browser, and more. These data can be used to compare participants to the overall population, to identify trends, and to ensure that rSurvey accommodates all users. Collecting information on the default language of the web browser provides insights into participation among respondents whose native language is not English. (The browser settings among those who participated online were 97.7% English, 2.2% Spanish, and 0.1% Other.)

4.5 TRAVEL DIARY DATA COLLECTION PLATFORMS

As described earlier, the study collected travel diary data in two ways: via the rMove smartphone app and via an online travel diary survey. While two-thirds of households used rMove in some way and one-third used the online travel diary, 95% of the collected trip data were from rMove, compared to 5% from the online diary. This is the result of several factors, including the longer travel period for rMove users (seven days vs. one day), the fact that households that used rMove tended to be larger and younger households, and the fact that rMove captures approximately 18% more trips per person per day than self-reported trip data (see Section 7.0 Expansion and Weighting for more details, and the separate weighting memo in Appendix D).

Broadly, the types of data collected for each trip included:

- Locations
- Travel time information
- Travel party composition
- Trip costs

TRIP DATA

The online travel diary survey was conceptually straightforward in how it asked participants to report the details of their travel throughout the travel period, but there are many considerations to ensure the data collected is complete and consistent. The basic outline of the survey was:

- To ask where the participants started and ended the day
- To ask participants to identify the places they went or trips made during the day
- To review the resulting trip roster and confirm that there are no missing trips
- To fill in the details for each trip, including trip start and end times, trip purpose, travel mode, travel party size, and cost
- To ask a few questions about the travel day overall, including if any package delivery or professional services occurred at your home, time spent teleworking, and time spent shopping online

- To repeat the process for each household member until complete

The following three figures provide examples of the data collection platform online (Figure 4-7), an example travel day as shown in the print materials and the online diary (Figure 4-8), and an example rMove screenshot (Figure 4-9).

FIGURE 4-7: TRIP ROSTER (ONLINE DIARY SCREENSHOT)

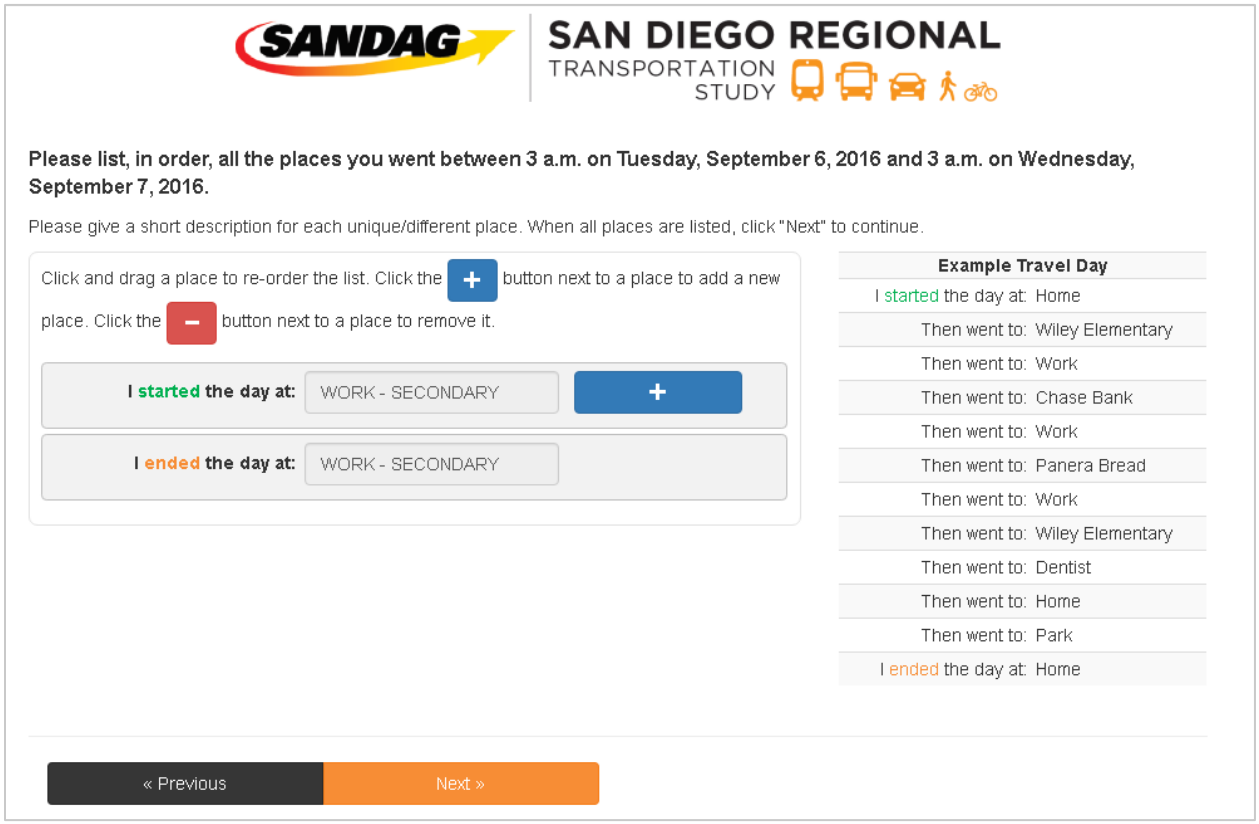


FIGURE 4-8: EXAMPLE TRAVEL-DAY IMAGE (USED ONLINE AND IN PRINT)

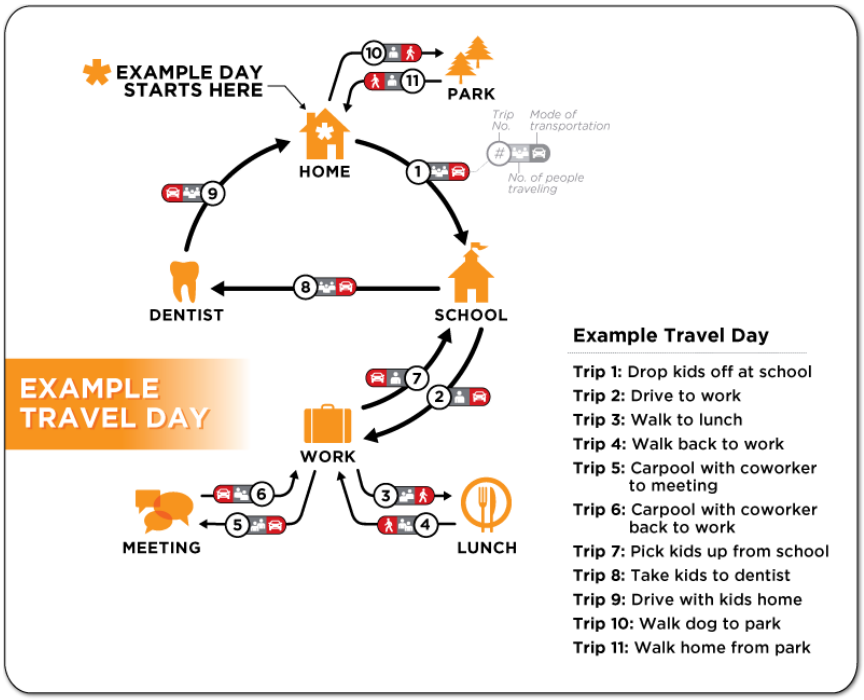
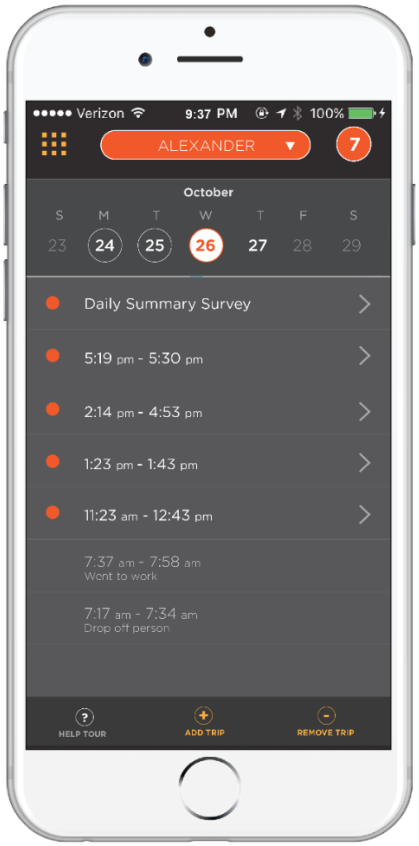


FIGURE 4-9: TRIP ROSTER (rMOVE SCREENSHOT)



5.0 STUDY BRANDING, COMMUNICATION, AND ADMINISTRATION

5.1 STUDY BRANDING

RSG developed the study branding collaboratively with SANDAG, including the study name, color scheme, and font selections. SANDAG developed a graphic identity for the study that used the agency's logo and preferred mode icons, which was appended to either English or Spanish (Figure 5-1). The study logo was used broadly in the print materials, online survey, and outreach efforts and on the study web page.

FIGURE 5-1: STUDY LOGO (ENGLISH AND SPANISH)

SANDAG | SAN DIEGO REGIONAL TRANSPORTATION STUDY

SANDAG | ESTUDIO REGIONAL DE TRANSPORTE DE SAN DIEGO

5.2 STUDY INVITATION MATERIALS

Each invited household received four mailings:

Prenotice Postcard: Postcards were mailed to prospective participant households in nine waves during the active study period. This postcard notified households that a formal study invitation would arrive shortly and that they would be offered an incentive upon completion of the study. The postcard also invited households to log onto the project web page or call the toll-free number to learn more about and begin the study.

Invitation packet: A formal study invitation packet was sent shortly after the prenotice postcard. The cover letter explained the study purpose, described the steps necessary to complete the study, and included SANDAG logos. The invitation packet also included an FAQ sheet.

Reminder Postcard: Two reminder postcards were mailed after the invitation packet (the first card 2–3 days after the invitation pack, and the second card 2–3 days later) to encourage every household to complete the study. These postcards included the study phone number and email, web page, and participant login information.

All mailings included both English and Spanish text. The postcards included a brief statement in Spanish, while the invitation packets included a fully translated Spanish letter and FAQ sheet. Figure 5-2 is an example bilingual postcard.

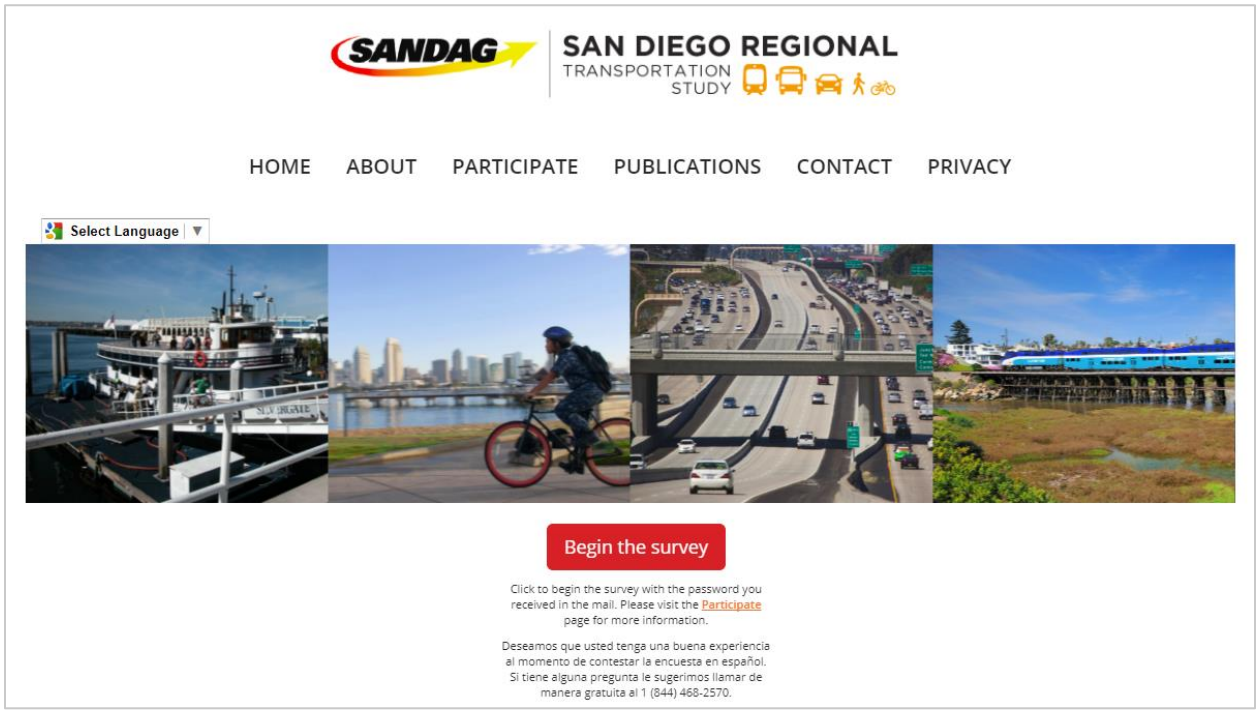
FIGURE 5-2: EXAMPLE SURVEY POSTCARD (FRONT)

5.3 STUDY WEB PAGES

PROJECT WEB PAGE

A project web page (sandag.org/study) was developed to describe the study and facilitate participation of invited households. The web page, which shared the same domain name as the SANDAG website, was designed to be simple and attractive to users, and featured a responsive design to render properly on smartphones, tablets, and other devices.

FIGURE 5-3: PROJECT WEB PAGE LANDING PAGE



5.4 PUBLIC OUTREACH

This section discusses the objectives and goals of the outreach program, the results, and recommendations for similar work in the future.

COMMUNICATIONS AND OUTREACH PLAN

The communications team, comprised of Cook + Schmid, RSG, and SANDAG, implemented the community outreach program for the San Diego Regional Transportation Study. The primary objective was to identify, engage, and persuade participants to complete the study. Specifically, this program sought to engage minorities and low-income individuals who have historically not participated in similar studies at consistent rates because of cultural, socioeconomic, and political barriers. Precedent exists for extraordinary efforts to achieve participation from hard-to-reach audiences. For example, the U.S. Census Bureau has used in-person interviews to contact hard-to-reach populations. The sections that follow describe the plan and process used in this study.

The communications and outreach program involved media relations, outreach to key stakeholders to serve as study ambassadors, collateral materials, social media, and partnerships with community-based organizations (CBOs) to conduct door-to-door outreach. The communications team designed a strategy and creative materials to increase awareness of the study.

MEDIA RELATIONS

A press release announced the study and its schedule; it also included a detailed explanation of how the information gathered would be used to plan for future transportation improvements. Press releases were sent to English and Spanish news media outlets countywide in late August 2016 and mid-January 2017.

Media relations with Spanish news outlets were particularly important to legitimize the study, raise awareness, and inform the Spanish-speaking community. Appendix C includes the press releases, talking points, published articles, and photos of TV coverage.

PUBLIC/COMMUNITY OUTREACH

Several stakeholders were identified to serve as ambassadors for the study: elected officials (some of whom serve on the SANDAG Board of Directors), community planning groups, chambers of commerce, and other prominent business/civic groups that represent trusted community sources. An email was sent to the SANDAG Board to inform them, their constituents, and members of respective stakeholder organizations about the study. The purpose of working with these groups was to further legitimize the study and raise public awareness. Appendix C includes the email and list of stakeholder groups.

COLLATERAL MATERIALS

A bilingual flier was developed and given to CBOs to distribute to increase study awareness. A bilingual door hanger was distributed through door-to-door outreach efforts (described in subsequent sections). Collateral was translated to increase access to the study among Spanish-speaking audiences. Some of these documents and materials include the SANDAG fact sheet about the study and other study-related resources, such as rMove app materials, initial invitation, and FAQs.

SOCIAL MEDIA

SANDAG social media platforms were used to promote the study and leverage the engagement of existing followers. A social media editorial calendar was developed, which included timed study milestone messages.

COMMUNITY-BASED ORGANIZATION PARTNERSHIPS

Direct outreach to individual households invited to participate was facilitated by working with CBOs in hard-to-reach neighborhoods. The reasoning was that working with trusted local organizations in their respective communities would engage residents and address some of the barriers to participation listed below.

- Limited English Proficiency
- Head of household with low level of education or literacy level
- Housing factors, including:
  - High rates of residential mobility
  - Irregular housing and household arrangements
  - Housing units occupied by multiple families/social units
- Confidentiality concerns
- Lack of cooperation or trust
- Cultural and social differences
- Limited communication with or prior negative interactions with/attitudes toward government
- Cynicism about survey value and purpose

Identifying Community-Based Organization Outreach Areas

The first step in finding community-based organization outreach areas identified target neighborhoods. Census BGs that represent a sizeable proportion of Hispanic and lower-income households were evaluated. Specific neighborhoods were identified and the following CBOs with a strong presence in those neighborhoods served as outreach effort partners: Casa Familiar, Barrio Logan College Institute, Olivewood Gardens, and South Bay Community Services.

Recruitment of CBO Partners

Prior relationships SANDAG had with these CBOs were leveraged to encourage the leadership of these organizations to participate. Part of the agreement included a small stipend for the CBOs. The stipend was provided in two payments: a partial deposit at the start of work and the balance at the end of the project. To solidify the partnership, CBOs signed contractual agreements that detailed the partnership purpose, CBO expectations (approach to outreach, rules regarding political advocacy, and the protection of privacy), and payment.

Identifying Target Addresses

Once these partnerships were secured, addresses on the sample address list were reviewed and narrowed to include a few hundred addresses in each selected area. These addresses were organized into a user-friendly format to monitor door-to-door outreach. They also were organized by USPS postal carrier route and listed in sequential order to create walking routes that would be easier for field staff (Appendix C).

Training CBO Field Staff

A training manual was designed to prepare and train field staff for the outreach efforts. The training manual included details about the study's background and purpose, the roles and responsibilities of all parties, the methodology of outreach, speaking points, FAQs, and a study schedule. A required element of the partnership was a legal agreement, which described the general conduct expected of each field staff member. Each CBO was required to sign the agreement before beginning outreach. (For purposes of this report, field staff refers to the CBO representatives conducting the outreach, which included *promotoras*, *kitchenistas*,[3] and CBO staff members.)

The CBOs held four training sessions for the managers or coaches (those who would lead the field staff in the efforts). In addition, CBOs conducted four training sessions with the field staff. The sessions included a quick introduction to SANDAG (to provide some local context about how the public agency fits in the community), an overview of all the content included in the training manual, the outreach logs, and role-playing for door-to-door outreach teams. The training emphasized the importance of CBOs to the study. Field staff were cognizant of their role and were eager to talk to community members. The CBO teams studied the materials and processes during these sessions. In a few cases, field staff members sought to better understand the rMove app, and RSG provided a passcode so they could test the app.

[3] "A promotora is a specially trained Hispanic/Latino community member who promotes community health education and is a liaison between CBOs and the communities they service. A promotora is different than a professional healthcare worker who receives formal medical training or certification. Kitchenistas play a similar role, but for traditional cooking and healthy eating programs and initiatives.

Implementation

CBOs conducted door-to-door outreach between January 30, 2017 and March 8, 2017. These dates coincided with the study timeline, and the outreach was synchronized with the mail drops for the outreach areas. This was done to ensure that the targeted households had already received an initial mailed invitation from SANDAG. Each CBO created a staffing schedule and visited assigned addresses. In many cases, they made multiple visits to an address. Field staff left door hangers with information about the study for residents who were not home at the time they visited. Outreach efforts were monitored and evaluated through weekly check-ins. In some cases, members of the communications team walked with the field staff to assist, observe, and support the outreach efforts. Outreach logs helped guide and record visits to each household. These logs were divided among smaller teams within each CBO and then later compiled.

Results, Impacts, and Unforeseen Barriers

Response rates indicate that the outreach was effective. The response rate for areas where outreach occurred was higher than areas where no outreach took place. While the increased participation was encouraging, field staff were surprised by the number of participation barriers encountered. For example, many households had multiple families living at the address, which complicated study participation. Further, as field staff went door-to-door, they often noticed an extreme unwillingness to participate (e.g., a knock at an open screened door went unanswered). Residents also indicated that they were uncomfortable with the requirement of the study to share information about their location and their daily routine because of their concern about immigration status. Despite the confidentiality clause, some residents still stated that they did not trust that their information would be secure. This resistance may be related to the fact that the bulk of the outreach was conducted during a time when national policies under the new presidential administration created a highly sensitive political climate, particularly around immigration status.

Table 5-1 summarizes the results from the four CBOs. See Appendix C for the complete final reports submitted by each CBO.

TABLE 5-1: DOOR-TO-DOOR OUTREACH RESULTS

ORGANIZATION	STAFF	HHs ASSIGNED	HH VISITED / ATTEMPTED	CONFIRMED INTEREST TO PARTICIPATE	CONFIRMED THEY DID NOT PLAN TO PARTICIPATE
Casa Familiar	14	380	380 HHs attempted	158	82
Barrio Logan College Institute	4	253	170 HHs attempted	40	4
Olivewood Gardens	7	421	395 visits attempted	44	33
South Bay Community Services	28	480	1,011 visits attempted	324	167
Total	**53**	**1,534**	**N/A**	**566**	**286**

RECOMMENDATIONS FOR THE FUTURE

Even with tailored messages for hard-to-reach segments to "help their community," there remained an overall lack of trust in governmental processes, which proved to be a significant barrier. During door-to-door outreach, field staff followed the talking points and used sample invitations and surveys to create a dialogue and build rapport with the residents. Based on this experience, the team compiled several recommendations to improve outreach activities and participation for the next study:

Recruitment process. The fact that there were multiple steps to recruit for the study caused confusion for some CBO field staff. CBO staff were not involved with the recruitment survey process and could not help participants complete that step to earn the incentive.

Incentive eligibility. Some participants did not understand that the $10 gift card incentive for phone or online survey participation was for the entire household and not for individual household members. Further, it was not obvious to some participants that they would only be able to receive the incentive if the entire household participated. To add clarity, an infographic was created to help educate participants (Appendix C).

Survey questions. Some study questions were viewed as too personal (e.g., race/ethnicity), which made some respondents uncomfortable. This sentiment created a challenge to encourage others (neighbors, friends, and family) to participate.

Direct recruitment. Consider using CBOs to directly recruit study participants (rather than using the list of households invited through an ABS).

Assigned travel date(s). Consider different methods like allowing reporting of travel for the previous weekday versus assigning a travel date in the future. Or, at a minimum, try to reduce or eliminate time between recruitment and assigned travel.

SUMMARY

The communications and community outreach effort fine-tuned messages and provided bilingual materials to improve study access and encourage participation in Spanish-speaking neighborhoods. The partnership with CBOs helped increase trust among residents. Field staff emphasized the importance of participation and provided tools to make the process easier for participants. Using various communication channels (e.g., media, social media, and direct outreach), the outreach and communication effort helped to establish the study's legitimacy among invited households. The door-to-door outreach increased participation among communities that were engaged through the team's efforts when compared to similar communities that were not reached directly.

5.5 PARTICIPANT SUPPORT

INBOUND PARTICIPANT SUPPORT

The study maintained three inbound communications channels to support participants before, during, and after their data collection periods. First, a call center with a toll-free number helped participants answer their online surveys and to help answer questions from participants or curious nonparticipants. Second, an email inbox fielded similar inquiries. Third, rMove allowed participants to submit "feedback" via the

app, which was then responded to via email. All three communications channels were staffed with the intent to respond to inquiries within one business day.

OUTBOUND PARTICIPANT SUPPORT

The call center also provided outbound reminder calls to select households that used the online travel diary to remind them about their surveys before and after their assigned travel day. All households that used rMove, and most households that used the online diary, received their travel period reminders via targeted and timely emails.

6.0 DATASET PREPARATION

6.1 OVERVIEW

Collected data are cleaned and processed. The process begins with real-time data validations throughout data collection that affect what data gets collected. These real-time validations are initially described in Section 4.4 on the data collection platforms that were used. The cleaning and processing continues with removing incomplete or invalid households from the dataset, reviewing and cleaning the trip data (particularly the smartphone-based GPS data), and deriving new variables to assist with analysis. The following sections summarize each of these steps. A separate, more-technical Dataset Guide accompanies the dataset itself.

6.2 DATASET PREPARATION

COMPLETION CRITERIA

The 6,199 complete households in the final dataset met the following two conditions:

1. The household completed the recruit survey by answering all required questions.
2. All household members completed all travel diary surveys on at least one concurrent day throughout their travel period.

These completion criteria resulted in high-quality, consistent data. Households using rMove could have between one and seven complete travel days while households using the online travel diary (including households that also partially used rMove) had one complete travel day only. Of the 6,199 complete households, 60 households only had complete travel days on weekend days. The 6,139 remaining households all had at least one complete weekday. The study collected more than 22,500 complete travel days, an average of 3.6 per household overall. Finally, all complete households lived within the study region. Any households that reported a primary home address outside of San Diego County were excluded from the final dataset.

GPS DATA REVIEW AND QUALITY CONTROLS

Cleaning data from rMove helps to reduce the number of false/spurious trips collected by each smartphone device and the ability of rMove to miss short stops with less than a few minutes of dwell time. Participants sometimes inconsistently correct their own trips in the app, requiring further cleaning after the data are sent from the participant's device to the data server.

Data cleaning and processing the rMove data occurred in three stages:

Automated data cleaning: The first stage of data cleaning employed a machine-learning algorithm to automatically classify trips that ranked high in terms of needing to be dropped from the dataset (false/spurious trips) or high in terms of needing no edits (trips that can be kept without review). This algorithm is based on reviewed and labeled trip data from previous datasets and is judiciously employed to minimize the rate of false positives (dropping trips that are valid) and false negatives (keeping trips that should be dropped). The remaining set of trips that did not fall into a high likelihood of either classification were reviewed by analysts in the next stage.

Manual spatial review and correction: In the second stage of cleaning, analysts reviewed trips and trip-path data to determine if one of three possible "corrections" needs to be applied:

1. Drop or remove a trip from the dataset (e.g., a participant walking around their yard is not a valid trip)
2. Split a trip where an additional stop is apparent (e.g., a participant stops to drop-off another household member at school on the way to his or her workplace); in these cases, the answers from the initial trip are applied to all resulting trips after splitting
3. Join a trip where a stop between two trips is not apparent (e.g., rMove loses the signal on the highway and cuts out, but picks up a moment later further along the highway); in these cases, the analyst chooses which trip's survey answers are applied to the resulting joined trip; typically, the original answers are the same for both surveys

Scripted processing and derivations: Finally, RSG performed various scripted trip modification and derivations on the initial cleaned dataset. These included the following:

- Deriving trips for children in rMove households that were reported by other household members
- "Trimming" trip departure and arrival times at the beginning or end of a trip to ensure that the start and end times are accurate
- Removing location points with accuracy ranges greater than 250 meters
- Imputing trip distance using the Google API for the fraction of trips that were not able to capture path data (including user-added trips)
- Removing redundant or extraneous location points on the trip-path location points to help reduce file size and to improve the cleanliness of the path data and the resulting trip distance
- Unlinking transit trips to reliably include access and egress legs
- Performing various other derivations to improve the ease of using the datasets, such as applying various important fields across all levels of the dataset (e.g., variables about which travel days are complete at the household or person level).

The dataset produced contained consistent, clean trip data with reliably unlinked transit trips and clean trip-path data.

INTEGRATING DATA FROM MULTIPLE RETRIEVAL MODES

The study used two modes of travel data collection that needed to be integrated into a single dataset. This required recoding many survey variables and values to be consistent with one another. While both diary modes were consistent with one another, there were several minor differences in the data collection that needed to be harmonized as part of the final dataset. Questions about toll road use, working and shopping from home, where each person started their travel day, participant-identification of Park & Ride locations, and participant-identification of the access and egress details for their transit trips were all handled differently between the two data collection modes. Additionally, rMove had a more detailed set of trip purposes that were harmonized with the online travel diary purposes. Overall, the data from the two data collection modes were integrated into a single dataset that can be used to perform impactful analyses about the San Diego region.

7.0 EXPANSION AND WEIGHTING

7.1 THE ROLE OF WEIGHTING

Survey data weighting for this project involved three primary steps:

1. Calculating initial expansion weights to expand the sample to represent the study area population
2. Adjusting the initial weights to meet marginal population distributions of key household and person-level sociodemographic measures
3. Calculating trip (and travel day) adjustment factors to account for known reporting biases associated with certain (or any) data collection methods

The full weighting memo, provided as Appendix D, contains the details of this operation; however, the basic steps are repeated here.

7.2 EXPANSION

All residential addresses within each sampling strata (described in the study sampling plan) had an equal probability of being invited to the study, but invitation rates varied between the strata to account for targeted oversampling (e.g., high walk and bike shares, high-/low-income, zero-vehicle shares) and to account for "compensatory oversampling" where response rates were expected to be low. Each stratum includes separately calculated expansion weights to account for the differences between the probabilities of being invited in each of the various strata. Dividing the number of households present within the stratum (using the most recent ACS data) by the number of households in the final survey sample living within the same stratum produced the initial expansion weight for each sampling stratum.

The study used four sampling strata:

1. **Regular ("general population") sample**, which included Downtown San Diego and all other BGs not part of the three oversample groups
2. **Transportation oversample**, which had the highest invitation rate (four times as high as the "general population" rate)
3. **Hispanic, Spanish, and low-income oversample** (invitation rate 2.5 times higher than the "general population" rate)
4. **Other oversample**, which included a mix of areas near military bases and universities, and other areas with a high fraction of young nonfamily households (invitation rate two times higher than the "general population" rate)

TABLE 7-1: RESULTS OF INITIAL EXPANSION WITHIN SAMPLING STRATA

SAMPLE SEGMENT	OVERSAMPLE RATE	ACS 2011–15 HOUSEHOLDS	COMPLETE HOUSEHOLDS IN SAMPLE	INITIAL EXPANSION WEIGHT	RESPONSE RATE RELATIVE TO REGULAR SAMPLE
Regular sample	1x	754,772	2,952	255.6816	100%
Transportation oversample	4x	171,083	2,221	77.0297	83%
Hispanic oversample	2.5x	103,561	490	211.3490	48%
Other oversample	2x	64,741	476	136.0105	94%
	Total	**1,094,157**	**6,139**		

TABLE 7-2: ADJUSTMENT OF INITIAL EXPANSION WEIGHTS TO 2015 ONE-YEAR ACS ESTIMATES

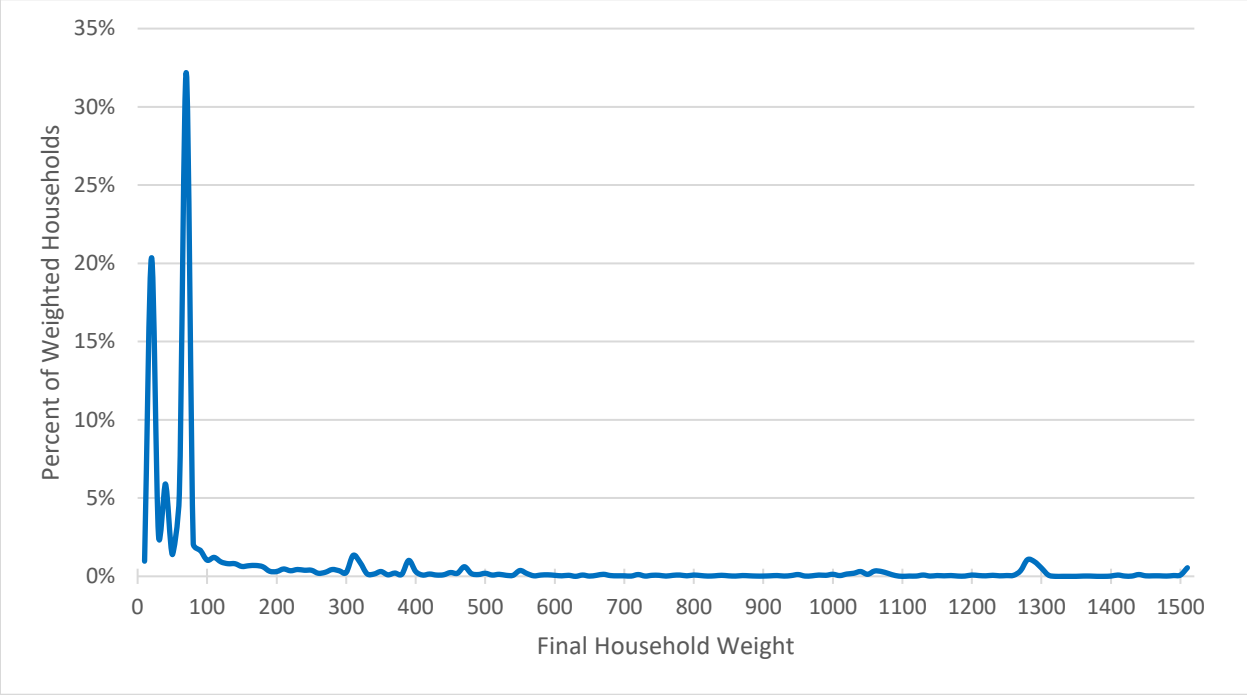
SAMPLE SEGMENT	INITIAL EXPANSION WEIGHT	ADJUSTED INITIAL WEIGHT	COMPLETE HOUSEHOLDS	INITIAL EXPANDED HOUSEHOLDS
Regular sample	255.6816	260.2273	2,952	768,191
Transport. oversample	77.0297	78.3992	2,221	174,125
Hispanic oversample	211.3490	215.1065	490	105,402
Other oversample	136.0105	138.4286	476	65,892
		Total	**6,139**	**1,113,610**

7.3 FINAL WEIGHTS

HOUSEHOLD AND PERSON WEIGHTS

The average weight is 181, implying that the study achieved a 0.55% sample rate overall. The median and mode weights were both 65, less than the average of 181, evidence of the fact that the distribution of weights is right-skewed (seen in Figure 7-1). The maximum weight is 1,561, which was applied to six households, all of which were large households from the Regular sample segment, each with other attributes that made them relatively rare. The lowest weight was 19.6, which applied to approximately 450 households of varying composition. Figure 7-1 visualizes the overall distribution of household weights.

FIGURE 7-1: DISTRIBUTION OF FINAL HOUSEHOLDS WEIGHTS



ADJUSTING THE WEIGHTS FOR MULTIDAY DATA

The concepts of household-days and person-days of travel are important for the SANDAG AB model. Conceptually, each household-day and person-day should represent an average weekday's activities and travel (if any trips are made). Table 7-3 includes all complete weekday person-days in households that provided complete data for at least one weekday. These are the same 6,139 households that were included in the household weighting. (As mentioned, 60 households had complete travel days only on the weekend. RSG excluded these households from the weighting analysis.)

All households who completed the survey online or by telephone, using the more traditional travel diary methods, had a single travel day that is on a Tuesday, Wednesday, or Thursday. Table 7-3 shows that there were 4,080 such "online" travel days in the data, split evenly across the three days. Households that responded using rMove could respond for up to seven days, but only the weekday travel days were included in the travel-day weighting. Table 7-3 shows that for weekdays when all household members provided complete data, there were 28,605 "rMove-complete HH day" person-days in the data, also split evenly across the five weekdays.

The data include 6,163 "rMove-incomplete HH day" person travel days. These are cases when a person provided complete data for a weekday, but at least one other household member did not. These cases were left in the data as possibly useful for model estimation, but are given a weight of zero for model calibration. In other words, the person-day weights were only positive for complete household weekdays.

For Table 7-4, shows the same distributions as Table 7-3 but now weights each person-day using the household weight. The distribution of trips by weekday and the average trips per person-day remain like those in Table 7-3, although the difference in trips rates between the rMove and online data becomes somewhat larger. Table 7-4 represents the total weighted travel days collected by the study.

For Table 7-5, RSG created a factored weight so that all valid household weekdays would add to one weighted weekday for each person. For each complete HH weekday, the “multiday factor” = 1 / (complete HH weekdays), otherwise it equals zero. The factored person-day weight (called “multiday_weight_456x”) is equal to the household weight (newwt_456x) times the multiday factor. Table 7-5 shows that the total number of weighted person-weekdays is 2,922,538, which is the same as the weighted number of person records in the person file, since each person contributes exactly one person-day after adjustment with this weight. Also, the “rMove- incomplete HH day” rows drop out of the table, since those have a multiday weight of zero. The reason for this multiday adjustment is to balance the impact of each household’s data, given how different households completed varying numbers of travel days (from 1 to 7 days). This “multiday weight” is used in the day and trip analysis in Sections 8.4 and 8.5.

For rMove, the average number of trips from Monday and Friday was 4.65, which is like the average number of trips from Tuesday to Thursday (4.70), and the fraction of travel days across the weekdays is similar. Also, applying the multiday factor changed the average number of trips per rMove person-day from 4.71 to 4.68. These differences were small enough to not necessitate any differential factoring across the different days of the week.

TABLE 7-3: UNWEIGHTED PERSON-DAY RECORDS, BY TYPE AND WEEKDAY

NUMBER OF PERSON-DAY RECORDS	TRAVEL DAY OF WEEK					TOTAL
	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	
rMove-complete HH day	5,497	6,006	5,867	5,791	5,444	28,605
rMove-incomplete HH day	1,366	1,103	1,133	1,165	1,396	6,163
Online diary	0	1,327	1,377	1,376	0	4,080
Total	**6,863**	**8,436**	**8,377**	**8,332**	**6,840**	**38,848**
Fraction by Day of Week	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Total**
rMove-complete HH day	19.2%	21.0%	20.5%	20.2%	19.0%	100%
rMove-incomplete HH day	22.2%	17.9%	18.4%	18.9%	22.7%	100%
Online diary	--	32.5%	33.8%	33.7%	--	100%
Total	**17.7%**	**21.7%**	**21.6%**	**21.4%**	**17.6%**	**100%**
Average Trips per Person-Day	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Total**
rMove-complete HH day	4.27	4.43	4.67	4.72	4.90	4.60
rMove-incomplete HH day	4.14	4.15	4.23	4.38	4.72	4.34
Online diary	--	3.74	3.78	3.72	--	3.75
Total	**4.24**	**4.29**	**4.47**	**4.50**	**4.86**	**4.47**

TABLE 7-4: WEIGHTED PERSON-DAY RECORDS, BY TYPE AND WEEKDAY

WEIGHTED PERSON-DAY RECORDS	TRAVEL DAY OF WEEK					TOTAL
	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	
rMove-complete HH day	1,172,250	1,315,285	1,223,056	1,253,128	1,156,692	6,120,411
rMove-incomplete HH day	419,916	342,270	386,536	359,072	434,805	1,942,599
Online diary	--	313,470	362,985	403,423	--	1,079,878
Total	**1,592,166**	**1,971,025**	**1,972,577**	**2,015,623**	**1,591,497**	**9,142,888**
Fraction by Day of Week	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Total**
rMove-complete HH day	19.2%	21.5%	20.0%	20.5%	18.9%	100%
rMove-incomplete HH day	21.6%	17.6%	19.9%	18.5%	22.4%	100%
Online diary	--	29.0%	33.6%	37.4%	--	100%
Total	**17.4%**	**21.6%**	**21.6%**	**22.0%**	**17.4%**	**100%**
Weighted Average Trips per Person-Day	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Total**
rMove-complete HH day	4.42	4.54	4.82	4.79	4.98	4.71
rMove-incomplete HH day	4.27	4.34	4.32	4.63	4.99	4.52
Online diary	--	3.40	3.44	3.42	--	3.42
Total	**4.38**	**4.33**	**4.47**	**4.49**	**4.98**	**4.52**

TABLE 7-5: WEIGHTED PERSON-DAY RECORDS, BY TYPE AND WEEKDAY, USING THE HH MULTIDAY-ADJUSTED WEIGHT

WEIGHTED PERSON-DAY RECORDS	TRAVEL DAY OF WEEK					TOTAL
	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	
rMove-complete HH day	364,880	407,995	373,066	376,240	320,479	1,842,660
Online diary	--	313,470	362,985	403,423	--	1,079,878
Total	**364,880**	**721,465**	**736,051**	**779,663**	**320,479**	**2,922,538**
Fraction by Day of Week	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Total**
rMove-complete HH day	19.8%	22.1%	20.2%	20.4%	17.4%	100%
Online diary	--	29.0%	33.6%	37.4%	--	100%
Total	**12.5%**	**24.7%**	**25.2%**	**26.7%**	**11.0%**	**100%**
Weighted Average Trips per Person-Day	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Total**
rMove-complete HH day	4.43	4.44	4.87	4.82	4.91	4.68
Online diary	--	3.40	3.44	3.42	--	3.42
Total	**4.43**	**3.99**	**4.17**	**4.10**	**4.91**	**4.22**

TRIP WEIGHTS AND TRIP CORRECTION FACTORS

The study collected travel diary data using rMove and the online travel diary. The final part of the weighting process compared and adjusted trip rates based on detectable biases from the two data collection methods. Because this study was one of the first majority smartphone-based studies in the United States, this process involved using new methods to perform the analysis. The details of this analysis are provided in full in the weighting memo in Appendix D; however, the results and final correction factors are summarized below. The two primary factors that affected the trip reporting rates were participants' age and the data/reporting type (rMove vs. Online Diary). Table 7-6 lists the average of the adjustment factors sorted by age group and data/reporting type. The rMove nonproxy data were assumed as the "correct" trip rates, so the adjustment had no effect. For children under age 16, all data were by proxy using similar methods, so there was no "correct" source to adjust to. For the children between the ages of 16 and 17 who reported by proxy, the average adjustment factor was 1.77. For all the adult rSurvey respondents, the average adjustment factor was approximately 1.10 for nonproxy person-days and 1.35 for proxy person-days. Because most person-days were in the rMove nonproxy column, the overall mean adjustment factor was only 1.02.

TABLE 7-6: AVERAGE TRIP-RATE ADJUSTMENT FACTORS, BY AGE GROUP AND DATA COLLECTION TYPE

AGE	rMOVE-NO PROXY	rMOVE-BY PROXY	rSURVEY-NO PROXY	rSURVEY-BY PROXY	TOTAL
Under 5 years old	--	1.0	--	1.0	1.0
5–15 years	--	1.0	--	1.0	1.0
16–17 years	1.0	1.77	--	1.77	1.52
18–24 years	1.0	--	1.42	1.99	1.07
25–34 years	1.0	--	1.40	2.00	1.03
35–44 years	1.0	--	1.21	1.67	1.01
45–49 years	1.0	--	1.21	1.69	1.02
50–54 years	1.0	--	1.08	1.52	1.01
55–59 years	1.0	--	1.08	1.49	1.02
60–64 years	1.0	--	1.09	1.51	1.02
65–74 years	1.0	--	1.0	1.38	1.01
75–79 years	1.0	--	1.0	1.40	1.02
80–84 years	1.0	--	1.0	1.43	1.04
85 years or older	1.0	--	1.0	1.46	1.07
Total	**1.0**	**1.03**	**1.10**	**1.35**	**1.02**

Table 7-7 shows the average linked trip rates by age and data collection type after the multiday-adjusted household weight and the trip-rate adjustments were applied to the person-days. This table uses "linked trips," rather than the "unlinked trips" as reported in the rest of the report (unless otherwise noted). Linked trips, as defined here, exclude the identified walk and bike access and egress legs for multimodal trips. By excluding these identified access and egress legs, the trip rates shown in this table more accurately reflect trip rates as they are generally understood, however the overall impact of using linked trips in this table is rather minimal. In applying the trip-rate correction factors, the average number of trips per day for rMove data increased somewhat to 5.08, but the weight of the rMove data decreased due to the multiday adjustment, so the overall trip rate decreased to **4.30 trips per day for the average person. This equates to 11.3 trips per day for the average household.** These are the final adjusted and weighted linked trip rates from the dataset for this report. Future modeling and analysis efforts may involve different methods of weighting, filtering, or linking the trips and result in slightly different trip rates.

TABLE 7-7: AVERAGE LINKED TRIPS PER WEEKDAY, BY AGE GROUP AND DATA COLLECTION/REPORTING TYPE (ADJUSTED & WEIGHTED)

AGE	rMOVE-NO PROXY	rMOVE-BY PROXY	rSURVEY-NO PROXY	rSURVEY-BY PROXY	TOTAL
Under 5 years old	--	3.59	--	2.33	3.30
5–15 years	--	3.26	--	3.22	3.25
16–17 years	3.90	3.46	--	4.28	3.94
18–24 years	4.67	--	4.05	5.65	4.56
25–34 years	5.14	--	3.98	6.14	4.96
35–44 years	5.53	--	4.75	3.20	5.28
45–49 years	5.96	--	4.55	3.20	5.45
50–54 years	5.20	--	4.30	3.66	4.90
55–59 years	4.65	--	3.69	4.06	4.20
60–64 years	4.14	--	3.36	3.91	3.72
65–74 years	4.28	--	3.30	3.57	3.67
75–79 years	2.92	--	3.34	2.18	3.06
80–84 years	3.20	--	3.17	2.64	3.11
85 years or older	2.53	--	2.05	1.08	1.98
Total (Average Person)	**5.08**	**3.36**	**3.76**	**3.53**	**4.30**
Total (Average Household)					**11.3**

Section 8.0 provides additional analysis using both the weighted and unweighted data.

8.0 SURVEY RESULTS

8.1 RESPONSE SUMMARY

The study exceeded its target of 5,500 households—6,199 households completed the study. Two-thirds (67%) of households used rMove to collect data in some way (at least one adult in the household used rMove), with more than 63% of households participating solely using rMove (all adults in the household used rMove). Another 3.4% of households included at least one household member who used rMove.

TABLE 8-1: RESPONSES, BY PARTICIPATION GROUP

PARTICIPATION GROUP	UNWEIGHTED		WEIGHTED	
	FREQUENCY	PERCENT	FREQUENCY	PERCENT
rMove only	3,912	63.1%	659,736	59.2%
Online diary only	2,077	33.5%	391,120	35.1%
Split HH: rMove and online diary	210	3.4%	62,767	5.6%
Total	**6,199**	**100.0%**	**1,113,624**	**100.0%**

Table 8-2 shows that the regular sample had the largest overall size (as measured by number of households) *and* the lowest sample rate. The transportation oversample had a relatively high sample rate overall—1.3% of households. This table complements Table 8-1 by showing the resulting sample rates sorted by segment rather than the response rates sorted by segment.

TABLE 8-2: RESPONSES, BY SAMPLE SEGMENT

SAMPLE SEGMENT	OVERSAMPLE RATE	ACS 2011–15 HOUSEHOLDS	COMPLETE HOUSEHOLDS IN SAMPLE	SAMPLE RATE	SAMPLE RATE RELATIVE TO REGULAR SAMPLE
Regular sample	1.0x	754,772	2,952	0.40%	1.00x
Transportation oversample	4.0x	171,083	2,221	1.31%	3.32x
Hispanic oversample	2.5x	103,561	490	0.48%	1.21x
Other oversample	2.0x	64,741	476	0.74%	1.87x
Total		**1,094,157**	**6,199**	**0.56%**	**1.42x**

Overall, the dataset collectively represents the largest, most accurate, most realistic, most representative, and most comprehensive dataset ever assembled to assess travel behavior in San Diego County. The analyses in this report reflect the dataset as it was at the time of delivery. The dataset reflects unlinked trip data, implying that access, egress, and changing travel modes are broken out separately, and the results in this report reflect those unlinked trips (unless otherwise noted). Future modeling and analysis on the dataset may result in different results or summary statistics for many possible reasons. Given the complexity, size, lifespan, and varying analytical applications of this dataset, it is expected that the dataset will be actively used to answer questions about San Diego's transportation on an ongoing basis and not necessarily always adhere to the numbers that are initially reported here. In any case, the dataset

can be used with confidence to analyze and assess many distinct aspects of transportation behavior to inform transportation planning in San Diego.

RESPONSE SUMMARY MAPS

The following maps summarize certain aspects of the data collected in the study. As shown in Figure 8-1, the sample rate varied by census BG, often tracking the rate at which households were oversampled; however, there was significant variation among sample rate by census BG even within each sample segment. With an average sample rate of just above 0.5%, Figure 8-1 highlights which regions significantly surpassed the average sample rate (mostly urban areas). Figure 8-2, Figure 8-3, and Figure 8-4 present three maps of trip destinations by census BG. The first map shows overall trip counts, the second map shows only trips collected via rMove, and the third map shows only trips collected via the online diary. The highest concentrations of trip destinations occur in areas that were oversampled, including Downtown San Diego, and in areas with high employment or university attendance. Figure 8-2 (Overall counts) and Figure 8-3 (rMove counts) are nearly identical, whereas Figure 8-2 (Overall counts) and Figure 8-4 (online diary counts) are dramatically different in their shading, visually confirming that the vast majority of data was collected via rMove.

In the last comparable study from 2006, 3,651 households reported data for one day, the results of which are mapped in Figure 8-5. The results from 2006 are most similar to the online diary counts from the current study shown in Figure 8-4. The high volume of additional data and geographic coverage provided by the current study is a testament to value of the new methods and tools that were used and to the willingness of SANDAG to support that innovation.

Finally, similar to the other maps, Figure 8-6 displays a heat map of trip destinations collected within Southern California and Mexico. Areas with a dense collection of trip destinations are shown in red, whereas areas with less dense trip destinations are shown in shades of yellow, green, and blue. The intuitive interpretation of this graphic is that this scale helps to show the relative coverage of trip destinations across the region. Many areas are extremely well covered. The western half of San Diego County is densely covered and a fair number of destinations external to San Diego County received a high number of trips, mostly parts of greater Los Angeles and Mexico.

FIGURE 8-1: SAMPLE RATE, BY CENSUS BLOCK GROUP

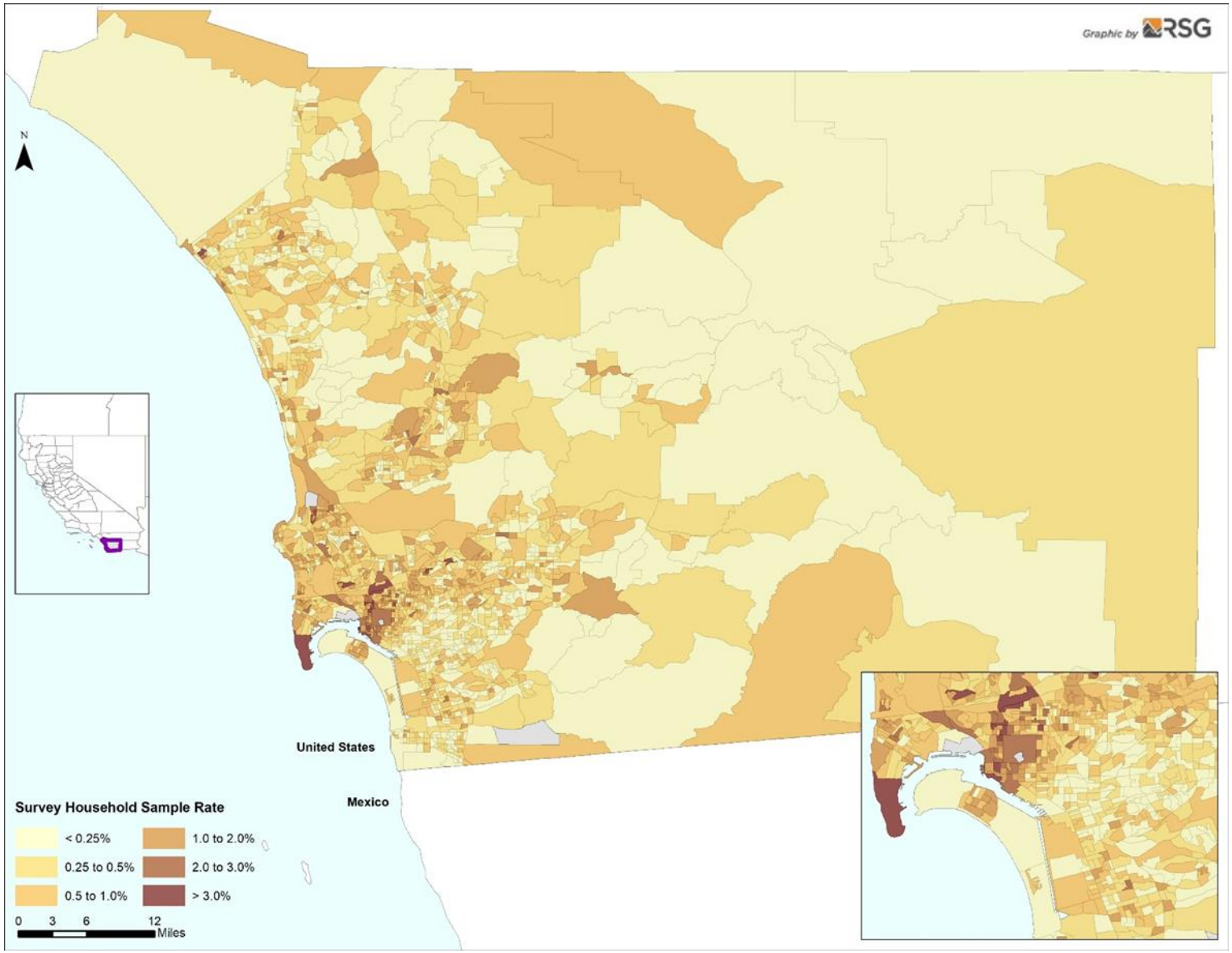


FIGURE 8-2: COUNT OF TRIP DESTINATIONS, BY CENSUS BLOCK GROUP (UNWEIGHTED)

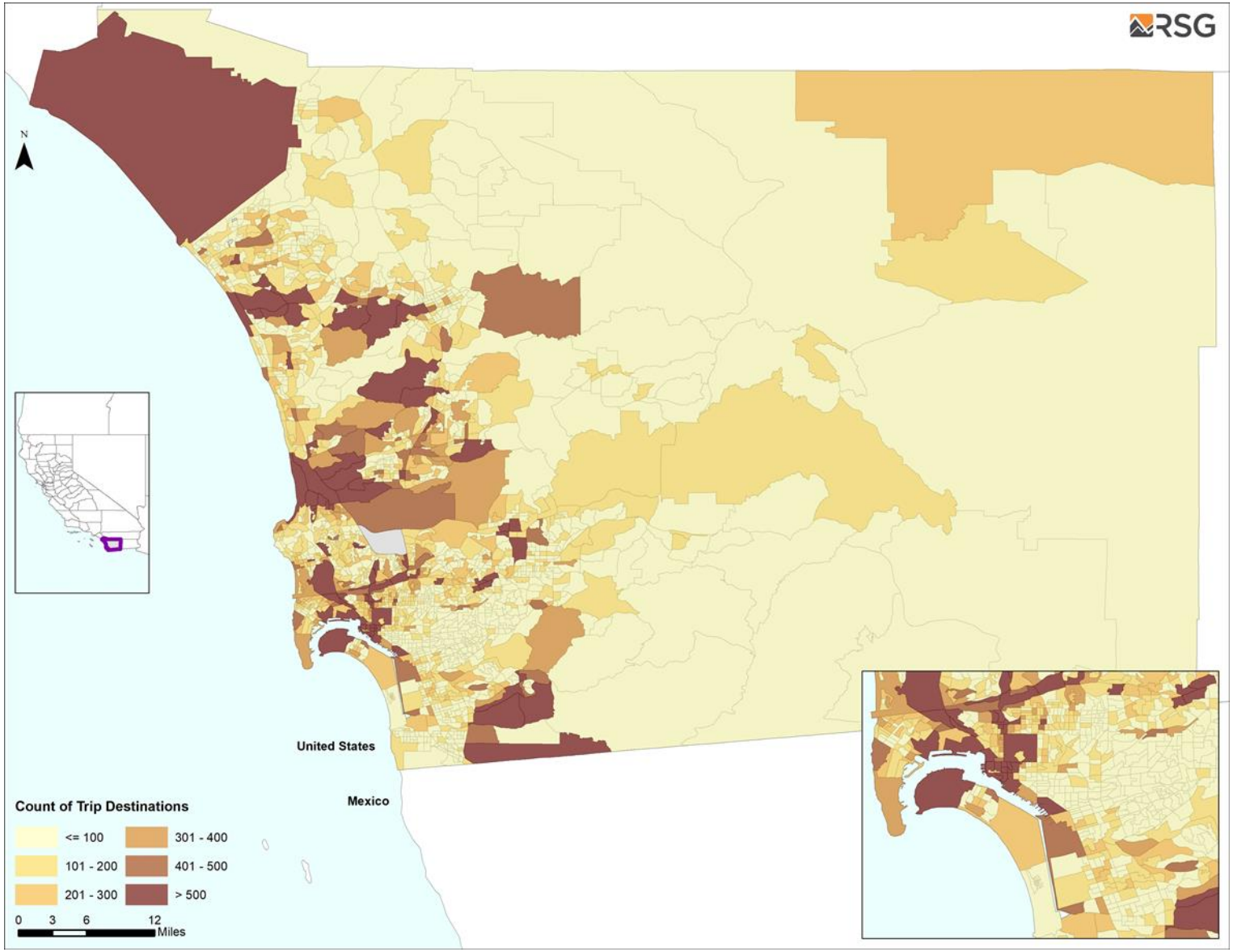


FIGURE 8-3: COUNT OF rMOVE TRIP DESTINATIONS, BY CENSUS BLOCK GROUP (UNWEIGHTED)

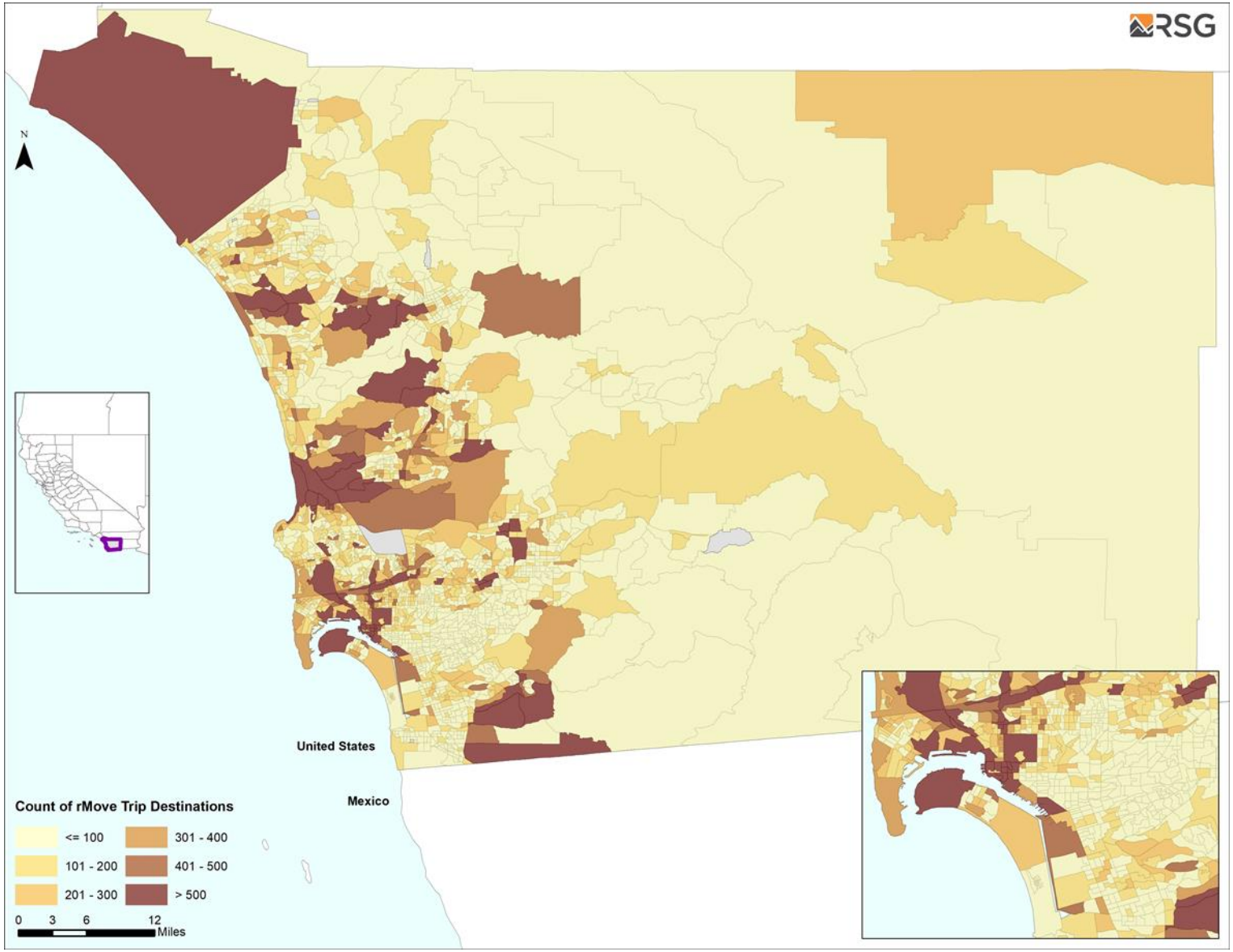


FIGURE 8-4: COUNT OF ONLINE DIARY (rSURVEY) TRIP DESTINATIONS, BY CENSUS BLOCK GROUP (UNWEIGHTED)

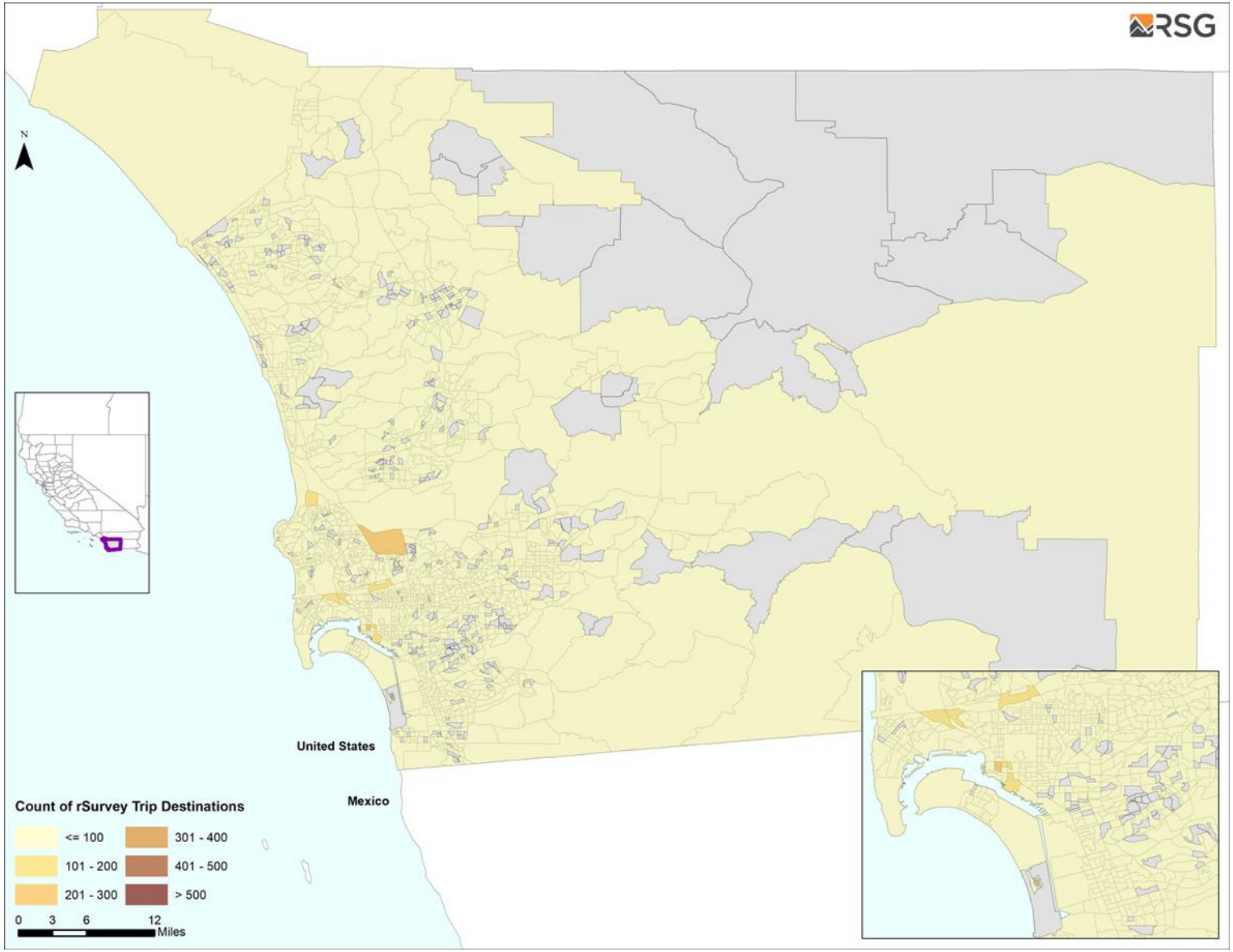


FIGURE 8-5: COUNT OF TRIP DESTINATIONS FROM THE 2006 SANDAG HOUSEHOLD TRAVEL STUDY (UNWEIGHTED) (PROVIDED BY SANDAG)

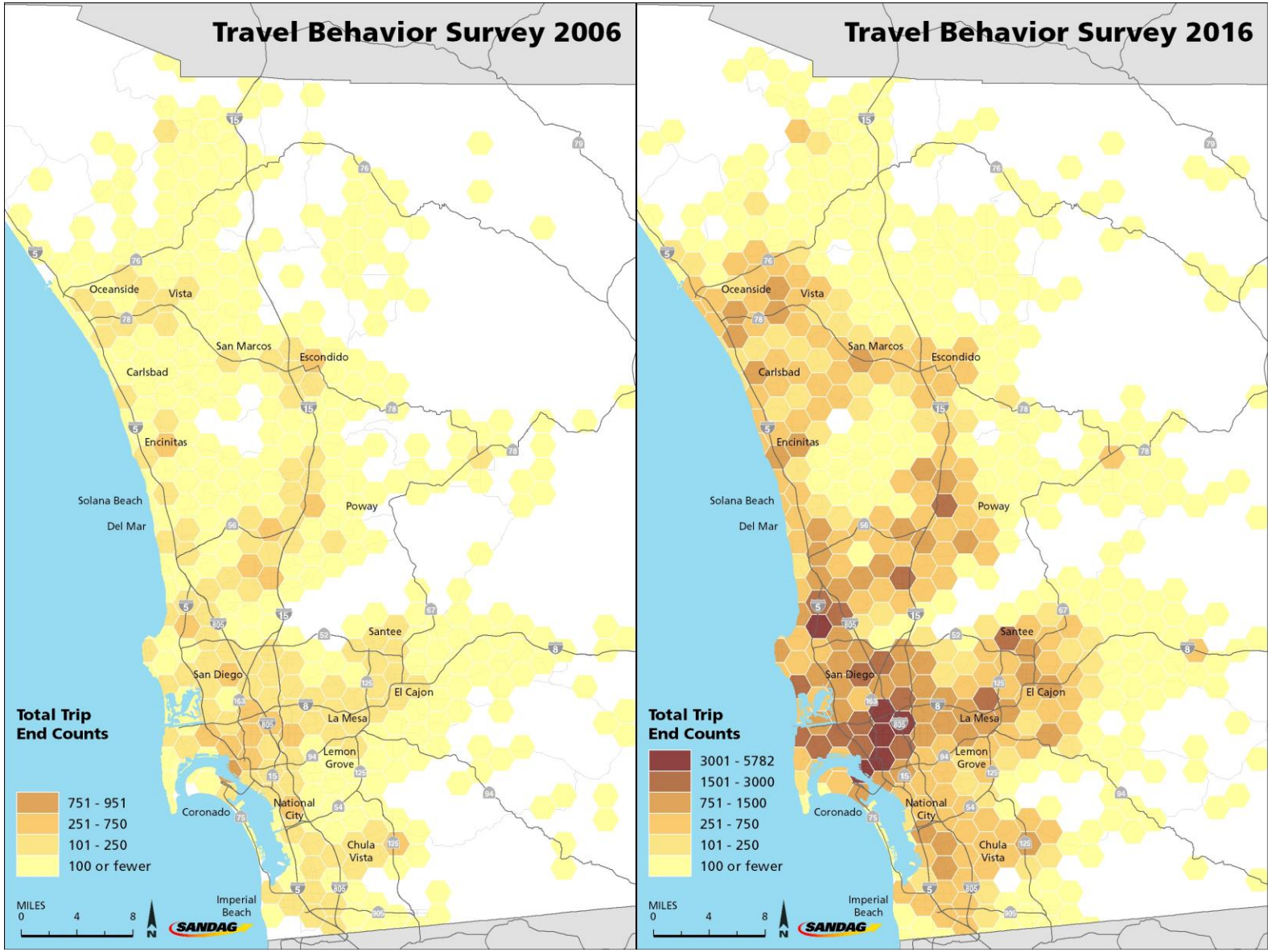
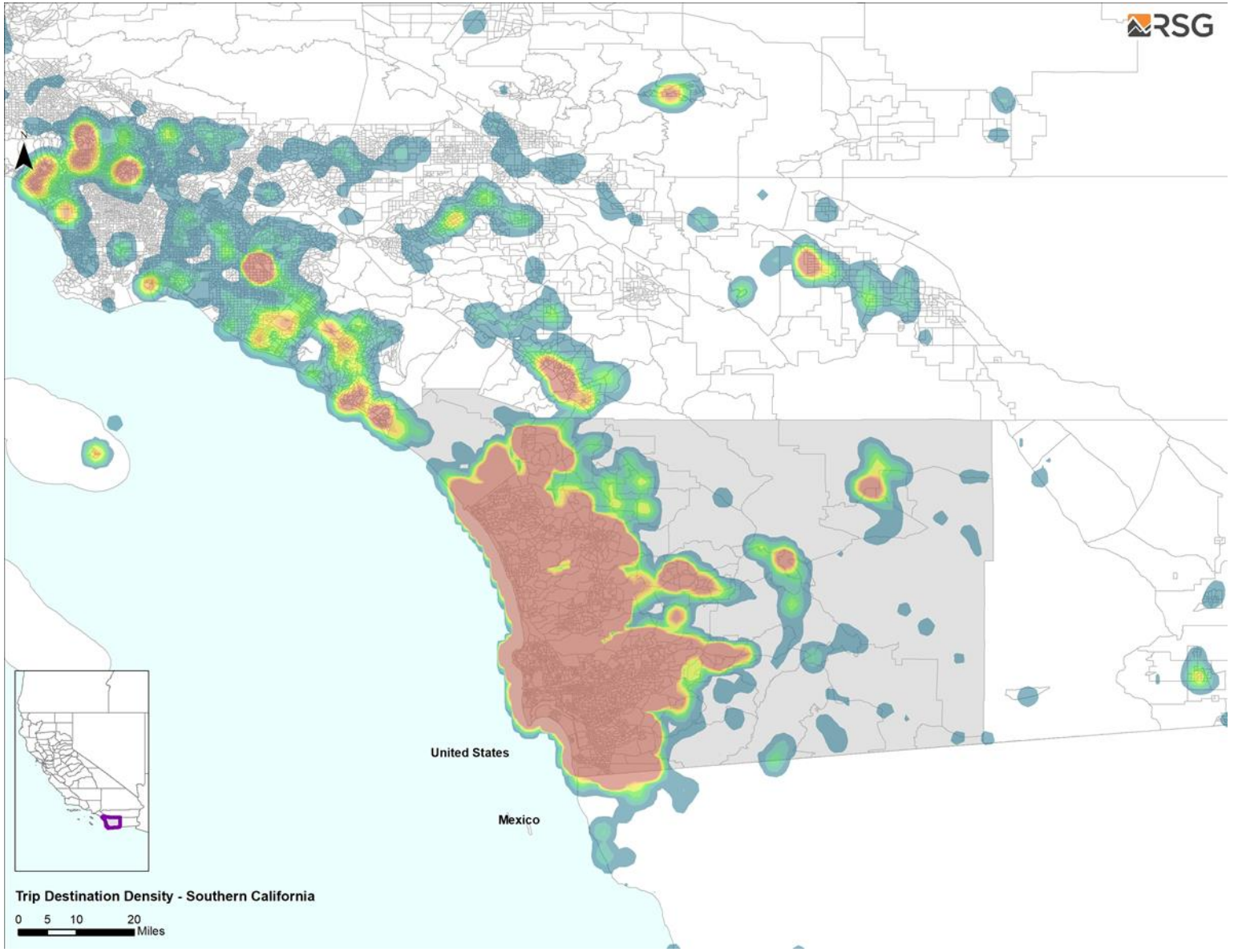


FIGURE 8-6: HEAT MAP OF TRIP DESTINATIONS ACROSS SOUTHERN CALIFORNIA AND MEXICO (UNWEIGHTED)



8.2 HOUSEHOLD RESULTS

Table 8-3 and Figure 8-7 through Figure 8-9 present the household-level dataset characteristics analysis results. Many of the results are shown as percentages of the overall number of complete households (6,199). This facilitates comparisons of the resulting distributions and weighted and unweighted data (when both figures are presented). Because the weighted results closely approximate the ACS totals on nearly every measure, the weighted totals can typically be used as a reference for the relevant ACS distributions. Furthermore, because the participation group (rMove or the online travel diary) was a key factor in how the data were collected—in addition to being a new and innovative data collection practice—many of the figures are segmented by participation group. Many of the figures do not include the results for split households, as their contribution to the total was often minimal.

Results by household size are an important measure for HTS projects. Like many household-level studies, this project's participation was skewed toward smaller households, as it is often easier for smaller households to participate and complete the surveys. RSG corrected this bias in the weighting process. Importantly, there were differences between households that used rMove and those that did not. Households using rMove tended to be larger than households not using rMove, with nearly 24% of rMove households having three or more persons, compared to just 15% of households using the online travel diary, as shown in Table 8-3 and Figure 8-7. These distributions were affected by the presence of "split households" that only partially used rMove; however, including these households in the online diary group raises the share of households with three or more persons from 15% to 17.8%.

TABLE 8-3: HOUSEHOLD SIZE, BY PARTICIPATION GROUP (AS PERCENTAGE OF COMPLETED HOUSEHOLDS) (UNWEIGHTED)

NUMBER OF PERSONS	rMOVE ONLY	ONLINE DIARY ONLY	SPLIT HH: rMOVE & ONLINE DIARY	TOTAL
1 person	39.1%	46.8%	0.0%	40.3%
2 people	37.0%	37.7%	59.5%	38.0%
3 people	10.9%	7.8%	21.4%	10.2%
4 people	9.7%	4.2%	14.8%	8.0%
5 or more people	3.2%	3.5%	4.3%	3.4%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

FIGURE 8-7: HOUSEHOLD SIZE, BY PARTICIPATION GROUP (AS PERCENTAGE OF COMPLETED HOUSEHOLDS) (UNWEIGHTED AND WEIGHTED)

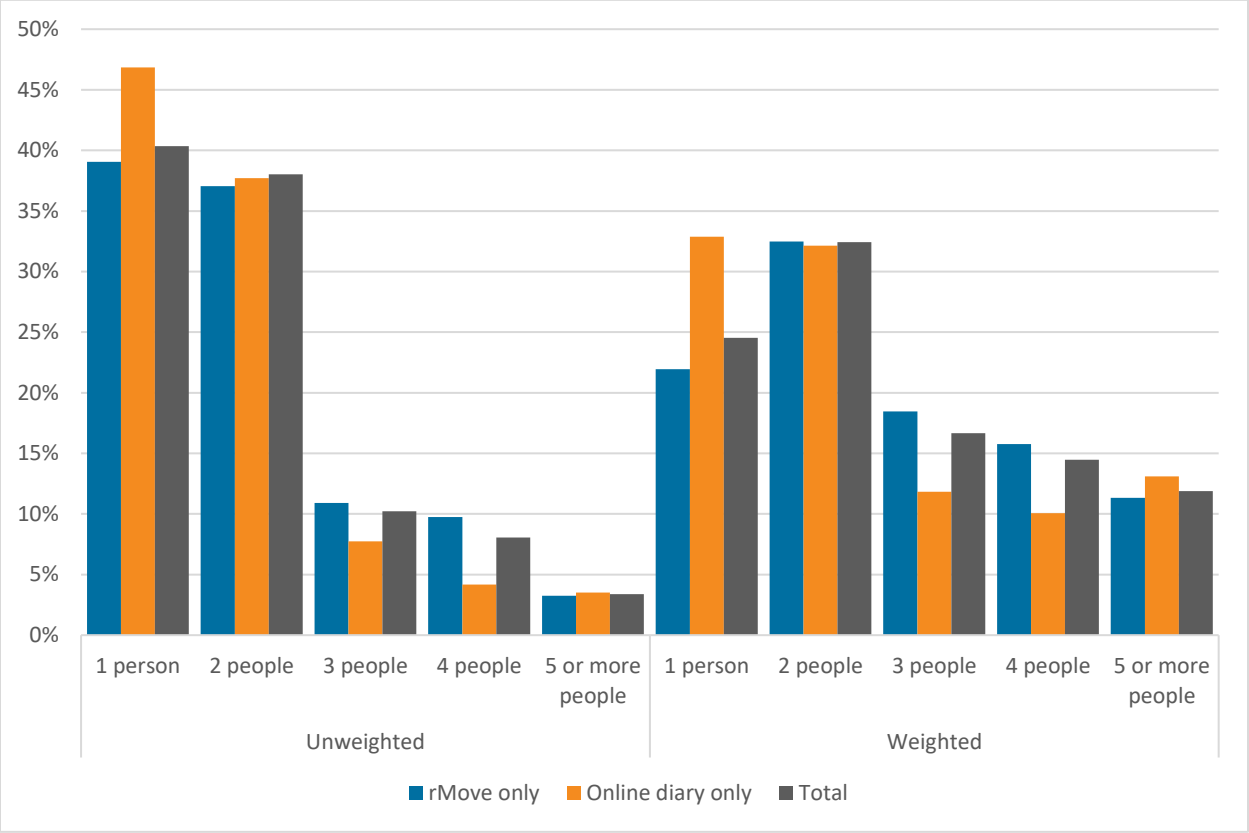


Figure 8-8 presents the summary of household income across participation groups. Higher-income households are more likely to own smartphones, thereby affecting study participation method. Households reporting incomes below $30,000 per year comprised 34% of households that solely used the online diary and comprised only 11% of households that solely used rMove. Conversely, households reporting incomes of $150,000 or more per year comprised 21% of households that solely used rMove and comprised only 8% of households that used the online diary.

FIGURE 8-8: HOUSEHOLD INCOME, BY PARTICIPATION GROUP (AS % OF COMPLETED HOUSEHOLDS) (UNWEIGHTED AND WEIGHTED)

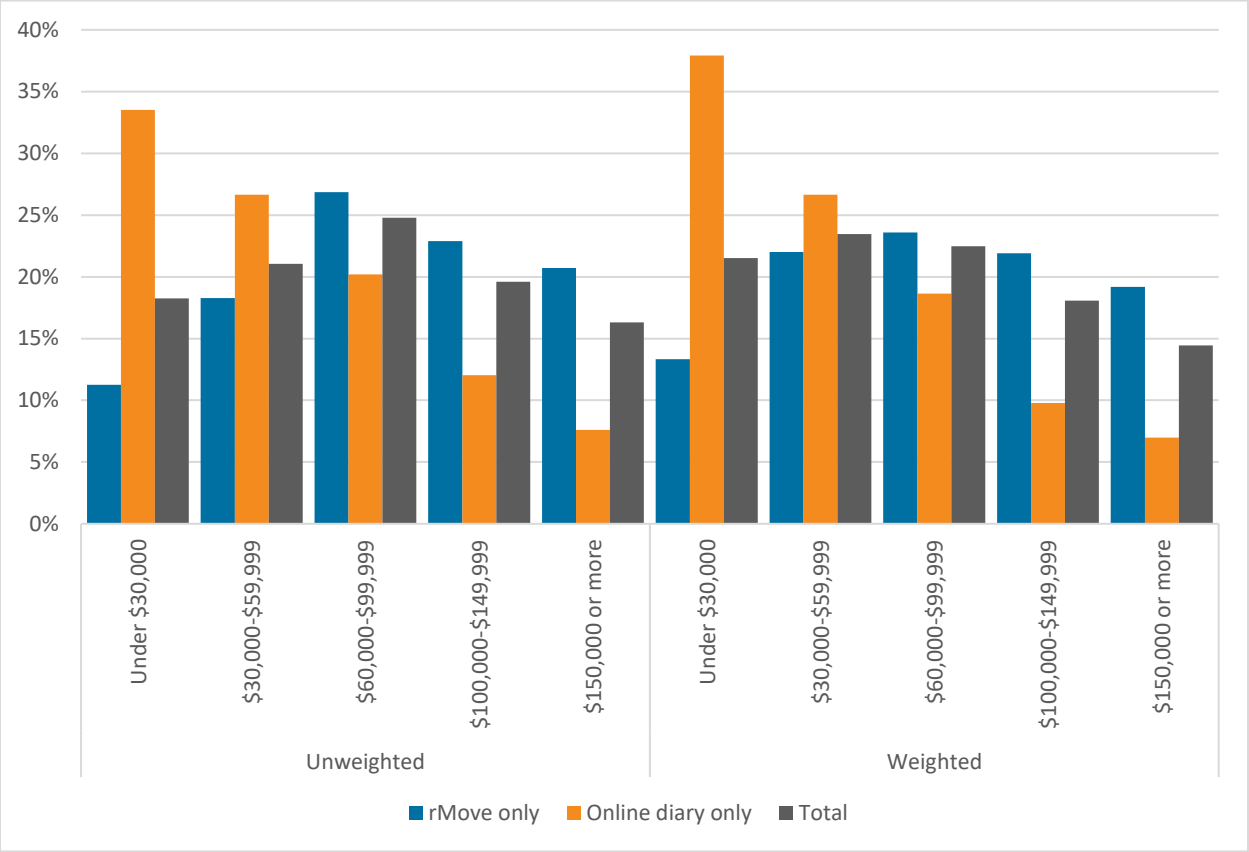


Figure 8-9 shows the results for household vehicle ownership. These results approximate the results by household size, as households with three or more vehicles are underrepresented in the unweighted data. Interestingly, data for households with zero vehicles were weighted downward even though zero-vehicle households are traditionally viewed as a “hard-to-reach” households for travel surveys. The high presence of zero-vehicle households among those using the online travel diary relates to the higher rate of lower-income and urban/downtown households that used the online diary, both of which were aggressively oversampled in the study. The number of household vehicles and household income have a 0.497 Pearson correlation, confirming this relationship.

FIGURE 8-9: HOUSEHOLD VEHICLES, BY PARTICIPATION GROUP (AS % OF COMPLETED HOUSEHOLDS) (UNWEIGHTED AND WEIGHTED)

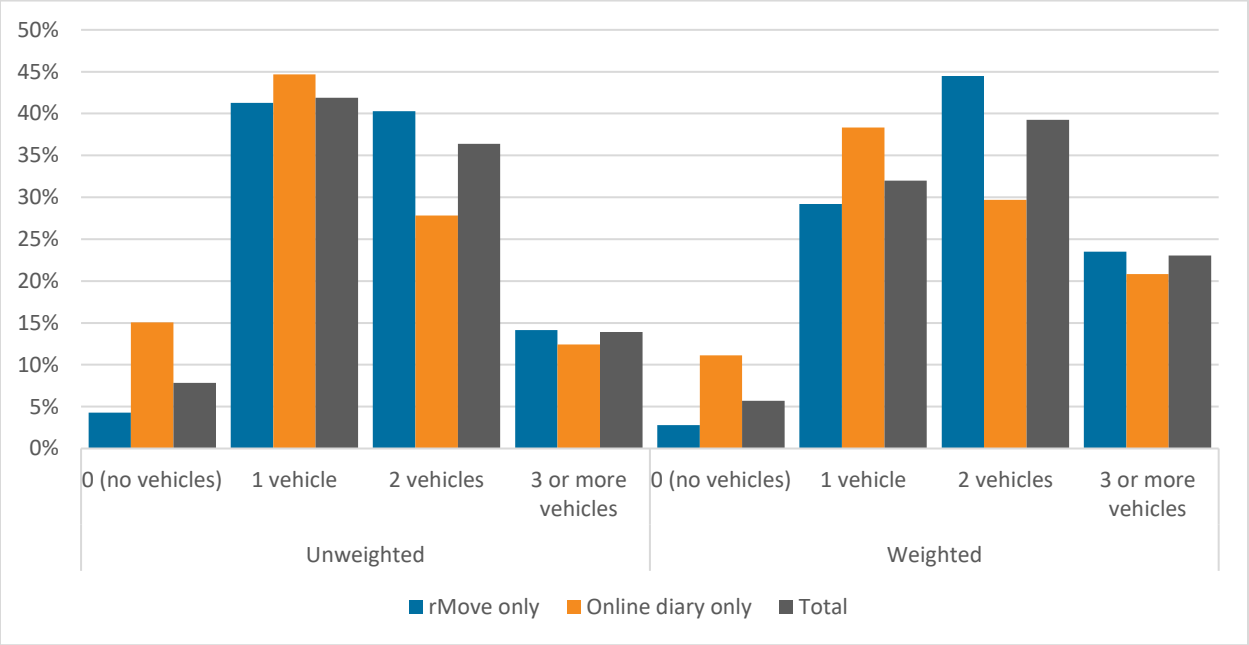


Figure 8-10 presents the number of bikes owned sorted by participation group. Several factors are associated with bike ownership, including income, household size, age, and household location. These data are available to help understand bike ownership in San Diego County; however, this section does not include in-depth analysis. Overall, 51% of unweighted and 56% of weighted households own at least one bike, with households using rMove more likely to own a bike.

FIGURE 8-10: HOUSEHOLD BIKES, BY PARTICIPATION GROUP (AS % OF COMPLETED HOUSEHOLDS) (UNWEIGHTED AND WEIGHTED)

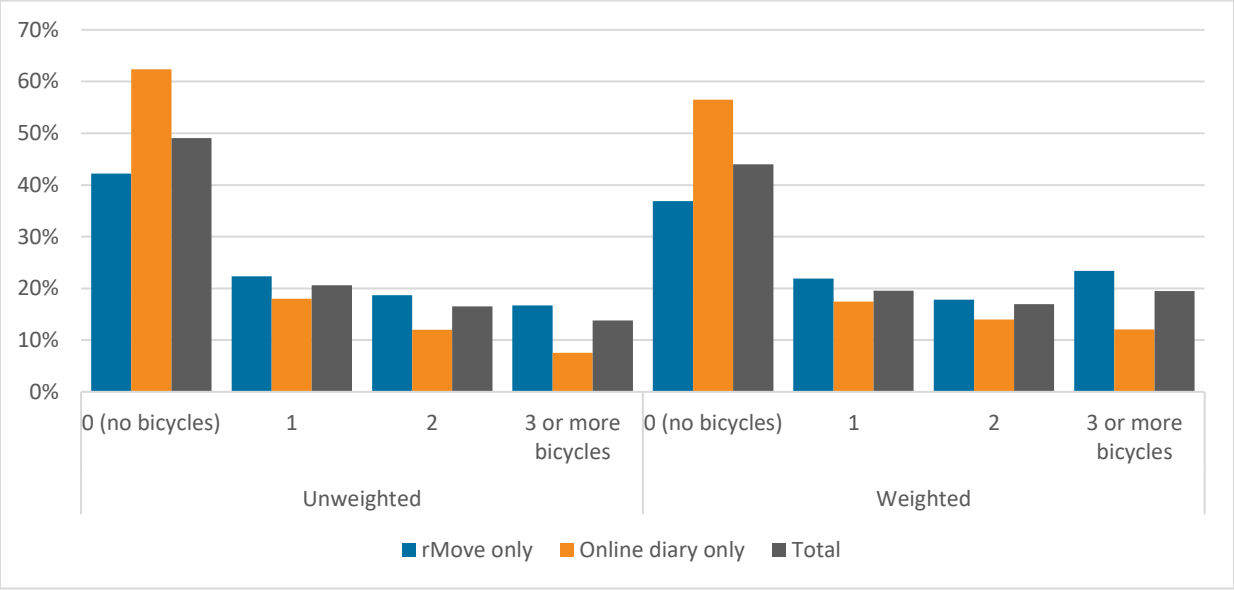


Figure 8-11 presents the results of the survey questions about which navigation and trip planning tools are used within each household. As expected, households using rMove reported much higher usage of digital and smartphone or app-based services. Google Maps is a dominant player, with nearly 80% of households reporting they use it. In-car navigation, MapQuest, and Uber were the next three most likely planning and navigation tools in use. SDMTS.com was the most commonly used publicly offered service, with approximately 18% of households reporting its use.

FIGURE 8-11: HOUSEHOLD USE OF SELECT NAVIGATION SERVICES, BY PARTICIPATION GROUP (AS % OF COMPLETED HOUSEHOLDS) (UNWEIGHTED)

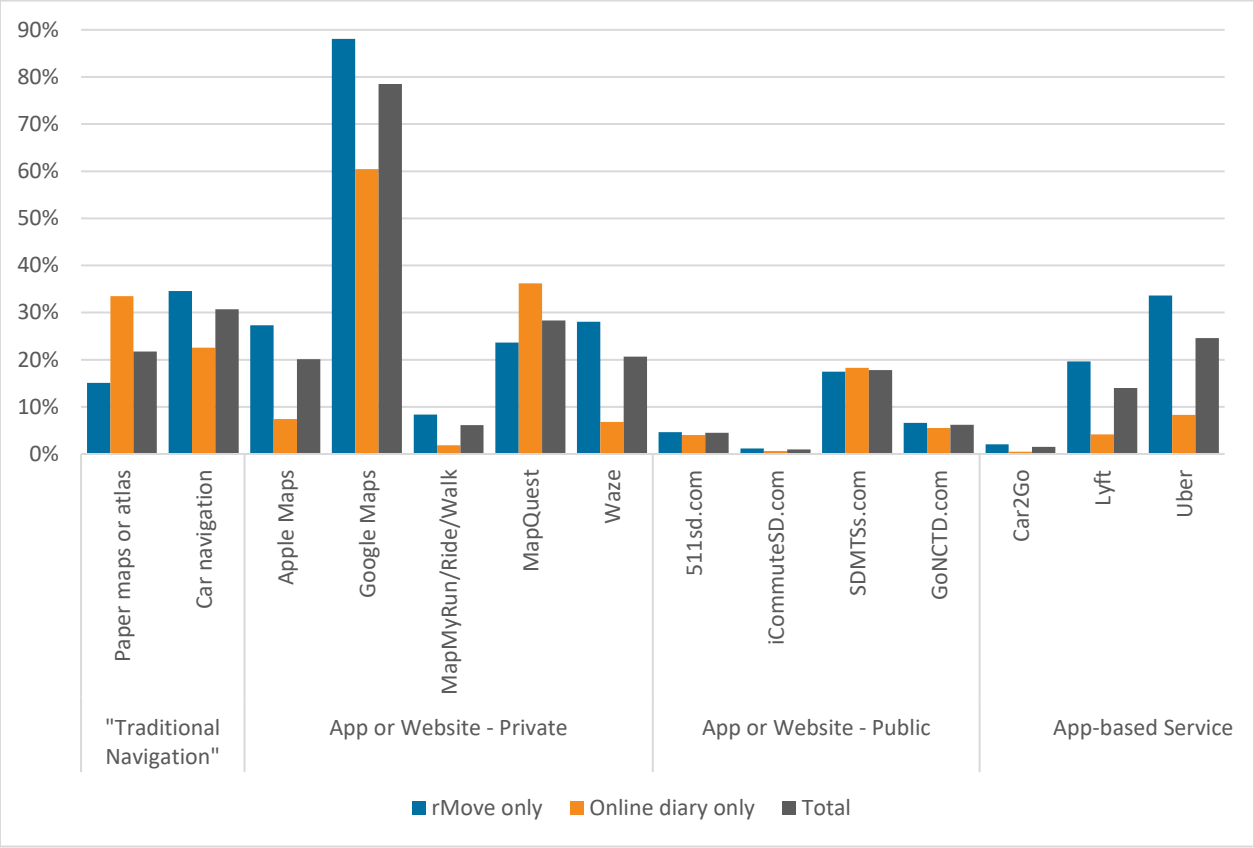
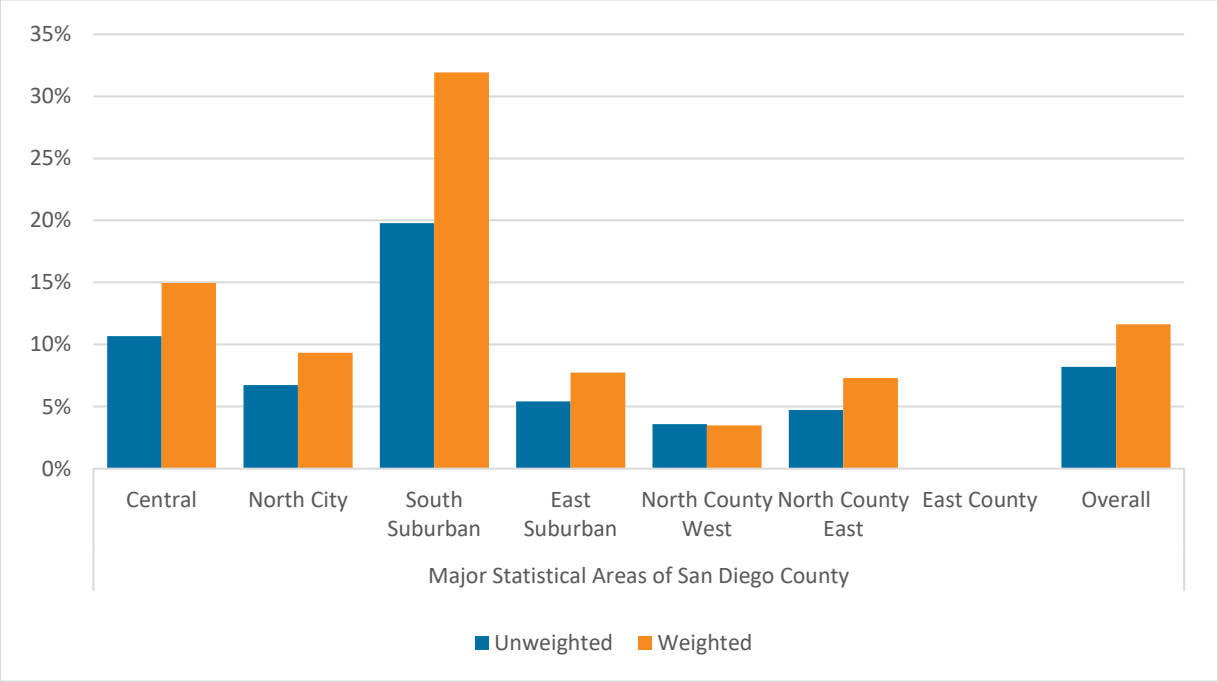


Figure 8-12 presents the results from the survey questions about crossborder travel. Participants were asked the number of trips they have taken from the United States to Mexico within the past 30 days. This question was technically optional; however, 99.3% of households provided an answer. Overall, 8% of unweighted households reported at least one trip to Mexico, jumping to 12% with the weighted data. Looking at the data by the MSA for San Diego County provides more detail (a map of the MSAs is provided in Figure 2-1). Unsurprisingly, the South Suburban MSA reported the highest rate of border travel, with 20% of unweighted and 32% of weighted households reporting travel. The East County MSA did not have any reported crossborder travel; however, the sample size for that MSA was small. In general, all but the North County West MSA have the weighted results showing higher rates of crossborder travel than the unweighted results.

FIGURE 8-12: HOUSEHOLDS REPORTING AT LEAST ONE TRIP TO MEXICO IN THE PAST 30 DAYS (AS % OF COMPLETED HOUSEHOLDS) (UNWEIGHTED AND WEIGHTED)



8.3 PERSON RESULTS

Person-level data collected in the study included key elements like age, ethnicity, gender, employment, and educational enrollment. This section provides some high-level analysis of this data. Figure 8-13 presents these unweighted results while Figure 8-14 provides the weighted results. Significant differences exist in the age distribution among the diary methods. The unweighted data for households using rMove closely resembles the total weighted figures overall, suggesting that smartphone-owning households are well-representative of the overall population on age. Households using rMove were underrepresented among those age 75 and older and those between the ages of 18 and 24. The 18–24 age group was equally underrepresented by both the rMove and online diary participation groups; however, elderly participants were strongly represented in the online diary participation group. Future projects should emphasize sample and recruitment efforts for those between the ages of 18 and 24 as they were the most underrepresented overall and are most likely to not be captured via a traditional ABS recruitment.

These individuals may live on campus or on base at places of higher education or in the military, respectively.

FIGURE 8-13: PERSONS, BY AGE GROUP AND PARTICIPATION GROUP (UNWEIGHTED)

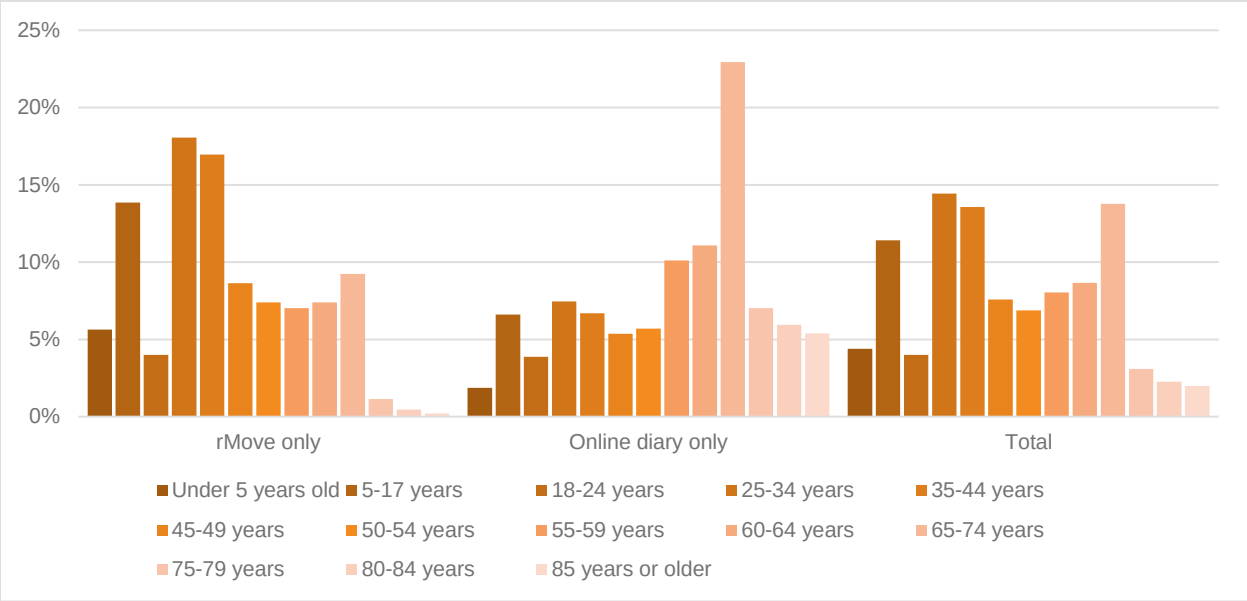


FIGURE 8-14: PERSONS, BY AGE GROUP AND PARTICIPATION GROUP (WEIGHTED)

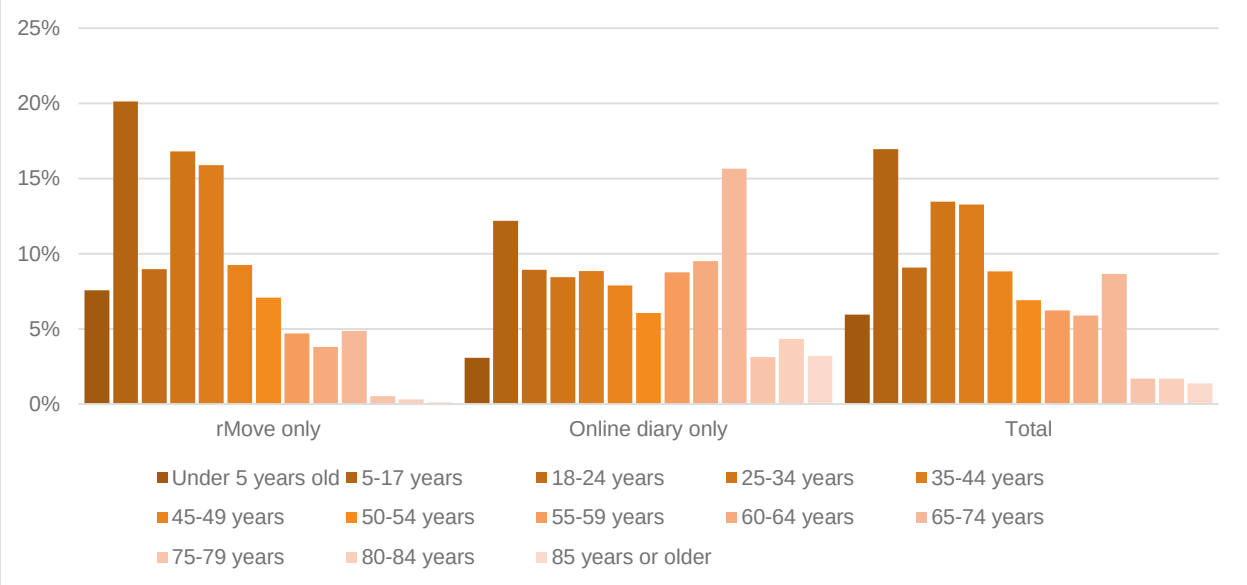


Figure 8-15 presents the unweighted and weighted results of ethnicity sorted by participation group for those age 16 and older. Hispanic ethnicity was underrepresented in the unweighted dataset, even after the project's extensive oversampling and outreach efforts. Part of this gap is likely attributable to nonresponse bias; however, a potentially important contributing factor is the difference in how this study and the ACS asked participants to self-identify with the Hispanic category. Given how the census is revising their current questions about race and ethnicity for the 2020 census, this is a potential area to

revisit in future studies. Similarly, black respondents are somewhat underrepresented; however, this group was closer to their ACS benchmarks than the Hispanic population. The remainder of the ethnicity groups were at or above their ACS benchmarks.

FIGURE 8-15: RACE/ETHNICITY, BY PARTICIPATION GROUP (AS % OF PERSONS AGE 16 AND OLDER) (WEIGHTED AND UNWEIGHTED)

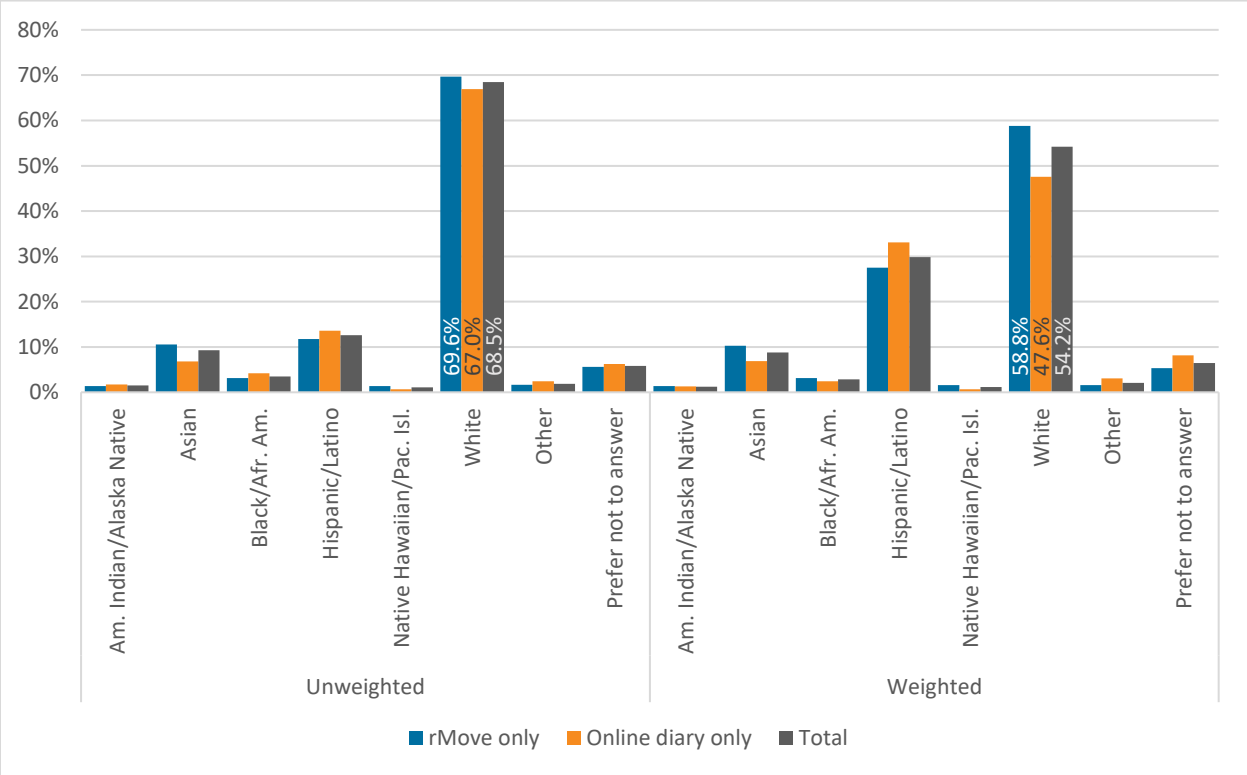


Figure 8-16 and Figure 8-17 present the weighted and unweighted employment figures for participants who were age 16 or older. The unweighted figures closely match the weighted figures overall and across the life cycle, slightly underrepresenting the part-time employed and the unemployed.

FIGURE 8-16: EMPLOYMENT STATUS AMONG THOSE 16 AND OLDER (UNWEIGHTED)

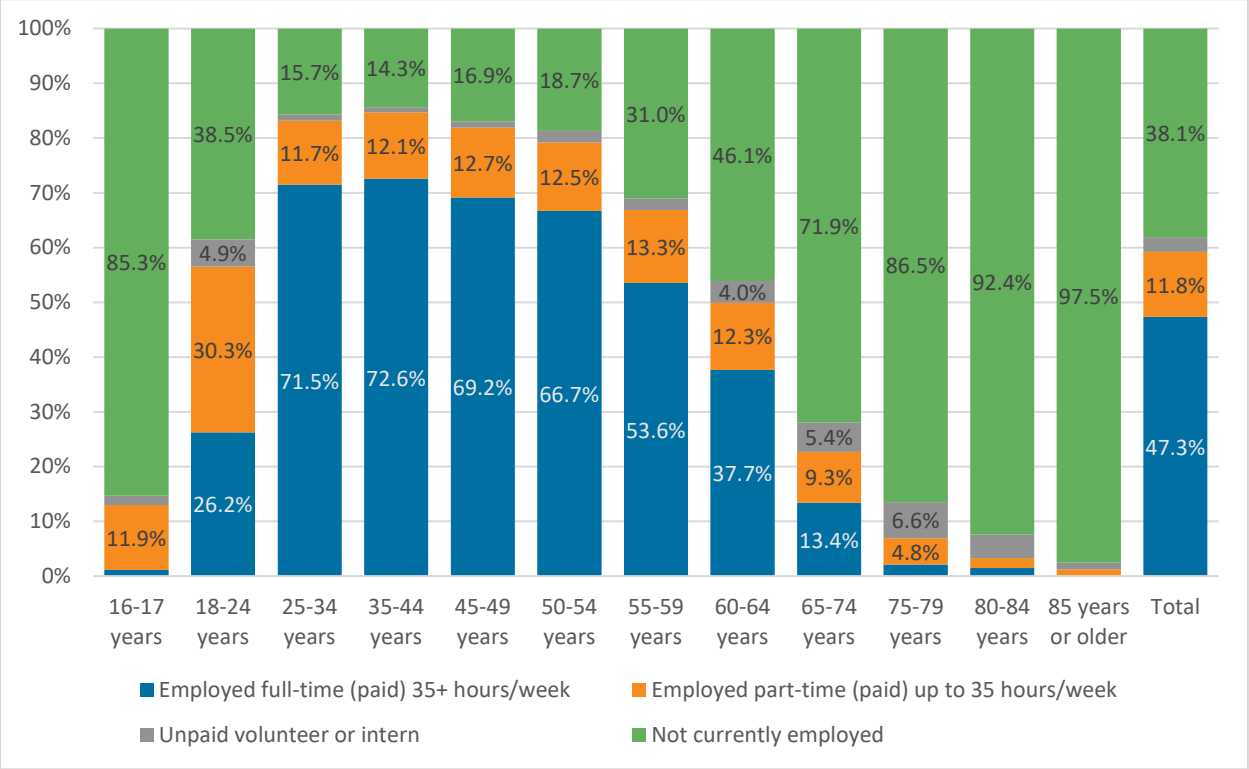


FIGURE 8-17: EMPLOYMENT STATUS AMONG THOSE 16 AND OLDER (WEIGHTED)

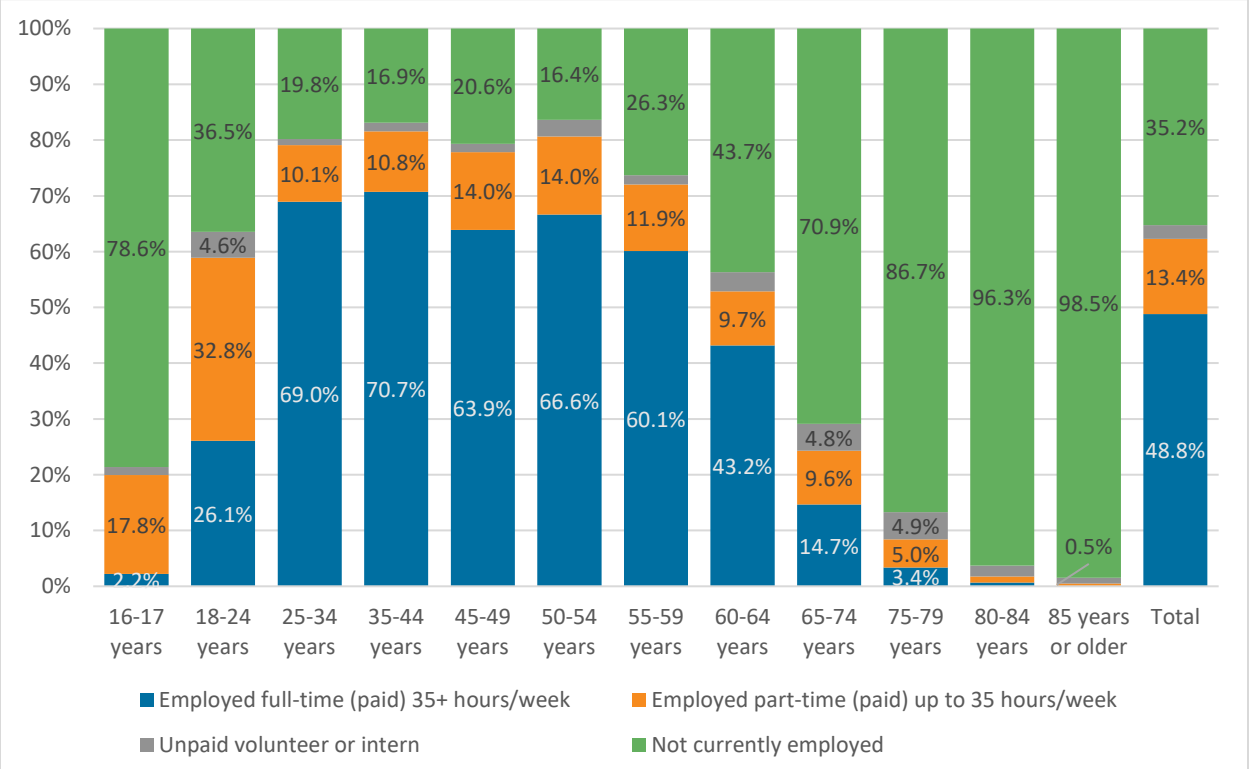


Figure 8-18 and Figure 8-19 present the results sorted by student type. These results include children in day care but exclude some survey categories for children under age 18 who were attending various forms of home school (excluded here due to low incidence rates). Comparing the unweighted and weighted data suggests good representativeness; however, high schoolers were one of the more underrepresented groups. Those enrolled in higher education are well represented, which is likely attributable to oversampling in regions around the study area's colleges and universities, although the study overall did underrepresent those age 18 to 24, as noted earlier. Overall, the discrepancy among households using rMove and those using the online diary is explained by the non-smartphone-owning population being older and—as described previously—having smaller household sizes (i.e., less likely to have children present in the household).

FIGURE 8-18: STUDENT TYPE (UNWEIGHTED)

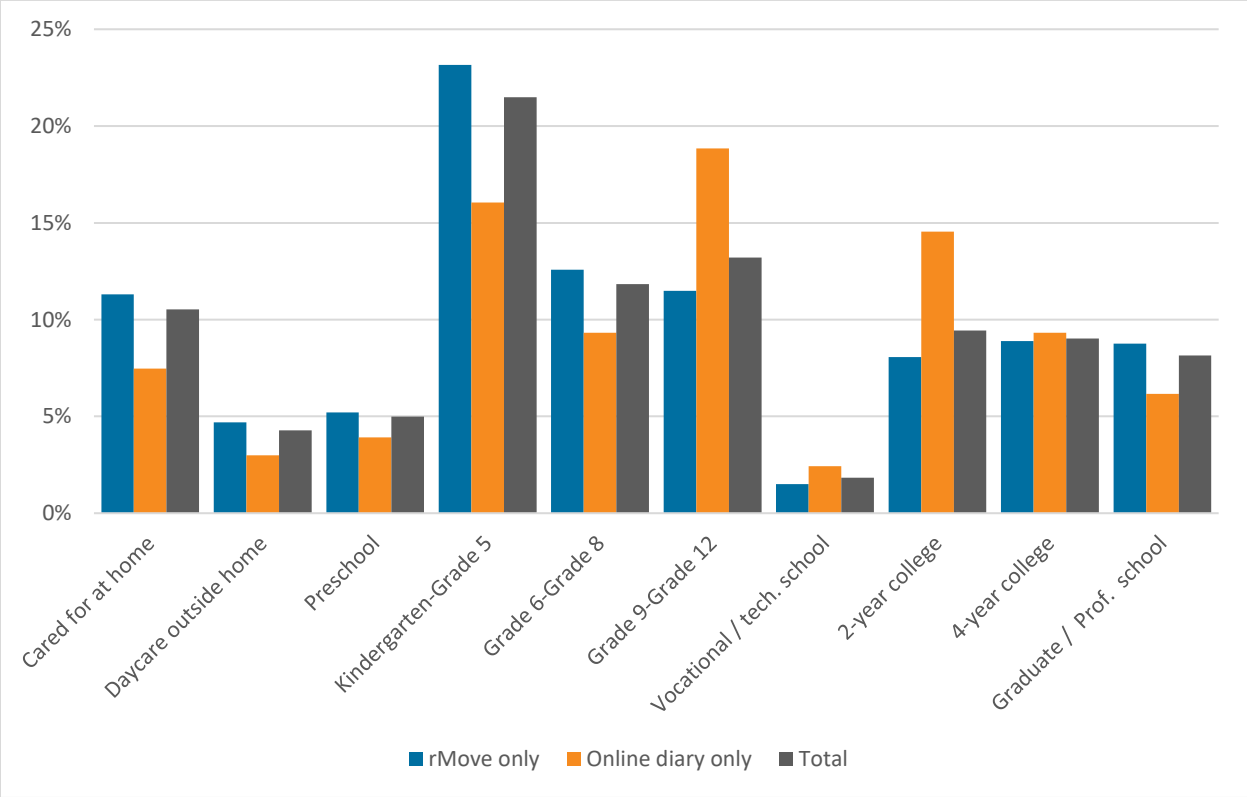


FIGURE 8-19: STUDENT TYPE (WEIGHTED)

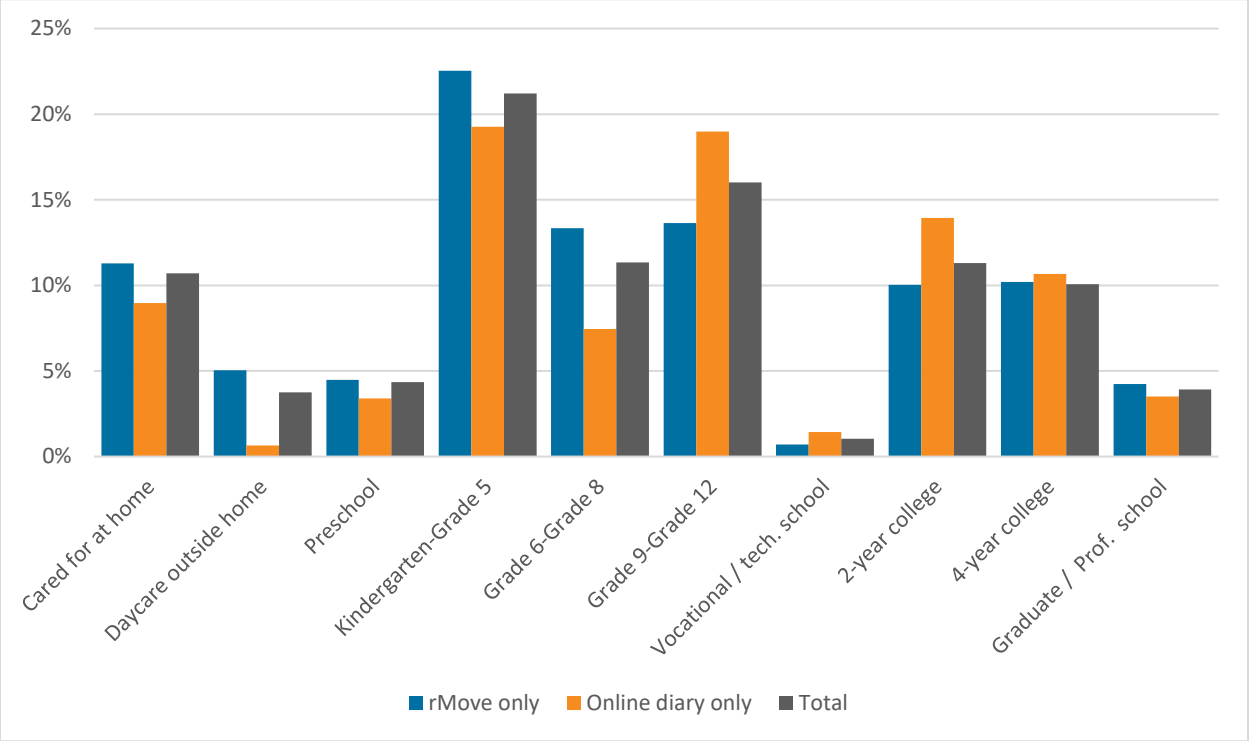


Figure 8-20 and Figure 8-21 present participants' work and school locations sorted by census BG. These data closely match the household location densities from Figure 8-1; however, several key areas of employment and education stand out. Military bases are particularly well represented among the work locations, and census BGs around the various universities, including San Diego State and UC San Diego, stand out.

FIGURE 8-20: PARTICIPANT WORK LOCATIONS (UNWEIGHTED COUNTS)

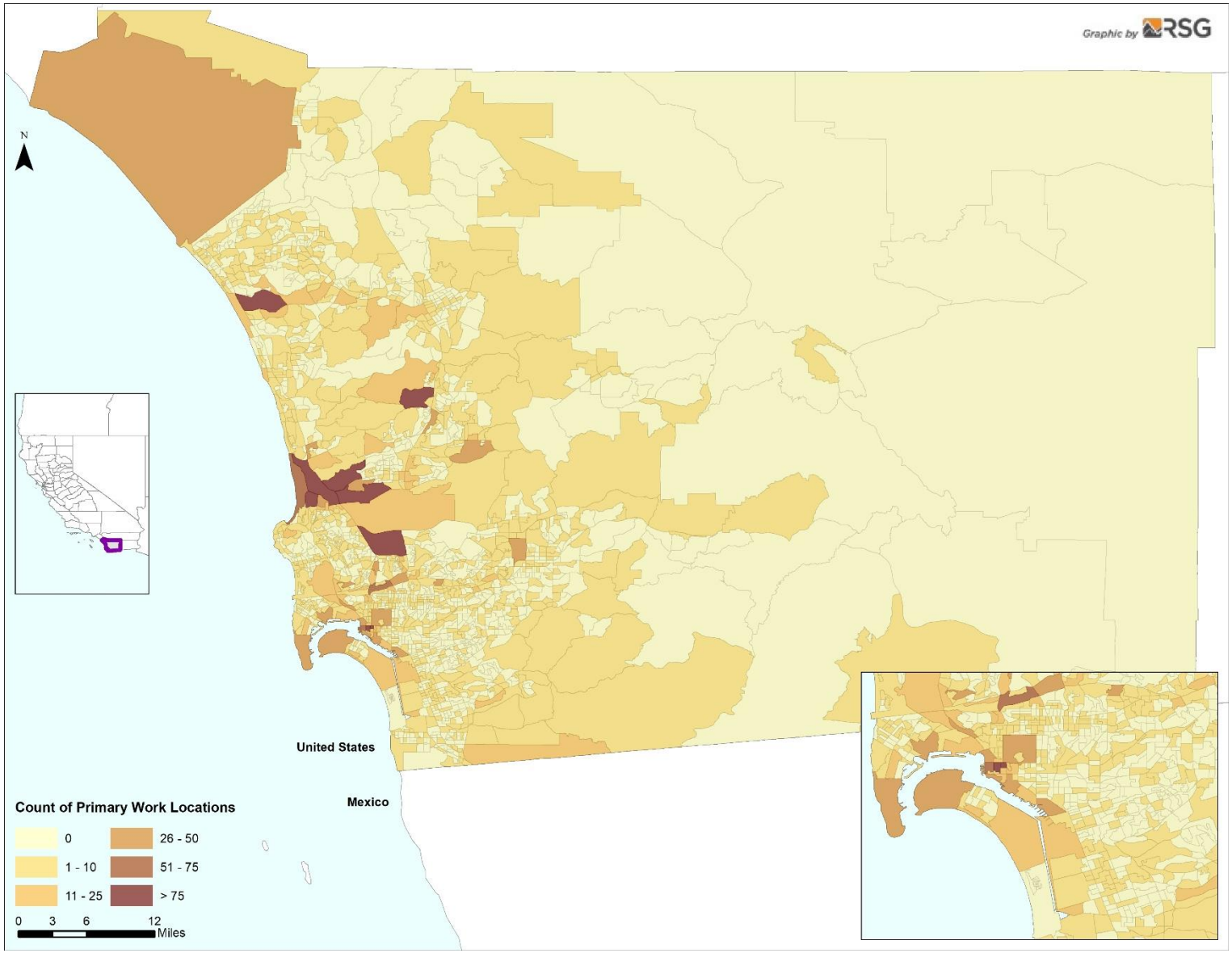
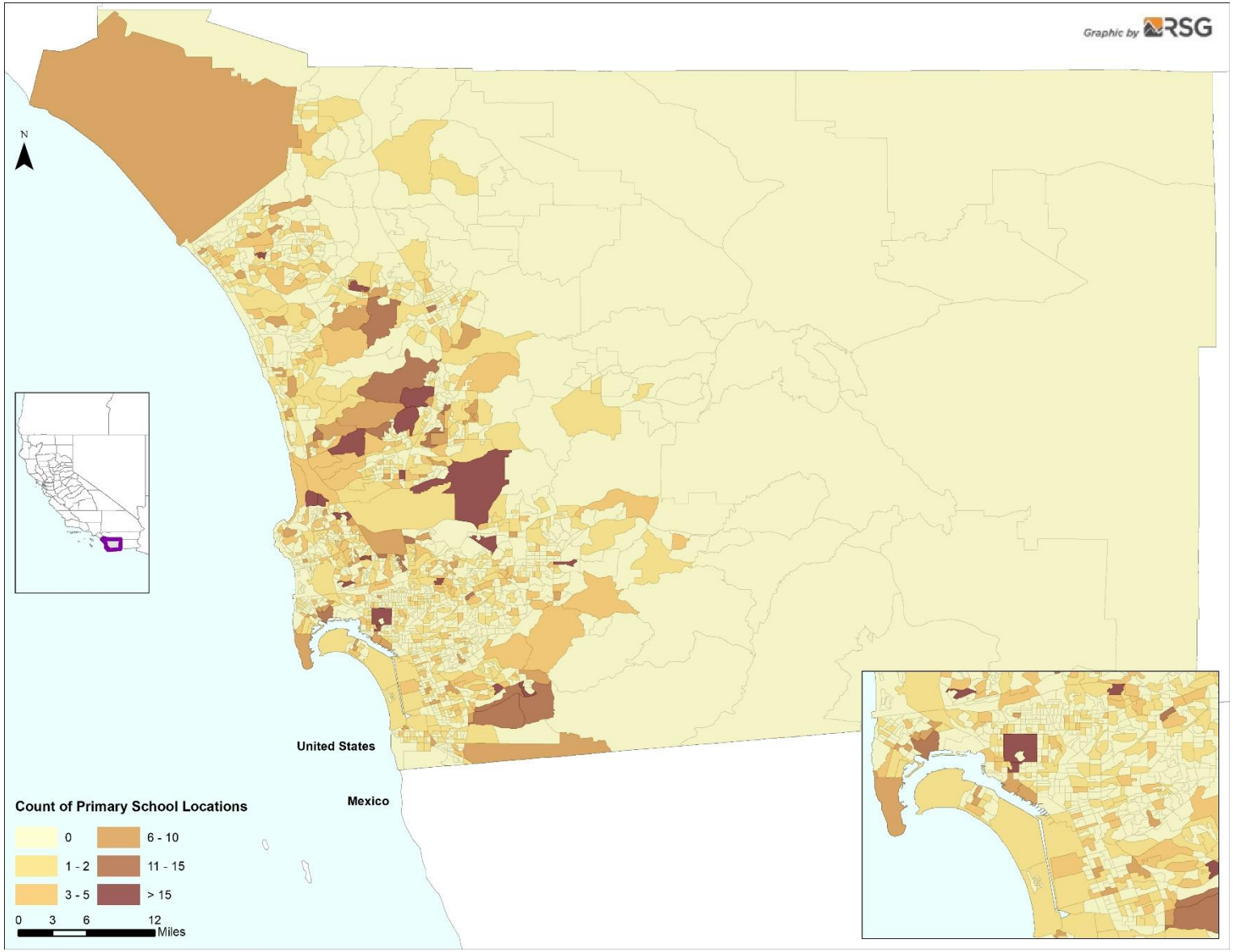


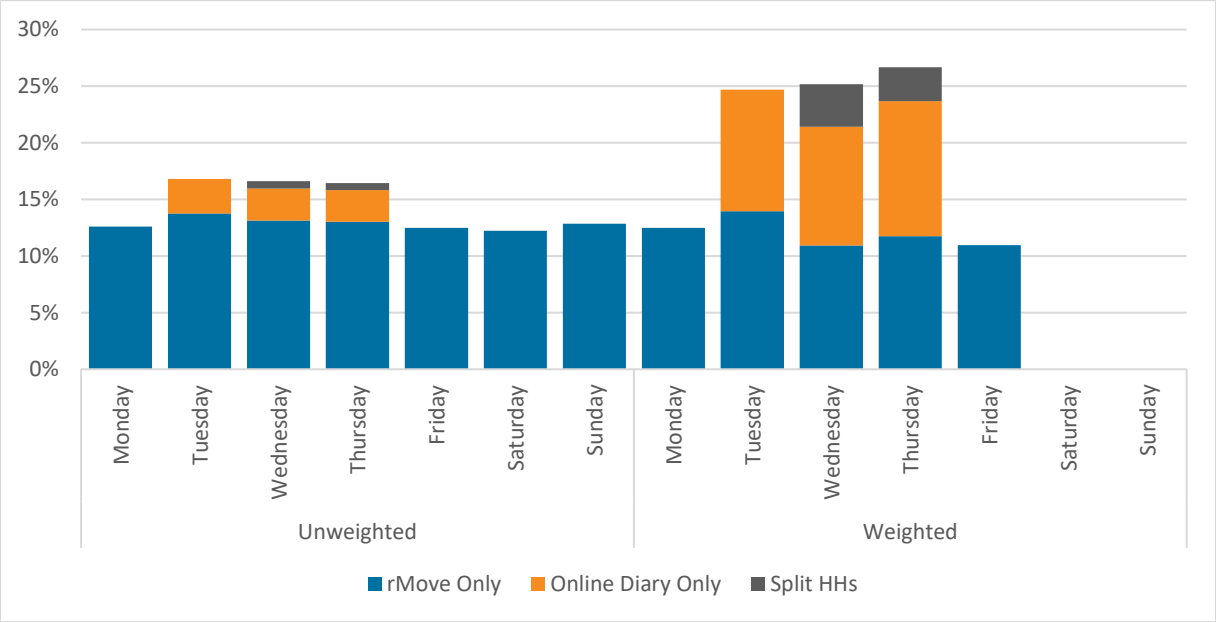
FIGURE 8-21: PARTICIPANT SCHOOL LOCATIONS (UNWEIGHTED COUNTS)



8.4 DAY-LEVEL RESULTS

Figure 8-22 shows the number of complete days by day of week from the unweighted dataset. The weighted data excluded weekend days and was adjusted by data collection mode to account for households reporting multiple travel days and those only reporting a single travel day.

FIGURE 8-22: PERCENT OF TRAVEL DAYS WITH COMPLETE HOUSEHOLD INFORMATION BY DAY OF WEEK (UNWEIGHTED AND WEIGHTED, UNLINKED TRIPS)



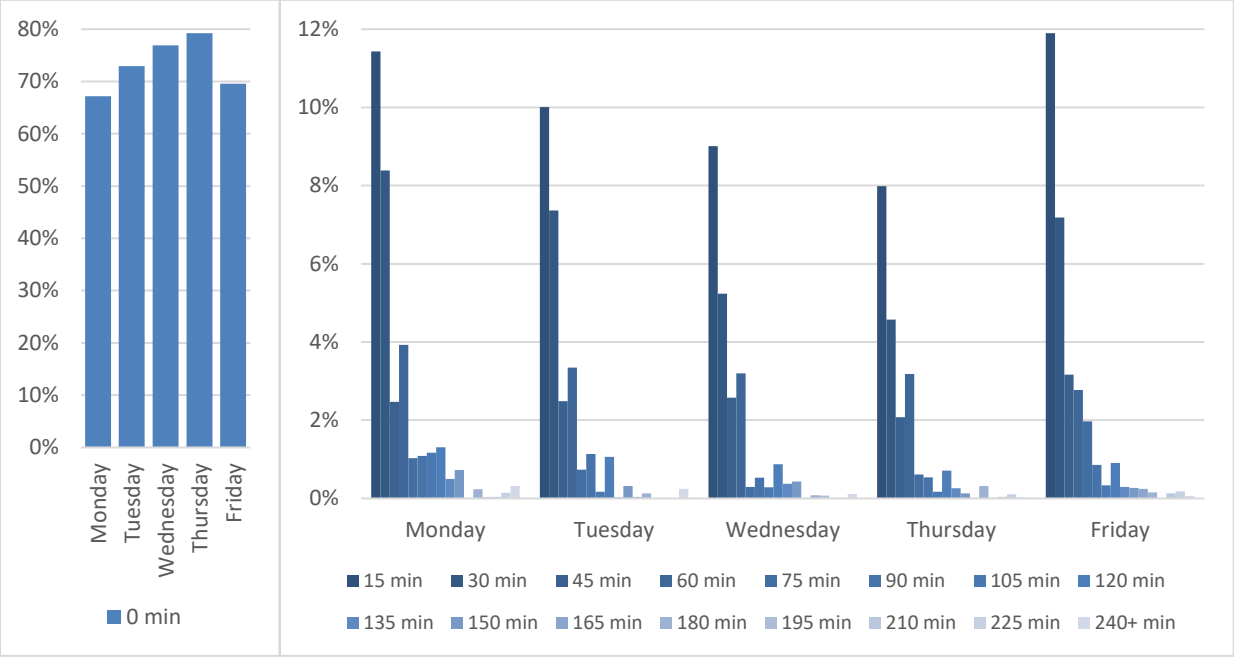
AT-HOME ACTIVITIES

The study asked questions about online shopping and telework for each day, which are analyzed in Figure 8-23 and Figure 8-24. Because these distributions are so heavily skewed to the low end of the spectrum, two charts are provided for each topic. The left-most charts show the percentage of people reporting no time doing these activities, while the right-most charts show the distribution for people reporting any time doing these activities. Additionally, these charts refer to the weighted data, which only reflect activity on weekdays, and does not analyze activity on weekends.

Across weekdays, 21-33% of participants report some level of online shopping activity. The distribution of online shopping time is similar across days with an overall decrease in time Monday through Thursday and a peak on Friday. It may also be possible that many respondents round to the nearest half-hour, given the shape of each curve (Figure 8-23).

21-33% of participants report some level of online shopping activity each weekday, with Mondays and Fridays having the highest share

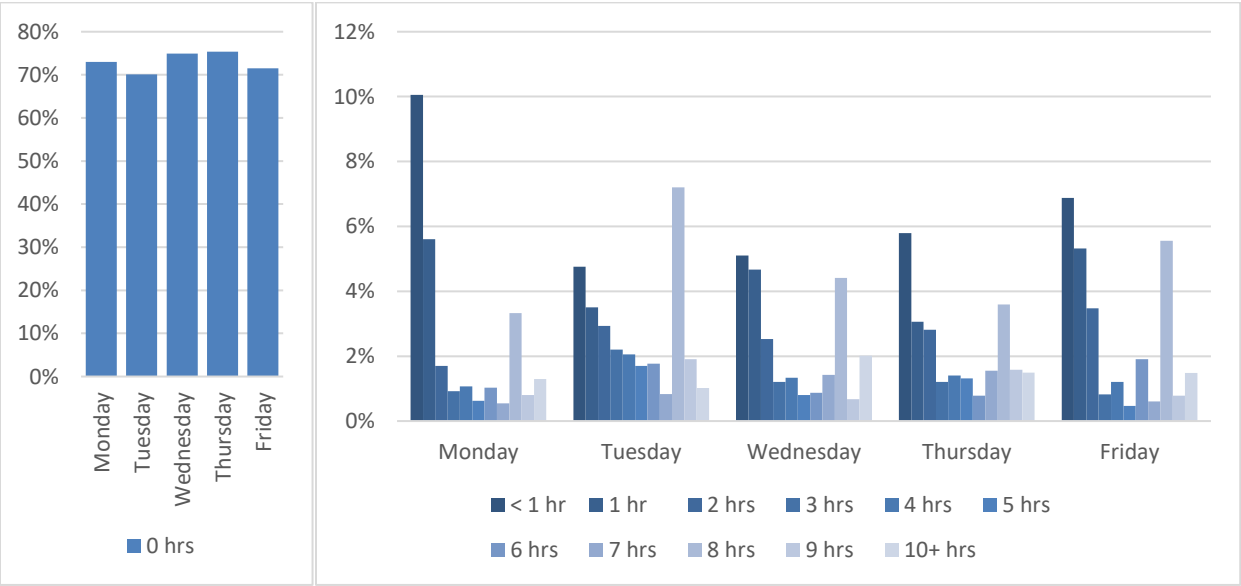
FIGURE 8-23: ONLINE SHOP TIME BY DAY OF WEEK (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS)



Across weekdays, 25-30% of participants reported some kind of teleworking. Among survey participants who reported teleworking, the most frequent telework days were Tuesday and Friday with slight decreases at the start and middle of the week. Across all days, the most frequent lengths of telework time were short intervals (e.g., 15-30 minutes) or full work days of eight hours (Figure 8-24).

25-30% of participants reported some kind of teleworking on weekdays

FIGURE 8-24: TELEWORK TIME BY DAY OF WEEK (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS)



8.5 TRIP ANALYSIS RESULTS

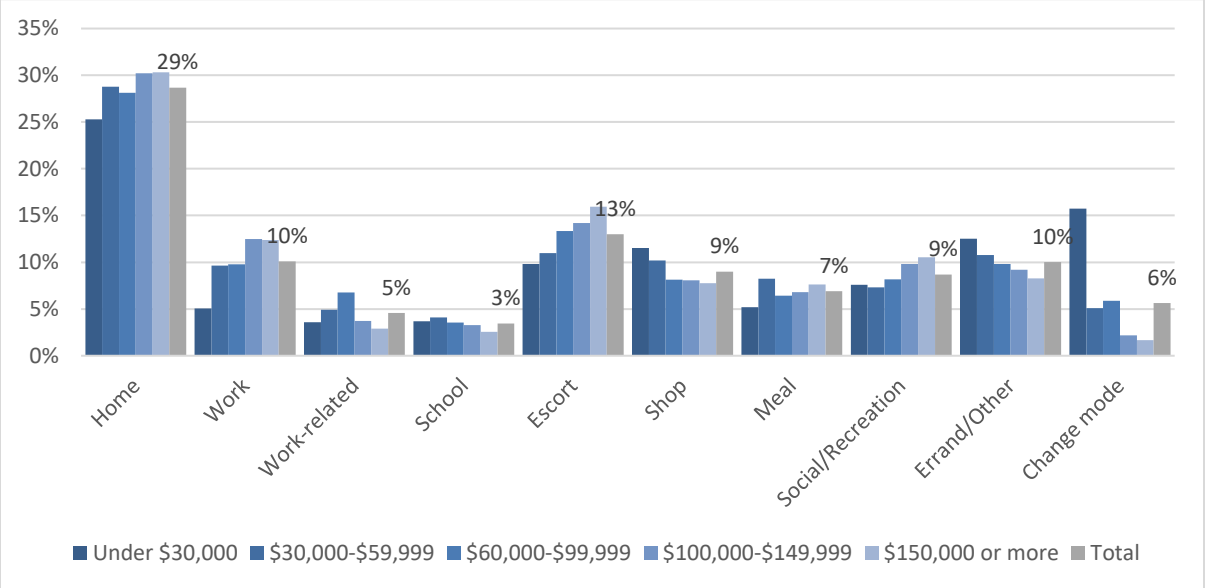
The study results include several notable and consistent patterns across all trips (e.g., “Home” was the most common trip purpose and “Car” was the most common trip mode). However, some patterns are only recognizable when trips are categorized by household size, income, location, and other variables. The following sections demonstrate these high-level patterns. These results only show the weighted data results for complete household travel days (days with 100% complete data); these results are based on the unlinked trips dataset at the time of delivery unless otherwise noted.

In addition, this dataset is a primary input to future transportation modeling at SANDAG. Certain figures reported here, such as travel mode shares, may differ from future travel demand modeling scenarios. Transit and walk mode shares, in particular, are likely to be different between this report and future modeling scenarios for several reasons. These reasons include the use of linked versus unlinked trips and the incorporation of additional data into the SANDAG models (such as the regional transit on-board survey). This dataset reflects the travel of residents of San Diego County and does not necessarily reflect the travel of visitors or nonresidents, which is an additional reason for possible differences between the figures in this report and future modeling scenarios.

TRIPS BY INCOME

The most common trip destination purpose was to go home, with 29% of all trips overall, a finding that was consistent across household income levels. Outside of trips to home, social/recreational trips were the most frequent trip types in among all income brackets except for the lowest income bracket, which had a higher share of “change mode” trips (Figure 8-25). This matches findings that the lowest income bracket also took significantly more transit trips (and the lowest share of car trips).

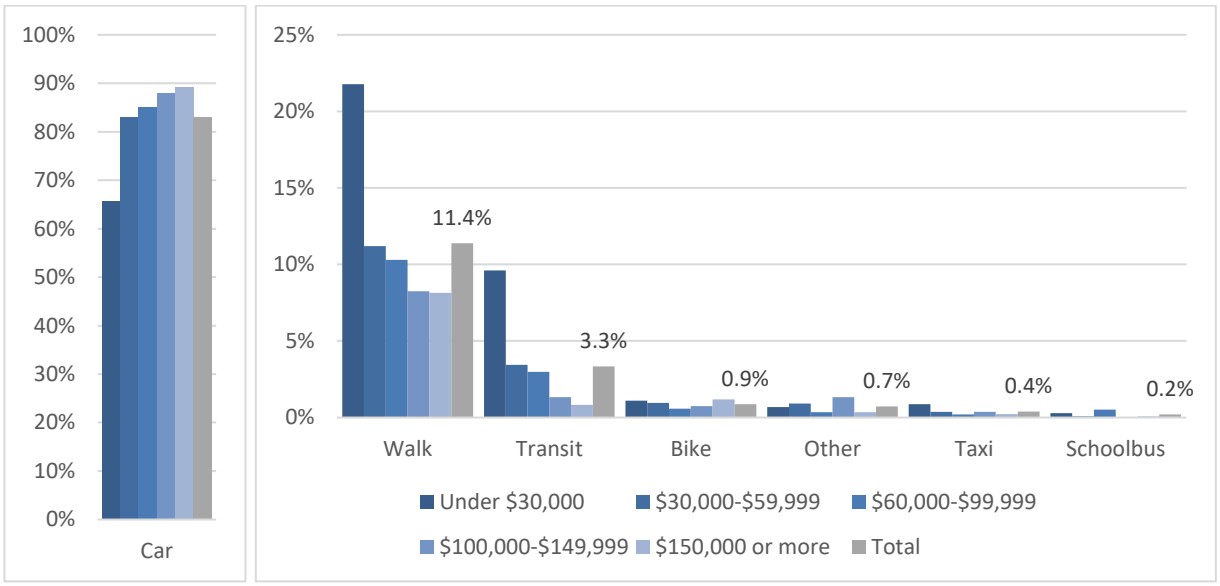
FIGURE 8-25: DESTINATION PURPOSE, BY HOUSEHOLD INCOME (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



Looking at trips by mode, car trips are the overwhelming number one mode, with an 83% mode share overall, followed by walking (11%), transit (3%), and all other modes combined at roughly 2%. Looking at

variations by income, participants from low-income households (under $30,000 in annual income) were much more likely to walk and take transit than the overall population.

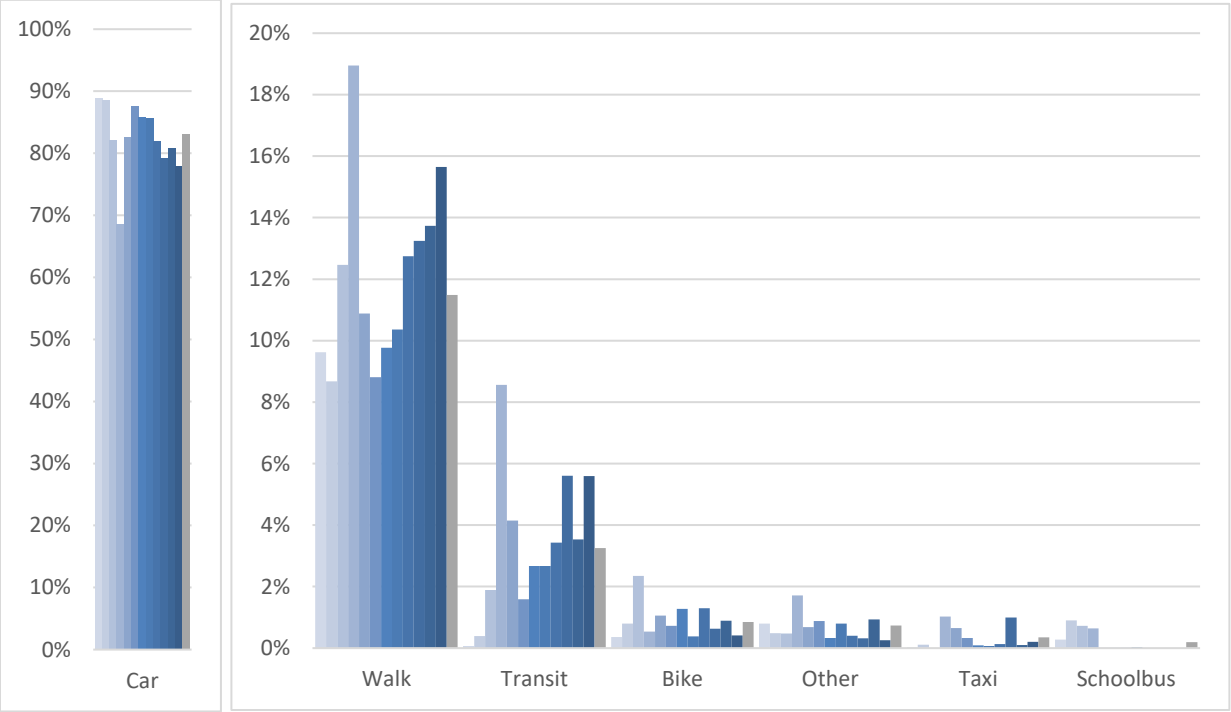
FIGURE 8-26: TRIP MODE, BY HOUSEHOLD INCOME (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



TRIPS BY AGE

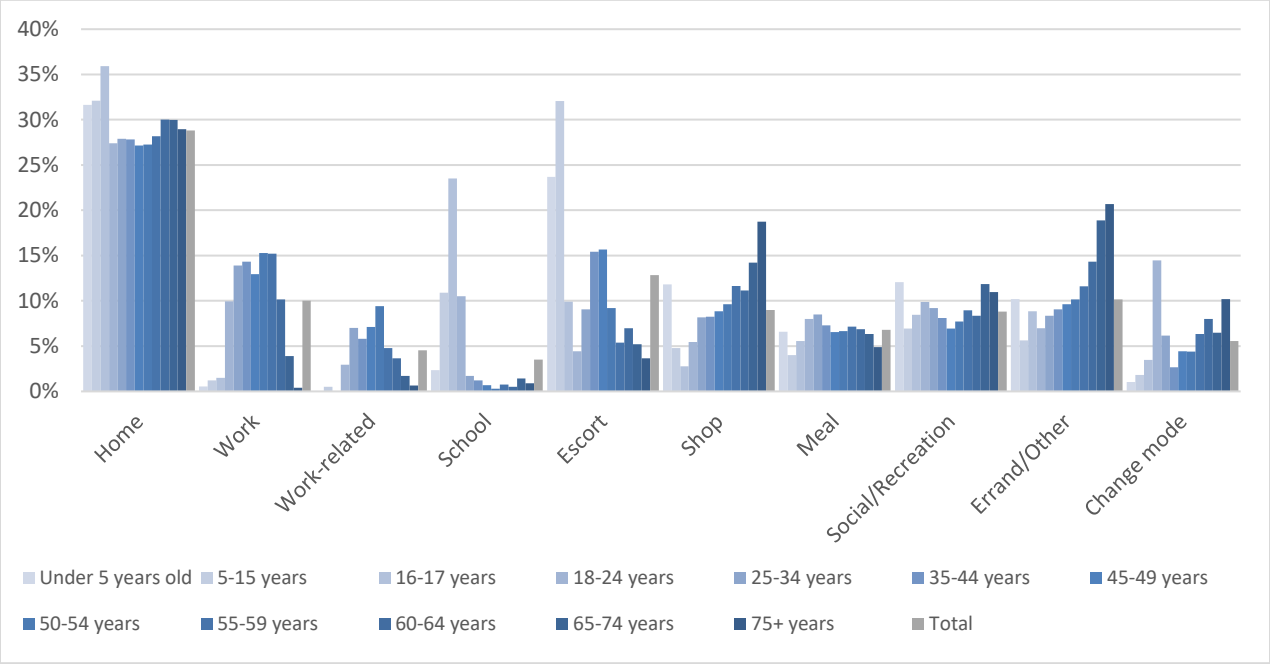
Trip modes shares vary slightly by age, as people 18-24 years old are slightly more likely to use transit, walk, and bike, with the largest gains coming from increased transit usage (Figure 8-27). Similarly, transit usage spikes for the elderly population, surpassing 5% for those 60-64 and 75 years or older. Otherwise, car usage is mostly stable at around 80% across age groups. Taxi usage, while a small share overall at less than 1%, also shows a skewed age distribution toward the young. This is likely due to the fact that 85% of taxi trips used the relatively new smartphone-based ride-hailing services, such as Uber or Lyft, whose customer bases appear to be much younger than the overall population.

FIGURE 8-27: TRIP MODE, BY AGE (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



Trip purpose shares vary by age, with clear patterns around school attendance for younger people, work attendance for those middle-aged, and a higher share of shopping and errands among older people (Figure 8-28). Escort trips also show clear patterns by age, with adults of child-rearing age, and children themselves, having a higher share of those trip purposes.

FIGURE 8-28: TRIP PURPOSE, BY AGE (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



TRIPS BY HOUSEHOLD SIZE

Home was the most frequent trip purpose among households of all sizes. Households with three or more members took many more “escort” trips, which, similar to the prior results, are related to having more trips that include escorting children. The results otherwise do not show much significant variation by household size (Figure 8-29).

Mode shares show more variation by household size than trip purposes by household size. Overall, smaller households are likely to have higher nonautomotive modes shares. Single-person households had the smallest share of car trips (70% vs 83% overall). Those households were much more likely to walk (19% vs 11% overall), to use transit (8% vs 3% overall), and to bike and take a taxi. These trends continue for two-person households as well, although to a lesser degree. After car trips, walk and transit were the most common modes across all household sizes. (Figure 8-30).

FIGURE 8-29: DESTINATION PURPOSE, BY HOUSEHOLD SIZE (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)

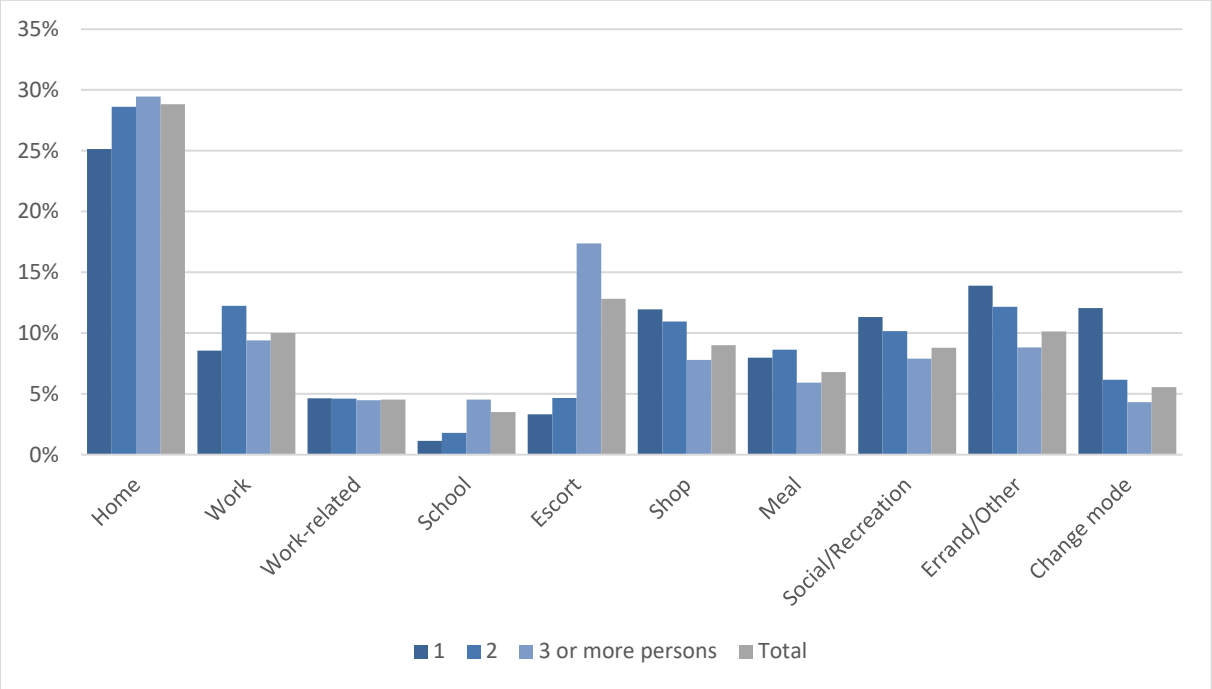
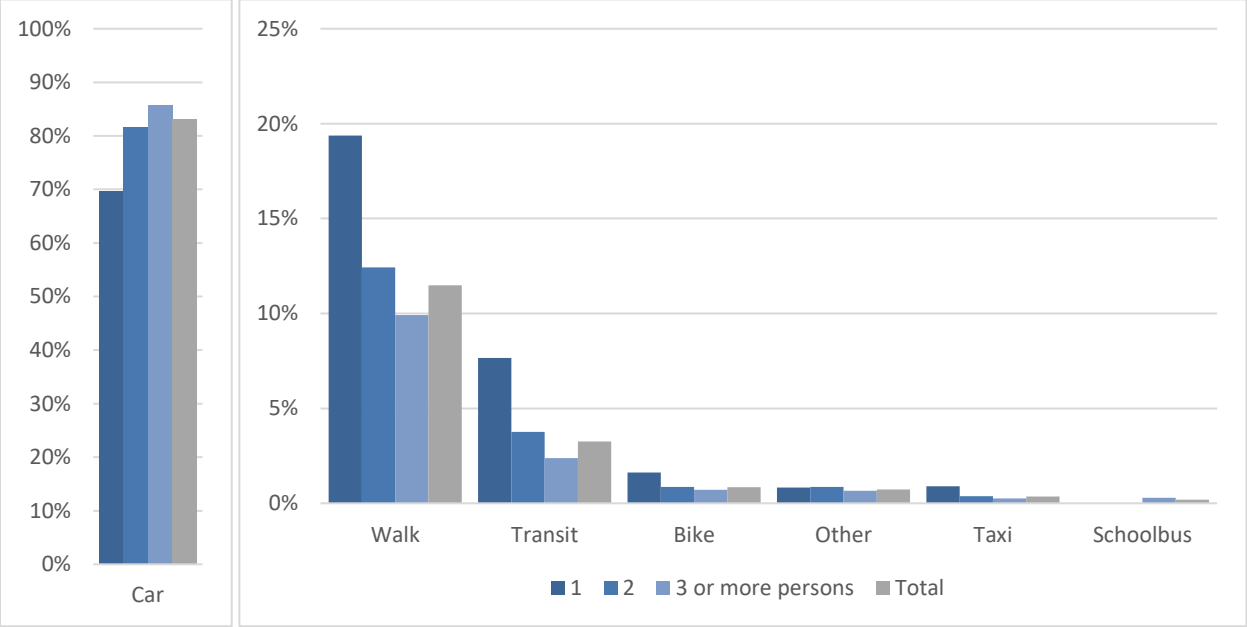


FIGURE 8-30: TRIP MODE, BY HOUSEHOLD SIZE (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



TRIPS BY STUDENT STATUS

The figures below analyze trip modes and purposes by two variables: student status (for all persons 18 and older) and school type (for students of all ages). Adult students have a higher share of school-related trips, as expected, but also have a smaller share of work, work-related trips, and shopping trips compared

to the overall population. Full-time students make the most “change mode” trips, related to the high share of transit use for those 18-24 years old (Figure 8-31). Among students of all ages, higher rates of escort trips (and varying rates of school trips) reflect how the data for children was proxy reported (Figure 8-32).

FIGURE 8-31: DESTINATION PURPOSE, BY STUDENT STATUS (FOR PERSONS AGE 18+) (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)

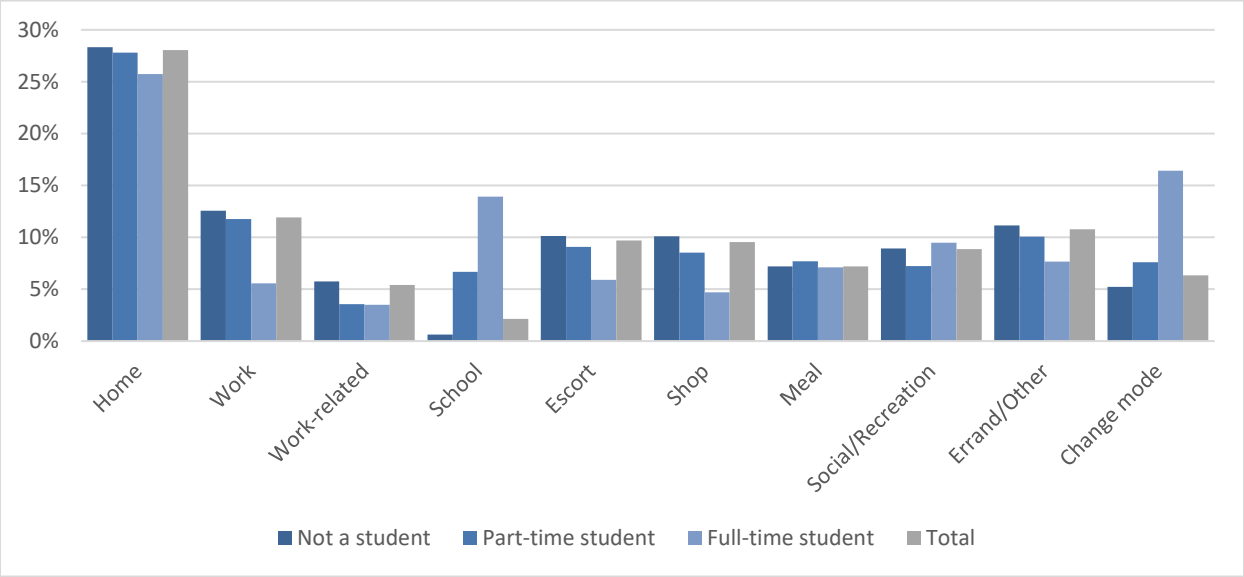
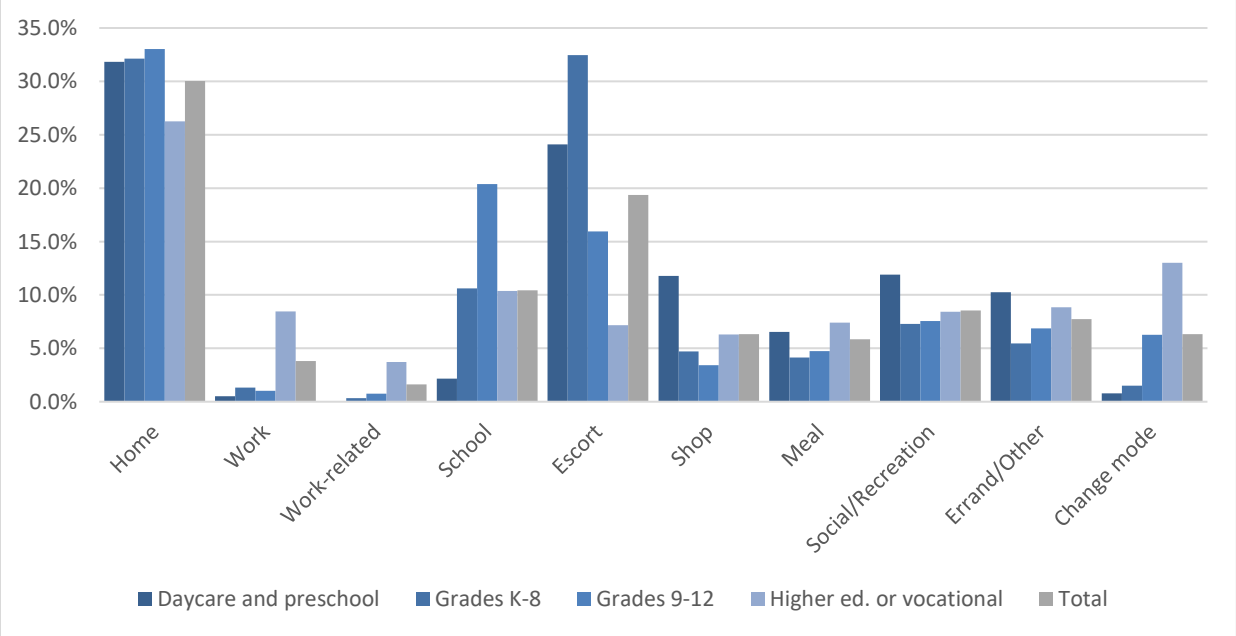


FIGURE 8-32: DESTINATION PURPOSE, BY SCHOOL TYPE (ONLY FOR THOSE ATTENDING SCHOOL/DAYCARE) (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



Looking at trip mode, full-time adult students demonstrated the greatest use of every noncar mode, however car was still easily the mode most frequently used. Interestingly, even among all students, “school bus” was still among the least common travel modes, peaking at roughly 2.0% of trips for adult

full-time students (Figure 8-33). Walking and transit are higher for students in Grades 9-12 and higher education, peaking for those enrolled in higher education or vocational school (Figure 8-34).

FIGURE 8-33: TRIP MODE, BY STUDENT STATUS (ONLY FOR THOSE AGE 18 AND OLDER) (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)

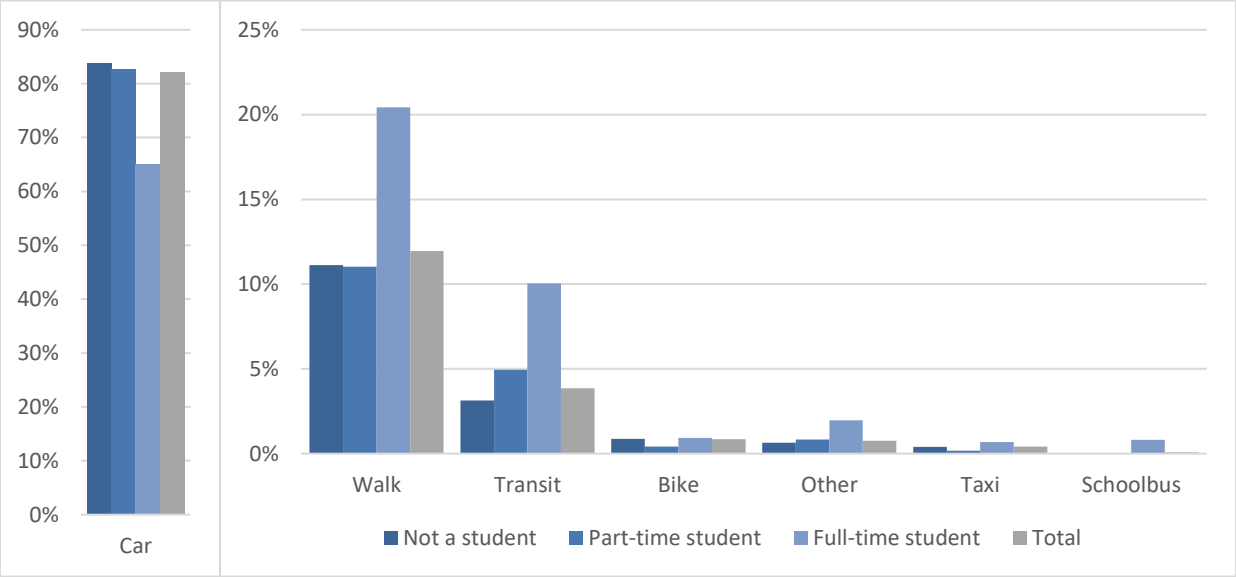
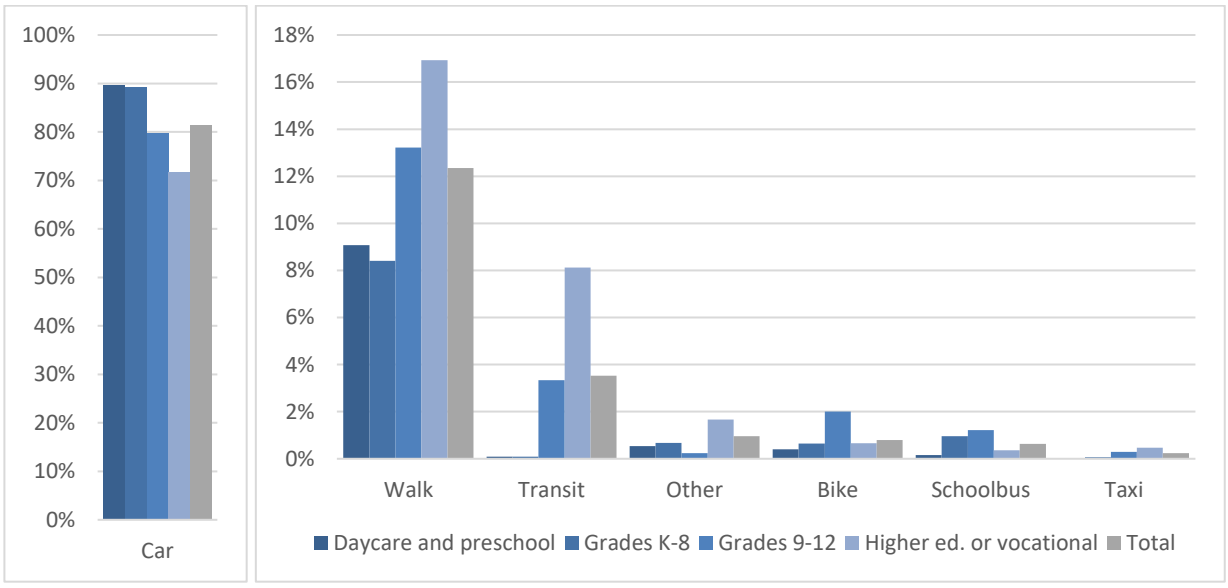


FIGURE 8-34: TRIP MODE, BY SCHOOL TYPE (ONLY FOR THOSE ATTENDING SCHOOL/DAYCARE) (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



TRIPS BY EMPLOYMENT STATUS

Looking at trip purposes by employment status, "home" was the most frequent trip purpose for all employment statuses, while work was the second most common among employed individuals. Unemployed individuals took comparatively more trips in almost all other categories than employed

individuals, which is to be expected given that unemployed individuals took no work or work-related trips (Figure 8-35).

Analyzing mode shares by employment status shows similar results to those of household income. Persons that are unemployed made a higher percentage of walk and transit trips than employed individuals, while full-time employed individuals traveled less frequently by transit (Figure 8-36).

FIGURE 8-35: DESTINATION PURPOSE, BY EMPLOYMENT STATUS (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)

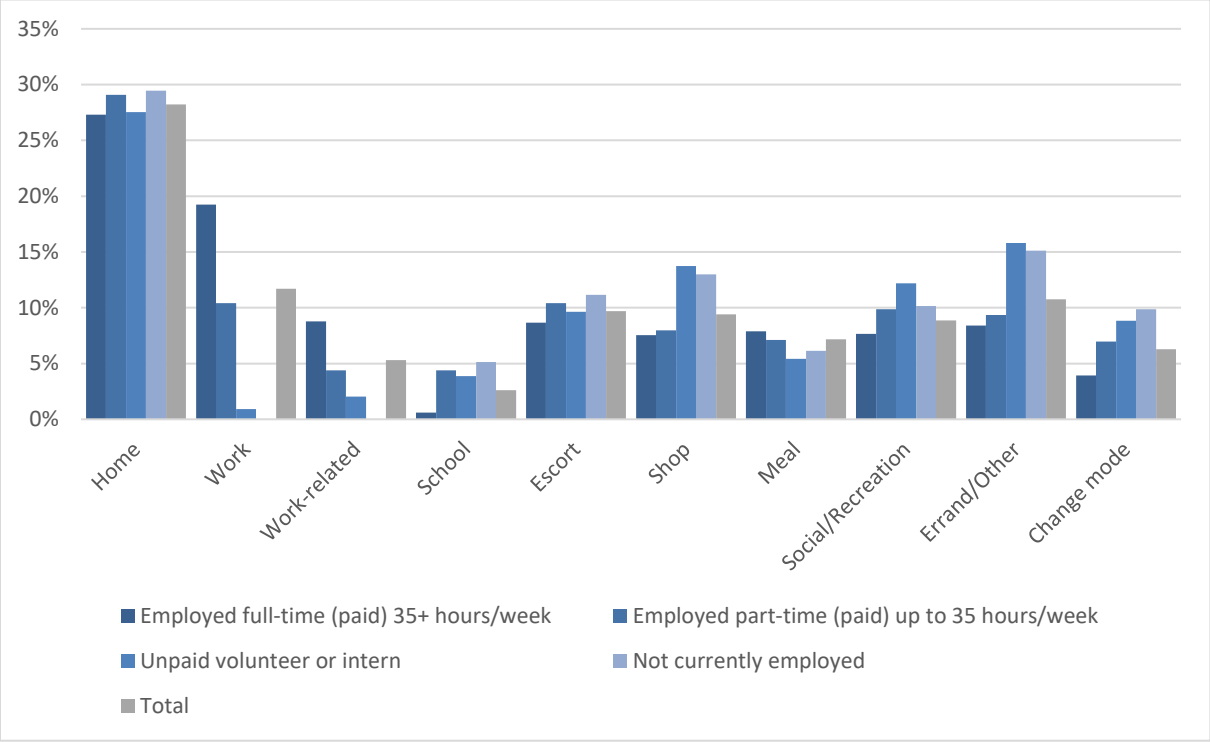
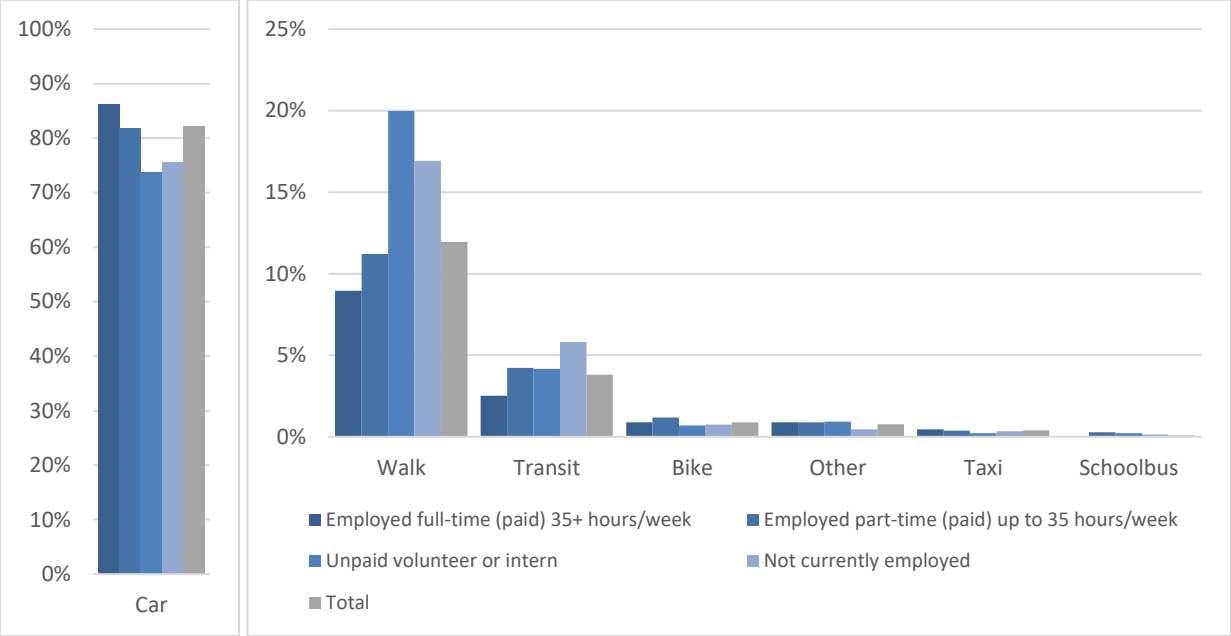


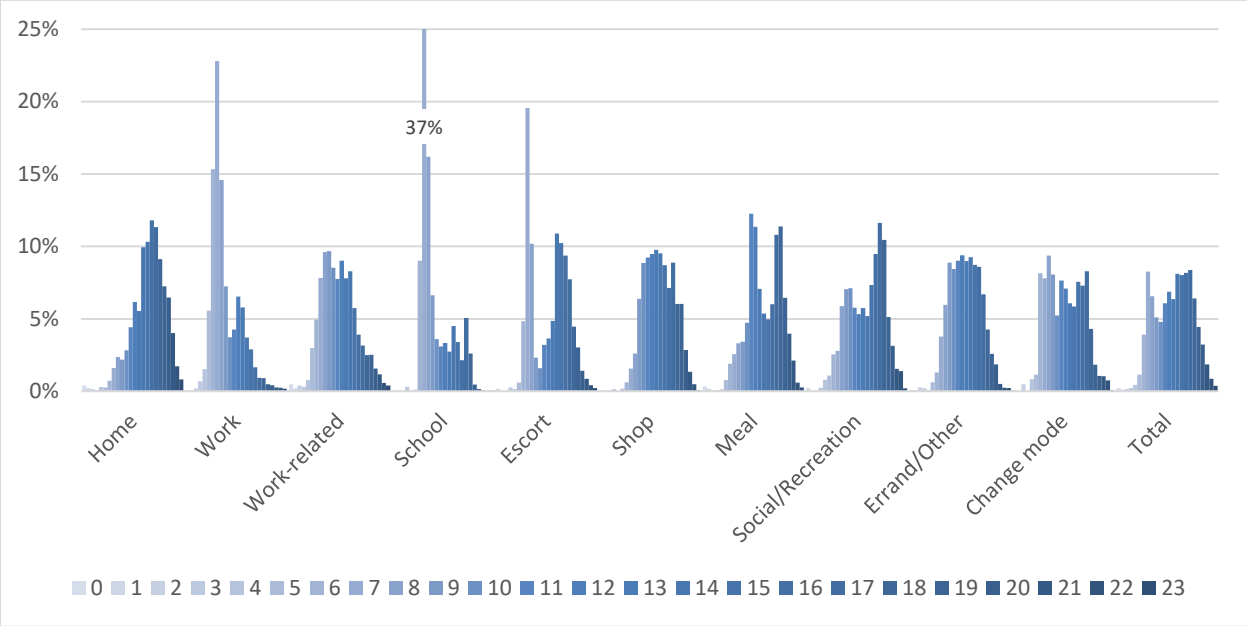
FIGURE 8-36: TRIP MODE, BY EMPLOYMENT STATUS (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



TRIPS BY DEPARTURE TIME

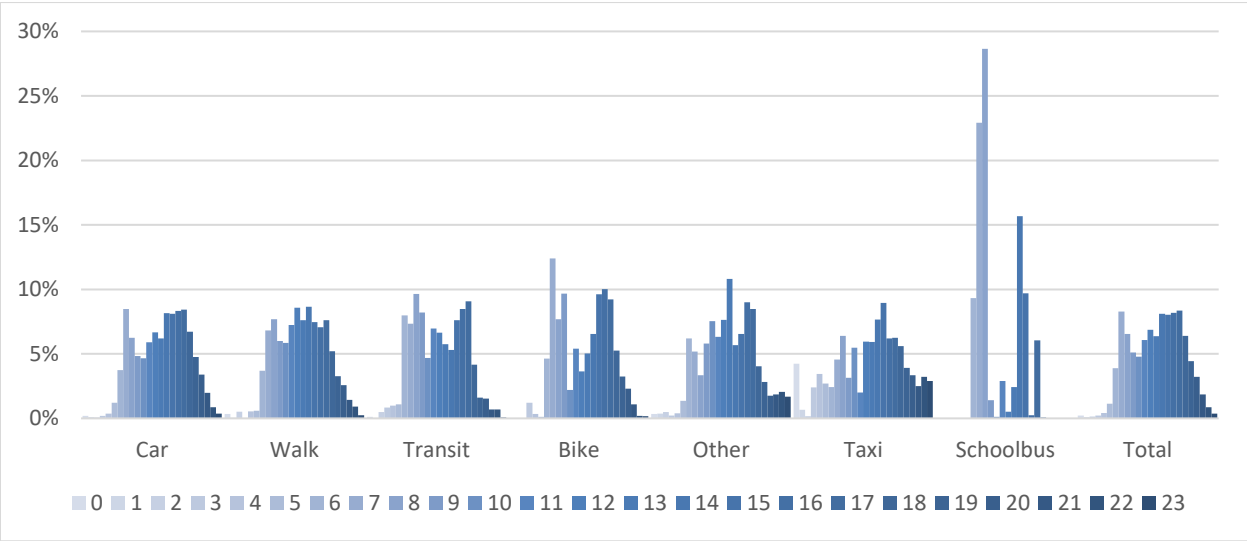
Looking at trips by time of day shows interesting patterns of activity during the day. Analyzing trip purposes by departure time of the trip shows the rhythms and cadences of daily life. Some trip purposes are more evenly distributed throughout the daylight hours, while others followed more distinct or spiked travel patterns. In general, most work and school trips began early in the morning, whereas most home trips occurred in the afternoon and evening. There were two “meal” peaks, each around lunch and dinner times. Escort trips also peaked in the morning, possibly because of adults dropping children off at school or daycare (Figure 8-37).

FIGURE 8-37: DESTINATION PURPOSE, BY HOUR OF DEPARTURE (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



Looking at mode by trip departure time shows slightly less variation than trip purpose. Most modes are evenly distributed throughout the day, except for bike and school bus (Figure 8-38).

FIGURE 8-38: TRIP MODE, BY HOUR OF DEPARTURE (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



TRIPS BY MSA

SANDAG uses MSAs to divide the county into seven regions. The following figures provide the basic breakdown of results by MSA. The analysis indicates that trip purpose distributions are fairly consistent across MSA geographies (Figure 8-39). The Central MSA took the largest share of walk and transit trips, which may have been a result of its density and transit service offerings (Figure 8-40). Due to the low sample size, the results for East County are excluded from these figures.

FIGURE 8-39: DESTINATION PURPOSE, BY MSA (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)

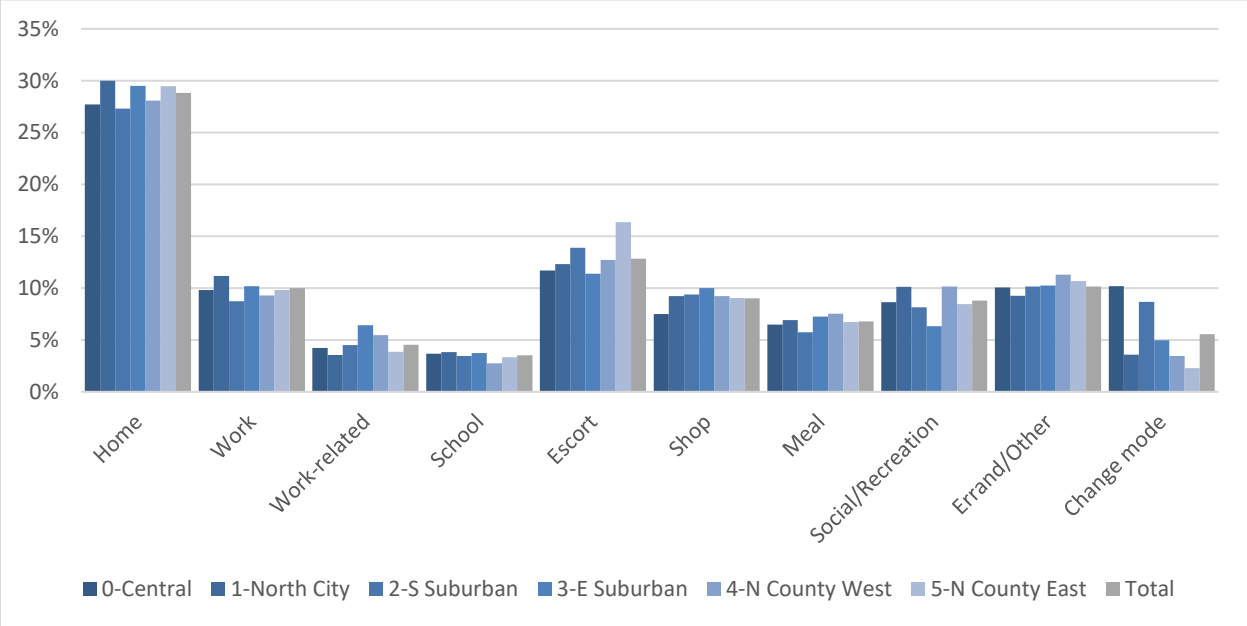
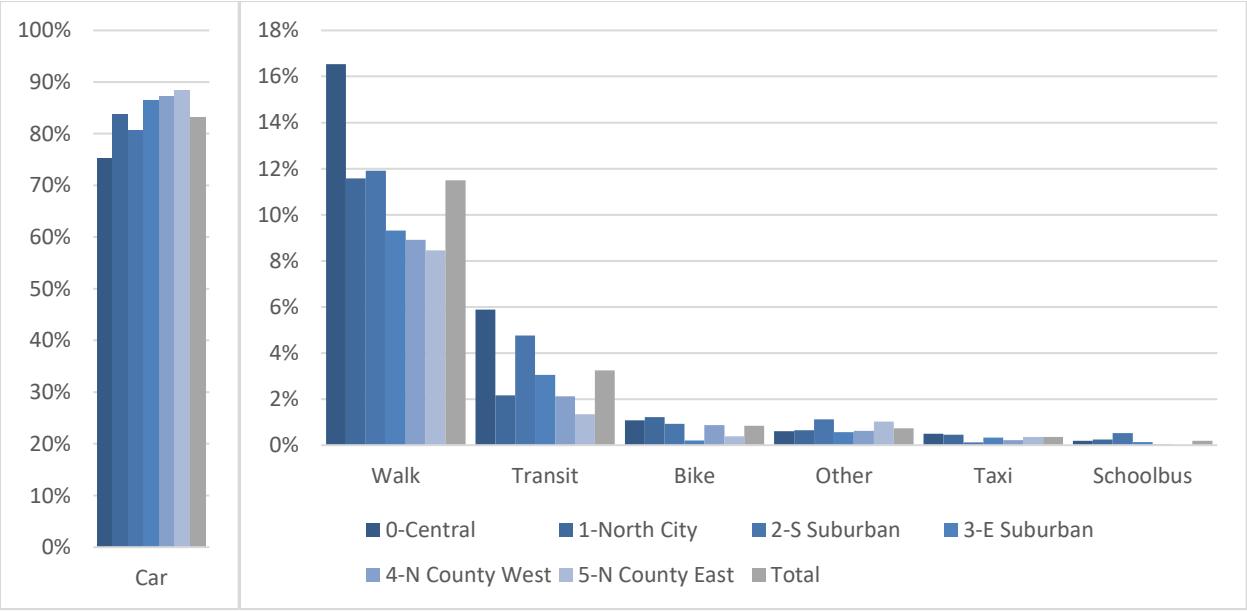


FIGURE 8-40: TRIP MODE, BY MSA (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



WORK TRIPS

While work trips (i.e., trips with a destination purpose of “work” or “work-related”) exhibit many of the same patterns as trips overall, some patterns are only apparent when broken out separately. For example, car and bike trips exhibited similar distributions while taxi, walk, and “other” modes were used more sporadically throughout the day. The car, bike, and total mode shares all peak at the 7AM departure house, while and taxi peak at the 8AM hour, ‘other’ peaks at 6AM, and school bus peaks at 2PM.

It should be noted that transit trips are not included here, given that this is an “unlinked” dataset, implying that most the transit trips are given a destination purpose of “change mode” rather than “work” in this dataset. (Figure 8-41). The distribution of work-related trip times was found to vary slightly across income levels and MSAs, however further analysis can more clearly differentiate “commutes” from all work and work-related trips. (Figure 8-42 and Figure 8-44).

FIGURE 8-41: WORK TRIPS: TRIP MODE, BY DEPARTURE HOUR (12 A.M. TO 11 P.M., COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)

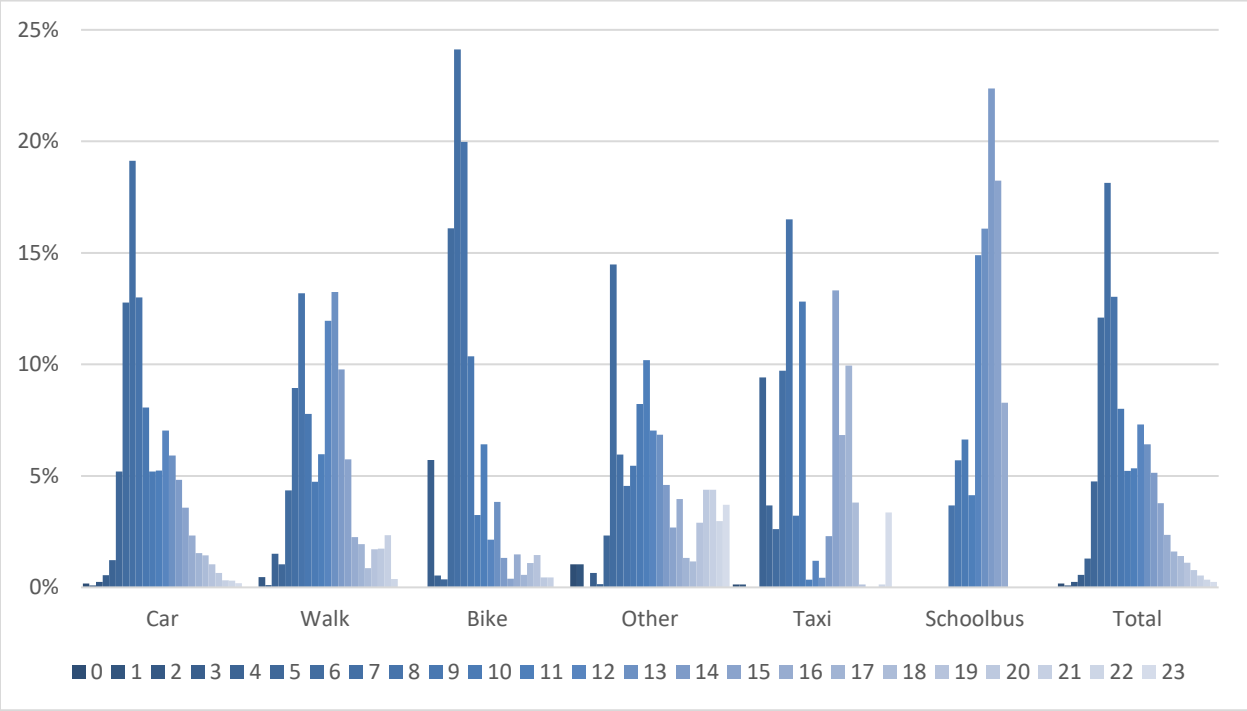


FIGURE 8-42: WORK TRIPS: TRIP DURATION, BY MSA (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)

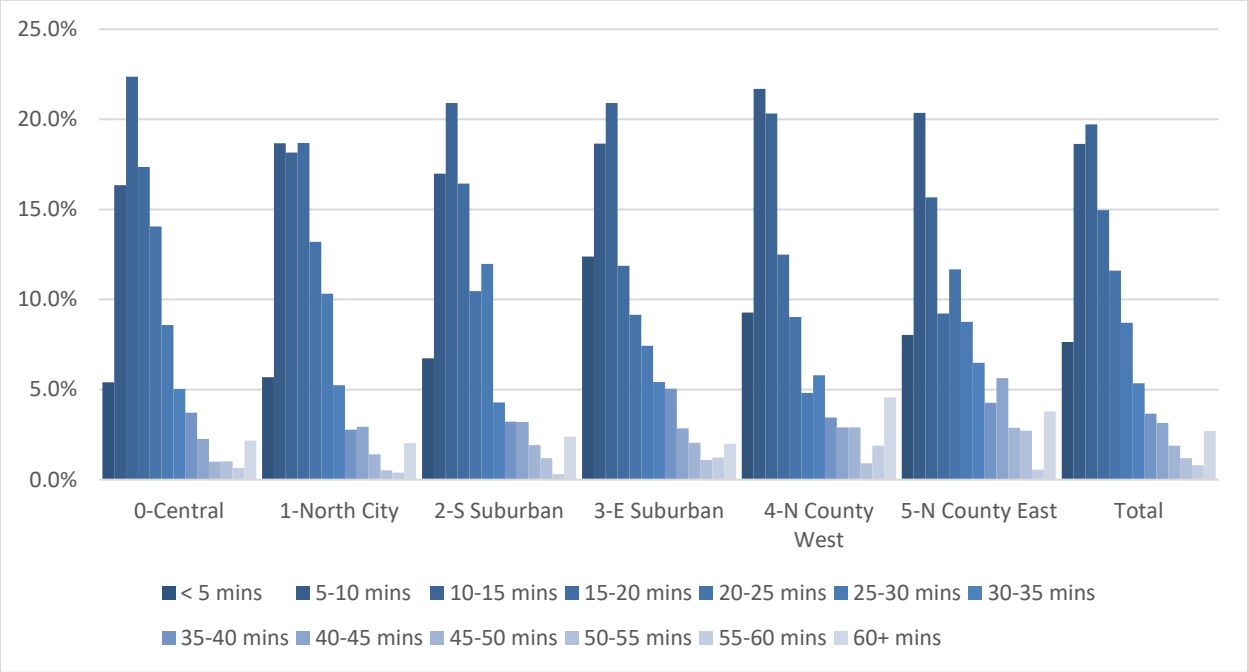


FIGURE 8-43: WORK TRIPS: AVERAGE TRIP DURATION AND DISTANCE BY MSA (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)

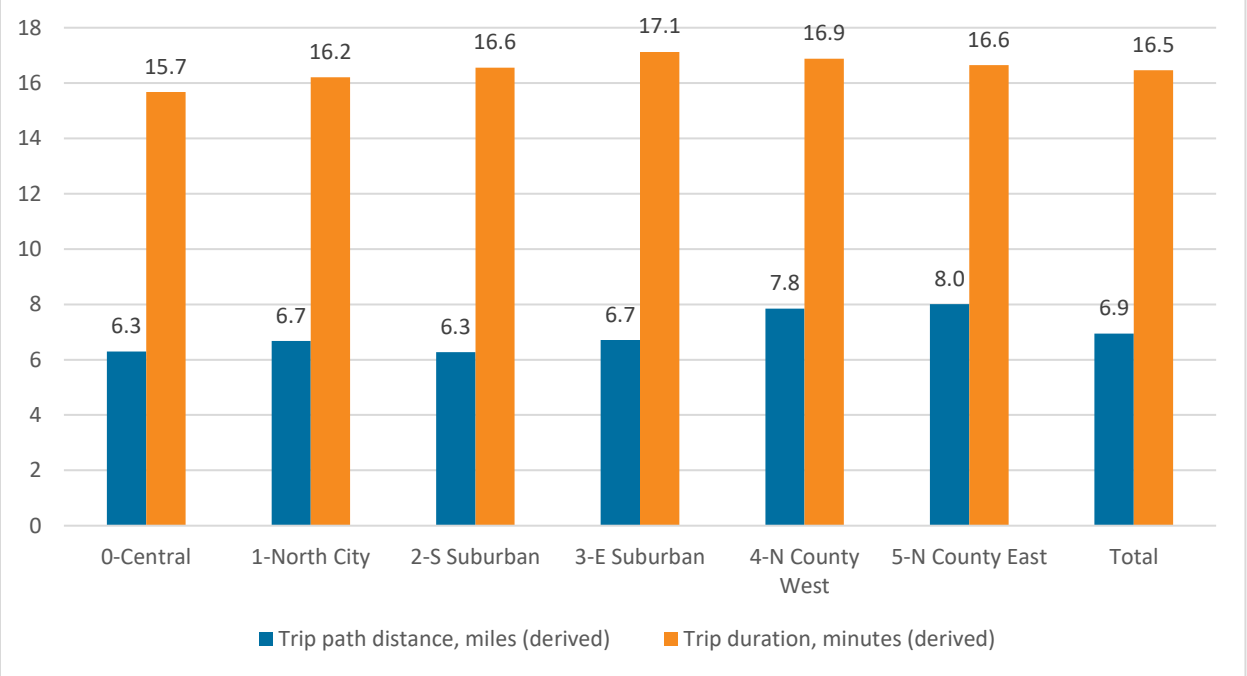
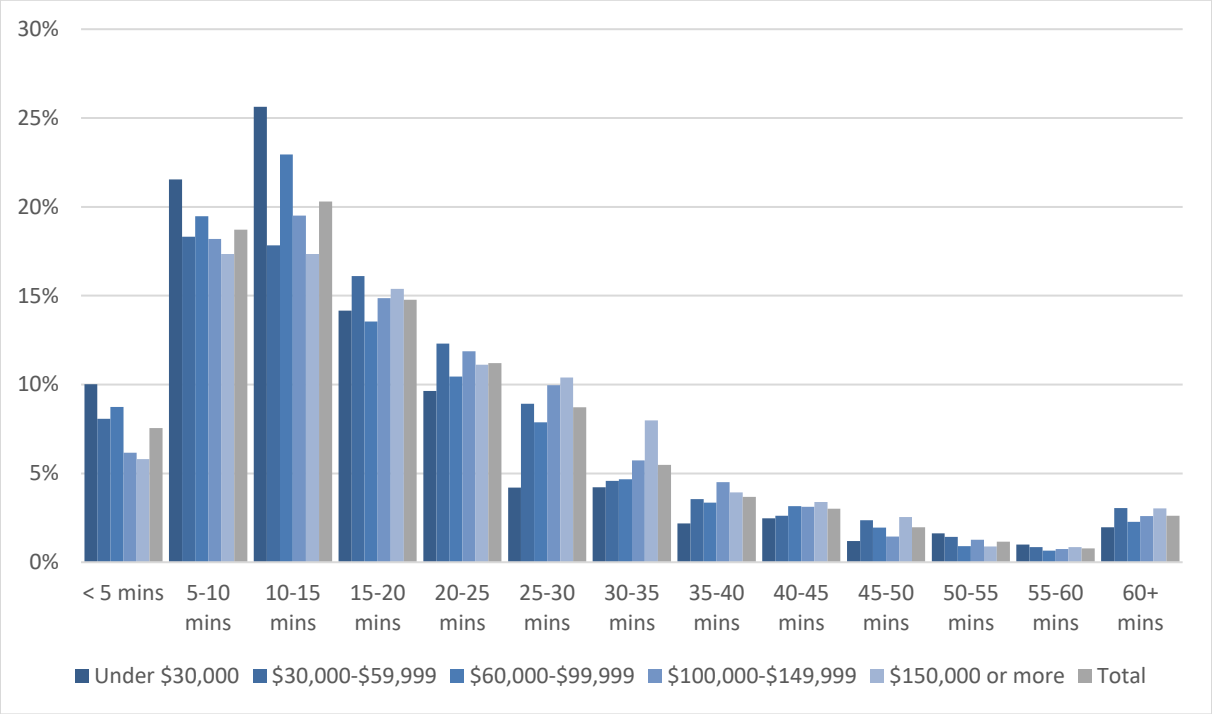


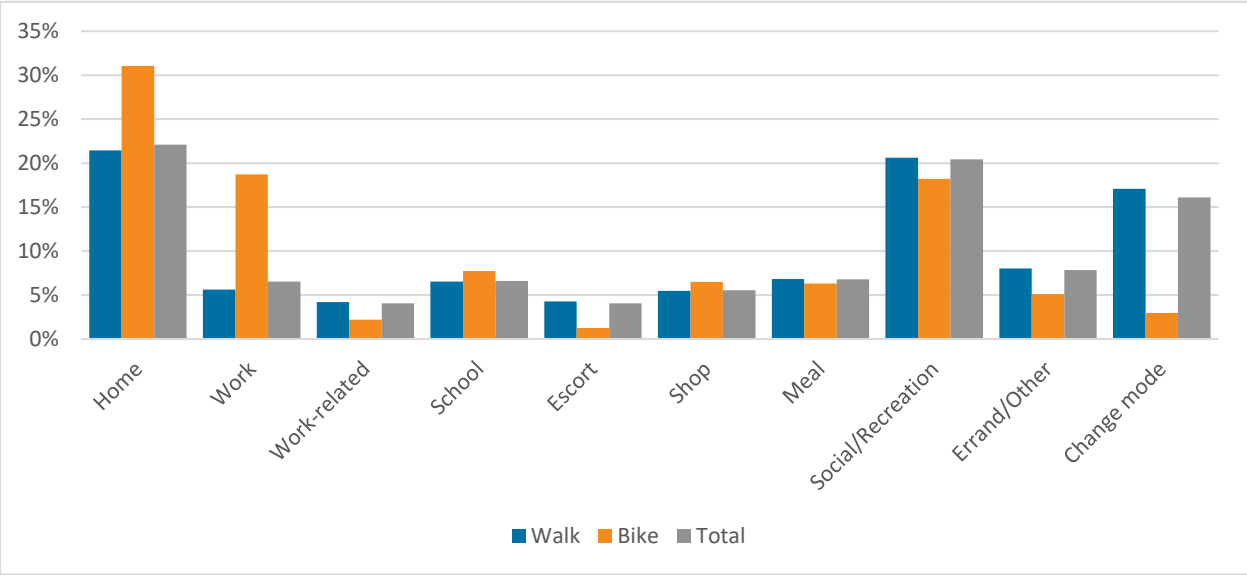
FIGURE 8-44: WORK TRIPS: TRIP DURATION, BY INCOME (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



ACTIVE TRANSPORTATION TRIPS

The most common trip purpose among walk and bike trips was “social/recreation” with the second most common purpose as “change mode.” Most of these trips were walk trips rather than bike trips. The distribution of these trips is even throughout the day, with slight walk peaks during the commute-to-work hours (Figure 8-45).

FIGURE 8-45: ACTIVE TRANSPORTATION TRIPS: TRIP PURPOSE, BY MODE (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



TRIP DISTANCE AND DURATION, BY MODE

When segmented by mode, the distributions of trip duration and distance remain consistent across modes. “Walk” trips are one of the few exceptions in both cases, primarily because most individuals opted for another mode (other than walking) once the trip reached a certain distance. The disproportionate number of walk trips under one mile was also likely a result of many people walking to the location of their next mode (e.g., walking to a bus stop). “Other” trips include a significant spike in the 60+ minute category, potentially because of airplane trips, which are categorized as “other” modes (Figure 8-46 and Figure 8-47).

FIGURE 8-46: TRIP DURATION, BY MODE (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)

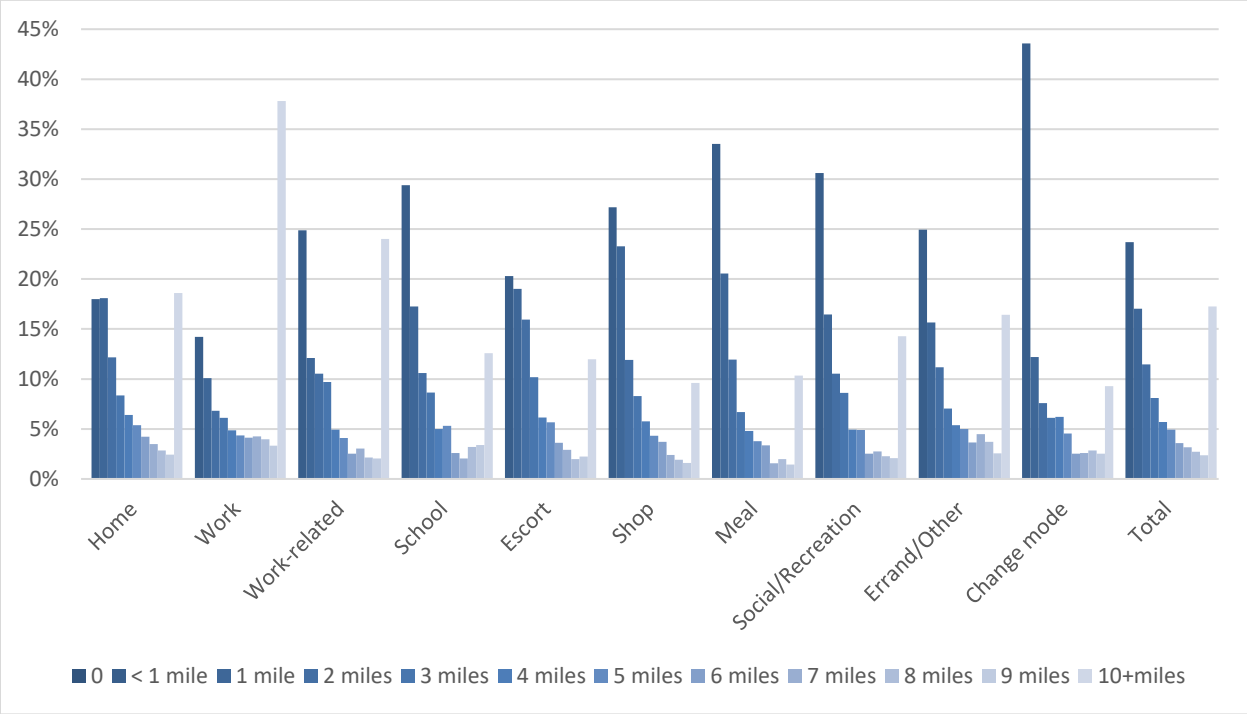
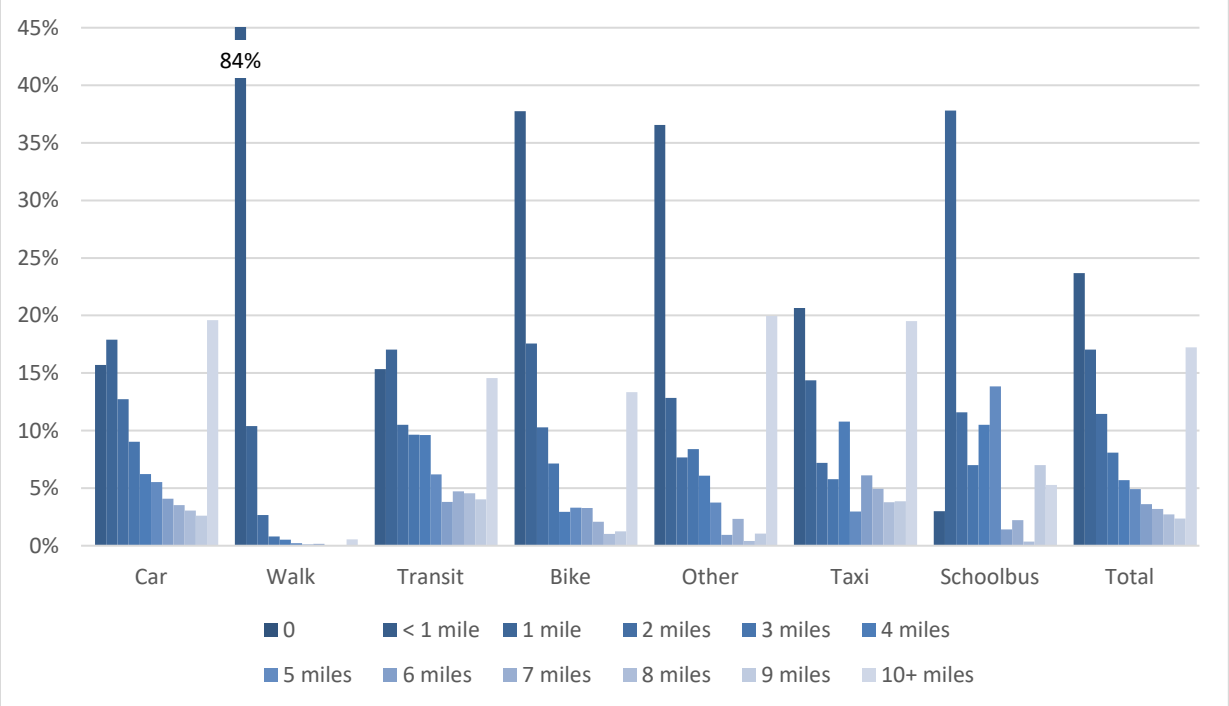


FIGURE 8-47: TRIP DISTANCE, BY MODE (COMPLETE HOUSEHOLD DAYS, WEIGHTED DATA, UNLINKED TRIPS FROM THE HTS DATASET AS DELIVERED)



9.0 ADDITIONAL SURVEYS

9.1 ACTIVE TRANSPORTATION SURVEYS

SURVEY DESIGN

The San Diego Regional Transportation Study included an add-on survey to inform and support the main study by collecting data on bike riders, including data on origin and destination, route choice, rider perceptions of safety, and basic demographics. Following a small pilot of the add-on survey in September 2016, the main add-on survey was conducted at 25 locations across San Diego County between January 30, 2017 and February 16, 2017. ChenRyan placed signs in both directions at each site, alerting bike riders of the upcoming survey station. National Data & Surveying Services (NDS) recorded simultaneous video counts during each site's survey period to track the total number of bike rider passing through each area. The study collected approximately 900 completed surveys over the course of the entire three-week program. After completing the intercept surveys, participants who lived in San Diego County and owned qualified smartphones were offered an invitation to participate in rMove for one week. Only persons who were intercepted were asked to participate in rMove, and the other members of their household were not allowed or required to participate in rMove. This add-on study was a joint effort between RSG and ChenRyan Associates, with ChenRyan designing and implementing the intercept survey of bike riders and RSG designing and implementing the rMove survey, online demographic survey, and overall study coordination and administration.

SAMPLE/INTERCEPT PLAN

The project team proposed the set of 25 survey collection locations to collectively represent a cross-section of location types (e.g., coastal, campus, inland), bike facilities (e.g., bike paths, bike lanes, no bike lanes) and regions of the county. Each site was surveyed twice—once during the highest three-hour period for bike traffic, and once during other ("off-peak") hours.

These differing facility types and market areas provided information about the rate of people riding bikes at each survey site. To ensure a diverse regional and demographic representation, the complete criteria for selecting these locations included the following factors:

- Presence of bike riders as reflected by recent bike counts
- High variety of bike facility types (No facility, Class I (e.g., bike path), Class II (e.g., bike lane on a road), Class III (e.g., bike route on a road, but no lane), or presence on the Regional Bike Network)[4]
- A mix of traffic volumes
- Proximity to automated counting stations
- A mix of informally defined cycling "market areas" (Coastal, Campus, Inland, South Bay, Downtown, and Hipster)

ChenRyan visited and reviewed the selected sites beforehand to establish signage positioning and to test internet connectivity, which was required to collect survey data on the iPads being used.

[4] For more detail on bike class facilities, please see http://www.dot.ca.gov/dist1/d1projects/manila-atp/bikeways_explained.pdf.

ADMINISTRATION AND IMPLEMENTATION

There were several unique aspects of conducting a bike-intercept survey that required the project team to be flexible and revise the study during its administration. First, even though several locations were scoped out in person before data collection, one site in Oceanside and one site in Downtown San Diego were moved midway during data collection to help increase the likelihood of intercepting bikes in a safe and reliable manner (also described in the section below). Second, a minor logic change to the intercept survey itself ensured that more people would be asked a question to better understand their overall tour purpose. Third, inclement weather played a factor in forcing the team to schedule several data collection days, particularly as the likelihood of successfully asking a cyclist to stop in the rain to take a survey was so low.

Overall, the administration of the study relied upon strong coordination and communication among the project team and required several adjustments in order to successfully execute.

EXPANSION

Throughout the intercept study, NDS recorded 24-hour video footage at each intercept location on one of the two days when each site actively collected surveys. This footage was used to determine the total number of bike riders who passed each of the 25 survey locations during both on-peak and off-peak hours.

RSG took the following steps to determine the final intercept survey expansion factors:

1. Aggregated the total video-recorded cyclist counts (observations) and completed survey counts at each location during on-peak hours
2. Aggregated the total video-recorded cyclist counts (observations) and completed survey counts at each location during off-peak hours
3. Divided the total observations by the total completed surveys at each location during both on- and off-peak hours; this yielded a total of 50 factors (two factors for each site—one on-peak and one off-peak), which were appended to the final dataset

There were three exceptions to the aforementioned process:

1. The project team moved a site in Oceanside on the second day of survey collection and video was captured only at the second site. Given that the location was moved only two blocks, the video counts collected at the second site were used for both survey locations.
2. The project team also moved in Downtown San Diego on the second day of survey collection and video was only captured at second site. The surveys completed during the first day of collection were pooled with another site in Downtown San Diego while the surveys completed during the second day were processed according to the standard steps listed above.
3. RSG collected one survey at a site listed as “other,” so this survey did not factor into any expansion process, and no factor was appended in the final dataset.

RESULTS

The active transportation supplemental study was successful in adding a significant number of cycling trips to the study dataset (1,133), as well as completing 846 intercept surveys across San Diego County. The trips collected in rMove were dramatically more likely to involve cycling, with more than 25% of trips involving cycling, compared to 1% of trips collected in the main study. The participants in the active transportation supplemental study were also more likely to walk, with walking as 17% of trips, compared with just 11% for the main study. Collectively, biking and walking account for nearly 43% of trips for this in the active transportation dataset, compared to 12% for those in the main study dataset. The 1,133 trips from the supplemental study provide a 43% increase in the total number of cycling trips collected during the project.

TABLE 9-1: PARTICIPATION AND COMPLETION IN ACTIVE TRANSPORTATION STUDY

	INTERCEPTED AND BEGAN SURVEY	STEP 1 COMPLETED INTERCEPT SURVEY	INVITED TO rMOVE	ACTIVATED rMOVE	STEP 2 COMPLETED rMOVE	STEP 3 COMPLETED ENTIRE STUDY
Totals	**913**	**846**	**507**	**176**	**108**	**77**

TABLE 9-2: SHARE OF CYCLING TRIPS IN ACTIVE TRANSPORTATION AND MAIN STUDY DATASETS

	INTERCEPT STUDY			MAIN STUDY		
	COMPLETED rMOVE TRIP SURVEYS	TRIPS WITH BIKE AS MODE	CYCLING TRIPS MODE SHARE	COMPLETED rMOVE TRIP SURVEYS	TRIPS WITH BIKE AS MODE	CYCLING TRIPS MODE SHARE
Trip Counts	**4,449**	**1,133**	**25%**	**268,944**	**2,599**	**1%**

The active transportation study will be analyzed and used in different aspects of modeling and planning going forward.

RECOMMENDATIONS FOR FUTURE BIKE-INTERCEPT STUDIES

If this intercept study process is repeated in the future, the following changes may yield improved results:

- **Coordinate site selection with the local jurisdictions (especially when spanning multiple jurisdictions)**. Each jurisdiction may have a better understanding of likely high-response rate locations.
- **Keep the volume differences between peak-hour and non-peak-hour periods in perspective when determining survey collection times**. Large time gaps between the peak hour and nonpeak hour make it difficult to staff locations. For example, if the difference in volume between the peak hour and nonpeak hour is only one bike, then the peak hour and nonpeak hour could be grouped together to ease staffing.
- **Consider that high nighttime peak-hour volumes may be false positives**. For example, the Market Street location (site #17) had a peak period that extended late into the night. However, the counts at these locations were either erroneous (given what was witnessed in person during survey collection), or they did not represent a useful cross-section of the true local population.

- **Consider time constraints of people on bikes**. Commuter bike riders in downtown locations are unlikely to stop and provide survey input due to time constraints. While the intercept survey itself often only took a few minutes to complete, people were still hesitant to engage at that moment on their bikes. Promising a quick engagement with these riders helps, as does offering a safe engagement (e.g., off the road) with water or snacks would support more participation. Site selection for these difficult intercept locations is extremely important.
- **Include travel time (30+ minutes) in the estimated time requirement for volunteers/temporary staff**. Most sites required 30+ minutes of driving during peak hours.
- **Adjust staffing for more flexibility**. Keep two head surveyors and one or two extra temporary staff on hand to visit/check-in at individual sites and address any unexpected changes.

9.2 MILITARY ON-BASE SURVEY

SURVEY DESIGN

Active duty military who live off-base were sampled at twice the normal rate as part of the overall ABS methodology. But active military who live on base, particularly in group quarters, are an important and traditionally underrepresented traveling population in regional surveys. Additionally, it is difficult to reach this population directly via mailings or phone calls. As such, RSG and SANDAG pursued the following approach and study design:

- SANDAG:
  - Obtained permission to disseminate a study invite to active military who live on base
  - Designed a social media campaign and articles for relevant military publications in the San Diego region to disseminate the word about the military travel study
- RSG:
  - Designed and printed an invitation postcard, which was to be distributed at the various military bases in the San Diego region. The on-base mail facilities and personnel supported this initiative.
  - Modified the one-day online travel diary so the on-base military population could complete the recruit survey and travel diary at the same time (reported travel for the previous weekday, rather than a future weekday as was done in the main study). This decreased the participant burden for a population that is busy and often “on-the-move.”
  - Modified the survey to an “open-link” that does not require a unique, preset password. This lowered the risk of the military contact making a mistake and allowed military to forward the invite email to others.
- Additional Details:
  - The study offered a small raffle prize (an iPad) to respondents, rather than a guaranteed incentive for each respondent
  - A complete individual survey (for service member who lives on base) was counted as a complete survey, rather than counting only complete household surveys.
  - Several sensitive questions were removed from the modified survey to accommodate military-related needs for anonymity.

SAMPLE PLAN

Without the ability to send mail to those living on base, nor to intercept people living on base, the traditional ABS and intercept methods used for the rest of San Diego County could not extend to the military study. Instead, a combination of postcard distribution, social media, and traditional media was used to recruit participants. These methods were used differently for various military bases and services. SANDAG coordinated these recruitment efforts over a matter of months to ensure that every action that was taken was with the support and approval of the various military liaisons working with SANDAG.

The large Naval bases in the region were willing to distribute a single postcard to those living in family housing on base, which represent a minority of those living on those bases. Some mailings from the main study ABS captured those living on Marine bases as well, however they were understood to be limited.

SANDAG coordinated the publication of a news article in the San Diego Union Tribune.[5] This article, in addition to other social media posts about the study, were also variously published or sent through the local Navy and Marine social media channels to help increase participation.

RESULTS

The military on-base supplemental study was unable to collect a significant amount of data by itself, however the project overall collected data from 365 people with some sort of current military affiliation, as well as a large number of trips to and from the various military bases around the region. This data can be used to better understand the travel patterns to military installations in San Diego and the impacts they have on regional travel.

RECOMMENDATIONS FOR THE FUTURE

The success of military-related studies, particularly those involving personnel living on base, hinges upon receiving strong support from the Department of Defense. For similar studies in the future, SANDAG may want to work with and coordinate through the Department of the Navy and their Human Research Protection Program. While the effort to get through a more formal human research certification process may be intensive, it may also come with more formal and complete support from the bases and military services, which is essential for a successful research project.

[5] The San Diego Union-Tribune, "Transportation study needs help from military families" published February 7, 2017 *http://www.sandiegouniontribune.com/military/sd-me-military-study-20170207-story.html*.

10.0 CONCLUSIONS AND CONSIDERATIONS

10.1 SUMMARY

The study **obtained 6,199 complete households, exceeding the project goal of 5,500** complete households. These households completed 22,598 days where all household members provided all travel details.

This dataset compares favorably to the 2006 SANDAG household travel study. Complete households increased by 70% (6,199 vs. 3,651 households) and travel days increased by more than 500% (22,598 vs. 3,651 complete travel days). The dataset collected more than 282,000 trips and nearly 31 million GPS points to detail the origins, destinations, and travel paths of trips (this location point count was later reduced to approximately 6 million using an algorithm to keep only critical and unique location points). More than 193,000 trips were collected on days with complete data for the household, an increase of 460% compared to the 2006 study. Across multiple demographic measures, the data collected were representative, especially after RSG applied a rigorous data weighting process using data from the ACS.

The study also captured supplemental sample for bike riders and those living on military installations to help with travel modeling for those special markets. These studies yielded mixed results, with the supplemental study of bike riders gathering much more data than the military supplemental study, which struggled to find viable, consistent methods of recruiting participants. For bike riders, intercept-based data collection was chosen as the most effective method. Furthermore, intercept-based recruitment for smartphone-based data collection was proven as a viable option for future studies; however, further steps to increase the completion rates would be helpful in applying this method more broadly.

Overall, the study applied innovative methods to capture a higher-quality and higher-quantity dataset. RSG looks forward to supporting SANDAG in their modeling and analytical efforts involving this dataset.

10.2 FUTURE CONSIDERATIONS

Many of the limitations of this study involved the uncertainty surrounding new methods of data collection. The study's sampling, data collection and administration, and resulting weighting and analysis all involved some degree of uncertainty or required the use of new methods. Future studies and analyses should focus on improving the following:

- Improve the ease with which households can begin their smartphone-based data collection (i.e., promoting an all-on-the-smartphone data collection experience, rather than requiring completing an online survey beforehand).
- Continue efforts to improve the representativeness of the data. While the overall representativeness of the dataset was good, further effort could improve participation among 18 to 24-year-old individuals, Hispanic and minority ethnicity individuals, and large households (which are mostly family households). Each of these groups has been difficult to reach in the past and continue to be.
- Build upon the methods for weighting and analysis used for this study. The trip-rate corrections and comparisons between data collected online and data collected on smartphones can continue to be refined and improved. For example, the multiday data collected via rMove was somewhat discounted within the weighting process (when compared to single travel day data collected

online). Future research and new methods will help unlock more of the value of having multiple travel days for persons and households.

- Develop tools and best practices for how to best use the smartphone-based trip-path data, which offers many opportunities to improve the quality of the dataset. Examples include improving the transit trip unlinking process, performing land use coding or analyses, coding the path data to the transportation network, and performing more consistency checks on the dataset (e.g., Does the collected and reported data make sense? Is it consistent?).
- Determine the value of the multiday travel data
- Determine the value of weekend travel days
- Determine best practices for data anonymization and data sharing, given how so much of the collected data is location-based and potentially personally identifiable

RSG looks forward to supporting SANDAG as they analyze the dataset in the years to come.