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This study provides a report on the Smart Parking Pilot, which was a partnership among the California Department of Transportation (Caltrans); the Institute of Transportation Studies-Berkeley's (ITS-Berkeley) Transportation Sustainability Research Center (TSRC) at the University of California, Berkeley; ITS-Berkeley's California Center for Innovative Transportation (CCIT); the San Diego Association of Governments (SANDAG); the North County Transit Agency (NCTD), and ParkingCarma, Inc. The project was designed to explore the application of smart parking and pricing at public transit stations along the COASTER rail line in San Diego, California. In addition, this report completes a review of parking management and pricing technologies, previous parking pricing studies, and previous research on pricing response. The project also conducted a survey of people who drive and park at COASTER parking lots and people who ride COASTER (N=1,631). The survey was split into two sample frames. The Driver frame (N = 815) consisted of those who drove and parked at the COASTER lot (and may or may not have taken COASTER), and the NonDriver frame consisted of those that accessed COASTER without driving and took the train (N = 816). The survey was designed to evaluate respondent travel patterns and their response to potential changes in parking pricing and public transit fares.

The survey was completed in July of 2011 at all stations and parking lots along the COASTER line. The results from the survey suggest caution in implementing a new pricing policy during times of economic constraint and uncertainty among consumers. The survey was conducted at a time when parking was not full at any of the stations and during a year in which major corporations were experiencing considerable consumer backlash against modest pricing actions. The survey found that with the exception of one station, COASTER parking lots were overwhelmingly used for accessing COASTER. The survey also found that COASTER is reducing the need for automotive ownership and driving, as 16% of Drivers and 30%of NonDrivers indicated that in the absence of COASTER their household would have to purchase another car. In addition, 71% of Drivers indicated that they would drive to their destination, if COASTER was not available, while 38% of NonDrivers indicated that they would do the same. The report concludes with an analysis of the financial impacts of different pricing scenarios on COASTER revenue based on the survey data and finishes with recommendations for the existing economic climate.

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Value Pricing Pilot Program

Smart Parking Value Pricing Pilot Project (VPPP) on the COASTER Commuter Rail Line in San Diego, California

Report to the San Diego Association of Governments

Final Report

March 27, 2012

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Abstract

This study provides a report on the Smart Parking Pilot, which was a partnership among the California Department of Transportation (Caltrans); the Institute of Transportation Studies-Berkeley's (ITS-Berkeley) Transportation Sustainability Research Center (TSRC) at the University of California, Berkeley; ITS-Berkeley's California Center for Innovative Transportation (CCIT); the San Diego Association of Governments (SANDAG); the North County Transit Agency (NCTD), and ParkingCarma, Inc. The project was designed to explore the application of smart parking and pricing at public transit stations along the COASTER rail line in San Diego, California. In addition, this report completes a review of parking management and pricing technologies, previous parking pricing studies, and previous research on pricing response. The project also conducted a survey of people who drive and park at COASTER parking lots and people who ride COASTER (N=1,631). The survey was split into two sample frames. The Driver frame (N = 815) consisted of those who drove and parked at the COASTER lot (and may or may not have taken COASTER), and the NonDriver frame consisted of those that accessed COASTER without driving and took the train (N = 816). The survey was designed to evaluate respondent travel patterns and their response to potential changes in parking pricing and public transit fares. The survey was completed in July of 2011 at all stations and parking lots along the COASTER line. The results from the survey suggest caution in implementing a new pricing policy during times of economic constraint and uncertainty among consumers. The survey was conducted at a time when parking was not full at any of the stations and during a year in which major corporations were experiencing considerable consumer backlash against modest pricing actions. The survey found that with the exception of one station, COASTER parking lots were overwhelmingly used for accessing COASTER. The survey also found that COASTER is reducing the need for automotive ownership and driving, as 16% of Drivers and 30%of NonDrivers indicated that in the absence of COASTER their household would have to purchase another car. In addition, 71% of Drivers indicated that they would drive to their destination, if COASTER was not available, while 38% of NonDrivers indicated that they would do the same. The report concludes with an analysis of the financial impacts of different pricing scenarios on COASTER revenue based on the survey data and finishes with recommendations for the existing economic climate.

1. Introduction

The Smart Parking Pilot project is a partnership among the California Department of Transportation (Caltrans); the Institute of Transportation Studies-Berkeley's (ITS-Berkeley) Transportation Sustainability Research Center (TSRC) at the University of California, Berkeley; and ITS-Berkeley's California Center for Innovative Transportation (CCIT); the San Diego Association of Governments (SANDAG); the North County Transit Agency (NCTD), and ParkingCarma, Inc. This project investigates smart parking technologies and techniques along the COASTER route in San Diego County to develop a regional toolkit and implementation plan to assist public transit agencies considering the application of smart parking pricing at transit stations in the regional context. The toolkit and implementation plan will draw on the qualitative experience and quantitative evaluations of the COASTER smart parking pilot that was implemented on August 17, 2009 at three COASTER stations: Carlsbad Village, Poinsettia, and Encinitas. The project went through a number of phases that were in part a reaction to the changing conditions due to the economy as they related to the COASTER line. When the project was first proposed in 2006, the COASTER parking lots were at capacity and demand exceeded supply. This produced an environment in which parking pricing would be have been supportive of public transit, without impacting parking lot usage. As the project progressed, economic conditions within the San Diego region changed, and parking at the COASTER lots became underused. This drastically impacted the demand and the value of smart parking reservation technologies that enable riders to reserve spaces at high-demand COASTER parking lots. These changes resulted in the project partners re-scoping the evaluation to focus on COASTER riders and their forecasted response to potential changes in parking prices and fares. A survey of more than 1,600 COASTER riders was completed, and the results evaluate how riders traveled and how they would respond to changes in parking and fare prices. In addition, the survey evaluated the impact that the COASTER service has on auto ownership and commuting among its existing ridership base.

This report begins with a discussion of the background and history of the smart parking pilot project and continues with literature and case study reviews. The authors then review the COASTER system, including its stations and layout. The stated preference survey that was implemented to evaluate the effects of transit fare and station parking pricing on COASTER ridership and station access modes is presented along with the results. Project conclusions follow to assist public transit agencies, as they consider the application of parking pricing at transit stations in the regional context.

2. Background

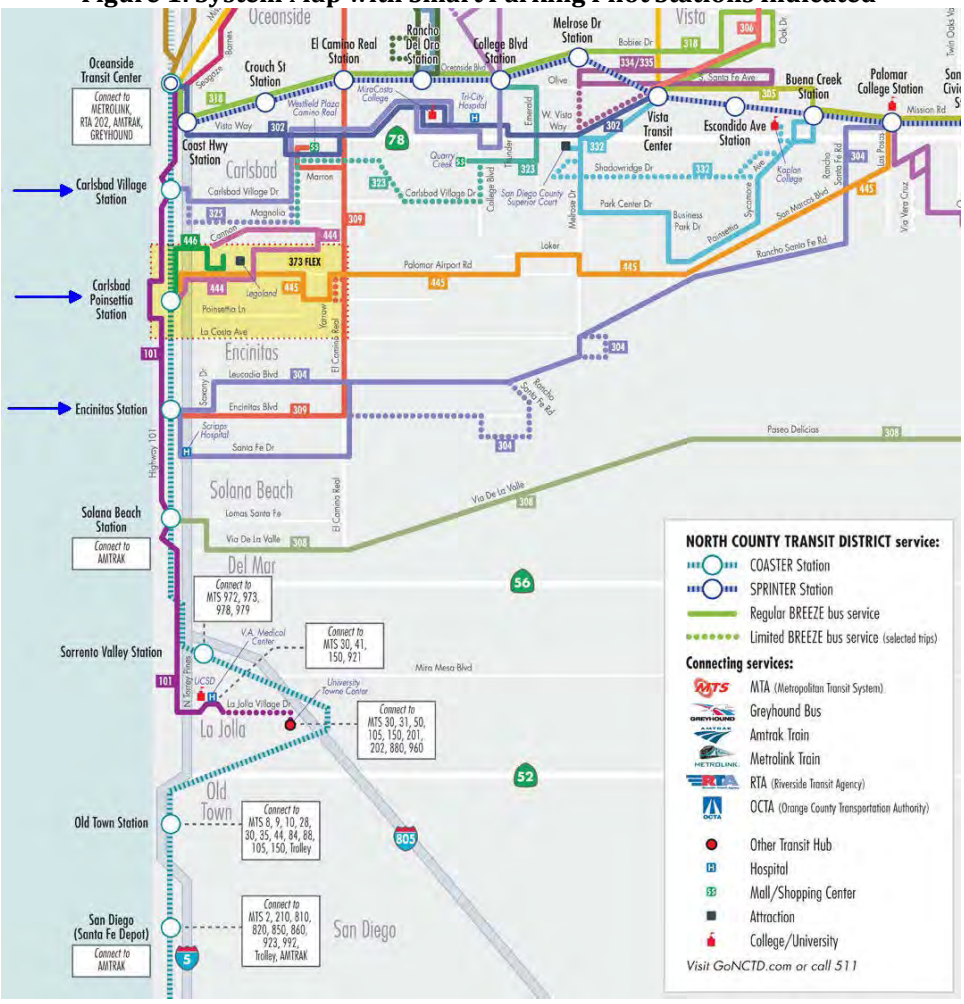
2.1. Project History Summary

The San Diego Value Pricing Program Pilot (VPPP) for the COASTER system was originally intended to build upon the transit-based smart parking field test research conducted at the Rockridge station of the San Francisco Bay Area Rapid Transit (BART) from December 2004 to April 2006 (Shaheen and Kemmerer, 2008; Rodier and Shaheen, 2010). At the time the COASTER study was proposed (2006), parking at most of the stations on the COASTER corridor filled well before the final commute train departed, and ridership was clearly limited by station parking capacity. The pilot would implement recent advances in sensor, payment, and enforcement technologies to operate parking facilities more efficiently, with the short-term goals of enhancing customer parking experiences, increasing the effective supply of existing parking with minimal investment—thus increasing ridership and overall revenue. Over the longer term, these innovative systems could further expand ridership by generating revenue to add parking capacity and improve access.

The problem identification analysis and proposed near-term parking management strategies to address those problems were presented to the North County Transit Agency (NCTD) staff and their Board in September 2008. Proposed alternatives for the near term included strategies to: 1) freeing up more space for COASTER riders by restricting non-COASTER and overnight parking or allowing non-COASTER and overnight parking through fee payments; 2) generating more COASTER riders per parking space by encouraging carpooling and vanpooling and by providing preferential parking for those commuters adjacent to the platforms; and 3) attracting new or more frequent daily COASTER riders through the provision of reserved paid parking, which would also be located in a preferential location, and by providing information on the real-time availability of general free parking at the COASTER stations via the ParkingCarma™ reservation website.

The NCTD Board conditionally approved the near-term strategies in September 2008, and the project partners began working to implement the pilot project. Initial project implementation efforts included approval and deployment of preferential carpool and vanpool parking, reserved paid parking services, and provision of real-time parking availability information via the ParkingCarma™ website. The pilot implementation received NCTD approval in May 2009, and it was implemented in August 2009 at the Carlsbad Village, Poinsettia, and Encinitas stations, which are indicated by arrow in a system map presented in Figure 1.

Figure 1: System Map with Smart Parking Pilot Stations Indicated



The pilot implementation allowed COASTER riders to reserve one of ten advanced paid parking spaces for solo drivers and six free spaces for carpool/vanpools at each of these stations via the QuickPark reservation system linked to SD511.org and available via the ParkingCarma™ reservation website. During the initial pilot project implementation, the economy entered into a deep recession. NCTD increased fares and cut back service due to significant budget deficits. Between 2007 and early 2009, the NCTD increased fares by $1 per trip (Hawkins, 2010). At the same time, it had also become apparent that the same factors were impacting COASTER ridership and parking demand levels. This directly affected the application and use for the QuickPark parking reservation system. Given the relatively low demand for reserved parking spaces during this time frame (a total of 10 reservations for a period of three months), project partners began working with the NCTD and SANDAG to develop a work plan that took advantage of the existing resources available for research and planning to capitalize on completed efforts, while improving the project outcome.

2.2. Project Re-Scope Summary

Given the project circumstances, the UC Berkeley research team worked with NCTD and SANDAG staff on the development of a path forward, consistent with the original VPPP scope of work deliverables but customized to existing transit parking demand conditions—focusing more on improving the usefulness of the final project for SANDAG and FHWA. The objective was to lay the foundation for future smart parking program expansion once the economy turned around and greater service demand returned. These discussions led to a project focused on examining and assessing the impacts of public transit fares and transit ridership levels when considering transit parking pricing. The work plan was discussed and presented to NCTD, SANDAG, and included participation from the FHWA, which subsequently approved a revised the San Diego VPPP project scope in September 2010.

The underlying principles that guided the workplan development during this process included: 1) maintaining consistency with the original VPP deliverables, 2) assuring that all deliverables can be used in a regional toolkit/implementation plan for future smart parking deployments, and 3) using lessons learned drawn from the qualitative experience and quantitative evaluations of the COASTER smart parking pilot (as well as the larger available evidence in the literature). The VPPP deliverables were enhanced to provide more detailed information and lessons learned to assist SANDAG, the FHWA, MPOs, and public transit agencies as they consider the application of smart parking pricing at public transit stations in a regional context.

The Re-Scoping effort included the completion of three main elements:

- Conducting a thorough analysis of gauging public acceptance through a Transit Parking Pricing and Fare, Revenue, and Ridership Trade-Off analysis. This effort included a literature and case study review of public transit agencies and parking pricing, implementation of a stated preference survey designed to understand the affect of changing transit fares, and station parking pricing on mode shares. These surveys were pre-tested and then implemented on weekdays from Monday, July 11, 2011 through Friday, July 22, 2011 at COASTER stations by a professional consulting firm, hired by TSRC, UC Berkeley. Participants were surveyed in three locations at all eight stations: platform, parking areas (for seven stations), and aboard the trains. A total of 1,632 surveys were completed during a two-week data collection period. Eight-hundred sixteen (816) of these were completed by those who drove to a station that day, and another 816 were completed by those who did not. This document provides a report on these data.

- Smart Parking System/QuickPark COASTER Parking reservation system usage statistics. During the on-going reservation system, COASTER users would continue to access the QuickPark program of the ParkingCarma website through 511sd.com to make

reservations for carpool/vanpool riders and available for free to COASTER riders. Since the QuickPark project's inception, approximately 250 reservations were made from August 2009 to September 2011. A new program feature would require patrons to provide their Compass Card (regional rail pass) number so that the program could be linked to the Compass Card for monthly reservations. The intent of this effort was to continue to monitor the use, functionality, and application of the QuickPark reservation system via the ParkingCarma website.

- Development of the Concept of Operations Document describing the operation of a transit smart parking system. This effort was led by CCIT, UC Berkeley. The Concept of Operations within this project provides a detailed discussion of the design and costs of a transit smart parking system. The purpose of this specific ConOps is not to support the development of system requirements, as is the case in most ConOps completed for conventional systems engineering management plans. Because of the project scope changes, the ConOps is a reference document that can be used by public agencies and private providers to develop a smart parking system for public transit agencies. The Concept of Operations has been submitted under a different cover.

3. Literature and Case Study Review

This section provides a review of past research and work done in the area of parking management with intelligent transportation systems technologies. The review covers parking management strategies and systems, payment systems, park-and-ride pricing, existing pricing, as well as past user behavior research with respect to parking pricing.

3.1. Review of parking management strategies and advanced systems

3.1.1. Parking management strategies

New management systems enable the collection of detailed data on parking demand patterns and create new opportunities to optimize use of resources and increase cost effectiveness. Currently, the parking literature provides a good foundation for understanding the effects of parking pricing and other parking management strategies in downtowns, urban centers, retail, and employee parking lots. Although the same principles apply to public transit station parking as to other parking contexts, transit-parking facilities often face additional complexities and unique practical management issues.

Because riders dislike uncertainty and inconvenience in finding parking, public transit officials often maintain spare parking capacity, relative to average occupancy, to accommodate fluctuations in stochastic demand—with an 85% average occupancy being the rule of thumb

(Shoup 2005). To mitigate the effects of excess demand, the transit agency can either implement more advanced management strategies, including pricing, parking restrictions, and technology solutions, or it can expand parking supply (Merriman 1998).

Investment decisions at overcrowded transit parking facilities are complex. Adding parking usually has diminishing marginal returns. Riders may stop carpooling, move from alternate parking locations, or switch from a nearby station, so an additional space may serve well under one additional rider per day (Merriman 1998). A study of parking conditions at stations in the Metra commuter rail system in Chicago (Illinois, US) showed that passengers using overflow parking on the street or elsewhere tended to move into the Metra lots where parking was more convenient, so additional parking spaces did not create a proportional increase in ridership. However, adding additional parking did not appear to induce users employing alternative access modes to start driving (Ferguson 2000). Park-and-ride users tend to switch from driving alone at higher rates than from bus or other public transit modes, but transit parking's effectiveness at diverting trips off of the highway depends on factors including the level of transit service, the fare and parking prices, the availability of other public transportation, roadway congestion levels, and many structural factors (Foote 2000; Turnbull et al. 2004). Generally, if the marginal expected revenue of the net new spaces is greater than the marginal cost, the proposed new spaces should be added. The expected revenue from supplying additional parking to public transit stations comes mostly from a greater number of ticket sales due to increased ridership and also from parking fee revenue. Shoup (2005) provides a useful discussion of the costs of supplying additional parking and the opportunity cost of investments. When the cost per additional space is sufficiently high because of land values or the type of construction necessary, real estate development may bring more benefit in revenue and ridership than investing in parking (Shoup 2005).

Typically, public transit agencies make parking investments according to simplified decision-making processes. The Washington Metropolitan Area Transit Authority (WMATA) in Washington, DC and the State of New York's Metropolitan Transit Authority in New York City have measured parking demand by projecting ridership and assuming a constant modal access share for drivers (WMATA 2008; MTA Metro-North Railroad 2005; Marchwinski et al. 2003). Often, public transit agencies simply direct their investments to the stations with the most overcrowding (SANDAG 2002) or those stations where they wish to induce demand (New York MTA 2008). One reason many public transit agencies do not use comprehensive decision models is that they do not fully internalize the cost of building a new lot or garage. Much of the funding for these projects can come from the federal, state, or local government in the form of grants or bonds (SEPTA 2007).

A central lesson of the recent parking literature is that parking managers ought to rationalize pricing. Shoup (2005) argues that providing free transit parking is often an inefficient subsidy

that is unfair to riders arriving by alternate modes since they do not receive any benefits from the parking and forego funding invested in parking. When transit parking is underused, parking costs per ride generated are even higher, and the public transit authority ought to find more beneficial uses for its real estate, such as transit-oriented development. Cash-out programs have demonstrated that many commuters adjust their habits significantly when presented with the true cost of their parking, and pricing is a strong tool to influence driver behavior (Shoup 2005). Studies of downtown parking reveal that when surplus-parking demand exists, search and congestion costs diminish the consumer surplus created by discounted parking prices. Lack of space turnover reduces accessibility and negatively affects businesses. An optimal management plan will not necessarily generate the most revenue, but rather it will maximize overall benefit. Reinvesting surplus parking revenue into the community can magnify the benefits of parking pricing and win over political support (Shoup 2004).

Studies suggest that the same principles can apply to transit parking facilities. In one of the earliest studies of the effects of park-and-ride pricing on public transit ridership, the Massachusetts Bay Transit Authority (MBTA) reduced parking fees at underused stations and found that revenue from the increased number of cars more than compensated for the lower price charged. The difference in the cost of parking at adjacent stations caused a shift of parkers from the more expensive lot to the cheaper lot, resulting in a redistribution of available spaces (Mass Transportation Commission of the Commonwealth of Massachusetts 1964). A study of the Liberty State Park intermodal public transit facility in New Jersey showed that free parking was an effective tool to induce demand at the parking lot because most parking lots nearby were overcrowded and required payment. Parking use and ridership continued to increase even after New Jersey Transit reinstated parking charges at the park-and-ride facility (Marchwinski 2003).

Airport operators' parking facilities provide an instructive example for transit park-and-ride since they face similar modal competition and stochastic demand. In response to competition, airport operators have led innovation in parking management, going beyond flat fees and creating sophisticated parking pricing strategies. At Minnesota-St. Paul International Airport, parking generates a third of the airport operator's revenue. The airport's parking competes successfully with alternate access modes and maintains a very high occupancy rate. The airport attributes a large share of its success to augmenting superior convenience and focusing on customer needs: minimizing travel time from cars to the terminal. Real-time monitoring allows prices to be adjusted for entering passengers at specific lots based on current and forecasted demand (Decker 2007). The British Airport Authority has a sophisticated yield management system that allows managers to closely monitor demand forecasts and adjust pricing regularly in response to the market (Frank-Keyes 2007).

Parking has key attributes that make yield management a valuable tool. Parking spaces are perishable goods: any instance they go unused, value is lost. It is important to maintain

occupancy levels and maximize usage levels. New technologies are continually improving the ease of reserving spaces and gathering information about customers and parking use. Teodorovic and Lucic (2006) view variable pricing as an important tool to regulate demand and to equitably raise tax revenue; they apply yield management principles to create a generalized program to optimize revenue for a parking structure or neighborhood with excess parking demand. They also observe that technology allows easy market segmentation, which can be used to benefit vulnerable groups and promote more efficient use of spaces while raising additional revenue (Teodorovic and Lucic 2006).

Public transit agencies may not seek to only maximize revenue. Nevertheless, they can benefit from the airport parking example. A private transit park-and-ride facility in New Jersey offers a range of parking options including a daily commuter rate, monthly reserved and non-reserved passes, a monthly commuter pass, and regular charge by time. The pricing system segments the market based on parking purpose, convenience, and length of stay (Nexus Properties 2008). A station with the MBTA employs an hourly rate, but during special events, it uses a flat rate, which is equivalent to at least five hours of parking (MBTA 2008). BART's most recent pricing strategy offers separate options for carpools, long-term users, reservations, and valet services (BART 2008). Advanced parking management technology innovations could accelerate the further adoption of advanced pricing and management strategies by public transit authorities.

3.1.2 Advanced parking management systems

Advanced parking management systems are technology and software tools that can be used to improve integration of separate parking operation elements and increase parking facility efficiency. Smart parking is the application of advanced parking management systems with a focus on the customer interface and service, for example, to help users with the location of parking, advance information on parking conditions, parking space reservations, and easy electronic payment options. The context of smart parking applications continues to broaden and now includes private parking facilities, central business district parking information systems, airport parking, street parking, and public transit parking.

Advanced parking management systems allow for a more efficient parking experience for drivers as well as owner-operators of parking facilities with respect to enforcement, revenue management, and management data. Parking facilities that use advanced parking management systems can collect real-time parking space inventories that help the facility managers track the demand for parking (Federal Transit Administration 2008). Improved demand data allow parking managers to set more effective pricing policies, increase enforcement efficiency, and develop improved business strategies. Smart parking benefits drivers by saving search time, reducing parking uncertainty, improving parking decisions, saving money, preventing parking violations, and, in general, decreasing parking frustrations.

3.1.2.1 Advanced payment systems

Advanced payment systems are an important component of smart parking and can be central to quality customer service and experience. In this section, pay-by-phone, smart cards and radio frequency identification (RFID), and in-vehicle meters are reviewed.

Pay-by-phone systems use automated answering machines or short messaging service (SMS) to allow prepayment of parking. Drivers use their mobile phones to wirelessly deposit money towards time in a parking space, and most systems can give users updates about remaining or expired time via SMS messages. Drivers usually must register their license plate and credit card information to use the wireless metering (Smith et al. 2007). Pay-by-phone systems have been widely implemented for paid street parking or surface lots because they require minimal up-front costs—mainly signage, advertising, and handheld devices for parking enforcement officers. The pay-by-mobile method works within multiple parking zones, rates, and tariffs (Laufer 2007). Handheld devices give enforcement officers a list of license numbers that are paid within a given area. The officer then checks the plate of a vehicle against his list and writes citations for vehicles not on it (Podmore 2005).

In West Palm Beach, launching pay-by-phone was a cost-effective alternative to replacing old street parking meters with expensive kiosks to offer users cashless payment options. Users dial the local number on the meter and enter the meter's identification number. When leaving, users merely dial the same number and press "one" to confirm their departure. Business owners supported this more flexible and convenient parking system that would not deter customers. The system allows the city to monitor individual space occupancy and revenue generation to track users and to check citation appeals against digital records. Users have signed up at rates well above initial projections ("West Palm Beach Rings in New Year With 'Pay-by-Cellphone' Success" 2007).

In Vancouver, Canada, and Seattle, Washington, Verrus Mobile Technologies Inc. provides pay-by-mobile parking options. Adoption rates of the payment system are very high in both cities, with average usage running at more than three sessions per week per customer (Podmore 2002). Vancouver integrated the system with its enforcement database that allows officers to check a vehicle's payment status, permits, and past citations, and to ticket or dispatch towing from a single device. The city records as many as 1,500 transactions a day; 20% of drivers use the pay-by-mobile option. The system is already showing higher compliance rates and increased revenue (Yong 2007). Two London neighborhoods have fully replaced street meters with pay-by-mobile technology to reduce collection overhead and combat mete theft (Decker 2007).

Newer systems have improved performance and continue to introduce new features. Users can be notified if their parking request violates any parking restrictions, preventing unnecessary tickets

and towings (Podmore 2005); they can also review their usage via online statements (Yong 2007). Because of improved communication with the customer, parking managers can more easily change pricing schemes, adjust parking zones, and manage permit parking. Pay-by-mobiles is ideal for open parking lots because there are no lines drivers must wait in to pay or receive a ticket; the transaction can be done while they are walking to their destinations. However, not everyone owns or will have a mobile phone with them at the time they are parking. A phone might need to be placed in the parking lot for this option to be viable.

Smart cards allow drivers to electronically "load" money onto a card with an integrated circuit chip and then have the money debited with each card use. Smart card technology is highly secure and relatively inexpensive (Laufer 2007). Fee calculations are performed simply by reading and writing to data files on smart media with the smart card. This leads to large reductions in ticket consumption costs, major improvements in equipment and system reliability, significant decreases in field maintenance costs, as well as decreases in transaction times.

As part of the June 2004 launch of the SmarTrip card, Washington Metropolitan Area Transit Authority (WMATA) instituted cashless parking at all 42 Metro stations with parking and required every driver to purchase the US$5.00 smart card. Every rail station is equipped with at least one smart card dispenser, but drivers can also buy smart cards online and in select stores. During the summer, it was found that up to 50% of smart cards purchased for parking are bought by one-time users who must still pay the $5.00 surcharge to cover new card cost and handling. Many WMATA parking facilities have spare capacity on most days, and the smart card system deters low frequency users (Ashok 2006). Parking facilities at six pilot stations now accept credit cards in an attempt to accommodate these users (WMATA 2008). Metropolitan Atlanta Rapid Transit Authority (MARTA) has overcome the problem of infrequent users by offering a limited use smart card (Smart Card Alliance 2006). Contrary to the permanent smart card, the limited use cards are not linked to a specific user account or credit card.

RFID tags are another wireless payment technology that can be installed in a smart card, mobile phone or in a vehicle, and typically serve as account numbers from a third-party system responsible for billing and history (Dekozan 2007). There are two types of RFIDs: short-range and long-range wireless communication systems. Long-range RFID technology uses higher frequency radio signals and is more appropriate for long distance communication and for applications with high-speed transportation. The most promising form of long-range RFID is cellular-based parking technology like the Triffiq unit used in some Dutch cities. Upon parking, the driver turns on an in-vehicle device that communicates with the company's central system through the cellular network and with the enforcement officer's handheld device. The device offers the convenience of pay-by-mobile with simpler enforcement (Mouskos et al. 2007).

Short-range wireless communication systems send the information from a transponder installed

in the vehicle to an antenna reader—usually within 100 feet—to a data processing center. The Port Authority of New York and New Jersey at Kennedy, Newark, and LaGuardia airports are implementing this type of approach as a parking payment system (Mouskos, Boile, & Parker 2007). Short-range wireless communication systems are most effective in parking facilities with a gated entrance, which typically ensures vehicles are within the radius of the antenna reader. The advantages of using RFID are that they are low cost and low maintenance and have simple operation. Radio signals assure no contact and can penetrate opaque structures.

The E-ZPass toll collection system has been installed at toll facilities throughout the Northeast U.S. and allows on-the-fly toll payment at freeway speeds. The system can also control access and payment at parking facilities and be used to estimate a facility's occupancy without tracking every vehicle entering and exiting. An antenna reader must be installed at each entrance and exit, and the parking facility must have a server, landline or wireless communication, and a data processing center to use the E-ZPass system (Mouskos et al. 2007). Because each unit costs US$25 to purchase and to open an account, the inconvenience and cost may preclude some drivers from participating, especially infrequent users. Both smart cards and RFID streamline transactions and save users time, while gathering valuable data. However, the two options require more investment and can be impractical for open parking facilities requiring a more complex installation.

In-vehicle meters are typically an extension of smart card or pay-by-phone systems. When drivers pull into a parking spot they either use a smart card or mobile phone to pay for their parking. The in-vehicle meter communicates wirelessly with a centralized management system and allows for easy, visual parking enforcement similar to pay and display meter receipts ("Pay by Cell" 2008). Typically, the user must purchase the in-vehicle meter, which can be expensive even if subsidized. The higher user cost discourages technology adoption and is not practical for low frequency users, so the technology is more often implemented for commuter parking (Bergstrom 2005; "Pay by Cell" 2008).

The University of Wisconsin in Milwaukee launched a program that offers in-vehicle meters to employees. This program gives employees the option to pay as they park in lieu of purchasing an expensive annual permit. Users lease the in-vehicle meters through the university, paying a US$20 administrative charge and a US$25 deposit. Drivers turn on the meter when they park and use a smart card to pay for the desired amount of time at rates between US$0.40 and US$0.50 per hour, about half the typical daily rate. The university created a new fine for users who fail to turn on their meters. Soon after the implementation of the program, it became apparent that the in-vehicle meters were more labor intensive for the office staff than annual parking permits. However, the program did successfully reduce parking lot overcrowding and improve the efficiency of parking usage (Bergstrom 2005; University of Wisconsin Milwaukee Parking Study).

In-vehicle meters allow price discrimination among user groups and promote more efficient use of parking resources through pay-as-you-go parking pricing. However, the technology is not cost effective for serving low frequency users. In-vehicle meters can reduce enforcement costs, but the necessity of installing a redundant payment system for other users can easily offset the technology benefits.

E-parking is an advanced parking management concept for off-street parking that brings together parking reservation and payment systems. The e-parking system relies on an electronic parking brokerage for parking providers. Drivers use their cellular phones, PDAs, or the Internet to access the portal site and view available spaces and prices and then reserve a parking space based on their preferred location. The system confirms the reservation with the parking provider and gives the user an access code. The car enters and exits the parking facilities using Bluetooth to open the barrier. Once the car exits the parking facility, electronic payments are made and the whole operation is registered on the brokerage site (Hodel and Cong 2003).

The e-parking concept would benefit high-demand destinations with a fractured parking market and many suppliers. Centralized reservation systems promote more efficient use of parking resources. Drivers can benefit from reduced uncertainty and more competition among suppliers, saving users both time and money. Parking managers can learn more about overall demand and improve their pricing and revenue management (Shaheen et al. 2005). However, the system breaks down in markets like airports where the dominant parking supplier has little incentive to use the system. At overcrowded public transit stations, e-parking could be an effective solution to encourage additional private parking supply by allowing private businesses and organizations to monetize their parking resources when they are not in use by patrons.

Parking information systems allow a driver to receive information on parking availability from the Internet, mobile phone, PDA, or variable message signs on the road. Sensors or gates monitor the parking facility's occupancy, so parking space availability or forecast information can be updated regularly (Bannert 2002; US Dept. of Transportation 2007). Many parking information systems are integrated with reservation and payment systems for parking facilities. Information on parking locations, costs, space reservations, and restrictions helps users improve their travel decision making and promotes more efficient transportation system use (Smith et al. 2007).

Cologne, Germany has one of the world's most advanced parking guidance systems. Stadtinfo monitors 37 parking facilities with a total capacity of about 17,000 spaces. The system gathers data from parking facilities and street meters and disseminates timely parking and other travel information to drivers via variable message signs, videotext, TV, and radio—allowing them to better plan their trips and to make better travel decisions. The system is integrated with a parking reservation system that allows users to book spaces in advance in garages around the city

(Stadtinfo Cologne 2007). Parking information systems are an important component of any smart parking system communicating up-to-date system information to the public.

Parking companies frequently deploy components of advanced parking management systems or comprehensive programs. Until recently, Europe and Japan have led implementation of advanced parking management systems, but adoption of advanced parking management technology and practice is accelerating in the U.S. Companies like mPARK, Verrus Mobile, New Parking, and ParkMagic are spreading their pay-by-mobile technology throughout the U.S. All of these companies use similar technology: the driver calls in, uses a credit card to pay for parking time, and then the information is forwarded to parking enforcement officers via their handheld devices ("West Palm Beach Rings in New Year With 'Pay-by-Cellphone' Success" 2007; Wordsworth 2007; "Pay by Cell" 2008; Podmore 2005).

ParkMagic and Ganis Systems both manage in-vehicle meters. Ganis Systems' users pay with a smart card, and ParkMagic uses the pay-by-mobile method. Neither system requires additional equipment for enforcement officers, and both claim to be low cost for the owner/operator of a parking facility (Pay by Cell 2008; Bergstrom 2005).

Streetline is partnering with the City of San Francisco to use sensor technology to update information on the availability of street parking spaces at a data center (Swedberg 2007). SIPARK is also using a similar technology concept to inform drivers of park facilities with empty parking spaces (Bannert 2002). MobileParking provides drivers both availability information and a parking reservation service (US Dept. of Transportation 2007). Pay-by-phone is the most common medium for transactions for all these services. With cellular phones nearly ubiquitous, drivers can use the same interface to receive parking information and to complete payment. Pay-by-phone systems save parking managers expensive infrastructure investment, allow managers to track individuals' behavior, and make use of a technology that most drivers are already familiar and comfortable.

3.2 Review of park-and-ride pricing programs in the United States

The current extent of priced park-and-ride facilities in the U.S. was determined through existing smart parking literature, websites of public transit agencies and local news organizations, and email and telephone communications with transit agency employees. In the U.S., at least eight metropolitan areas charge for parking at their park-and-ride lots at rail stations. These areas include the San Francisco Bay Area, Sacramento, Denver, Chicago, Pittsburgh, Atlanta, Washington, D.C., and Boston. Daily parking rates range from US$1 to US$12 dollars. Six agencies offer monthly passes for at least one lot in their system, generally priced between US$15 and US$115. Lot operations are sometimes managed by the agency, such as in Sacramento, and other times by private operators, which is the case in Pittsburgh.

An agency's decision to begin pricing park-and-ride facilities may be in response to overcrowded lots, the need to increase revenues, or both. For example, in the mid-1990s, the Puget Sound Ferry Terminal parking in Seattle was oversubscribed (Turnbull et al. 2004). Parking fees were introduced in 1997 to provide users of the facility with a more reliable service. The agency also began operating shuttles to and from other nearby parking lots, so that all previous park-and-ride users would be able to use the ferry service easily. A study on the ridership impacts of these measures found a 37% decrease in use in the short term; however, by 1999, usage returned to 94% despite the parking fees. Table 1, shown at the end of this section, provides a summary of the park-and-ride rates in each city.

3.2.1 Existing Programs

<u>San Francisco Bay Area</u>
The Bay Area Rapid Transit (BART) District charges at 23 of its 32 park-and-ride lots. The monthly reserved parking has been available since 2002, and the daily fee has been charged since 2006 (BART 2005). Customers can pay with cash or with the smart card (Clipper Card) that they use to pay fares. The fee is $1 at 20 lots, $2 at Colma and Daly City, and $5 at West Oakland (BART 2010, 1).

When BART approved parking pricing, they agreed on a pricing formula based on usage levels (BART 2010, 2; Syed 2010). The pricing formulas written into BART policy are as follows:

- The daily fee for parking at every space at each station would be:
  - $1.00 per day should the number of spaces used at the station be less than 50% of the total spaces for three or more weekdays a week for four consecutive weeks;
  - $2.00 per day should the number of spaces used at the station equal or exceed 50% of the total spaces for three or more weekdays a week for four consecutive weeks; and
  - $3.00 per day should the number of spaces used at the station equal or exceed 90% of the total spaces for three or more weekdays a week for four consecutive weeks.
- The monthly fee for every reserved parking space at each station would be:
  - $42.00 per month should the number of monthly permits sold be less than 10% of the station parking spaces;
  - $63.00 per month should the number of monthly permits sold equal or exceed 10% of the station parking spaces;
  - $84.00 per month should the number of monthly permits sold equal or exceed 25% of the station parking spaces; and
  - $105.00 per month should the number of monthly permits sold equal 40% of the station parking spaces.

In a before-and-after study of the parking fees implemented in 2006 by Syed, Golub, and Deakin (2009), it was found that "some stations reached capacity at a later time, but some filled earlier. Therefore, it appears that fill times are less related to parking charges and more related to overall commute behavior, which is shifting to travel earlier in the morning throughout the Bay Area." The same study found that "total BART ridership at the stations with the new fees did not change significantly after the fees were introduced. The declared frequency of use of BART by parkers declined slightly for both stations after parking pricing was introduced and regular users dropped by 6-8%."

BART implemented a 6.1% fare increase in July 2009, but there has not been an analysis as to the ridership effects, particularly since all travel in the region has been lowered due to the recession. Based on reviews of the quarterly ridership reports published on the BART website, there are no sharp declines in ridership in the quarter that the price increase was introduced (BART 2010, 3).

Sacramento

Sacramento began implementing park-and-ride fees on January 1, 2010 (Sacramento Regional Transit, 2010). Their program was implemented to shift demand from overcapacity lots to underused ones. Revenue from the program will also help to offset the fiscal deficit the agency is facing. So far, the program has proven successful. Approximately 150 cars shifted downstream to free park-and-ride lots. However, the number of monthly passes being used at the stations has not dropped significantly. The agency is still performing analysis as to whether people are carpooling or finding alternative modes.

Denver

Denver also began pricing at 34 out of 73 of its park-and-ride facilities, having phased in their program from February to May 2009 (The Denver Channel 2009). Like Sacramento, their primary goal was to shift demand from overcapacity lots to underused ones; a fee was implemented in lots that had 80% capacity or higher. Because the Denver transit system does not have a Smart Card, customers must pay in cash at the parking facilities. A unique feature of the Denver program is the difference in price for in-district residents compared to out-of-district ones, where in-district residents are those whose license plate is registered to an address that is "in" of the Regional Transit District service boundary (Regional Transportation District 2010). Additionally, only in-district residents are offered monthly passes. The agency found that the pricing implementation has not had a large effect on lot usage (Rynerson 2010). Overall travel in the region is down due to the recession, but many of the priced lots are still filling to capacity. Shortly before the parking fees were implemented, the public transit fare was increased, so the potential to study the impacts of parking fees on ridership is limited (Regional Transportation District 2008).

Chicago

Chicago charges for parking at its 17 park-and-ride facilities (Chicago Transit Authority 2008, 1). The fee is generally US$4 for 12 hours, but some stations have a more complex fee structure ranging from US$4 to US$12 at different time intervals. Monthly parking passes are available at two lots for US$80. Four lots provide reserved monthly parking for US$40, which allows permit holders to park in reserved spots until 10 A.M. daily, after which the spots become open to the general public. Customers with these permits are required to pay a daily fee each time they park in a reserved spot, which is in addition to the US$40 monthly permit fee. Reserved monthly parking requires a US$4.95 one-time registration fee and a US$3.00 monthly administration fee. The daily and monthly park-and-ride rates were increased on January 1, 2009; however, public transit fares were increased simultaneously, making it difficult to study the ridership impact of the increased parking fees (Chicago Transit Authority 2008, 2).

Pittsburgh

Pittsburg has implemented park-and-ride fees at only one of their facilities (Cleaver 2010). The lot was constructed a few years ago and has had the same parking fee since the facility opened. Any other parking lots that charge a fee are run by private agencies, and the public transit agency does not collect information on their usage.

Atlanta

Metropolitan Atlanta Rapid Transit Authority (MARTA) provides parking at 28 of its 38 rail stations (Kelly 2010). Of the 28, nine provide long-term parking options. MARTA began charging a daily rate of US$0.60 in 1985. Monthly rates were added 1987, and by 1995, it cost US$15 for a monthly permit and US$1 for daily use of their park-and-ride lots. In 2001, MARTA adopted a new strategy and decided to abolish daily and monthly parking fees and instead only charge long-term parkers, who had not had special rates in the past, a daily fee.

Long-term parking is considered “occupying a space for 24 hours or more.” The fee for parking long-term has risen two times since implementation, most recently in October 2009. At that time, the parking fee rose from US$3 to US$6 depending on the station, and public transit fare also rose from US$1.75 to US$2. Customers can pay via credit card or cash. While it is difficult to distinguish the fare hike from the parking fee change, there seems to have been an impact since park-and-ride usage rates dropped from 65% in September 2009 to 55% in November 2009, after which it remained fairly steady through the latest measurements in March 2010. Another factor affecting park-and-ride use is the current economic crisis; MARTA found that park-and-ride usage and employment rates are, to some degree, inversely correlated.

In early 2009, MARTA conducted in-person stated preference surveys with 1,921 park-and-ride users to determine willingness to pay a daily rate (Metropolitan Atlanta Rapid Transit Authority 2009). The survey asked whether the rider “would ride MARTA less or not at all,” if the daily

parking charge was US$1, US$3 or US$5, and if the payment system was honor boxes, an alternative pricing system, or the system smart card (called the Breeze card). Approximately one-third (36%) of respondents said they would ride MARTA less or not at all, if a US$1 fee was implemented; the number was 81% for a US$3 fee and US91% for a $5 fee. When asked about payment methods, preference was given to the Breeze card over using an alternative pricing system or honor box. Based on the park-and-ride usage rate trends discussed above, it appears that riders were less likely to stop using MARTA because of parking fee increases than the results of the stated preference study suggest; a parking fee increase from US$3 to US$6 only decreased usage by approximately 15%.

Washington, D.C.

The Washington Metropolitan Area Transit Authority (WMATA) provides parking facilities at 42 Metrorail stations, all of which charge an hourly or daily parking fee during weekdays (WMATA 2010, 1). The hourly parking rate is US$1 per hour in all lots, and the daily rates range from US$3.25 to US$4.75. Three stations provide multi-day parking, which can be used for up to ten days, at the same cost per day as the regular parking spots. Finally, 34 of the 42 stations provide reserved parking for permit holders until 10 A.M; permit holders are required to pay a US$65 monthly fee for a parking permit good at one station, as well as the daily parking fee each time they park. WMATA requires payment via the SmarTrip Smart Card for daily parking at many stations; however, seven stations began accepting credit cards for daily parking fees as part of a pilot program. Cash is only accepted at metered parking spaces.

On August 1, 2010, WMATA implemented several fare changes, including a US$10 increase for the monthly reserved parking permit from US$55 to US$65 (WMATA 2010, 2). Based on the agency's performance reports, ridership decreased 4.42% in August; however, due to the simultaneous increase in fares and parking fees, it is difficult to attribute this decrease solely to the parking changes (WMATA 2010, 3).

Boston

The Massachusetts Bay Transportation Authority (MBTA) has implemented fees at 99 out of 150 of its park-and-ride facilities. Since November 2008, daily parking fees are US$7 at subway parking garages, US$5 to US$6 at subway surface lots and US$4 at commuter rail surface lots (MBTA 2010). One lot offers monthly parking for US$50. Payment options include cash, Smart Card or ParkMobile, which allow travelers to pay via mobile phone or online.

No study has been conducted regarding the ridership impacts of parking fees (Roderick 2010). Many of the station lots are operated by a private agency, so MBTA does not have access to usage information. In a 2005-2006 inventory that inventoried 141 MBTA private and town-owned parking lots, the Boston Region Metropolitan Planning Organization (BRMPO) found fewer park-and-ride lots filled during the morning peak period, and the percentage of parking

usage had also decreased (Boston Region Metropolitan Planning Organization 2010). In the 2005-2006 inventory, 63 commuter rail stations were full, while in the 2000 and 2002 inventories, 72 were full. The parking use percentages at eight of the 11 commuter rail lines have decreased since the inventories in 2000 and 2002. Results were similar for park-and-ride lots at rapid transit stations. The lots at 16 stations were full before the last peak-period train in the 2005-2006 inventory, as compared to 22 stations in the 2000 and 2002 inventories. All four rapid transit lines also saw decreases in parking use. These decreases were attributed to the expanded parking facilities at several stations, increased parking fees and increased public transit fares in 2004 and 2007. Despite the decrease in parking usage and number of park-and-ride lots that fill to capacity, some stations experienced higher demand for parking; similarly, a few commuter rail stations filled to capacity in 2005 to 2006 but did not in previous inventories.

3.2.2 Summary of U.S. park-and-ride pricing programs

Table 1 shows an overview of the information found for U.S. cities regarding park-and-ride pricing programs, including daily, monthly, and long-term parking fees.

Table 1: Park-and-Ride Pricing in United States Cities

City	Agency	How much?
Sacramento	Sacramento Rapid Transit (RT)	Daily: US$1 Monthly: US$15
San Francisco	Bay Area Rapid Transit (BART)	Daily: US$5(1 lot)/ US$3(1)/ $2(1)/ US$1(20) Monthly: US$115.50 (high)/US$30 (low)
Denver	Regional Transportation District (RTD)	Daily: In-District Cars - free first 24hrs; US$0/$1/$2 additional 24 hours Out-of-District - US$0/$2/$4 Monthly: In-District Reserved Space for US$37.50
Chicago	Chicago Transit Authority (CTA)	Daily: Generally US$4 for 12 hours, some stations have more complex fare structure ranging from US$4 to US$12 at different time intervals Monthly: Available at one lot for US$80, reserved spots available for US$40 plus daily fee
Pittsburgh	Port Authority of Allegheny County	Daily: Either US$2 or US$6 Monthly: Available at two lots, one is US$22 and one is US$90
Washington, D.C.	Washington Metropolitan Area Transit Authority (WMATA)	Hourly: US$1/hour, Daily: US$3.25 to US$4.75 Monthly: Reserved Space for US$65 plus daily fee
Atlanta	Metropolitan Atlanta Rapid Transit Authority (MARTA)	Daily & Monthly: Free Long term parking available at some lots, cost US$5 or US$8.

Boston	Metropolitan Boston Transit Authority (MBTA)	Daily: US$7 at subway parking garages, US$5 to US$6 at subway surface lots, US$4 at commuter rail surface lots Monthly: US$50 at one lot

3.3 Review of existing research on user behavior

Budget constraints have continuously been a challenge for urban public transit providers throughout the country. When budgets are cut, transit agencies have the difficult task of adjusting their operations to remain within the newly lowered budget. Agencies have various responses to achieve this goal, including raising public transit fares or reducing service levels. If an agency owns parking facilities along its routes, additional options include introducing parking pricing, raising existing parking charges, or providing incentives to park-and-ride users. This section provides an overview of the existing literature on these various agency strategies and their effects on ridership and revenue.

3.3.1 Raising public transit fares

The overall impact of raising transit fares for an agency depends on whether the loss in ridership from a fare increase outweighs the increased revenue per rider. The loss in ridership depends on the fare elasticity, which is estimated to range from -0.09 for the New York MTA (Hickey 2005) to -0.60 for transport in the United Kingdom (Wardman and Shires 2003).

According to the Transport Research Laboratory, fare elasticity is dependent on the size of the city, magnitude of the fare change, and the level of the original fare (2004). The study provided fare elasticity estimates for a group of international locations, including -0.41 for all public transport and -0.50 for suburban rail. For the United Kingdom specifically, a study by Wardman and Shires estimated a -0.60 fare elasticity for suburban rail (2003).

New York City has monitored the impacts of public transit fare increases since 1972; Table 2 shows the historical fare changes, as well as the estimated ridership changes and elasticities of each fare increase. The data show that elasticities have ranged from -0.29 to 0.12 for the subway and -0.42 to -0.26 for buses, with average elasticities of -0.09 and -0.37, respectively. In 2003, New York City implemented the first fare increase in eight years, shown in Table 3 (Hickey 2005). This fare increase differed from those previously due to the new presence of a smart card payment system. In the late 1990s, New York City Transit (NYCT) introduced a MetroCard for use on all public transit systems. Various incentives were offered that provided a varied fare structure compared to earlier forms of fare payment. For example, a 10% bonus was added for MetroCard purchases of US$15 or more. According to Hickey, the transit agency had no previous experience with either the direct ridership effects of unlimited-ride pass price changes

or the shift of customers when prices of different fare media increase at different rates and customers can shift from one fare medium to another. Before implementation, the agency expected a 20% increase in revenue based on model estimates. After implementation, the agency found that ridership losses were less than expected, but revenue only increased 14 to 18%. This lower revenue figure was caused by a greater shift of customers between fare instruments after the fare increase, with a larger percentage ridership increase to a fare instrument that had a smaller fare increase.

Table 2: NYCT Fare Increases: Average Weekday Ridership Change and Point Elasticities

		Subway		Bus	
Date of Fare Change	Change in Fare	Ridership Change	Point Elasticity	Ridership Change	Point Elasticity
1/5/72	17%	–4%	–0.24	–6%	–0.38
9/1/75	43%	–5%	–0.12	–17%	–0.40
6/28/80	20%	–3%	–0.13	–5%	–0.26
7/3/81	25%	–3%	–0.11	–11%	–0.42
1/2/84	20%	–1%	–0.07	–7%	–0.35
1/1/86	11%	1%	0.12	–3%	–0.30
1/1/90	15%	–4%	–0.29	–6%	–0.37
1/1/92	9%	0%	–0.04	–4%	–0.41
11/12/95	20%	1%	0.04	–8%	–0.41
Average	20%	–2%	–0.09	–7%	–0.37

Source: (Hickey 2005)

Table 3: Fare Structure Approved May 4, 2003

			MetroCard Bonus						Express Bus		
	Cash/SRT/ Token[a]	Regular MetroCard	Percent	Threshold	Effective Fare	7-Day Pass	30-Day Pass	1-Day Pass	Base Fare	30-Day Pass[b]	7-Day Pass[b]
Old fare	$1.50	$1.50	10	$15	$1.36	$17	$63	$4	$3	$120	NA
New fare	$2.00	$2.00	20	$10	$1.67	$21	$70	$7	$4	NA	$33
% change	33%	33%	—	—	22%	24%	11%	75%	33%	NA	NA

SRT = single-ride ticket.
[a]Token was eliminated under new fare structure.
[b]Also valid on subway and local bus.

Source: (Hickey 2005)

Beyond point elasticities, researchers are beginning to distinguish between short-run and long-run fare elasticities (Fearnley and Bekken 2005). In the short-term, riders may have fewer options in responding to a change in fare than in the long term. By relying on short-term elasticities, planners and managers may be underestimating the impacts of fare increases or service withdrawals. The study found that the average rider's elasticity is approximately twice as large in the long term as in the short term.

3.3.2 Reducing service levels

An agency's decision to reduce service levels can either take the form of reducing service coverage or reliability. These two aspects of service are known qualitatively to have an impact on ridership, but a quantitative relationship is more elusive.

Despite the fact that service reliability is often found to be of great importance to public transit users, there are relatively few studies on the matter (TRL 2004). Studies have shown that people value their time waiting for service 1.8 to 3.0 times as much as in-vehicle time.

Studies on the impact of reduced service coverage are also limited; however, Holmgren found that, when using transit vehicle-kilometers as a measure of service coverage, ridership elasticity is approximately 1.05 in the short term and 1.38 in the long term (Holmgren, 2007).

3.3.3 Increasing parking pricing

Travelers are generally resistant to price increases at park-and-ride facilities in the short term, which leads to demand for parking at the facilities to decrease. However, long-term results show that people may adjust to the change and demand may rise again, as was the case in Seattle in the late-1990s. Overall, people cite that pricing is less important than maintenance of service, security, and convenience. While many studies investigate commuters' perception and response to parking fees, there is no literature that addresses the revenue changes resulting from the charges.

In the San Francisco Bay Area, the BART District evaluated the user response to increased parking fees (Syed et al. 2009). Although some "choice" users may have used BART less as a result of the fees, others may have used BART more due to better parking availability options. Riders indicated that they were more than willing to pay for new fees if the transit service, security, and convenience are maintained. Also, parking pricing has been shown to effectively manage and spread out parking demand over time.

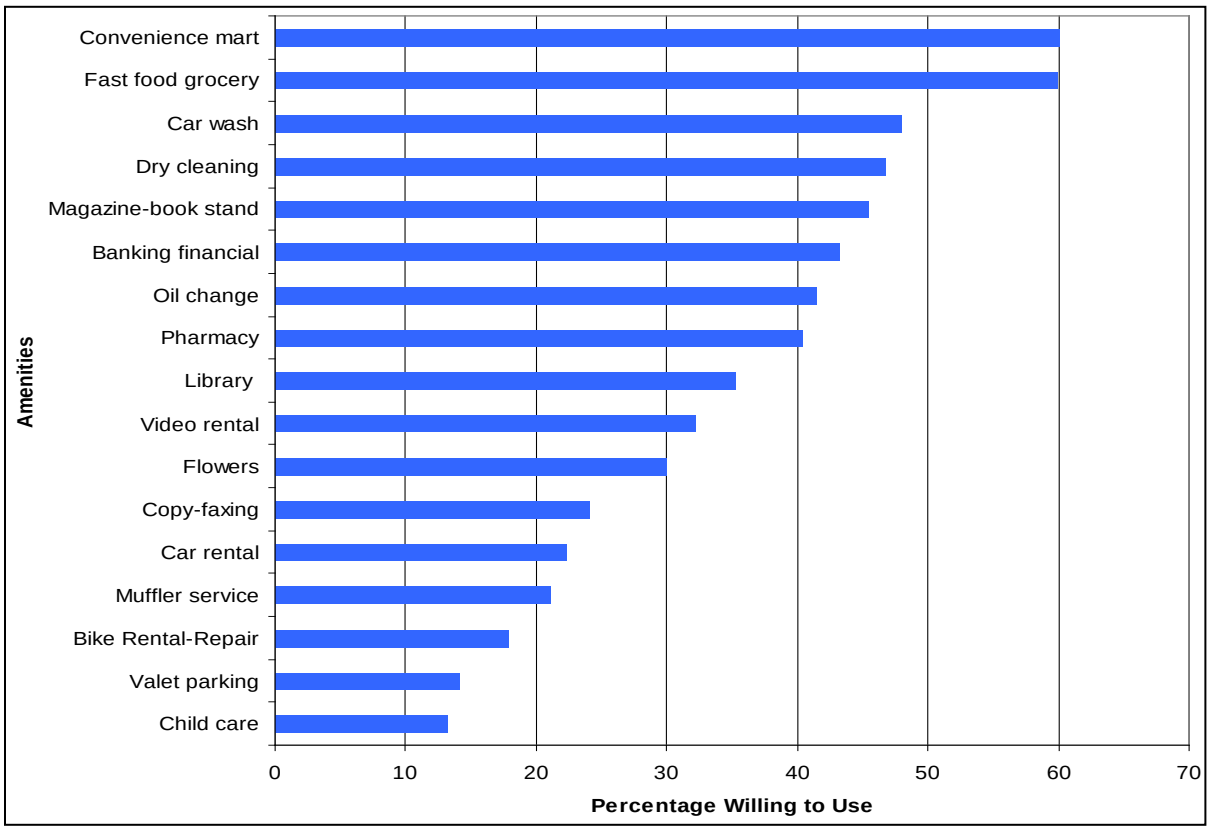
In Tel Aviv, Israel, a study of a park-n-ride facility found commuters were more sensitive to parking cost increases than public transit fare increases (Polydorpoulou and Ben-Akiva 2001). The analysis shows that increasing parking costs by US$1 has an effect equivalent to raising the transit fare by US$2.06. Additionally, commuters were more concerned with parking prices at public transit stations than at their final destinations. One must note that the Tel Aviv survey sample showed participants overwhelmingly accessed public transit by alternate modes and that the sample included many more transit users than would be typical of most U.S. commuters.

3.3.4 Incentives for park-and-ride users

Transit agencies often provide incentives for park-and-ride users, such as improved lot conditions or new lot services, to increase demand for the park-and-ride facility.

The Chicago Transit Authority (CTA) implemented a survey of park-and-ride users in 1998 to gain a better understanding of the park-and-ride market (Foote 2000). The agency found that survey respondents responded to shopping-related amenities at the park-and-ride facilities that would allow them to consolidate their trips. Figure 2 below displays the survey results regarding which specific amenities park-and-ride users would be interested in using.

Figure 2: Percentage of Survey Respondents Willing to Use Potential Amenities



Source: (Foote 2000)

In Florida, a study was conducted to determine the economic benefits of shared use park-and-ride facilities (Wambalaba and Goodwill 2004). Shared use park-and-ride is defined as parking spaces that can be used to serve two or more individual land uses without conflict; in this study, retail centers allow commuters to park personal vehicles at their parking lots to access public transit or carpool/vanpool services with the expectation that doing so will increase customer sales and customer base. The study found that frequent commuters using the shared facility shop approximately once a week, spending US$37.79 per shopper per week. Forty-three percent of the

shoppers stated that they would have shopped elsewhere or not at all, suggesting that the shared park-and-ride facility did increase the retail center's customer base.

4. Review of COASTER System

The COASTER operates within North County and the City of San Diego. It services eight stations along a coastal rail with Oceanside at the northern terminus and downtown San Diego at the Southern terminus. The system began operations in 1995 carrying 700,000 passenger trips. In 2010, total boards were close to 1.3 million. The COASTER line is a diesel-powered regional rail system with eight stations. Seven of these stations have dedicated parking lots, while one, in downtown San Diego does not. At the northern terminus of the line is the Oceanside station, which is a broader terminal for Amtrak, the SPRINTER light rail, and Metrolink providing rail service north to Los Angeles. All COASTER stations are served by the BREEZE bus system operated by NCTD. At the southern terminus is the Santa Fe Depot station in downtown San Diego. This station also serves Amtrak. In between these two termini are six stations that are on or near the coastline. Figure 3 shows a map of the COASTER line (light blue or teal) along with other NCTD public transit infrastructure.

Figure 3 NCTD Map of the COASTER Line

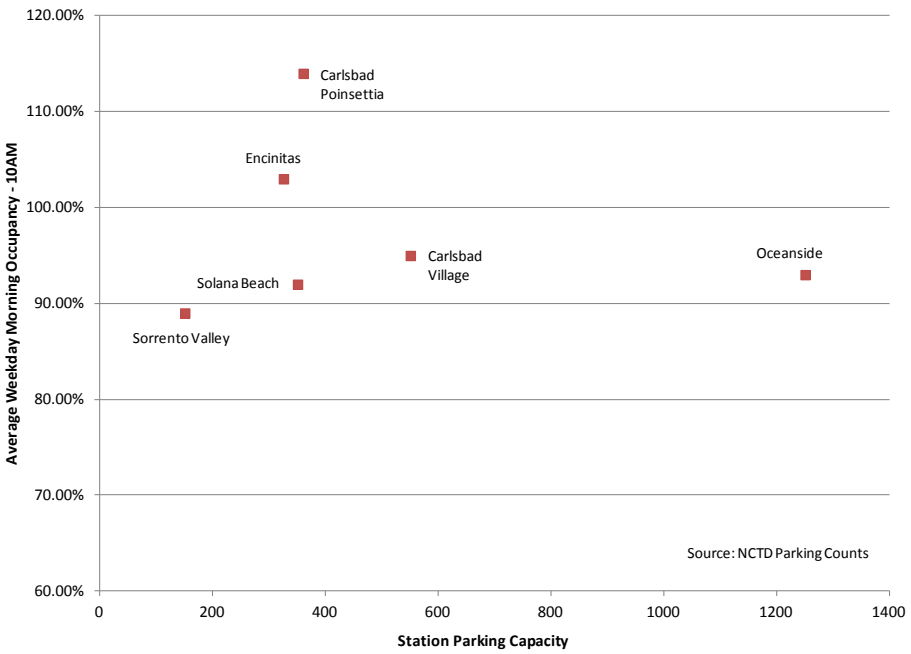
4.1. Conditions at COASTER Stations in 2002 and 2009

4.1.1. 2002 San Diego Association of Governments Survey

At the time of the 2002 survey conducted by SANDAG, COASTER parking facilities did not have a comprehensive parking management strategy, but had excess parking demand. Then, as is the case today, all COASTER parking was free and unmanaged with minimal signage. Observational analysis showed that long-term and non-public transit users occupied from 5 to 60% of parking during commute hours. Available parking is a major factor in COASTER ridership. Most riders prefer to drive alone to the station. According to SANDAG's 2002 COASTER parking and access survey, 68% of North County COASTER riders typically drove alone to the station.

After the morning commute, occupancy was on average 96% for the six North County stations. In the most crowded lots, users parked in undesignated spaces, often illegally, to take advantage of any extra space in the lots. According to the observational analysis by survey staff, the lots at Carlsbad Poinsettia and Encinitas typically filled well before the last morning commute train leaves. Back then, NCTD's parking count data suggested that Carlsbad Village and Solana Beach would begin filling regularly within the next year, and Oceanside would fill regularly within two years. Parking occupancy data for the COASTER system collected in 2002 is presented in Figure 4.

Figure 4: COASTER Station Parking Occupancy in 2002



4.1.2. 2009 San Diego Association of Governments Survey

SANDAG later published the results of a 2009 survey regarding COASTER ridership and rider travel behavior. With respect to total ridership, the survey suggested that the trend toward increased ridership had continued since the previous survey, with a 4% increase in boardings from 2001 to 2009. Of these trips, those from home to work decreased from 81 to 68%, while the trips for recreational uses increased from 7 to 11% since 2002. Nearly 70% of riders used public transit four or more days a week, and 65% of riders used a monthly pass.

In terms of mode options, 46% of riders walked to the first or last stop of their one-way linked trip, while 33% used an automobile and 19% used a bike. Additionally, 78% of riders identified themselves as "choice riders," meaning that they could have driven to their destination but chose to use public transit instead; this percentage has decreased since 2002, with choice riders consisting of 83% of respondents (SANDAG, 2010).

5. 2011 Value Pricing Pilot Program Stated Preference Survey

This section presents the methodological design and results from the research conducted as part of this study. The primary research instrument was a clipboard survey conducted on the population of COASTER riders and people who drove and parked at COASTER lots. The following sections provide a methodological overview as well as a discussion of the data and resulting analysis.

5.1. Design

In 2011, as part of this VPPP study, TSRC, UC Berkeley researchers—with input from the project partners and assistance from Ewald & Wasserman (a marketing firm based in San Francisco, California)—designed a stated preference survey to evaluate the effect of parking and fare pricing actions on the travel behavior of those who rode or parked at COASTER parking lots. Two stated preference surveys were designed and deployed within the COASTER system. One of the surveys was designed specifically for people who drove to a COASTER station and parked in the lot. This sample frame (called "Drivers") was directed at anyone using the COASTER parking lot, including those who parked at the station but did not go to COASTER. The frame was motivated by the study's focus on parking costs, and the need to develop an understanding of those most impacted by potential parking cost changes. The other sample frame consisted of people who used COASTER and accessed the station without using a private vehicle (called "NonDrivers"). This frame was motivated by the need to evaluate the impact and response of other riders to changes in COASTER pricing. The dichotomous design sought a balanced look at the opinions and response of those accessing COASTER without an automobile. The authors analyze these two surveys side-by-side in the results discussion below.

Researchers administered the surveys by clipboard on the train and train platforms, as well as in parking lots (for Drivers only). On-site interviewers asked respondents on the train, if they drove an automobile to access COASTER. Their response determined which survey they were given (see Appendix A for both surveys). Both surveys fit on a single page front and back and contained very similar questions. The Driver frame contained some specific questions for those that drove, while NonDrivers contained specific questions probing why they did not drive to COASTER. Both surveys contained the questions necessary to generate a profile of the respondent's travel for the intercepted trip. This included questions about the respondent's trip purpose, departure time, access and egress mode, trip purpose, origin, destination, as well as the COASTER stations used. To evaluate origin and destination, the survey requested two intersecting streets and a city near their origin and final destination. This question format allowed respondents to preserve privacy, while still providing a good approximation of the key terminal points of the trip. These data are used to evaluate the spatial distribution of ridership, which can be correlated to pricing response.

The survey also queried respondents on household vehicle ownership, including the number of household members that can drive, the number of cars or motorcycles the household leased or owned, and whether respondents had access to one of these vehicles. The respondents were asked to estimate the fuel economy (miles per gallon) of the vehicle that they use most frequently.

The two surveys were designed to also obtain information about how the COASTER users would most likely make their trip, if the COASTER service stopped operating and was not available. This question was inserted to evaluate what impact would occur, if a person were priced out of using COASTER; in aggregate the question serves to assess the existing impact that the COASTER has with respect to reducing automotive travel. In addition to asking about travel change, the survey asked if the purchase of another car would be necessary in their household, if the COASTER service was not operating. This question was designed to evaluate how COASTER impacts automobile ownership. Both surveys ask whether respondents would walk, drive alone, carpool/vanpool, bicycle, motorcycle/moped, taxi, take another form of transit to their destination, or if they would not make the trip at all. These questions are informative for connecting the impacts of riders deciding not to use COASTER, if they are priced out.

A core objective of the survey was to understand how the participants would respond to different pricing scenarios. Both surveys asked respondents, if paying to park at a COASTER parking lot would impact how respondents use or travel to COASTER. If respondents believed that a daily parking price could have an impact on how they use COASTER, the respondents were asked to assess probabilistically how they would change their behavior over a range of prices. For example, for changes in parking price, respondents were asked if they would probably still park,

maybe still park, or probably stop parking a car at the COASTER lot. The survey design continues by inquiring how participants would most likely change their travel behavior, if parking costs became too expensive or whether this would cause them to stop using COASTER at all. A similar structure was applied to a question on changing fares. The surveys finish by asking whether the respondent would prefer raising parking costs or fare by US$1 a day and then querying basic demographics.

5.2. Survey Implementation

Ewald & Wasserman implemented the two stated preference surveys at all eight COASTER stations in July 2011, with the intent of capturing the population of those that parked and rode the train, those that parked and did not ride the train, as well as those that rode the train but did not access the station by automobile. Survey respondents 18 years and older were intercepted in three locations: on the platform of the stations, the parking area of the stations (for seven of the eight stations with parking lots), and aboard the trains. Based on the respondents' preference, the surveys were either administered verbally by the field interviewer or self administered on a clip board with the field interviewer attending near-by for any questions or requested clarifications.

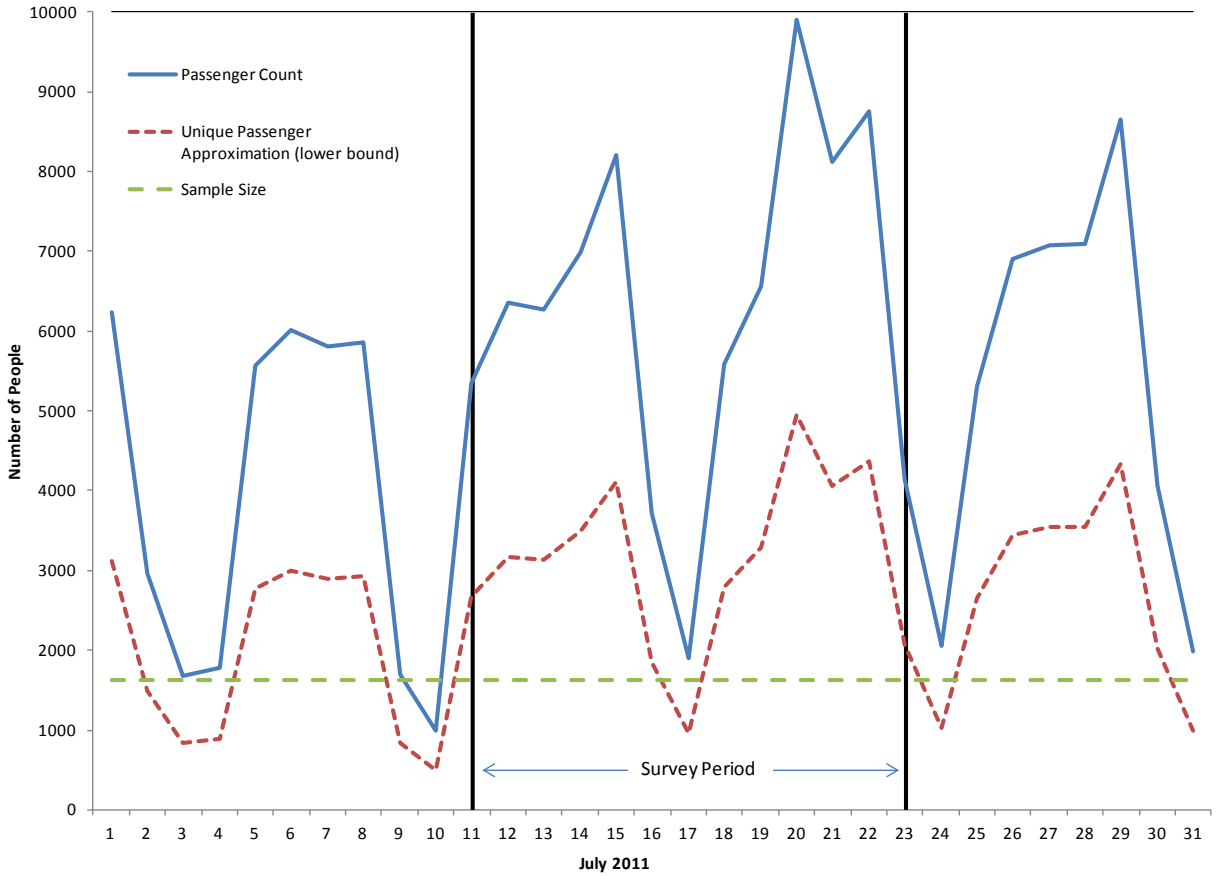
Data collection was conducted on weekdays from Monday, July 11, 2011 through Friday, July 22, 2011. Along with the intercept surveys, interviewers recorded the number of vehicles parked in each COASTER parking lot. Counts were made of patrons parking in the COASTER lots and using the train system as well as those that were parking but not using the train system. This provided an accurate representation of typical weekday parking usage at the seven COASTER stations with parking lots.

The survey contained both revealed preference and stated preference elements. The revealed preference elements constitute questions that ask information about actual events, such as the details of the respondent's current trip. Responses to these questions have a high degree of accuracy because they are querying events that are actually happening. The stated preference elements comprise questions that ask information about hypothetical actions that respondents would take given a hypothetical situation, such as the unavailability of COASTER or a change in fare price. Responses to these questions explore what respondents think that they would do, and they are naturally subject to greater uncertainty. This uncertainty means that responses to stated preference questions related to price and alternative mode choice may be different in reality if the hypothetical scenario was ever manifested. These responses still comprise the best guess of actions that would be taken under the stated scenarios, but it should be understood that they are inevitably accompanied with a degree of uncertainty.

6. Results and Analysis

Survey researchers collected a total of 1,632 questionnaires, evenly split with 816 surveys collected among people who drive to and park at a COASTER station, and 816 from people who ride COASTER but do not drive to a station. The response rate was exceptionally high: 75.5%. In total, 1,555 of the respondents were riders of the COASTER, while the remaining 77 respondents parked at a COASTER lot and went to a local destination. As a share of the riding population on COASTER, the survey coverage was rather high for a public transit survey sample. Weekday ridership data from NCTD during the month of July 2011 showed that total daily passengers ranged between 5,304 to 9,902. The lowest ridership occurred on Monday, July 25th and the highest ridership occurred on Wednesday July 20th. It is not certain what caused the highest ridership number, but one possibility is ComicCon, which is an annual event held in San Diego that began on that day. These ridership numbers reflect passenger trips during a single day. An approximation of unique passengers taking COASTER on any given day is obtained by dividing the passenger counts by two. This approximation is a lower bound, because two one-way passengers are converted into one due to this approximation. To illustrate ridership trends during the month of the survey, Figure 5 shows the passenger ridership, unique passenger approximation and sample size for the month of July 2011.

Figure 5: Ridership of COASTER during July 2011

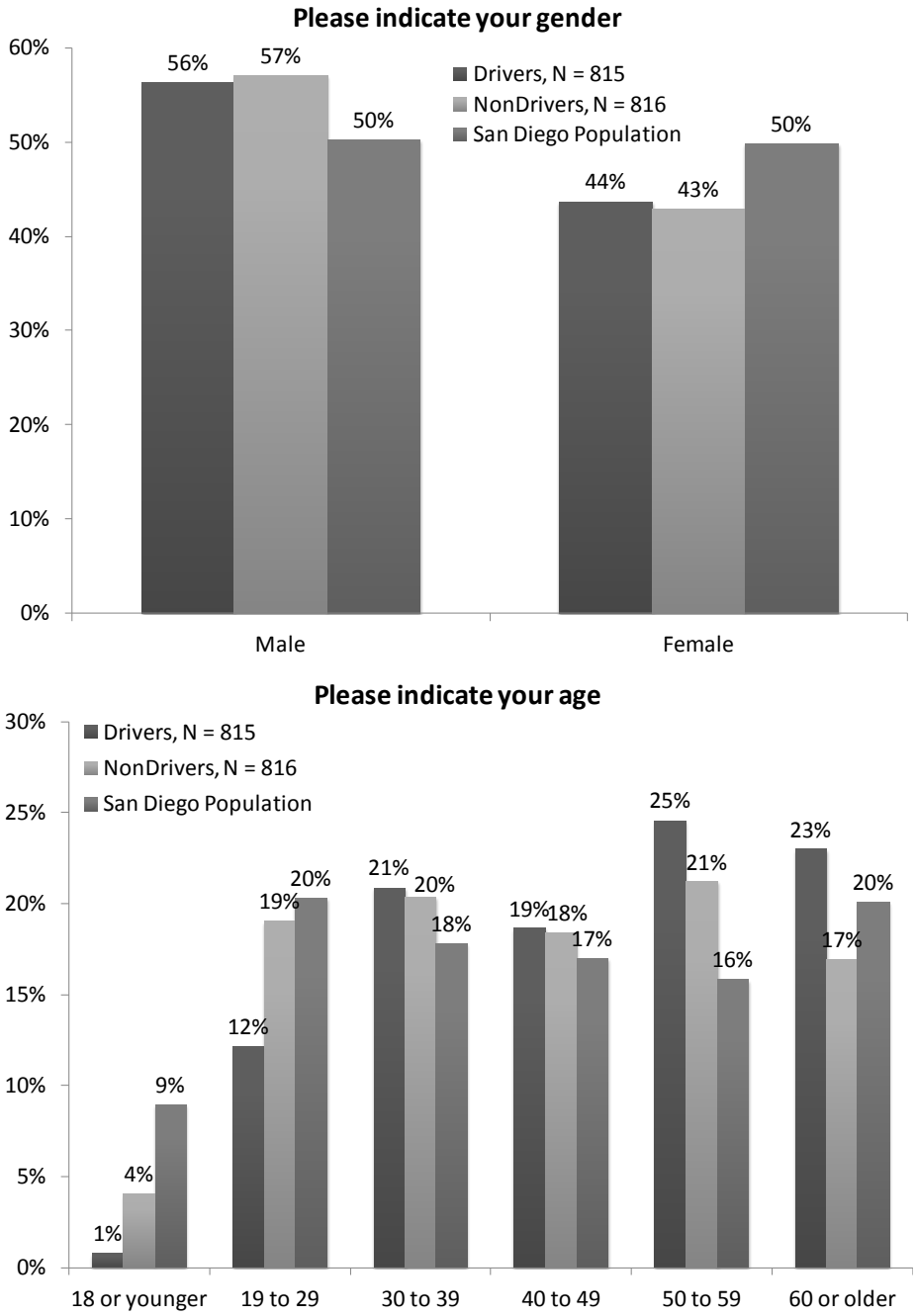


The peaks are naturally driven by weekday activity and supported by a daily cohort of regular riders. The survey period delineated on the graph shows that data collection occurred during the height of July ridership. While the exact proportion of sample size-to-population is not precisely known due to the fluctuations in ridership over the month, it constitutes 31% of the peak-level of approximated unique passengers that were observed on July 20, 2011.

6.1 Respondent Demographics

The respondent demographics reflect characteristics of COASTER ridership found in previous studies (SANDAG, 2010). The COASTER ridership is slightly tilted towards men, with little difference between the Driver and NonDriver sampling frames. Respondent age is evenly distributed across the working age population, which is the largest decadal cohort consisting of those between 50 to 60 years old. Figure 6 shows the gender balance and the age distribution of the two sample frames, as well as the San Diego Population as derived from the 2010 American Community Survey San Diego-Carlsbad-San Marcos MSA.

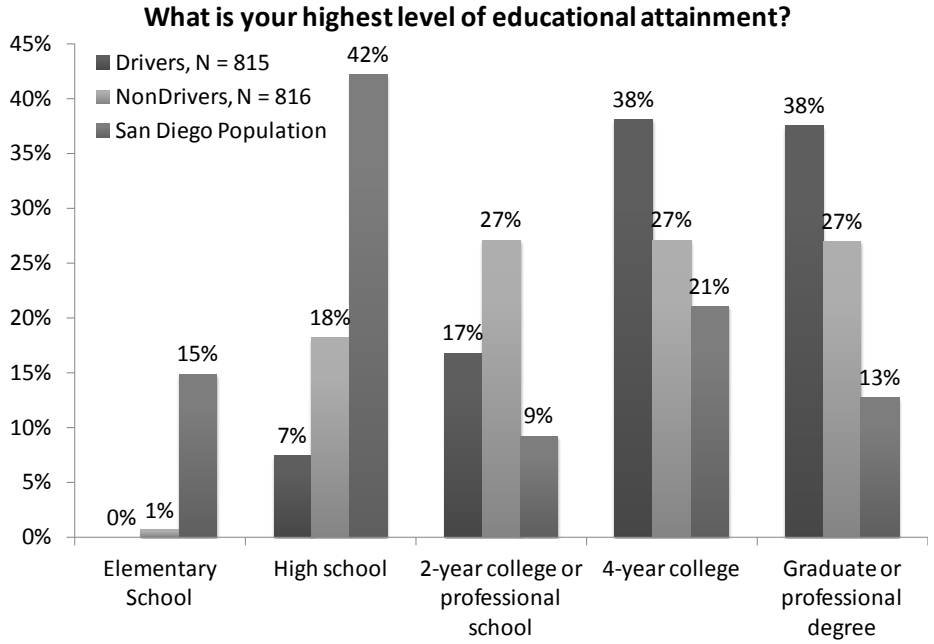
Figure 6: Gender Balance and Age Distribution of the Sample

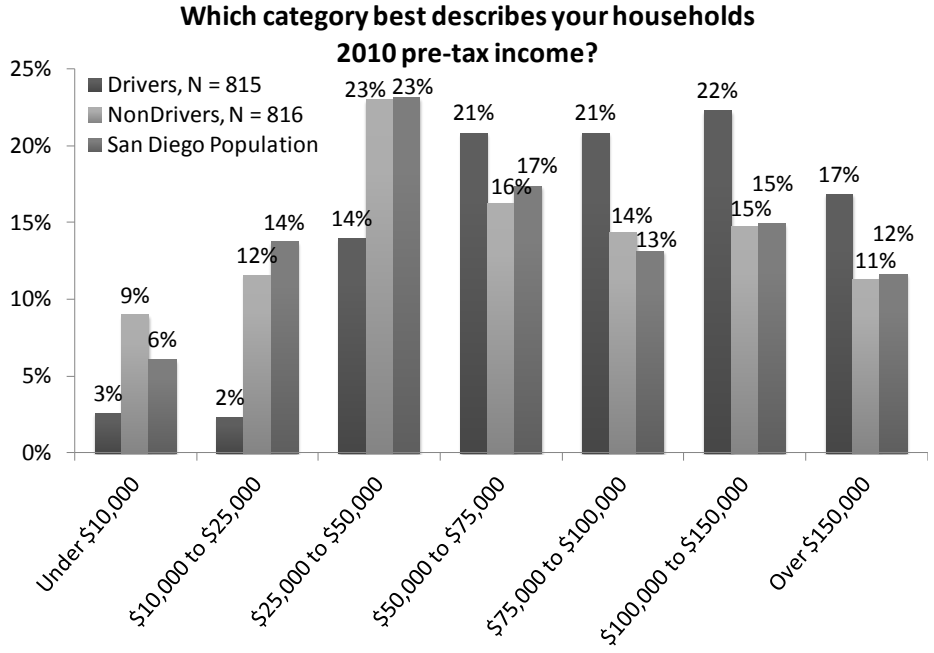


In comparison to the San Diego population, COASTER riders are generally older. Drivers are on average older than NonDrivers. A similar comparison is presented for education and income. The education level of the respondents was found to be high, but consistent with the COASTER's educated rider based. There was a notable difference between the education distribution of Drivers and NonDrivers, with Drivers holding education levels skewed somewhat higher. Both samples exhibited a higher education than the metropolitan population. With respect

to income, a similar difference was found. The income of Drivers was higher than the population, while the distribution of NonDrivers was generally in line with the San Diego population. Figure 7 shows both distributions.

Figure 7: Distribution of Sample Age and Income

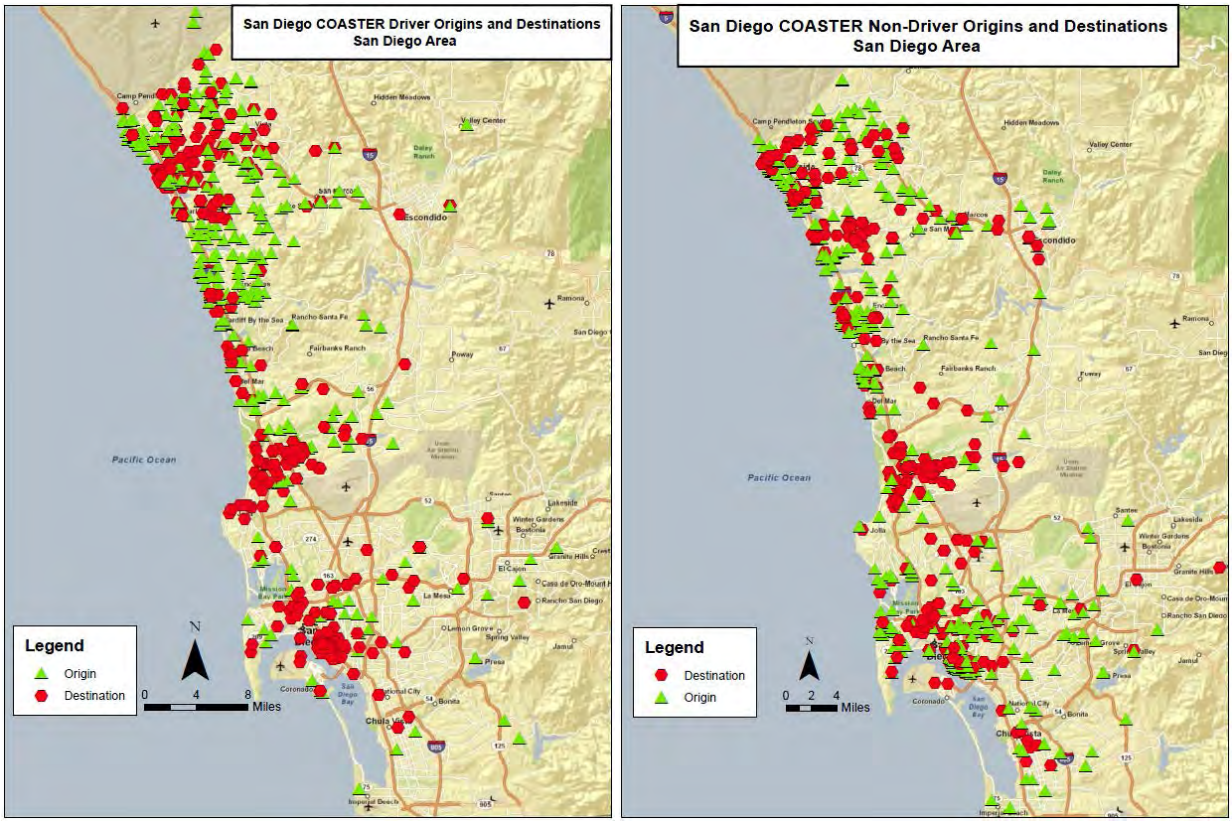




6.2 Travel Distribution and Trip Characteristics

Researchers queried respondents on a number of basic trip parameters such as trip purpose, travel frequency, access and egress mode, parking location, and ticket type. In addition, the survey asked respondents to provide an approximation to the location of their origin and the location of their final destination. Respondents were asked to provide two streets that intersect near their origin and destination, as well as the city. This form of location solicitation offered a better approximation than a zip code, but it preserved respondent privacy by not revealing the precise address of either end of the trip. These data were then geocoded for mapping. Figure 8 shows a map of the complete origins and destinations for both Drivers and NonDrivers. Appendix B contains maps of survey respondents, broken down by each station of origin.

Figure 8: Map of Origins and Destinations from the Driver and NonDriver Survey



The side-by-side maps show that the COASTER is a relatively well-balanced train line. The peak direction of COASTER is from north (Oceanside) to south (San Diego). But as the maps show, there are a considerable number of respondents both cohorts traveling with destinations at both ends of the line. Note that a large number of NonDriver respondents originate in the City of San Diego and take the COASTER north.

As expected, the most common trip purpose of among Drivers and NonDrivers was commuting

to work, and the most common point of trip origination was home. More than half of those driving to COASTER stations were going to work, while about 42% of NonDrivers were also commuting to work. Very few respondents engaged in travel that did not have home or work as one of the end-points, but traveling to destinations other than work was more common among NonDrivers.

Table 4 shows a cross-tabulation of the origin type and trip purpose. The Driver sampling frame is given at the top, in which the sample total is 728 due to a few missed responses, and the exclusion of those that parked at COASTER but did not take it (discussed below). The NonDriver sampling frame is below the Driver sample frame as the question was slightly different. The 811 total is due to a few missing responses. Missing responses will cause most of the analyses to not add up to the total of 816 in either sample frame.

Table 4: Cross-Tabulation of Origin Type and Trip Purpose

Question	Response	Where will you go after you get off the Coaster?									
		Home	Business meeting	Shopping	Recreation/ visit friends	Work	School	Sports event	Medical Services	Other	Total
Where did you come from before you parked your car? [Drivers]	Home	46	12	8	67	477	11	22	1	36	680
	Business meeting	0	0	0	0	0	0	0	0	0	0
	Shopping	1	0	0	0	0	0	0	0	0	1
	Recreation/visit friends	0	0	0	11	1	0	0	0	0	12
	Work	16	1	0	2	2	0	1	0	0	22
	School	0	0	0	0	0	0	0	0	0	0
	Sports event	0	0	0	0	0	0	0	0	0	0
	Medical Services	0	0	0	0	0	0	0	0	0	0
	Other	1	0	2	6	1	0	0	0	3	13
	Total	64	13	10	86	481	11	23	1	39	728
Where did you come from to get on the COASTER? [NonDrivers]	Home	55	24	21	86	337	28	22	21	76	670
	Business meeting	0	2	1	5	0	0	0	0	1	9
	Shopping	0	0	1	1	1	0	0	0	0	3
	Recreation/visit friends	0	3	9	19	4	1	2	1	9	48
	Work	0	0	1	6	8	0	0	2	5	22
	School	0	0	1	0	0	1	1	0	0	3
	Sports event	0	0	0	0	0	0	1	0	0	1
	Medical services	0	1	0	0	0	0	0	1	0	2
	Other	0	4	5	23	11	0	1	0	9	53
	Total	55	34	39	140	361	30	27	25	100	811

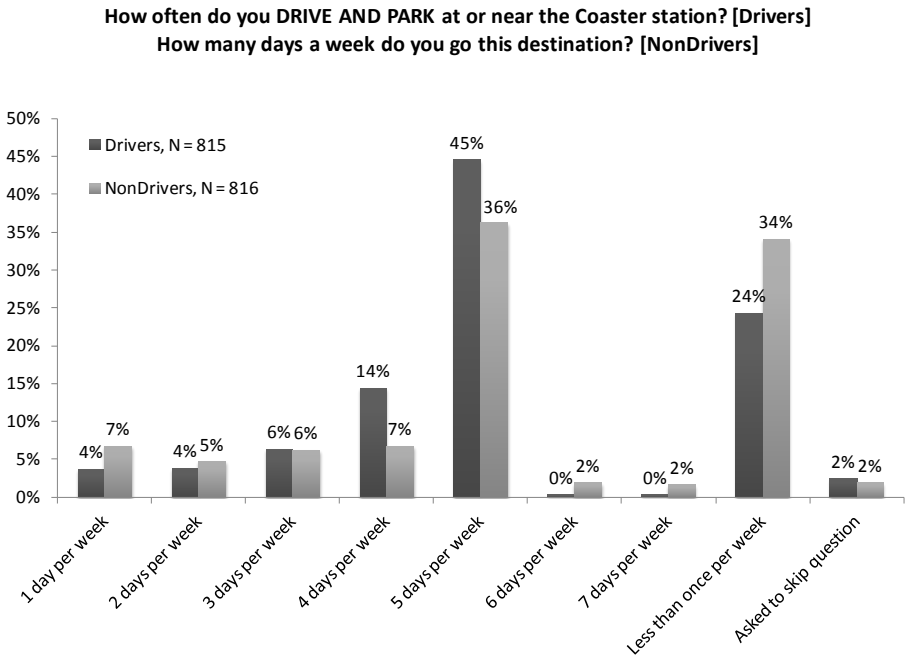
Among those that drove to the COASTER stations but did not ride, a slightly different distribution of destinations was observed. Within the Driver survey, 77 respondents (9%) drove to one of the COASTER stations but did use COASTER and instead traveled to a nearby location. For this cohort, a work destination was still the most common, but recreational trips were also common. Home was still the most common origin as shown in Table 5.

Table 5: Cross-Tabulation of Origin Type by Trip Purpose for NonRiders of COASTER

Question	Response	What type of destination are you going to now?									
		Home	Business meeting	Shopping	Recreation/ visit friends	Work	School	Sports event	Medical Services	Other	Total
Where did you come from before you parked your car? [Drivers]	Home	2	2	3	13	18	0	1	0	15	54
	Business meeting	3	0	0	0	0	0	0	0	0	3
	Shopping	0	0	0	0	0	0	0	0	0	0
	Recreation/visit friends	0	0	0	1	0	0	0	0	0	1
	Work	7	0	0	2	1	0	0	0	4	14
	School	0	0	0	0	0	0	0	0	0	0
	Sports event	0	0	0	0	0	0	0	0	0	0
	Medical Services	0	0	1	0	0	0	0	0	0	1
	Other	0	1	1	0	0	0	1	0	0	3
	Total	12	3	5	16	19	0	2	0	19	76

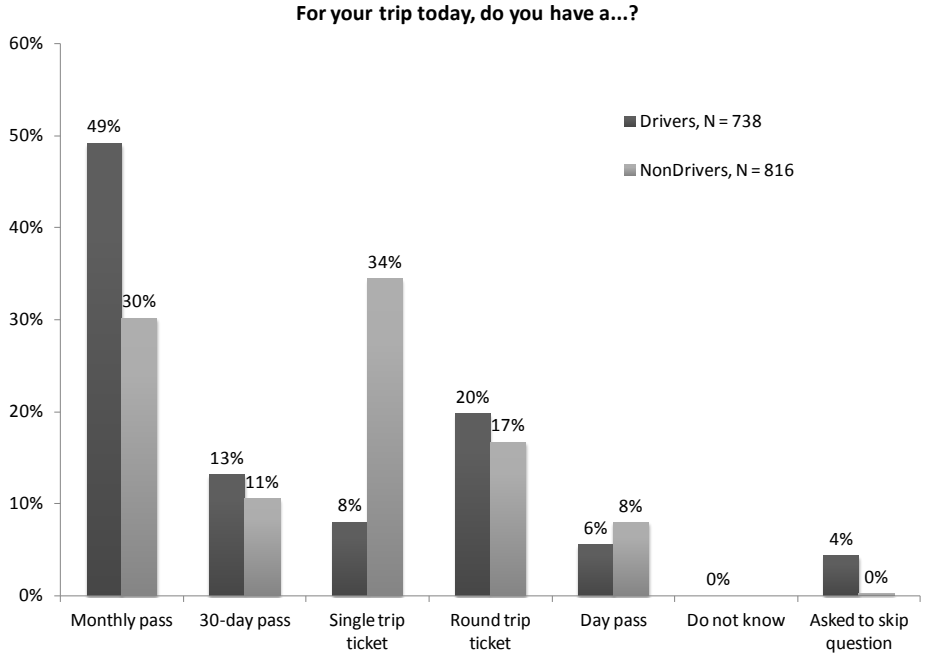
In terms of travel frequency, most respondents were regular COASTER users. The most common weekly frequency of COASTER use was five days a week for both sampling frames. The second highest frequency were those using COASTER less than once a week. The distribution of trip frequency is presented in Figure 9.

Figure 9: Distribution of Trip Frequency



There was also a notable difference between Driver and NonDriver ticket types. As shown in Figure 10, half of all Drivers held monthly tickets, whereas the most common type of ticket held by NonDrivers were single trip tickets.

Figure 10: Distribution of COASTER Ticket Type



Hence Figure 9 and Figure 10 suggest that Drivers were among the more regular users of the COASTER line. A large share of NonDrivers were also regular users, as 41% held either a monthly pass or a 30-day pass. Notably, a total of 59% of NonDrivers only had a ticket for the day versus 34% of drivers. It is also coincidental that the proportion of NonDrivers carrying a single trip ticket was of similar magnitude to those making their COASTER trip at a frequency of “less than once a week,” as indicated in Figure 9.

By definition, the sampling frame of Drivers accessed the station by car. The access mode of NonDrivers naturally varied across the stations. To show the distribution of access modes across the NonDriver sample as defined by access station, Table 6 presents a cross tabulation of access modes to the first station accessed during the day among NonDrivers.

Table 6: Access Mode of NonDrivers

Egress Mode	Modal Circumstance	Drivers (Total)	Oceanside	Carlsbad Village	Carlsbad Poinsettia	Encinitas	Solana Beach	Sorrento Valley	Old Town (San Diego)	Santa Fe Depot (San Diego)	No Station Given
Walk	Walk all the way	319	10	9	2	8	6	19	58	207	0
Taxi	Taxi	4	2	0	0	0	1	0	0	1	0
Motorcycle/moped	Motorcycle/moped	2	0	0	0	0	0	0	0	2	0
Bicycle	Bike parked at station	2	0	0	0	0	0	0	1	1	0
	Brought bike on train	13	1	0	1	0	1	0	3	7	0
Car	Drive alone (just driver, no passengers)	49	7	9	5	4	1	7	5	10	1
	Carpool	8	2	0	0	2	0	2	1	1	0
	Be dropped off/picked up at station	18	3	1	0	2	1	4	6	1	0
Vanpool	SANDAG Subsidized	3	0	0	0	0	0	3	0	0	0
	Unsubsidized	7	0	0	0	0	0	7	0	0	0
	Unsure	4	1	0	0	0	0	3	0	0	0
Bus/Train	SPRINTER	8	3	0	3	0	0	0	2	0	0
	Trolley	87	2	1	0	1	0	0	21	62	0
	Bus	42	1	0	13	0	2	8	5	13	0
	Shuttle	87	6	0	1	0	4	71	4	1	0
Other	Other	29	4	0	1	0	0	21	1	1	0
Total		682	42	20	26	17	16	145	107	307	1

Table 6 shows that NonDrivers accessed stations through a wide range of modes. Although there is no majority access mode, the most common mode used was walking, followed by car as a dropped off passenger. Interestingly, the survey suggests that bicycles were mostly brought on the train, as opposed to parked at the station. For many rail systems, the balance of bicycle use is the opposite, with parked bikes dominating the usage circumstance. This suggests that the use of bicycles on COASTER is driven by a need to use the bicycles at the egress station (i.e., last mile solution). Other forms of access, including public transit were also well represented as access modes.

The egress modes of NonDrivers show that many also walked to their destination, although this egress mode was concentrated in downtown San Diego. In terms of bicycling, the same 57 respondents carrying their bikes on the train used it to depart from the train, while two of the respondents parking their bike at the origin station proceeded to pick up another bicycle at their destination station. The largest mode used for egress was another form of public transit, with work shuttles playing a large role. For Drivers, a higher proportion of travelers used walking as their egress mode, with public transit constituting the second highest mode. Table 7 and Table 8 show the distribution of egress modes by station for NonDrivers and Drivers, respectively.

Table 7: Egress Mode of NonDrivers

Egress Mode	Modal Circumstance	Non-drivers (Total)	Oceanside	Carlsbad Village	Carlsbad Poinsettia	Encinitas	Solana Beach	Sorrento Valley	Old Town (San Diego)	Santa Fe Depot (San Diego)	No Station Given
Walk	Walk all the way	251	34	10	6	21	24	20	30	101	5
Taxi	Taxi	21	3	1	3	0	4	0	2	7	1
Motorcycle/moped	Motorcycle/moped	0	0	0	0	0	0	0	0	0	0
Bicycle	Bike parked at station	2	0	0	1	0	0	0	0	0	1
	Brought bike on train	57	6	0	4	6	5	10	10	16	0
Car	Drive alone (just driver, no passengers)	31	7	5	6	0	1	6	2	3	1
	Carpool	16	3	3	0	1	0	3	4	1	1
	Be dropped off/picked up at station	85	22	5	6	3	8	12	14	12	3
Vanpool	SANDAG Subsidized	3	0	0	0	0	0	3	0	0	0
	Unsubsidized	3	0	0	1	0	0	1	1	0	0
	Unsure	5	2	0	0	0	0	2	0	1	0
Bus/Train	SPRINTER	28	21	0	3	0	0	0	2	2	0
	Trolley	64	5	2	0	1	2	1	16	37	0
	Bus	128	19	7	16	10	6	6	21	41	2
	Shuttle	61	2	2	1	0	5	47	4	0	0
Other	Other	21	4	1	1	4	3	4	1	3	0
Total		776	128	36	48	46	58	115	107	224	14

Table 8: Egress Mode of Drivers

Egress Mode	Modal Circumstance	Drivers (Total)	Oceanside	Carlsbad Village	Carlsbad Poinsettia	Encinitas	Solana Beach	Sorrento Valley	Old Town (San Diego)	Santa Fe Depot (San Diego)	No Station Given
Walk	Walk all the way	319	10	9	2	8	6	19	58	206	0
Taxi	Taxi	4	2	0	0	0	1	0	0	1	0
Motorcycle/moped	Motorcycle/moped	2	0	0	0	0	0	0	0	2	0
Bicycle	Bike parked at station	2	0	0	0	0	0	0	1	1	0
	Brought bike on train	14	1	0	1	0	1	0	3	8	0
Car	Drive alone	49	7	9	5	4	1	7	5	10	1
	Carpool	8	2	0	0	2	0	2	1	1	0
	Be dropped off/picked up at station	18	3	1	0	2	1	4	6	1	0
Vanpool	SANDAG Subsidized	3	0	0	0	0	0	3	0	0	0
	Unsubsidized	7	0	0	0	0	0	7	0	0	0
	Unsure	4	1	0	0	0	0	3	0	0	0
Bus/Train	SPRINTER	8	3	0	3	0	0	0	2	0	0
	Trolley	87	2	1	0	1	0	0	21	62	0
	Bus	42	1	0	13	0	2	8	5	13	0
	Shuttle	87	6	0	1	0	4	71	4	1	0
Other	Other	29	4	0	1	0	0	21	1	1	0
Total		683	42	20	26	17	16	145	107	307	1

Finally, Drivers were asked where they parked before accessing the station. The most common parking location was in the lot itself. About 10% of respondents parked outside of the dedicated COASTER lots, mostly near Oceanside and downtown. During the time of the survey, the lots were well used, but never at capacity according to the parking counts. Table 9 shows a cross-tabulation of parking location by parking station. Seven of the eight stations have parking lots, with Santa Fe Depot in downtown as the one station lacking a dedicated lot. It was therefore not clear why five people had indicated parking in the COASTER lot, but it might have been due to a nearby lot that the respondent thought belonged to COASTER. Nonetheless, the number is small, and as people access the downtown station by car to go north, parking in areas around downtown is used to access the Santa Fe depot station.

Table 9: Cross-Tabulation of Parking Location and Parking Station

Parking Location	Oceanside	Carlsbad Village	Carlsbad Poinsettia	Encinitas	Solana Beach	Sorrento Valley	Old Town (San Diego)	Santa Fe Depot (San Diego)	No Station Given	Total	Percent
In the Coaster station parking lot	193	145	129	102	55	43	58	5	1	731	91%
On the street adjacent at an unmetered spot	9	3	0	3	2	2	4	0	0	23	3%
On the street at a metered spot	0	0	0	0	0	0	0	1	0	1	0%
At another parking lot < 2 blocks of the Coaster station	10	8	1	3	0	0	2	6	0	30	4%
At another parking lot >than 2 blocks away from station	3	3	1	1	0	0	0	0	0	8	1%
Other	1	0	2	1	0	0	2	1	0	7	1%
Total	216	159	133	110	57	45	66	13	1	800	
Percent	27%	20%	17%	14%	7%	6%	8%	2%	0%		

In addition to surveying people on the trains, platform and parking lots, the field team collected parking counts of cars parked within the COASTER lots on selected days between 1 to 2 PM. Because of the spatial distribution of the COASTER line, counts were staggered over a week, and each lot had between two to four counts completed. These counts served to evaluate how well used the station parking lots were relative to capacity. The results showed that none of the stations reach capacity on any of the days in which they were counted, although three came close. These three stations were Carlsbad Poinsettia, Solana Beach, and Old Town San Diego. Table 10 shows the count data as reported by the survey field operators.

Table 10: Vehicle Counts within COASTER Parking Lots

Station / Date	Oceanside	Carlsbad Village	Carlsbad Poinsettia	Encinitas	Solana Beach	Sorrento Valley	Old Town
Tuesday, July 12, 2011					312		348
Wednesday, July 13, 2011					323	80	
Thursday, July 14, 2011	538	265					
Friday, July 15, 2011			272	196			
Monday, July 18, 2011							383
Tuesday, July 19, 2011						84	389
Wednesday, July 20, 2011		307	349	215			
Thursday, July 21, 2011	554				332		408
Friday, July 22, 2011		280	323				
Average Count	***546***	***284***	***315***	***205.5***	***322***	***82***	***382***
Reported Capacity	1250	550	360	325	350	150	437
Average Utilization	**44%**	**52%**	**87%**	**63%**	**92%**	**55%**	**87%**

About 91% of respondents within the Drivers sampling frame parked at COASTER and rode the line. The remaining 9% (77 respondents) were parked at the COASTER, but then traveled to a local destination (NonRiders). The distribution of NonRiders as a share of all Drivers is not uniform across all stations. In particular, Solana Beach emerged as the single station with the most NonRiders, which incidentally is also the station with highest average capacity use. The distribution of Driving Riders and Driving NonRiders is given in Table 11.

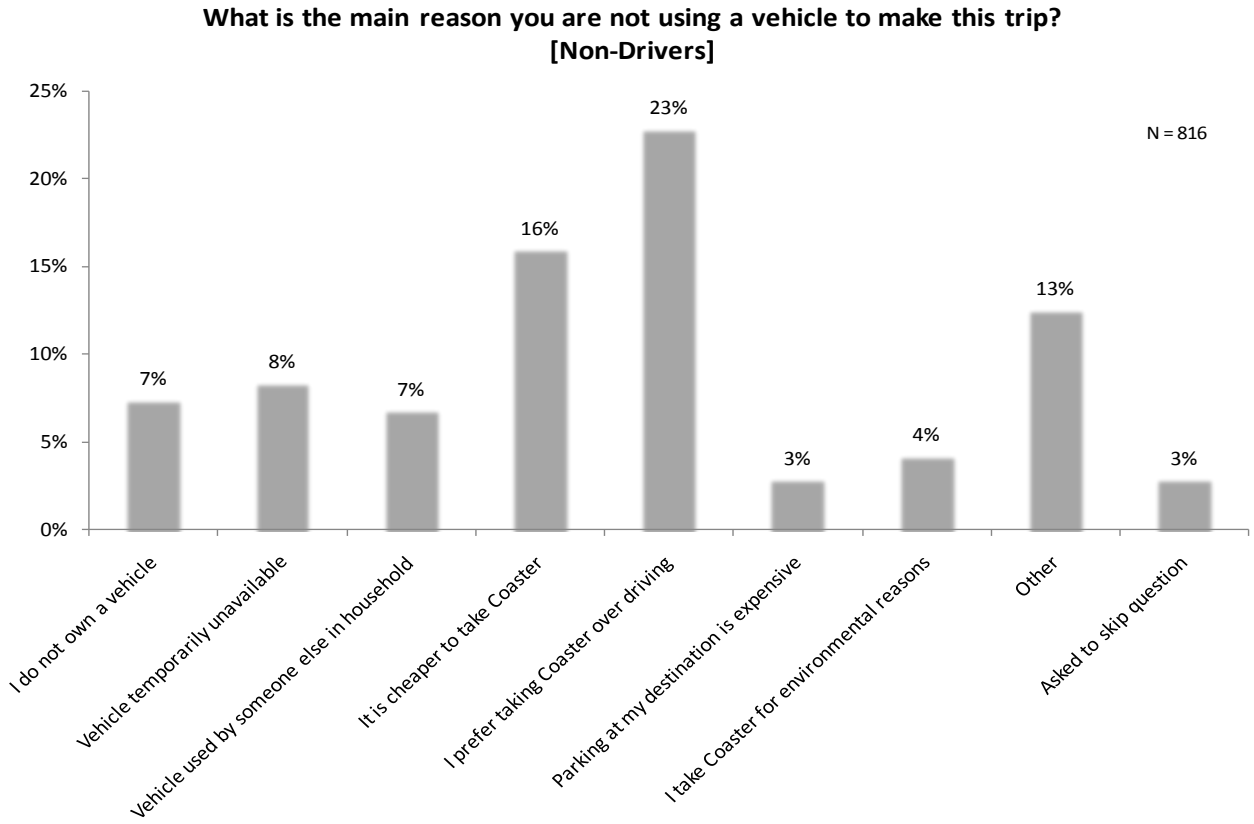
Table 11: Distribution of Drivers that Ride and Do Not Ride COASTER

Parking and Riding COASTER Status	Riding COASTER	NOT Riding COASTER	Riding COASTER (%)	NOT Riding COASTER (%)	Total
All Drivers	739	77	91%	9%	816
Oceanside	198	22	90%	10%	220
Carlsbad Village	153	8	95%	5%	161
Carlsbad Poinsettia	129	5	96%	4%	134
Encinitas	106	7	94%	6%	113
Solana Beach	33	26	56%	44%	59
Sorrento Valley	43	2	96%	4%	45
Old Town	62	5	93%	7%	67

6.3 Impact of the COASTER on Driving and Automobile Ownership

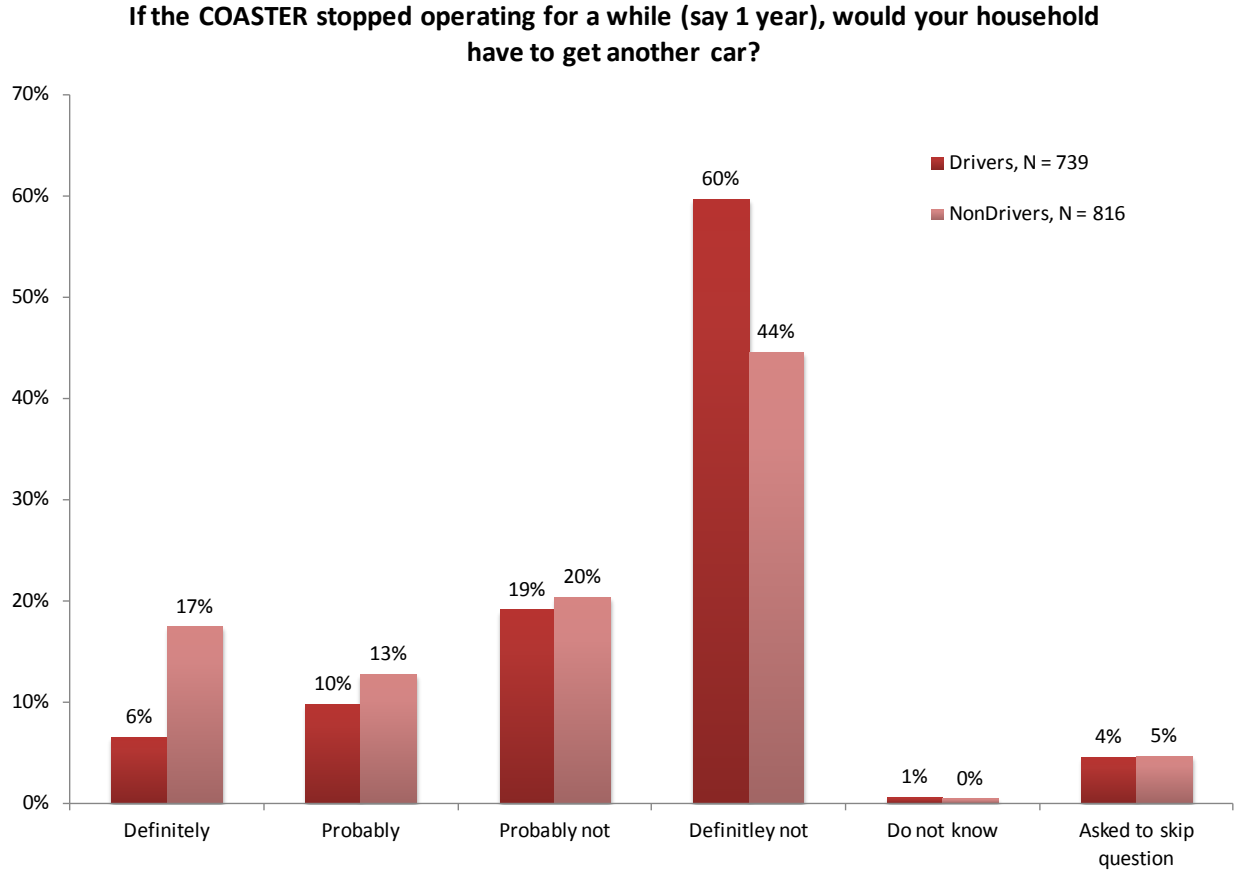
The survey contained questions that probed the degree to which the COASTER substitutes for other travel modes and automobile ownership. To start, NonDrivers were asked to provide the main reason that they were not using a vehicle for the trip in which they were surveyed. The most common (23%) answer was simply that respondents preferred taking COASTER over driving, whereas the second most common response (16%) was that the COASTER was cheaper. Three responses pertaining to lack of vehicle availability comprised 22% of respondents collectively, and for about two-thirds of those respondents, the lack of vehicle availability was temporary. Figure 11 illustrates the distribution of response across the NonDriver sample.

Figure 11: Why Non-Drivers Did Not Use A Vehicle for the Trip



To evaluate how COASTER impacts household vehicle ownership, respondents were asked whether their household would have to acquire a vehicle, if COASTER shut down for a year. The results provide insights into the degree in which the availability of COASTER impacts the need for San Diego households to own a car. The distribution is shown in Figure 12.

Figure 12: The Impact of COASTER on Household Vehicle Ownership

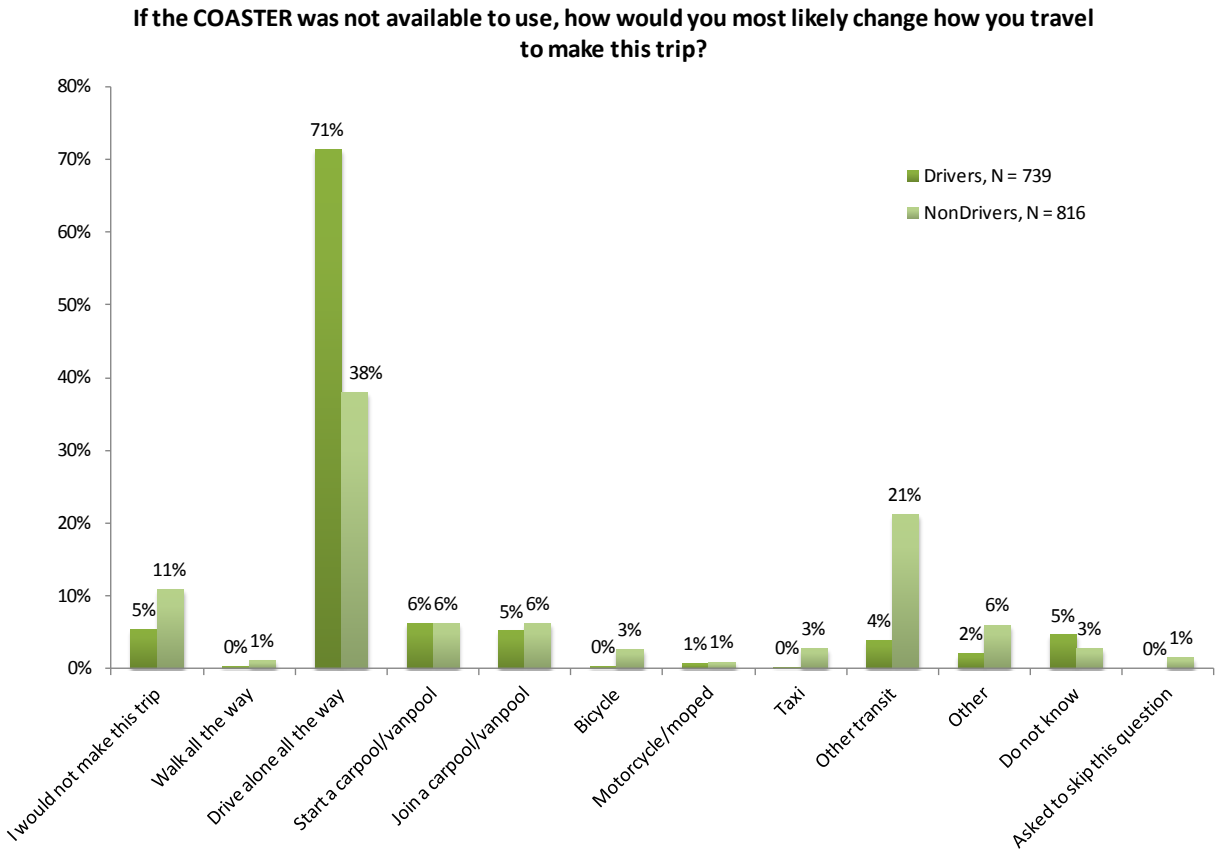


Because the question is effectively a hypothetical scenario, the responses were offered in a probabilistic scale of "Definitely," "Probably," "Probably not," and "Definitely not." Not surprisingly, Drivers already have a car and thus 79% of them indicated that the disappearance of COASTER would not require their household to get another vehicle. Interestingly, about 16% of Drivers indicated the COASTER was serving as a substitute for a household automobile. This could arise, if COASTER's role reduces the need for an additional vehicle. The question was only asked of Drivers riding COASTER, which is why the sample size is lower. For NonDrivers, the share of automobile substitution is higher as 30% indicated that they would probably or definitely need to get another vehicle, if the COASTER stopped operating.

The survey also explored how respondents in both sampling frames would make their current trip, if COASTER was not available. The purpose of this question was to evaluate the degree to which travelers on the COASTER would shift towards driving or other forms of public transit. Figure 13 shows that for both Drivers and NonDrivers, the most common alternative mode was drive alone. For Drivers, 71% (527) stated that they would drive alone to their destination, if COASTER was not available to use. For NonDrivers, the share of people who would have to drive alone was 38% (310), but in total more than half of the overall sample of 1,632 respondents were not driving to their destination as a result of the COASTER service. For Drivers, the

remaining alternatives received a nominal share of about 5%. For NonDrivers, the use of other public transit and "not making the trip" were prominent alternative responses.

Figure 13: Respondent Travel Shift in the Absence of COASTER



6.4 Response to Changes in Parking Pricing

Researchers designed the survey with specific questions to evaluate the respondent reaction to the prospect of an increase in parking cost or the COASTER fare. For each price change, respondents were asked two questions in tandem. The first question asked whether a price change (of any amount) would impact whether they would use COASTER or park at the COASTER lot. Those who said that it would were directed to a follow-up question that asked in general terms how they would react given various price changes in either parking or fares. As an illustration, the design of the question for changes in COASTER parking costs is provided in Figure 14, as it was given in both surveys. (See Appendix A for the complete surveys of both frames.)

Figure 14: Design of Willingness to Pay for Parking Question

19 **If parking a car at COASTER station lots had a daily cost, what impact (if any) would this have on your use of COASTER?**

1 ☐ It would not impact how I use COASTER or how I travel to COASTER parking lots **(GO TO QUESTION 22)**

2 ☐ It may impact how I use COASTER or how I travel to COASTER parking lots depending on the daily cost

20 **At each cost of daily parking below, please indicate how you think you would change your use of COASTER given the following parking costs per day** *(Please select one answer per row).*

Cost per day to park at a COASTER lot	PROBABLY STILL park a car at the COASTER lot	MAYBE STILL park a car at the COASTER lot	PROBABLY STOP parking a car at the COASTER lot
$0.00 (Free, no cost)	☐ 1	☐ 2	☐ 3
$1.00	☐ 1	☐ 2	☐ 3
$2.00	☐ 1	☐ 2	☐ 3
$3.00	☐ 1	☐ 2	☐ 3
$4.00	☐ 1	☐ 2	☐ 3
$5.00	☐ 1	☐ 2	☐ 3
$6.00	☐ 1	☐ 2	☐ 3
$7.00	☐ 1	☐ 2	☐ 3

The question is a stated preference and allows the respondent to provide a probabilistic answer to how they think they would respond at each parking price. The question design is unique in that it permits respondents to provide a relative reaction to each cost in terms that capture the natural uncertainty anyone would have with a hypothetical situation. It is also compact, permitting its delivery within a clipboard survey. A similar question was asked of fare price changes. Because fares were generally paid in the form of single ticket or monthly fares, the question captured both structures. This was simple to do as COASTER had a linear and consistent relationship between its round trip fare price and the analogous monthly ticket price for all stations. For both pricing response questions, the content was the same for both sampling frames. Figure 15 illustrates the congruent design of the pricing response question, as given in the clipboard survey.

Figure 15: Design of Response to Fare Change Question

22 **If COASTER fares changed (as either an increase or decrease), how would this change your use of the system?** *(Please select one answer per row.)*

1 ☐ It would not impact how I use COASTER **(GO TO QUESTION 24)**

2 ☐ It may impact how I use COASTER depending on the fare change.

23 **At each change in fare below, please indicate how you think you would change your use of COASTER.** *(Please select one answer per row).*

If the Change in Round Trip Fare or (Monthly Fare) was…	Use COASTER MORE	Use COASTER THE SAME	Use COASTER LESS	STOP using COASTER
$2 Less per Round Trip (Monthly Pass $30 Less)	☐ 1	☐ 2	☐ 3	☐ 4
$1 Less per Round Trip (Monthly Pass $15 Less)	☐ 1	☐ 2	☐ 3	☐ 4
$1 More per Round Trip (Monthly Pass $15 More)	☐ 1	☐ 2	☐ 3	☐ 4
$2 More per Round Trip (Monthly Pass $30 More)	☐ 1	☐ 2	☐ 3	☐ 4
$3 More per Round Trip (Monthly Pass $45 More)	☐ 1	☐ 2	☐ 3	☐ 4
$4 More per Round Trip (Monthly Pass $60 More)	☐ 1	☐ 2	☐ 3	☐ 4

Unlike the parking cost question, the fare question contained options that solicited response for both a fare decrease and a fare increase. To save space, the option of "no change" was not given as it was implicit that respondents would "Use COASTER THE SAME." This was not possible with the parking cost question because parking at COASTER lots was free at the time of the survey.

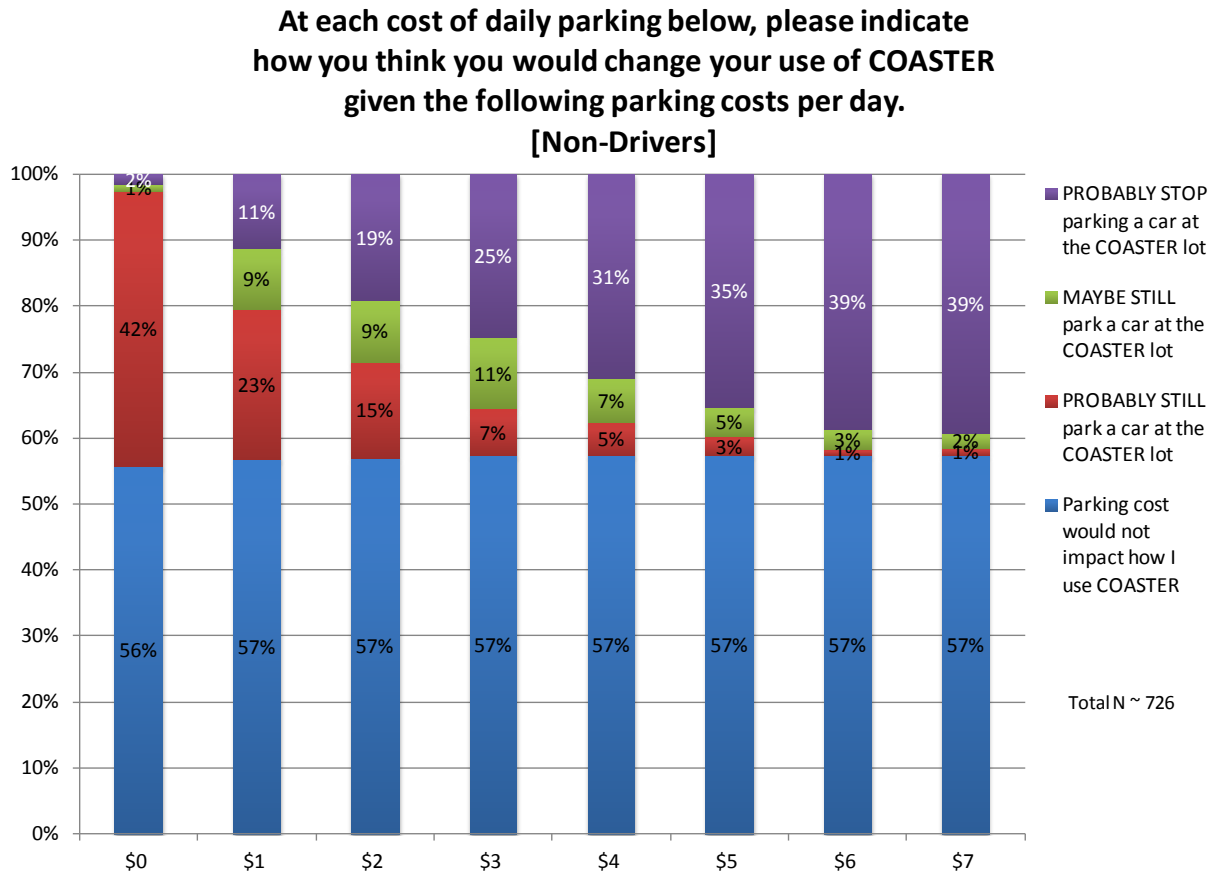
The results of these questions are presented in the form of a spectrum of the collective response to price. In effect, it illustrates a price response curve that shows a distribution of response at each price given the collective respondent answers. Table 12 illustrates the general response to changes in parking cost as indicated by Question 19 in Figure 14.

Table 12: Response of to Change in Parking Cost

	If parking a car at COASTER station lots had a daily cost, what impact (if any) would this have on your use of COASTER?	Drivers	NonDrivers
PARKING COST	It would not impact how I use COASTER or how I travel to COASTER	18%	51%
	It may impact how I use COASTER or how I travel to COASTER	80%	43%
	Asked to skip question	2%	6%
	Total (Respondents)	816	

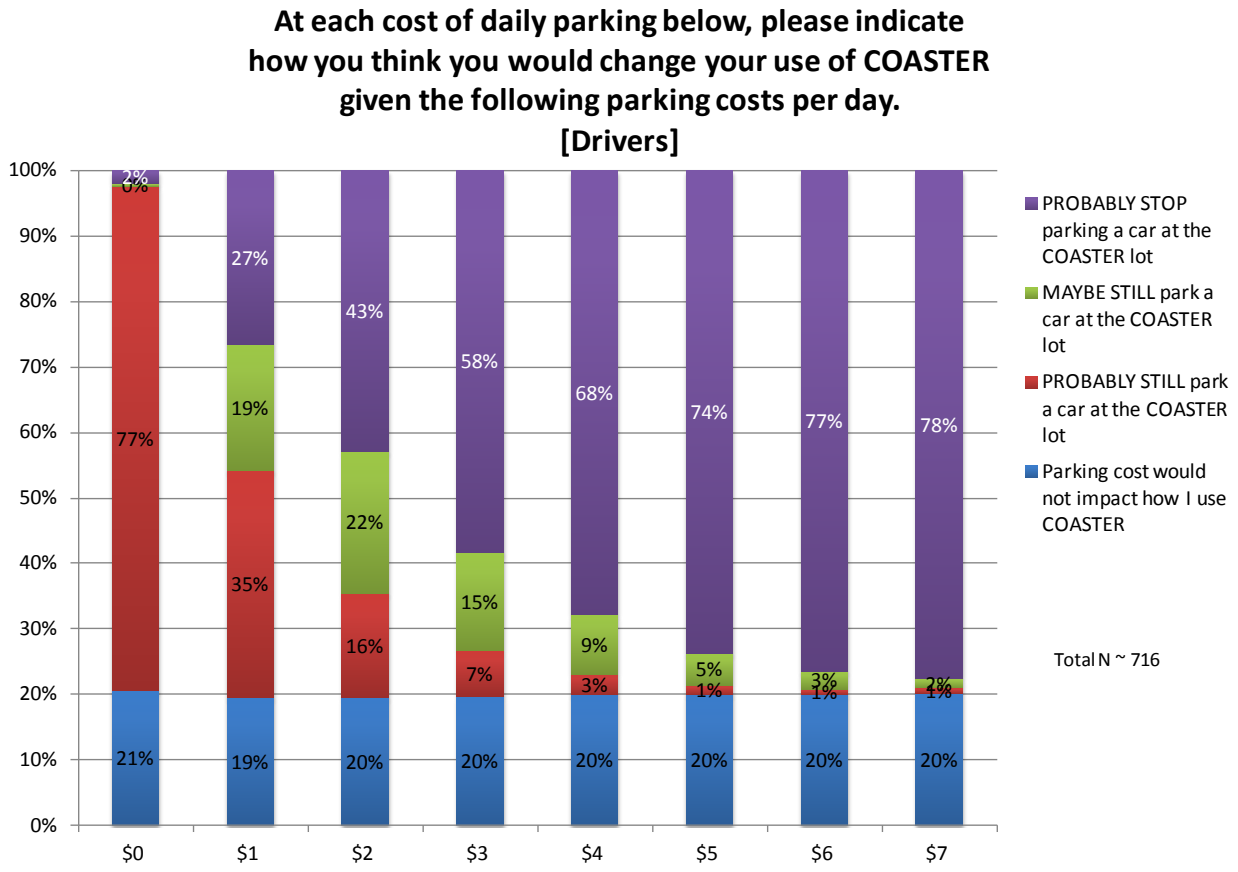
Table 12 shows a split in the reaction of Drivers and NonDrivers that is not surprising. A little more than half (51%) of NonDrivers stated that an increase in parking costs would not impact how they use COASTER or how they travel to the COASTER. In contrast, 80% of Drivers and 43% of NonDrivers stated that it would. These respondents were directed to the next question. The distribution of the collective response of NonDrivers is presented in a price response curve in Figure 16 below.

Figure 16: NonDriver Response Curve to Changes in Parking Cost



The price response curve of NonDrivers combines the total proportion of each response together into a single column. To fairly represent the shares of NonDriver respondents that would react to a change in parking cost, the proportion of respondents stating that parking cost would not impact their use of the COASTER are indicated on the bottom. As the price increases, a growing share of respondents indicated that they would probably stop parking a car at the COASTER station. In addition, the share of "maybe" responses grew in the middle of the price range and then shrunk. As the price rose to relatively high levels, the certainty in reaction grew. The utility of this curve is that it provides a clear description of the stated response to increases in parking costs. The relatively low sensitivity of NonDrivers to parking costs was an expected result. For Drivers, the sensitivity to cost was higher. Figure 17 shows the response curve of Drivers to changes in parking costs.

Figure 17: Driver Response Curve to Changes in Parking Cost

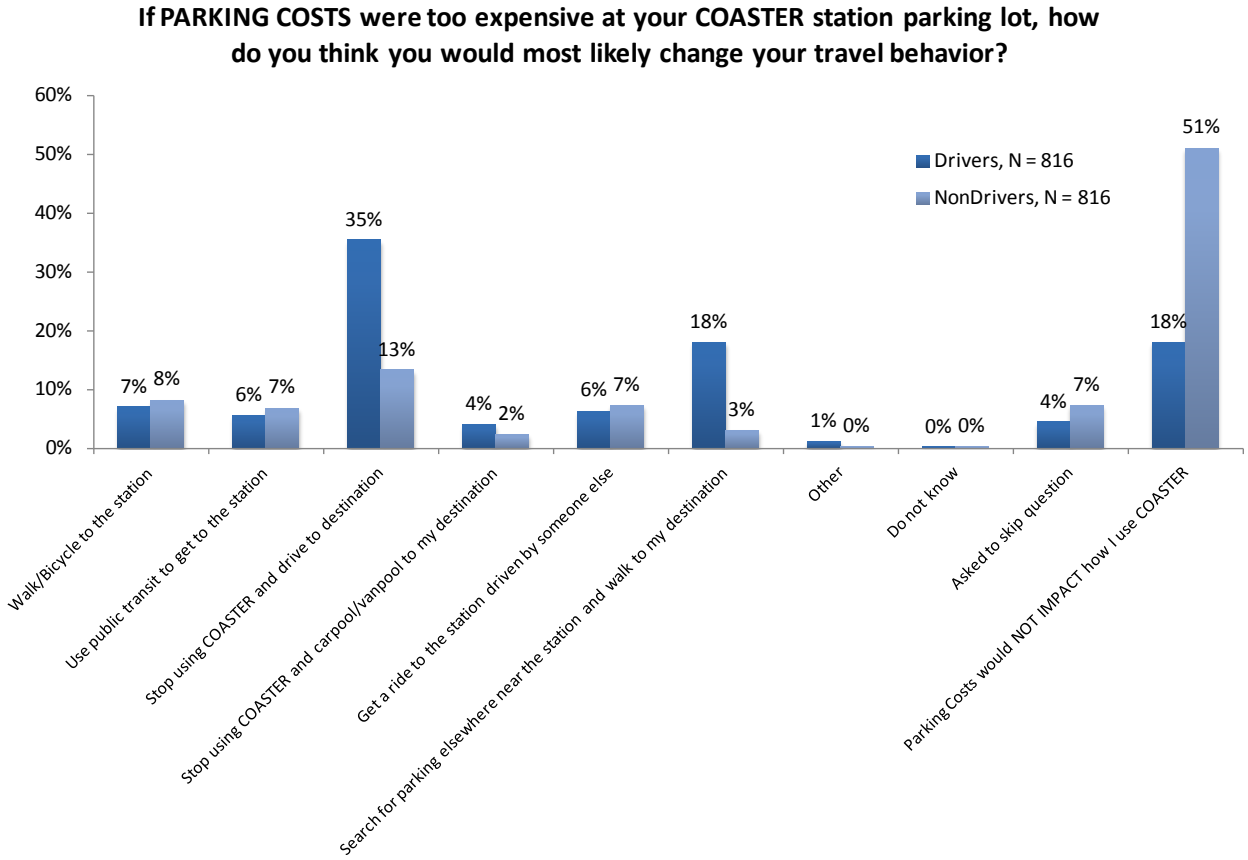


The response curve of Drivers, 44% of whom drive to COASTER five days a week, exhibits a greater relative shift towards "probably stop" parking at COASTER than NonDrivers. At a price of US$1, nearly 30% of Drivers indicated that they would "probably stop" parking at COASTER stations. As with the NonDriver response curve, the share of "Maybe" responses swells and then shrinks as most respondents believed that they would not park at COASTER, if the daily cost

was US$7.

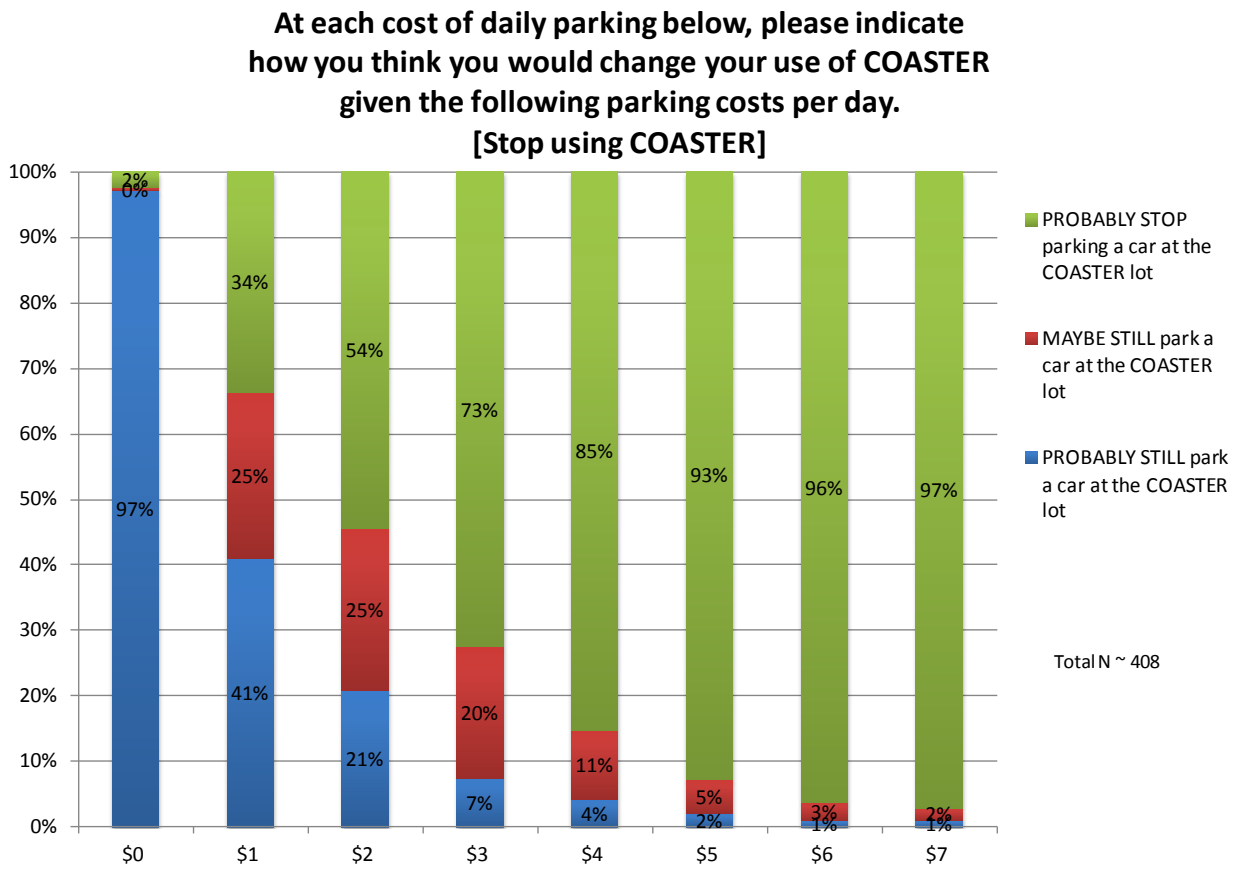
For all of the respondents who indicated that a change in parking cost would influence how they use COASTER, a follow up question was given probing what alternative action they would take, if parking was too expensive. Specifically, the question asked, "If PARKING COSTS were too expensive at your COASTER station parking lot, how do you think you would most likely change your travel behavior?" Figure 18 provides the distribution of response for both Drivers and NonDrivers.

Figure 18: Travel Response to Parking Costs Rising to Be Too Expensive



To put the complete sample in context, Figure 18 includes those who indicated that they would not be impacted by a change in parking cost. Most of the alternatives consist of actions that respondents might have taken to avoid the parking cost, but still use COASTER. However, one critical response indicates that 35% of Drivers and 13% of NonDrivers would stop using COASTER and drive to their destination. Another 4% and 2% of these cohorts indicate that they would take a vanpool. *These respondents comprise those COASTER riders that state that they would leave COASTER, if the price of parking got too high.* The cost response curve of this subgroup is presented in Figure 19.

Figure 19: Response Curve of Those That Would Stop Using COASTER If Parking Was Too Expensive



There is a key point in Figure 19 that serves to drive the results of the financial analysis presented in Section 7. Figure 19 shows that about one-third of those that would drive a car or take vanpool once COASTER's parking became too expensive would do so, if parking costs increased to just US$1. The group of people that would shift away from COASTER entirely at a parking price of US$1 constitutes 143 respondents or about 9% of the total sample.

Who these people are is influential to the overall financial impact projected from raising parking costs during this economic period. If such riders were occasional patrons of COASTER, the impact of the revenue loss would be overwhelmed by the revenue gain from more regular riders. But, if such sensitive riders are the more regular patrons of COASTER, then the revenue loss from their forgone patronage would be more challenging to recover. This issue is explored in more detail in Section 7.

6.5 Response to Changes in COASTER Fares

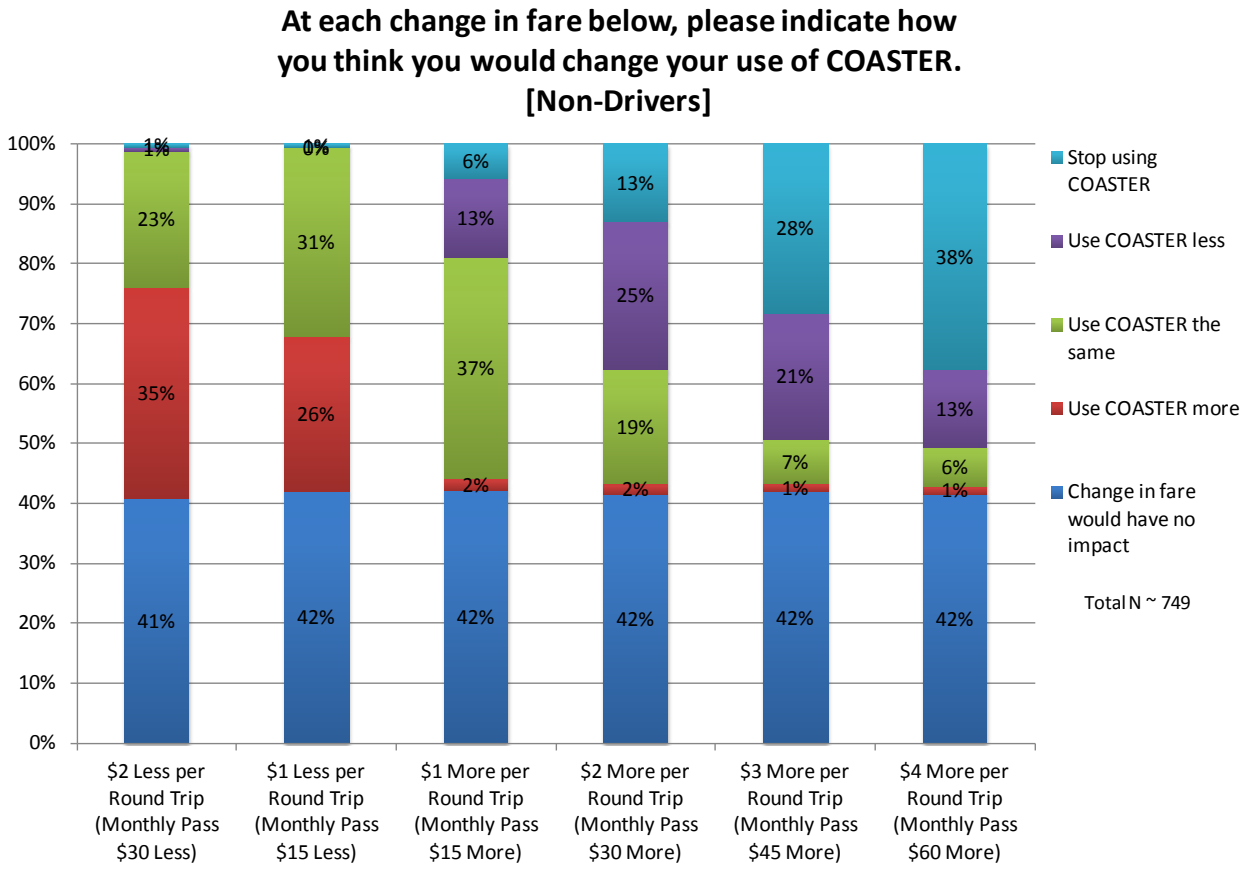
Just as the survey probed respondent reactions to changes in parking price, a similar series of questions were asked to evaluate how respondents would react to fare changes. The split in response was very different from that observed for parking costs. Table 13 shows the relative breakdown of respondents that would be impacted by COASTER, as a result of a fare change.

Table 13: Response to Change in COASTER Fare

	If COASTER fares changed (as either an increase or decrease), how would this change your use of the system?	Drivers	NonDrivers
FARES	It would not impact how I use COASTER	35%	38%
	It may impact how I use COASTER or how I travel to COASTER	61%	58%
	Asked to skip question	5%	5%
	Total (Respondents)	816	

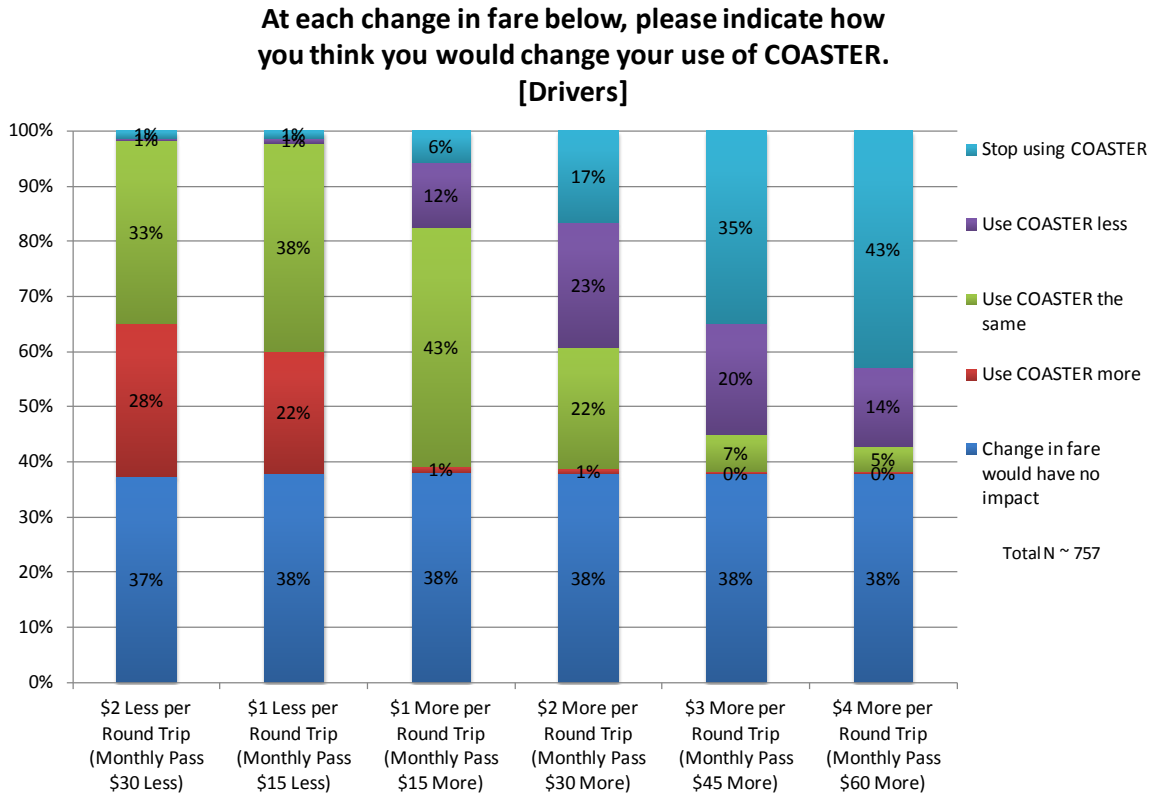
Not surprisingly, a larger share of NonDrivers stated that it may impact their use of COASTER, but surprisingly a smaller share of Drivers stated that they would be impacted. As before, the spectrum of response to a potential fare increase is indicated by two cost response curves. Figure 20 shows the cost response curves for NonDrivers.

Figure 20: Cost Response Curve of NonDrivers to Change in COASTER Fare



The fare cost curve of the NonDrivers sample is different from the parking curves given earlier in that the first two columns show the NonDriver response to a *fare reduction*. The value of having these options in the question is that it: 1) probes the degree to which reducing the fare would potentially draw more ridership, and 2) it helps ground respondents in answers about their expected behavior towards price changes. The results of Figure 20 show that reducing fares by US$2 per round trip (US$30 monthly), would induce 35% of NonDrivers to use COASTER more. A price increase of US$1 per round trip (US$15 monthly), would induce 6% to stop using COASTER and 13% to use COASTER less, while 81% would not be impacted. To evaluate the reaction of Drivers to the same question, Figure 21 shows their cost response curve.

Figure 21: Cost Response Curve of Drivers to Change in COASTER Fare



Drivers were found to react very similarly to NonDrivers. The slope of the cost curve, and the share of respondents shifting behavior at specific prices aligned well with the cost curve of the NonDrivers. A US$1 per round trip (US$15 monthly) increase on drivers would not change the behavior of 82% of Drivers, but induce 12% to reduce COASTER usage and 6% to stop using COASTER.

At the end of the price response questions, respondents to both surveys were asked a direct question about where they would most prefer to see a price increase, if they had to accept one. The question was specifically worded as: “If, in order to cover operating cost shortfalls and make up for reduced federal and state support, the COASTER had to raise either parking costs OR fares by US$1 per day, which would you prefer?” Only two responses were given, “fare increase” and “parking cost increase.” The results of this question are given in Figure 22.

Figure 22: Preference of Increase in Parking Cost or Public Transit Fares

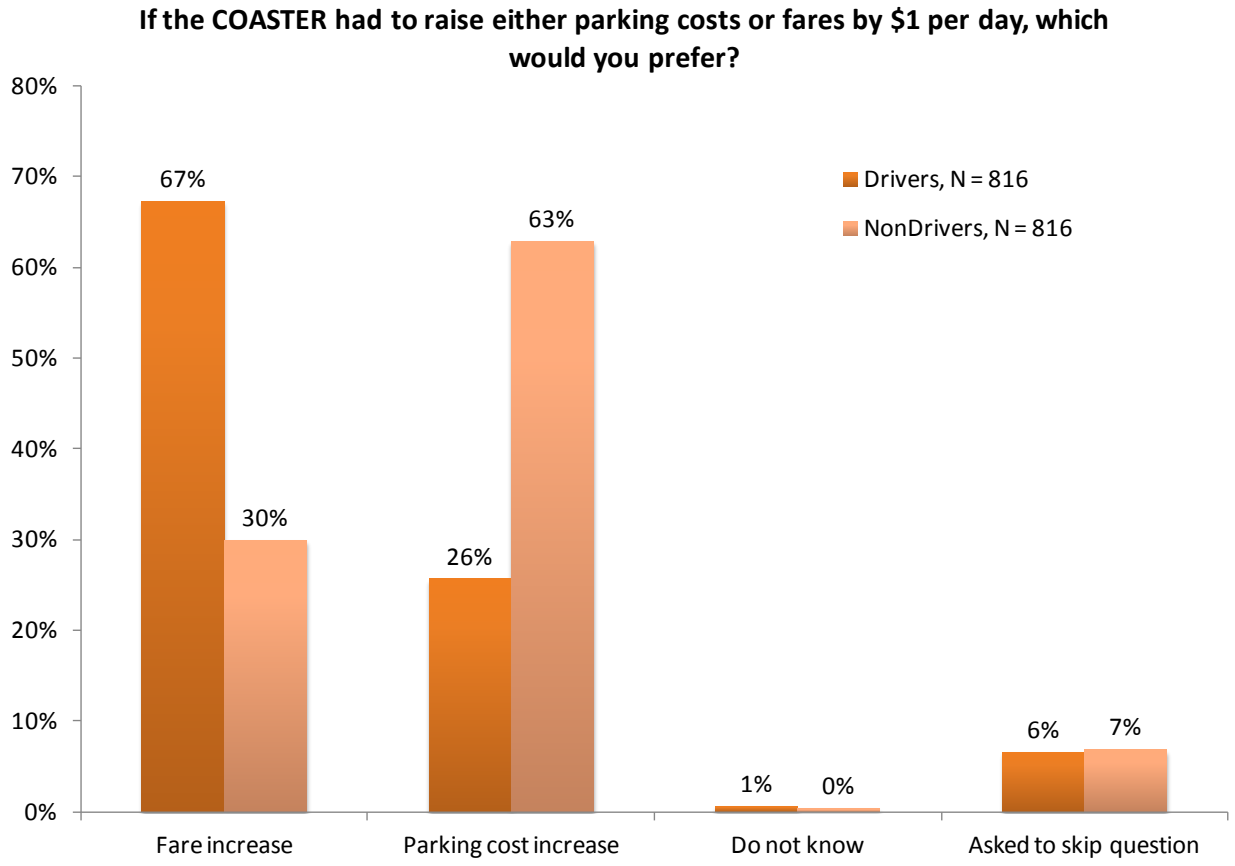


Figure 22 shows a near complete split in preference between Drivers and NonDrivers. About 2/3 of Drivers prefer a fare increase, and about 2/3 of NonDrivers prefer a parking cost increase. Hence, there is no general agreement about a preferred type of price increase if one were needed, with the majority of each cohort seeking to disperse the costs imposed on them directly.

7. Financial Analysis of Parking Cost and Changes in Fare on COASTER Revenue

The responses given by the COASTER riders can be used to evaluate the possible financial implications of increasing parking prices and/or changing fares. This section details an analysis of the financial impact of changing parking prices and fares on revenue earned by COASTER and NCTD. The financial analysis differs from the cost-benefit analysis in that it focuses entirely on how changes in price would change rider behavior and COASTER usage, when combined with the revenue earned from changing prices.

The financial analysis is based on several key factors as provided by the survey responses. The financial analysis considers: 1) the respondent's frequency of COASTER usage, 2) the fare paid by the respondent (which, with (1) is converted to an annual revenue earned by that rider), 3) the

stated reaction to different parking prices and fares of the respondent, and 4) the change in access to and use of COASTER by the respondent, if parking is too expensive. These four factors for each respondent are used to compute revenue earned, and when and if that revenue is lost given a change in parking price or fare. At the same time, the analysis considers in balance the additional revenue earned from the remaining population that would continue to ride COASTER and pay the increased parking price or fare.

The results are presented for both the raw sample (data as collected), and a weighted sample (adjusted to better match the riding population). The weighting procedure is explained in Section 7.1.

The results of this financial analysis are subject to the survey responses given. In particular, the results are influenced by the stated response of riders to parking and fare price changes. These responses are taken at their word, in that a respondents stated departure from COASTER at a parking price of say US$2, is in fact what that respondent would do. Naturally, this is a limitation of the analysis in that it is stated preference. It is possible that in reality the respondent would stay on COASTER at prices at which they indicated that they would depart (as experienced in the MARTA survey of 2009) (Metropolitan Atlanta Rapid Transit Authority, 2009). It is less like that the uncertainly falls in the other direction, in which a rider stating that they would stay on at a given price would in fact depart. Like any forecast based on stated preference information, there are the associated uncertainties between stated and revealed action. Another important consideration in evaluating these results is that they are derived from surveys taken during July 2011. Although the economy has been technically growing throughout the year, the mood of the American public has been broadly pessimistic on the economy for some time. This is the result of macroeconomic facts that include a state unemployment rate at or near 12% for the entire year, a continuing decline in the housing market, stagnant wages, and relatively low growth in gross domestic product and jobs. For many, economic uncertainty was high and thus the stated responses should be interpreted as more reflective of reality in this or similar economic climates.

Overall, the financial analysis sought to provide perspective of how individuals within the sample expected to alter (or not) their travel behavior given prospective price changes. With an increase in parking price or fare, some riders will inevitably be priced out and find an alternative means of transportation that meets their cost objectives. COASTER will lose revenue from these riders that it is currently earning. Others will absorb the price increase given the value that COASTER returns to them and the absence of better alternatives. COASTER will earn more from these riders. The balance of these impacts on the COASTER population is the subject of this section.

7.1. Weighting the Sample

To analyze the impact of these changes on the COASTER population, the sample is re-weighted. The sample was originally collected with two equally sized frames of Drivers and NonDrivers. This design was motivated by an expressed need to ensure adequate representation of people who drive to COASTER and to ensure the sampling of people parking in the COASTER parking lots but not riding COASTER. However, this split is not assumed to be accurate nor do ridership data indicate this to be the case. The intercept survey implementation was otherwise designed to universally engage everyone on the platforms, on the trains, and parking in the parking lots. If the unweighted combination of the two samples were used to express the dynamics of the COASTER population, it would imply that the population is roughly split between Drivers and NonDrivers.

The key dimension of reweighting in this analysis is by station of origin and by Driver/NonDriver. This dimension was chosen as the critical distinction of the sample from the population because the sample size was already a large portion (>30%) of the overall COASTER ridership and that spatial coverage of the line was complete. But the oversampling of drivers would likely disrupt the sample's true share of drivers at specific stations. To adjust for this expected imbalance, the sample is reweighted according to population data available on ridership at each station. As indicated earlier, NCTD provided the project with data on the ridership levels. NCTD provided data on station-specific boardings during July 2011. The data include total weekday boardings per station, which is translatable into average boardings per weekday.

The survey effort included a count of cars within the seven COASTER stations that have parking lots. In addition to the analysis completed earlier, these counts served to inform the relative balance of Drivers and NonDrivers boarding at each station. The average number of cars at each station served as an estimate of the driving population share. The remaining share, as determined by the difference between the average boardings and the average car counts, serves as an estimate of the NonDriver share. The population balance of Drivers and NonDrivers is then determined for each station. The sample observations are given a weight to rebalance the sample such that the weighted ratio of Drivers and NonDrivers in the sample match that of the population station by station. This weighting applied to the station of origin. Table 14 shows the NCTD boardings, average weekday boardings, average cars per day from the sample, the share balances of the population and sample, as well as the relative weights applied to each. Downtown San Diego (Santa Fe Depot Station) was not included in the weighting, as it does not have a parking lot and thus most every passenger originating at the station is a NonDriver.

Table 14: COASTER Boardings in July 2011 and Sample and Population Shares by Station

COASTER STATION	Total Boardings per Weekday	Average Boardings per Weekday	Average Cars per Day in Parking Lot	Estimated Population Share of Drivers Originating at Station	Estimated Population Share of NonDrivers Originating at Station	Sample Share of Drivers Originating at Station	Sample Share of NonDrivers Originating at Station	Driver Weight	NonDriver Weight
Oceanside	20,446	1022	546	53%	47%	48%	52%	1.1	0.9
Carlsbad Village	14,676	734	284	39%	61%	68%	32%	0.6	1.9
Poinsettia	12,283	614	315	51%	49%	57%	43%	0.9	1.1
Encinitas	12,892	645	206	32%	68%	40%	60%	0.8	1.1
Solana Beach	8,307	415	322	78%	22%	67%	33%	1.2	0.7
Sorrento Valley	19,382	969	82	8%	92%	62%	38%	0.1	2.4
Old Town	14,605	730	382	52%	48%	59%	41%	0.9	1.2

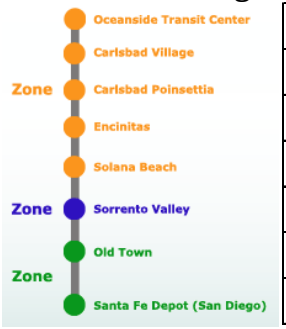
The population shares show that at some stations, such as Oceanside, the balance between Drivers and NonDrivers was relatively equal, and the sample shares reflected this balance. At other stations, such as Carlsbad Village and Solana Beach, the population shares and sample shares were considerably different. The corresponding weights on respondents from each station rebalance the sample to match the estimated population shares.

7.2. Computational Analysis of Changes in Parking and Fare Pricing of COASTER

In this section, the authors analyze the financial impact of the parking pricing usage questions asked in Section 6.4 to evaluate the response of the broader population to changes in parking pricing. The cost response curves provide an estimate of the stated reaction of different riding cohorts to different price increases. These responses are used to estimate the reaction of the individuals, and specific survey questions are used to ascertain what that reaction implies for COASTER revenue.

To ascertain the impact of any change in the behavior of COASTER riders, the fare paid by the respondent was needed. In both surveys, the origin and destination station was obtained. At the time of the survey, the COASTER system had three travel zones. The traversal of zones by passengers determined which fare is paid. Figure 23 shows the COASTER zones in 2011 and the relative fares paid given the number of zones crossed by a rider with a given ticket type.

Figure 23: COASTER Zones and Fares in July 2011



Adult Fares	Zones Traversed			Senior Fares	Zones Traversed		
Ticket Type	1 Zone	2 Zones	3 Zones	Ticket Type	1 Zone	2 Zones	3 Zones
Monthly pass	120	150	165	Monthly pass	41.25	41.25	41.25
30-day pass	120	150	165	30-day pass	41.25	41.25	41.25
Single trip ticket	4	5	5.5	Single trip ticket	2	2.5	2.75
Round trip ticket	8	10	11	Round trip ticket	4	5	5.5
Day pass	14	14	14	Day pass	14	14	14

As shown in Figure 10, the ticket type for respondents was known, as was the zonal traversal of given the origin and destination station. When the ticket type was not provided, a single trip ticket price was assumed. In addition, senior tickets applied to those 60 years and older, and thus respondents within this age category were assigned fare values from the senior table depending on ticket type. In addition to these factors determining ticket type and price, the trip frequency of the respondent on COASTER was needed to estimate the number of trips per year that the respondent takes. This frequency estimate was derived from the trips per week question asked and presented in Figure 9 with the assumption that the respondents traveled 50 weeks a year. For example, a person stating that they made their trip one day a week was assumed to make 50 such trips a year. Respondents stating that they made the trip “less than once per week” were assumed to make the trip once every four weeks. The trip frequency, along with the fare, permitted a direct estimate of the revenue that each individual paid to COASTER over the course of the year. With this estimate, it is then possible to ascertain the impact of an individual being priced off COASTER.

One additional question was necessary to complete an assessment of the parking pricing impact on COASTER revenue. As parking pricing rises, drivers and those impacted by higher prices can react in a number of ways. As indicated in Figure 18, a question was asked of those impacted by parking costs to assess how they would alter their travel patterns if parking was too expensive. Two of the options given allow riders to indicate that they would stop using COASTER and drive to their destination. While these responses were not the majority selected by respondents of either survey, they were the most frequently selected. The remaining responses indicated that the riders would access COASTER using an alternative means such as walk, bicycle, public transit, or a ride from someone else. The distinction between these options is important. COASTER forgoes the ticket revenue and parking revenue of those that opt to drive once they are priced out of parking. For those priced out of parking that move to alternative means of station access, COASTER forgoes the parking revenue but retains the previously estimated ticket revenue. At each hypothetical parking price, the price response curve provides the “opt out” price for most of the sample. For this analysis, those that indicated that they would “maybe still” park at COASTER were considered to not change their behavior at the given price, while those stating that they would “probably not” park at the COASTER lot were evaluated as having changed

their behavior.

With each hypothetical increase in parking price, the revenue from the population parking and driving is included as additional revenue to COASTER, while the reduction in ridership and parking is also considered simultaneously. This analysis assumes that Drivers that decide to stop parking at a given price are not replaced. This assumption is supported by the fact that parking was not found to be at capacity at any of the stations during the survey. This assumption would not hold in an environment in which parking was regularly at capacity within the system. In such an environment, those priced out of parking would be at least to some degree replaced by other drivers willing to pay for parking. However, at the time of the survey, parking supply exceeded parking demand at COASTER stations, hence a replacement assumption is not valid. A similar assumption is in place for ridership in response to fare changes.

Given these assumptions, the impact of parking pricing is a function of:

1) The computed revenue earned by COASTER at each parking price, including hypothetical parking payments and computed ticket fares;
2) The response to parking at each price from US$0 to US$7; and
3) The travel shift of the respondent when COASTER parking is indicated to be too expensive. This can include riders that forgo COASTER completely or just forgo driving to COASTER based on their survey responses.

At each price, the total revenue earned by the individual and across the sample is computed and summed across it. The weights, as described in Section 7.1, are then multiplied by the revenue earned from the respondent. This sum of both the weighted and unweighted revenues are given in the results. These sums are not designed to match the actual revenue earned by COASTER during a year, but they are designed to show how a representative sample of COASTER riders would respond to costs. The trends of these sums can be used to inform policy decisions.

7.3. Results of the Financial Analysis on Parking Prices and Fares

The financial analysis suggests that raising parking prices at COASTER station lots would result in lower overall revenue to COASTER. This result is driven by the relatively large number of drivers that indicated that they would stop using COASTER and drive to their destination, if parking prices were increased to at least US$1. The total forecasted weighted and unweighted revenue earned from the sample at each parking price is given in Figure 24. As explained in more detail later, these results came at a time when the public had exhibited particularly fierce reactions to pricing increases. Companies including Netflix, Verizon, Bank of America and other major banks, all experienced considerable customer backlash during this survey period when announcing price increases (Wingfield and Stelter, 2011; Bernard, 2011; Chen and Lieber,

2011). In most cases, the companies rescinded their announced action.

Figure 24: Total Sample Revenue Projections at Different Parking Prices

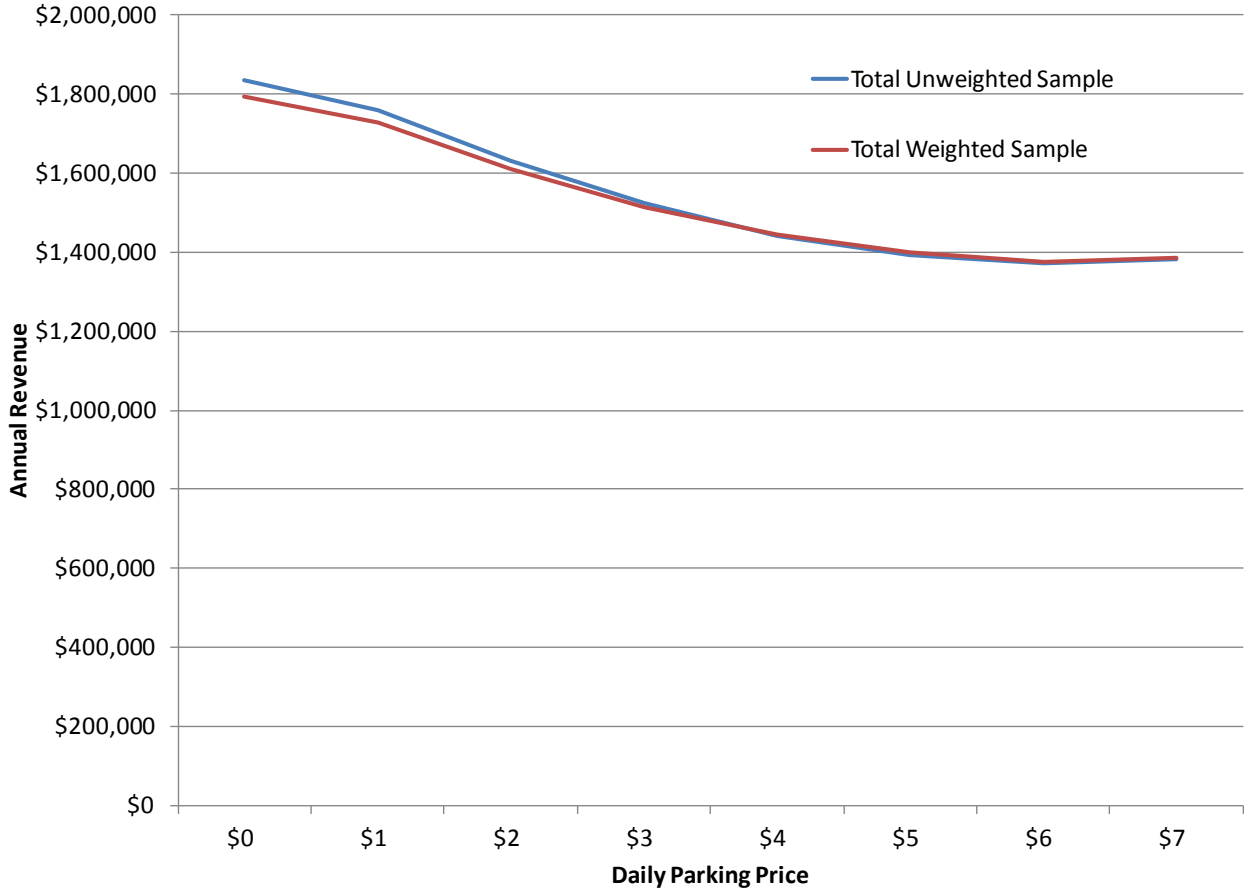
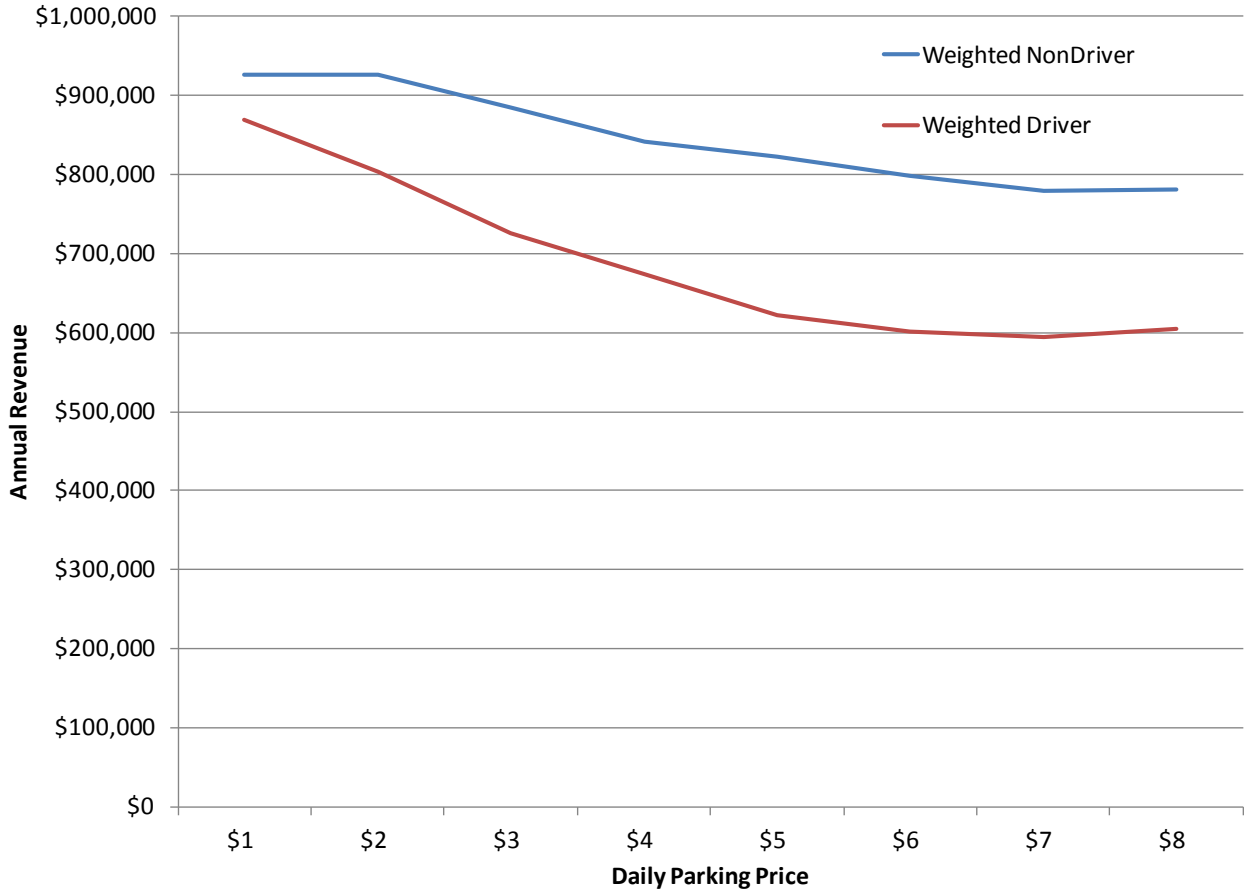


Figure 24 shows the change in revenue that is forecasted to occur at the stated parking prices. As the curve shows, the total revenue earned by both the weighted and unweighted sample drops below the level attained with a parking price of US$0. The revenue levels off at a price of US$6, but it never recovers to the level achieved with free parking. The key reason for this trend is the stated influence that parking pricing has on drivers. As shown earlier, Figure 19 showed the cost response curve of respondents that would stop using COASTER, if parking became too expensive. In that curve, 34% of all respondents that would stop using COASTER, if priced out of parking would do so at a cost of US$1. This cohort also happens to be a group that uses COASTER regularly—holding monthly passes. For example, a rider holding a monthly pass crossing three zones pays US$165 a month, and over 12 months, contributes US$1,980 towards COASTER revenue. The loss of this single rider requires nearly 2,000 parking spaces to be used during the year to make up for it. The individuals that state their intention to abandon COASTER at a parking price of US$1 is "top heavy." Of the 101 Drivers that indicated they would stop driving to COASTER and would instead not use COASTER for travel, 80 of them are three-zone monthly pass holders. This amounts to a revenue loss of US$158,400. Over the year, the

recovery of that loss requires that 158,400 daily parking passes be sold. Based on the parking capacities reported in Table 10, there are 3,422 parking spaces in the COASTER system. They would have to be all sold to capacity for 47 days for the loss of these 80 riders to be recovered from the US$1 daily parking cost. By itself, this would seem doable, if COASTER parking was fully used regularly, but recall that these are just the sample counts. The total riding population is between three to four times larger. The drop in revenue is completely driven by the Drivers. As shown in Figure 25, the NonDrivers react far less severely in net to an increase in parking cost. Some NonDrivers do depart from COASTER, but the net increase in parking revenue from others recovers the cost. The fall in revenue from Drivers is shown more precipitously.

Figure 25: Total Sample Revenue Projections for Drivers and NonDrivers

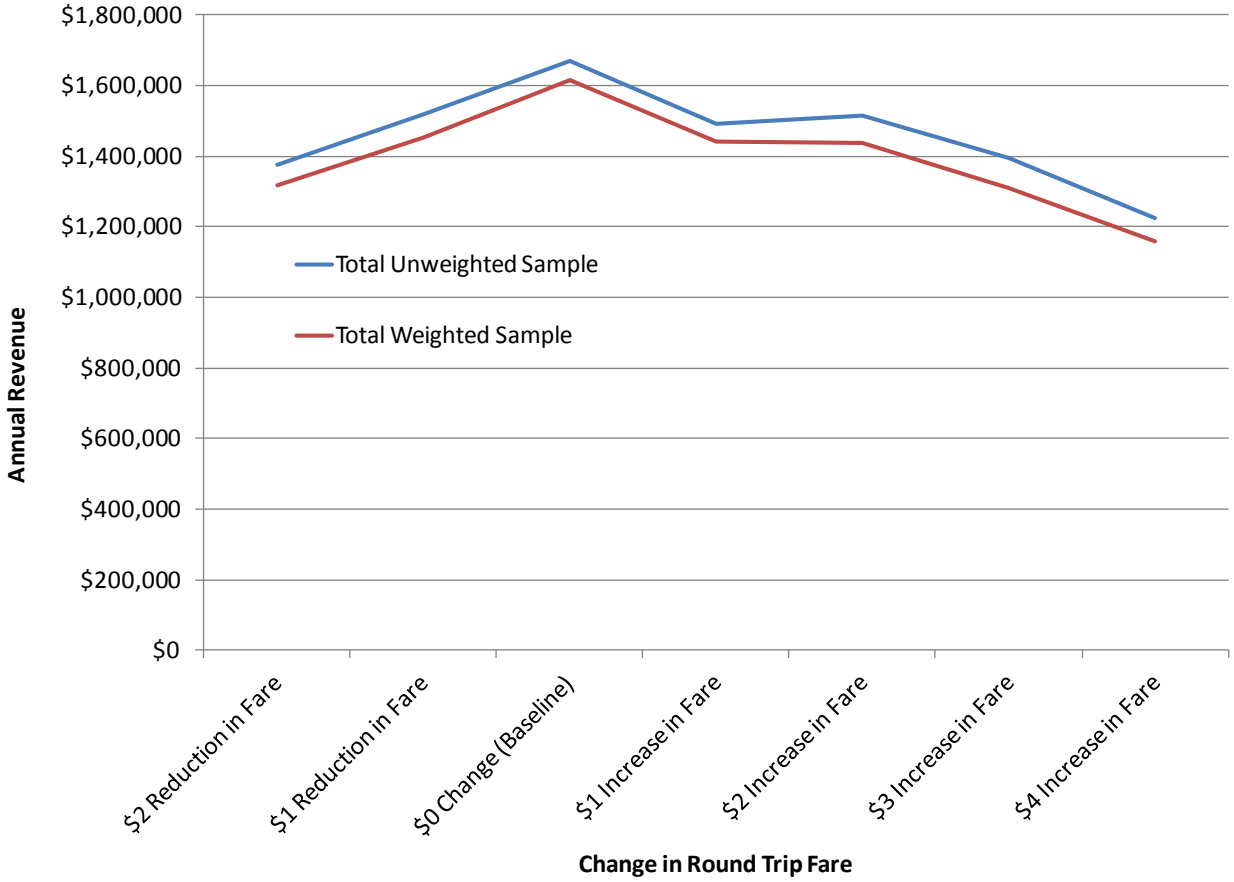


The key consideration that emerges from this analysis is that in the case of COASTER, the ridership that drives and parks at the station comprise a large share of the regular users with monthly passes. If parking pricing drives these everyday riders away, the lost revenue per rider is high. The analysis here suggests that this loss is not recovered by increased parking revenue.

An analysis of revenue changes due to fare changes results in a similar conclusion. The questions that focused on fare charges evaluated the reaction of people to fare reductions and increases,

since existing fares are non-zero. The results of the total fare analysis are shown in Figure 26.

Figure 26: Total Sample Total Revenue from Fare Changes



The resulting trend that emerges from Figure 26 has some similarities and distinctions from the parking cost changes. The first two observations are the computed revenue changes that would occur with a fare reduction. The graph shows that revenues stay flat or decline. This decline is driven by the reduction in price per ticket. Respondents stating that they would use COASTER more, counters this decline. By “more,” respondents were assumed to use the COASTER 20% than their stated usage; however, this assumption is subject to some uncertainty. Also not considered in the case of a fare reduction is the draw of people who do not use COASTER currently. These people were outside the scope of the survey, and thus, the projections do include the addition of new ridership that might occur as a result of fare reductions. This implies that the revenue reductions resulting from reducing fare would be an underestimation. The increase in fare was assumed to push some riders away from COASTER. The cost response curves shown earlier indicate the pace at which this happens with increasing price. The results indicate a difference in the conclusion between the weighted and unweighted sample. The unweighted indicates that revenues would be relatively flat up to a US$2 increase in round-trip fare (US$30 monthly); however, the weighted sample indicates a more precipitous decline in revenue

resulting from a fare increase.

7.4. A Deeper Dissection of the Financial Analysis

This section digs deeper into the change in revenue forecasted for COASTER. In short, the fundamental dynamic that is reducing the financial return of any increase in parking pricing is the stated exodus of high value riders. High value riders are those that are paying more than US$1,600 in annual ticket fare to COASTER. The vast majority of these high value riders are paying US$1,980, the maximum possible, which is the three-zone monthly pass (US$165) multiplied by 12 months.

Table 15 shows the number of drivers that stated that they would stop riding COASTER and do something else (e.g., drive, carpool, etc.) in response to respective parking price. This table does not include riders that would stop driving to COASTER but would still access COASTER by other means. Table 15 presents these riders as a subgroup of the combined sample of 1,631. They are categorized by the annual fare that they pay to COASTER. Table 15 shows that the distribution of passenger loss by fare paid is skewed towards the higher fares. For simplicity, these data are shown for the raw sample.

Table 15 Cumulative Passenger Loss by Parking Price and Annual Ticket Fare Paid

Combined Sample	Cumulative Passenger Loss by Parking Price by Current Annual Fare Paid								
Annual Ticket Fare Currently Paid	$0	$1	$2	$3	$4	$5	$6	$7	Total
1 to 400	0	25	19	18	12	14	7	2	97
400 to 800	0	21	17	8	7	2	1	0	56
800 to 1200	0	3	0	1	0	0	1	0	5
1200 to 1600	0	8	6	8	2	2	1	1	28
1600 to 2000	0	81	63	39	28	13	7	0	231
Total	0	138	105	74	49	31	17	3	417

To put the loss of these high-grossing riders in context, the loss of one rider resulting from a parking price increase of US$1 would require 1,980 spaces to be filled and paid. This could be done in a single day, if parking is full at all COASTER stations as there are about 3400 spaces in the system. However, as parking was not at capacity at the time of the report, this analysis assumes that those riders lost from a parking price increase would not be replaced by new drivers. Hence, as prices increase, there are fewer and fewer filled spaces to recover the loss of these high value riders. Table 16 multiplies the fare paid by the riders shown in Table 15 to illustrate the cumulative loss associated with their departure.

Table 16 Cumulative Ticket Revenue Loss by Parking Price and by Annual Fare

Combined Sample	Cumulative Ticket Revenue Loss by Parking Price								
Annual Ticket Fare Currently Paid	$0	$1	$2	$3	$4	$5	$6	$7	Total
1 to 400	0	$2,966	$219	$3,850	$1,241	$1,825	$878	$244	$11,222
400 to 800	0	$10,560	$8,685	$3,960	$3,670	$990	$700	$0	$28,565
800 to 1200	0	$3,200	$0	$1,100	$0	$0	$1,000	$0	$5,300
1200 to 1600	0	$11,075	$8,510	$11,470	$2,625	$2,775	$1,375	$1,440	$39,270
1600 to 2000	0	$155,880	$120,035	$74,370	$54,335	$24,360	$13,350	$0	$442,330
Total	0	$183,681	$137,449	$94,750	$61,871	$29,950	$17,303	$1,684	$526,687

Based on the survey response and the fares paid by those respondents, in aggregate, the increase in parking price to US$1 would result in a loss of US$183,681 from respondents in the combined sample. This loss is overwhelmingly driven by the departure of three-zone monthly riders. To put this loss in context, this is about 11% of the ticket revenue earned by the entire combined sample of 1,631 riders (this is true for both weighted and unweighted data; though these numbers are unweighted).

Since this loss would be driven by a new source of revenue gained through parking charges, it is relevant to evaluate the revenue that would be earned by those that continue to ride COASTER and park at the lot. The parking revenue earned at each price within the sample is determined by the respondents that indicated that they would still drive, park, and pay for COASTER parking and the frequency with which they use COASTER. Those that stop parking at COASTER, but still access COASTER by other means, induce no net revenue change. The parking revenue earned at each price is given in Table 17, which is compared to the total ticket revenue lost at each price (the bottom row in Table 16, summed cumulatively across columns).

Table 17 Parking Revenue Earned as Compared to Ticket Revenue Lost

Combined Sample	Total Parking Revenue Earned at Each Parking Price							
Annual Ticket Fare Currently Paid	$0	$1	$2	$3	$4	$5	$6	$7
Parking Revenue	0	$135,875	$166,550	$165,450	$152,700	$139,000	$133,350	$145,600
Cumulative Loss in Ticket Revenue	0	$183,681	$321,129	$415,879	$477,750	$507,700	$525,003	$526,687
Net Change in Revenue	0	-$47,806	-$154,579	-$250,429	-$325,050	-$368,700	-$391,653	-$381,087

Table 17 shows the nature of the revenue loss by parking price within the combined sample of 1,631 respondents. The revenue earned by those that remain at COASTER and pay for the parking is US$135,875, which is less than the projected US$183,681 to be lost in ticket revenue

by those that stop using COASTER. This loss generally gets worse as the price goes up until a price of US$7, at which point it declines slightly.

It is important to emphasize that this result is subject to the uncertainty that naturally arise from stated response to price changes. The uncertainty is also lopsided. As stated earlier, it is more likely that some of the respondents who stated that they would depart COASTER at a given price would in fact stay. It is less likely that respondents would leave COASTER at a price that they stated they would be willing to pay. The challenge in interpretation is similar to that which arises in stated preference surveys on price. Effectively, it requires the assumption that some people simply answered incorrectly from what they would actually do, and this assumption introduces its own uncertainty because in effect a sensitivity analysis is betting that more people will stay with COASTER given a price increase than is indicated in the survey data.

7.5. The economic climate of 2011 and pricing policy

There are a number of reasons why this result has emerged. The California price of gasoline was between a price US$3.80 and $4.00 during the months of June and July 2011. This was historically high, but below the previous peak of US$4.64 (EIA, 2011). This relatively high price would suggest that the COASTER might remain relatively competitive with private vehicle use. However, the current economic climate has been perceived to be very hostile to the average consumer. Consumer reactions to other institutions raising prices even by small nominal amounts have drawn unusually strong public reactions. For example, Bank of America, which recently tried to raise debit card fees by just US$5 a month, experienced considerable consumer backlash, which was strong enough to force them to abandon the plan in November 2011 (Bernard, 2011). Other big banks, including Chase and Wells Fargo, have decided against raising prices at this time in part because of this experience (Bernard, 2011). Netflix also experienced a larger than expected exodus of subscribers as a result of a modest price increase (Wingfield and Stelter, 2011). In December 2011, Verizon announced plans to charge a $2 convenience fee for billing, only to rescind it a day later due to customer backlash (Chen and Lieber, 2011). All of these cases involved price increases that, on a monthly basis, were less than a US$1 per day price increase of public transit parking would impose on the commuter. In all of the above circumstances, large companies experienced this backlash by raising prices on activities that consumers were already doing and had to do, in order to utilize the services. Such is similar with transit parking. Hence, there is evidence that the economic climate in the years surrounding 2011 have made consumers very price sensitive. Some of this sensitivity may be in part driven by emotion, as well as by economic constraints. The data here indicate that this price sensitivity extends up to the high-fare riders. This dynamic in the context of the economic climate of 2011, suggest caution in pricing policy.

8. Conclusion

In addition to evaluating pricing, this survey provides data demonstrating that the COASTER is taking cars off the road and reducing household vehicle ownership. These effects are lowering air pollution and redirecting capital back to the San Diego metropolitan region. With respect to pricing, the survey results show that the stated price sensitivity of COASTER riders is different between Drivers and NonDrivers. Not surprisingly, Drivers have a greater stated sensitivity to parking cost changes than do NonDrivers. Only 20% of Drivers believed that the change in parking fares would not impact how they used COASTER, whereas nearly 60% of NonDrivers had the same opinion. Surprisingly, more Drivers (38%) stated that they would not change the way that they used COASTER in response to fare changes, in comparison to 42% of NonDrivers. Given a stark choice between raising prices on parking or round trip fares by US$1, a majority of Drivers preferred that fares be raised by US$1, whereas a similarly sized majority of NonDrivers preferred that parking costs be raised by US$1.

The objective of this study was, in part, to evaluate whether parking pricing would be strategic for COASTER to undertake in the current environment. In this survey, Drivers were found to have a higher income than NonDrivers, and thus on balance, should be able to absorb the costs more readily than NonDrivers. But Drivers exhibit two travel characteristics that are important to consider in pricing policy. One characteristic is that Drivers are by far, more regular COASTER customers than NonDrivers. Indeed, 58% of Drivers travel on COASTER four to five days per week, versus 43% of NonDrivers. In contrast, 34% of NonDrivers take COASTER less than once a week versus 24% of Drivers. Drivers exhibited a greater propensity to stop using COASTER and drive to their destination, if COASTER became too expensive. This propensity is the dynamic that drove the revenue projections from an increase in parking prices down. Hence, given that Drivers are a consistent customer base to COASTER, the pricing policy impact on this cohort should be considered carefully.

One question that emerged from this analysis is: why would so many Drivers prefer that a US$1 charge be levied on fares as opposed to parking? There are several likely explanations. One is simply political: American culture is generally accustomed to free parking. It is likely that economics and time are key explanatory variables. In addition, as more than half of the study drivers have monthly passes, their increase in cost due to a fare increase would be US$15, given the current formula applied by NCTD ($1 per round trip is equal to $15 for a monthly ticket that crosses the same number of zones). This would amount to an increase of US$180 throughout the year for the monthly pass, whereas a US$1 daily parking charge would impose a cost increase closer to US$260 annually. In addition, paying for parking is an additional task for drivers to complete before catching the train (depending upon implementation strategy). As more than 60% of Drivers are monthly ticket or 30-day pass holders, they currently do not have a daily transaction involved with catching the train. Paying US$1 for parking adds a transaction to a

routine, which is mostly centered on the commute, paying US$1 for fares would not. Integrating parking pricing with services, like the Compass Card, could mitigate this problem. Another economic reason may be based on the fact that monthly ticket holders can more easily pay for their tickets pre-tax, whereas single ticket holders cannot. Given the favorable tax policy towards public transit tickets (IRS Code Section 132f), consumers paying higher fares (mainly drivers) indicated that given a choice, they would prefer a fare increase over a parking price increase. A US$1 fare increase paid pre-tax translates into a US$1 increase in revenue to COASTER, but less than a US$1 increase in price to the rider. In contrast, paying for parking in daily increments would more likely require spending post-tax dollars. Similar tax policy does exist for parking under the same IRS code, but it requires a new payment—and one that must be done in monthly increments. These are all impediments to paying for parking as efficiently as monthly transit tickets. Thus, how parking is charged to riders could have a notable impact on their willingness to pay.

The analysis completed in this study does not suggest that charging for parking will increase revenues for the COASTER line at this time, particularly in light of the current economic climate. This conclusion is based on several exogenous dynamics. First, during 2011, parking is not used to capacity at any of the COASTER lots. This means that charging for parking will cause some riders not to park at the COASTER lot. Some of those riders will choose other means of transportation, and COASTER will lose both the parking revenue and the fare from those riders. In an environment where parking is at capacity, this loss may not occur—as riders who decide not to pay for parking are replaced by those that do. The lost ticket revenue is important to consider with respect to drivers, as the survey showed that they are the three-zone monthly pass holders of the system. Each lost passenger of this type requires nearly 2,000 spaces to be filled and paid for a year to break even. In the data, it is the departure of just 80 respondents of this type that contributes considerably to the forecasted drop in revenue resulting from parking price increases among a sample of more than 1,600 riders.

These considerations, as well as others related to the environmental impact of shifting drivers to the road, should be evaluated in light of future pricing decisions. The COASTER system has a mitigating impact on the public costs of automobile use in the San Diego region. Hence, pricing decisions may impact the relative magnitude of those public benefits. One area in which pricing may be beneficial is by managing and reducing the propensity of parking at COASTER stations by non-transit riders. This is most evident at the Solana Beach station, where based on survey responses and observed parking occupancy counts, nearly half of Drivers parking were not using COASTER. At the same time, the station had the highest level of average parking use. Charging for parking at stations with high levels of non-rider use, might be one policy that addresses a key problem with free parking at public transit stations. It may also serve as a means of introducing parking pricing gradually to the public by targeting the stations where COASTER parking would

be made more available as a result, and non-riders that decide to park there anyway would generate revenue.

The results of this survey suggest that a majority of drivers would pay at least US$1 for parking and still use COASTER. But the financial analysis indicates that many of those that stated that they would depart COASTER are three-zone monthly users. These conclusions with respect to parking pricing are contingent on this stated action becoming a revealed action. If it does, then COASTER would lose money by introducing parking pricing. If it does not, then parking pricing may be net neutral or positive for COASTER. In the longer run, under different economic and parking demand conditions, a parking pricing strategy should be considered.

To fully evaluate the benefits of parking pricing, the agencies involved should evaluate the broader objectives sought by the policy. Is the policy designed to manage parking or is it designed to increase revenue? If the policy is strictly intended to increase revenue (i.e., lowering taxpayer costs), then the agencies should consider whether parking pricing is the most efficient means of achieving this objective in the given economic climate. In an environment where parking is at capacity, the policy is more likely to be successful. However, outside of those conditions, the agencies may find that it is more efficient to seek other revenue sources (e.g., advertising).

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Appendix A – Intercept Surveys

TRANSPORTATION SURVEY

Thank you for your help with this survey. Your input will help to improve our services to meet the needs of our riders! All answers are completely confidential.

1 Where did you park your vehicle today?

1 ☐ In the COASTER station parking lot
2 ☐ On the street adjacent at an unmetered spot
3 ☐ On the street at a metered spot
4 ☐ At another parking lot within 2 blocks of the COASTER station
5 ☐ At another parking lot more than 2 blocks away from the COASTER station
10 ☐ Other, please describe:_____

2 Which COASTER station is closest to where you parked?

1 ☐ Oceanside Transit Center
2 ☐ Carlsbad Poinsettia
3 ☐ Solana Beach
4 ☐ Old Town (San Diego)
5 ☐ Carlsbad Village
6 ☐ Encinitas
7 ☐ Sorrento Valley
8 ☐ Santa Fe Depot (San Diego)

3 Where did you come from before you parked your car? *(Please select one)*

1 ☐ Home
2 ☐ Business meeting
3 ☐ Shopping
4 ☐ Recreation/visit friends
5 ☐ Work
6 ☐ School/college
7 ☐ Sports event
8 ☐ Medical services
10 ☐ Other, please describe:_____

4 What are two intersecting streets that are nearby that place?

Street #1:_____
Street #2:_____
City:_____

5 At what time did you start your trip from home today?

_____ _____ : _____ _____ 1 ☐ AM / 2 ☐ PM

6 How often do you DRIVE AND PARK at or near the COASTER station? *(Please circle one)*

1·····2·····3·····4·····5·····6·····7 times per week

77 ☐ Less than once a week

7 Are you (or have you been) riding the COASTER today?

1 ☐ No **(GO TO QUESTION 8)**
2 ☐ Yes **(GO TO QUESTION 11)**

8 What type of destination are you going to now? *(Please select one)*

1 ☐ Home
2 ☐ Business meeting
3 ☐ Shopping
4 ☐ Recreation/visit friends
5 ☐ Work
6 ☐ School/college
7 ☐ Sports event
8 ☐ Medical services
10 ☐ Other, please describe: _____

9 What are two intersecting streets that are nearby that place?

Street #1:_____
Street #2:_____
City:_____

10 How many days a week do you go to this destination? *(Please circle one)*

1·····2·····3·····4·····5·····6·····7 days per week

77 ☐ Less than once a week

AFTER YOU ANSWER THIS, GO TO QUESTION 19 ON THE BACKSIDE. ⟶

11 After riding COASTER away from your car today, at which station will you (or did you) get off?

1 ☐ Oceanside Transit Center
2 ☐ Carlsbad Poinsettia
3 ☐ Solana Beach
4 ☐ Old Town (San Diego)
5 ☐ Carlsbad Village
6 ☐ Encinitas
7 ☐ Sorrento Valley
8 ☐ Santa Fe Depot (San Diego)

12 Where are you (or were you) going from that station? *(Please select one)*

1 ☐ Home
2 ☐ Business meeting
3 ☐ Shopping
4 ☐ Recreation/visit friends
5 ☐ Work
6 ☐ School/college
7 ☐ Sports event
8 ☐ Medical services
10 ☐ Other, please describe: _____

13 What are two intersecting streets that are nearby that place?

Street #1:_____
Street #2:_____
City:_____

14 After you exit that station, how do you get to your destination?

1 ☐ Walk all the way
2 ☐ Taxi
3 ☐ Motorcycle/moped
4 ☐ Bicycle
↳ ○ Bike parked at station ○ Brought bike on train
5 ☐ Car
↳ ○ Drive alone ○ Carpool ○ Be dropped off/ picked up at station
6 ☐ Vanpool
↳ ○ SANDAG-subsidized ○ Unsubsidized ○ Unsure
7 ☐ Bus/train
↳ ○ SPRINTER ○ Trolley ○ Bus ○ Shuttle
10 ☐ Other, please describe: _____

15 For your trip today, do you have a:

1 ☐ Monthly pass
2 ☐ 30-Day pass
3 ☐ Single trip ticket
4 ☐ Round trip ticket
5 ☐ Day pass

16 How many days a week do you typically make this trip using COASTER? *(Please circle one)*

1·····2·····3·····4·····5·····6·····7 days per week

77 ☐ Less than once a week

17 If the COASTER stopped operating for a while (say 1 year), would your household have to get another car? *(Please circle one)*

Definitely·····Probably·····Probably Not·····Definitely Not

PLEASE CONTINUE ON THE BACKSIDE PAGE.

18 **If the COASTER was not available to use, how would you most likely change how you travel to make this trip?** *(Please select one)*

1 ☐ I would not make this trip
2 ☐ Walk all the way
3 ☐ Drive alone all the way
4 ☐ Start a carpool/vanpool
5 ☐ Join a carpool/vanpool
6 ☐ Bicycle
7 ☐ Motorcycle/moped
8 ☐ Taxi
9 ☐ Other transit
→ ○ SPRINTER ○ Trolley ○ Bus ○ Shuttle
10 ☐ Other, please describe: _____

19 **How many cars or motorcycles does your household have?**

1 ☐ Zero 2 ☐ One 3 ☐ Two
4 ☐ Three 5 ☐ Four 6 ☐ Five or more

20 **How many people in your household can drive?**

1 ☐ Zero 2 ☐ One 3 ☐ Two
4 ☐ Three 5 ☐ Four 6 ☐ Five or more

21 **How many miles per gallon do you think you get with your most frequently used vehicle (approximately)?**

Miles per gallon: _____

22 **If parking a car at COASTER station lots had a daily cost, what impact (if any) would this have on your use of COASTER?**

1 ☐ It would not impact how I use COASTER or how I travel to COASTER parking lots
(GO TO QUESTION 25)
2 ☐ It may impact how I use COASTER or how I travel to COASTER parking lots depending on the daily cost

23 **At each cost of daily parking below, please indicate how you think you would change your use of COASTER given the following parking costs per day** *(Please select one answer per row).*

Cost per day to park at a COASTER lot	PROBABLY STILL park a car at the COASTER lot	MAYBE STILL park a car at the COASTER lot	PROBABLY STOP parking a car at the COASTER lot
$0.00 (Free, no cost)	☐1	☐2	☐3
$1.00	☐1	☐2	☐3
$2.00	☐1	☐2	☐3
$3.00	☐1	☐2	☐3
$4.00	☐1	☐2	☐3
$5.00	☐1	☐2	☐3
$6.00	☐1	☐2	☐3
$7.00	☐1	☐2	☐3

24 **If PARKING COSTS were too expensive at your COASTER station parking lot, how do you think you would most likely change your travel behavior?** *(Please select one)*

1 ☐ Walk/Bicycle to the station
2 ☐ Use public transit to get to the station
3 ☐ Stop using COASTER and drive to destination
4 ☐ Stop using COASTER and carpool/vanpool to my destination
5 ☐ Get a ride to the station driven by someone else
6 ☐ Search for parking elsewhere near the station and walk to my destination
10 ☐ Other, please describe: _____

25 **If COASTER fares changed (as either an increase or decrease), how would this change your use of the system?** *(Please select one answer per row).*

1 ☐ It would not impact how I use COASTER
(GO TO QUESTION 27)
2 ☐ It may impact how I use COASTER depending on the fare change.

26 **At each change in fare below, please indicate how you think you would change your use of COASTER.** *(Please select one answer per row).*

If the Change in Round Trip Fare or (Monthly Fare) was…	Use COASTER MORE	Use COASTER THE SAME	Use COASTER LESS	STOP using COASTER
$2 Less per Round Trip (Monthly Pass $30 Less)	☐1	☐2	☐3	☐4
$1 Less per Round Trip (Monthly Pass $15 Less)	☐1	☐2	☐3	☐4
$1 More per Round Trip (Monthly Pass $15 More)	☐1	☐2	☐3	☐4
$2 More per Round Trip (Monthly Pass $30 More)	☐1	☐2	☐3	☐4
$3 More per Round Trip (Monthly Pass $45 More)	☐1	☐2	☐3	☐4
$4 More per Round Trip (Monthly Pass $60 More)	☐1	☐2	☐3	☐4

27 **If, in order to cover operating cost shortfalls and make up for reduced federal and state support, the COASTER had to raise either parking costs OR fares by $1 per day, which would you prefer?**

1 ☐ Fare increase 2 ☐ Parking cost increase

28 **Please indicate your gender and age:**

1 ☐ Male 2 ☐ Female

1 ☐ 18 or younger
2 ☐ 19 to 29
3 ☐ 30 to 39
4 ☐ 40 to 49
5 ☐ 50 to 59
6 ☐ 60 or older

29 **Which category best describes your household's 2010 pre-tax income?**

1 ☐ Under $10,000
2 ☐ $10,000 to $25,000
3 ☐ $25,000 to $50,000
4 ☐ $50,000 to $75,000
5 ☐ $75,000 to $100,000
6 ☐ $100,000 to $150,000
7 ☐ Over $150,000

30 **What is your highest level of educational attainment?**

1 ☐ Elementary school
2 ☐ High school
3 ☐ 2-year college or professional school
4 ☐ 4-year college
5 ☐ Graduate or professional degree

Those are all the questions. Thank you very much for taking the time to do the survey. Your feedback will help to improve the use and management of COASTER stations. Please return the survey to the field interviewer.

FOR E&W STAFF TO FILL OUT:

Date: _____ ID: _____

Station or Train #: _____

Time: _____

Location: Parking Lot / Platform / On train

Administered: SA / RA

TRANSPORTATION SURVEY

Thank you for your help with this survey. Your input will help to improve our services to meet the needs of our riders! All answers are completely confidential.

1 Which COASTER station did you (or will you) enter for this trip?

1 ☐ Oceanside Transit Center
2 ☐ Carlsbad Poinsettia
3 ☐ Solana Beach
4 ☐ Old Town (San Diego)
5 ☐ Carlsbad Village
6 ☐ Encinitas
7 ☐ Sorrento Valley
8 ☐ Santa Fe Depot (San Diego)

2 How did you arrive at this station?

1 ☐ Walk all the way
2 ☐ Taxi
3 ☐ Motorcycle/moped
4 ☐ Bicycle
→ ○ Parked bike at station ○ Brought bike on train
5 ☐ Car
→ ○ Drive alone ○ Carpool ○ Was dropped off/ picked up
6 ☐ Vanpool
→ ○ SANDAG-subsidized ○ Unsubsidized ○ Unsure
7 ☐ Bus/train
→ ○ SPRINTER ○ Trolley ○ Bus ○ Shuttle
10 ☐ Other, please describe: _____

3 Where did you come from to get on the COASTER? *(Please select one)*

1 ☐ Home
2 ☐ Business meeting
3 ☐ Shopping
4 ☐ Recreation/visit friends
5 ☐ Work
6 ☐ School/college
7 ☐ Sports event
8 ☐ Medical services
10 ☐ Other, please describe: _____

4 What are two intersecting streets that are nearby that place?

Street #1: _____
Street #2: _____
City: _____

5 At what time did you start your trip from home today?

_____ _____ : _____ _____ 1 ☐ AM / 2 ☐ PM

6 At which COASTER station will you (or did you) get off?

1 ☐ Oceanside Transit Center
2 ☐ Carlsbad Poinsettia
3 ☐ Solana Beach
4 ☐ Old Town (San Diego)
5 ☐ Carlsbad Village
6 ☐ Encinitas
7 ☐ Sorrento Valley
8 ☐ Santa Fe Depot (San Diego)

7 Where will you go after you get off the COASTER? *(Please select one)*

1 ☐ Home
2 ☐ Business meeting
3 ☐ Shopping
4 ☐ Recreation/visit friends
5 ☐ Work
6 ☐ School/college
7 ☐ Sports event
8 ☐ Medical services
10 ☐ Other, please describe: _____

8 What are two intersecting streets that are nearby that place?

Street #1: _____
Street #2: _____
City: _____

→

9 After you exit the station, how will you get to your destination?

1 ☐ Walk all the way
2 ☐ Taxi
3 ☐ Motorcycle/moped
4 ☐ Bicycle
→ ○ Bike parked at station ○ Brought bike on train
5 ☐ Car
→ ○ Drive alone ○ Carpool ○ Be dropped off/ picked up at station
6 ☐ Vanpool
→ ○ SANDAG-subsidized ○ Unsubsidized ○ Unsure
7 ☐ Bus/train
→ ○ SPRINTER ○ Trolley ○ Bus ○ Shuttle
10 ☐ Other, please describe: _____

10 For your trip today, do you have a:

1 ☐ Monthly pass
2 ☐ 30-Day pass
3 ☐ Single trip ticket
4 ☐ Round trip ticket
5 ☐ Day pass

11 How many days a week do you go to this destination? *(Please circle one)*

1·····2·····3·····4·····5·····6·····7 days per week

77 ☐ Less than once a week

12 How many people in your household can drive?

1 ☐ Zero
2 ☐ One
3 ☐ Two
4 ☐ Three
5 ☐ Four
6 ☐ Five or more

13 How many cars or motorcycles does your household have?

1 ☐ Zero **(GO TO QUESTION 17)**
2 ☐ One
3 ☐ Two
4 ☐ Three
5 ☐ Four
6 ☐ Five or more

14 Do you have access to use one of those vehicles?

1 ☐ No **(GO TO QUESTION 16)**
2 ☐ Yes

15 How many miles per gallon does the vehicle you would most likely use get (approximately)?

Miles per gallon: _____

16 What is the main reason you are not using a vehicle to make this trip? *(Please select one)*

1 ☐ I do not own a vehicle
2 ☐ Vehicle temporarily unavailable
3 ☐ Vehicle used by someone else in household
4 ☐ It is cheaper to take COASTER
5 ☐ I prefer taking COASTER over driving
6 ☐ Parking at my destination is expensive
7 ☐ I take COASTER for environmental reasons
10 ☐ Other: _____

17 If the COASTER stopped operating for a while (say 1 year), would your household have to get another car? *(Please circle one)*

Definitely·····Probably·····Probably Not·····Definitely Not

PLEASE CONTINUE ON THE BACKSIDE PAGE.

18 **If the COASTER was not available to use, how would you most likely change how you travel to make this trip?** *(Please select one)*

1 ☐ I would not make this trip
2 ☐ Walk all the way
3 ☐ Drive alone all the way
4 ☐ Start a carpool/vanpool
5 ☐ Join a carpool/vanpool
6 ☐ Bicycle
7 ☐ Motorcycle/moped
8 ☐ Taxi
9 ☐ Other transit
→ ○ SPRINTER ○ Trolley ○ Bus ○ Shuttle
10 ☐ Other, please describe: _____

19 **If parking a car at COASTER station lots had a daily cost, what impact (if any) would this have on your use of COASTER?**

1 ☐ It would not impact how I use COASTER or how I travel to COASTER parking lots
(GO TO QUESTION 22)
2 ☐ It may impact how I use COASTER or how I travel to COASTER parking lots depending on the daily cost

20 **At each cost of daily parking below, please indicate how you think you would change your use of COASTER given the following parking costs per day** *(Please select one answer per row).*

Cost per day to park at a COASTER lot	PROBABLY STILL park a car at the COASTER lot	MAYBE STILL park a car at the COASTER lot	PROBABLY STOP parking a car at the COASTER lot
$0.00 (Free, no cost)	☐1	☐2	☐3
$1.00	☐1	☐2	☐3
$2.00	☐1	☐2	☐3
$3.00	☐1	☐2	☐3
$4.00	☐1	☐2	☐3
$5.00	☐1	☐2	☐3
$6.00	☐1	☐2	☐3
$7.00	☐1	☐2	☐3

21 **If PARKING COSTS were too expensive at your COASTER station parking lot, how do you think you would most likely change your travel behavior?** *(Please select one)*

1 ☐ Walk/Bicycle to the station
2 ☐ Use public transit to get to the station
3 ☐ Stop using COASTER and drive to destination
4 ☐ Stop using COASTER and carpool/vanpool to my destination
5 ☐ Get a ride to the station driven by someone else
6 ☐ Search for parking elsewhere near the station and walk to my destination
10 ☐ Other, please describe: _____

22 **If COASTER fares changed (as either an increase or decrease), how would this change your use of the system?** *(Please select one answer per row.)*

1 ☐ It would not impact how I use COASTER
(GO TO QUESTION 24)
2 ☐ It may impact how I use COASTER depending on the fare change.

23 **At each change in fare below, please indicate how you think you would change your use of COASTER.** *(Please select one answer per row).*

If the Change in Round Trip Fare or (Monthly Fare) was…	Use COASTER MORE	Use COASTER THE SAME	Use COASTER LESS	STOP using COASTER
$2 Less per Round Trip (Monthly Pass $30 Less)	☐1	☐2	☐3	☐4
$1 Less per Round Trip (Monthly Pass $15 Less)	☐1	☐2	☐3	☐4
$1 More per Round Trip (Monthly Pass $15 More)	☐1	☐2	☐3	☐4
$2 More per Round Trip (Monthly Pass $30 More)	☐1	☐2	☐3	☐4
$3 More per Round Trip (Monthly Pass $45 More)	☐1	☐2	☐3	☐4
$4 More per Round Trip (Monthly Pass $60 More)	☐1	☐2	☐3	☐4

24 **If, in order to cover operating cost shortfalls and make up for reduced federal and state support, the COASTER had to raise either parking costs OR fares by $1 per day, which would you prefer?**

1 ☐ Fare increase
2 ☐ Parking cost increase

25 **Please indicate your gender and age:**

1 ☐ Male
2 ☐ Female

1 ☐ 18 or younger
2 ☐ 19 to 29
3 ☐ 30 to 39
4 ☐ 40 to 49
5 ☐ 50 to 59
6 ☐ 60 or older

26 **Which category best describes your household's 2010 pre-tax income?**

1 ☐ Under $10,000
2 ☐ $10,000 to $25,000
3 ☐ $25,000 to $50,000
4 ☐ $50,000 to $75,000
5 ☐ $75,000 to $100,000
6 ☐ $100,000 to $150,000
7 ☐ Over $150,000

27 **What is your highest level of educational attainment?**

1 ☐ Elementary school
2 ☐ High school
3 ☐ 2-year college or professional school
4 ☐ 4-year college
5 ☐ Graduate or professional degree

Those are all the questions. Thank you very much for taking the time to do the survey. Your feedback will help to improve the use and management of COASTER stations. Please return the survey to the field interviewer.

FOR E&W STAFF TO FILL OUT:

Date: _____ ID: _____

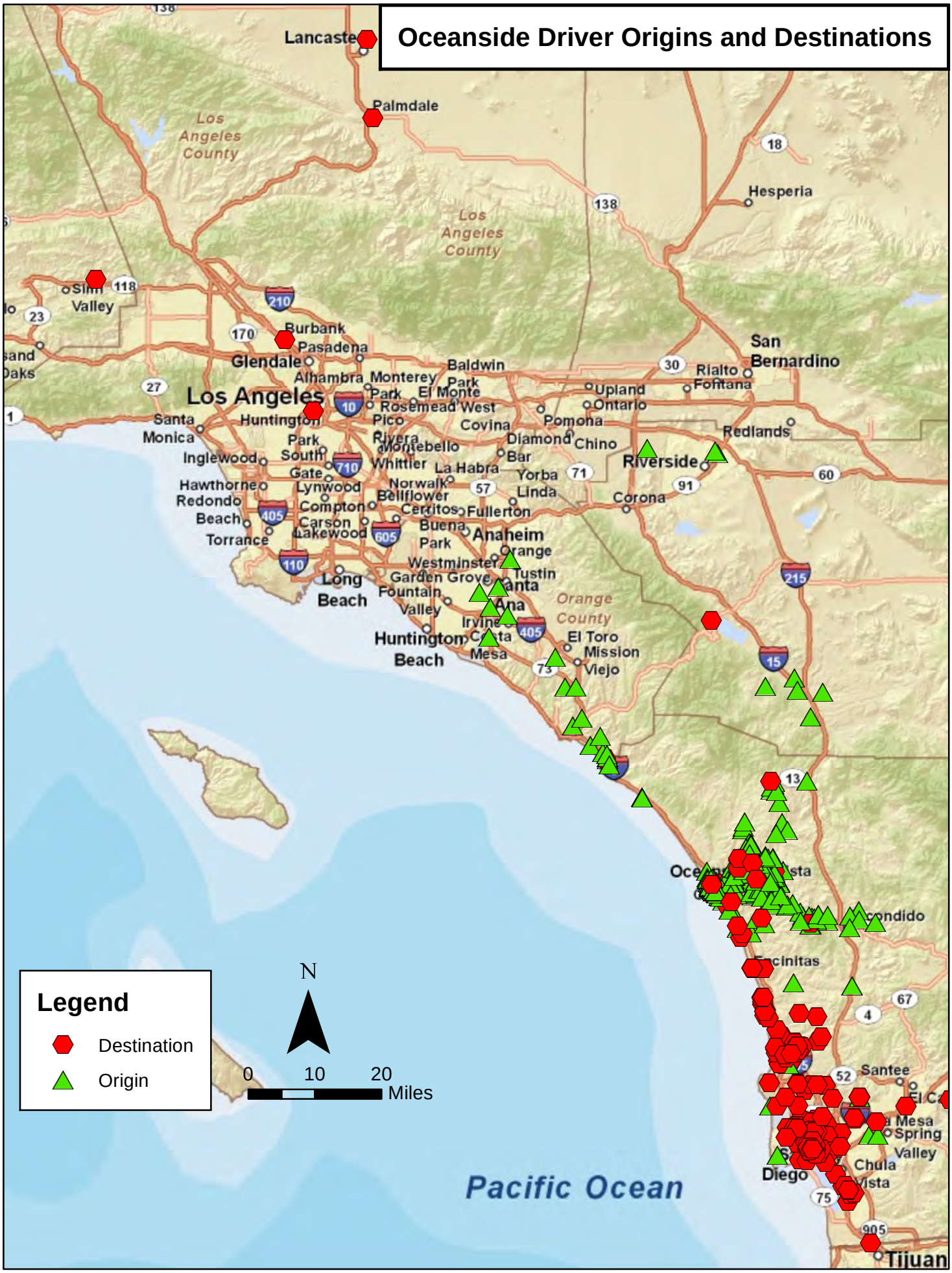
Station or Train #: _____

Time: _____

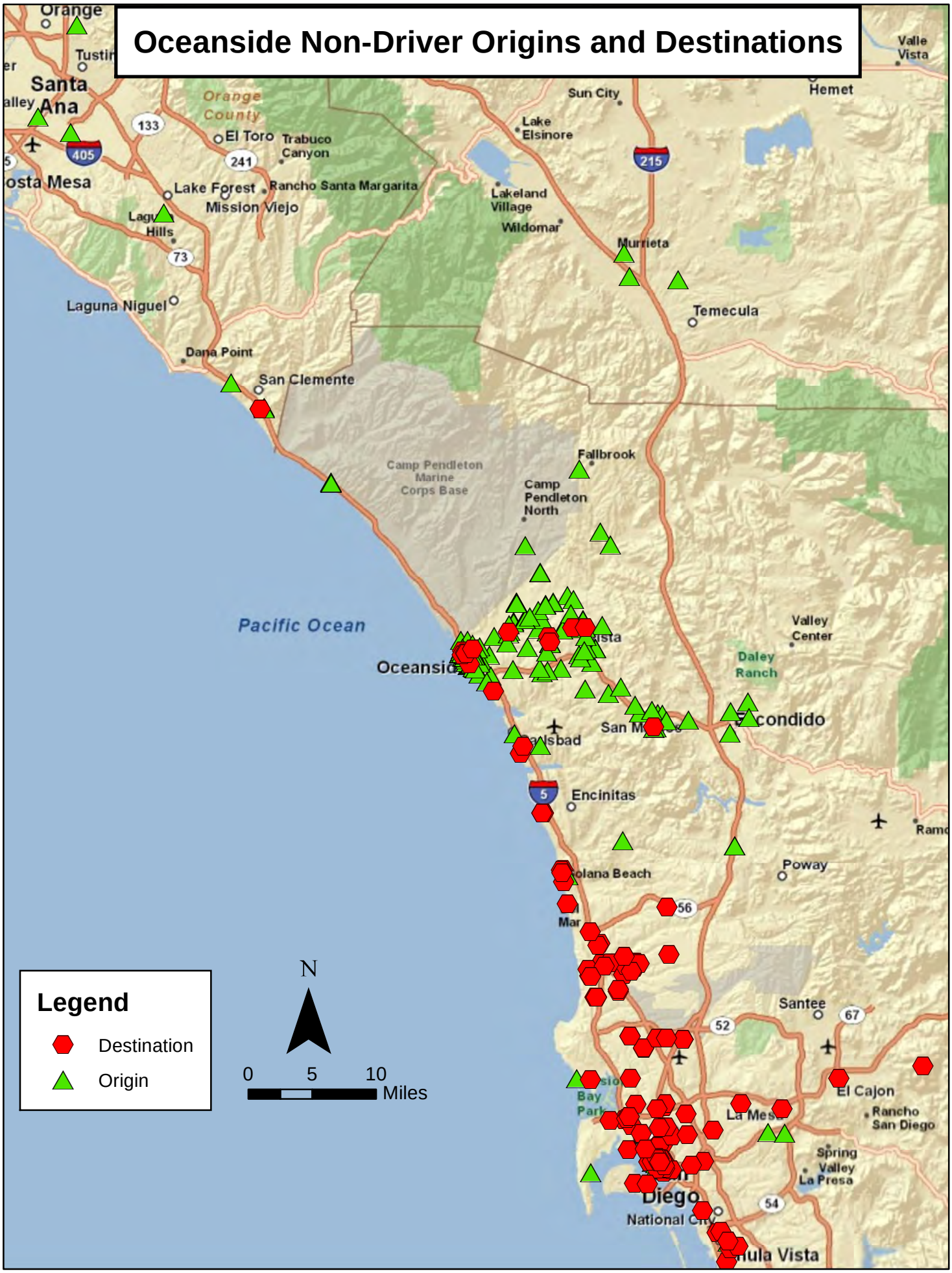
Location: Parking Lot / Platform / On train

Administered: SA / RA

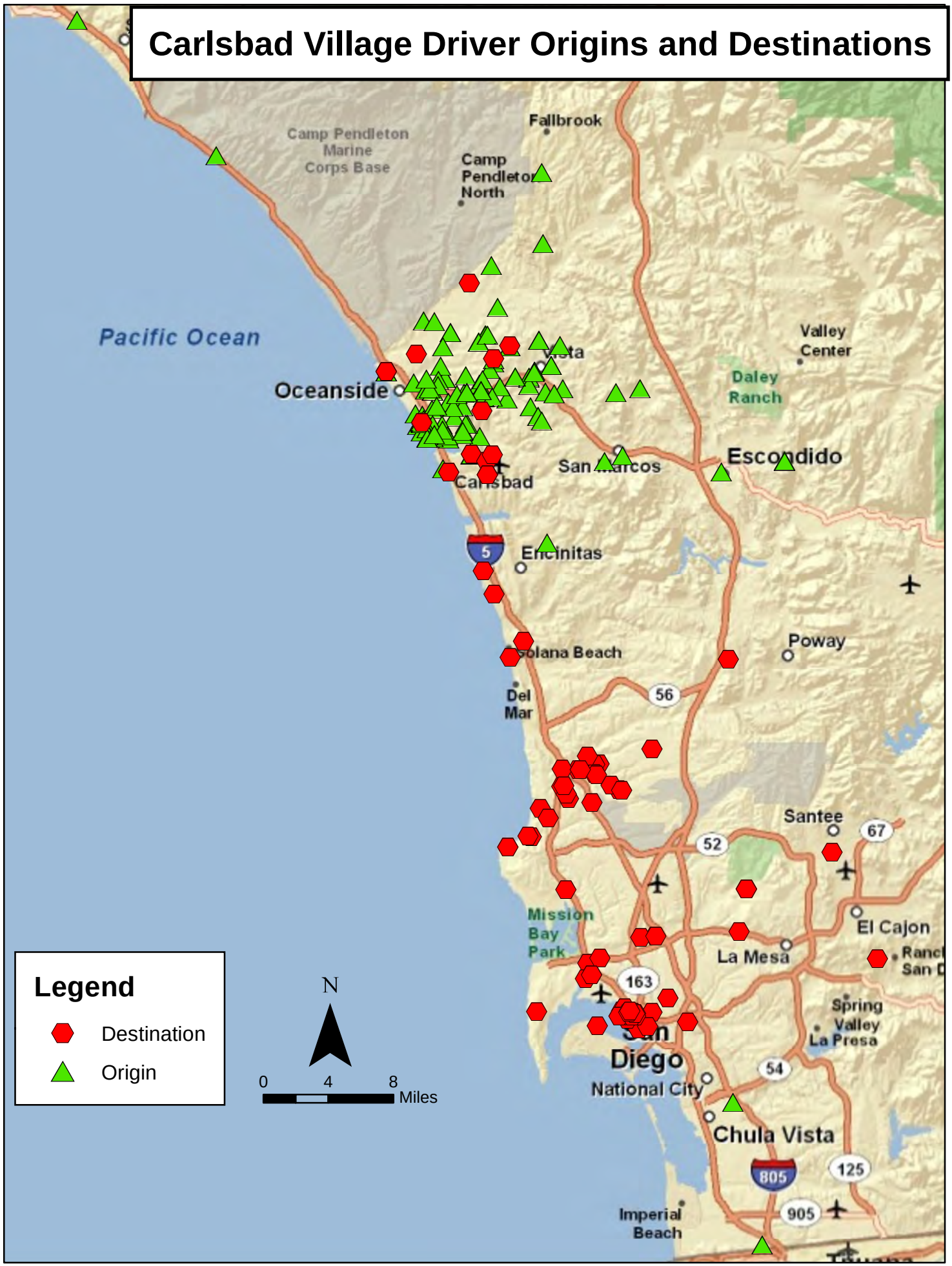
Appendix B – Maps of Origins and Destination by Starting Station


Oceanside Driver Origins and Destinations
Legend
Destination
Origin
N
0
10
20
Miles
Pacific Ocean
Los Angeles County
Orange County
Lancaster
Palmdale
Hesperia
Simi Valley
Burbank
Pasadena
Glendale
Los Angeles
Santa Monica
Huntington Park
South Gate
Inglewood
Hawthorne
Redondo Beach
Torrance
Lynwood
Compton
Carson
Lakewood
Long Beach
Huntington Beach
Alhambra
Monterey Park
El Monte
Rosemead
West Covina
Baldwin Park
Pico Rivera
Montebello
Whittier
La Habra
Norwalk
Bellflower
Cerritos
Fullerton
Buena Park
Anaheim
Orange
Westminster
Garden Grove
Tustin
Santa Ana
Fountain Valley
Irvine
Costa Mesa
El Toro
Mission Viejo
Diamond Bar
Yorba Linda
Pomona
Chino
Upland
Ontario
Rialto
Fontana
San Bernardino
Redlands
Riverside
Corona
Oceanside
Vista
Escondido
Encinitas
Santee
Mesa Spring
Valley
Chula Vista
San Diego
Tijuan

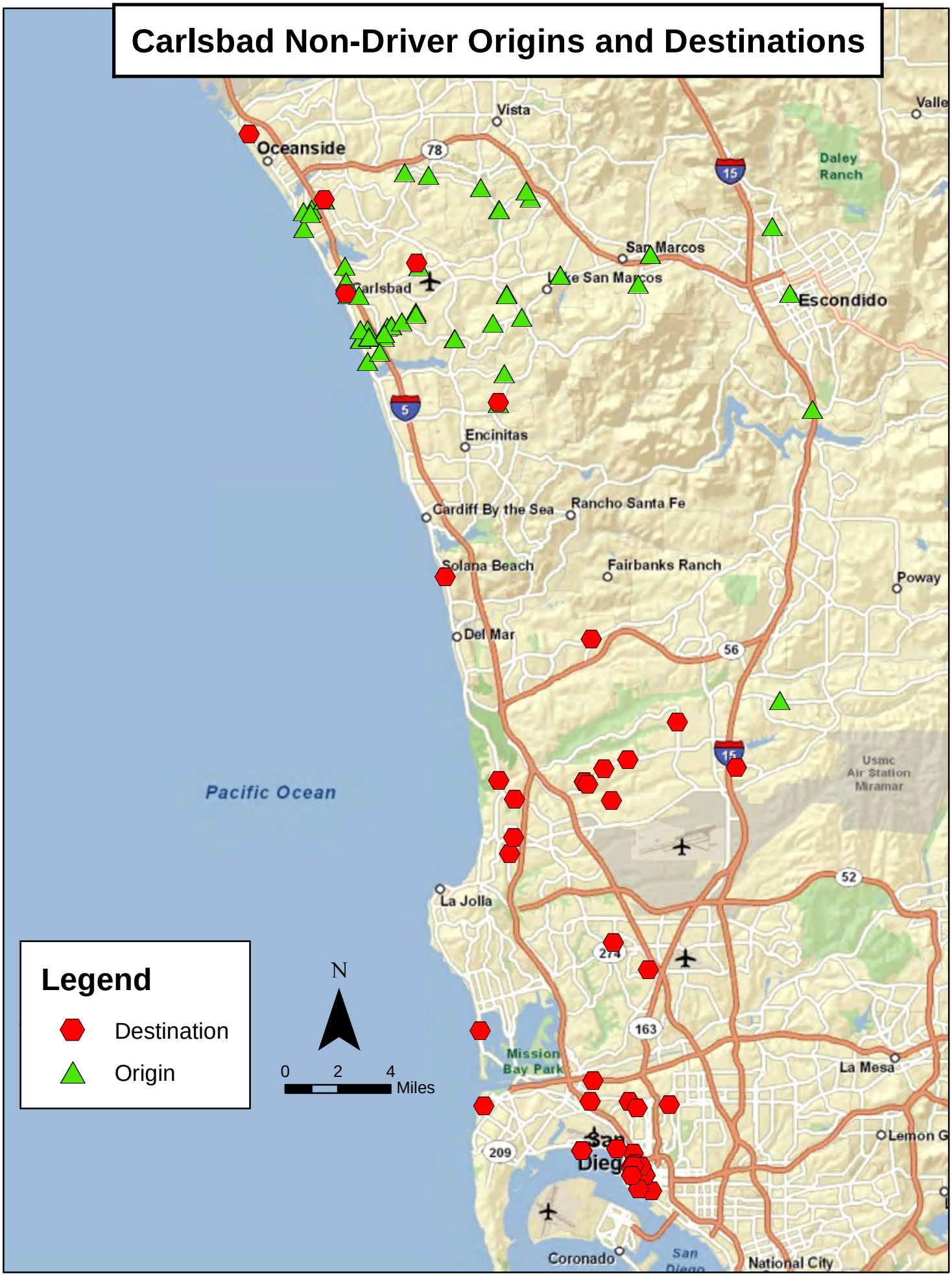
Oceanside Non-Driver Origins and Destinations



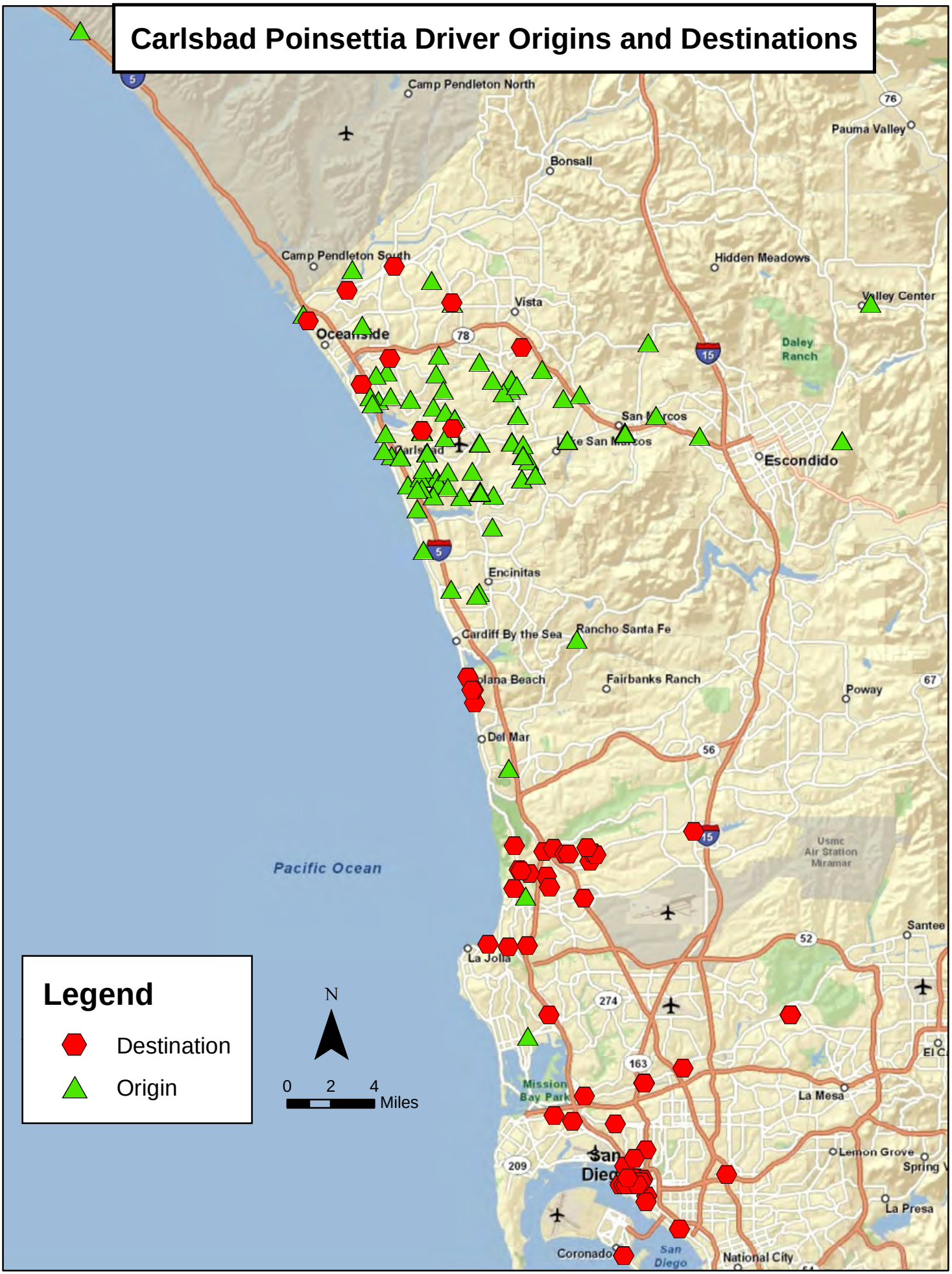
Carlsbad Village Driver Origins and Destinations



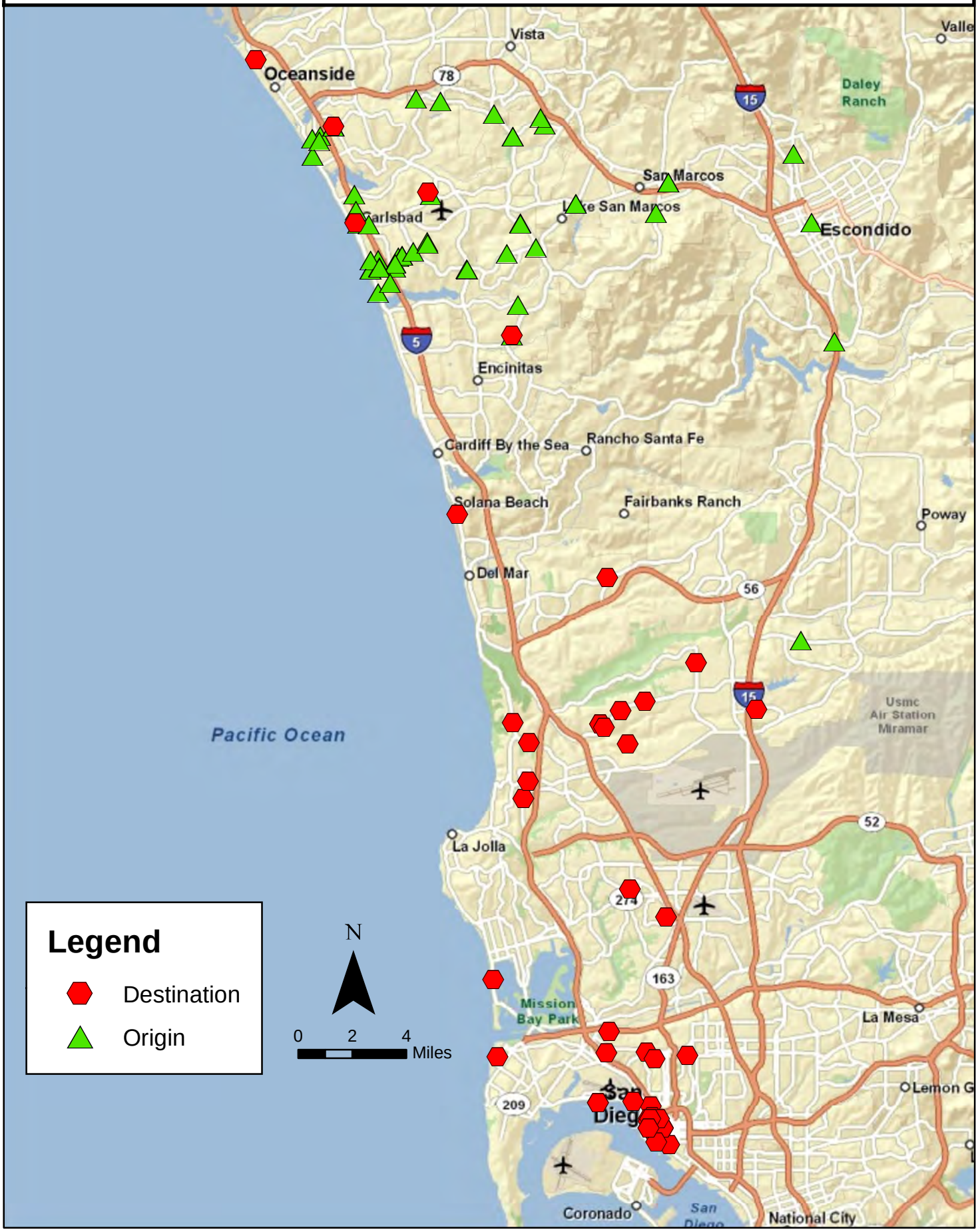
Carlsbad Non-Driver Origins and Destinations



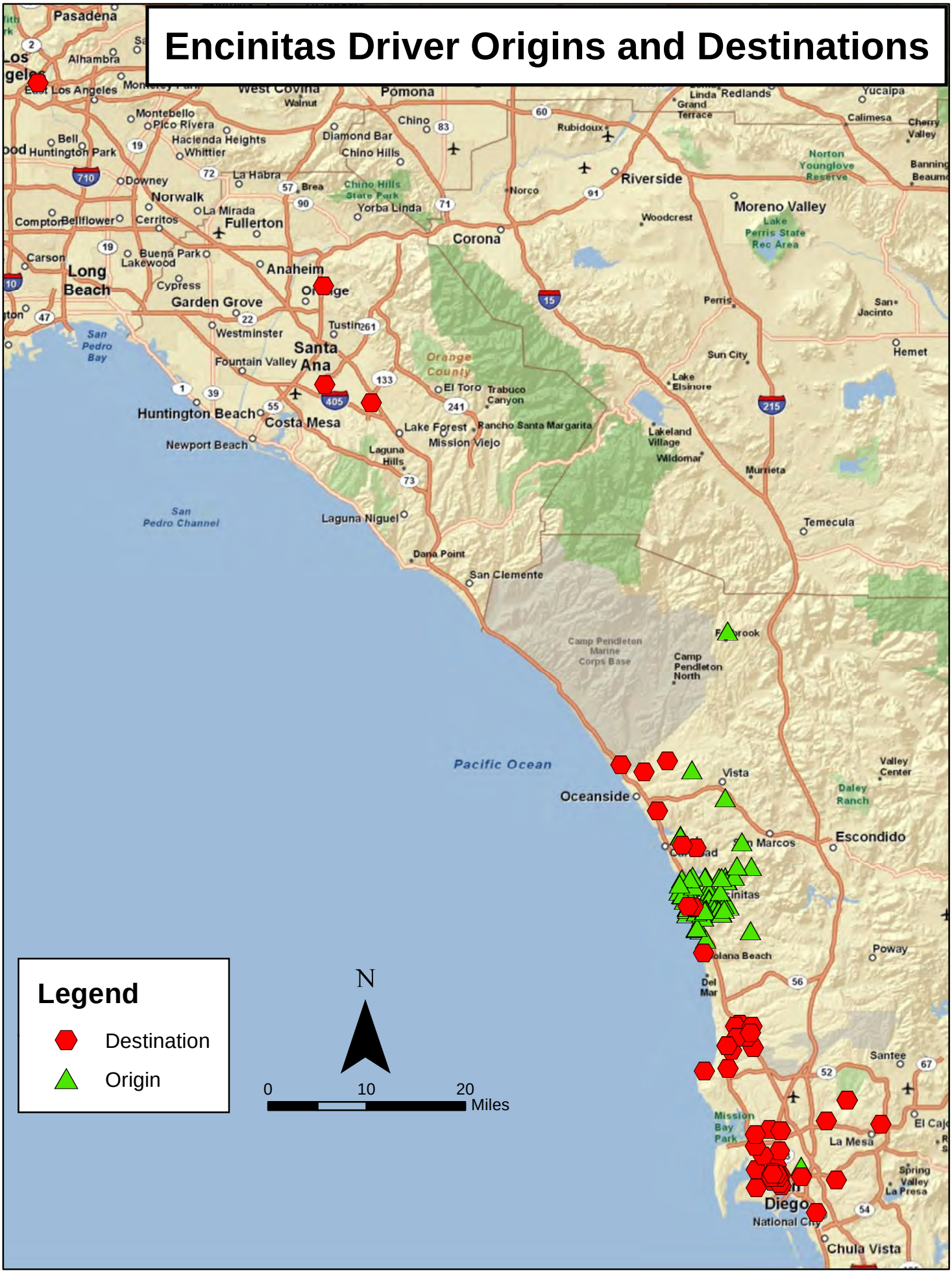
Carlsbad Poinsettia Driver Origins and Destinations



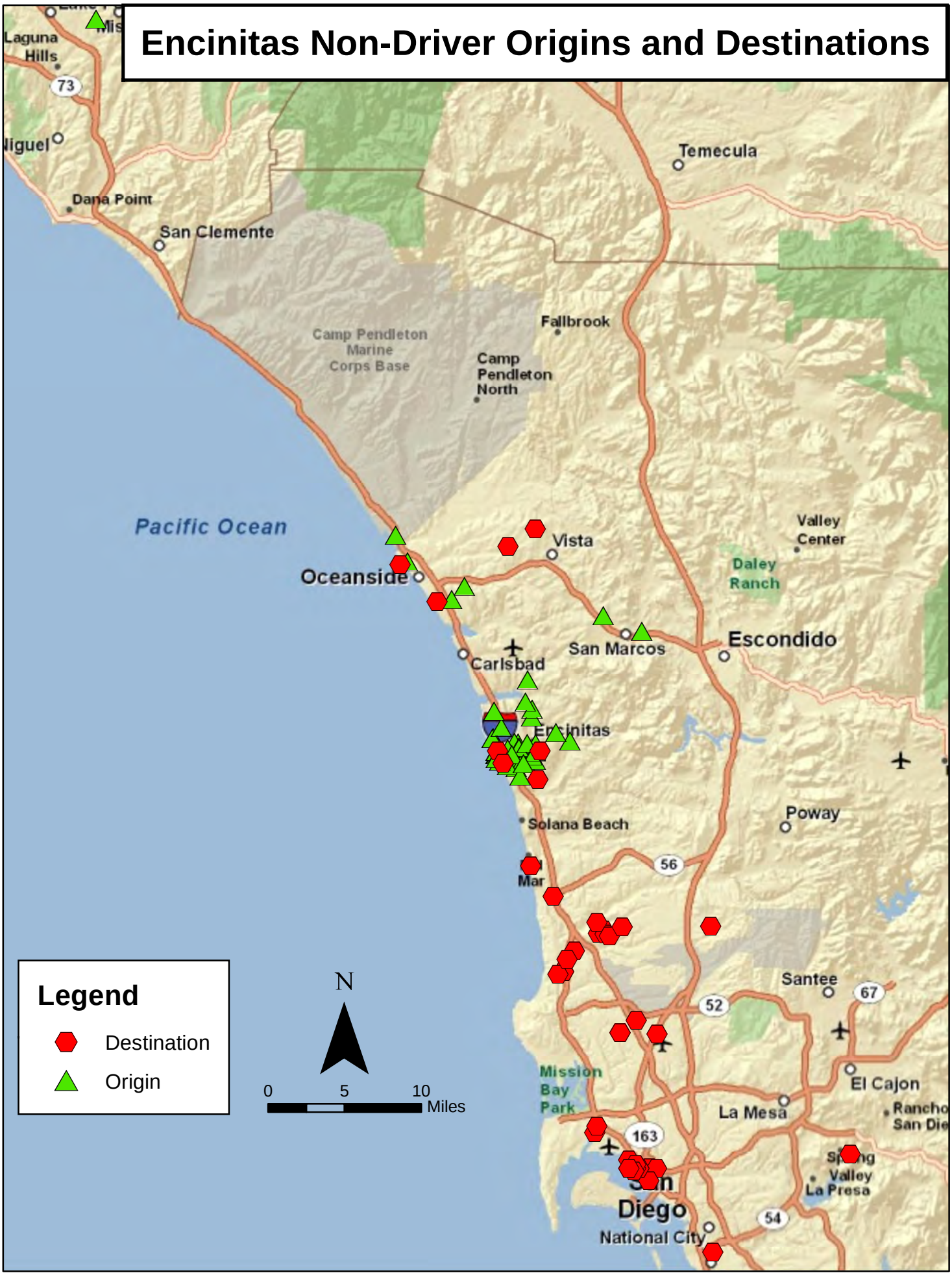
Carlsbad Poinsettia Non-Driver Origins and Destinations



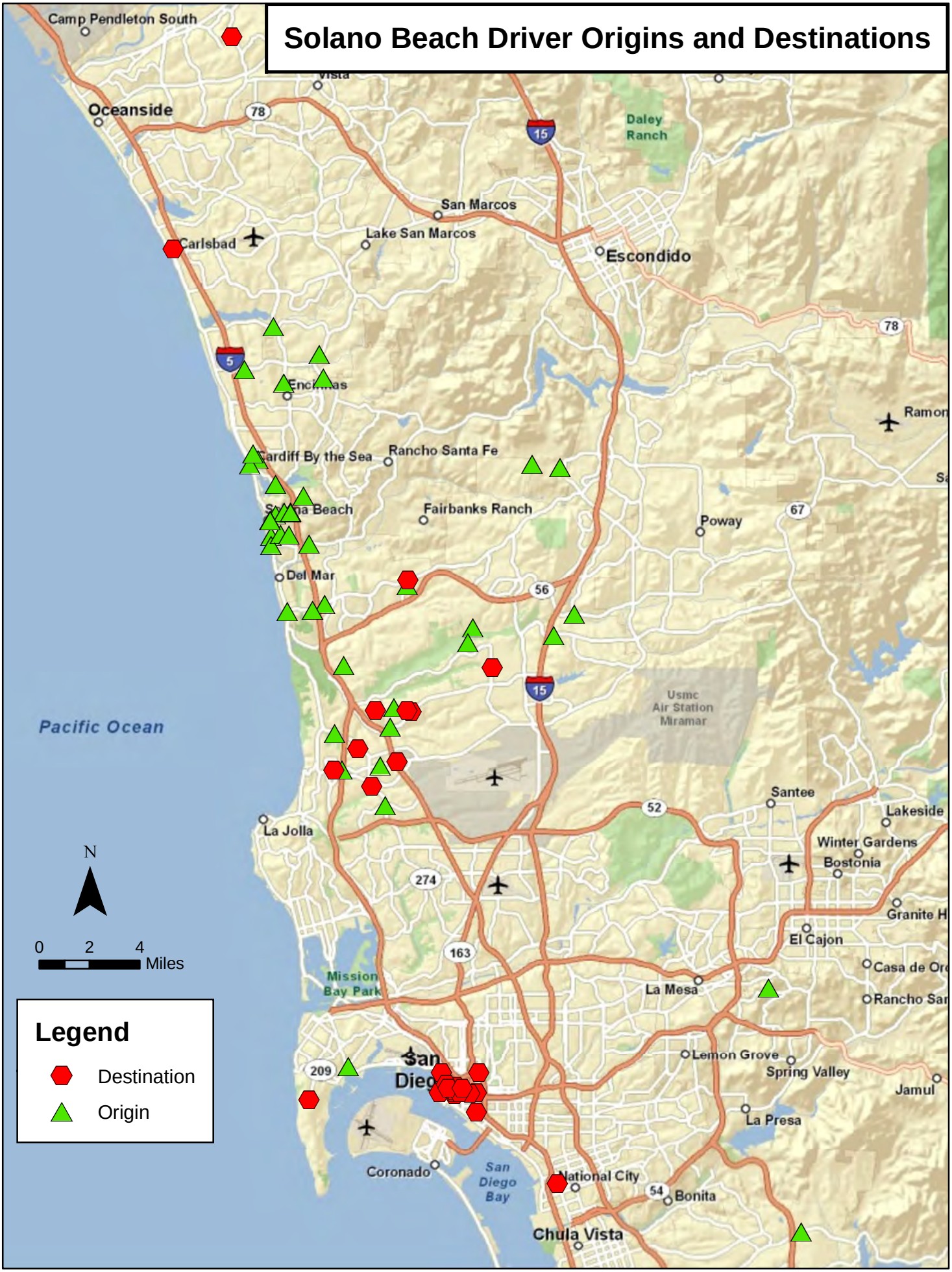
Encinitas Driver Origins and Destinations



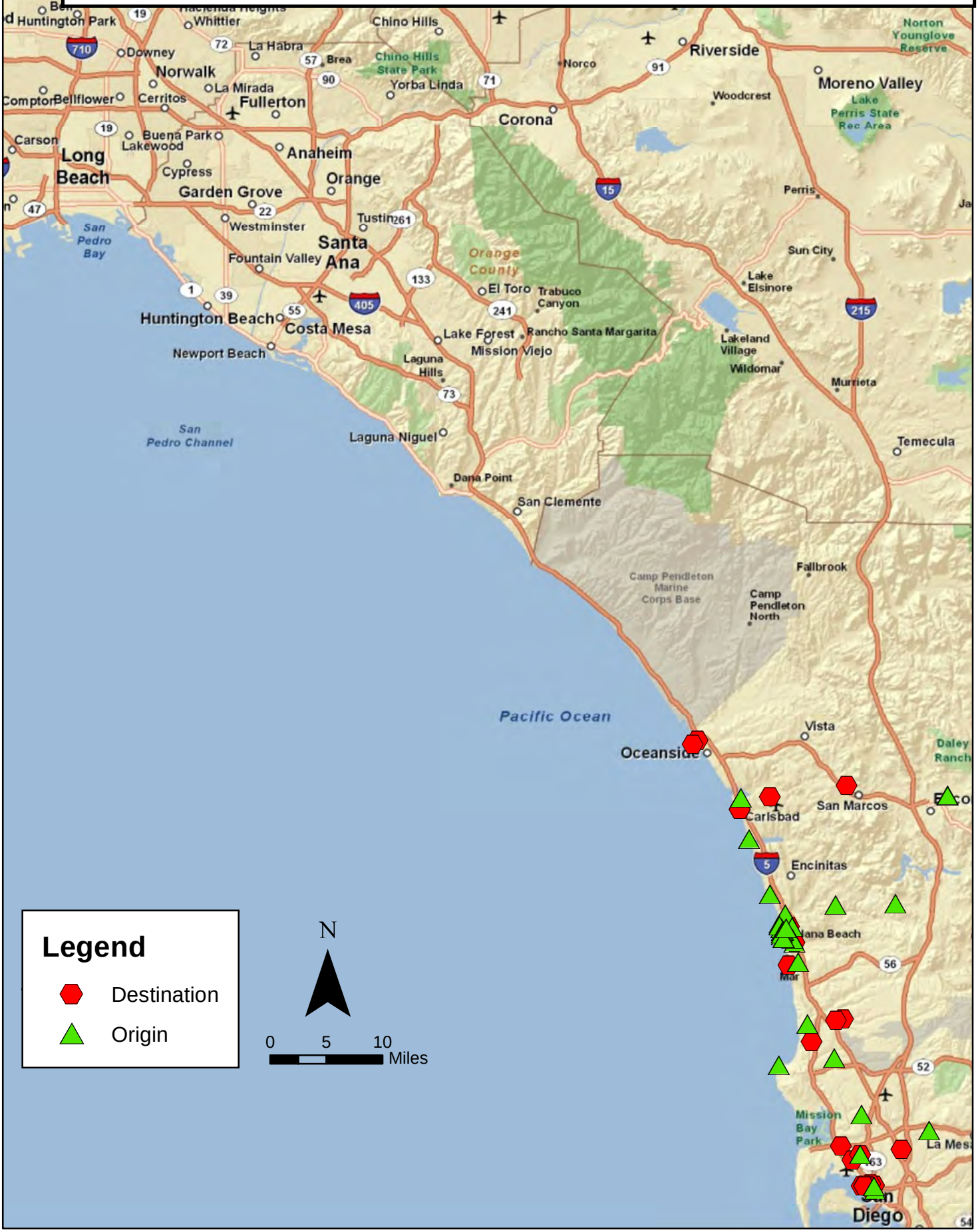
Encinitas Non-Driver Origins and Destinations



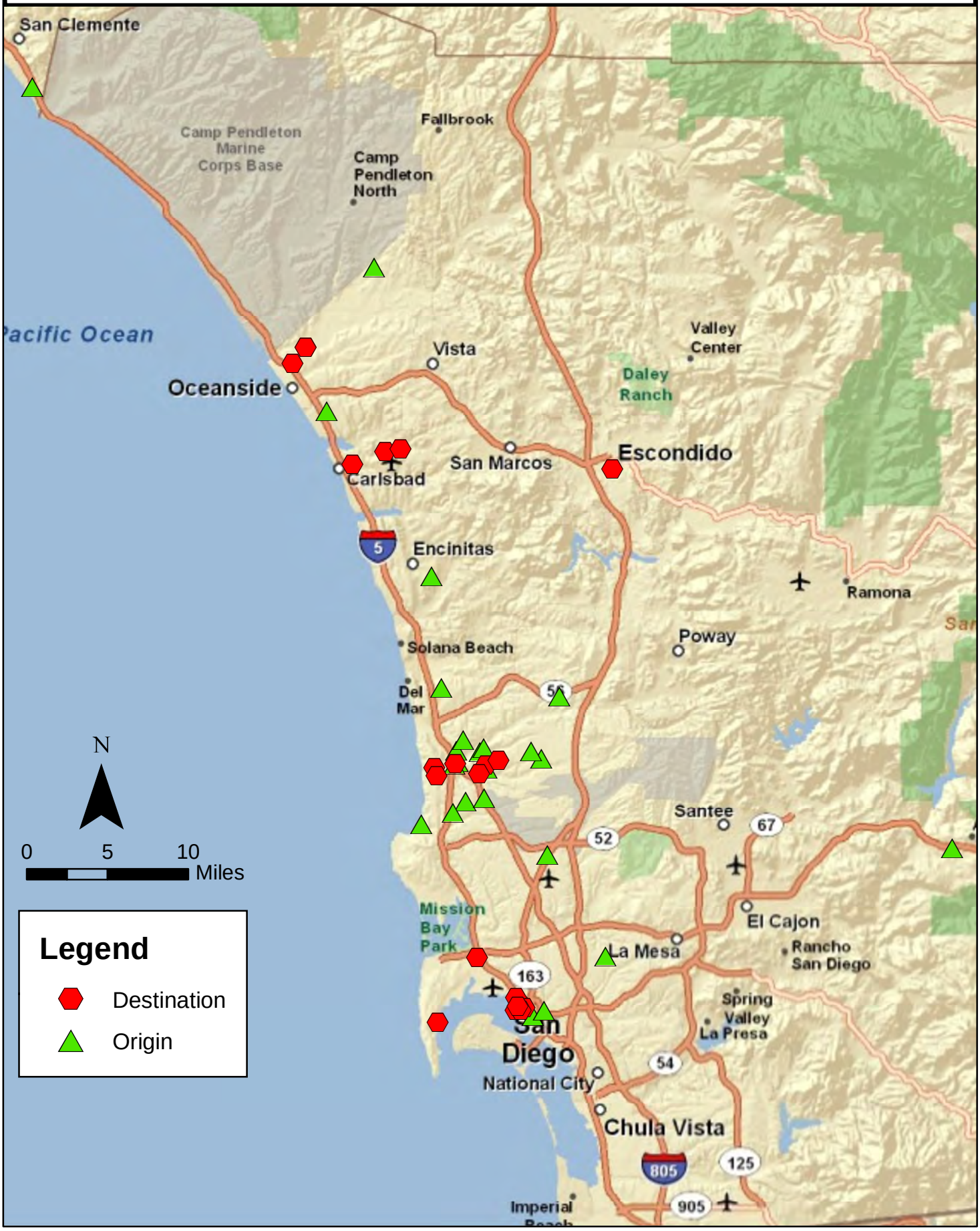
Solano Beach Driver Origins and Destinations



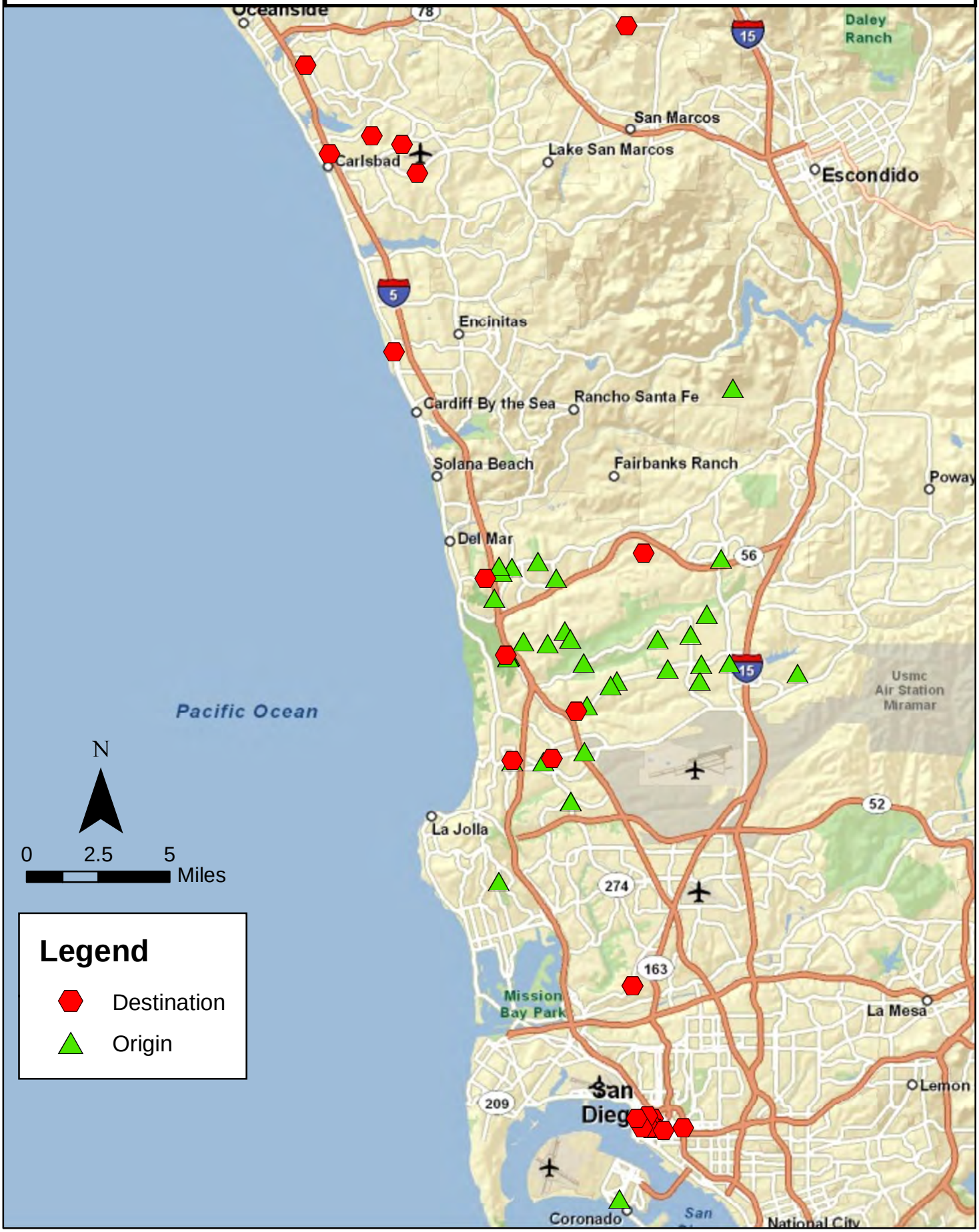
Solana Beach Non-Driver Origins and Destinations



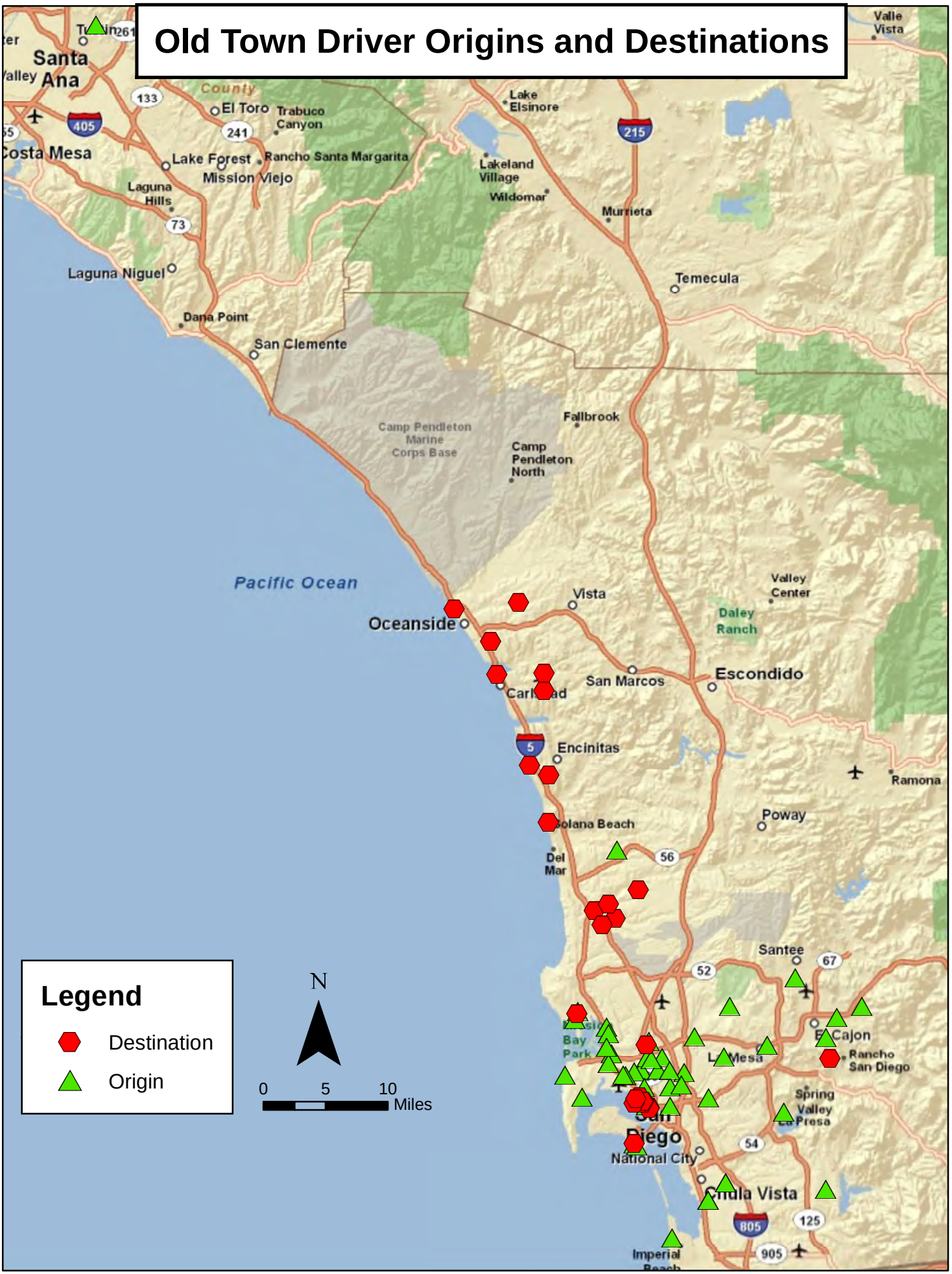
Sorrento Valley Driver Origins and Destinations



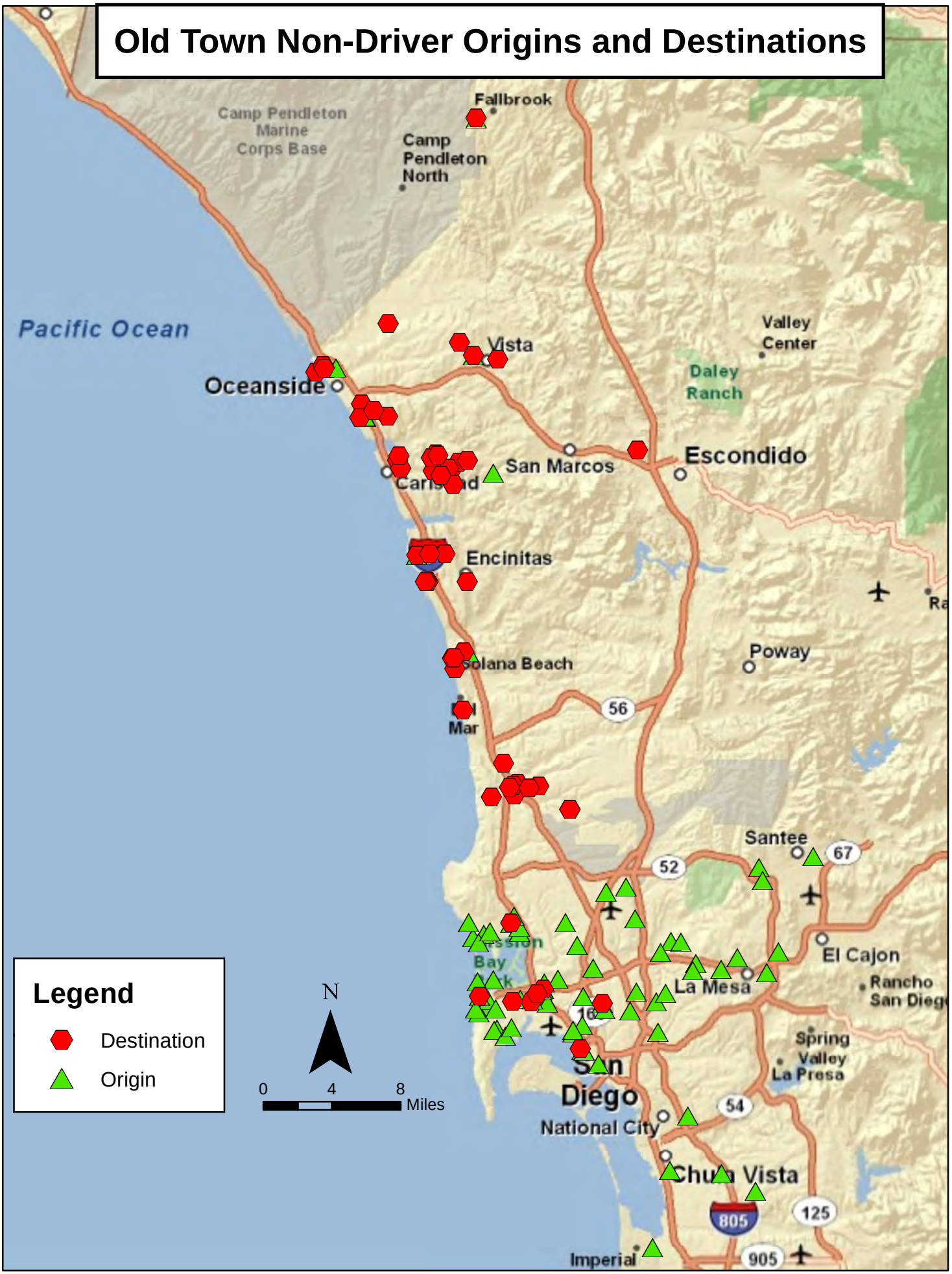
Sorrento Valley Non-Driver Origins and Destinations

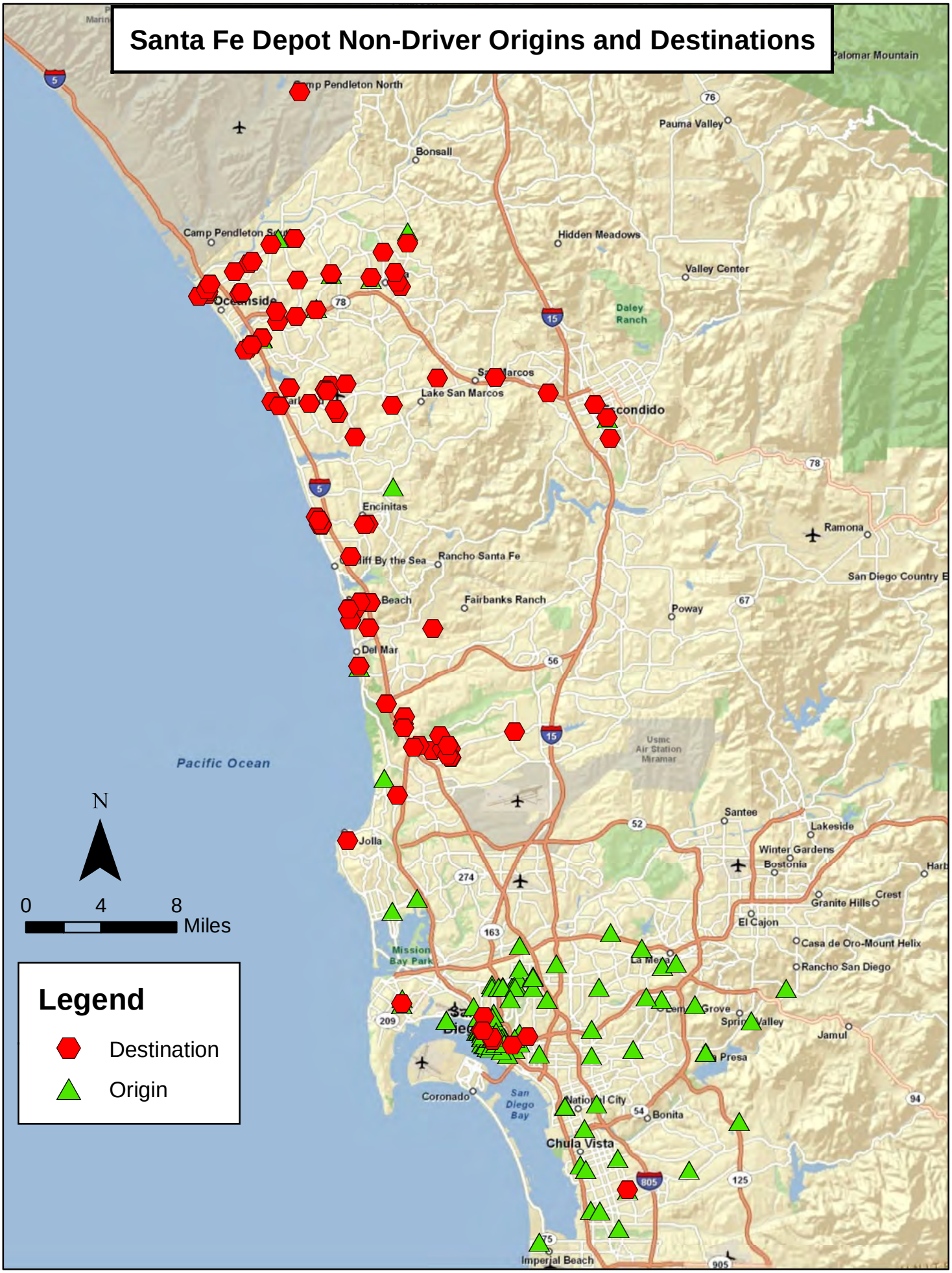


Old Town Driver Origins and Destinations



Old Town Non-Driver Origins and Destinations



Santa Fe Depot Driver Origins and Destinations

Santa Fe Depot Non-Driver Origins and Destinations