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16. ABSTRACT
The Seamless Travel Project, in coordination with the National Bicycle & Pedestrian Documentation Project, is the largest and longest combined count and survey effort in the United States focusing only on bicyclists and pedestrians. Using San Diego County as a case study, the Seamless Travel Project is the first of its type to develop an extensive database of count and survey data for use in analyzing and identifying factors that influence bicycling and walking. While the bicycle and walk modes are studied together, it is recognized that they are distinct from one another and they are always counted, surveyed, and analyzed separately. This Final Report provides a review of the methodology along with count and survey results, development of predictive models, model results, and information on how the count/survey results and models can be used by public agencies and transportation professionals.

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CALIFORNIA PATH PROGRAM
INSTITUTE OF TRANSPORTATION STUDIES
UNIVERSITY OF CALIFORNIA, BERKELEY

Seamless Travel: Measuring Bicycle and Pedestrian Activity in San Diego County and its Relationship to Land Use, Transportation, Safety, and Facility Type

Michael G. Jones, Sherry Ryan, Jennifer Donlon, Lauren Ledbetter, David R. Ragland, Lindsay Arnold

California PATH Research Report
UCB-ITS-PRR-2010-12

This work was performed as part of the California PATH Program of the University of California, in cooperation with the State of California Business, Transportation, and Housing Agency, Department of Transportation, and the United States Department of Transportation, Federal Highway Administration.

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(University of California, Berkeley)

Year: 2010 Caltrans Task Order 6117

<u>Seamless Travel:</u> Measuring Bicycle and Pedestrian Activity in San Diego County and its Relationship to Land Use, Transportation, Safety, and Facility Type

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(Measuring Bicycle and Pedestrian Activity in San Diego County and its Relationship to Land Use, Transportation, Safety, and Facility Type)

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[1] Alta Planning + Design, Inc.
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Seamless Travel:
Measuring Bicycle and Pedestrian Activity in San Diego County and its Relationship to Land Use, Transportation, Safety, and Facility Type

Abstract

This paper provides the data collection and research results for the Seamless Travel project. The Seamless Travel Project is a research project funded by Caltrans and managed by the University of California Traffic Safety Center, with David Ragland, PhD., as the Principal Investigator and Michael Jones as the Project Manager. The project is funded by Caltrans Division of Innovation and Research and is being conducted by the Traffic Safety Center of University of California Berkeley and Alta Planning + Design.

Measuring bicycle and pedestrian activity is a key element to achieving the goals of the California Blueprint for Bicycling and Walking (the Blueprint)[7]. Meeting these goals, which include a 50% increase in bicycling and walking and a 50% decrease in bicycle and pedestrian fatality rates by 2010, and increases in funding for both programs, will require a quantifiable and defensible base of knowledge. This research helps meet two of the Blueprint's major strategic objectives: (1) collecting data on volumes and facilities, and (2) determining the most cost-effective methods of estimating bicycle and pedestrian collision rates.

Understanding why people walk or ride bicycles, how the type and quality of facility influences these trips, and how adjacent land uses, density, access, roadway traffic volumes, and other items impact walking or bicycling, are all critical to meeting the goals of the Blueprint. Good baseline information on walking and bicycling is important to answer questions like that posed in the title of this research: are Class I bike paths so attractive to potential commuters that they should be given priority over Class II bike lanes, Class III bike routes, or other facilities?

Counts and surveys conducted throughout California since 2000 consistently show a substantially higher demand for and use of Class I bike paths than on-street facilities.[8] Is this due to inconsistent on-street systems, a lack of riding expertise by the public, perceived or real safety concerns, recreational versus commuter use, high roadway traffic volumes and speeds, and/or other factors?

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[7] California Blueprint for Bicycling and Walking: Report to Legislature, California Department of Transportation, May 2002

[8] Alta Planning + Design, staff experience on 62 bicycle and pedestrian plans in California since 1990

This research is designed to (a) evaluate existing bicycle and pedestrian data sources and collection methods, (b) conduct comprehensive counts and surveys of bicyclists and pedestrians in a consistent manner using the National Bicycle & Pedestrian Documentation Project (NBPD) as a template [9], (c) conduct counts and surveys using San Diego County (with extensive historical count information) as a model community, (d) analyze how bicycle and pedestrian activity levels relate to facility quality and factors such as land use and demographics, (e) identify factors that are highly correlated with increased bicycling and walking, (e) provide methods for quantifying usage and demand that will enhance research on benefits and exposure, and (f) evaluate how the transit-linkage (bicycle and pedestrian connections to transit) can be improved.

This Report presents materials developed including a literature review, advisory committee meeting input, project objectives, data collection methodology, results from the data collection effort, analysis of correlations, trends, and patterns, conclusions on the accuracy and applicability of the data, and recommendations on increasing walking and bicycling in California.

[9] *National Bicycle and Pedestrian Documentation Project*, Jones, M., Buckland, L., Cheng, A., Transportation Research Board, Aug. 2005

FINAL REPORT

SEAMLESS TRAVEL:

Measuring Bicycle and Pedestrian Activity in San Diego County and its Relationship to Land Use, Transportation, Safety, and Facility Type

PREPARED FOR

Task Order 6117

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EXECUTIVE SUMMARY

The Seamless Travel Project, in coordination with the National Bicycle & Pedestrian Documentation Project, is the largest and longest combined count and survey effort in the United States focusing only on bicyclists and pedestrians. Using San Diego County as a case study, the Seamless Travel Project is the first of its type to develop an extensive database of count and survey data for use in analyzing and identifying factors that influence bicycling and walking. While the bicycle and walk modes are studied together, it is recognized that they are distinct from one another and they are always counted, surveyed, and analyzed separately. This Final Report provides a review of the methodology along with count and survey results, development of predictive models, model results, and information on how the count/survey results and models can be used by public agencies and transportation professionals.

Key findings include:

The Seamless Travel Project represents a significant advance in the non-motorized field of research. Current and past research efforts have been limited by the lack of adequate data to test and verify theories. The Seamless Travel Project is the largest study of bicyclist and pedestrian behavior in the United States, with the largest number of manual count locations (80), the first to use automatic count data collected over a 365-day period to adjust manual counts, the first study to incorporate data from the National Bicycle & Pedestrian Documentation Project in comparing results from around the country, the first to incorporate extensive survey results with manual counts, and the first effort to date to create a predictive model that has been tested against actual count results.

California should develop and implement a systematic bicyclist/pedestrian count and survey program. A systematic count and survey of bicyclists and pedestrians by Caltrans and local agencies is an important step meeting the goals of the California Blueprint for Bicycling and Walking (the Blueprint)[10], Complete Streets policies, and other goals. The Seamless Travel study provides specific materials (Training Manual and Powerpoint) for how to conduct manual and automatic machine counts, surveys, use of the data, and recommendations on how counts could be institutionalized and funded. Counts and survey methods should be consistent with the National Bicycle & Pedestrian Documentation Project.

Annual use should be the standard measurement for the bicycle and pedestrian modes. Given the day to day and seasonal variability at many locations, and the fact that determining peak hour capacity is not an overriding need, the use of annualized figures will allow a more accurate comparison between locations.

Methods and conclusions based on data from San Diego County and the National Bicycle & Pedestrian Documentation Project should be applicable to many community types and locations. Compared to other modes where methods (such as the ITE Trip Generation Manual) and data collected from limited locations nationwide are accepted by all agencies, there is no existing similar acceptance for the bicycle/pedestrian field. The Seamless Travel project and National Bicycle & Pedestrian Documentation Project represent the greatest

[10] California Blueprint for Bicycling and Walking: Report to Legislature, California Department of Transportation, May 2002

accumulation of data available today, and the data and methods should be applicable to a broad range of communities nationwide. However, seasonal and other local variables do exist that require additional efforts, especially year long machine counts.

Where peak hour volumes are needed to evaluate capacity, the standard 'Design Period and Design Day' on Class I and multi-use pathways should be as follows:

Maximum design load:	11am-1pm, July, 4th
Weekday:	11am-1pm, Mid-July, Tuesday, Wednesday, or Thursday (non-holiday)
Weekend day:	11am-1pm, Mid-July, Saturday (non-holiday)

Class I and Multi use pathway capacity ranges between 15 and 270 persons per hour per foot of pathway width. Free flow conditions suitable for higher bicycle commuting speeds are represented at the lower end, while the maximum capacity range would require bicyclists to dismount or ride very slowly. Both ends of the range require adequate separation between directional flow, and preferably modes as well**.**

For planning purposes, the use of 120 persons per hour per foot of path width as the maximum capacity is recommended to maintain adequate flows. Centerline separation and supporting pathway management techniques (signing, enforcement etc) on any pathway with design day volumes over 10 persons per hour per foot of path width and pedestrian mode split over 20%, or over 15 persons per hour per foot of path width and under 20% pedestrian mode split are recommended. Design hour or day pedestrian volumes on sidewalks should conform with the Highway Capacity Manual pedestrian level of service methodology, which is also used to determine crosswalk capacities.

Bicycle and pedestrian volumes can be classified in ranges to facilitate mapping and analysis. The recommended classification range is as follows:

Bicycle Volumes	
Low	0-20 per hour
Moderate	21-60
High	over 61
Pedestrian Volumes	
Low	0-40 per hour
Moderate	41-100
High	Over 100

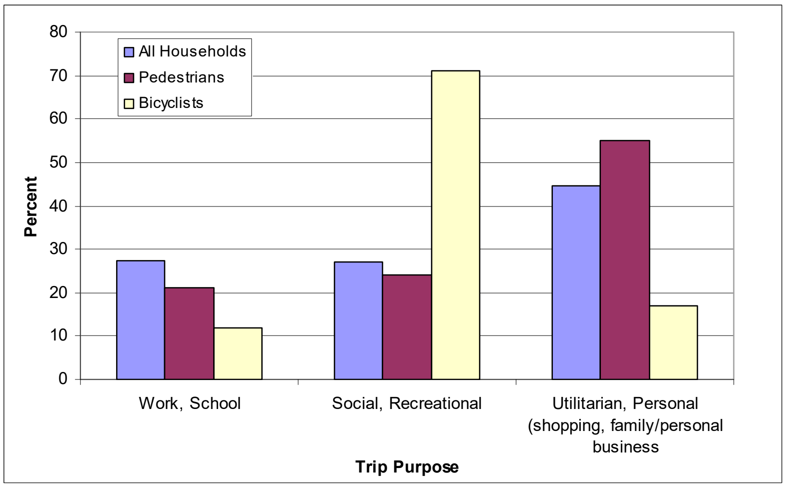
The perception of the walk and bicycle trip making as recreational or discretionary is unfounded. The walk and bicycle modes have significant (and often the same) percentages of work, school, or utilitarian trip making as household travel in general, and private vehicle trips (see **Table 1** and **Figure 1**). While funding for pedestrian and bicycle facilities is typically limited to 'transportation' functions only, funding for roadways, transit, and other systems make no such distinction. The result is a potential funding bias against non-motorized facilities, as well as a potential resistance to accommodate non-motorized modes in new projects despite adoption of Complete Streets and other similar policies.

Table 1: Comparison of Trip Purpose

	All Households (Percent)[1]	Pedestrians[2] (Percent)	Bicyclists[2] (Percent)
Work, School, Utilitarian	27.5	21	12
Social, Recreational	27.1	24	71
Utilitarian, Personal (shopping, family/personal business)	44.6	55	17

1. Bureau of Transportation Statistics, National Household Travel Survey, Fig 7, 2001
2. San Diego County survey results

Figure 1: Comparison of Trip Purpose



Class I bike paths and multi-use paths in general serve as important transportation facilities. The surveys of trip purpose combined with the year-long counts of four (4) bike paths in San Diego County show (see **Table 2**) these pathways alone are used by an estimated 691,969 bicyclists on work/school/utilitarian trips. This volume is 90% higher than the total estimated annual volumes of all on-street bicycle trips counted at 69 of the 80 manual count locations. It is likely that paths serve as important incubators for bicyclists learning or re-learning how to ride bicycles as a transportation vehicle for short trips.

Table 2: Comparison of Pathway and On-Street Bicycling by Trip Purpose

Location	Total Annual Use	Transportation Trips[1]
Bayside Path	513,558	133,525
Gilman Path/ Rose Canyon	164,638	42,805
Strand Path	148,109	38,508
Boardwalk	1,835,426	477,131
Subtotal	2,661,426	691,969
On-Street Locations[2]	1,401,837	364,477

1. Defined as school, work, utilitarian trips
2. 69 of the 80 count locations, normalized to annual counts

Bike lanes are not an indicator of bicycle use. Bicycle use on streets with bike lanes is similar as streets without bike lanes. This does not mean that bike lanes do not attract or serve bicyclists. Firstly, bike lanes have traditionally been installed where they are feasible rather than where the highest existing uses are located. Secondly, all things being equal, bicyclists will choose the best, most direct route with the best combination of topography, lane width, and traffic volumes speeds available.

Location Determines Data. The location of the five (5) automatic counters drives the pattern of data collected. Bicycle and pedestrian activity is affected by facility type (pathways, sidewalks), surrounding land use, weather, time of year, and many other factors. The data therefore provides a 'snapshot' of a limited range of possible activity patterns in San Diego County or in any community. However, this data along with other year round data from around the country starts to provide a picture of activity trends that can be used to frame parameters of activity.

Bicycle use in San Diego County based on historical counts back to 1987 has generally been stable, and is increasing in the past year. Various agencies in San Diego including SANDAG and Caltrans have conducted bicycle counts since 1985. Twelve (12) locations were consistently counted between 1985 and 2008 (13 years). Initially the figures indicated a steep decline in use at these 12 locations between 1985 and 1990. However, an in-depth analysis of the figures shows that almost all of the decline was due to one location (Site #16: College/Montezuma). This location is next to the LRT station near San Diego State University, which was completed during the count period, and may have impacted or changed bicycling patterns in the area. **Table 3** shows how, if this site is removed, volumes at the remaining 11 locations were stable from 1985-2007. In all cases, volumes in the most recent count (2008) have jumped between 40-85%. The last column on **Table 3** and **Figure 2** shows the average percent change of all 12 locations from 1985-2008, showing a consistent increase during this period except between 1990 and 1993.

Table 3: Historic Bicycle Counts San Diego County 1985-2008

Year	AM Counts[1]	Average %[2]	AM Counts	Average %[3]	Average % Change[4]
1985	1,022		414		
1987	913	-10	396	-4	+27
1990	659	-28	395	0	-2
1993	701	+6	440	+11	+12
1997	541	-33	410	-7	+12
2007	586	+8	386	-6	+12
2008	823	+40	713	+85	+30

1. AM Counts, weekdays 7am-9am, adjusted seasonally, 12 locations
2. Count locations increased from 12 in 1985 to 80 in 2008
3. AM Counts, weekdays 7am-9am, adjusted seasonally, 11 locations excluding College/Montezuma
4. Average % change of all 12 locations from year to year

Figure 2: Historic Counts

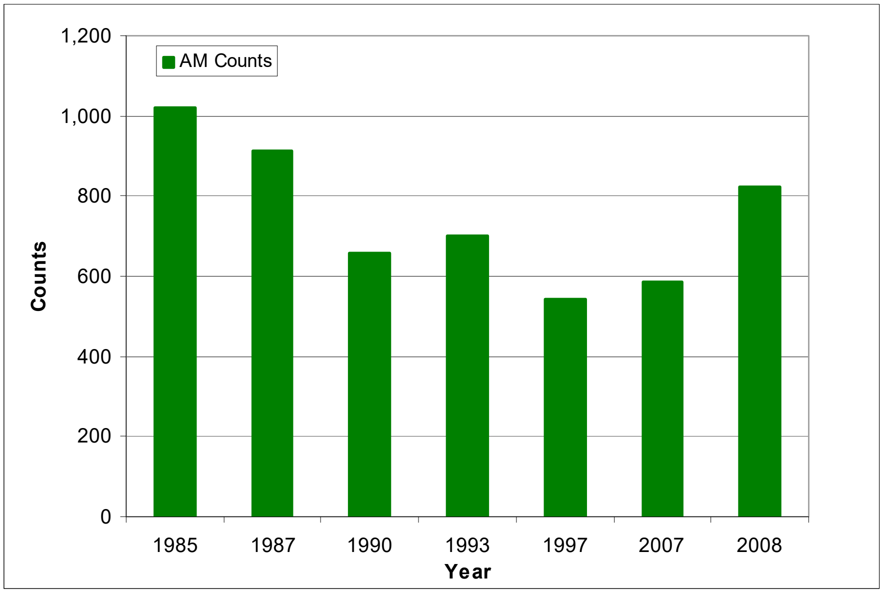
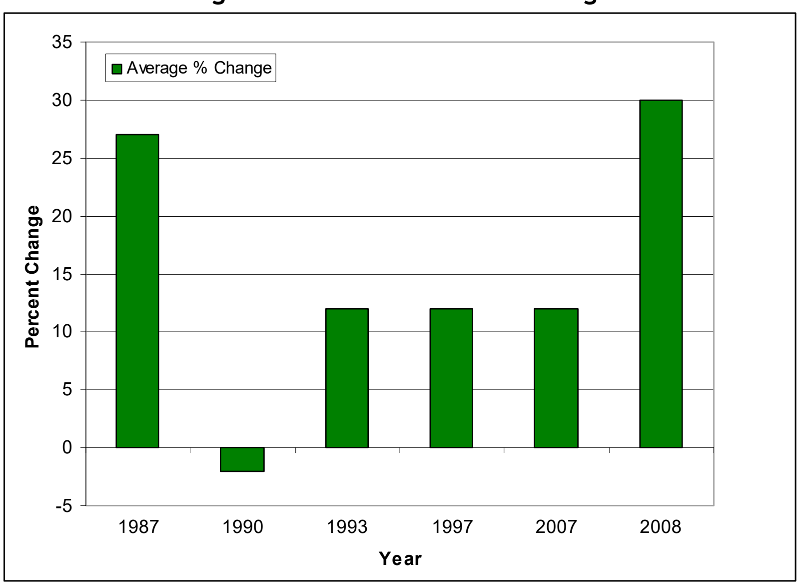


Figure 3: Historic Percent Change



Mode split on Class I and multi-use pathways is highly related to regional and local patterns, with bicycle mode splits ranging from 30% to 90% and pedestrian mode splits from 10% to 70%. Predictive models should be able to identify a general mode split based on adjacent demographics and land uses. Commuter paths located next to some kinds of land uses may require the development of alternative routes, special delineation and/or management to preserve the ability to be used by bicyclists for commuting.

Multi-use paths in San Diego County, such as the one above in Chula Vista, are mostly used by bicyclists

Class I and multi-use paths in San Diego County are used mostly by bicycles. While this varies by location and facility, bicyclists are the primary users of the pathways counted in San Diego County. Nationally, pedestrians outnumber bicyclists on pathways 75% to 20% on average. Mode split appears to be correlated with adjacent land uses, regional bicycling patterns, and quality of the bikeway network

Over the course of a year, there are no distinct daily peak periods for pedestrians and bicyclists. Unlike motor vehicle traffic patterns, there is no sharp commute pattern for either bicycle or pedestrian mode regardless of facility type. Activity is evenly spread throughout the day, with minor peaking patterns. This is likely due to the mix of recreational and utility/work/school trips, and also an indication of the low proportion of commute trips overall. This finding is true for locations with (a) connections to mixed land uses (residential, commercial, office), (b) recreational trips and destinations, and/or (c) visitor usage. This finding would not apply to locations such as large employment centers with little/no retail or restaurant uses, or near major transportation hubs.

Actual day-to-day variability at many count locations may make forecasting difficult. Actual day to day variability is largely related to the volumes (higher volumes = less day to day variability) and trip types (recreational trips = higher variability). With many count locations having very low volumes, any predictive model will need to accept a relatively high margin of error. Also, validation counts would need to be conducted over a longer period of time during the same month of year, or, adjusted using local automatic count machine data.

The 6am – 9pm period accounts for a consistent 95% of the total volumes. Bicycle and pedestrian volumes gently taper off from about 6pm to 12 midnight. From 12 midnight to 6am there is very little activity. Focusing on the 6am to 9pm period will capture a consistent snapshot of the vast majority (95%) of activity. The exception may be count locations near large entertainment centers or districts.

Bicyclists and pedestrians have nearly an identical daily pattern of use on multi-use pathways. While bicyclists accounted for 55% of all users on the five (5) pathways, peaking patterns were proportional with pedestrian volumes. This indicates trip purpose on pathways, regardless of mode, is similar between bicyclists and pedestrians, and that the combined modes can be used to analyze patterns.

Pedestrian volumes on sidewalks in some areas are highly consistent and spread evenly throughout the day and evening, with little discernable peaking. The hourly pedestrian volumes on University Avenue in the Hillcrest neighborhood of San Diego (a higher density, older neighborhood with good transit service) was extremely even on both weekdays and weekdays, with virtually no change between about 10am and 12 midnight. This reflects the fact a neighborhood with a mix of residential and commercial uses produces nearly constant and consistent walking volumes for most of the day. This will allow manual counts conducted during any time of the year to be adjusted to an annual total figure. This finding is true for locations with (a) connections to mixed land uses (residential, commercial, office), (b) recreational trips and destinations, and/or (c) visitor usage. This finding would not apply to locations such as large employment centers with little/no retail or restaurant uses, or near major transportation hubs.

Peak periods on Class I and multi-use paths have a consistent annual peak period of 11am-1pm, with minor variations. This will allow manual counts conducted during any time of the year to be adjusted to an annual total figure. This finding is true for locations with (a) connections to mixed land uses (residential, commercial, office), (b) recreational trips and destinations, and/or (c) visitor usage. This finding would not apply to locations such as large employment centers with little/no retail or restaurant uses, or near major transportation hubs.

Pedestrian volumes on sidewalks, while generally consistent, will have seasonal changes in peak periods depending on the adjacent land uses. Peak periods on sidewalks for pedestrians range from 1-3pm on weekdays in the Fall/Winter/Spring to 9-11pm in the Summer. This finding is true for locations with (a) connections to mixed land uses (residential, commercial, office), (b) recreational trips and destinations, and/or (c) visitor usage. This finding would not apply to locations such as large employment centers with little/no retail or restaurant uses, or near major transportation hubs.

Given the consistency in peaking patterns on Class I bike paths and multi-use paths and sidewalks in the locations described, manual counts can be used to extrapolate annual data. This assumes the count location has a moderate to high volume, is not predominately recreational, and can be validated with counts conducted during the same period for at least two (2) days, or, validated with a local automatic count machine.

Bicycle and pedestrian count results can yield some unusual, unexpected results, reflecting highly localized conditions. For example, the second highest month of activity on the four (4) pathways was March, possibly due to the college and university break schedules. Other unexpected results could be caused by events such as marathons or races, construction, special events, pulses of patrons from nearby rail, transit or ferry operations, and sporting events.

Day of week volumes are consistent between modes and locations, both in San Diego County and nationally. Over the course of a year, bicycle and pedestrian volumes by day of week are nearly identical, with Saturday being the day with the highest activity, and weekends being higher than weekdays. This breakdown is very consistent with national counts.

Monthly volumes appear to be highly related to regional conditions, especially weather. The monthly pattern in San Diego County had both intuitive results (July with the highest volumes) and unusual results (March had the second highest with 12%). Compared to other locations in the country with more severe winters, use is relatively even over 12-months in San Diego County. The need for automatic counters in different regions is apparent in order to establish local monthly adjustment factors.

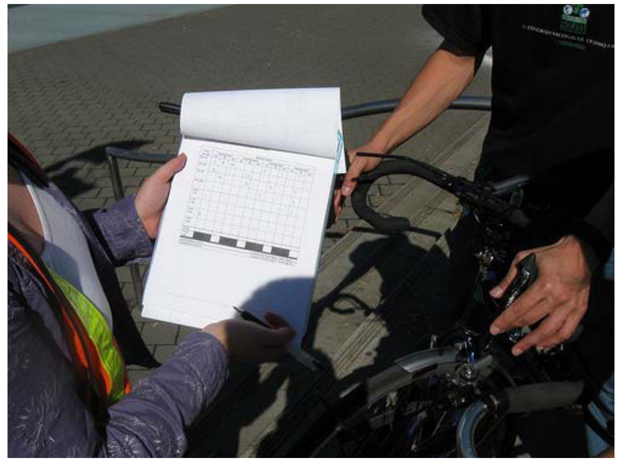
The correlation between actual counts and variables is complex. An analysis of over 30 variables with the 80 bicycle and pedestrian count locations shows that while there are some distinct patterns (especially with pedestrian volumes), most variables are highly correlated with each other (and therefore not helpful) and there are significant numbers of 'outliers' that cannot be easily explained.

Population density and transit ridership are not the strongest indicators of walking. Some variables commonly thought to be highly correlated to walking, such as population density and transit ridership, turned out to be only mild indicators and much less effective than others (such as employment density). If an agency's goal is to create neighborhoods or corridors with higher levels of walking, a mixture of employment and residential uses is critical.

Forecasting models cannot rely on multiple regression analysis. Multiple regression analysis using computer-based programs provide very high 'Multiple R' factors for some variables, such as employment density for pedestrians. A closer examination of these outcomes reveals that, in the best of cases, over 50% of the count locations had model estimates that were off by more than 50 persons per hour, and many were incorrect by over 100 people/hour. This confirms published research that states that computer generated multiple regression models produce artificially high outcomes and formulas that are not accurate enough for general use.

A model with refinement factors provides the best possible forecasting tool. Using the multiple regression outcomes as a starting point, a refinement model with variables triggered by specific thresholds of volumes helps to improve the forecasting accuracy of the bicycle and pedestrian models. The models should be accurate enough with local adjustments (especially for monthly changes) to allow for estimates of use by location, exposure analysis, and other uses. These refinements can be modified and expanded as more data is collected over time.

1. INTRODUCTION



Counts and Surveys were conducted over a two-year period

In 2006, Caltrans contracted with the Traffic Safety Center of University of California Berkeley and Alta Planning + Design to develop a model for estimating bicycle and pedestrian demand within San Diego County. The project methodology includes conducting bicycle and pedestrian counts and intercept surveys over a two-year period throughout the county and evaluating the effects that socio-demographic, land use, and other variables have on walking and biking rates within the county. The project is funded by Caltrans Division of Innovation and Research.

The research team identified trends in walking and bicycling; evaluated the relationship between usage and facility quality, physical factors, and social factors; and reviewed the potential for using land-use and infrastructure improvements to increase walking and bicycling. The product of this research will provide Caltrans staff, local agency staff, advocates, elected officials, and others with the information and tools needed to understand walking and bicycling rates, patterns, relationships, and trends within San Diego, and may be useful to other areas of the state and country.

The Seamless Travel Project is the first large-scale test of count and survey methodology outlined by the National Bicycle and Pedestrian Documentation Project (NBPD). The NBPD is an annual bicycle and pedestrian count and survey effort developed and managed by Alta Planning + Design in coordination with the Institute of Transportation Engineers Pedestrian and Bicycle Council. The goals of the NBPD are to establish a consistent national bicycle and pedestrian count and survey methodology, to establish a national database of bicycle and pedestrian count information generated by these consistent methods and practices and to use the count and survey information to begin analysis on the correlation between various factors and bicycle and pedestrian activity.

FORMATION OF ADVISORY COMMITTEE

Local stakeholders and a Caltrans Technical Advisory Group were involved in developing the project methodology and have been regularly updated on the progress of the Seamless Travel project.

Technical Advisory Group

This group met several times to discuss the progress of the project and provide direction. Members of the group include:

Ann Mahaney, Project Manager, Caltrans HQ

Bob Justice, University Contract Manager, Division of Research & Innovation, Caltrans

Richard Haggstrom, Senior Transportation Engineer, Caltrans HQ

Ken McGuire, Bike Program Manager, Caltrans

David Ragland, Director, UC Berkeley Traffic Safety Center

Michael Jones, Principal, Alta Planning + Design

Lauren Buckland, Associate, Alta Planning + Design

<u>Stakeholder Group</u>

This group consists of all the members of the Technical Advisory Group listed above, as well as local San Diego Stakeholders. The Local Stakeholder Group includes members from San Diego Association of Governments (SANDAG), City of San Diego, County of San Diego, Caltrans District 11, San Diego State University and *Walk*SanDiego. The purpose of this group is to provide local knowledge and advice.

Members of the group include all TAG members, as well as:

Brad Jacobsen, Associate Traffic Engineer/Bicycle Program Coordinator, City of San Diego

Bob James, Bicycle and Pedestrian Coordinator, Caltrans, San Diego

Sherry Ryan, Associate Professor/Planner, San Diego State University

Steve Ron, Project Manager, San Diego County DPW

Chris Schmidt, Senior Planner, Caltrans, D-11

Stephan Vance, Senior Regional Planner, SANDAG

Andy Hamilton, WalkSanDiego

Kristen Mueller, WalkSanDiego

Meeting Schedule and Conference Presentation Dates and Summary

During the duration of the Seamless Travel Project the following meetings and presentations were held:

Date	Meeting	Summary
January 18, 2007	Stakeholder Meeting	Kick-off meeting held with TAG and stakeholder group to introduce all to the project and to solicit information from the stakeholders on work that has already been done in San Diego County regarding bicycle and pedestrian counts and surveys.
March 19, 2007	TAG Meeting	The TAC reviewed the Statement of Work for Seamless Travel through Task 5. Review of selected count locations.
June 6, 2007	Stakeholder Meeting	Michael Jones presented a PowerPoint summarizing the count location selection and initial count and survey data.

Date	Meeting	Summary
June 6, 2007	California Bicycle Advisory Committee	Lauren Ledbetter presented an update on the Seamless Travel Project to the CBAC. Comments regarding the methodology were incorporated as appropriate into project.
August 7, 2007	ITE Annual Meeting, Pittsburgh, PA	Lauren Ledbetter presented the Seamless Travel methodology and preliminary data collection efforts in "Estimating Bicycle and Pedestrian Demand"
September 18, 2007	TAG Meeting	Michael Jones presented a PowerPoint summarizing the project to-date, count and survey methodology, preliminary count and survey data, modeling options and next steps.
January 16, 2008	Transportation Research Board Annual Meeting	Lauren Ledbetter presented the Seamless Travel methodology and the data collection and survey results in "Estimating Bicycle and Pedestrian Demand in San Diego County"
January 30, 2008	CalPed Meeting	Michael Jones presented an update on the Seamless Travel Project to the California Ped Committee.
November 12, 2008	TAG Meeting	Michael Jones presented a PowerPoint summarizing the project to-date, count and survey findings, inital modeling steps.
March 5, 2009	TAG Meeting	Michael Jones presented a PowerPoint summarizing the modeling outputs and potential data uses..
February 3, 2010	TAG Meeting	Michael Jones presented the findings, conclusions, and potential applications

PROJECT OBJECTIVES

Background

One of the greatest challenges facing the bicycle and pedestrian field is the lack of documentation on usage and demand. Without accurate and consistent information on demand and usage, it is difficult to measure the positive benefits of investments in these modes, or to compare them to other transportation modes such as the private automobile.

Existing data sources such as the *U.S. Census Journey-to-Work*, and the *National Household Travel Survey*[11] document aspects of biking and walking (mostly as they relate to work commute trips of employed adults or national/regional travel behavior). These resources miss much of the actual bicycling and walking activity in our communities—such as trips made by students, utilitarian trips, and linked trips, and they do not tell us where we could expect to find pedestrians/bicyclists (trip distribution) or how

[11] U.S. Department of Transportation, Bureau of Transportation Statistics, 2000

What factors influence bicycling and walking?

many pedestrians/bicyclists we would find at any specific location. The data sources also may not represent a true cross section of user groups or provide sufficient detail on background elements (such as destinations and origins or frequency) that could provide insight into behavior.

Locally, counts and surveys conducted by agencies around the state and country are done with no consistent methodology that would allow researchers to understand bicycle and pedestrian activity trends and relationships to physical and social factors. The result is a limited understanding of the role of bicycling and walking as transportation modes, difficulty in projecting future use, difficulty in measuring developing collision rates, and a lack of understanding of how factors such as facility type, climate, topography, land use, and income influence activity levels.

Without bicycle and pedestrian usage information, transportation professionals may have difficulty justifying new bicycle and pedestrian investments, may undercount bicycling and walking in regional modeling efforts, and may undervalue the transportation, safety, economic, and health benefits of bicycle and pedestrian infrastructure.

Goals and Objectives

The key goals of the Seamless Travel Project are to:

(a) Evaluate existing bicycle and pedestrian data sources and collection methods

(b) Conduct comprehensive counts and surveys of bicyclists and pedestrians in a consistent manner using the National Bicycle & Pedestrian Documentation Project[12] as a template

(c) Conduct counts and surveys using San Diego County as a model community

(d) Analyze how bicycle and pedestrian activity levels relate to facility quality, and other factors such as land use and demographics

(e) Identify factors that are highly correlated with increased bicycling and walking

(e) Provide methods for quantifying usage and demand that will enhance research on benefits and exposure, and

(f) Evaluate how the transit-linkage can be improved.

At the completion of this project a report will be produced on trends in walking and bicycling; how usage relates to items such as facility quality, physical factors, and social factors; and the potential for land-use and infrastructure improvements to increase walking and bicycling. The research will provide Caltrans staff, local agency staff, advocates, elected officials, and others with the information and tools needed to understand walking and bicycling rates, patterns, relationships, and trends.

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[12] *National Bicycle and Pedestrian Documentation Project*, Jones, M., Buckland, L., Cheng, A., Transportation Research Board, Aug. 2005

The Seamless Travel Project is designed to meet these goals through the following objectives and performance criteria.

Goal 1: Evaluate existing bicycle and pedestrian data sources and collection methods

Objective 1.1. Work closely with local agencies, staff, and organizations to maximize the efficiency of the data collection and analysis process.

Objective 1.2. Evaluate existing bicycle and pedestrian data sources to determine the data quality, methodology used, and suitability of using these sources for time-related analyses.

Objective 1.3. Use existing bicycle and pedestrian data sources and collection methods to inform the data collection methods used in this research project.

Objective 1.4. Identify and evaluate automated and manual count techniques, and develop recommendations on the best applications and their related advantages and limits.

Goal 2: Conduct comprehensive counts and surveys of bicyclists and pedestrians in a consistent manner using the National Bicycle & Pedestrian Documentation Project as a guide

Objective 2.1. Utilize National Documentation Project's (NBPD) existing methods, forms, training, dates and times, location requirements, surveys, and other materials as a starting point, allowing research team to facilitate data collection.

Objective 2.2. Refine the NBPD methodology as needed to ensure that the other goals are met.

Objective 2.3. To the extent possible, structure the data collection methodology to allow integration of bicycle and pedestrian data into pre-existing local, regional, or statewide modeling efforts, including the NBPD.

Goal 3: Conduct counts and surveys using San Diego County as a model community

Objective 3.1. Work with a local stakeholders group to ensure that the count and survey collection reflects local knowledge and stakeholder's interests.

Objective 3.2. Ensure that the counts and surveys reflect a diversity of facility types, demographic groups, economic groups, and land-use types.

Objective 3.3. Build on past count and survey efforts in San Diego County, to provide a database and model that allows for the study of trends, patterns, and relationships, with applications for the rest of the State.

Goal 4: Analyze how bicycle and pedestrian activity levels relate to facility quality, and other factors such as land use and demographics

Objective 4.1. Use GIS data from SanGIS, SANDAG, the U.S. Census and other sources to relate activity levels to land use, facility type, and demographics.

Objective 4.2. Utilize spot field visits and aerial maps to verify and categorize facility quality.

Objective 4.3. Collect representative trip type and demographic data using surveys to identify non-physical factors that may affect bicycle and pedestrian activity levels.

Goal 5: Identify factors that are highly correlated with increased bicycling and walking

Objective 5.1 Utilizing historic data and data collected during the research project, employ regression analysis to identify any factors highly correlated with increased bicycling and walking.

Objective 5.2. Develop a methodology for rating and categorizing items that are related to bicycle and pedestrian activity levels, including a methodology for categorizing qualitative factors such as facility quality.

Goal 6: Provide methods for quantifying usage and demand that will enhance research on benefits and exposure

Objective 6.1. Develop an Online Database that will allow all collected data to be studied by the research team, Caltrans, local agencies, and other research institutions.

Objective 6.2. Using high correlation factors identified during the course of research, develop Bicycle and Pedestrian Demand Models that can help predict bicycle and pedestrian activity levels at specific locations, for use in planning, exposure and collision analysis, design, and management of non-motorized facilities.

Objective 6.3. Develop a Technical Report that provides an overview of the research project, objectives, methods used, summary of results in text and tabular format, analysis of correlations, trends, and patterns, conclusions on the accuracy and applicability of the data, and recommendations on increasing walking and bicycling in California.

Objective 6.4. Develop a Training Manual for use by Caltrans and local agencies for conducting bicycle and pedestrian counts and surveys in their communities.

Objective 6.5. Develop a PowerPoint presentation summarizing the research, conclusions, and recommendations of the research that can be used by Caltrans and other organizations for presentations.

Goal 7: Evaluate how the transit-linkage can be improved

Objective 7.1. Develop a Summary Report that includes information about preferences for different types of bicycle facilities, potential for increased transit-linked trips, estimations of benefits, and meeting the specific objectives of the California Blueprint.

Objective 7.2. Include count and survey locations that are near transit stops and use transit stop and route characteristics in analyzing the count and survey data.

The consistent, comprehensive data on walking and bicycling produced through the National Documentation Project, which now has data from over 60 agencies nationwide, will allow researchers to address the following:

- Trends in walking and bicycling
- Exposure data for collision analysis
- Preferences for facility types by users
- Role of walking and bicycling in local and regional transportation modeling efforts

- Developer responsibilities for bicycle and pedestrian impacts and mitigations
- Land-use planning and urban design to support walking and bicycling
- Documentation of health, economic, and other benefits
- Adequate facility design to meet user needs
- Documentation of usage and benefits for funding.

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2. SYNTHESIS OF PUBLISHED RESEARCH

REVIEW OF EXISTING COUNT AND SURVEY METHODS

Interest in bicycle and pedestrian modes as a small but important component of the multi-modal transportation system has been growing since the adoption of the Intermodal Surface Transportation Efficiency Act (ISTEA) in the early 1990s. A combination of increased interest in resolving traffic congestion, building livable communities and streets, supporting more active and healthy lifestyles, enhancing pedestrian and bicyclist safety, and encouraging Safe Routes to Schools, has resulted in a desire and need to accurately measure bicycling and walking rates, collision rates, and to understand why, when, and where people walk or bicycle. Furthermore, standardized pedestrian and bicycle data collection and analysis techniques are important factors for elevating the status of planning and funding for these travel modes.

EXISTING DATA SOURCES

The lack of consistent data on bicycling and walking is commonly cited, and is probably the single greatest impediment to being able to understand these modes. In 2000, the Bureau of Transportation Statistics published a report summarizing the existing bicycle and pedestrian data sources and the importance, quality and usefulness of this data. According to the report *Bicycle and Pedestrian Data: Sources, Needs & Gaps*, national data is commonly available, but consistent state, regional and local data is not. The report notes that data quality ranges from fair to poor (Bureau of Transportation Statistics, 2000).

Bicyclists using an overcrossing

On a national level, the *U.S. Census Journey-to-Work*, *National Survey of Bicyclist and Pedestrian Attitudes and Behavior* (NHTSA), and the *National Household Travel Survey* provide the only readily available, consistent bicycle and pedestrian count and survey information. These sources provide good background information on bicycling and walking, but either (a) provide information on a limited part of these trips or (b) provide national level data only. Due to its data collection methodology, the U.S. Census often undercounts the actual number of walking and biking trips made in a locality. The census data only counts commute trips, leaving out the significant number of people who bicycle or walk for recreation, to conduct personal business, or to socialize. Additionally, the Census long-form, which is used to gather journey to work information, requires that respondents choose only one mode. As a result, multi-modal trips, such as walking to transit, are not counted as a walking trip (California Department of Transportation, May 2002).

The National Household Travel Survey (NHTS) provides useful information on household-based trip making. The NHTS selects a random sample of U.S. households and asks each to complete a travel diary. All types of trips are collected, not just commute trips, and every component of a multi-modal trip is captured. However, the NHTS uses a smaller sample size than the U.S. Census, and is only useful at a national level. Recently, the NHTS has expanded its add-on program, which allows states and metropolitan planning organizations to purchase additional sample surveys for their area. Caltrans purchased an add-on for the San Diego area for 2008.

The *National Survey of Bicyclist and Pedestrian Attitudes and Behavior* (NHTSA) provides detailed information on walking and bicycling that compliments the NHTS and studies of aggregate (area wide) walk and bike trips. The NHTSA conducted telephone interviews of non-institutionalized people 16 years or older in the summer of 2002. Participants provide information about their bicycling and walking behaviors in the most recent 30 days. The data cannot estimate future activity but offers a summary of activity in the summer months.

As with any survey that relies on a subset of a population, sampling error may affect the accuracy of the Census and the NHTS data. Both the Census Long Form (which collects the journey-to-work data) and the NHTS use samples of the population, and may under represent or omit subgroups of the population. This is especially pertinent for bicycle commuting data, for which the mode share is usually less than 1%.[13]

The quantity and quality of regional and local bicycle and pedestrian data vary. State, regional and local data collection efforts are generally tailored to suit the specific needs of the community or project being evaluated (Greene-Roesel et al. 2007). The Bureau of Transportation Statistics notes that, "While a few cities and metropolitan planning organizations routinely conduct pedestrian and bicycle counts, most collect them only sporadically for specific studies or do not collect them at all"(Bureau of Transportation Statistics 2000). In California, it is common for metropolitan planning organizations or regional transportation planning agencies to collect regional travel surveys. Though these surveys generally focus on motor vehicle trips, most have a mode share component.

PEDESTRIAN AND BICYCLE RESEARCH EFFORTS

Despite the lack of coordination among agencies, it is recognized that developing a coherent bicycle and pedestrian data collection system is important for non-motorized planning, project development, encouragement activities, and funding. The Bureau of Transportation Statistics notes that "certain types of data, such as numbers of trips by facility and user type, are potentially useful to a wide range of user groups; but coordination among these groups is required to establish standardized, mutually beneficial data collection procedures." To offset the high cost of collecting data, agencies are relying on innovative solutions, such as automated count technology or incorporating non-motorized data collection into existing traffic data collection procedures.

NATIONAL BICYCLE AND PEDESTRIAN DOCUMENTATION PROJECT

The National Bicycle & Pedestrian Documentation Project (NBPD) is an effort led by Alta Planning + Design, in collaboration with the ITE Pedestrian & Bicycle Council, in response to the lack of useful data on walking and bicycling. While other modes such as motor vehicles have established conventions to collect and use data (such as trip generation for traffic modeling), the lack of consistent data for the walking/bicycling modes has made it difficult to justify funding, justify the allocation of capacity and right-of-way, develop exposure rates, among other issues.

[13] Using Journey to Work data from the U.S. Census 2000, the bicycle mode share for the United States is 0.40% and the bicycle mode share for California is 0.80%.

The concept for the NBPD is very simple:

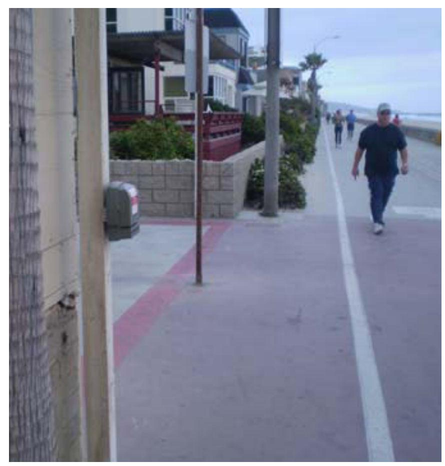
1. Provide materials and directions to agencies to conduct consistent counts and surveys,
2. Provide standard count dates and times,
3. Provide a location where this information can be sent,
4. Make this information available to the public.

The count and survey materials and methods have been evolving as more groups and researchers learn about the program, and determine their own unique needs for the information.

As NBPD moves forward it will have four basic primary applications: (1) safety – through exposure analysis, (2) trip generation—as part of impact analysis, land use and transport policy, ordinances, etc., (3) monitoring – identifying changes and trends in overall activity use, and (4) modeling – projecting existing/future activity, identifying the relationship between walking/bicycling and land use, multi-modal analysis, demographics, etc.

COUNT METHODOLOGIES

Bicycle and pedestrian counts are generally conducted either through manual counts or through automated counts. Many communities have combined manual counts with existing motorized vehicle counts at little or no extra cost. Manual counts are typically conducted by two counters per intersection, though a third person may be needed at busier intersections. Manual counts allow for collection of additional information, including type of users, use of helmets, turning movements and gender. (Schneider, Patton et al.) Manual count methods include using a tally sheet, an electronic board, a non-electronic counting board with periodic manual tallying, and using a handheld counter with periodic manual tallying.



Automated counter

Automated technologies are useful in conducting longer-term counts and establishing daily, weekly, or monthly variations in usage. With the exception of video playback systems, automated technologies generally require fewer person-hours than manual counts. The most common automated technologies used for non-motorized data collection are:

- Passive infrared (detects a change in thermal contrast)
- Active infrared (detects an obstruction in the beam)
- Ultrasonic (emits ultrasonic wave and listens for an echo)
- Doppler radar (emits radio wave and listens for a change in frequency)
- Video Imagining (either analyzes pixel changes or data are played back in high speed and analyzed by a person)
- Piezometric (senses pressure on a material either tube or underground sensor)
- In-pavement magnetic loop (senses change in magnetic field as metal passes over it)

Most automated technologies work well for counting users that pass a specific point but, with the exception of active infrared and time lapse video technologies, cannot easily distinguish between bicyclists and pedestrians (Beckwith and Hunter-Zaworski 1997; Wolter and Lindsey 2001). Time-lapse video has been used in Davis, California to capture user type, demographic information, and behavior (Schneider et al. 2005). The Massachusetts Highway Department successfully modified an active infrared traffic sensor and developed custom software to count and classify bicyclists and pedestrians. The sensor was able to accurately count 97% of bicyclists and 92% of pedestrians, and accurately classified 77% of bicyclists (Noyce and Dharmaraju 2002). A combination of technologies such as Eco-Counter's Eco-Multi, can also distinguish between types of users.

All automated count technologies have an error factor, with no-detection rates varying from 5% to 45%, depending on environmental conditions and usage patterns (Beckwith and Hunter-Zaworski 1997). Trail counts in Indiana using infrared traffic counters found the infrared sensors systematically underrepresented users by 15% (Wolter and Lindsey 2001). A Portland, Oregon study tested the accuracy of three types of pedestrian sensors: passive infrared, Doppler radar and ultrasonic. The sensors were tested under a variety of conditions, and were found to have varying error rates and could be susceptible to adverse weather conditions (Beckwith and Hunter-Zaworski 1997). Comparing automated counts with manual counts allows researchers to correct for inherent error rates.

Ultimately, the decision to use automated or manual count technologies depends on the duration of the count effort, the existence of other ongoing count efforts, the type of data that are to be collected, the number of person-hours available for data collection and analysis, and the overall budget of the count effort. Automated count technologies have a higher start-up cost than manual count technologies, though they generally require fewer person-hours than manual counts and can mean long-run cost savings. Manual counts require more person-hours than automated counts, but can collect additional characteristics of bicyclists and pedestrians. A summary of manual and automated counts characteristics is provided in **Table 4**.

Table 4: Manual and Automated Count Characteristics

Manual Counts	Automated Counts
Integrating pedestrian and bicycle counts with existing motor vehicle counts can reduce costs Field observations are labor-intensive, which may limit the number of count locations Observations have a higher level of accuracy, and can be more complex than automated counting methods (i.e., can include behaviors and other characteristics of users)	Technologies can significantly reduce labor costs Settings and positioning of devices must be adjusted to maximize accuracy Placement should minimize interference with pedestrians and bicyclists and potential for vandalism Most technologies work in rain and a wide variety of temperatures Many technologies allow for remote data download Most technologies do not count all types of non-motorized users and few can be used to observe behaviors

Source: (Schneider, Patton et al. 2005)

PEDESTRIAN AND BICYCLE TRAVEL BEHAVIOR SURVEY METHODS

Bicycle and pedestrian surveys are useful to understand why people are walking and bicycling, to collect socio-demographic information, and to discern attitudes about walking, biking and facilities. Surveys are generally conducted either as a sample of the general population, or targeted specifically to non-motorized users. Surveys have been criticized for two common shortcomings. First, surveys frame the questions and limit the possible responses, thus increasing the chance that unexpected responses will be unrecorded or that questions will be misunderstood. Second, traditional survey collection methods, such as travel diaries and phone recruitment can under represent certain population groups, such as the elderly and the poor. Clifton and Handy (2001) recommend using focus groups to test survey reliability and ensure they are worded so that the target audience understands the questions. Survey respondents should be compared with the population being sampled, and underrepresented segments of the population may need to be reached through different channels.

Schneider et al. (2005) summarize key differences in travel surveys based upon general population sampling and targeted sampling. These findings are summarized in **Table 5**.

Table 5: Characteristics of General and Targeted Surveys

Samples of the General Population	Targeted Surveys
Results of well-executed random-sample surveys can represent the entire community	Agency can obtain detailed characteristics about people who make non-motorized trips
Results can provide baseline and follow-up data for the community as a whole	Results can provide baseline and follow-up data about non-motorized users
Potential participants should be identified using a random selection procedure	Differences between survey participants and the overall population are important to recognize
Survey instrument design and survey distribution techniques are critical to achieving a high response rate and representative results	Survey instrument design and survey distribution logistics are critical to the quality of the survey
Gathering and analyzing responses can be labor-intensive	Labor costs can be high, unless volunteers are recruited

Source: (Schneider, Patton et al. 2005)

Short intercept surveys can be supplemented by longer take-home surveys. In 2002, the Rhode Island Department of Transportation conducted user surveys on six bicycle paths, where groups of users were intercepted and a short survey was administered to persons willing to participate. The on-path survey asked for the participant's street address or email so a paper copy of a longer survey, or a web link to the longer survey could be sent to the participant. The survey collected information on mode of access to the path, time spent and distance traveled on the path, usage by time of day, day of week and season, and use of the path for commuting (Gonzalez et al. 2004).

To reduce costs, the Rhode Island survey used University of Rhode Island students and volunteers to conduct the surveys. Students and volunteers were given detailed instructions on how to introduce themselves, identify their purpose, and describe the two-phase survey. According to the summary report, interviewers felt the experience was "pleasant" and that most people on the path were "enthusiastic users" (Gonzalez et al. 2004).

Abraham et al. (2002) used a stated preference survey to determine cyclist's route choice preferences. The intention of the survey was to develop parameters that could be used in the City of Calgary's travel demand model. The survey was distributed by email to downtown bicyclists who had participated in a prior survey and were willing to be contacted again. The survey found that bicyclists strongly preferred off-street bicycle facilities and low-traffic residential roads.

The National Survey of Pedestrian and Bicyclist Attitudes and Behaviors conducted for the U.S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA) conducted telephone interviews. Random phone surveys reach a more representative sample however it is limited to participants with a phone and is expensive to administer. The survey found respondents did not use multi-use paths and bike lanes because they were either not convenient or did not go where the bicyclist wanted to go.

BICYCLING AND PEDESTRIAN TRAVEL MODELING

Market Street and 5th Avenue, San Diego

Recent research studying the link between walking and environmental factors has found that certain environmental factors such as land use and sidewalk completeness are positively correlated with pedestrian volumes (Berke et al. 2007). However, these studies have not clearly demonstrated a causal link between environmental factors and pedestrian activity (Handy 1991; Boarnet and Crane 2001). In an Austin, Texas study Cao, et al. (2006) demonstrated that residential self-selection plays a role in walking rates, especially in utilitarian walking (e.g. walking to the store). In other words, people who prefer to walk to the store may move to neighborhoods that are more walkable. There is still a question about the causal link between walking and the built environment. For planning purposes, creating a built environment that supports walking should generally increase walking rates, though it may do so in part by attracting "walkers" to a neighborhood.

The Austin study suggests that recreational walking, like strolling, is affected by the residential built environment, while utilitarian walking is more affected by the destination's built environment (e.g. store quality and proximity).

FOUR-STEP MODELING PROCESS

Transportation models fall under two groups: aggregate models or disaggregate models. Aggregate studies model travel behavior based on the characteristics of an area (e.g. population density, employment density, household income, facility type). Disaggregate studies model travel behavior from the perspective of individual travel choices. These models apply individual characteristics and preferences (e.g. attitudes, trends related to gender or age) to a population with known characteristics to predict travel behavior.

Aggregate and disaggregate models differ in their ease of use and predictive abilities. Aggregate models can be developed using readily available data and methods. Disaggregate models are more complicated to develop and require custom data and survey collection, but are more effective at predicting travel behavior (Federal Highway Administration 1999).

Regional transportation modeling and forecasting began in the 1950s with the growing need to predict and plan for expected increases in population, vehicle ownership and vehicle miles traveled. The passage of the 1963 Federal Aid Highway Act institutionalized regional transportation planning by requiring that urban areas employ a "continuing, comprehensive and cooperative" transportation planning process. Since these beginnings, institutionalized transportation models have been modified to reflect changing social patterns and new environmental regulations and conformance requirements. The model commonly used today is the four-step Urban Transportation Model System (UTMS) (Pas 1995).

The UTMS takes transportation system characteristics and land-use system characteristics as inputs, uses four sub-models to determine trip generation, trip distribution, trip mode choice and trip assignment, and produces an estimate of the volume and speed of traffic on the transportation network. The four sub-models are commonly run in the sequence described below (Pas 1995; Meyer and Miller 2001).

Step 1: Trip Generation asks: "How many trips?" and predicts the number of trips produced by and attracted to each area of analysis. This number is calculated based on the land-use type, intensity of the use, and the socioeconomic characteristics of the activities using the land.

Step 2: Trip Distribution asks: "Where do trips go?" and links each trip generated in step one to an origin and a destination. The gravity model is the most commonly used method for distributing trips. The gravity model calculates the number of trips from an origin to a destination based on (1) the number of trips leaving a destination, (2) the attractiveness of the destination, and (3) the difficulty (friction) of traveling from the origin to the destination.

Step 3: Trip Modal Split asks: "How do people get there?" and predicts the percentage of travel that will use each mode between origins and destinations. Mode choice is estimated in two common ways. The first, an aggregate model, links the mode split to the characteristics of the transportation system (e.g. transit frequencies, relative speed of biking or walking vs. driving) and the characteristics of the users (e.g. average auto ownership, age, average income). The disaggregate model is concerned with the travel behavior of individuals. These models link an individual's choice to the characteristics of all mode choices available for that trip (such as travel cost, travel time) and the characteristics of each individual (such as auto ownership, average income).

Step 4: Trip Assignment asks: "What route will people take?" This step predicts the route that each trip will take from each origin to each destination. The model considers attributes of the route, including travel time and distance, number of stops, aesthetic appeal, but travel time is the most commonly used attribute.

The four steps described above represent a sequential decision making process: Should I make a trip? Where should I go? Should I drive, walk, bike, or take the bus? What route should I take? This process has been criticized as a "highly unrealistic representation of traveler's decision making," but the intention of the four-step model is not to model individual trip decisions, but to provide a "pragmatic approach to reducing the extremely complex phenomenon of travel behavior into analytically manageable components" (Meyer and Miller 2001). Some four-step models switch the order of steps two and three, performing the modal split before distributing the trips.

Historically, transportation modeling has been focused on highway or transit networks, and considers just two modes: private vehicles and public transportation (Sheppard 1995; Meyer and Miller 2001). Factors that could influence the decision to walk or bike are not usually included in the four-step process. When developing a non-motorized transportation model, or when incorporating non-motorized transportation into a traditional four-step model, several factors should be considered, as outlined in **Table 6**.

Though walking and bicycling are often lumped together, there are significant differences between the two modes. Most models that are developed for forecasting non-motorized transportation are developed specifically for bicyclists or pedestrians. Three of the most significant differences between the two modes are:

(1) *Walking trips are generally shorter than bicycling trips*. This may affect the spatial scale of analysis.

(2) *A large percentage of walking trips are trips to access other modes*, including the automobile or transit. Bicycle trips are generally stand-alone trips. Modeling should consider the fact that pedestrian trips may not replace automobile trips, but may result from those trips. Conversely, the quality of the walking environment may need to be considered in predicting transit mode shares.

(3) *The decision to ride a bicycle involves a greater conceptual leap than the decision to walk*. Public health and social marketing fields have shown that the decision to even consider riding a bicycle is a multi-staged process involving a variety of interacting personal, social and environmental factors. Attitudinal research is important for modeling and understanding pedestrian travel, but is perhaps most significant for bicycle travel (Federal Highway Administration 1999).

Methods for modeling non-motorized travel are more varied than those used for motor vehicle and transit modeling. Methods range from comparative studies to incorporation into regional four-step demand models. Several common types of models are described in **Table 7**.

Table 6: Selected Factors Influencing Non-Motorized Travel

Variable	Description
Link Characteristics	Measurable characteristics of a link in a roadway or pathway network (e.g., traffic volume, lane width, or pavement quality)
Link "Friendliness"	The overall acceptability of a link as a bicycle or pedestrian route – a function of link characteristics. Also varies by user characteristics (e.g., experiences vs. novice bicyclist.)
Network Characteristics	Characteristics of a network of links (e.g., connectivity) that determine its overall acceptability or "friendliness" to the user
Network "Friendliness"	A general measure of how acceptable the local road/path network is for bicycling or walking
Supporting Policies	Other programs, policies, facilities, etc,. which affect the acceptability of bicycling or walking (e.g. bicycle parking, showers/lockers, and educational programs)
Population Characteristics	Characteristics of the local population which relate to likelihood of bicycling or walking (e.g. socioeconomic characteristics or attitudes)
Climate/Weather	General propensity to walk or bicycle, as a function of climate/weather. This might be considered a constant for a given area/region
Characteristics of Other Modes	Relative travel times and costs of bicycling or walking vs. other modes, as well as safety, comfort, or other factors which influence choice of mode. Policy variables might include parking pricing, transit service improvements, etc.
Land Use	Density and distribution characteristics of population, employment, shopping, and other activities which affect where people travel, how many trips are generated, trip length, etc.
Topography	Where it is significant, topography will influence the travel patterns of pedestrians, with people selecting more level routes even when they are less direct
Aesthetics	Bicyclists and pedestrians will typically choose a route that is more aesthetic (shade trees, views, lower traffic), even if is not direct. In some cases, bicyclists/pedestrians will deliberately seek out these types of facilities for recreation/exercise
Transit Access	Accessibility to transit especially impacts pedestrian trip making, since all transit trips begin and end with a pedestrian trip

Source: (Federal Highway Administration 1999)

Table 7: Methods for Modeling Non-Motorized Travel Demand

Purpose/Method	Description
Demand Estimation	Methods that can be used to derive quantitative estimates of demand
Comparison Studies	Methods that predict non-motorized travel on a facility by comparing it to usage and to surrounding population and land-use characteristics
Aggregate Behavior Studies	Methods that relate non-motorized travel in an area to its local population, land use, and other characteristics, usually through regression analysis
Sketch Plan Methods	Methods that predict non-motorized travel on a facility or in an area based on simple calculations and rules of thumb about trip lengths, mode shares, and other aspects of travel behavior
Discrete Choice Models	Models that predict an individual's travel decisions based on characteristics of the alternatives available to them
Regional Travel Models	Models that predict total trips by trip purpose, mode, and origin/destination, and distribute these trips using a gravity (time/distance) formula across a network of transportation facilities, based on land-use characteristics such as population and employment and on characteristics of the transportation network

Sources: (Schwartz et al. 1999; Federal Highway Administration 1999)

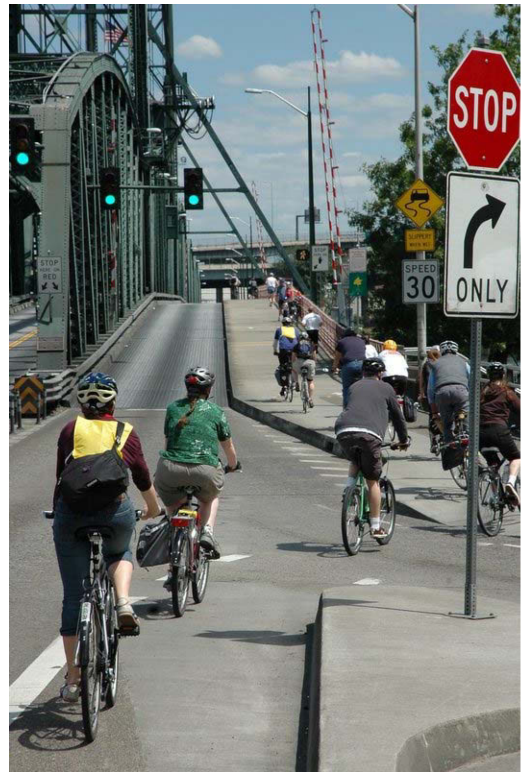
Pas notes that "even mathematical models of travel and related behavior implicitly employ subjective judgments and reflect particular perspectives on human behavior"(Pas 1995). The FHWA recommends that for both disaggregate and aggregate models, "it is important to remember that decision making ultimately occurs at the individual level and that a forecasting procedure should approximate the individual decision-making process as closely as possible (Federal Highway Administration 1999). Additionally, the validity of model outputs is related to the quality of the data inputs.

Collecting high quality non-motorized bicycle and pedestrian data will allow modelers to more accurately estimate walking and biking.

NON-MOTORIZED TRANSPORTATION FORECASTING EFFORTS

Forecasting models of bicycle and/or pedestrian travel has been developed by several researchers and groups nationwide since the Seamless Travel project started in 2007, with notable efforts in Portland, Oregon (Columbia River Crossing, CRC Transportation Planning Team, 2008) and in Alameda County, California (Traffic Safety Center, Schneider, Arnold, Ragland, 2008). Both of these modeling efforts advanced the state of non-motorized forecasting by using extensive count data, which provides significantly more realistic basis than previous efforts.

The *Columbia River Crossing* project was part of a major corridor study of a proposed new crossing of the Columbia River between Portland, Oregon, and Vancouver, Washington. A model was developed to forecast future bicycle and pedestrian trips across the new bridge using a combination of U.S Census mode share, travel surveys, a bicycle trip study conducted by Portland State University, and travel characteristics on a nearby bridge (Hawthorne Bridge). The model uses total forecasted trips on the new bridge from the regional travel demand model, and assigns a mode split to those forecast trips of five (5) miles or less for bicycles (2 miles or less for pedestrians), based on local survey results. The model forecasts a 650% increase in pedestrian trips and a 150% increase in bicycle trips. The assumption behind the model is that a straight line correlation exists between vehicle and bicycling/walking trips based on travel time/trip length, assuming the quality of the facilities remains the same or improves.



Forecasting future trips in Portland, Oregon

The Alameda County forecasting model developed by the U.C. Berkeley Traffic Safety Center (*A Pilot Model for estimating Pedestrian Intersection Crossing Volumes*, 2008) is based on pedestrian counts at 50 locations and specific variables including total population within .5 mile radius, employment within a .25 mile radius, number of commercial retail properties within .25 miles, and the presence of a regional transit station within .1 miles of the count location. The 'r' value for this combination of variables was .987.

In referring to previous pedestrian modeling efforts including the Space Syntax Model, the pedestrian model created for Manhattan (Cameron) and Milwaukee (Benham and Patel), the study states that "few studies to date have used continuous counts to account for daily, weekly, and seasonal variations in pedestrian activity or capture the effects of weather and other factors on pedestrian volumes."

The study selected 50 intersections in a variety of settings for its count locations, eliminating locations in low density areas due to the potential for high variability. Each leg of an intersection was counted separately, with some pedestrians being counted more than once. Infrared counters were installed to conduct 24-hour a day counts, and calibrated with manual counts. Counts were conducted over a 13-week period. Over 40 different potential variables were considered and tested using GIS mapping tools and regression analysis.

CONCLUSION

Each of the data sources and research efforts described in this chapter provides another piece in the puzzle to understand bicyclist and pedestrian travel. It is clear from the research that there are three basic types of data and forecasting tools:

Area Wide (Aggregate) Trips:

Using household daily trip generation and available travel and demographic information, it is possible to develop estimates of area wide (or national) bicycle and walking trips. This information can be used for area wide planning and other purposes, such as the Non-Motorized Transportation Pilot Project.

Land Use Based Trips:

Travel estimating for vehicles (using the ITE *Trip Generation Manual*) is based almost exclusively on this type of analysis. This data is then used as part of the four step modeling process to create traffic models, assess impacts, and measure Level of Service. ITE has initiated a land use based trip generation data collection effort for walking and bicycling trips, but is application and use is unknown at this point.

Corridor or Specific Location Estimating

While the land use-based trip generation techniques described above are used as the basis for vehicle traffic models which can provide estimates of specific location and corridor volumes, no such validated model exists today for bicycling and walking trips. Advances have been made in some areas (Columbia River Crossings, Alameda County) but no model has yet been based on data collected for a long period of time (at least one year) and over a large geographical area for both modes.

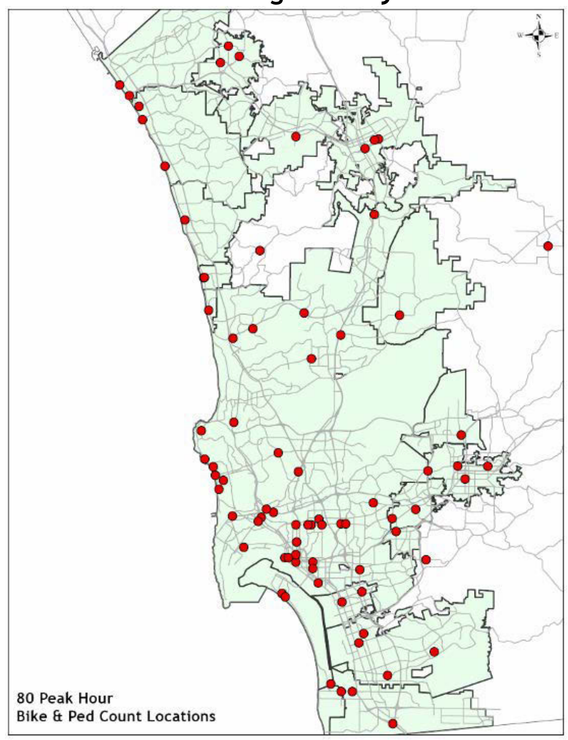
The *Guidebook on Methods to Estimate Non-Motorized Travel* (1999, Vol. 1, Section 4) states that "further development of modeling techniques and data sources are needed to better integrate bicycle and pedestrian travel into mainstream transportation models and planning activities." This research effort seeks to enhance the existing sources of bicycle and pedestrian data within the San Diego region.

3. PRIMARY DATA COLLECTION

This chapter addresses the count and survey data collection effort conducted during Years One and Two of the Seamless Travel Project.

WHY SAN DIEGO COUNTY?

Figure 4: Peak Hour Count Locations in San Diego County



San Diego County was chosen as a model community for two reasons. First, regular bicycle counts were conducted throughout the county in 1985, 1987, 1990, 1993, and 1997. Count locations remained the same from year-to-year, with the addition of new count locations in later years. The original set of count locations was randomly selected from the existing and proposed county bicycle network. This historic bicycle count data can be used to test and evaluate the counts and correlations identified by the Seamless Travel Project. Second, San Diego County has an extensive, frequently updated countywide GIS database that is freely available. Historic GIS information is also available, allowing a comparison of historic bicycle counts to historic land uses.

The research team worked closely with local agencies, staff, and organizations to maximize the efficiency of the data collection and analysis process. Representatives from several local agencies were invited to participate in a local stakeholder team. This team provided input into methods and also provided valuable local expertise. The following agencies were represented: San Diego Association of Governments, City of San Diego, San Diego County, WalkSanDiego, San Diego Bicycle Coalition, Caltrans District 11 (San Diego District) and Caltrans Headquarters.

COUNT METHODOLOGY

The Seamless Travel Project includes two (2007 and 2008) manual peak period counts at 80 locations throughout San Diego County and one-year of automated 24-hour counts at five locations (August 2007 to July 2008).

Count locations were based on (a) historic count locations and (2) representative locations based on land use (urban, suburban, rural), demographics (a full range of ethnic and income locations), and facility types (bike paths, streets with bike lanes, arterials, local streets). It was determined that a random sample would require many more count locations than were possible given the project budget in order to cover the range of desired land uses, demographics, and facility types. Instead, count locations were selected to ensure that a variety of demographic and physical characteristics were represented. Using GIS analysis and input from local stakeholders, a final set of 80 count locations (40 historic bicycle counts, 40 new counts) was established. Count locations were chosen to represent:

- Presence and type of bicycle facilities, including no bicycle facility
- High pedestrian crash areas
- Areas identified for future smart growth
- Locations near transit stops (trolley, bus, ferry)
- Locations near planned or recently completed bicycle and pedestrian projects
- Variety of land uses and demographics

All 17 jurisdictions within the county and the unincorporated county are represented in the count locations. The count locations focus on the more populated, western half of the county. Error! Reference source not found. displays the locations of the eighty peak period count locations across the County of San Diego.

Peak period manual counts were conducted during the traditional peak hours (AM weekday peak from 7 AM to 9 AM and midday weekend peak from noon to 2 PM) at all 80 count locations. Additional PM peak (4 PM-6 PM) manual counts were conducted in Year Two at 20 locations, with all 80 locations counted at the conclusion of the study. The choice to count only one peak period for all locations was due to budgetary constraints. The AM peak was chosen based on counts from the National Household Travel Survey, Bay Area Travel Survey and southern California counts conducted by Alta that show bicycle and pedestrian travel peaks at the same time during the AM peak, but during the PM peak, pedestrian travel peaks earlier than bicycle travel.

AUTOMATED COUNT METHODOLOGY

In addition to peak-hour counts, the Seamless Travel Project collected automated year-long counts to establish trends in bicycling and walking. After evaluating the various automated counting tools available on the market, the research team decided to use a combination of passive infrared counters and active infrared counters. Both count tools collect time-stamped data, contain their own power source, and allow data to be downloaded to a computer for analysis. Active infrared counters allow bicyclists and pedestrians to be classified. They are more challenging to install (two units as opposed to one), but are less expensive than passive infrared. Passive infrared counters do not classify bicyclists and pedestrians, but only require one unit per installation. Passive infrared counters can classify counts by direction as well.

Active infrared counters can be set up to detect the speed of travelers thereby allowing for an approximate differentiation between bicyclists and pedestrians based upon assumed travel speeds for the two modes. Two units are installed along a single corridor. One unit is set to trigger a count when the traveler is moving at a low speed (the pedestrian), while the other unit is calibrated to trigger when a traveler is moving at a higher speed. The low-speed unit counts all pedestrians and bicyclists while the higher speed unit counts only bicyclists. Pedestrian counts can be determined by subtracting the bicyclist count from the combined count. The research team experimented in the field to determine the appropriate speed at which the two units will need to be set, however the California Bicycle Advisory Committee has suggested that 8 mph is a good speed at which to start counting bicyclists.

Infrared counters have been shown to consistently undercount pedestrians. Pedestrians that walk side-by-side are generally counted as one pedestrian. Undercounts range from 5 to 30 percent, but are generally consistent at a location (Greene-Roesel et al. 2007). To calibrate the infrared counters for the Seamless Travel Project, the researchers compared manual counts to automated counts to establish a correction factor for each site.

Pedestrians walking side-by-side can create inaccuracies in automatic counters

One automated count location (Mission Beach Boardwalk) was discovered to have very high and variable error rates in 2008. Extensive manual counts were conducted to determine the cause for this, and to develop an accurate correction factor. It was determined that the width of the Boardwalk (22 feet) combined with extremely high volumes (for example, 3,135 people were counted in one 2 hour period) resulted in error rates as high as 70%. The infrared counters were unable to distinguish between so many people walking/riding side by side when they passed the counter.

Count locations for the year-long automated counts were more restricted than the peak-hour manual counts. Due to the count technology chosen, only off-street areas could be used. Infrared counters cannot easily be used to monitor on-street bikeways, as vehicles will trip the sensor. It was determined that using a pneumatic tube counter for on-street bikeways could pose safety concerns, and might be affected by buses and vehicles rolling over the tube.

Year-long automated counts were conducted at five sites. These sites were chosen to reflect a variety of recreational, commuter, bicycle and pedestrian traffic. A map of count locations is shown in **Figure 5**. Information collected from the year-long automated counts was used to evaluate hourly, daily, monthly and seasonal trends in biking and walking.

Equipment Technology

The research team reviewed published literature on counting non-motorized travel and conducted internet searches to determine the most suitable technology available for this project. Key criteria guiding this review included equipment cost, ease of installment, and potential for differentiating pedestrian and bicycle modes. **Table 8** presents an overview of automatic count technology.

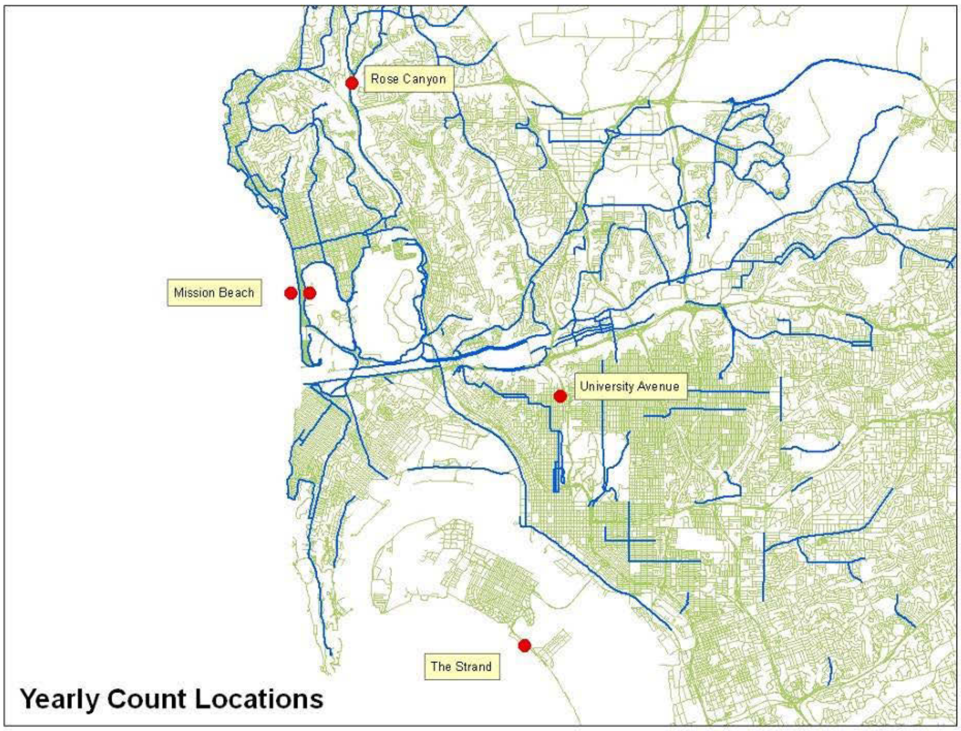
Table 8: Automatic County Technology Overview

Technology	How it Works	Differentiate between bikes and peds?	Where can it be used?	Can it be moved to other locations?	Other Considerations	Technology Cost
Passive infrared	Detects a change in thermal contrast	No	Sidewalk, path	Easily		$,2000-3,000
Active infrared	Detects an obstruction in the beam	Yes	Sidewalk, path	Easily		$800-$7,000
Video imaging	Analyzes pixel changes	Unknown	Intended for indoor use	Yes	Difficult detection outdoors, no bike/ped application yet	$1,200-$8,000
Video playback	Video analyzed by a person	Yes	Anywhere	Yes	Difficult detection at night and bad weather. Considerable staff time	$7,000
Piezometric Tube	Senses pressure on tube	No	Path, on-street	Easily	Bicycles only. Potential tripping hazard	$1,600
Piezometric Pad	Senses pressure	No	Sidewalk, path	No		$2,000-3,000
In-pavement magnetic loop detectors	Senses magnetic field change as metal passes	No	Path, on-street	No	Requires cutting into pavement to install	$2,000-3,000

Based on review in 2007, two types of count equipment technology were purchased: an active infrared counter manufactured by TrailMaster and a passive infrared counter manufactured by JAMAR. The active infrared equipment includes a transmitter that emits an infrared pulsing beam and a receiver, which detects the beam. When the infrared beam is broken by a walker or bicyclist, the receiver counts an event. The infrared beam's pulse rate is adjustable, and allows for the TrailMaster to be sensitive to the length of time required for an object to break the infrared beam. A benefit of this technology is that two TrailMasters can be installed in the field at one location, and then each set differently, one to record all events and the other to record only pedestrians[14]. This allows for an estimation of mode share along a path. The TrailMasters were installed inside small electric boxes and attached to poles or trees near the respective pathways or walkways.

The JAMAR Scanner employs passive infrared technology whereby a single piece of equipment emits a beam that is broken by a heated object passing through it, such as a human or an automobile. Therefore, when a walker or bikers passes through the beam, the equipment detects the heat and counts an event. This technology cannot distinguish mode or speed, but can detect the direction of the traveler.

Figure 5: Yearly Count Locations in San Diego County



Count Site Locations

Five locations within San Diego County were selected as sites for conducting continuous, year-long 24-hour counts (**Figure 5**). The site selection was based upon the need to collect data from a mix of urban environments and facility types, and to capture differences in commute versus recreational trip making. A local signage company, Kitt Signs, was hired to retrofit off-the-shelf electric boxes to hold the TrailMasters, as well as to install all of the equipment in the field. The JAMAR Scanners were not fitted into electric boxes, as they are encased in heavy, weatherproof plastic casing.

Each of the sites and justification for selection are summarized below:

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[14] All fast-moving trail users, such as skateboarders, are recorded as bicyclists.

Gilman Drive / Rose Canyon Bike Path: This site is located in the City of San Diego along a relatively long and well-utilized bicycle path that connects coastal residential areas to significant concentrations of high-tech, university-related, and retail/service employment. The site was expected to be dominated by bicycle trip-making with a strong emphasis on commuting. Two TrailMasters were installed at the site to capture differences in pedestrian and bicycle mode shares.

Bayside Walk @ San Juan Place and Bayside Walk @ Ormund Place: This site is located in the City of San Diego's Mission Beach community along Mission Bay. The pathway is part of a relatively long facility that goes around Mission Bay's entire eastern bay. The location tends to have heavy recreational usage by both bicyclists and walkers/joggers, but is also utilized by residents for shopping trips and to obtain other services in nearby Pacific Beach. Two TrailMasters were installed at adjacent locations along the Bayside Walk to capture differences in pedestrian and bicycle mode shares.

The Boardwalk @ San Juan: This site is located in the City of San Diego's Mission Beach community along the Boardwalk. The pathway is part of a long beach area pathway system that runs adjacent to the ocean and connects with other pathways around Mission Bay. The location tends to be heavily utilized for recreational travel. A JAMAR Scanner was installed at the site. The site was selected in order to capture the upper extent of pedestrian and bicycle demand in San Diego, as this is one of the most heavily traveled non-motorized pathways in San Diego.

Bayshore Bikeway @ Avenida de las Arenas: This site is located in the City of Coronado along the Bayshore Bikeway (The Strand). Two TrailMasters were installed at this location. The pathway is part of a relatively long facility that goes around San Diego Bay. The location serves recreational bicyclists and was selected in part because it was recently completed.

University Avenue between 4th and 5th Avenues: This site is located in the City of San Diego within a relatively older, pedestrian-oriented neighborhood with mixed land uses and high residential densities. A JAMAR Scanner was installed at this location. The location was selected to represent urban pedestrian travel where high levels of multi-purpose walking trips are made.

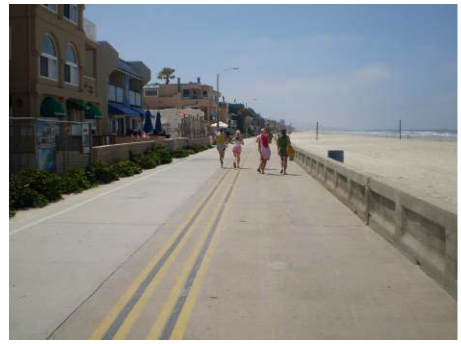
Figure 5 provides a citywide overview of the count locations, while **Figure 6** and **Figure 7** present a more detailed view of counts locations and equipment installation at the respective sites.

Figure 6: Rose Canyon Bike Path, Mission Beach Boardwalk and Bayside Year-Long Automated Count Locations

Rose Canyon Bike Path

Moderately high activity, bike commuters/ recreational walkers and bikers

Collected mode split information



Mission Beach (Boardwalk)

High activity area, mainly recreational, did not collect mode split information

Mission Beach (Bayside Boardwalk) (not shown)

Moderately high activity, mainly recreational, collected mode split information

Figure 7: University Avenue and Bayshore Bikeway Year-Long Automated Count Locations

University Avenue (sidewalk)

High pedestrian activity area, mainly utilitarian urban travel, did not collect mode split information

Bayshore Bikeway, Coronado

Moderate activity levels, mainly recreational walkers and bikers, collected mode split information

Validation Methods

The research team verified the accuracy of the 24-hour counting equipment by conducting manual counts while the machines were counting, and then comparing the manual count data to the machine count data. The first validation count revealed several types of installation problems. For example, at the University Avenue site, the Scanner was initially located too close to a business entrance and was found to be counting inaccurately due to people entering and exiting the business. The Scanner was shifted away from the business door and found to count with increased accuracy. The angle at which the infrared beam is directed across a facility also proved to be an important factor in the count accuracy. Several of the counting machines had to be shifted to transmit at a 45-degree angle across the facility in order to record people traveling side-by-side. This adjustment improved the accuracy of the machine count.

Validation Results

This section summarizes results of the validation analysis by equipment type, first discussing validation analysis results for the passive infrared equipment installed along The Boardwalk and University Avenue, and then discussing validation analysis results for the active infrared equipment installed along the Bayside Walk, the Bayshore Bikeway, and the Rose Canyon Bike Path.

Passive Infrared Counters

Table 9 presents results of the validation efforts at the two sites where passive infrared technology was installed – The Boardwalk and University Avenue.

Table 9: Passive Infrared Validation Counts JAMAR Scanner

Location	First Validation				Second Validation				
	Date & Time of First Validation Count	Total Manual Count	Total Machine Count	Percent Diff.	Adjustment	Date of Second Validation Count	Total Manual Count	Total Machine Count	Percent Diff.
The Boardwalk	7/13/07 (2:45 PM to 4:00 PM)	580	400	-31.0%	Reposition at 45° angle across facility.	7/17/07 (12:30 PM to 1:30 PM)	427	337	-21.1%
University Avenue	7/13/07 (8:00 AM to 9:15 AM)	62	58	-6.5%	Reposition away from business entrance.	7/23/07 (9:15 AM to 10:15 AM)	20	17	-15.0%

Source: (Alta Planning + Design, November 2007)

The Boardwalk Site: The JAMAR Scanner was initially mounted on a sign post facing west along the north/south running Boardwalk, with the infrared beam aimed directly across the pathway. The first validation count was conducted on July 13, 2007, between 2:45 PM and 4:00 PM. The JAMAR Scanner was found to be undercounting by approximately 31%. The Scanner was then repositioned to face north-west, at a 45 degree angle across the pathway, in the hopes that the equipment would be more sensitive to people walking next to each other. A second validation count was conducted on July 17, 2007 between 12:30 PM and 1:30 PM. The counts revealed that the machine position adjustment improved the machine's count to within approximately 21% of the manual count.

University Avenue Site: The JAMAR Scanner was mounted on a street light pole facing north along the east/west running University Avenue, with the infrared beam aimed directly across the pathway. The first validation count was done July 13, 2007 between 8:00 AM and 9:15 AM. This validation count showed that the machine was counting within 6.5% of the manual count, however, Alta staff noticed that the beam was aimed almost directly at a business storefront and that every time someone entered or exited the store, the Scanner recorded an event. The Scanner was repositioned to face north-west, at a 45 degree angle across the sidewalk and away from the store entrance. The second validation count was done on July 23, 2007 between 9:15 AM and 10:15 AM. The Scanner was then found to be counting within 15% of the manual count.

Active Infrared Counters

Table 10 summarizes the validation analysis results for the active infrared counting machines installed at the Bayshore Bikeway, the Bayside Walk, and the Rose Canyon Bike Path.

Rose Canyon Bike Path Site: The Rose Canyon Bike Path validation count was conducted June 6, 2007 between 3:30 PM and 5:45 PM. The north set of boxes (one transmitter and one receiver) was set to capture an event for objects moving at any speed, and the south set of boxes was set to capture events for objects moving at the speed of a pedestrian. Both sets of boxes broadcast infrared beams directly across the path. The machines set to capture all travelers undercounted by about 12%, while the machines set to count pedestrians undercounted by about 25%.

Bayshore Bikeway: The Bayshore Bikeway validation count was conducted July 9, 2007 between 10:15 AM and 12:15 PM. The north set of boxes was set to capture events for objects moving at any speed, while the south set of boxes was set to capture objects moving at a pedestrian's typical speed. The two sets of equipment were initially set so that their beams traversed the path at a 90 degree angle. The first validation count showed that the south set of boxes was undercounting by approximately 92% and the north boxes were undercounting by about 22%.

The southern boxes were repositioned to direct the beam at a 45 degree angle across the path. The northern set of boxes was realigned to ensure proper readings. A second validation count was done on July 13, 2007 between 10:15 AM and 11:30 AM, and showed undercounting by about 36% at the southern location and by about 12% at the northern location.

The pulse rate setting was then adjusted at the southern location, along with finding a new location that allowed for positioning the receiver and transmitter closer together. A third validation count was conducted on July 16, 2007 between 9:00 AM and 10:15 AM at the southern location, and found that the machine count was within about 8% of the manual count.

Table 10: Active Infrared Validation Counts
TrailMaster

Location	First Validation							Second or Third Validation							
	Date & Time of First Validation Count	Total Manual Count		Total Machine Count		Percent Difference		Adjust-ment	Date & Time of Second or Third Validation Count	Total Manual Count		Total Machine Count		Percent Diff.	
		All	Ped	All	Ped	All	Peds			All	Ped	All	Ped	All	Ped
Gilman Drive/Rose Canyon Bike Path	6/6/07 (3:30 PM to 5:45 PM)	75	4	66	3	-12.0	-25.0	--	--	--	--	--	--	--	--
Bayshore Bikeway @ Avenida de las Arenas	7/9/07 (10:15 AM to 12:15 PM)	67	13	52	1	-22.4	-92.3	Reposition at 45° across facility. (2nd Validation Count)	7/16/07 (9:15 AM to 10:15 AM)	80	11	70	15	-12.5	36.4
	--	--	--	--	--	--	--	Changed Infrared Beam Pulse Rate (3nd Validation Count)	7/16/07 (10:30 AM to 11:30 AM)		12		11		-8.3
Bayside Walk @ Ormund Place and @ San Juan	6/9/07 (12:30 PM to 2:30 PM)	444	101	366	21	-17.6	-79.2	Changed Infrared Beam Pulse Rate	7/10/07 (4 PM to 6 PM)		89		46		-48.3

Source: (Alta Planning + Design, November 2007)

Bayside Walk Site: Two TrailMasters were installed along the Bayside Walk site, with the northern machine set to record events for objects moving at any speed, and the southern machine set to record events caused by objects moving at the speed of a pedestrian. The validation counts were conducted on June 9, 2007 between 12:30 PM and 2:30 PM, and showed that the northern machine was counting within 17.6% of the manual count, and the southern machine was undercounting by about 75.3%.

A bicyclist at the Bayside Walk Site, at Santa Clara St.

Alta staff noticed that at this particular site walkers were moving along at relatively high speeds, and that it was unlikely that the machine was recording these fast walkers. The pulse rate of the southern machine was therefore reset in an effort to capture slightly higher speed walkers. Alta staff also noticed a high presence of grouped walkers. Unfortunately, installation opportunities at this location are limited, and the transmitter cannot be rotated to direct the infrared beam across the pathway at a 45 degree angle. A second validation analysis was conducted on July 10, 2007 between 4 PM and 6 PM, showing that the southern machine was still undercounting by approximately 48.3%. Pedestrians walking side by side continue to be an issue for the southern TrailMaster at this location.

<u>Summary of Observations</u>

The JAMAR Scanners are undercounting by approximately 15% to 21%. The machine at the higher volume location, The Boardwalk, shows less accurate counts than the machine at the lower volume location along University Avenue.

The TrailMasters are undercounting all travelers by approximately 12% to 18%. Again, machines at the lower volume locations, the Rose Canyon Bike Path and the Bayshore Bikeway, are providing more accurate count data than the machines at the higher volume locations along Bayside Walk in Mission Beach.

The TrailMasters are undercounting pedestrians by approximately 25% to 48%, displaying a similar inverse relationship between count accuracy and traffic volume. It should be noted that limitations in installation opportunities at the Bayside Walk and San Juan Place in Mission Beach, which prohibit directing the infrared beam at a 45 degree angle across the pathway, are resulting in the most inaccurate machine counting of all study locations.

The TrailMasters appear to be slightly more accurate than the JAMAR Scanner in counting all travelers, however the TrailMaster requires identification of count locations where equipment can be installed on both sides of the pathway, while the JAMAR Scanner can be effectively installed in locations with poles/street lights on just one side of the pathway or sidewalk. In other words, the Scanner allows for effective counting in urban environments, while the TrailMaster is more limited to counting along pathways or trails, where trees or poles can be found along both sides of the facility.

MANUAL COUNTS AND SURVEYS

Manual peak period counts were conducted at eighty (80) intersection locations across San Diego County during the months of July and August 2007. Graduate students from San Diego State University were hired and received training to conduct counts and collect survey information. Counters were instructed to record a pedestrian or bicyclist at the intersection leg where the traveler approached the intersection.

Peak period counts were conducted at eighty intersections during a weekday (Tuesday, Wednesday, or Thursday) morning peak period (7 AM to 9 AM) and a weekend (Saturday or Sunday) midday peak period (12 PM to 2 PM). In addition, evening peak period counts (4 PM to 6 PM) were collected at a sample of twenty intersections, which were selected to represent a geographic distribution of study intersections.

Survey Methodology

In addition to conducting counts, the Seamless Travel Project collected surveys from user intercepts at thirty-five of eighty peak-period count locations. The following sections describe survey pre-testing and pilot testing, survey administration, and special modifications to the bicycle intercept survey approach.

Survey Pre-Testing and Pilot Testing

The surveys were pre-tested and pilot tested in the field to determine how easy it was for people to understand and give answers. A pre-test was conducted on 14 individuals in Pacific Beach on June 15, 2007. The pre-test participants were asked to provide feedback on question wording, sentence structure and overall input to make the survey more easily understood. As a result of pre-testing efforts, the following changes were made:

- Added the Gym/Recreation as a destination choice for Question 6
- Added "Never" box as an option for Question 7
- Added "Never" box as an option for Question 8
- Added "Never" box as an option for Question 9, and
- Made minor grammatical corrections.

After pre-testing the survey, pilot tests were administered at the Rose Canyon Bike Path on June 21, 2007 between 5 PM and 6 PM. A total of 12 pilot test surveys were administered (8 bicycle and 4 pedestrian). The subjects took the surveys and had no issues with the phrasing or meaning of any questions.

Survey Administration

Alta staff administered bicycle and pedestrian intercept surveys with the assistance of temporary employees hired to expedite survey collection. Prior to administering surveys, Alta staff completed the Collaborative Institutional Training Initiative training to conduct research involving human subjects. One staff research assistant debriefed and trained the remaining surveyors in the field. On-site trainings accentuated sensitivity to vulnerable populations, including exclusion of child subjects. On-site trainings also emphasized obtaining verbal consent from participants, acknowledging participants' anonymity, and their right to terminate participation at any time. Alta equipped temporary employees with written material to orient them to the purpose and scope of the study, as well as an adaptable script for recruiting participants.

Thirty-five of eighty study sites were selected to capture a variety of land use and population characteristics. Multiple surveyors were fluent in Spanish enabling administration of the survey in largely Hispanic communities.

Generally, surveyors were organized into teams of two for safety and overall effectiveness, and assigned to various locations. Surveyors went into the field with both English and Spanish surveys, as well as card tables, signage, multiple clipboards, pens and informational material for public distribution.

<u>Modification of Bicycle Intercept Surveying</u>

It became apparent during the initial weeks of surveying that bicyclists were difficult to engage in survey participation. The most pronounced challenge to bike interception was insufficient time to communicate the purpose of the study and invite participation. This challenge necessitated refining survey methods to concentrate on cyclists for the final two weeks of the surveying period. Two key refinements were as follows:

- Alta designed and employed signage (printed on four 2 x 3 foot sheets of cardboard by a professional signage company) in order to attract bicyclists' attention. Signage proved to be an effective mechanism for communicating with cyclists.

- Alta staff created pocket-sized flyers that directed recipients to a Seamless Travel Project webpage where they were able to complete the survey online. The flyers indicated the date, time and location of the interception so that respondents could include that data when completing the survey online. This method proved particularly effective when surveying cyclists who were interested in participating in the study but were apprehensive about interrupting their workouts.

Survey flyer

Together, a modified site list, signage and internet-based surveying substantially increased bicyclist response rates.

ACCURACY OF THE COUNT AND SURVEY DATA

Since one of the primary objectives of this research project is to improve the quality and accuracy of bicycle and pedestrian demand estimating tools, setting reasonable accuracy goals is a key first step. In the transportation field, the most commonly used and widely accepted travel demand estimating tools are those developed by the Institute of Transportation Engineers (ITE) in their *Trip Generation*, *Parking Generation*, and similar publications. Since these are the most widely used and accepted demand forecasting resources in the transportation field, it is reasonable to assume that the bicycle and pedestrian data should meet, at a minimum, the statistical accuracy of these publications. It is useful to note that, in almost all cases, the data used in these publications are collected on a voluntary basis by local agencies who then fill out forms and return them to ITE for periodic updates. Accuracy of these trip generation estimates vary widely--in some cases only a single data point is used to provide the estimate.

While ITE informs readers that, "*Trip Generation* is an educational tool for planners, transportation professionals, zoning boards, and others who are interested in estimating the number of vehicle trips generated by a proposed development," and clearly cites the statistical accuracy of each land category, many public agencies use the results of these publications to set traffic impact, level of service, and other legal and regulatory requirements.

According to Shoup (2003), "*Trip Generation's* estimate of 7.27 weekday trips per occupied room of a business hotel is based on only one observation. It illustrates perfectly the statistical insignificance and inappropriate precision of many parking and trip generation rates."

Shoup goes on to discuss misuse of these estimates:

> Statistically sophisticated users understand the extreme uncertainty of trip generation rates and can ignore the false precision. But many users are not statistically sophisticated. To them, ITE's trip generation rates are the relationship between transportation and land use. Some zoning codes explicitly specify ITE's trip generation rates as the basis for making land-use decisions and as the basis for assessing traffic impact fees, regardless of the sample size or statistical significance of the rates.
>
> In Signal Hill, California, for example, the traffic impact fee is $66 per daily vehicle trip generated by a development project. The number of trips is calculated by multiplying the size of the project times its trip generation rate "as set forth in the most recent edition of the Traffic [*sic*] Generation manual of the Institute of Transportation Engineers." The sixth edition's trip generation rate for a fast food restaurant is 496.12 trips per 1,000 square feet, so Signal Hill's traffic impact fee is $32.74 per square foot of restaurant space. The uncertain trip generation rates thus determine cities' tax rates.

The large variation in the accuracy of trip and parking generation rates are further compounded because: (a) daily variation in vehicle trips at any specific location can vary, and (b) widely-used traffic models regularly need to manually calibrate their projected volumes at screen lines or to manual count volumes by significant percentages.

Professionals, including those responsible for making laws and regulations, have accepted these margins of error in order to take advantage of the benefits of forecasting transportation conditions in the motor vehicle field. Professionals will need to accept a similar margin of error in achieving statistical accuracy when forecasting bicycle and pedestrian use.

4. COUNT AND SURVEY RESULTS

Count and survey data collected in 2007 and 2008 provide the basis for developing a database and forecasting model for bicycle and pedestrian trips. Key findings from this data are presented below and are based on the surveys and automated count machines in San Diego County.

SURVEYS

A total of 367 pedestrians and 212 bicyclists responded to surveys. Twenty-five count locations were selected for the survey effort. Pedestrians and bicyclists were surveyed in the field locations, however, since bicyclists tend to be reluctant to stop and take a survey, an online version was developed and bicyclists were directed to take the online survey in those instances when they did not want to stop. The location of the surveys in San Diego County are shown in **Figure 8**.

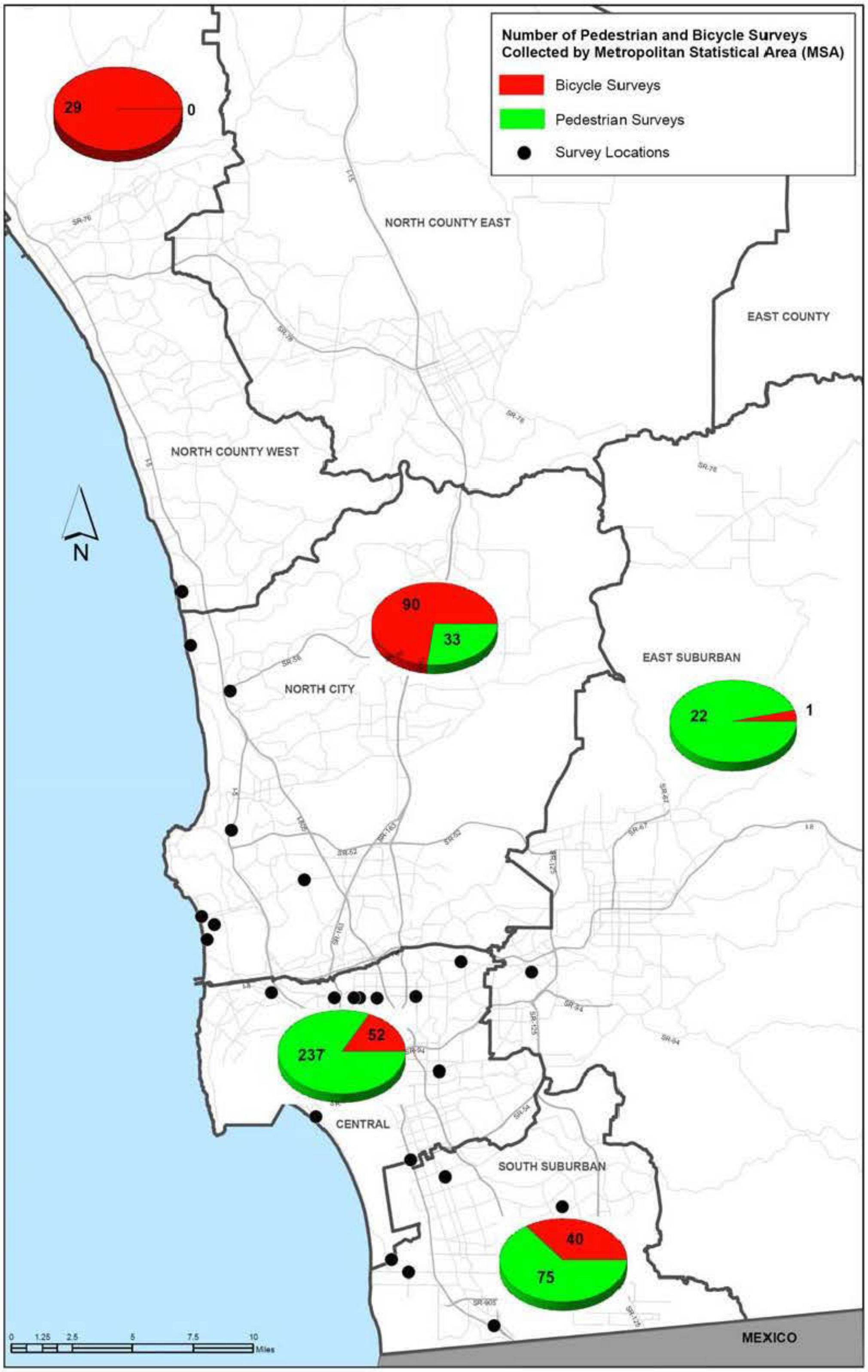
A total of 367 surveys were completed by pedestrians from 25 count locations in San Diego County

Comparisons with Other Surveys

The validity and accuracy of the survey results addressed above have been compared to the results of the same questions asked in surveys around the country. This comparison helps to solidify the confidence in the survey results or, in some places, may point to inadequacies or regional differences in the survey effort.

Survey results from Minneapolis, Minnesota, Marin County, California, National Bicycle & Pedestrian Documentation Project (7 survey sites nationally), the Delaware Valley, Pennsylvania, and from the Thunderhead Alliance document, "Benchmarking Report 2007," and the 2008 National Traffic Safety Administration (NHTSA) "National Survey of Bicyclist and Pedestrian Attitudes and Behavior" have been used for comparison purposes. **Appendix F** presents more detail on these sources.

Figure 8: Number of Pedestrian and Bicycle Surveys Collected by Metropolitan Statistical Area



Results of Bicycle Surveys

A total of 212 surveys were returned by bicyclists from 25 count locations. The returned surveys represented between 0.5% and 16.0% of the total number of bicyclists counted at those locations (**Table 11** below).

Table 11: Bicycle Survey Respondent Locations and Percent of Total Volumes

Site ID	Location	Number	Percent of Total
6	Sixth Avenue & Laurel Street	5	2.4%
8	Euclid Avenue & Imperial Avenue	3	1.4%
16	College Avenue & Montezuma Road	11	5.2%
101	Camino Del Mar & 15th Street	25	11.8%
110	Linda Vista Road & Mesa College Drive	8	3.8%
111	Genesee Avenue & Balboa Avenue	1	0.5%
112	Gilman Drive & Rose Canyon Bike Path	4	1.9%
207	SR-75 & Bayshore Bikeway	34	16.0%
410	Pacific Highway & Lomas Santa Fe	14	6.6%
604	El Camino Real & SR-56 Bike Path	17	8.0%
610	5th Avenue & University Avenue	6	2.8%
613	Everts Street & Crown Point Bike Path	14	6.6%
614	Bayside Walk & Santa Clara Bike Path	19	9.0%
615	Heritage Park & East Palomar Street	4	1.9%
616	Park Boulevard & University Avenue	4	1.9%
617	30th Street & University Avenue	3	1.4%
620	43rd Street & University Avenue	5	2.4%
622	Mission Boulevard & Garnet Street	2	0.9%
626	SR-75 & Avenida de las Arenas	8	3.8%
627	San Ysidro Boulevard & Via de San Ysidro	1	0.5%
628	25th Street & Commercial Street	1	0.5%
635	Cedros Avenue & Lomas Santa Fe	15	7.1%
638	3rd Avenue & F Street	1	0.5%
639	Spring Street & La Mesa Boulevard	1	0.5%
644	Bayshore Bikeway & Sweetwater River Bikeway	6	2.8%

The vast majority (71%) of bicyclists responded that their trip purpose was exercise/recreation (see **Table 12** below). About 21% reported that they were bicycling for school, work, or shopping. In comparison, 67% of the bicycle trips in Marin County were exercise/recreational. Nationally, 50% of bicycle trips are recreational according to the Bureau of Transportation Statistics (BTS), 53% were recreational/exercise according to the NHTS survey, 35% are recreational in the Delaware Valley, and only 9% are recreational in Minneapolis. It is clear from these results that (a) bicycle trip purpose may be related to the location and facility type of the survey, and/or (b) there may be very large regional differences in trip purpose.

Table 12: Bicycle Trip Purpose

Trip Purpose	Percent of Respondents
To get to work	10%
For shopping or errands	8%
To get to a bus or train stop	0%
For exercise or recreation	71%
To get to school	2%
To get home	8%
Other	5%

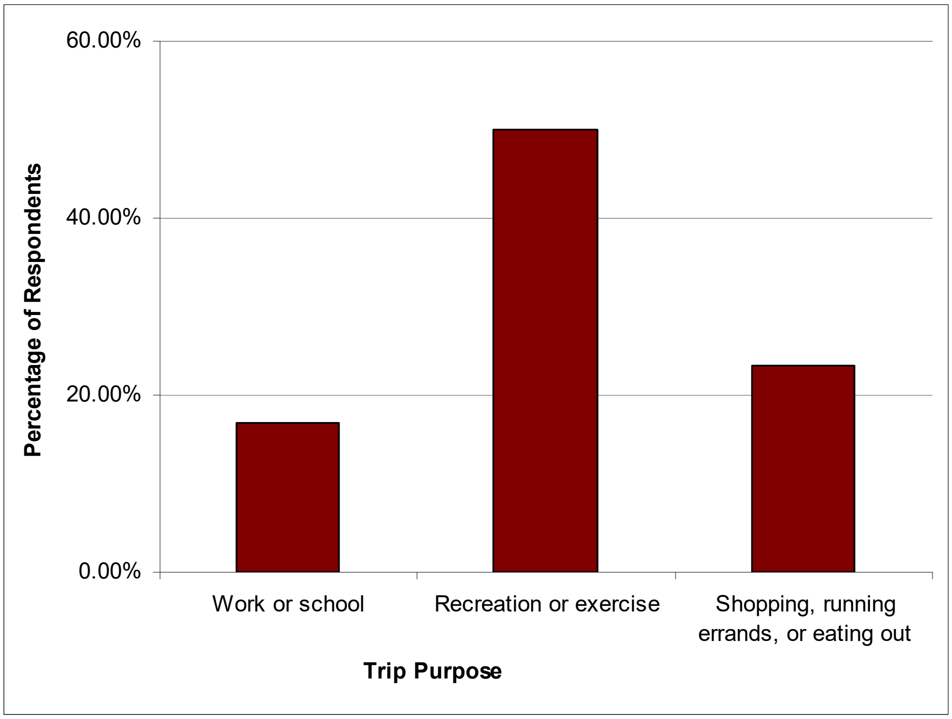
The frequency of bicycling varied by trip type (see **Table 13** below). Nearly 70% of San Diego County respondents bicycled for recreation or exercise at least once a week and 39% bicycled for shopping or errands at least once a week. In comparison, only 19% of respondents to the NHTSA survey bicycled at least once a week regardless of destination during summer months. Frequency rates in other locations ranged from 4.4 times per week in Minneapolis to 2.3 times per week in Marin County. This indicates that the bicyclists responding to the surveys in San Diego County were, on average, rode more frequently than bicyclists in other locations.

Table 13: Frequency of Bicycle Riding

Destination	5-7 Days per Week	1-4 Days per Week	Several Times per Month	Less than Once a Month	Never
Work or school	20.1%	16.9%	5.2%	13.0%	40.3%
Recreation or exercise	29.9%	50.0%	14.3%	2.6%	2.6%
Shopping, running errands, or eating out	15.6%	23.4%	14.9%	18.2%	27.9%

Figure 9 shows the trip purpose of those who bicycled 1-4 times a week. Recreation and errands trips were the most common.

Figure 9: Destination of Those Who Bicycle 1-4 Times a Month



When asked why they did not ride more often, survey respondents cited excessive traffic (77%), a lack of bikeway facilities (61%), and poor conditions on bike paths or roads (56%) (see **Table 14** below).

Table 14: Reasons Preventing Respondents from Bicycle Riding More Often

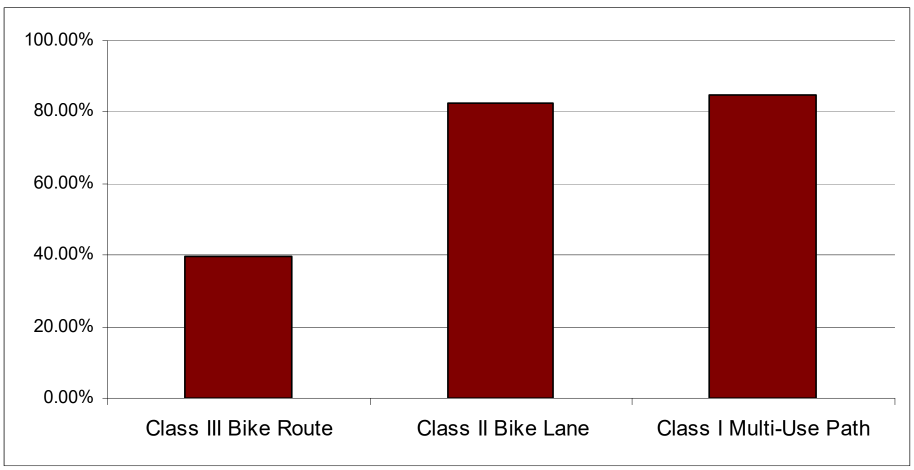
Reason	Agree	Disagree
"I don't have enough time for biking"	34.6%	65.4%
"Too many cars / Cars drive too fast"	77.4%	22.6%
"It is too difficult to cross major streets"	65.7%	34.3%
"No bike paths, routes, or lanes"	61.1%	38.9%
"Places are too far away"	32.2%	67.8%
"Not enough lighting"	46.1%	53.9%
"I have things to carry"	38.4%	61.6%
"I need to travel with small children"	21.3%	78.7%
"Poor condition of the bike paths or roads"	56.3%	43.7%

A significant number of respondents indicated that riding on bike lanes (83%) or on a separated bike path (85%) were the types of facilities they enjoyed using (see **Table 15** and **Figure 10**). However, a surprisingly large number of respondents (40%) indicated they had no issue with riding on streets without any facilities, indicating that the respondents were a relatively experienced group of bicyclists.

Table 15: Types of Facilities Respondents Enjoy

Facility Type	Yes	No
On roads with cars, even if there are no bike facilities	39.6%	60.4%
On roads with cars, only if there are bike lanes	82.6%	17.4%
On paths separated from motor vehicles	84.8%	15.2%

Figure 10: Preferred Bicycle Facilities



Income levels for respondents averaged about $69,400 (**Table 16**), which is higher than the 2005 median income for San Diego County ($64,000). Surveys of other areas consistently show income levels for bicyclists as being higher than the mean for the community. The NHTSA survey found those with higher incomes are more likely to have access to a bicycle. Only 34% of NHTSA respondents with income less than $30,000 reported access to a bicycle. That figure jumps to 65% for those with incomes more than $75,000. San Diego shows a similar pattern.

Table 16: Income Level of Bicycle Respondents

Income	Percent of Respondents
Less than $30,000	25.4%
$31,000 - $70,000	29.1%
$71,000 - $100,000	19.6%
More than $100,000	25.9%

The breakdown of bicyclists by race (**Table 17**) shows a pattern that is quite different than the actual racial breakdown of the County. According to the U.S. Census 2006 Quick Facts, non-Hispanic whites accounted for 52% of the population and 75% of respondents, and Hispanic, Mexican, Mexican-

American, and Chicano residents accounted for 30% of the population and 14% of respondents. Since the survey locations were spread throughout the county, location is not likely a factor. It is more likely that (a) ethnic and racial groups are not equally likely to bicycle, and/or (b) some groups are less likely to answer intercept surveys. In comparison, less ethnically diverse areas such as Minneapolis and Marin County—which are predominately white, showed survey results that more or less mirrored the actual population breakdown.

Table 17: Race/Ethnicity of Bicycle Respondents

Race / Ethnicity	Percent of Respondents
White/Non–Hispanic	74.5%
Black/African American	4.4%
Mexican/Mexican–American/Chicano	14.2%
Other Spanish/Hispanic/Latino	1.5%
Asian	2.9%
American Indian/Alaskan Native	1.5%
Other	1.0%

Males accounted for a disproportionate percent of respondents compared to females (**Table 18**). There are a variety of explanations for this pattern, which is found nationwide in almost all surveys reviewed for this project. This could be due to (a) women's concerns about safety and security, (b) preference for other types of recreational activities and/or (c) the fact that women generally have less time for recreational activities than men. The NHTSA survey had similar results (60% male, 40% female) based on average number of days a week a person had bicycled.

Table 18: Gender of Bicycle Respondents

Gender	Percent of Respondents
Male	67.8%
Female	32.2%

Results of Pedestrian Surveys

A total of 367 surveys were completed by pedestrians from 25 count locations where intercept interviews were conducted. Surveyors were instructed to approach pedestrians randomly, explain the purpose of the survey, and complete it based on the pedestrian's responses. The surveys represented between 0.3% and 10% of the total number of pedestrians counted at those locations (**Table 19**).

Table 19: Number of Pedestrian Intercept Surveys by Location

Site ID	Location	Number	Percent of Total
6	Sixth Avenue & Laurel Street	28	7.6%
8	Euclid Avenue & Imperial Avenue	20	5.4%
16	College Avenue & Montezuma Road	30	8.2%
101	Camino Del Mar & 15th Street	7	1.9%
110	Linda Vista Road & Mesa College Drive	7	1.9%
111	Genesee Avenue & Balboa Avenue	1	0.3%
112	Gilman Drive & Rose Canyon Bike Path	2	0.5%
207	SR-75 & Bayshore Bikeway	12	3.3%
208	13th Street & Palm Avenue	8	2.2%
610	5th Avenue & University Avenue	34	9.3%
612	5th Avenue & Market Street	10	2.7%
614	Bayside Walk & Santa Clara Place	8	2.2%
615	Heritage Park & East Palomar Street	20	5.4%
616	Park Boulevard & University Avenue	37	10.1%
617	30th Street & University Avenue	29	7.9%
620	43rd Street & University Avenue	18	4.9%
621	Sports Arena Boulevard & Rosecrans Street	2	0.5%
622	Mission Boulevard & Garnet Street	8	2.2%
626	SR-75 & Avenida de las Arenas	2	0.5%
627	San Ysidro Boulevard & Via de San Ysidro	17	4.6%
628	25th Street & Commercial Street	16	4.4%
631	Kettner Boulevard & Broadway	2	0.5%
632	Alabama Street & University Avenue	9	2.5%
638	3rd Avenue & F Street	18	4.9%
639	Spring Street & La Mesa Boulevard	22	6.0%

The primary reasons for walking given by respondents (**Table 20**) were transportation/commute to school, work, or transit (21%), or utilitarian reasons such as shopping (24%). Discretionary/ recreational trips accounted for 24% of all trips. In comparison, work/school and exercise/recreation trips varied widely in other communities (15-65%), with only utilitarian trips relatively consistent at 20-27%. This indicates that utilitarian trips tend to be consistent while recreational trips may be sensitive to the facility type, area of survey (land use, density, etc.), and possibly seasonal and regional variations.

Table 20: Walk Trip Purpose

Trip Purpose	Percent of Respondents
To get to work	12.5%
To get to school	4.6%
To get to transit stop	4.1%
For exercise/recreation	24.3%
For shopping errands	24.0%
To walk a dog	0.8%
To get home	7.6%
Other	22.1%

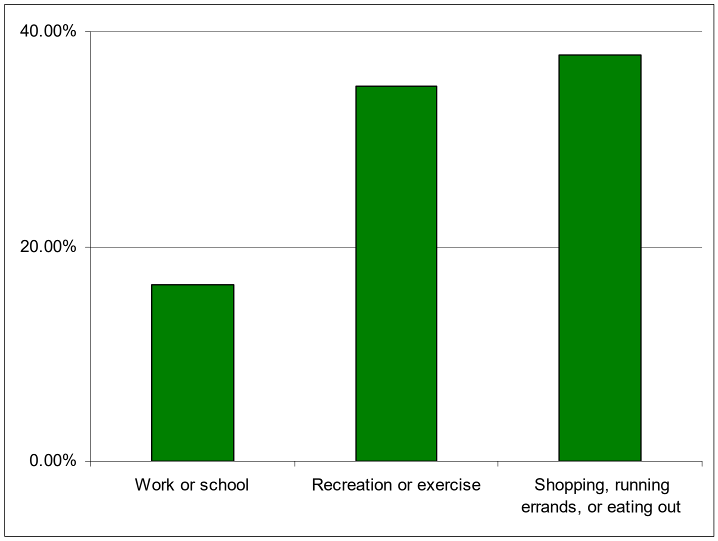
The frequency of walking trips varied by trip type (**Table 21**). Over 70% of respondents walked for recreation or exercise at least once a week and over 62% of respondents walked for shopping, errands or eating out at least once a week. Other surveys show similar patterns. The NHTSA survey found 72% of respondents walked at least once a week during summer months.

Table 21: Frequency of Walking

Destination	5-7 Days per Week	1-4 Days per Week	Several Times per Month	Less than Once a Month	Never
Work or school	31.7%	16.4%	10.6%	6.6%	34.7%
Recreation or exercise	36.6%	34.9%	13.7%	6.4%	8.4%
Shopping, running errands, or eating out	25.0%	37.8%	21.8%	7.4%	8.0%

Figure 11 shows the trip purpose of those who walked 1-4 times a week. As with bicycle trips, recreation and errands trips were the most common.

Figure 11: Trip Purpose



The reasons cited for not walking more (**Table 22**), other than personal reasons such as 'not enough time' or 'places too far away', include safety (too much traffic-57%, insufficient lighting-60%), security (crime-44%), and lack of facilities (43%).

Table 22: Reasons Preventing Respondents from Walking More Often

Reason	Agree	Disagree
"Not enough time for walking"	49.2%	50.8%
"Too many cars/cars drive too fast"	56.6%	43.4%
"I don't feel safe from crime"	43.6%	56.4%
"Drivers don't stop for pedestrians"	63.5%	36.5%
"No sidewalks or incomplete sidewalks"	43.0%	57.0%
"Places are too far away"	60.9%	39.1%
"Not enough lightning"	59.6%	40.4%
"I have things to carry"	60.3%	39.7%
"I need to travel with small children"	25.6%	74.4%
"Poor conditions of sidewalks"	39.9%	60.1%

Most respondents felt that existing facilities were adequate (see **Table 23** below).

Table 23: Quality of Pedestrian Facilities

Quality of Facility	Agree	Disagree
"There is enough room to walk"	83.8%	16.2%
"I feel safe from traffic walking here"	67.0%	33.0%
"I feel safe from crime walking here"	63.1%	36.9%
"The scenery is interesting"	70.8%	29.2%
"The walking surface is in good condition"	69.1%	30.9%
"All the amenities I need are along this facility"	69.5%	30.5%

Over 80% of respondents had an income less than $70,000 (see **Table 24** below). The median income in San Diego County of $64,000. Since people under 18 were excluded from this survey, this indicates that respondents may be walking because they do not own a car or cannot afford to operate a car. As can be seen in **Table 22** (Walk Trip Purpose), approximately 4% of the respondents were walking to a transit stop.

Table 24: Income Level of Pedestrian Respondents

Income	Percent of Respondents
Less than $30,000	54.8%
$31,000 - $70,000	28.3%
$71,000 - $100,000	9.9%
More than $100,000	7.0%

The breakdown of pedestrians by race (**Table 25**) shows a different distribution than who lives in the County. Latinos and Mexican-Americans made up a disproportionate number of pedestrians (37% of respondents versus 30% of the population), as did African Americans (10% of respondents versus 5% of the population).

Table 25: Race / Ethnicity of Pedestrian Respondents

Race/Ethnicity	Percent of Respondents
White/Non-Hispanic	40.4%
Black/African–American	10.3%
Mexican/Mexican–American/Chicano	27.5%
Other Spanish/Hispanic/Latino	9.8%
Asian	6.3%
American Indian/Alaskan Native	2.2%
Other	3.5%

The breakdown of pedestrians by gender (**Table 26**) was much more balanced than for the bicycle mode, although there were still slightly more men. This could simply reflect the higher participation rate in the labor force, or a higher propensity to be willing to stop and answer survey questions.

Table 26: Gender of Pedestrian Respondents

Gender	Percent of Respondents
Male	51.8%
Female	48.2%

<u>Survey Results-Pedestrians</u>

(1) Trip purpose for pedestrians was primarily (63%) transportation-related including transit, shopping, work, and school commute trips. Surveys from other locations nationwide show a wide variety of pedestrian trip purpose results, indicating that (a) pedestrian trip purpose is highly related to the location and facility type of the survey, and/or (b) there may be very large regional differences in trip purpose.

(2) Pedestrians indicated that issues such as traffic, crime, poor driver behavior, lack of facilities and lighting were major factors for not walking more often.

(3) Pedestrians responding to the survey had an average income 54% below the median county income level, suggesting that many people walk out of economic necessity.

(4) A disproportionate share (46%) of pedestrian respondents identified themselves as Hispanic or Latino [15] compared to San Diego County as a whole, where 30% of the population identify as Hispanic or Latino.

<u>Survey Results-Bicyclists</u>

(1) Trip purpose for bicyclists in San Diego was 26% of trips being transportation (work, school, and utilitarian) and 74% exercise/recreation. The exercise/recreation percent is significantly higher than national surveys, which range from 37% to 67%. These results suggest that (a) bicycle trip purpose is highly related to the location and facility type at the site of the survey, and/or (b) there may be very large regional differences in trip purpose.

(2) Trip frequency was much higher in San Diego County than other locations nationwide (9.6 times per week versus 2-4/week), indicating that local bicyclists ride their bicycles more often than bicyclists elsewhere. Most bicyclists enjoy riding on bike paths (83% versus 37% who enjoy riding on streets with no bike lanes). A large majority (72%) of bicyclists cited 'too many cars/cars drive too fast' as a reason they do not ride more often.

(3) Bicyclists in San Diego County have incomes that are slightly higher than the county median income. This is consistent with other surveys, which also find that bicyclists tend to have higher-than-average incomes.

(4) A larger share of bicyclists in San Diego County are white than is true for the general population (73% vs. 52%). A greater reluctance on the part of non-whites to respond to an intercept survey, even with bi-lingual surveyors, may partially explain this disparity.

(5) Consistent with national surveys, bicyclists were more likely to be male than female (73% vs. 27%).

[15] Hispanic and Latino included respondents who marked ""Mexican / Mexican – American / Chicano" or "Other Spanish / Hispanic / Latino"

AUTOMATED COUNT RESULTS

The five automated count machines in San Diego County collected bicyclist and pedestrian counts 24 hours a day from August 17, 2007 to August 16, 2008. A total of 4,690,904 bicyclists and pedestrians were counted at the five (5) locations, with 43% (2,029,478) being pedestrians and 57% (2,661,426) being bicyclists. **Table 27** provides a summary of the counts by location.

Table 27: Summary of 12-Month Counts San Diego County August 17 2007-August 16 2008

	Bikes	Bike %	Pedestrian	Pedestrian %	Total
Bayside Path	513,558	80%	131,524	20%	644,285
Gilman Path	164,638	90%	18,734	10%	183,373
Strand Path	148,109	81%	34,998	9%	183,107
Beach Boardwalk	1,835,121	58%	1,328,881	42%	3,154,450
Hillside Neighborhood	0	0	525,690	10%	525,690
Total	2,661,426		2,029,478		4,690,904

It is useful to note that bicyclists outnumbered pedestrians on all four pathways, even those located in a dense residential and commercial area such as Mission Beach. The Hillside neighborhood sidewalk count included only pedestrians.

VOLUME, CAPACITY, LOS ANALYSIS

Capacity issues on roadways drive much of the analysis of vehicle trip generation, distribution, and level of service analysis. Pathways can accommodate very high numbers of users. The Mission Beach Boardwalk recorded a total of 56,057 users on Friday, July 4, 2008, the highest daily count recorded by far (the next highest day was 26,635). The peak period that day was generally 10am-4pm, with 6,098 users recorded between 11-12am. The 'capacity' of the Boardwalk, and any multi use pathway, in terms of maximum aggregate capacity with no consideration for flow, delay, or conflicts, is then about 270 persons per hour per foot of width.

The transportation performance of multi-use (aka shared use paths, and sometimes, Class I) pathways has been evaluated by FHWA in a study entitled 'Shared Use Pathway Level of Service: A Users Guide (FHWA, 2006). The methodology can be used to identify the level of service (as defined by perception, delays and conflicts) for bicycle commuters. **Table 28** below provides the design day LOS for the four (4) pathways studied in San Diego County.

Table 28: Pathway Level of Service San Diego County 2009

Location	User Perception	Path LOS
Bayside Path	C	E
Gilman Path	B	B
Strand Path	C	C
Boardwalk	E	F

Source: FHWA Share Use Pathway Level of Service (2006)

The LOS methodology uses one-way volumes, mode split, width, and presence of a centerline to determine LOS from a general user perception basis and bicycle commuter basis. Two of the four facilities scored a LOS C or B (Gilman, Strand), largely due to lower volumes and fewer pedestrians. The other two facilities (Bayside and Boardwalk) scored LOS E or F, reflecting the combination of higher volumes, higher pedestrian percentage. The maximum capacity of users assuming an 80% bicycle and 20% pedestrian mode split to maintain at least a LOS C is then about 15 users per hour per foot of width.

The usefulness of this analysis is difficult to determine. Bicycle commuters are not likely to use the facility during its 'design day' peak period. Since most pathway users have made a choice to use the facility for a discretionary trip, congestion becomes a secondary factor. It could be argued, in fact, that the congestion on a pathway (especially one in a recreational area) is one of the attractions of a facility. Conversely, bicyclists trying to use a pathway for commuting purposes would prefer fewer pedestrians so they can maintain higher speeds and avoid conflicts.

ANALYSIS OF HOURLY COUNTS

Peak Hour Patterns

Peak hours and periods (peak 2 consecutive hours) are commonly-used time periods and tools used for travel estimating and analysis. For vehicles the peak period and hour is typically used to determine count times and the capacity needs for roads and intersections. The peak hour counts are commonly used to develop average daily traffic estimates (ADTs), which are also used for travel estimating and level of service analysis.

An analysis was conducted to (a) identify the peak weekday and weekend periods for bicycles and pedestrians by facility type (multi-use path and sidewalk) and (b) determine if these periods were consistent enough to allow planners to select count periods for future efforts and also to determine average daily use based on peak period counts.

Table 29: Peak Periods by Mode and Season[1]
Automatic Count Locations[2]

		Bicycles on Paths (peak period %) [3]	Pedestrians on Paths (peak period %)[3]	Pedestrians on sidewalk (peak period %)[3]
Summer	Weekends	11-1pm (21%)	11-1pm (20%)	9-11pm (15%)
	Weekdays	11-1pm(17%)	11-1pm (18%)	5-7pm(16%)
Fall	Weekends	11-1pm (15%)	11-1pm (21%)	1-3pm (15%)
	Weekdays	8-10am (16%)	8-10am (17%)	1-3pm (20%)
Winter	Weekends	11-1pm (24%)	11-1pm (24%)	12-2pm (18%)
	Weekdays	11-1pm (19%)	11-1pm (19%)	1-3pm (19%)
Spring	Weekends	10-12am (19%)	10-12am (20%)	1-3pm (16%)
	Weekdays	11-1pm (16%)	11-1pm (17%)	5-7pm (15%)

1. Peak period = 2 highest consecutive hours
2. Five automatic Count locations
3. Highest peak period for season and percent of daily volumes in that period

Table 29 above provides a summary of hourly volumes by mode, location, and weekday/weekend. While initial findings showed a significant variation in peaking patterns for both modes, over the course of an entire year some very distinct and regular patterns emerged. As was discussed previously, there are not distinct daily peak periods at any of the locations over the course of a year compared to roadways, which typically have sharp AM and PM peak periods. The peak two-hour period on multi-use pathways is most often the 11am-1pm period, representing 15-24% of the daily total). There is little seasonal difference in use.

Pedestrian volume peak periods on a sidewalk, at least in an area such as the Hillcrest neighborhood with a mix of land uses including restaurants, change with the seasons with the summer months having a late evening weekend peak (9-11pm) and later weekday peak (5-7pm) than the other seasons.

Table 30: Hour of Day
San Diego County, 5 Locations, Aug 07-Sep 08

Hour Starting	April-September				October-March			
	Path		Ped. Dist.		Path		Ped. Dist.	
	Weekday %	Weekend %	Weekday %	Weekend %	Weekday %	Weekend %	Weekday %	Weekend %
6 am	2	1	1	1	2	0	1	0
7 am	4	3	2	1	4	2	2	1
8 am	7	6	4	3	6	6	3	2
9 am	9	9	5	3	7	10	5	4
10 am	9	9	6	5	9	10	6	5
11 am	9	11	7	6	9	11	8	8
12 noon	8	10	9	7	9	11	9	10
1 pm	7	9	9	7	9	10	10	13
2 pm	7	8	8	9	9	10	9	11
3 pm	7	8	8	9	8	10	8	8
4 pm	7	7	7	9	8	8	7	7
5 pm	7	6	7	8	7	5	6	6
6 pm	7	5	7	8	6	3	7	6
7 pm	5	4	7	8	4	2	7	6
8 pm	4	3	7	8	2	1	6	6
9 pm	2	2	6	8	2	1	5	5

Percent each hour is of total between 6am-10pm

Note: 95% of all use is between 6am and 9pm

Figure 12: Hour of Day April - September

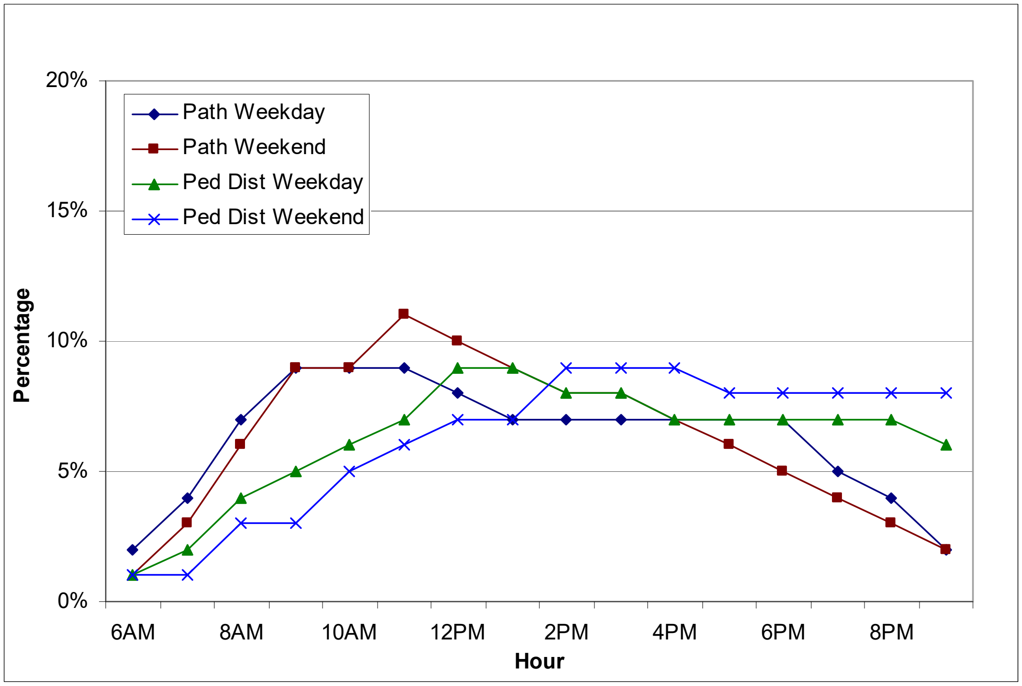


Figure 13: Hour of Day October-March

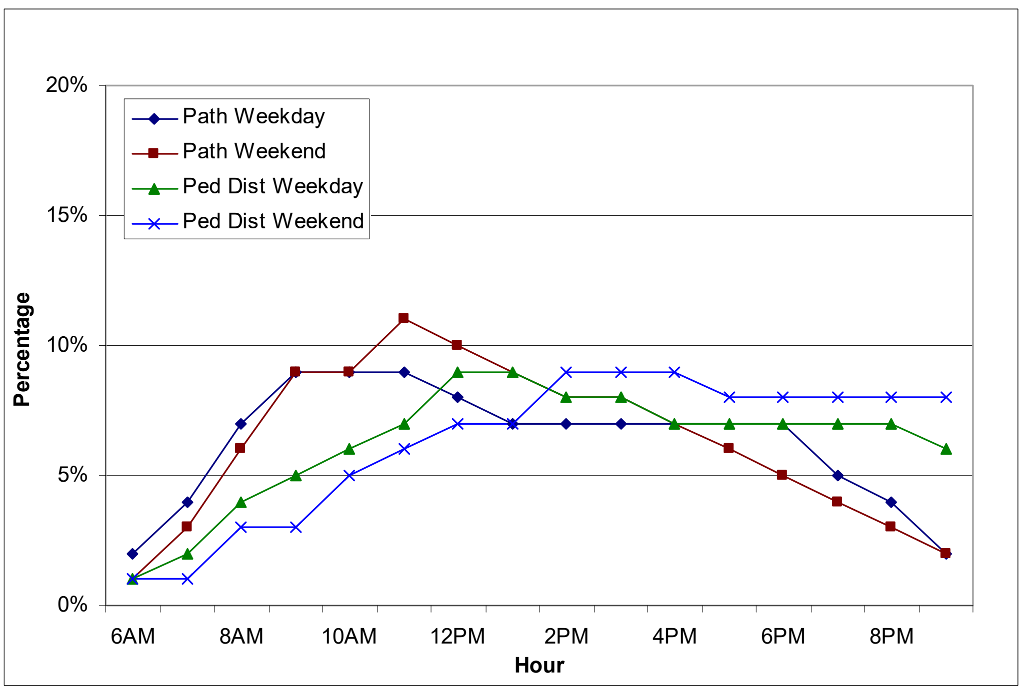


Table 30, **Figure 12** and **Figure 13** above presents the final hourly breakdown of use by season (April-September, October-March), and by facility (pathway, sidewalk). These figures are expected to be generally accurate for pathways and sidewalks in areas with moderate climates, relatively high visitor trips, and mixes of land uses (residential and commercial).

<u>Comparisons with National Data</u>

The peak-hour analysis for bicyclists and pedestrians in San Diego County are compared with averages of hourly counts conducted nationwide and collected as part of the National Bicycle & Pedestrian Documentation Project. The purpose of this comparison is to (a) determine how similar bicycle and pedestrian hourly volumes are to other locations nationwide, and (b) help confirm the reliability of the data collected in San Diego County.

The national hourly counts come from a variety of pathway locations throughout the United States, including New York City, Houston, Texas, Licking County, Ohio, and Indianapolis, Indiana. Some of these counts were conducted for limited periods in the summer or early fall, while others were conducted year round. While these are not necessarily representative locations in the United States, they do provide a good cross section of locations (urban, suburban, rural). Like the San Diego Count locations, they are primarily located on multi-use pathways, and include both bicyclists and pedestrians.

Table 31 presents combined bicycle/pedestrian pathway count figures that are compared to national figures for weekdays. The percentages reflect the percent of daily total volumes accounted for during each hour. As can be seen, the San Diego County and national figures follow similar trends, with the national data having a peak period later in the afternoon. The difference in peaking patterns may be due to time of year and/or the amount of recreational and visitor usage (ie, mid-day use) experienced in San Diego versus other locations.

Table 31: Comparison of Weekday Hourly Counts San Diego County-National Pathway Data

Hour Starting	San Diego Average %	National Average %[1]
8am	6	7
9am	8	7
10am	9	7
11am	9	7
12pm	9	7
1pm	8	5
2pm	8	5
3pm	8	6
4pm	7	8
5pm	7	11
6pm	6	11

1. National Bicycle and Pedestrian Documentation Project (2009)

ANALYSIS OF DAY OF THE WEEK COUNTS

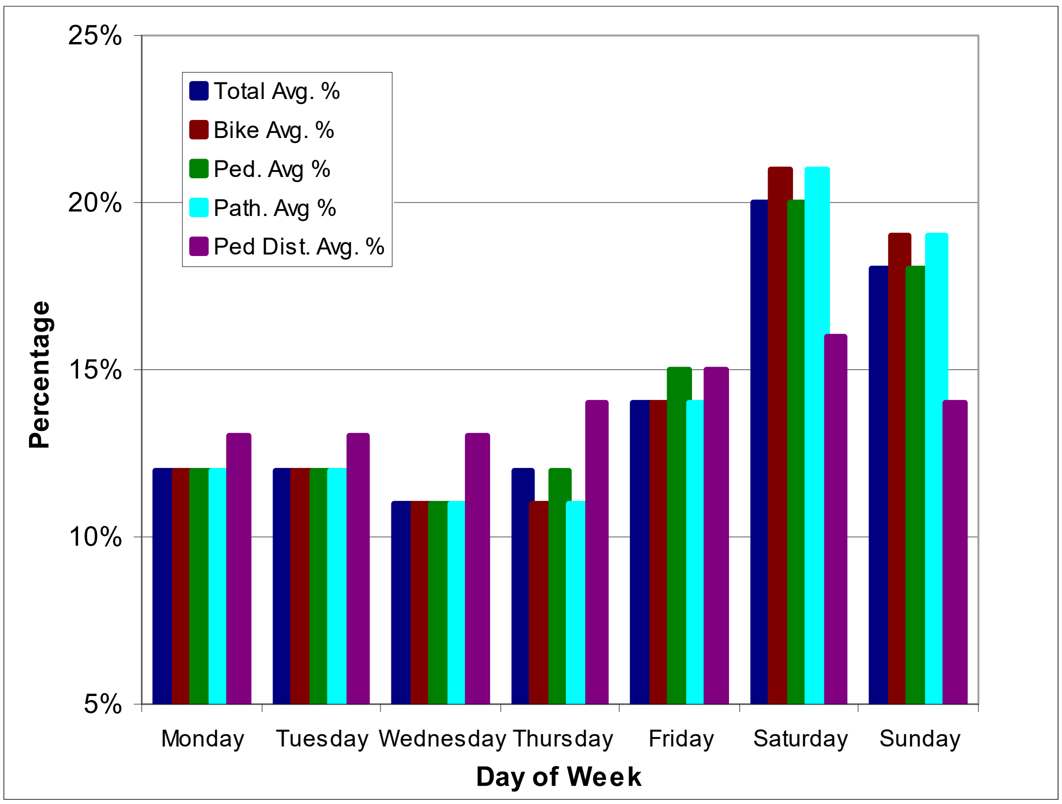
Transportation studies break traffic volumes down between weekday and weekend day volumes due to the different patterns on those days of the week. Weekday counts are typically conducted between Tuesday and Wednesday (as representative or typical days), while weekend counts are conducted on either Saturday or Sunday. An analysis was conducted to identify the day of the week counts for bicyclists and pedestrians at the five (5) automated count locations (see **Table 32** and **Figure 14**) based on a year-long count period.

Table 32: Day of the Week
San Diego County, 5 Locations, August 2007-July 2008

Day	Total Avg. %	Bike Avg. %	Ped Avg. %	Path Avg. %	Ped Dist Avg. %
Monday	12	12	12	12	13
Tuesday	12	12	12	12	13
Wednesday	11	11	11	11	13
Thursday	12	11	12	11	14
Friday	14	14	15	14	15
Saturday	20	21	20	21	16
Sunday	18	19	18	19	14

*Percent each day is of weekly average total by mode and facility

Figure 14: Day of the Week



As can be seen, bicycle and pedestrian activity is about 55% higher on weekends than weekdays, with Saturday the busiest day, and there is remarkable consistency between bicycle and pedestrian activity levels on each day of the week. Volumes on Fridays are about 15% higher than other weekdays. Volumes on Saturdays are 40% higher than the weekly average. These patterns would be expected to be different in areas isolated from recreational, residential and/or retail/restaurant uses.

Comparisons with National Data

A comparison of the daily counts at the five (5) automatic count locations for San Diego County with the National Bicycle & Pedestrian Documentation project database (**Table 33**) shows the breakdown of daily volumes is virtually identical between the two sources.

Table 33: Comparison of Day of Week Counts San Diego County-National Data

Day	San Diego Average %	National Average %[1]
Monday	12	13
Tuesday	12	12
Wednesday	11	12
Thursday	11	11
Friday	14	14
Saturday	21	20
Sunday	19	19

1. National Bicycle and Pedestrian Documentation Project (2009)

As seen, the comparison between day of week counts on paths in San Diego County with pathways nationwide (from the National Bicycle & Pedestrian Documentation project) shows a nearly identical breakdown. This confirms the count results in San Diego County as being usable for making monthly and annual projections, assuming enough counts are conducted over time and at representative locations.

ANALYSIS OF MONTHLY COUNTS

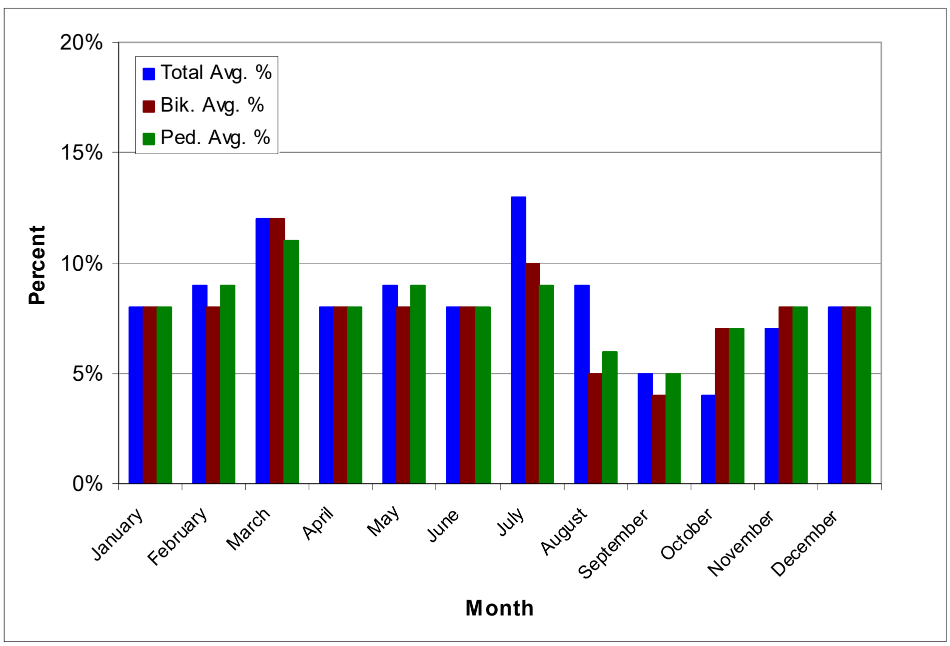
Counts of bicyclists and pedestrians at the five count locations conducted between August 17, 2007 and August 16, 2008 provided a monthly breakdown of activity. Volumes were broken down by mode (bicycle, pedestrian) and facility type (recreational path, commuting path, pedestrian district).

Table 34: Month of Year
San Diego County, 5 Locations, Aug 2007-July 2008

Month	Total Avg. %1	Bike Avg. %2	Ped Avg. %3	Path Avg. % 4	Ped Dist Avg. %5	Commuter Trail Avg. %6
January	8	8	8	7	8	5
February	9	8	9	7	8	5
March	12	12	11	10	8	7
April	8	8	8	8	8	9
May	9	8	9	8	10	9
June	8	8	8	9	8	8
July	13	10	9	14	8	17
August	9	5	6	11	9	8
September	5	4	5	7	9	13
October	4	7	7	5	9	7
November	7	8	8	6	8	5
December	8	8	8	6	8	7

*Percent each month is of total annual use
1. Average of all 5 count locations
2. Average of all bicycle volumes
3. Average of all pedestrian volumes
4. Average of all 4 path locations
5. Average of Hillcrest sidewalk location
6. Average of 2 commuter paths (Strand, Gilman)

Figure 15: Month of Year



As can be seen in **Table 34** and **Figure 15**, combined bicycle/pedestrian volumes vary by month from a low of 4% in October to 13% in July. Some unusual figures include a very high March figure (13%) and a very low September figure (5%). Reasons for these and other figures may include:

(1) Local weather patterns: While the weather in San Diego is generally good all year round, local fog conditions may impact the number of people using pathways.

(2) School schedules: The schedule of college and university schedules may impact volumes. For example, March is both Spring break for most schools and the first warm weather of the season. Many schools typically start in September.

(3) Visitors: National and state visitors come to San Diego often in the winter, while local/regional visitors come to the coast in the summer and on holidays.

(4) Special events: major events such as races, tours, sports, and bike to work week may impact volumes.

Bicycle and pedestrian volumes by month are almost identical. Pedestrian volumes in the Hillcrest neighborhood are very consistent month to month, while the recreational paths (Mission Beach Boardwalk, Bayside Walk) and commuter paths (Strand, Gilman) both have a sharp July peak.

Comparisons with National Data

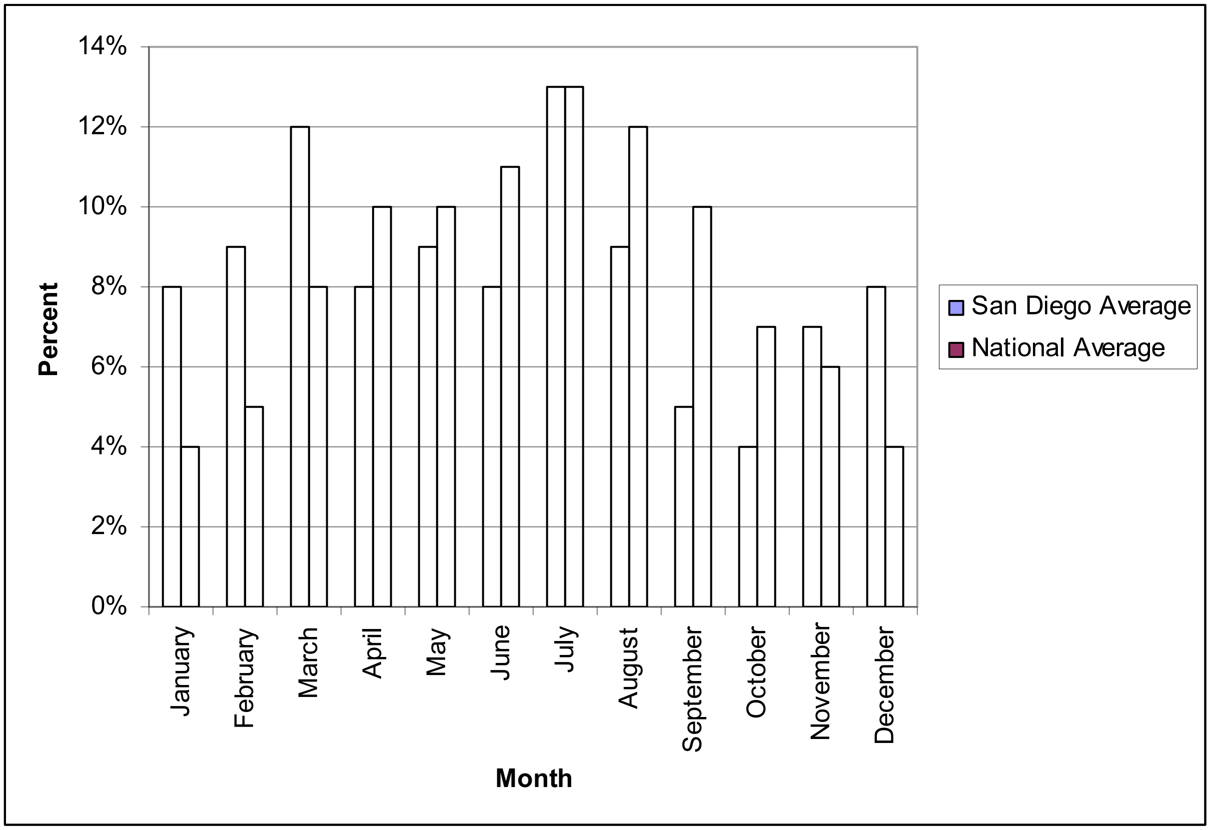
Comparisons with monthly data collected as part of the National Bicycle & Pedestrian Documentation (NBPD) Project (see **Table 35** and **Figure 16**). It is useful to note that the NBPD count locations are all on multi-use pathways, and do not include any on-street or downtown count locations. It is clear that regional variations in weather and other factors greatly impacts monthly volumes. While July accounts for 13% of the annual total in San Diego County and the NBPD locations nationally, the distribution in other months varies tremendously. For example, volumes in San Diego County are 100% higher than the average use elsewhere in the country, reflecting the moderate climate.

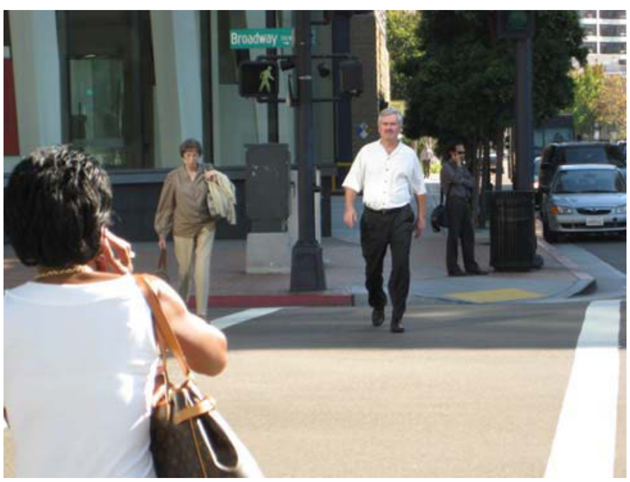
Table 35: Comparison of Monthly Volume
San Diego County-National Data

Month	San Diego Average %	National Average %[1]
January	8	4
February	9	5
March	12	8
April	8	10
May	9	10
June	8	11
July	13	13
August	9	12
September	5	10
October	4	7
November	7	6
December	8	4

1. National Bicycle and Pedestrian Documentation Project (2009)

Figure 16: Comparison of Monthly Volume





Broadway and Kettler Streets in San Diego. Pedestrian sidewalk volumes in San Diego County did not vary significantly from month to month

Pedestrian sidewalk volumes in San Diego County did not vary significantly month to month. It is assumed that any walk trip that is work, transit, and/or utilitarian in nature would continue regardless of weather or other factors. Discretionary walk trips, including those on recreational pathways, would be expected to vary similar to bicycle volumes.

MODE SPLIT

The split between bicyclists and pedestrians is shown below in **Table 36**. Despite being in distinct settings with different levels of volumes and different trip types, three of the multi-use pathways (Bayside Walk, Rose Canyon, Bayshore Bikeway) had a very similar breakdown between bicyclists (80-90%) and pedestrians (10-20%). These could be described as "typical" Class I bike paths, where pedestrian use is relatively low. The Beach Boardwalk has a unique setting and usage pattern, with almost an even split between pedestrian and bicyclists (58-42%). No bicyclists were recorded at the University Avenue location in the Hillcrest neighborhood because it was a heavily traveled, narrow sidewalk in a retail area. Bicyclist counts include all fast-moving users, including skateboarders.

Table 36: Comparison of Mode Split (Bicycling/Pedestrian) San Diego County/4 Other Pathways

Location	Bike	Pedestrian
San Diego County		
Bayside Path	80%	20%
Gilman Path	90%	10%
Strand Path	81%	19%
Beach Boardwalk	58%	42%
Manhattan Bike Path	43%	52%
Monterey Recreational Trail	54%	46%
Rhode Island (4 paths)	29%	60%
Indianapolis Path	65%	28%

These figures contrast with the results of mode split on other pathway systems in the United States (from the National Bicycle & Pedestrian Documentation Project), which show that on average 69% of pathway users are pedestrians and 25% bicyclists. **Table 36** shows the mode split on four (4) pathways around the country. It is assumed this difference can be explained by (a) quality of connecting bikeway systems in each location, (b) availability of bicycles especially to visitors, (c) proximity to and density of residential and office/commercial uses, and/or (d) general level of bicycling in the community.

DESIGN PEAK PERIOD AND DAY

Based on the data collected in San Diego County at the five (5) automatic machine count locations, we recommend the 'design peak period day' for pathways to consist of the following periods:

Maximum design load:	11am-1pm, July, 4th
Weekday:	11am-1pm, Mid-July, Tuesday, Wednesday, or Thursday (non-holiday)
Weekend day:	11am-1pm, Mid-July, Saturday (non-holiday)

MANUAL COUNTS

Manual counts were conducted at 80 locations in 2007 and 2008 between August and October in the AM, Mid-Day, and PM period (at selected locations). The counts were compiled and analyzed to identify anomalies and discrepancies. Count forms from locations with wide disparities between 2007 and 2008 were reviewed closely and adjusted where there had been miscalculations or errors.

Counts were also adjusted based on the monthly use factors from the automatic count machines. All manual counts on multi-use paths were adjusted using the monthly factors from the four multi-use path locations. All counts were factored to represent a mid-July weekday for the sake of comparison. We recommend that the mid-July weekday period serve as the de facto time for comparing hourly and weekly volumes between facilities and locations. This will allow for a uniform and consistent measurement and comparison. The table of monthly adjustment factors is shown below.

Table 37: Monthly Adjustment Factors

Month	Multi-Use Paths	All Other
January	1.0	1.0
February	0.89	0.89
March	0.5	0.5
April	1.0	1.0
May	1.0	1.0
June	1.0	1.0
July	0.57	1.0
August	0.89	1.0
September	1.6	1.0
October	2.0	1.0
November	1.14	1.0
December	1.0	1.0

Mission Blvd and Garnet Ave, San Diego

The 7AM-9AM count period was used as the primary source of raw data since all locations included this period. As discussed earlier, the 7AM-9AM period is not the peak period for bicycling or walking, which is typically 11am-1pm. However, bike/walk patterns have a relatively low daily profile and the 7-9AM period is very close to other periods, and can be used to calculate actual peak period volumes.

A total of 23,281 pedestrians and 6,612 bicyclists were recorded during the manual count sessions in 2007 and 2008. Bicyclist and pedestrian volumes varied widely among sites, with the highest AM peak period pedestrian count of 1,706 persons recorded Site #631 (Kettler Blvd. and Broadway in San Diego), and the highest bicycle count of 312 bicyclists recorded at Site #1 (Pomona Ave & Orange Ave/Silver Strand). There does not appear to be a relationship between bicyclist volumes and pedestrian volumes. Locations with high pedestrian volumes do not necessarily have high bicyclist volumes, and vice-versa, with the exception being selected popular pathways like the Boardwalk.

Figure 17 through **Figure 20** show maps of the peak-hour counts from the manual counts. In general, bicyclist counts are highest at the coast and pedestrian counts are highest in downtown San Diego. **Table 38** provides a summary of the average 2007/2008 manual AM peak hour counts at all 80 locations.

Figure 17: Weekday AM Peak-Hour Bicycle Counts

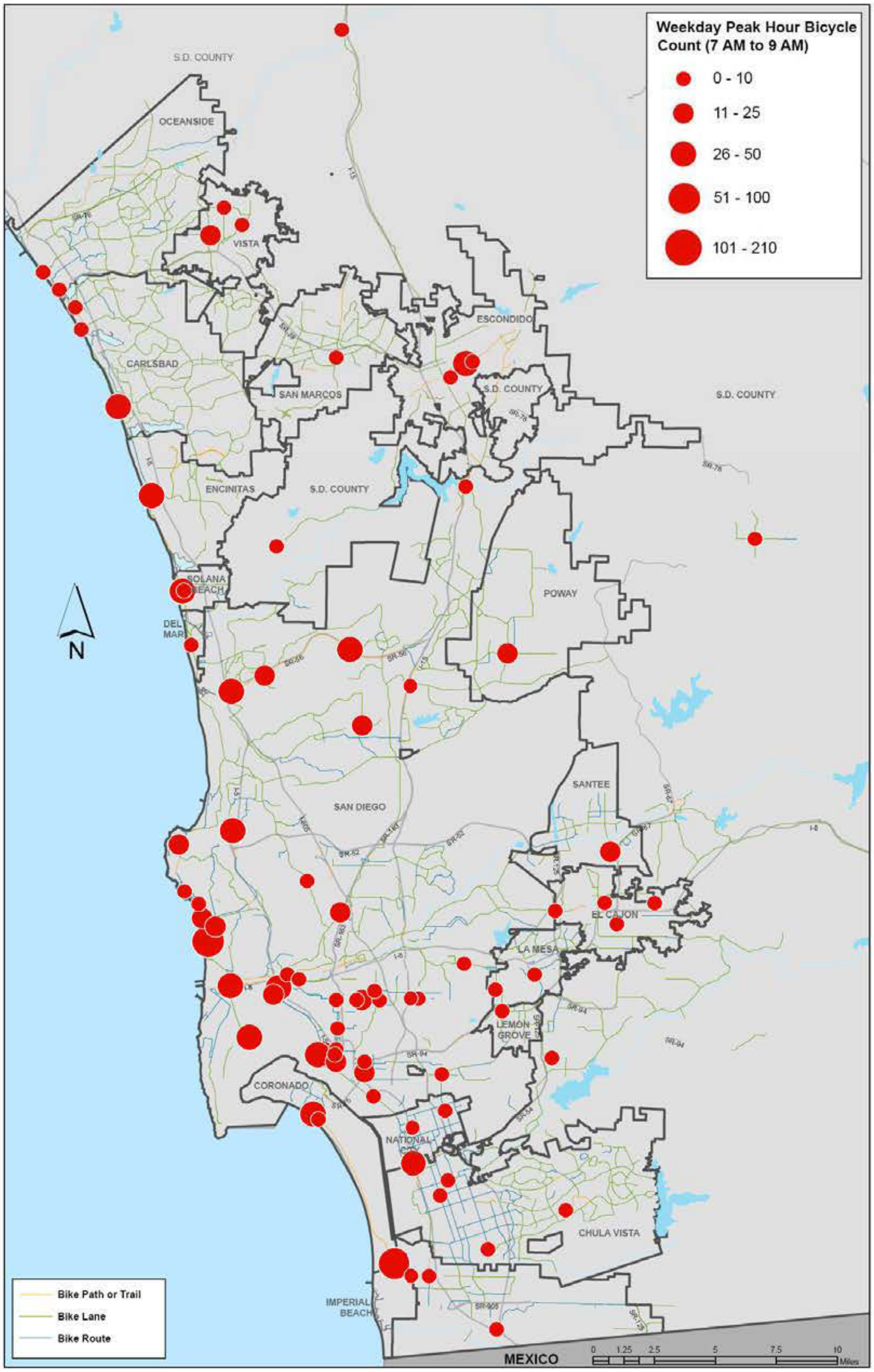


Figure 18: Weekend Midday Peak-Hour Bicycle Counts

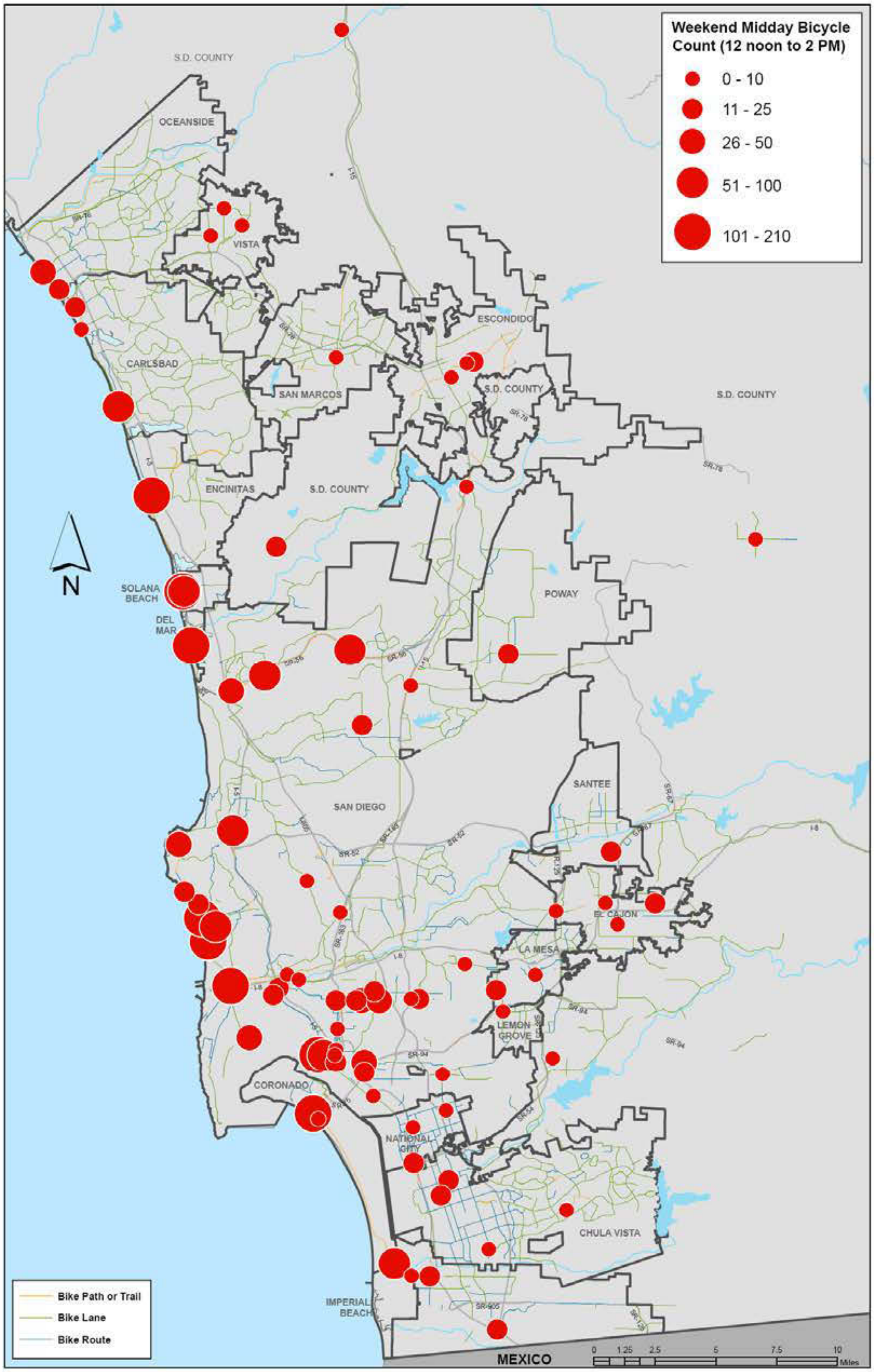


Figure 19: Weekday AM Peak-Hour Pedestrian Counts

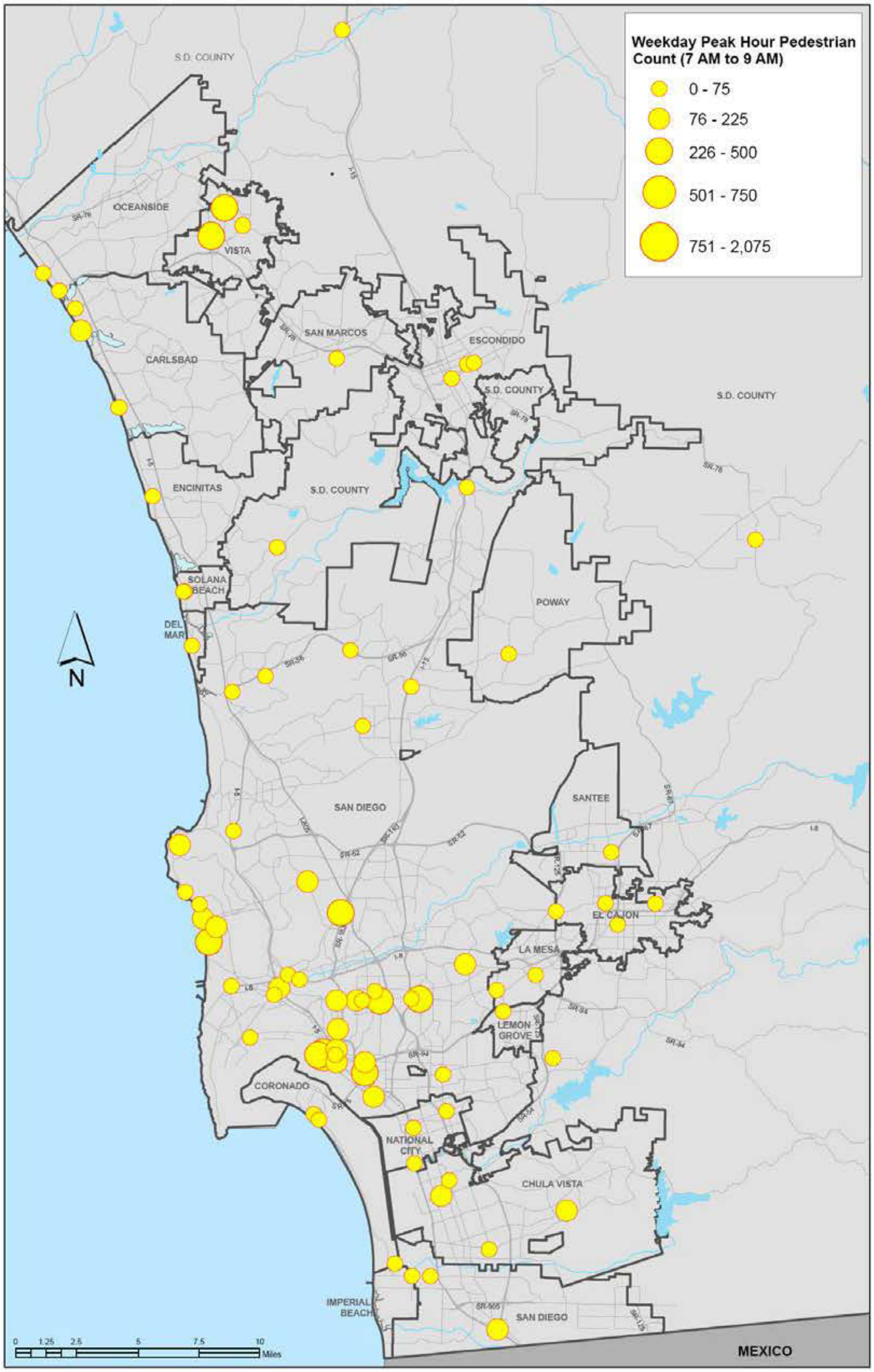


Figure 20: Weekend Midday Peak-Hour Bicycle Counts

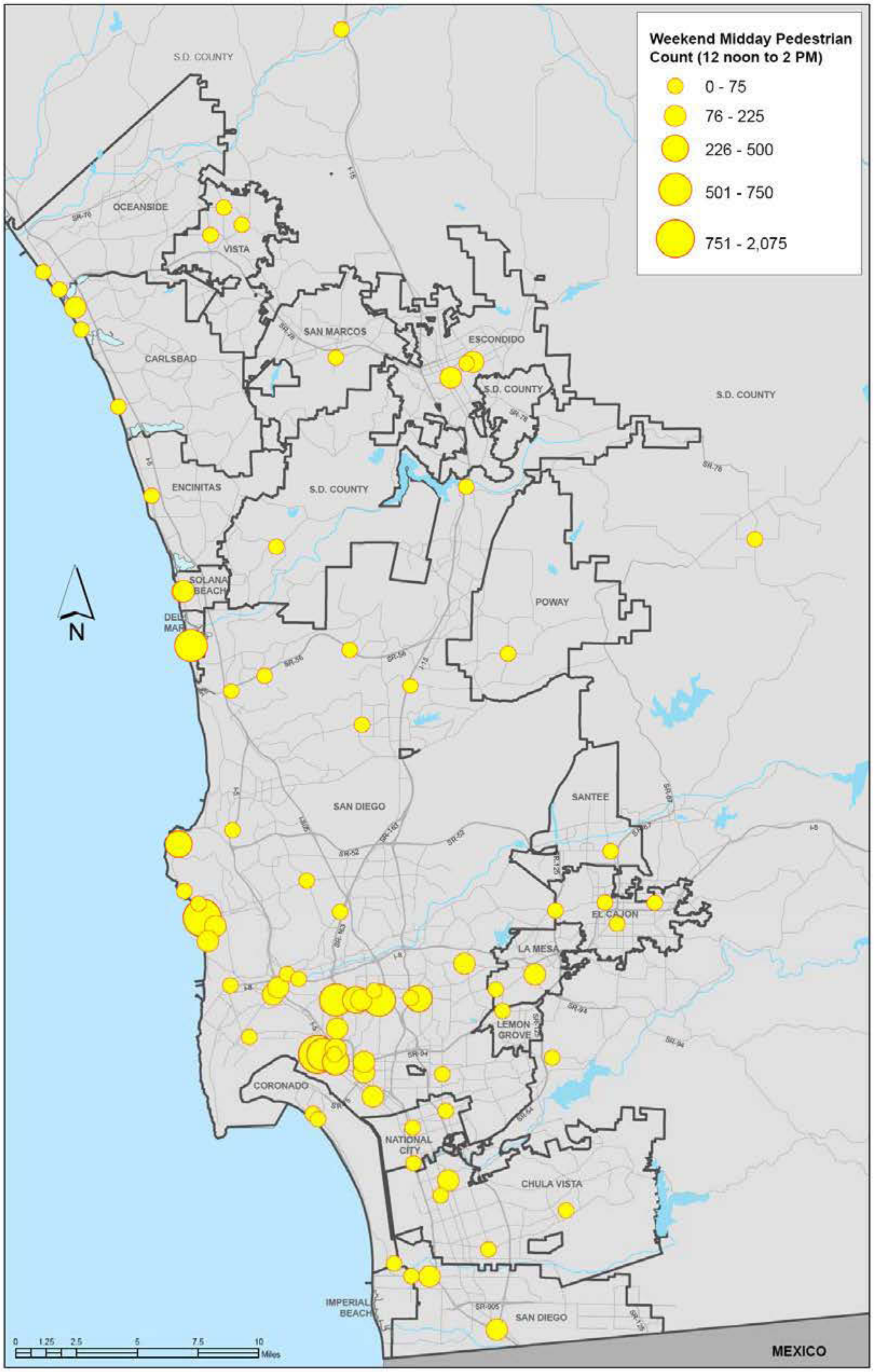


Table 38: Average Counts by Location

Site ID	Location	Average AM Pedestrian Counts	Average AM Bicycle Counts	Average Mid-Day Pedestrian Counts	Average Mid-Day Bicycle Counts
1	Pomona Ave & Orange Ave/Silver Strand	85	256	335	233
3	Eighth St & Euclid Ave	54	4	18	2
6	Laurel St & Sixth Ave	218	26	282	24
7	Broadway & Harbor Dr	653	84	3078	188
8	Imperial Ave & Euclid Ave	64	3	119	6
9	Howard Ave & Idaho St	75	14	153	22
10	Harbor Dr & Nimitz Blvd	51	58	34	108
11	Rosecrans/Taylor & Pacific Highway	362	89	180	81
12	Flood Control Channel & Sunset Cliffs	27	85	157	380
13	Harbor Dr & 28th St	164	8	306	29
16	Montezuma Rd & College Ave	393	155	260	35
101	15th St & Camino Del Mar	197	76	910	188
108	Loring & Mission Blvd	29	27	100	79
109	Friars Rd & Napa St	69	54	56	38
110	Mesa College Dr & Linda Vista Rd	545	30	43	17
111	Balboa Ave & Genesee Ave	117	22	55	5
112	Gilman Dr & Rose Canyon Bike Path	41	41	0	30
115	Scrips Pkwy & I-15 Bikeway	15	33	1	9
201	H St & 5th Ave	153	16	60	10
205	E Orange Ave & Hilltop	56	4	24	5
207	Bayshore Bikeway & SR-75	15	82	23	110
208	Palm Ave & 13th St	34	1	116	40
306	Fletcher Pkwy & Johnson Ave	59	12	51	16
308	Broadway & Second St	69	13	47	18
310	University Ave & 70th St	43	12	45	17
313	Broadway & Massachusetts Ave	65	11	72	3
315	Navajo Rd & Fanita Dr Bike Path	25	28	11	6
316	Mission Gorge Rd & Magnolia	39	29	23	23
401	Tamarack Ave & Carlsbad Blvd	204	85	238	157
403	Poinsettia Ln & Carlsbad Blvd	26	35	91	196

Site ID	Location	Average AM Pedestrian Counts	Average AM Bicycle Counts	Average Mid-Day Pedestrian Counts	Average Mid-Day Bicycle Counts
405	Encinitas Blvd & N. Coast Hwy	41	50	262	282
406	Oceanside Blvd & Pacific St	75	137	96	97
409	Loma Santa Fe & Pacific Highway	73	90	199	319
410	Valley Pkwy & Ash St	58	83	214	27
503	Barham Dr & Twin Oaks Valley Rd	13	20	13	7
505	Olive Ave & N Melrose Dr	306	52	51	16
508	E Vista Way & Vale Terrace Dr	39	18	77	11
509	W Bobier Dr & N Santa Fe Ave	312	28	74	8
510	SR-56 Bike Path & Camino Del Sur	31	57	19	112
601	Hotel Circle North & I-8 WB Off	22	4	14	4
602	SR-56 Bike Path & Carmel Creek Road	2	6	40	66
603	SR-56 Bike Path & El Camino Real	21	13	17	78
604	Pomerado ROAD & I-15	5	4	1	4
605	SR-76 & Old Highway 395	7	19	1	7
606	Hanson Lane & San Vincente Road	16	8	2	4
607	Jamacha Boulevard & Gillespie Drive	43	6	43	5
608	El Tordo & Linea Del Cielo	14	4	10	13
609	University Avenue & 5th Avenue	288	52	1063	62
610	Broadway & 4th Avenue	1	1	0	0
612	Market Street & 5th Avenue	535	53	954	34
613	Crowne Point Bike Path & Everts Street	81	27	211	211
614	Santa Clara Place & Bayside Walk	328	131	276	305
615	E Palomar/Palomar Path & Heritage Road	93	15	48	11
616	University Avenue & Park Boulevard	379	79	454	67
617	University Ave & 30th St	431	26	933	46
619	University Avenue & I-15 NB/SB Ramp	336	49	111	7
620	University Avenue & 43rd St	356	15	641	38
621	Rosecrans St & Sports Arena Blvd	44	20	140	28
622	Mission Boulevard & Garnet Street	145	30	1318	174
623	Mira Mesa Blvd & Camino Ruiz	81	38	55	14

Site ID	Location	Average AM Pedestrian Counts	Average AM Bicycle Counts	Average Mid-Day Pedestrian Counts	Average Mid-Day Bicycle Counts
624	Palm Avenue & Saturn Boulevard	76	6	149	33
625	Pearl Street & Girard Avenue	44	15	365	44
626	Ave de las Arenas & Silver Strand Path	100	153	29	96
627	San Ysidro Boulevard & Via San Yisidro	150	30	239	18
628	25th Street & Commercial St	259	18	351	28
629	25th & Market Street	208	16	225	23
630	5th Avenue & A St	445	22	282	16
631	Broadway & Kettler Boulevard	1346	72	1169	75
632	University Avenue & Alabama Street	105	50	182	58
633	La Jolla Boulevard & Midway St	46	15	131	40
634	Grand Avenue & State Street	102	28	252	51
635	Lomas Santa Fe Drive & Cedros Avenue	51	9	124	85
636	12th St & National City Blvd	34	4	37	4
637	Main Street & Magnolia Avenue	89	8	108	7
638	F Street & 3rd Avenue	140	5	180	15
639	La Mesa Blvd & Spring St	102	13	217	11
640	Vista Way & Broadway	27	17	20	20
641	W Grand Ave & Maple St	100	139	367	6
642	Escondido Creek Path & Date St	59	66	47	14
643	Poway Road & Community Road	46	75	45	18
644	Bayshore Bikeway & Sweetwater River Bikeway	13	37	18	51

Table 39: Summary Statistics Manual Counts

	Bicyclists			Pedestrians		
	Low	High	Average	Low	High	Average
AM	0	83	13.9	1	558	94.4
PM	3	140	36.5	4	982	242
Midday	0	207	34.6	1	2065	158.7

Notes: AM and PM counts were conducted on weekdays; mid-day counts were conducted on weekends. Eighty sites were surveyed for AM and mid-day. Twenty sites were surveyed for PM.

As can be seen in **Table 39**, bicycle volumes were significantly lower than pedestrian volumes. For example, 32% of the count locations had 20 or fewer bicycles in the peak AM hour, and only 12% of locations with volumes over 100 bicyclists per hour. In comparison, the pedestrian volumes had a much greater although even distribution of volumes. For example, only 16% locations had peak AM hour volumes under 20 persons/hour, while 36% of the locations had over 100 persons/hour.

Based on this, the recommended minimum classifications for GIS mapping and analysis for both modes are shown below.

Bicycle Volumes
Low 0-20 per hour
Moderate 21-60
High over 61

Pedestrian Volumes
Low 0-40 per hour
Moderate 41-100
High Over 100

The adjusted manual AM peak hour counts are used as the basis for the modeling effort described in the following chapter.

The implication of these findings is that unlike motor vehicle patterns, assumptions of peak hours and periods of activity for pedestrians can be made with much less certainty than for motor vehicles.

SUMMARY OF COUNT AND SURVEY FINDINGS

Conclusions of the count and survey data collected in San Diego County in 2007 and 2008 are presented below.

General Findings

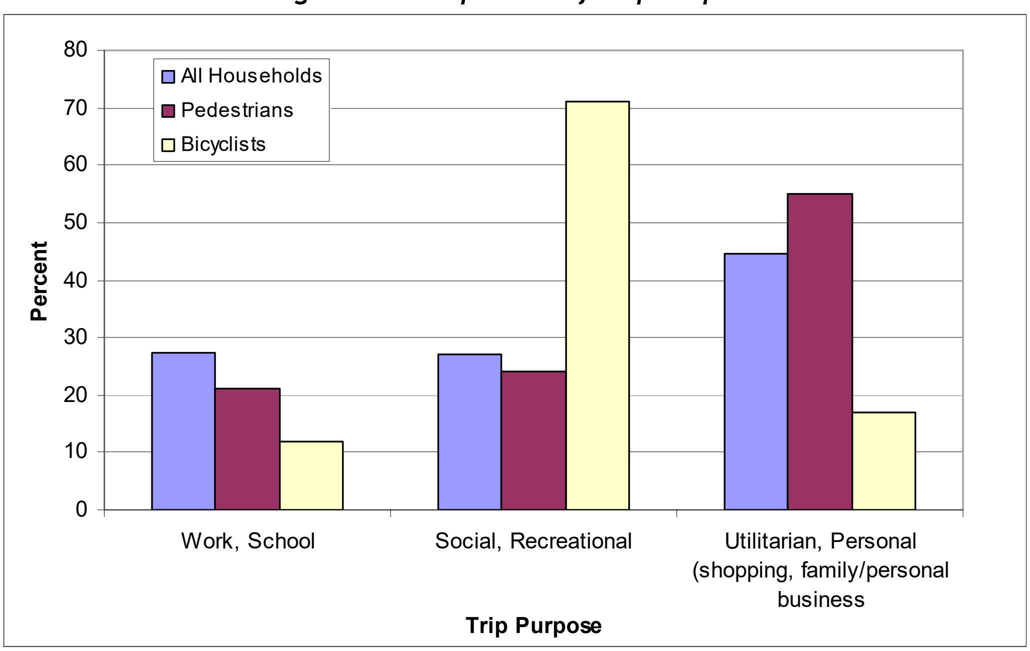
Finding #1: The perception of the walk and bicycle trip making as recreational or discretionary is unfounded. The walk and bicycle modes have the same or similar percentages of work, school, or utilitarian trip making as household travel in general, and private vehicle trips (see **Table 40** and **Figure 18**). While funding for pedestrian and bicycle facilities are typically targeted to those facilities that serve 'transportation' functions only, funding for roadways, transit, and other systems make no distinction. The result is a potential funding bias against non-motorized facilities, as well as a potential resistance to accommodating non-motorized modes in new projects despite adoption of Complete Streets and other policies.

Table 40: Comparison of Trip Purpose

	All Households (Percent)[1]	Pedestrians[2] (Percent)	Bicyclists[2] (Percent)
Work, School	27.5	21	12
Social, Recreational	27.1	24	71
Utilitarian, Personal (shopping, family/personal business	44.6	55	17

1. Bureau of Transportation Statistics, National Household Travel Survey, Fig 7, 2001
2. San Diego County survey results

Figure 21: Comparison of Trip Purpose



Finding #2: Class I bike paths and multi-use paths in general serve as important transportation facilities. The surveys of trip purpose combined with the year-long counts of four (4) bike paths in San Diego County shows (see **Table 41**) that these pathways alone are used by an estimated 691,969 bicyclists on work/school/utilitarian trips. This volume is 90% higher than the total estimated annual volumes of all on-street bicycle trips counted at 69 of the 80 manual count locations. It is likely that bike paths serve as important incubators for bicyclists learning or re-learning how to ride bicycles as a transportation vehicle for short trips.

Table 41: Comparison of Pathway and On-Street Bicycling by Trip Purpose

Location	Total Annual Use	Transportation Trips[1]
Bayside Path	513,558	133,525
Gilman Path/ Rose Canyon	164,638	42,805
Strand Path	148,109	38,508
Boardwalk	1,835,426	477,131
Subtotal	2,661,426	691,969
On-Street Locations[2]	1,401,837	364,477

1. Defined as school, work, utilitarian trips
2. 69 of the 80 count locations, normalized to annual counts

Finding #3: Bike lanes are not an indicator of bicycle use. Bicycle use on streets with bike lanes is about the same as streets without bike lanes. This does not mean that bike lanes do not attract or serve bicyclists. Firstly, bike lanes have traditionally been installed where they are feasible rather than where the highest existing uses are located. Secondly, all things being equal, bicyclists will choose the best, most direct route with the best combination of topography, lane width, and traffic volumes speeds available.

Finding #4: Location Determines Data: The location of the five (5) automatic counters drives the pattern of data collected. Bicycle and pedestrian activity is affected by facility type (pathways, sidewalks), surrounding land use, weather, time of year, and many other factors. The data therefore provides a 'snapshot' of a limited range of possible activity patterns in San Diego County or in any community. However, this data along with other year round data from around the country starts to provide a picture of activity trends that can be used to frame parameters of activity.

Historical Patterns

Finding #5: Bicycle use in San Diego County based on historical counts back to 1987 has generally been stable, and is increasing in the past year. Various agencies in San Diego including SANDAG and Caltrans have been conducting bicycle counts since 1985. Twelve (12) locations were consistently counted between 1985 and 2008 (13 years). Initially the figures indicated a steep decline in use at these 12 locations between 1985 and 1990. However, an in-depth analysis of the figures shows that almost all of the decline was due to one location (Site #16: College/Montezuma). This location is next to the LRT station near San Diego State University, which was completed during the count period, and may have impacted or changed bicycling patterns in the area. **Table 42** shows how, if this site is removed, volumes at the remaining 11 locations were stable from 1985-2007. In all cases, volumes in the most recent count (2008) have jumped between 40-85%. The last column on **Table 42** and **Figure 22** shows the average percent change of all 12 locations from 1985-2008, showing a consistent increase during this period except between 1990 and 1993.

Table 42: Historic Bicycle Counts San Diego County 1985-2008

Year	AM Counts[1]	Average %[2]	AM Counts	Average %[3]	Average % Change[4]
1985	1,022		414		
1987	913	-10	396	-4	+27
1990	659	-28	395	0	-2
1993	701	+6	440	+11	+12
1997	541	-33	410	-7	+12
2007	586	+8	386	-6	+12
2008	823	+40	713	+85	+30

1. AM Counts, weekdays 7am-9am, adjusted seasonally, 12 locations
2. Count locations increased from 12 in 1985 to 80 in 2008
3. AM Counts, weekdays 7am-9am, adjusted seasonally, 11 locations excluding College/Montezume
4. Average % change of all 12 locations from year to year

Figure 22: Historic Counts

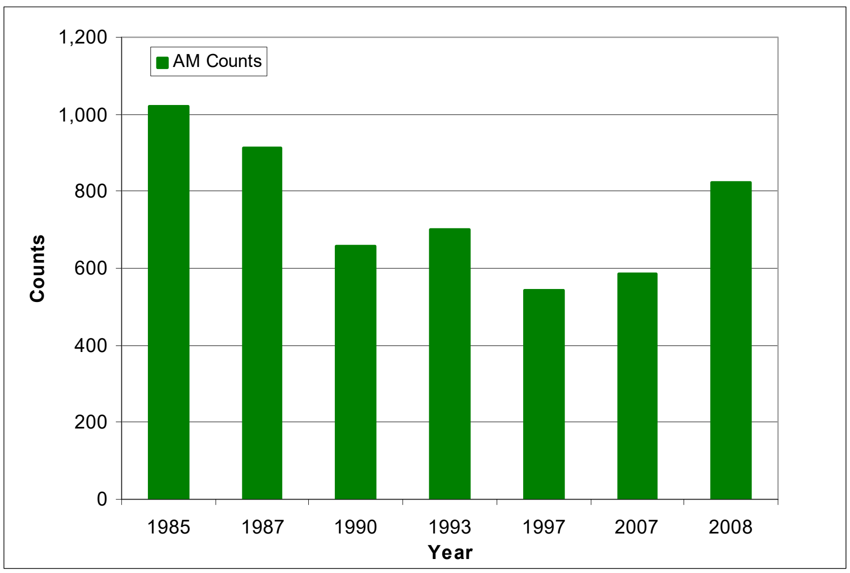
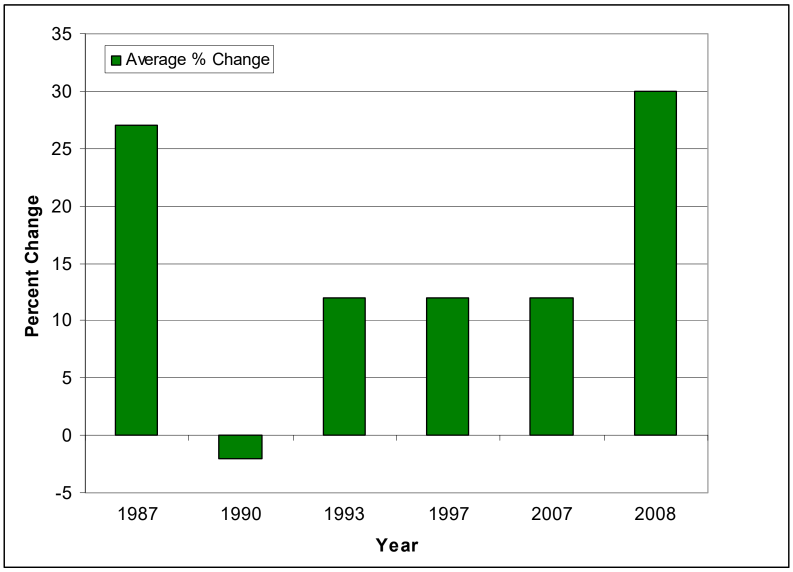


Figure 23: Historic Percent Change



Mode Split

Finding #6: Mode split on pathways is highly related to regional and local patterns, with bicycle mode splits ranging from 30% to 90% and pedestrian mode splits from 10% to 70%. Predictive models should be able to identify a general mode split based on adjacent demographics and land uses. Commuter paths located next to some kinds of land uses may require the development of alternative routes, special delineation and/or management to preserve the ability to be used by bicyclists for commuting.

Multi-use paths in San Diego County, such as the one above in Chula Vista, are mostly used by bicyclists

Finding #7: Multi-use paths in San Diego County are used mostly by bicycles. While this varies by location and facility, bicyclists are the primary users of the pathways counted in San Diego County. Nationally, pedestrians outnumber bicyclists on pathways 75% to 20% on average. Mode split appears to be correlated with adjacent land uses, regional bicycling patterns, and quality of the bikeway network.

Peak Periods and Hours

Finding #8: Over the course of a year, there are no distinct daily peak periods for pedestrians and bicyclists. Unlike motor vehicle traffic patterns, there is no sharp commute pattern for either bicycle or pedestrian mode regardless of facility type. Activity is evenly spread throughout the day, with minor peaking patterns. This is likely due to the mix of recreational and utility/work/school trips, and also an indication of the low proportion of commute trips overall. This finding is true for locations with (a) connections to mixed land uses (residential, commercial, office), (b) recreational trips and destinations, and/or (c) visitor usage. This finding would not apply to locations such as large employment centers with little/no retail or restaurant uses, or near major transportation hubs.

Finding #9: Actual day-to-day variability at many count locations may make forecasting difficult at some locations. Actual day to day variability is largely related to the volumes (higher volumes = less day to day variability) and trip types (recreational trips = higher variability). With many count locations having very low volumes, any predictive model will need to accept a relatively high margin of error. Also, validation counts would need to be conducted over a longer period of time during the same month of year, or, adjusted using local automatic count machine data.

Finding #10: The 6am – 9pm period accounts for a consistent 95% of the total volumes. Bicycle and pedestrian volumes gently taper off from about 6pm to 12 midnight. From 12 midnight to 6am there is very little activity. Focusing on the 6am to 9pm period will capture a consistent snapshot of the vast majority (95%) of activity. The exception may be count locations near large entertainment centers or districts.

Finding #11: Bicyclists and pedestrians have nearly an identical use pattern on multi-use pathways. While bicyclists accounted for 55% of all users on the five (5) pathways, the peaking patterns were proportional with pedestrian volumes. This indicates that trip purpose on pathways, regardless of mode, is similar between bicyclists and pedestrians, and that the combined modes can be used to analyze patterns.

Finding #12: Pedestrian volumes on sidewalks in some areas are highly consistent and spread evenly throughout the day and evening, with little discernable peaking. The hourly pedestrian volumes on University Avenue in the Hillcrest neighborhood of San Diego (a higher density, older neighborhood with good transit service) was extremely even on both weekdays and weekdays, with virtually no change between about 10am and 12 midnight. This reflects the fact that walking in a neighborhood with a mix of residential and commercial uses produces nearly constant and consistent volumes for most of the day. This will allow manual counts conducted during any time of the year to be adjusted to an annual total figure. This finding is true for locations with (a) connections to mixed land uses (residential, commercial, office), (b) recreational trips and destinations, and/or (c) visitor usage. This finding would not apply to locations such as large employment centers with little/no retail or restaurant uses, or near major transportation hubs.

Finding #13: Peak periods on multi-use paths have a consistent annual peak period of 11am-1pm, with minor variations. This will allow manual counts conducted during any time of the year to be adjusted to an annual total figure. This finding is true for locations with (a) connections to mixed land uses (residential, commercial, office), (b) recreational trips and destinations, and/or (c) visitor usage. This finding would not apply to locations such as large employment centers with little/no retail or restaurant uses, or near major transportation hubs.

Finding #14: Pedestrian volumes on sidewalks, while generally consistent, will have seasonal changes in peak periods depending on the adjacent land uses. Peak periods on sidewalks for pedestrians range from 1-3pm on weekdays in the Fall/Winter/Spring to 9-11pm in the Summer. This finding is true for locations with (a) connections to mixed land uses (residential, commercial, office), (b) recreational trips and destinations, and/or (c) visitor usage. This finding would not apply to locations such as large employment centers with little/no retail or restaurant uses, or near major transportation hubs.

Finding #15: Given the consistency in peaking patterns on pathways and sidewalks in the locations described, manual counts can be used to extrapolate annual data. This assumes the count location has a moderate to high volume, is not predominately recreational, and can be validated with counts conducted during the same period for at least two (2) days, or, validated with a local automatic count machine.

Finding #16: Bicycle and pedestrian count results can yield some unusual, unexpected results, reflecting highly localized conditions. For example, the second highest month of activity on the four (4) pathways was March, possibly due to the college and university break schedules. Other unexpected results could be caused by events such as marathons or races, construction, special events, pulses of patrons from nearby rail, transit or ferry operations, and sporting events.

<u>Standard Measurements</u>

Finding #17: Annual use should be the standard measurement for the bicycle and pedestrian modes. Given the day to day and seasonal variability at many locations, and the fact that determining peak hour capacity is not an overriding need, the use of annualized figures will allow a more accurate comparison between locations and areas.

Finding #18: Where peak hour volumes are needed to evaluate capacity, the standard 'Design Period and Design Day' on multi-use pathways should be as follows:

Maximum design load:	11am-1pm, July, 4th
Weekday:	11am-1pm, Mid-July, Tuesday, Wednesday, or Thursday (non-holiday)
Weekend day:	11am-1pm, Mid-July, Saturday (non-holiday)

Finding #19: Pathway capacity ranges between 15 and 270 persons per hour per foot of pathway width. Free flow conditions suitable for higher bicycle commuting speeds are represented at the lower end, while the maximum capacity range would require bicyclists to dismount or ride very slowly. Both ends of the range require adequate separation between directional flow, and preferably modes as well**.**

Finding #20: For planning purposes, we recommend the use of 120 persons per hour per foot of path width as the maximum capacity. We also recommend centerline separation and supporting pathway management techniques (signing, enforcement etc) on any pathway with design day volumes over 10 persons per hour per foot of path width and pedestrian mode split over 20%, or over 15 persons per hour per foot of path width and under 20% pedestrian mode split. Design hour or day pedestrian volumes on sidewalks should conform with the Highway Capacity Manual pedestrian level of service methodology, which is also used to determine crosswalk capacities.

Finding #21: Bicycle and pedestrian volumes can be classified to facilitate mapping and analysis. The recommended classification scheme is as follows:

<u>Bicycle Volumes</u>	
Low	0-20 per hour
Moderate	21-60
High	over 61
<u>Pedestrian Volumes</u>	
Low	0-40 per hour
Moderate	41-100
High	Over 100

Additional categories can be created as needed.

Days of the Week

Finding #22: Day of week volumes are consistent between modes and locations, both in San Diego County and nationally. Over the course of a year, bicycle and pedestrian volumes by day of week are nearly identical, with Saturday being the day with the highest activity, and weekends being higher than weekdays. This breakdown is very consistent with national counts.

Months of the Year

Finding #23: Monthly volumes appear to be highly related to regional conditions, especially weather. The monthly pattern in San Diego County had both intuitive results (July with the highest volumes) and unusual results (March had the second highest with 12%). Compared to other locations in the country with more severe winters, use is relatively even over 12-months in San Diego County. The need for automatic counters in different regions is apparent in order to establish local monthly adjustment factors.

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5. DEVELOPMENT OF A PREDICTIVE MODEL

This chapter discusses the development and applications of models that can estimate and forecast bicycling and walking, using formulas developed from the 80 manual, five (5) automatic machine count locations, GIS data on land use, demographics, and other data in San Diego County.

PURPOSE OF A BICYCLE/PEDESTRIAN ESTIMATING MODEL

A bicycle and pedestrian estimating model will serve a very similar purpose as any transportation model: (1) estimate volumes at specific locations and corridors, and (2) predict volumes at specific locations based on variables such as facility type, land use, and demographics. Other than general research purposes, a bicycle and pedestrian model could be a valuable tool in these areas:

- Land use and zoning decisions
- Requirements, allocation, and priorities for funding
- Performance measurement for meeting the goals of the California Blueprint for Bicycling and Walking including (a) volumes, (b) traffic safety, (c) local participation, (d) connectivity, and (e) infrastructure[16]
- Training and count/survey materials: designed to be used primarily by Caltrans and local agency staff desiring to conduct local counts or surveys
- Transportation modeling
- Measuring benefits and impacts
- Multi-modal planning
- Application of Complete Streets policies
- Design of streets, roadways, transit stations, bikeways, sidewalks
- Exposure analysis

As discussed earlier in this report, there are different types of models that accomplish different things. Together, these models can be used to answer many questions about walking and bicycling in different settings.

[16] *California Blueprint for Bicycling and Walking: Report to Legislature*, California Department of Transportation, May 2002, p. 4

Aggregate Models

What they can do:
These types of models provide estimates of persona, household, and overall trip making in an area based on demographics, household travel data, and/or survey data. These models can estimate total trip making in an area based on available household or personal information. Sources include the National Household Travel Survey (NHTS), U.S. Census, and local user surveys.

What they can't do:
The weakness of these models is the ability to accurately capture linked (non-home based trips) trips, and the ability to forecast volumes in specific locations or corridors.

Gravity Models

What they can do:
Most transportation models are gravity models, which use aggregate data on a zonal basis and assign trips generated from those zones to a gravity network. Trips for different modes are distributed to the network based on variables such as time and speed. These models are typically calibrated at screen lines with actual count information.

What they can't do:
Gravity models are strong at predicting vehicle and transit use on a defined network, but not great for predicting walking or bicycling trips. These models can not reflect all of the variables that influence bicycle and pedestrian trip making, such as topography, street conditions, lane widths, aesthetics, security issues, and others. In cities with a regular grid of smaller blocks and level topography, gravity models may offer some value for bicycle trips especially at bottleneck locations.

GIS-Based Models

What they can do:
GIS-based models can take local geographic, demographic, land use, facility type and quality, and other information, and predict the estimated volumes of pedestrians and bicyclists based on that information.

What they can't do:
These models can't explain every aspect of walk or bicycling trip making, especially those not directly-related to local conditions, or variables that simply cannot be modeled.

THE BICYCLE AND PEDESTRIAN DEMAND MODELS

Two models were created and tested using the count data and available GIS data in San Diego County. A separate Bicycle Demand Model and Pedestrian Demand Model were created reflecting the unique characteristics of trip making between the modes. The evolution, testing, use of, and accuracy of the models is discussed below.

The models predicting bicycle and pedestrian travel in San Diego were developed through several iterations, each exploring the data through a different analysis, in order to arrive at models of bicycle and pedestrian travel that are informative, intuitive, and easy to use. The analysis used in the development of the Seamless models included:

- Correlation and skewness testing of independent variables to reduce multicollinearity
- Comparison of built environment and socio-economic factors at low and high pedestrian activity locations
- Development of pedestrian attractor and generator models
- Ordinary Least Squares regression analysis using both stepwise and enter methodologies
- Residual analysis, including development of refinement variables

Variables likely to affect walking and bicycling were screened for correlation with the dependent variables of bicycle and pedestrian counts, respectively. Variables not shown to correlate with the dependent variable at the 90 percent significance level were removed from the analysis for each dependent variable. The relationship between the remaining independent variables was then assessed, and highly correlated (at the 90 percent significance level) variables were removed to avoid multicollinearity, or correlation between the independent variables. The attractor and generator models and comparison of low and high count locations did not directly affect the final regression analysis results; however, these steps furthered knowledge about relationships between independent variables in the analysis. Both regression model methodologies were considered in the final model selection, which was based on the residual analysis.

POTENTIAL VARIABLES

Independent variables expected to explain pedestrian and bicycle travel were separately developed for the areas within a quarter-mile and half-mile network distance of each study intersection locations where the counts were collected. These variables generally describe socio-economic characteristics, built environment characteristics, travel behavior characteristics, and transportation facility characteristics of the area near the intersection locations. The dependent variables tested in the Seamless models are bicycle and pedestrian weekday AM peak hour counts, respectively, shown in **Table 43**. Note that all manual counts were adjusted to a mid-July period using automatic machine counts in order to have a consistent count period.

Table 43: Dependent Variables Used in the Models

Variable	Description	Mean	Std. Dev	Skew-ness	Std Error Skew	Min.	Max.	N	Data Source
Bike AM Volume	Total adult & child bicycling trips at intersection/path during a 2-hour weekday AM peak	20.74	27.49	2.167	0.27	.000	21	81	Count conducted in the field; adjusted to mid-July using machine data
Ped AM Volume	Total adult & child walking trips at intersection/path during a 2-our weekday AM peak	144.85	184.27	2.01	0.27	.000	985	81	Count conducted in the field; adjusted to mid-July using machine data

As a "count" model, the natural logarithm of the total counts (bicycle and pedestrian, respectively) was used as the dependent variables in the Seamless models to force the result to remain positive.

TESTING MULTIPLE VARIABLES

SPSS and STATA statistical software were used for processing and analyzing data. Data were inspected for undesirable distributional properties such as skewness, which is a measure of asymmetry of the probability distribution of a variable. Many variables were highly skewed, distorting variance-based statistics such as correlation and regression and also potentially confounding results based upon these types of analyses. The skewness is likely the result of factors beyond those available for analysis, such as local special events, pulses of people coming from schools, transit, or employment, or other factors.

Log and power transformations were applied to pull in tails of highly skewed variables, and some variables were dichotomized in cases of extreme skewness. It is desirable for skewness to be close to 0, which represents a bell-shaped curve. The data sources and descriptive statistics of the independent variables tested in this analysis are described in Table 44. Each variable was considered separately for both a quarter-mile and a half-mile from each site.

MODELING BICYCLIST AND PEDESTRIAN BEHAVIOR

A series of modeling efforts were made to find the best formulas and 'fit' for the recorded bicyclist and pedestrian counts in the 80 locations in San Diego County. As can be seen in the following discussion, each modeling approach provided some insights into factors related to behavior, but none of the initial models provided an accurate enough result to be used as the basis for a predictive model.

MODELING APPROACH #1

Comparison of High and Low Pedestrian Activity Locations

Prior to developing the regression analysis, the team further scrutinized the independent variables through an analysis of common characteristics at locations with high or low bicycle or pedestrian counts. This analysis allowed the project team to identify variables that are likely to contribute to higher levels or walking or bicycling, with the intention of incorporating the variables into further modeling efforts. It also identified potential outliers or discrepancies amongst the data, which might yield a counterintuitive result in the regression model.

A T-test was used to determine whether there are statistically significant differences in the means (averages) of the independent variables for groupings of high and low count locations. The average value of the built environment and socio-economic factors (independent variables) was calculated for the 20 count locations with the highest and lowest pedestrian or bicycle counts separately. A total of six T-tests were calculated using high and low groups created for the following six aggregations of the count data:

- Total AM and Midday peak period pedestrian counts (adult and child)
- AM peak period pedestrian counts (adult and child)
- Midday peak period pedestrian counts (adult and child)
- Total AM and Midday peak period bicycle counts (adult and child)
- AM peak period bicycle counts (adult and child)
- Midday peak period bicycle counts (adult and child)

The team assessed whether the mean of each of the independent variables (i.e. the "background" built environment and socio-economic factors) was significantly different between the high and low groups in order to identify variables that correlated to the dependent variables.

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Table 44: Independent Variables Considered for the Bicycle and Pedestrian Volume Models

Variable	Description	Within One-Quarter Mile						Within One-Half Mile							Data Source
		Mean	Std. Dev	Skew-ness	Std Error Skew	Min.	Max.	Mean	Std. Dev	Skew-ness	Std Error Skew	Min.	Max.	N	
Built Environment Characteristics (within a quarter-mile)															
Total Housing Units	Housing Units	105.25	162.24	3.66	.27	.000	1,091.60	498.27	569.62	2.39	.27	.000	3,138.47	81	2008 SANDAG Land Use Shapefile
Single Family Housing	Single Family Housing Units	36.18	45.72	1.57	.27	.000	189.61	176.55	175.08	1.19	.27	.000	704.88	81	2000 Census
Multi-Family Housing	Multi-family Housing Units	67.28	130.06	4.28	.27	.000	901.97	312.17	438.22	2.82	.27	.000	2,428.23	81	2000 Census
Residential Acreage	Acreage of residential land uses	15.21	12.43	.58	.27	.000	43.60	80.56	50.07	.01	.27	.000	182.88	80	2008 SANDAG Land Use Shapefile
Commercial & Office Acreage	Acreage of commercial land uses	10.82	10.80	1.03	.27	.000	40.66	28.11	26.40	1.17	.27	.000	110.82	81	2008 SANDAG Land Use Shapefile
Industrial Acreage	Acreage of industrial land uses	1.14	3.82	5.39	.27	.000	28.63	6.08	14.74	3.55	.27	.000	87.43	81	2008 SANDAG Land Use Shapefile
Total Employment	Number of employees	1,082.66	2,018.74	4.28	.27	.133	12,985.67	3,464.31	6,244.90	3.97	.27	3.402	38,907.37	81	2000 Census; 2008 SANDAG Land Use Shapefile
Employment Density	Employees per nonresidential acre	57.38	84.45	3.42	.27	.000	460.86	55.70	70.57	3.00	.27	.000	369.80	81	2000 Census; 2008 SANDAG Land Use Shapefile
Total Population	Population	235.80	313.58	2.35	.27	.000	1,787.06	1,181.85	1,257.78	1.64	.27	.000	5,406.03	81	2000 Census; 2008 SANDAG Land Use Shapefile
Population Density	Population per residential acre	12.77	10.26	0.98	.27	.000	44.45	12.57	9.35	1.26	.27	.000	43.35	81	2000 Census; 2008 SANDAG Land Use Shapefile
Socio-Economic Characteristics															
All Households	Number of households	45.35	56.44	1.85	.27	.000	270.48	234.36	244.99	1.55	.27	.000	1,148.19	81	2000 Census
Poverty	Households below poverty	7.34	16.13	3.54	.27	.000	96.66	40.66	80.64	3.45	.27	.000	450.78	81	2000 Census
Car Ownership	Households without a vehicle	18.82	40.10	4.19	.27	.000	273.04	82.97	125.13	2.35	.27	.000	600.93	81	2000 Census
Youth	Population under 18 years	51.88	80.76	2.52	.27	.000	423.76	283.92	389.97	2.42	.27	.000	2,018.69	81	2000 Census
Young Adults	Population 18 to 24	Not calculated						425.54	518.369	3.715	.27	.000	3747		
Elderly	Population over 65 years	28.39	46.89	4.28	.27	.000	331.46	124.10	123.17	1.86	.27	.000	650.23	81	2000 Census
Hispanic Population	Hispanic population	85.51	156.18	2.95	.27	.000	750.49	451.73	716.55	2.59	.27	.000	3,274.19	81	2000 Census
Minority Population	Blacks, Asians and Other Race	90.33	153.49	2.59	.27	.000	812.57	477.55	723.71	2.61	.27	.000	3,807.62	81	2000 Census

Variable	Description	Within One-Quarter Mile						Within One-Half Mile							Data Source
		Mean	Std. Dev	Skew-ness	Std Error Skew	Min.	Max.	Mean	Std. Dev	Skew-ness	Std Error Skew	Min.	Max.	N	
Travel Characteristics															
Commuting Population	Commuting Population	105.44	151.52	2.95	.27	.000	931.11	523.67	581.44	2.02	.27	.000	3,029.44	81	2000 Census
Walking Commuters	Number Pedestrian Commuters	4.56	8.22	3.79	.27	.000	53.70	21.96	24.98	1.76	.27	.000	123.26	81	2000 Census
Biking Commuters	Number Bicycle Commuters	1.03	1.86	2.75	.27	.000	10.65	4.94	7.07	1.76	.27	.000	29.02	81	2000 Census
Population Commuting by Transit	Number Transit Commuters	8.15	16.40	3.34	.27	.000	98.65	40.78	67.06	2.50	.27	.000	288.85	81	2000 Census
Transit Ridership	Avg. daily transit stops ons/offs	2,483.24	6,417.70	4.43	.29	9.00	40,623.00	5,661.01	12,263.80	3.31	.28	8.00	64,887.00	67	2005 SANDAG tcov file
Transportation Facility Characteristics															
Transit Stops	Transit Stops per acre	4.97	3.39	1.77	.29	1.00	18.00	12.74	10.23	2.07	.28	1.00	56.00	67	2007 SANDAG Transit Stops Shapefile
Roadways	Footage of Roadway Network	13,219.56	6,704.08	.08	.27	357.9	26,397.6	47,215.47	24,698.26	.21	.27	1703.8	95,667.5	80	sangis
Bicycle Network	Footage of Bicycle Network	3,955.82	2,257.71	.34	.27	.000	11,419.3	10,880.94	5,349.50	.94	.27	687.4	27,578.10	81	2007 SANDAG Bicycle Network Shapefile
Intersections	Number of Intersection Approaches	3.77	0.48	-1.94	.27	2.00	4.00	3.77	.48	-1.94	.27	2.00	4.00	81	Collected in the field
Traffic Volume	Highest Intersection Approach Traffic Volume (Daily in 100's)	261.00	147.93	1.72	.27	.000	948.00	261.00	147.93	1.72	.27	.00	948.00	81	SANDAG Transportation Model data
Traffic Speed 1	Posted Speed Limit (North/South)	35.87	9.15	.89	.35	25.00	65.00	35.87	9.15	.89	.35	25.00	65.00	46	Collected in the field
Traffic Speed 2	Posted Speed Limit (East/West)	33.10	8.11	.44	.37	15.00	55.00	33.10	8.11	.44	.37	15.00	55.00	42	Collected in the field
Crosswalks	Number of Crosswalks	2.59	1.79	-.63	.27	.00	4.00	2.59	1.79	-.63	.27	.00	4.00	81	Collected in the field
Ped Heads	Number of Ped Heads	2.31	1.88	-.33	.27	.00	4.00	2.31	1.88	-.33	.27	.00	4.00	81	Collected in the field
Sidewalks	Number of Approaches with Sidewalks	3.31	1.38	-1.77	.27	.00	4.00	3.31	1.38	-1.77	.27	.00	4.00	81	Collected in the field
Bike Lanes	Number of Approaches with Bike Lanes	1.21	1.75	.86	.27	.00	4.00	1.21	1.75	.86	.27	.00	4.00	80	Collected in the field
Bike Paths	Number of Approaches with Bike Paths	.83	1.51	1.47	.27	.00	4.00	.83	1.51	1.47	.27	.00	4.00	81	Collected in the field
Activity Centers															
Retail dummy	Dummy variable of whether retail exists	0.80	0.401	-1.548	.27	0	1	0.86	0.345	-2.167	.27	0	1	81	2008 SANDAG Land Use Shapefile
Education dummy	Dummy variable of whether a school exists	Not calculated						0.70	0.459	-0.909	.27	0	1	81	2008 SANDAG Land Use Shapefile
Hotels dummy	Dummy variable of whether hotels exist	Not calculated						0.52	0.503	-0.076	.27	0	1	81	2008 SANDAG Land Use Shapefile

Variable	Description	Variables Calculated within Three-Quarters Mile							
		Mean	Std. Dev	Skewness	Std Error Skew	Min.	Max.	N	Data Source
Total Employment	Number of employees	6,177.94	10,418.086	3.382	.27	23	51,618	81	2000 Census; 2008 SANDAG Land Use Shapefile
Employment Density	Employees per nonresidential acre	2,440.14	4,114.89	3.382	.27	9	20,388	81	2000 Census; 2008 SANDAG Land Use Shapefile

Figure 24 shows high and low count locations for the morning and midday pedestrian counts. The 20 high pedestrian count locations tend to be near Downtown San Diego and beach areas, with the exception of a few locations in Vista near high schools. The 20 low count locations tend to be on the periphery of the City of San Diego in lower density neighborhoods and commercial centers. **Figure 25** shows high and low count locations for the morning and midday bicycle counts. The 20 high bicycle count locations appear to follow a linear pattern along the coast and the San Diego Bay. The 20 low bicycle count locations appear to be located in the periphery of the urbanized San Diego area, with the exception of a somewhat noticeable concentration of higher bicycle count locations in Southeastern San Diego and Chula Vista.

Table 45 displays the factors found to be significant for morning peak pedestrian count locations in the T-test assessment. All of the independent variables show statistically significant differences in means when comparing the high and low pedestrian count locations, indicating that differences exist between the built environment and socio-economic characteristics at intersections with high and low pedestrian counts. A complete list of the variables considered in this analysis is provided in **Appendices D** and **E**.

Table 45: Significant Differences in Means: Morning High and Low Pedestrian Count Locations

Variable	Pedestrian Count Locations Mean		T-Score
	Highest 20	Lowest 20	
Built Environment			
Total Employment	6,385	1,404	2.57*
Employment Density	99	29	2.94*
Population Density	18	7	3.62*
Total Households	341	98	2.87*
Single Family Housing Units	238	94	2.71*
Multi Family Housing Units	489	132	3.15*
Total Housing Units	733	231	3.25*
Residential Acres	92	54	2.29*
Half Mile Buffer Acres	267	193	2.73*
Transportation System/Travel Trends			
Half Mile Street Network Feet	62,527	31,954	3.21*
Number of Crosswalks	3.4	1.45	3.34*
Transit Stops	19	6	3.58*
Transit Ridership	11,886	1,170	2.98*
Commuters by Walking	40	11	3.30*
Commuters by Transit	83	11	3.16*
Total Commuting Population	765	242	3.30*
Socio-Economic Characteristics			
Minority Population	891	133	2.83*
Over 65 Population	159	60	3.05*
Households Without Vehicle	159	23	3.42*
Below Poverty Households	86	10	2.33*
Under 18 Population	481	90	2.59*
Hispanic Population	886	115	2.77*
All Population	1,860	473	3.38*

* T-score represents a significant difference between means

Figure 24: Pedestrian Activity at Count Locations

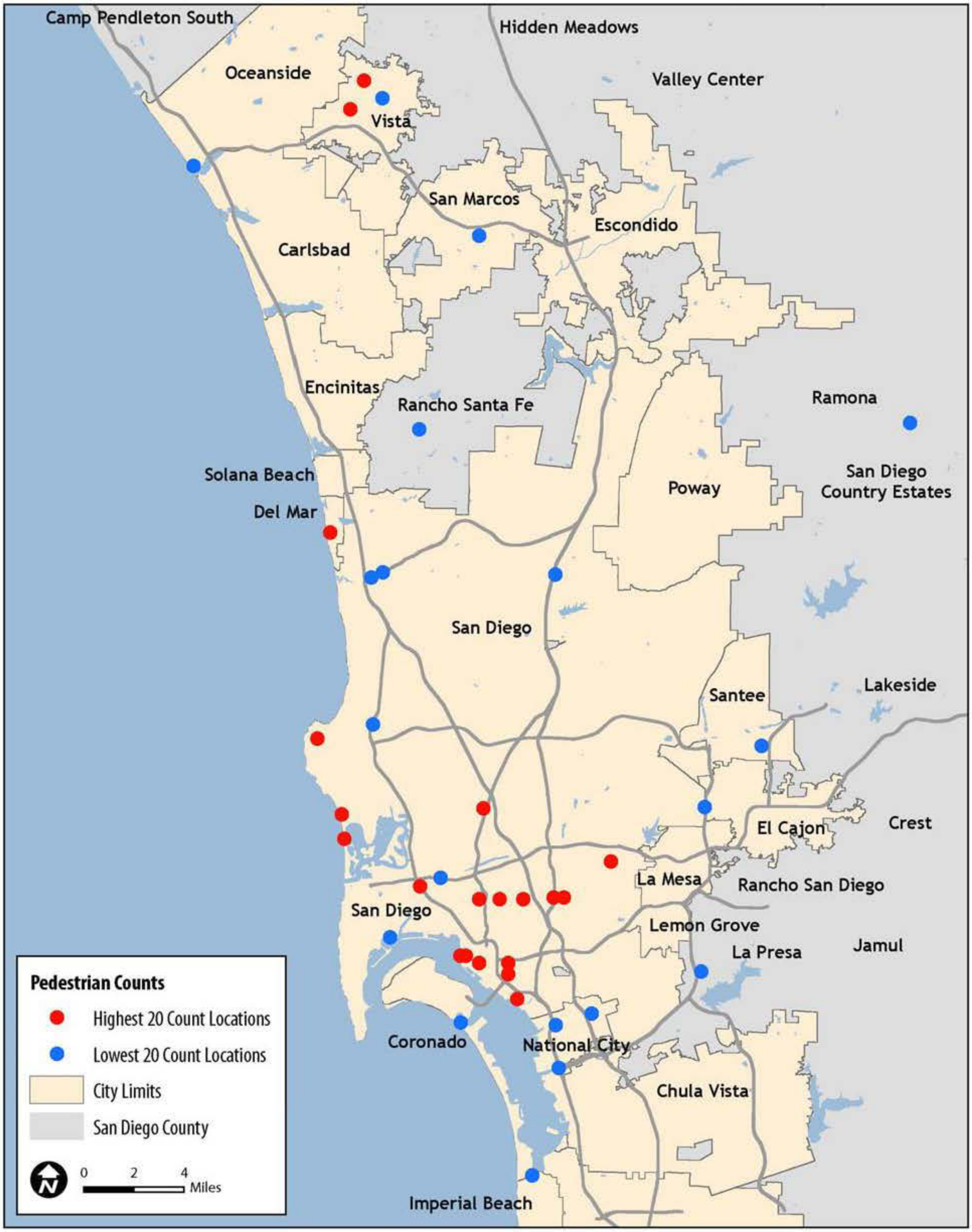
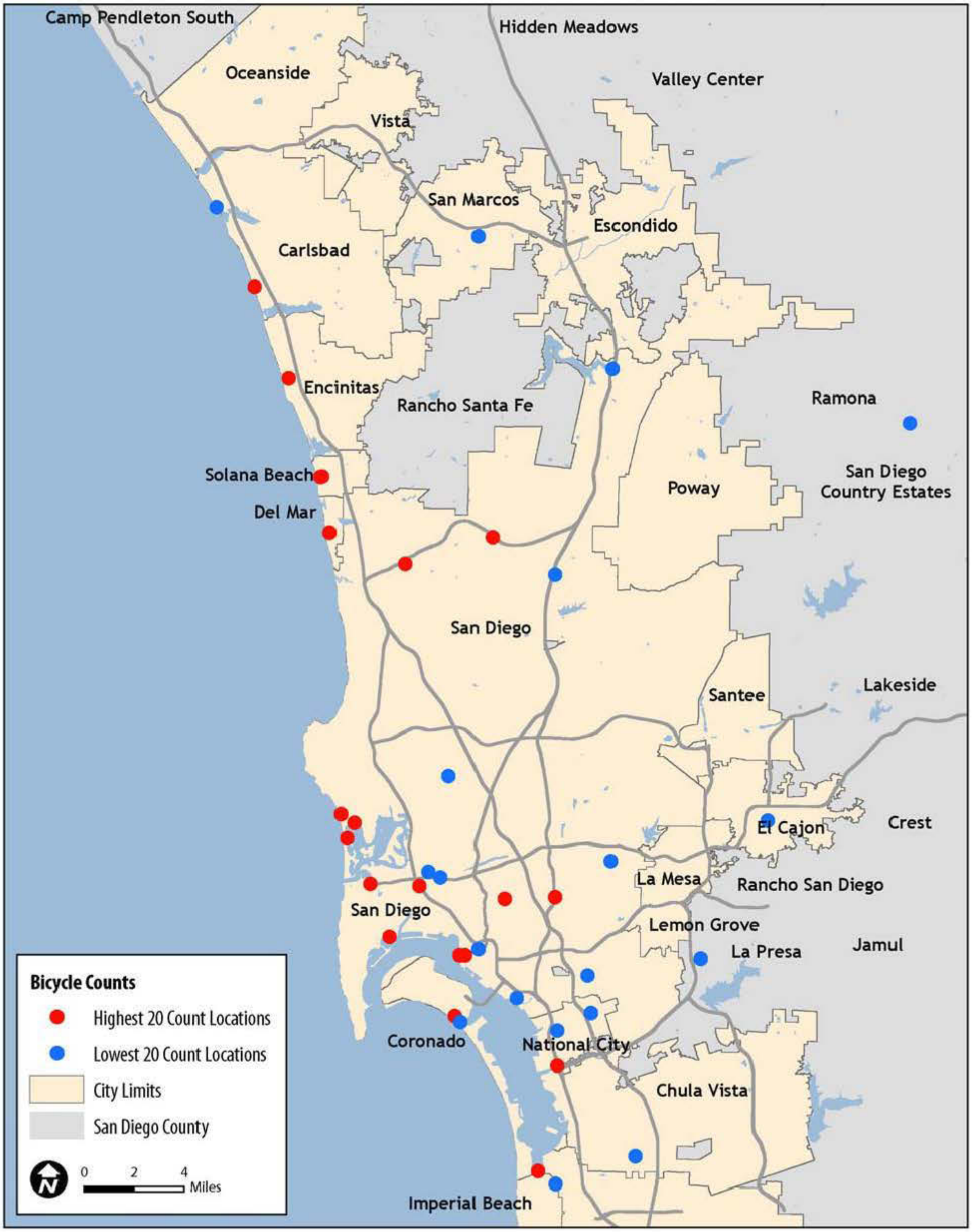


Figure 25: Bicycle Activity at Count Locations



The analysis of bicycle count locations shows that the mean values of the built environment or socio-economic characteristics do not have statistically significant differences in between the low and high count locations. This may be due to the smaller number of bicyclists counted, or that the "background" characteristics on their own do not explain where people bicycle in San Diego.

This statistical T-test analysis was a preliminary step in exploring the interactions and relationship between the dependent variables of bicycle and pedestrian counts, and the independent variables of built environment, transportation system/travel trends, and socioeconomic characteristics. The T-test analysis did not yield a model that could be used for predicting bicycle and pedestrian counts; the test did, however, identify factors that differ at locations with high and low pedestrian traffic. The null finding that no independent variable on its own differed at locations with high and low bicycle traffic indicates that several factors combine to predict bicycling.

MODELING APPROACH #2

Pedestrian Generator and Attractor Models

The second modeling approach uses a more traditional transportation demand modeling technique to predict walking in San Diego. Generator models predict land use characteristics that are likely to generate a large number of trips, particularly population and employment density, to identify areas that are expected to generate large numbers of pedestrian trips. Generator models are used in combination with attractor models, which use common pedestrian destinations such as schools, transit stops, parks, beaches, retail, and civic facilities to predict where pedestrians are traveling to. Generators and attractors are developed through experience with pedestrian and other types of trips and are chosen based on intuitive reasoning.

The analysis of pedestrian generators and attractors is based upon methodologies employed by the City of San Diego's 2006 *Draft Pedestrian Master Plan Citywide Implementation Framework Report*. This methodology received broad pubic review by the City of San Diego and was widely supported by San Diego Association of Governments staff.

Pedestrian Generator Model

Population density, measured as the number of persons per acre of residential land, is a strong indicator of potential pedestrian activity. Generally, higher population densities are associated with more urban environments, which tend to support pedestrian travel through mixed land uses and interconnected street networks. Certain population characteristics, such as age and household income, have also been shown to influence pedestrian activity. For example, youth tend to walk more given they cannot legally drive; elderly and physically disabled people tend to walk or use sidewalk facilities more, given physical impairments that may restrict their ability to drive; and finally, lower income households tend to walk more given their lack of access to vehicles for driving. Mixed land uses tend to generate higher levels of pedestrian activity since multiple and varying opportunities within close proximity of each other lends itself to shorter trip lengths, which in turn increases the propensity to make a trip on foot.

A GIS tool called Spatial Analyst was used to create a map which combines all of the individual generators into a single composite file. The pedestrian generators were weighted individually, with higher values assigned to locations with higher levels of pedestrian generating features shown in **Table**

46. Differing multipliers were also applied to the various pedestrian generators to account for the relatively greater importance of some generators over others.

The weight and multiplier values were assigned to the generators based on expected impact (**Table 46**). For example, three classes of population density were defined (more than 25 persons per acre, five to 25 persons per acre, and fewer than five persons per acre). Point values were then assigned to the different classes, with higher population densities receiving higher point values. A multiplier value of one or two was applied to all of the generators. Those generators receiving a multiplier of two should have a greater effect on pedestrian activity than those generators receiving a multiplier of one. The population density generator was assigned a multiplier of two, meaning that it is more highly correlated with walking than some of the other pedestrian generators. The weight and multiplier values were similarly applied by the City of San Diego in their 2006 *Draft Pedestrian Master Plan*.

Table 46: Pedestrian Generator Weights and Multipliers

Pedestrian Generator	Weights	Multipliers	Final Score
Pedestrian Commuters (percent pedestrian commuters by census block)			
More than 2	3	2	6
1 to 2	2		4
0.25 to 1	1		2
less than 0.25	0		0
Population Density (persons per residential acre by census block)			
Greater than 25	3	2	6
5 to 25	2		4
1 to 5	1		2
Employment Density (employees per nonresidential acre by traffic analysis zone)			
Greater than 15	3	2	6
5 to 15	2		4
1 to 5	1		2
Elderly (population older than 65 years per residential acre by census block)			
More than 10	3	1	3
5 to 10	2		2
1 to 5	1		1
Less than 1	0		0
Youth (population younger than 16 years per acre by census block)			
More than 10	3	2	6
5 to 10	2		3
1 to 5	1		2
Less than 1	0		0
Disabled (disabled population per residential acre by census block)			
More than 5	3	1	3
2 to 5	2		2
1 to 2	1		1
Less than 1	0		0
Land Use Adjacencies (mixed land uses)			
Presence of housing near commercial	2	2	4
Presence of housing near employment	1		2

Sources: Alta Planning + Design (2008), 2000 U.S. Census Bureau, *City of San Diego Pedestrian Master Plan*

Pedestrian Attractors Model

The distribution of various land use types can predict locations with high levels of walking. Such land uses include schools, transit stops, parks, beaches, retail, and civic facilities (libraries, post offices, and government buildings). An important focus for pedestrian travel is the public transit system, since a large percentage of transit riders typically do not own cars and must access the transit system on foot.

Spatial Analyst was again used to create a map combining the individual attractors into a composite file, with higher values assigned to locations closer to the pedestrian-attracting land uses and lower values assigned to locations further away from the pedestrian-attracting land uses. While the assessment of pedestrian generators was based mainly upon concentration of various population characteristics, pedestrian attractions are assessed in terms of distances to/from the attractor.

Varying weights were assigned to all locations based upon their proximity to pedestrian-attracting land uses. Concentric rings or buffers were created, emanating out from the pedestrian attracting land uses. The buffer distances assessed include: within one-eighth mile of an attraction, between one-eighth and one-quarter mile of an attraction, between one-quarter and one-third mile of an attraction, and between one-third and one-half mile of an attraction. Weight values are highest within one-eighth mile of an attracting pedestrian land use, and lowest in locations between one-third and one-half mile of a pedestrian attracting land use (see **Table 47**).

Table 47: Distance-Based Pedestrian Attractor Multipliers

Pedestrian-Attracting Land Uses	**Weights**	**Distanced-Based Multipliers**			
		Within 1/8 mile	**Between 1/8 and ¼ mile**	**Between ¼ and 1/3 mile**	**Between 1/3 and ½ mile**
Major Transit Centers (>10,000 daily boardings and alightings	5	7.5	5	3.75	2.5
Major Transit Stops (1,000-10,000 daily boardings and alightings)	4	6	4	3	2
Transit Stops (100-999 daily boardings and alightings)	3	4.5	3	2.25	1.5
Elementary Schools	3	4.5	3	2.25	1.5
Universities and Colleges	2	3	2	1.5	1
Middle Schools	2	3	2	1.5	1
Neighborhood Civic Facilities	2	3	2	1.5	1
Retail Facilities	2	3	2	1.5	1
Parks & Recreation	1	1.5	1	0.75	0.5
High Schools	1	1.5	1	0.75	0.5

Source: Alta Planning + Design (2008), City of San Diego Pedestrian Master Plan

Generators and Attractors Regression Models

The Generator and Attractor models were incorporated as independent variables considered in the Seamless regression analysis. The resulting models are shown in **Table 48**. The B value in **Table 48** is the regression coefficient, which is the average amount that the dependent variable increases when the independent variable in increased by one unit, holding other independent variables constant. The r-squared value shows the percent of variance of the dependent variable that is explained by the independent variables, including uncontrolled covariance effects on the dependent variable. F-test describes the significance of the r-squared, determining whether the model is statistically significant.

Table 48: Pedestrian Attractor and Generator Regression Model Results – Weekday AM Peak Counts

Model Variables	Attractor Model		Generator Model	
	B	**SE B**[17]	**B**	**SE B**
Constant	2.435	0.305***	2.431	0.280***
Average pedestrian attractor model score (0.25 mile)	0.173	0.027***		
Average pedestrian generator model score (0.25 mile)			0.139	6.988***
Overall Model				
Adjusted R^2	0.339		0.383	
F-Test	40.448***		48.831***	

The regression models developed from the Attractor and Generator models are statistically significant and yield an intuitive result. However, the models are developed through a complex and data-intensive analysis, which is not easily replicable by another jurisdiction desiring to employ this analysis. Furthermore, the attractors and generators are developed intuitively and utilize extensive experience with pedestrian trips. The goal of the Seamless project is to develop an easily-replicable and easily-understood model with a methodology that can be applied in another location. While the Attractor and Generator model is not statistically incorrect, the project team continued the analysis with a more standard regression analysis based on the count data and easily-developed independent variables.

MODELING APPROACH #3

Ordinary Least Squares Regression

In the final modeling approach, a standard ordinary least squares regression was employed with the transformed data. The large number of independent variables had to be reduced to a smaller subset of variables to be tested in the regression analysis to reduce multicollinearity (correlation between independent variables that would distort the model) and to yield a usable model. Using the 34 independent variables for the quarter mile measurements together, the pedestrian morning peak equation explains 45 percent of the variance in morning adult and child pedestrian trips. However, multicollinearity can be a severe problem with estimates of the effect of each predictor, since entry is forced only after removing the variation in other predictors and highly correlated predictors are suppressed. Given these results, forced entry of all variables is not reported for the remaining two dependent variables.

[17] *** indicates significance at 99 percent ($p<1.01$), ** indicates significance at 95 percent ($p<0.05$), and * indicates significance at 90 percent ($p<0.1$)

PEDESTRIAN MODEL

Stepwise Regression Models

The first method for reducing independent variables was an exploratory analysis conducted using backward stepping, in which all variables are forced into the analysis and variables that explain the least marginal variation in the dependent variable are eliminated one step at a time. A listwise approach was used for analysis purposes, which drops any case with missing data. The initial analysis yielded models with very high r-squared values (0.532 for the bicycle model and 0.952 for the pedestrian model), shown in **Table 49.**

Table 49: Pedestrian Volume Model (Stepwise Method)

Model Variables	Model A (stepwise)		Model B (stepwise)	
	B	**SE B**[18]	**B**	**SE B**
Constant	0.586	0.733	-1.219	0.154***
Employment Density (.5 mile)	0.718	0.171***	1.370	0.154***
Population Density (.25 mile)	0.415	0.115**		
Overall Model				
Adjusted R^2	0.510		0.940	
F-Test	16.116***		79.368***	

However, a stepwise approach can yield models with less real-world applicability than other approaches. In *Applied Logistic Regression Analysis,* Scott Meynard writes that, "stepwise procedures… capitalize on random variations in the data and produces results that tend to be idiosyncratic and difficult to replicate in any sample other than the sample in which they were originally obtained."[19] The University of North Carolina agrees that "stepwise methods can yield r-squared estimates which are substantially too high, significance tests which are too lenient (allow Type 1 error), and confidence intervals that are too narrow" (a Type 1 error is a false positive, or a model that report accuracy erroneously)[20] The Seamless models are intended for real-world application and the ability to reproduce the results is an important consideration in model selection.

Due to these concerns regarding stepwise models, a robust residuals analysis was performed on the data. Model B in the above regression analyses has a very high r-squared; however, when compared to the manual count data, the result was less accurate than desired. The regression model result is the natural logarithm of the expected count, and an exponential function was used to arrive at the predicted pedestrian volume.

[18] *** indicates significance at 99 percent (p<1.01), ** indicates significance at 95 percent (p<0.05), and * indicates significance at 90 percent (p<0.1)
[19] Menard, S.W. (1995). Applied Logistic Regression Analysis: Quantitative Applications in the Social Sciences. Sage University Press.
[20] Garson, G. D. (2009). "Multiple Regression", from *Statnotes: Topics in Multivariate Analysis.* Retrieved 9/25/2009 from http://faculty.chass.ncsu.edu/garson/pa765/statnote.htm

Residuals are defined as the difference between the observed values (the bicycle or pedestrian counts) and the values predicted by the model. **Table 50** shows the results of the residual analysis for the sites that the model was incorrect (over- or under-predicted) by over 100 pedestrians. Furthermore, the model is correct for only one site location (site 613), and is incorrect by more than 50 pedestrian for 30 of the 79 sites. Finally, but most importantly for a practical analysis intended for predicting pedestrian volumes for city and transportation planning purposes, the model substantially undercounts pedestrians more often than it over-counts them.

Table 50: Residual Analysis of Stepwise Pedestrian Models

Site	Morning Peak Period Pedestrian Counts (2008)	Model Estimate	Residual (estimated minus actual)
110	581	50	-531
16	383	53	-330
617	368	79	-289
620	321	53	-268
616	383	139	-244
510	226	8	-218
11	284	88	-196
401	233	67	-166
626	162	0	-162
614	222	77	-145
619	197	52	-145
610	318	182	-136
629	188	70	-118
13	126	13	-113
623	119	18	-101
108	37	155	118
630	597	781	184

The analysis of residuals, combined with reservations about the stepwise modeling methodology, encouraged the project team to continue developing regression models, in pursuit of a model with greater predictive capacity than those developed through the stepwise process.

Model Comparison Regression Models

A model comparison method was next used to select models with good overall fit to the data and statistically-significant independent variables. Similarly to the backward stepwise methodology, the model comparison method begins with all non-collinear independent variables and removes insignificant variables one at a time. The variable removal is done manually, and the method yields a model with smaller residuals, despite the lower r-squared.

The variables found to be correlated to pedestrian weekday morning counts include: employment density (within one-quarter mile, one-half mile and three-quarters mile), population density (within one-quarter mile), young population (between 18 to 24), and whether or not retail was located within a one-half mile of the site. **Table 51** shows the four models that resulted from the regression analysis.

Table 51: Alternative Pedestrian Volume Model Specifications

Model Variables	Model A (stepwise)		Model B		Model C		Model C	
	B	**SE B**[21]	**B**	**SE B**	**B**	**SE B**	**B**	**SE B**
Constant	-1.219	0.154***	0.507	0.477*	1.982	0.453***	1.555	0.449***
Employment Density (.25 mile)					0.638	0.143***		
Employment Density (.5 mile)	1.370	0.154***					0.723	0.119***
Employment Density (.75 mile)			0.409	0.080***				
Population Density (.25 mile)					0.665	0.123***	0.526	0.127***
Population 18 - 24			0.177	0.071***				
Retail dummy					-1.591	0.472***	-1.090	0.416***
Overall Model								
Adjusted R^2	0.940		0.455		0.471		0.516	
F-Test	79.368***		33.101***		20.552***		24.112***	

All pedestrian models incorporate employment density, at differing distances. A few of the sites that witnessed high pedestrian volumes were just beyond a half-mile of employment centers, which the retail dummy variable captured.

Refinement Factors

As the Seamless model is intended for application and use in predicting pedestrian volumes, it is important to have the models match the manual count data as closely as possible. Where the models incorrectly predict pedestrians or bicyclists, the model should be as close as possible to the correct result. A residual analysis was therefore conducted to determine a series of refinement factors. Refinement factors used in this analysis are independent variables that affect the dependent variables beyond a certain threshold, but not necessarily with a linear or logarithmic relationship.

For each model, the difference between predicted and observed pedestrian volumes at each site studies was used to determine additional factors that impacted the model at particular levels (**Table 52**). This analysis was used to identify independent variables that for example, the pedestrian model underpredicted pedestrians at locations with more than 6,000 transit boardings within a quarter-mile. An adjustment factor was developed to account for these discrepancies, and used to increase the explanatory power of the model. Table 52 shows the four models with refinement factors.

[21] *** indicates significance at 99 percent ($p<1.01$), ** indicates significance at 95 percent ($p<0.05$), and * indicates significance at 90 percent ($p<0.1$)

Model A has a significantly higher adjusted r-squared value than the other models considered in this analysis. However, the residual analysis shows that the model can be over- or under-estimating pedestrians by as much as 500. In addition, the regression model itself includes only employment density within a quarter-mile, while many other factors are expected to contribute to pedestrian activity. Model B includes both employment density within a three-quarter mile radius and the population between 10 and 24 years of age. This model has the highest overestimation of counts. Model C includes both population density within a quarter-mile and a dummy variable accounting for the presence of retail. This model is a good fit for the data. Model D is similar to Model C, but considers employment density within a half-mile, rather than a quarter-mile.

Table 52: Alternative Pedestrian Volume Model Specifications with Refinement

	Model A (stepwise)		**Model B**		**Model C**		**Model D**	
Regression Model Variables	Employment density (.25 mile)		Employment density (.75 mile), pop. 18 - 24		Employment density (.25 mile), pop. density (.25 mile), retail dummy		Employment density (.5 mile), pop. density (.25 mile), retail dummy	
Refinement Factors								
Refinement Variable	**Thres-hold**	**Factor**	**Thres-hold**	**Factor**	**Thres-hold**	**Factor**	**Thres-hold**	**Facto r**
HH without vehicles (.25 mile)	> 75	0.232						
HH without vehicles (.5 mile)			> 50	0.53	> 50	0.60	> 100	0.67
Industrial Acreage (.25 mile)	> 5	4.00						
Transit ridership (.25 mile)	> 19,000	0.69	> 6,000	4.88	> 6,000	2.8	> 6,000	2.14
Major attractors (.5 mile)	> 3	1.36						
Employment density (.75 mile)			> 174	2.38				
Walking commuters (.25 mile)			> 61	1.90				
Number of bike paths (.25 mile)					> 4	1.5	> 4	1.5
Overall Model								
Adjusted R^2	0.940		0.455		0.471		0.516	
F-Test	79.368***		33.101***		20.552***		24.112***	
Model Residuals								
Mean	-21		61		-6		-5	
Minimum	-573		-465		-424		-215	
Maximum	529		1,760		235		117	

While all three models are statistically accurate (F-Test showing significance greater than the 99 percent confidence level), Model D is recommended due to good overall model fit, statistically significant and logical independent variables, low residuals, and application to real-world situations with readily-available data. While Model A has a very high r-squared, the model explains more of the variance between pedestrian counts overall on an aggregate basis, whereas Model D has more explanatory power on a case-by-case basis.

Figure 26 shows the results of the pedestrian demand model.

The recommended pedestrian model formula is:

$P_{AM} = 1.555 + 0.723 * ED + 0.526 * PD - 1.090R$

Where:

P_{AM} = Morning peak pedestrian count

ED = Employment density within a half-mile

PD = Population density within a quarter-mile

R = Presence of retail within a half-mile

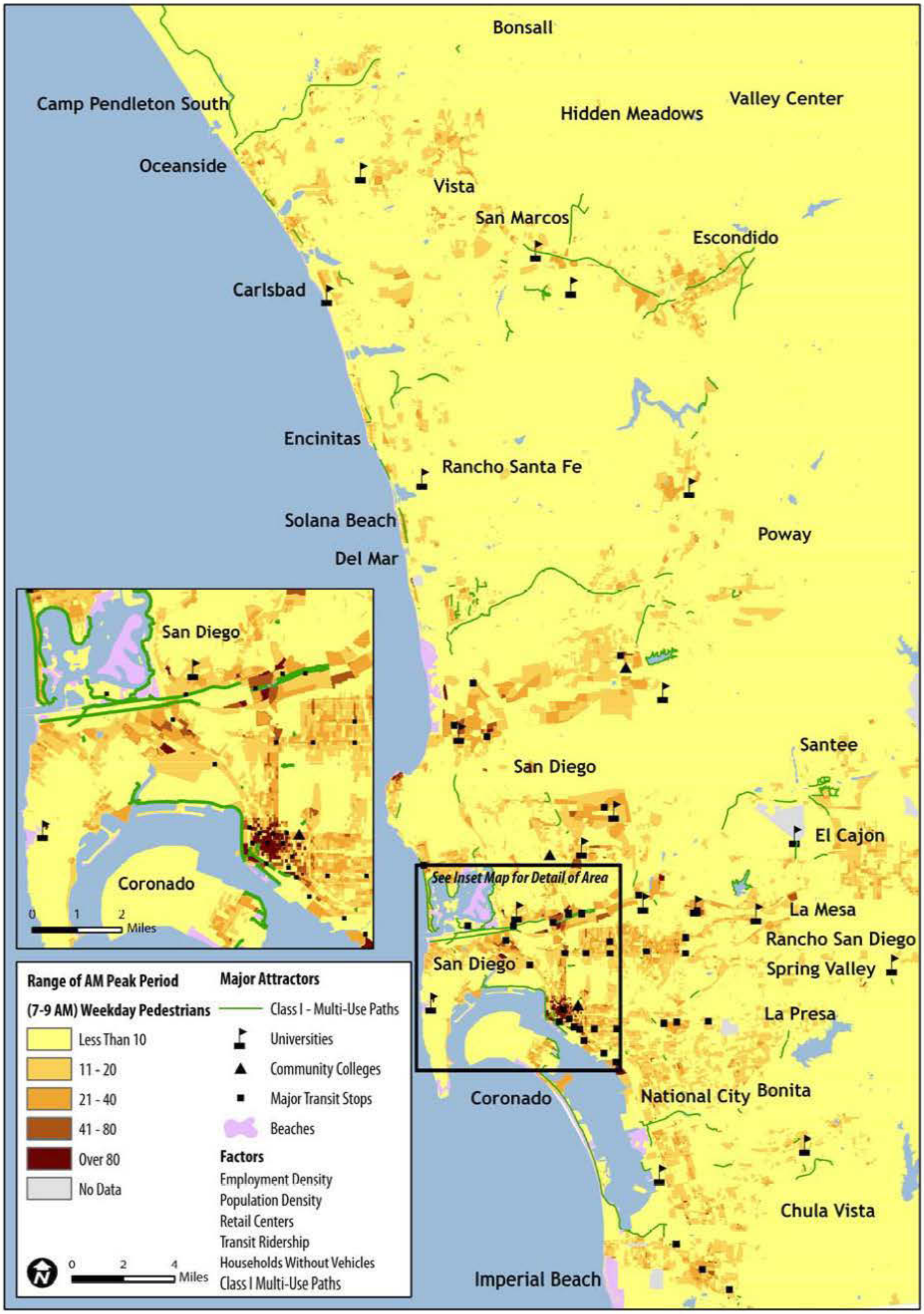
Refinement factors (multipliers for the result of the above equation if conditions exist, in this order):

More than 100 households without vehicles within a half-mile = 0.67

Greater than 6,000 transit ridership within a quarter-mile = 2.14

Four or more Class I bike paths within a quarter-mile = 1.5

Figure 26: Pedestrian Model Results



BICYCLE REGRESSION MODEL DEVELOPMENT

Derived from the exploratory analysis, the major independent factors correlated to bicycle counts on weekday mornings (at 95 percent or greater significance) include: number of approaches, number of sidewalks, and Class I facilities within a quarter-mile or half-mile. The regression models developed in this analysis are shown in **Table 53**.

Table 53: Alternative Bicycle Volume Model Specifications

Model Variables	Model A		Model B		Model C	
	B	SE B[22]	B	SE B	B	SE B
Constant	-4.279	1.709**	-2.773	2.015	-4.243	2.000*
Footage of Class I (.5 mile)	0.718	0.183***	0.213	0.475**	0.716	0.198***
Employment Density (.25 mile)	0.438	0.178**	0.446	0.220*	0.442	0.213*
Population Density (.25 mile)					-0.016	0.413
Overall Model						
Adjusted R^2	0.474		0.234		0.439	
F-Test	0.853**		4.210**		5.693**	

Model A was developed using the stepwise methodology and uses Class 1 trails and employment density. Model B used a model comparison method that resulted in the same independent variables as the stepwise model (Model A); however, the constant in the model is no longer significant at the 90 percent level. Similarly, Model C includes population density, which is not significant at the 90 percent level.

Refinement Factors

Additional refinement of the bicycle model was determined unnecessary based on an analysis of the residuals. Model A was determined to be the preferred model, with an average difference between predicted and observed counts of -14. The model estimation is within 50 bicyclists for 92 percent of the sites (74 out of 80), and within five bicyclists 30 percent of the sites (24 of 80). **Figure 27** shows the extrapolation of Model A to all of San Diego, predicting bicycle traffic patterns in the City.

The recommended pedestrian model formula is:

$B_{AM} = -4.279 + 0.718 * C + 0.438 * ED$

Where:

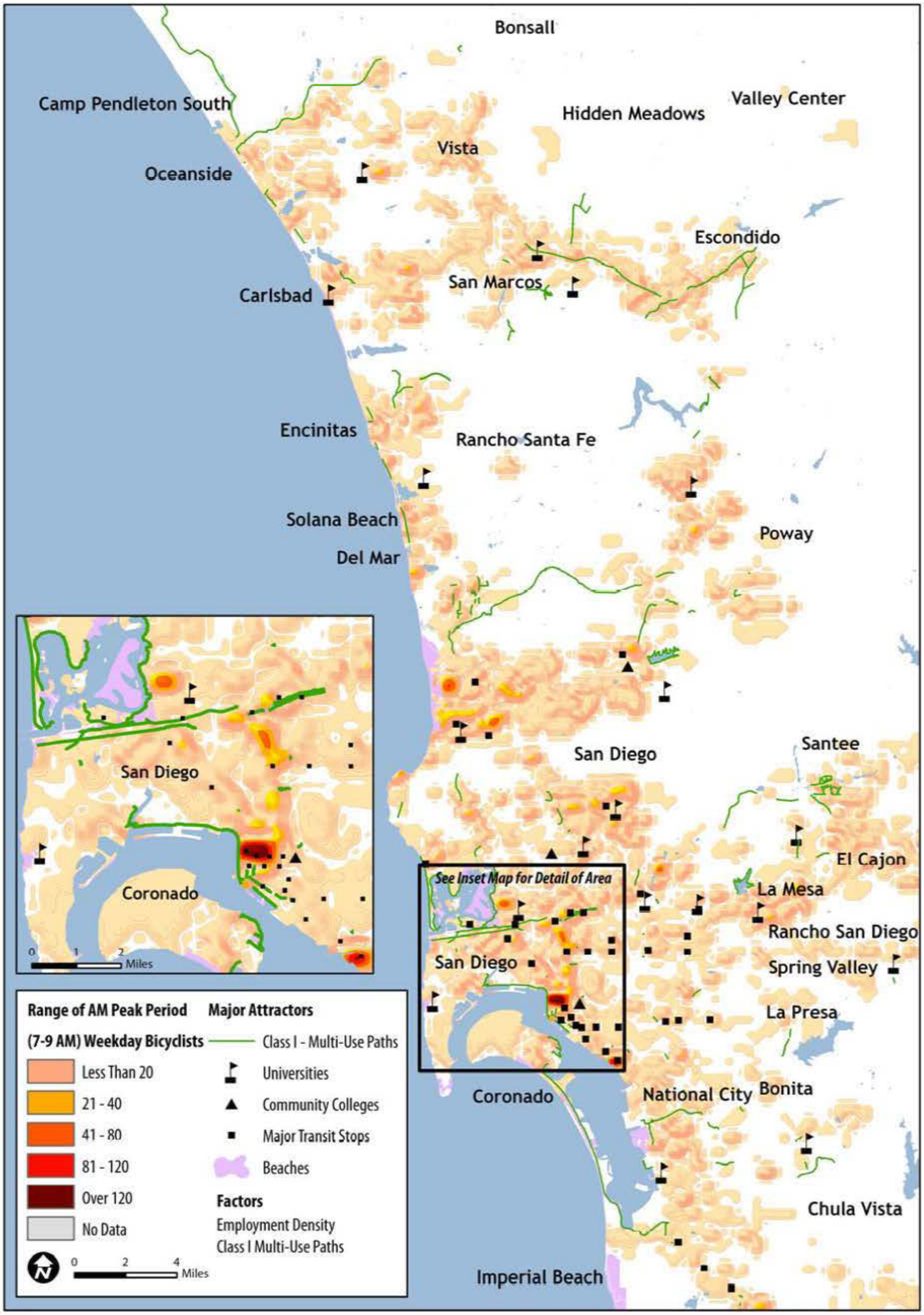
B_{AM} = Morning peak bicycle count

C = Footage of Class I bicycle path within a quarter-mile

ED = Employment density within a quarter-mile

[22] *** indicates significance at 99 percent (p<1.01), ** indicates significance at 95 percent (p<0.05), and * indicates significance at 90 percent (p<0.1)

Figure 27: Bicycle Model Results



Comparison of Seamless Models to Previous Bicycle and Pedestrian Models

As previously discussed, several models to estimate pedestrian and bicyclist demand have previously been developed. Most notably, Schneider, Arnold and Ragland of the University of California, Berkeley, Traffic Safety Center (TSC) developed a model for pedestrian crossing volumes at intersections (2008).[23] Utilizing a similar regression analysis to the Seamless project, the TSC team developed a model for pedestrians in Alameda County, California with an adjusted r-squared of 0.897.

Some notable differences exist between the TSC, other pedestrian models, and the Seamless pedestrian model – particularly, the previous models used locations with very high population densities. The TSC model removed all intersections with population densities under 50 residents per square mile within a 0.25-mile buffer of the intersection. The authors write, "Low density areas are likely to have very sparse, variable pedestrian activity, which is difficult to model" (2008: 7). As shown in **Table 54**, previous models were developed using high-density locations, which yields higher r-squared values due to a larger number of pedestrians counted. However, models that predict pedestrian activity only within high density areas are of limited usability to practitioners. The Seamless model has 24 locations with higher densities and 55 locations with lower densities than the TSC model.

Table 54: Previous Regression Modeling

Researcher	Year	Location	R^2
Schneider, Arnold and Ragland (TSC)	2008	Alameda County (San Francisco and Oakland)	0.90
Raford and Ragland	2005	Boston	0.86
Raford and Ragland	2004	Oakland	0.77
Desyllas, Duxbury, Ward, and Smith.	2003	Central London	0.82
Benham and Patel	1977	Milwaukee	0.60
Cameron	1971	Manhattan	0.23 to 0.61

Secondly, the Seamless model uses the residual analysis for model selection, in order to maximize the predictability of the model and to minimize highly over- or under-predicting pedestrian activity. While r-squared is often the main criterion for model selection, the statistic can be disingenuous as it explains the amount of variance in the data that is can be explained by the model – models developed using data with little variation are more likely to have higher predictability than models with a wide range of data points. Therefore, it is not surprising or problematic that the recommended Seamless model has a lower r-squared than other studies, as it predicts a larger range of pedestrian volumes.

The TSC analysis also found that the variable of retail within a half-mile of the site was statistically significant to the model. The Seamless project did not consider quantity of retail, as it was not possible to separate retail from other commercial and office uses for the San Diego area. However, the Seamless model considered a larger number of independent variables including land use densities, transit ridership, sidewalk coverage, street network density, percentage of households without vehicles available, and several other variables not included in the TSC analysis.

Finally, it is important to note the difficulties of extrapolating a model developed from one cities' data to a nationwide model. As stated in the TSC report, "since the analysis was conducted in one urban area (Alameda County, CA), more research is needed to refine the model equation and determine the

[23] Schneider, R.J., Arnold, L.S., and Ragland, D.R. (2008). A Pilot Model for Estimating Pedestrian Intersection Crossing Volumes. *Not Published.*

applicability of the results for other communities" (2008: 3). The Seamless model can be combined with previous modeling efforts in other cities to expand knowledge about factors important to pedestrian travel to move toward the goal of a series of bicycle and pedestrian models predicting nonmotorized travel patterns nationwide.

Considerations for Future Analysis

The Seamless bicycle and pedestrian models were developed over several years and utilize a variety of analytical tools to arrive at the best model for the data. As with any statistical model, the Seamless models have some limitations that should be noted. In general, additional variables that could be considered in the future include: presence of parks, retail establishments, choke points and other factors that may affect walking and bicycling. The bicycling model in particular could potentially be improved through the use of a gravity model, which uses utility and travel time skims to predict route choice, contributing to predicting demand at a particular location.

Finally, the refinement factors developed in the Seamless model could be brought into the regression analysis by creating dummy variables using the thresholds shown to be relevant; i.e. high transit ridership within a quarter-mile, using locations with over 6,000 transit riders. This process would likely increase the predictive capacity and usability of the regression model.

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A. MANUAL AND AUTOMATIC COUNT DATABASES

Manual Count Database.xls

Automatic Count database.xls

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B. TRAINING MANUAL

Conducting Bicycle and Pedestrian Counts and Surveys

A Caltrans Training Manual

UC Berkeley Traffic Safety Center / Alta Planning + Design

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I. Bicycle and Pedestrian Counts and Surveys

Introduction

In 2006, Caltrans Department of Research and Innovation funded a large-scale bicycle and pedestrian count and survey effort in San Diego County. The project, titled "Seamless Travel" was conducted by University of California, Berkeley's Traffic Safety Center and private consulting firm, Alta Planning + Design. This training manual has been developed as part of that project, and is based on the Seamless Travel methodology and lessons learned from implementation of the project. The manual is intended to serve as a resource for public agencies, community groups, research institutions, private firms, and individuals that would like to conduct bicycle and pedestrian counts and surveys.

Purpose of the Training Manual

This training manual has the following goals:

1. Provide consistent methodology for conducting bicycle and pedestrian counts and surveys.

2. Serve as a training resource for public agencies, community groups, research institutions, private firms, and individuals that wish to conduct bicycle and pedestrian counts.

3. Support the National Bicycle and Pedestrian Documentation Project data collection efforts.

History of the Development of this Manual

In 2003, Alta Planning + Design, in conjunction with the Institute of Transportation Engineers established an annual bicycle and pedestrian count and survey effort: the National Bicycle and Pedestrian Documentation Project (NBPD). The National Bicycle and Pedestrian Documentation Project's objectives are to:

1. Establish a consistent national methodology for conducting bicycle and pedestrian count and surveys.

2. Establish a national database of bicycle and pedestrian count information generated by these consistent methods and practices.

3. Use the count and survey information to begin analysis on the correlations bicycle and pedestrian activity and local characteristics.

A goal of the NBPD is to provide free methodology and data downloads for use by agencies and organizations. Data collection for the NBPD has been on a voluntary basis. To date, over 50 organizations have shared bicycle and pedestrian count and survey data from over 500 locations with the National Bicycle and Pedestrian Documentation Project.

In recent years, as awareness of the NBPD has increased, count and survey efforts, particularly larger-scale efforts, have increased. The Seamless Travel project in San Diego County is the first large-scale implementation of the NBPD methods.

The key goals of the Seamless Travel Project are to:

1. Evaluate existing bicycle and pedestrian data sources and collection methods.
2. Conduct comprehensive counts and surveys of bicyclists and pedestrians in a consistent manner using the National Bicycle & Pedestrian Documentation Project as a template.
3. Conduct counts and surveys using San Diego County as a model community.
4. Analyze how bicycle and pedestrian activity levels relate to facility quality, and other factors such as land use and demographics.
5. Identify factors that are highly correlated with increased bicycling and walking.
6. Provide methods for quantifying usage and demand that will enhance research on benefits and exposure.
7. Evaluate how the transit-linkage can be improved.

This training manual for conducting bicycle and pedestrian counts and surveys has been developed as one of the final deliverables for the Seamless Travel Research Project

Importance of Conducting Counts & Surveys

One of the greatest challenges facing the bicycle and pedestrian field is the lack of documentation on usage and demand. Without accurate and consistent information on demand and usage, it is difficult to measure the positive benefits of investments in these modes, or to compare them to other transportation modes such as the private automobile.

Existing data sources such as the *U.S. Census Journey-to-Work*, and the *National Household Travel Survey*[1] document aspects of biking and walking (mostly as they relate to work commute trips of employed adults or national/regional travel behavior). These resources miss much of the actual bicycling and walking activity in our communities—such as trips made by students, utilitarian trips, and linked trips, and they do not tell us where we could expect to find pedestrians/bicyclists (trip distribution) or how many pedestrians/bicyclists we would find at any specific location. The data sources also may not represent a true cross section of user groups or provide sufficient detail on background elements (such as destinations and origins or frequency) that could provide insight into behavior.

Locally, counts and surveys being conducted by agencies around the state and country are done with no consistent methodology that would allow researchers to understand bicycle and pedestrian activity trends and relationships to physical and social factors. The result is a limited understanding of the role of bicycling and walking as transportation modes, difficulty in projecting future use,

[1] U.S. Department of Transportation, Bureau of Transportation Statistics, 2000

difficulty in measuring developing collision rates, and a lack of understanding of how factors such as facility type, climate, topography, land use, and income influence activity levels.

Without bicycle and pedestrian usage information, transportation professionals may have difficulty justifying new bicycle and pedestrian investments, may undercount bicycling and walking in regional modeling efforts, and may undervalue the transportation, safety, economic, and health benefits of bicycle and pedestrian infrastructure.

Table 1 lists the benefits of conducting bicycle and pedestrian counts and surveys.

Table 1: Benefits of Conducting Bicycle and Pedestrian Counts and Surveys

Counts	Surveys
Establish baseline activity levels for comparison over the years	Establish baseline attitudes for comparison over the years
Establish "exposure" of bicyclists and pedestrians so that collision rates can be calculated and compared	Understand barriers to biking and walking
Conduct before-after analysis of bicycle and pedestrian activity levels	Identify ways in which biking and walking can be improved
Justify and prioritize bicycle and pedestrian projects	Identify rate of compliance with traffic laws (e.g. yielding to pedestrians, helmet use)
Locate bicycle and pedestrian projects where they are most needed	Target education, encouragement and enforcement programs to specific demographic groups (e.g. program to promote bicycling targeted toward women)
Increase competitiveness of funding applications	
Include data in travel demand models	

Integrating Counts into Existing Traffic Engineering Procedures

Motor vehicle counts by Caltrans and local jurisdictions are conducted as part of existing traffic engineering procedures for various reasons. Three of the most common in California include:

1. California Environmental Quality Act (CEQA) or National Environmental Policy Act (NEPA) requirements

2. American Association of State Highway and Transportation Officials (AASHTO) or California Manual on Uniform Traffic Control Devices (CA MUTCD) requirements for warrants for signals, stop signs, crosswalks or other traffic control devices

3. Level of Service requirements for Congestion Management Plans

While some of these situations (e.g. warrants for crosswalks) require pedestrian counts, bicycle and pedestrian counts are not universally required or collected. It is recommended that Caltrans consider requiring bicycle and pedestrian counts whenever motor vehicle counts are required, with the exception of limited access roadways that do not allow bicyclists or pedestrians.

Most traffic counts are collected during peak hours, and are either intersection counts that include turning movements collected by one or more manual counters, or screenline counts collected by pneumatic tubes or other automated devices. Integrating bicycle and pedestrian counts into these traffic counts can be relatively simple.

Intersection Turning Movement Counts

Intersection turning movement counts are helpful in exposure analysis and should be conducted at high collision locations and where safety studies are desired. Depending on the volumes of motor vehicles, bicyclists and pedestrians, and the geometry of the intersection, it may be possible to collect non-motorized counts without adding additional counters. Count boards generally include enough inputs to allow this type of complicated counting. Intersection count forms can also be used to collect intersection turning movement counts. Bicyclists typically behave in a fashion similar to motor vehicles and their turning movements are relatively simple to record. Pedestrian have many more turning movement permutations and collection of their movements poses a challenge. It is recommended that pedestrian counts are collected as screenline counts.

Screenline Counts

Screen line counts are primarily used to identify general trends in volumes, and to see how demographics, land use, and other factors influence walking and bicycling. To include bicyclist and pedestrian movements in screenline counts, it will be necessary to install additional automated count devices that are calibrated for bicyclists and pedestrians. Currently there are numerous devices on the market to collect bicycle and pedestrian counts such as pneumatic tubes, inductive loop, and infrared counters. Pneumatic tubes can collect on-street bicycle traffic without collecting motor vehicle traffic. Inductive loop counters installed in pavement can also be used to collect bicycle counts. Infrared count machines are recommended for collecting pedestrian count data on standard-sized sidewalks with low to moderate pedestrian counts. For wider sidewalks or locations with high pedestrian counts, the accuracy of infrared counters is reduced. A correction factor should be applied to infrared devices. Manual or video counts are the most reliable method for these situations.

In addition to regularly collecting bicycle and pedestrian counts during motor vehicle counts, it is important to collect additional bicycle and pedestrian counts. Further counts are important for numerous reasons. First, pedestrian and bicycle peak hours—particularly bicycle peak hours—can vary significantly from motor vehicle peak hours, because a greater proportion of these trips tend to be recreational or utilitarian rather than commute. Second, by only counting bicyclists and pedestrians during standard traffic counts, one misses the significant number of bicycle and pedestrian trips that take place on pathways, trails and other locations that are not associated with roadways. It is recommended that jurisdictions institute an annual bicycle and pedestrian count effort to develop baseline numbers for bicycle and pedestrian activity and to understand trends in this activity over time.

Location Selection

Your location choice is related to the type of data you want to collect. Random selection is statistically the best way to estimate area-wide activity levels. However, there is no methodology available today to extrapolate counts to area wide estimates that is currently done using a combination of aggregate-type models. Additionally, a random selection of locations is likely to result in locations with very little activity to count. Non-random location selection can be used to measure change in use or impacts of improvements.

The selection of random count locations can be narrowed by using strategic sampling. Characteristics such as population density, median income and proximity to commercial land uses can be used to narrow potential locations.

Non-random locations can be selected by using a variety of variables:

1. Historic count locations
2. Input from local stakeholders
3. High collision areas
4. Areas defined for future smart growth
5. Locations near transit stops
6. Locations near planned or recently completed bicycle and/or pedestrian projects
7. Presence and type of bicycle/pedestrian facilities
8. Presence of a mixed land uses

When selecting locations, it is important to consider how the counters or surveyors can access the location, their safety (traffic, crime), and their physical comfort (rain, heat, etc.).

Survey locations need special consideration for the safety of the surveyor and the participant. The location should include enough space for the survey to be conducted away from traffic while not obstructing the pedestrian through zone.

Training Counters and Surveyors

Counters and surveyors should be hired and trained a few weeks before the count dates. They can be found through bicycle and pedestrian advisory committees, advocacy groups, local colleges and agency interns. Advocates may volunteer their time while students and interns may require payment.

Counters and surveyors should be trained for interaction with the public, the process and form use. Example training presentations are presented in Sections VI and VII and are available at www.bikepeddocumentation.org. It is important the surveyors approach bicyclists or pedestrians without startling them in a friendly and engaging manner. A script should be provided to surveyors.

Background information including location, date, time period and weather conditions should be recorded before the session begins. Users such as skateboarders and rollerbladers are counted in the "Other" category. When counting bicycles, the number of people should be counted, not the number of bicycles. For example, two people on a tandem bicycle are counted as two.

Items counters should bring to the site include:

1. Instruction forms
2. Count or survey forms
3. Safety vest
4. Location map
5. Clipboard1
6. Pen or pencil and a spare
7. Watch or time device to record 15 minute intervals
8. Count/Survey manager business cards
9. Optional: hat, sunscreen, jacket, snacks, water

II. Counts

Count Methodologies

Bicycle and pedestrian counts are generally conducted either through manual counts or through automated counts. Some communities have combined manual counts with existing motorized vehicle counts at little or no extra cost. Two counters per intersection typically conduct manual counts, though a third may be needed at busier intersections. Manual counts allow for collection of additional information, including type of users, use of helmets, turning movements and gender (Schneider, Patton et al.).

Automated technologies are useful in conducting longer-term counts and establishing daily, weekly, or monthly variations in usage. With the exception of video playback systems, automated technologies generally require fewer person-hours than manual counts.

Most automated technologies work well for counting users that pass a specific point but, with the exception of active infrared and time-lapse video technologies, cannot easily distinguish between bicyclists and pedestrians (Beckwith and Hunter-Zaworski 1997; Wolter and Lindsey 2001). Time-lapse video has been used in Davis, California to capture user type, demographic information, and behavior (Schneider et al. 2005). The Massachusetts Highway Department successfully modified an active infrared traffic sensor and developed custom software to count and classify bicyclists and pedestrians. The sensor was able to accurately count 97% of bicyclists and 92% of pedestrians, and accurately classified 77% of bicyclists (Noyce and Dharmaraju 2002).

All automated count technologies have an error factor, with no-detection rates varying from 1% to 48%. A Portland, Oregon study tested the accuracy of three types of sensors: passive infrared, Doppler radar, and ultrasonic. The sensors were tested under a variety of conditions, and were found to have varying error rates: passive infrared had a 0% close range and 1.5% long range no-detection rate, Doppler radar had a 7% no-detection rate, and ultrasonic had a 3% close range and 45% long range no-detection rate (Beckwith and Hunter-Zaworski 1997). This San Diego study found a 12% to 48% no-detection rate for passive infrared counters and 15% to 21% no-detection rate for active infrared counters (Ragland et al. 2008). The infrared sensors tend to undercount pedestrians most likely because they do not detect pedestrians walking exactly side-by-side (Schneider et al. 2009). Comparing automated counts with manual counts allows researchers to correct for inherent error rates.

Ultimately, the decision to use automated or manual count technologies depends on the duration of the count effort, the existence of other ongoing count efforts, the type of data to be collected, the number of person-hours available for data collection and analysis, and the overall budget of the count effort. Automated count technologies have a higher start-up cost than manual count technologies, though they generally require fewer person-hours than manual counts and can mean long-run cost savings. Manual counts require more person-hours than automated counts, but can collect additional characteristics of bicyclists and pedestrians. A summary of manual and automated counts characteristics is provided in **Table 2**.

Table 2: Manual and Automated Count Characteristics

Manual Counts	Automated Counts
Integrating pedestrian and bicycle counts with existing motor vehicle counts can reduce costs Field observations are labor-intensive, which may limit the number of count locations Observations have a higher level of accuracy, and can be more complex than automated counting methods (i.e., can include behaviors and other characteristics of users)	Technologies can significantly reduce labor costs Settings and positioning of devices must be adjusted to maximize accuracy Placement should minimize interference with pedestrians and bicyclists and potential for vandalism Most technologies work in rain and a wide variety of temperatures Many technologies allow for remote data download Most technologies do not count all types of non-motorized users and few can be used to observe behaviors

Source: (Schneider, Patton et al. 2005)

Which Equipment is Right for Your Count?

The most appropriate count technology is dependent on the count location and purpose. Passive infrared is best suited for screenline sidewalk counts, but not in places where pedestrians gather, such as in front of cafes or busy transit stops (Schneider et al. 2009). Active infrared can distinguish between bicyclists and pedestrians, and is therefore appropriate for shared use pathways. In-pavement magnetic loops are best for detecting bicyclists traveling along bike lanes or pathways. Video playback can provide information concerning user type, behavior, and demographics, in addition to count data. Another consideration is the physical installation of the counting device. Some infrared technology requires sensors to be installed on both sides of the pathway, while other devices can be effectively installed in locations with poles/street lights on just one side of the pathway or sidewalk, such as in an urban setting.

Automated Count Technologies

Bicycle and pedestrian counts can be conducted manually or with automatic count technologies; however automatic counters have certain advantages. Automatic count technologies are useful in conducting longer-term counts, establishing daily, weekly, or monthly variations and almost always require fewer person-hours. The most common technologies used for bicycle and pedestrian counts are:

- Passive infrared (detects a change in thermal contrast)
- Active infrared (detects an obstruction in the beam)
- Ultrasonic (emits ultrasonic wave and listens for an echo)
- Doppler radar (emits radio wave and listens for a change in frequency)
- Video Imagining (either analyzes pixel changes or data are played back in high speed and analyzed by a person)
- Piezometric (senses pressure on a material either tube or underground sensor)
- In-pavement magnetic loop (senses change in magnetic field as metal passes over it)

Most automated technologies work well for counting users that pass a specific point but most, with a few exceptions such as active infrared and video, cannot easily distinguish between bicyclists and pedestrians. A combination of technologies such as Eco-Counter's Eco-Multi, can distinguish between types of users.

Technology Overview

The choice of an automatic count technology primarily depends on the type of data that is required to be collected, the project budget, and the number of people who can work on the project. All automatic count technologies require calibration. The following table outlines count technologies most adaptable to bicycle and pedestrian counts.

Table 3: Automatic Count Technologies

Technology	How it Works	Differentiate between bikes and peds?	Where can it be used?	Can it be moved to other locations?	Other Considerations	Technology Cost
Passive infrared	Detects a change in thermal contrast	No	Sidewalk, path	Easily		$,2000 -3,000
Active infrared	Detects an obstruction in the beam	Yes	Sidewalk, path	Easily		$800-$7,000
Video imaging	Analyzes pixel changes	Unknown	Intended for indoor use	Yes	Difficult detection outdoors, no bike/ped application yet	$1,200 - $8,000
Video playback	Video analyzed by a person	Yes	Anywhere	Yes	Difficult detection at night and bad weather. Considerable staff time	$7,000
Piezometric Tube	Senses pressure on tube	No	Path, on-street	Easily	Bicycles only. Potential tripping hazard	$1,600
Piezometric Pad	Senses pressure	No	Sidewalk, path	No		$2,000 -3,000
In-pavement magnetic loop detectors	Senses magnetic field change as metal passes	No	Path, on-street	No	Requires cutting into pavement to install	$2,000 -3,000

Conducting Automatic Counts

A standard decision process for conducting automatic counts is outlined below.

1. **Define the project.**

    a. How much money is available?

    b. What is the timeframe in which this needs to be completed?

    c. What will the count data be used for? To establish daily, weekly, monthly peaking patterns? To understand trail use over time? To capture user behavior? To verify manual counts?

    d. Do I need to collect bicycle and pedestrian data separately?

    e. Do I want to capture items other than counts? (e.g. helmet use, gender)

2. **Choose count locations.** Considerations include:

    a. Historical count location
    b. Existing or proposed bicycle facility
    c. High collision area
    d. Smart growth, mix of land uses
    e. Transit access
    f. Stakeholder recommendations
    g. Visit count locations to indentify exact placement of automated counter
    h. Observe bicycle and pedestrian movements to identify best location for counter
    i. Identify any permits necessary to install counters and begin permit process

3. **Select count technology.** The technology that is chosen will depend on the project budget, the type of information you would like to collect, how you would like the information to be summarized (e.g. 15-minute periods, 12-hour periods, or individually with a time stamp), the amount of data that needs to be stored before downloading, and the options for installing the counter at each count location. **Table 3** presented earlier, lists different automatic count technologies and their features.

4. **Purchase, install and calibrate automated counters**

    a. When choosing locations and methods for installation consider the potential for vandalism, inclement weather, ease of collecting information, and the stability of the counter alignment.

    b. When installing counters, it helps to have an assistant travel back and forth in the counter range to ensure detection and proper installation.

c. Check with the manufacturer to determine the best way to calibrate the counter. Typically, calibration involves counting manually for 2 hours, then comparing automatic counts to manual counts. If bicycle and pedestrian volumes are low, counts periods may need to be longer to ensure that you get enough data to estimate the error factor.

d. All counters will have some degree of error. The manufacturer should be able to provide placement and sensitivity guidelines that will reduce error. Factors such as width of travel way, number of pedestrians/bicyclists, and percentage of people traveling in groups can significantly affect accuracy of some types of counters.

5. **Collect data and schedule ongoing maintenance and calibration.** After the set-up process, automatic counters tend to be relatively easy to maintain. You will need to establish a schedule for downloading data, field checking the counter set-up and conducting periodic calibration tests.

Conducting Manual Counts

1. **Define the project.**

   a. How much money is available?

   b. What is the timeframe in which this needs to be completed?

   c. What will the count data be used for? To capture peak period counts? To capture user behavior? To verify automatic counts?

   d. How long will each count period last? Two hours? Eight hours? Twelve hours?

   e. Do I want to collect turning movements or screenline movements?

   f. Do I want to capture items other than counts? (e.g. helmet use, gender)

2. **Choose count locations.**

   a. Considerations include:

      i. Historical count location
      ii. Existing or proposed bicycle facility
      iii. High collision area
      iv. Smart growth, mix of land uses
      v. Transit access
      vi. Stakeholder recommendations

   b. Visit count locations to indentify where each counter will sit and determine the number of counters required for each location. Other considerations include

i. How will the counters access the location?

ii. Will the counters be safe?

iii. Will the counters be comfortable? i.e. heat, sun, rain, cold

c. Identify any permits or permissions necessary to survey and begin process

3. **Hire and train counters.**

a. Counters can be found through Bicycle/Pedestrian Advisory Committees, advocacy groups, colleges, internship programs.

b. Training should include proper ways to interact with the public, the process and form use.

4. **Schedule Counts**

a. When scheduling counts, consider typical vacation times, weather conditions and whether or not school is in session.

b. Select one weekday and one weekend day. Tuesdays, Wednesdays, and Thursdays are not significantly different.

c. Other issues may affect the count data including daylight savings, special events, road closures, weather, etc. If using counters hired through a temp agency, there may be a daily minimum number of hours required.

d. Key count times include:

i. Weekdays, 10am-Noon

ii. Weekdays, 5-7pm

iii. Saturday, 9am-Noon

5. **Conduct Counts and Quality Control.** It is important to include quality control measures in the manual count process. Quality control may consist of spot field checks to verify that counters are at the correct location and collecting the correct information. Reviewing and verifying data within a day or two of collection is important so that any discrepancies can be identified and counts can be redone, if necessary. Counters who care about bicycle and pedestrian issues have been shown to improve the accuracy of counts.

6. **Collect and Enter Data.** See **IV Count Forms** for example data count forms.

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III. Surveys

Bicycle and pedestrian surveys are useful to understand why people are walking and bicycling, to collect socio-demographic information, and to discern attitudes about walking, biking and facilities. Surveys are generally conducted either as a sample of the general population, or targeted specifically to non-motorized users. Surveys have been criticized for two common shortcomings. First, surveys frame the questions and limit the possible responses, thus increasing the chance that unexpected responses will be unrecorded or that questions will be misunderstood. Second, traditional survey collection methods, such as travel diaries and phone recruitment can under-represent certain population groups, such as the elderly and the poor. Clifton and Handy (2001) recommend using focus groups to test survey reliability and ensure they are worded so that the target audience understands the questions. Survey respondents should be compared with the population being sampled, and underrepresented segments of the population may need to be reached through different channels.

Schneider et al. (2005) summarize key differences in travel surveys based upon general population sampling and targeted sampling. **Table 4** illustrates these findings.

Table 4: Characteristics of General and Targeted Surveys

Samples of the General Population	Targeted Surveys
Results of well-executed random-sample surveys can represent the entire community	Agency can obtain detailed characteristics about people who make non-motorized trips
Results can provide baseline and follow-up data for the community as a whole	Results can provide baseline and follow-up data about non-motorized users
Potential participants should be identified using a random selection procedure	Differences between survey participants and the overall population are important to recognize
Survey instrument design and survey distribution techniques are critical to achieving a high response rate and representative results	Survey instrument design and survey distribution logistics are critical to the quality of the survey
Gathering and analyzing responses can be labor-intensive	Labor costs can be high, unless volunteers are recruited

Source: (Schneider, Patton et al. 2005)

Short intercept surveys can be supplemented by longer take-home or online surveys. In 2002, the Rhode Island Department of Transportation conducted user surveys on six bicycle paths, where groups of users were intercepted and a short survey was administered to persons willing to participate. The on-path survey asked for the participant's street address or email so that a paper copy of a longer survey, or a web link to the longer survey could be sent to them. The survey collected information on mode of access to the path, time spent and distance traveled on the path, usage by time of day, day of week and season, and use of the path for commuting (Gonzalez et al. 2004).

Designing a Survey Questionnaire

The development of the survey questionnaire includes identifying the preferred survey length, open-ended vs. closed ended questions, questions asked, survey format (online or paper), and number of languages.

The length of a survey may influence the number of surveys completed. Intercept surveys, where a surveyor intercepts a potential participant, should be no longer than five minutes and include 10-15 questions. On-line surveys may allow for additional time and questions.

The type of question included on the survey is important as well. Open-ended questions, where the participant can provide any answer, may lead to analysis problems. These types of questions are appropriate for identifying problematic locations, preferred routes, etc. Open ended questions should be kept to a minimum.

Survey format can include paper surveys or online surveys and both are recommended. Paper surveys provide time for the surveyor to interact with the participant and perhaps gather additional insight. Online surveys allow for data collection from participants who may not have the time to participant in an intercept survey. Online surveys are relatively easy to administer through services such as SurveyMonkey.com. A flyer directing participants to the online survey can be provided to potential participants.

If the agency develops their own survey rather than using the example standard questionnaire provided in **Section V**, it is important to pre-test the survey. Pre-testing will identify problematic or unclear questions. Pre-testing can be done with a small sample group at one of the identified survey locations during the planned survey time period.

Finally, when designing the survey questionnaire consider the importance of bilingual/multi-lingual surveys and surveyors. Surveys are commonly provided in English and Spanish; however, surveys in other languages are recommended in diverse communities where many languages are spoken.

Section V includes example survey questionnaires in English and Spanish. Also included is an example phone survey.

Intercept Survey vs. Random Phone or Mail Survey

Surveys can be administered in numerous ways including intercept, random phone or by mail. There are benefits and problems with each method. Intercept surveys will capture participants who are already walking and bicycling, and neglect those who do not. Random phone surveys reach a more representative sample however it is limited to participants with a phone and is expensive to administer. Mail surveys are less expensive than phone surveys and reach a more representative sample than intercept surveys. Mail surveys require a distribution list and a stamped return envelope. Acquisition of a mailing list may be problematic.

Conducting Surveys

1. **Define the Project.**
    a. How much money is available?
    b. What is the timeframe in which this needs to be completed?
    c. What will the data be used for?
    d. How long will each survey period last? Two hours? Three hours?
    e. Will the survey be available online?
    f. What information do I wan to collect? (e.g. frequency of bicycling, obstacles)
2. **Choose Survey Locations.**
    a. Considerations include:
        i. Historical count/survey locations
        ii. Existing or proposed bicycle facility
        iii. High collision area
        iv. Smart growth, mix of land uses
        v. Transit access
        vi. Stakeholder recommendations
    b. Visit survey locations to indentify where each surveyor will stand and determine the number of surveyors required for each location. Other considerations include
        i. How will the surveyors access the location?
        ii. Will the surveyors be safe?
        iii. Will the surveyors be comfortable? i.e. heat, sun, rain, cold
    c. Identify any permits or permissions necessary to survey and begin process
3. **Choose Online Survey Distribution Method.**
    a. How will survey website be distributed?
        i. Flyers
        ii. City website
        iii. Bicycle or pedestrian groups
        iv. Neighborhood groups

4. **Hire and train Surveyors.**
    a. Surveyors can be found through Bicycle/Pedestrian Advisory Committees, advocacy groups, colleges, internship programs.
    b. Training should include proper ways to interact with the public, participant selection, the process and form use. It is important to train surveyors to avoid bias and interaction with minors.

5. **Schedule Surveys**
    a. When scheduling surveys, consider typical vacation times, weather conditions and whether or not school is in session.
    b. Select one weekday and one weekend day. Tuesdays, Wednesdays, and Thursdays are not significantly different.
    c. Other issues may affect the survey data including daylight savings, special events, road closures, weather, etc. If using surveyors hired through a temp agency, there may be a daily minimum number of hours required.
    d. Key count times include:
        i. Weekdays, 10am-Noon
        ii. Weekdays, 5-7pm
        iii. Saturday, 9am-Noon

6. **Conduct Surveys and Quality Control.** It is important to include quality control measures in the survey process. Quality control may consist of spot field checks to verify that surveyors are at the correct location and collecting the correct information. Reviewing and verifying data within a day or two of collection is important so that any discrepancies can be identified and surveys can be redone, if necessary. Surveyors who care about bicycle and pedestrian issues have been shown to improve the accuracy of counts.

7. **Collect and Enter Data.** See **Section V** for example survey forms.

IV. Count Forms

STANDARD SCREENLINE COUNT FORM

Name: ___________________________ Location: ________________________# _______
Date: _____________ Time Period: _____________ Weather Conditions: _____________

Please fill in your name, count location, date, time period, and weather conditions (fair, rainy, very cold). Count all bicyclists and pedestrians crossing your screen line under the appropriate categories.

- Count for two hours in 15 minute increments.
- Count bicyclists who ride on the sidewalk.
- Count the number of people on the bicycle, not the number of bicycles.
- Pedestrians include people in wheelchairs or others using assistive devices, children in strollers, etc.
- People using equipment such as skateboards or rollerblades should be included in the "Other" category.

	Bicycles		**Pedestrians**		**Others**
	Female	**Male**	**Female**	**Male**	
00-:15					
15-:30					
30-:45					
45-1:00					
1:00-1:15					
1:15-1:30					
1:30-1:45					
1:45-2:00					
Total					

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STANDARD BICYCLE INTERSECTION COUNT FORM

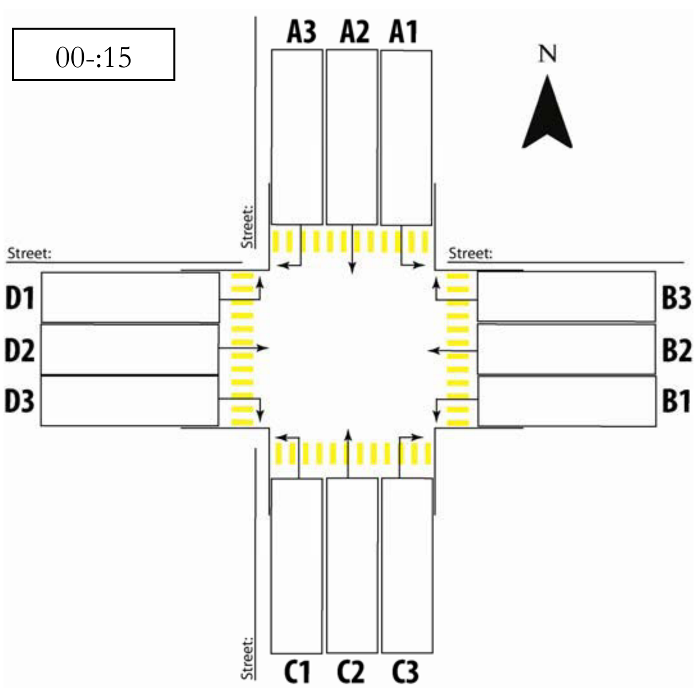
Name: ____ Location: ____

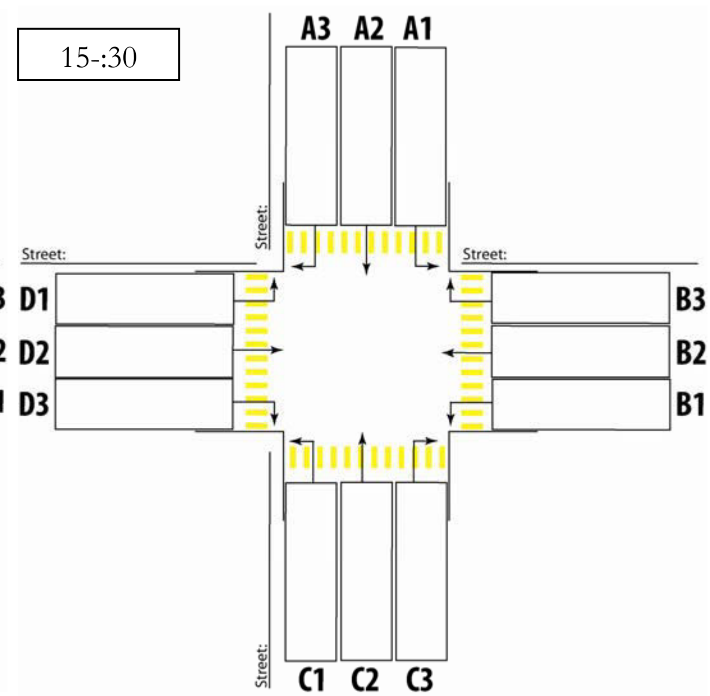
Date: ________________________ Start Time: ______________________ End Time: _________________________

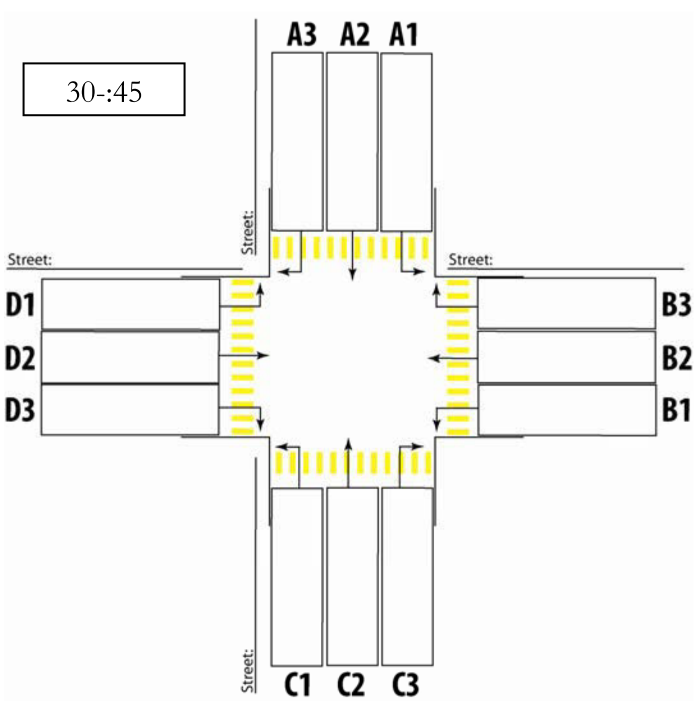
Weather: ______________________

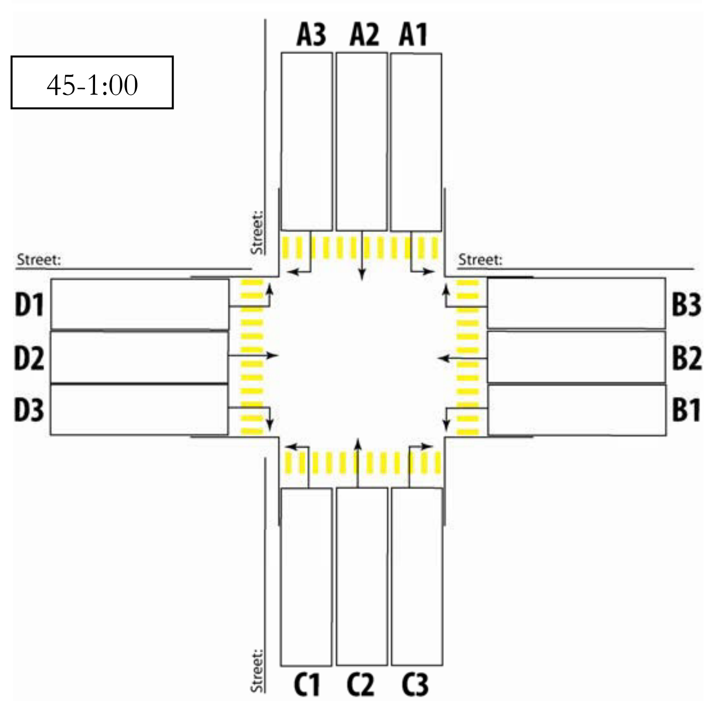
Please fill in your name, count location, date, time period, and weather conditions (fair, rainy, very cold).
Count all bicyclists crossing through the intersection under the appropriate categories.

- Count for two hours in 15-minute increments.
- Count bicyclists who ride on the sidewalk.
- Count the number of people on the bicycle, not the number of bicycles.
- Use one intersection graphic per 15-minute interval.

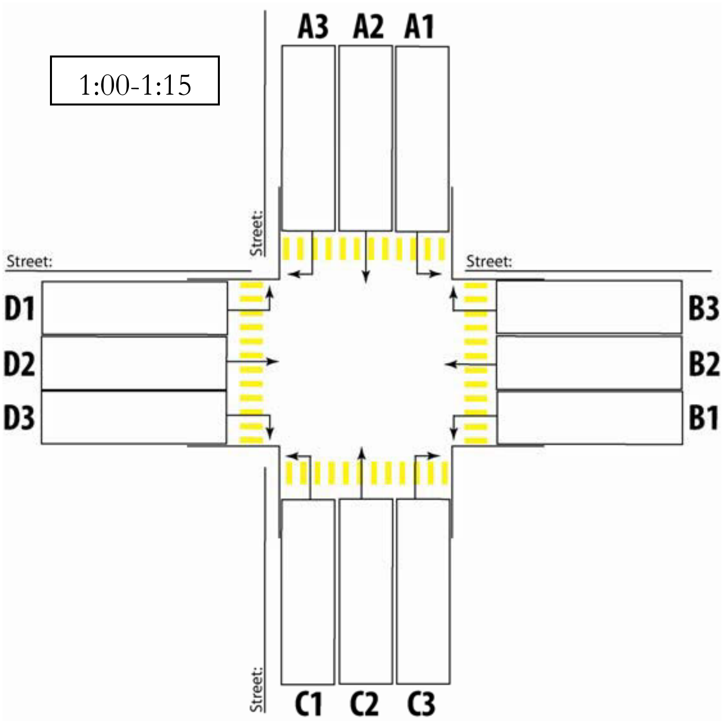




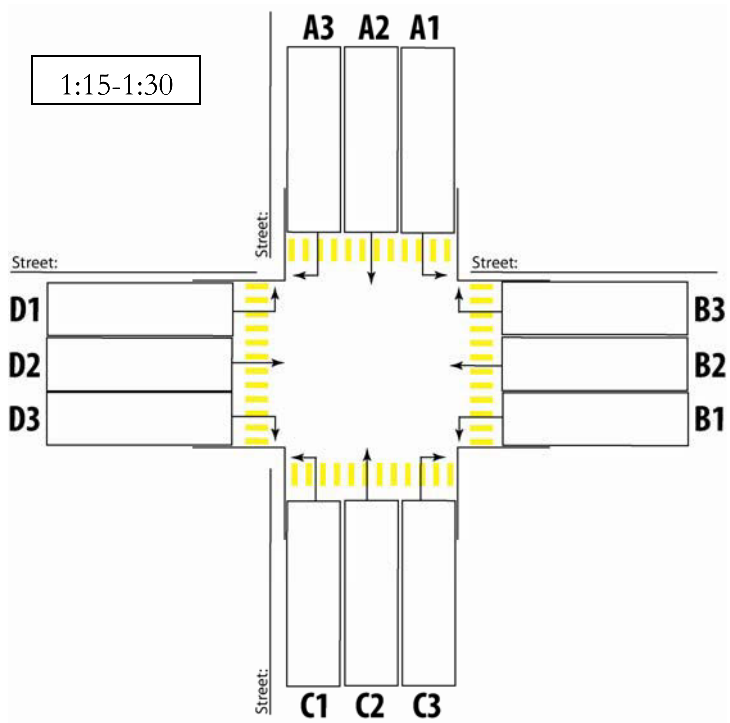




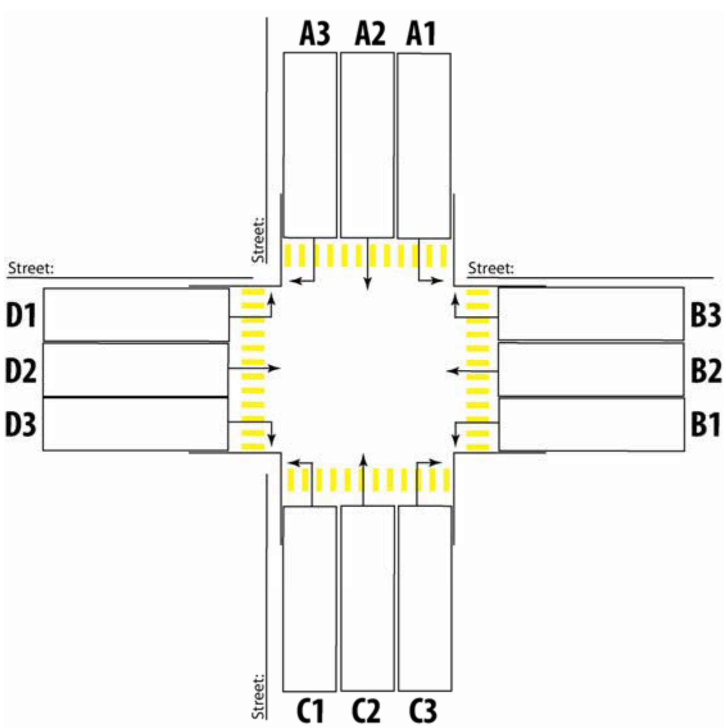
1:00-1:15



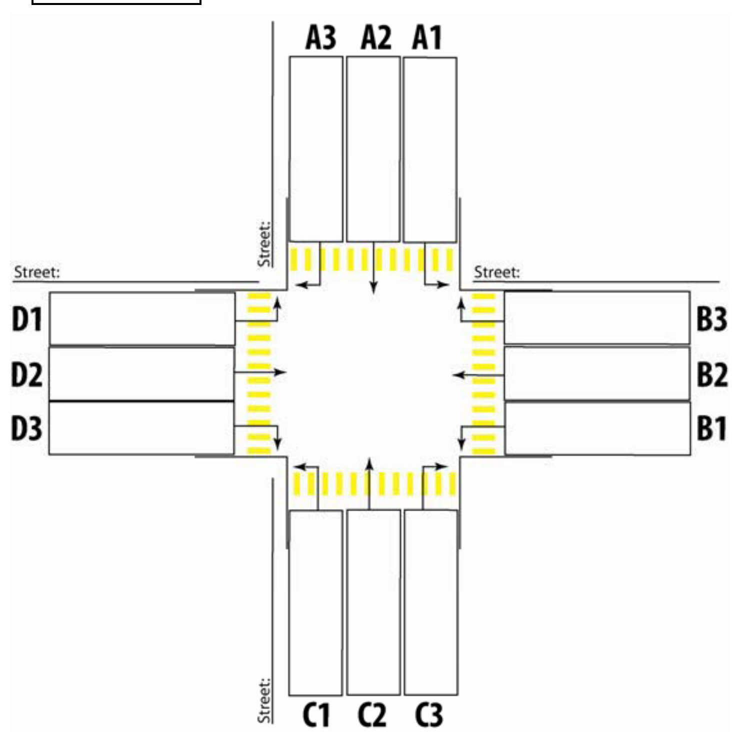
1:15-1:30



1:30-1:45



1:45-2:00



Notes:

STANDARD INTERSECTION COUNT TALLY SHEET

	Counts											
Time Period	**Leaving Leg A**			**Leaving Leg B**			**Leaving Leg C**			**Leaving Leg D**		
	A1	**A2**	**A3**	**B1**	**B2**	**B3**	**C1**	**C2**	**C3**	**D1**	**D2**	**D3**
00-:15												
15-:30												
30-:45												
45-1:00												
1:00-1:15												
1:15-1:30												
1:30-1:45												
1:45-2:00												
Total												
Total Leg:												

Street Name A to C:	**Location 1 (Total Leg A + Total Leg C) =**
Street Name B to D:	**Location 2 (Total Leg B + Total Leg D) =**

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V. Survey Forms

STANDARD PEDESTRIAN SURVEY

Location: ____________________________________ Date: _________________ Time: _______________

Surveyor: ____________________________________ Weather: _____________________________________
(sunny, cloudy, rainy, windy, hot, and/or cold)

"Excuse me, but may I ask you a few questions? I'm with [name of agency] and we want to learn more about why people walk where they do. This will take less than two minutes and the information will be kept confidential."

1. What is your home zip code?

Home zip code: _______________

2. What best describes the purpose of this trip?

☐ Exercising (a) ☐ Work commute (b) ☐ School (c)

☐ Recreation (d) ☐ Shopping/doing errands (e) ☐ Personal business (medical, visiting friends, etc.) (f)

3. In the past month, about how often have you walked here?

☐ First time (a) ☐ 0 – 5 times (b) ☐ 6 – 10 times (c) ☐ 11 – 20 times (d) ☐ Daily (e)

4. Please check the seasons in which you walk.

☐ All Year (a) ☐ Summer (b) ☐ Fall (c) ☐ Winter (d) ☐ Spring (e)

5. What is the total length of this trip (start to finish)? *(complete one or more of the following)*

1. *Distance*: _______ miles		***and / or***	**2. *Time*:** _______ minutes
and / or	***3. Origin (zip code)*** __________ *Or location description other than zip code:** __________________________________ ** Address, intersection, landmark, etc.*	***and***	***Destination (zip code)*** __________ *Or location description other than zip code:** __________________________________ ** Address, intersection, landmark, etc.*

6. Will any part of this current trip be taken on public transit?

☐ Yes (a) ☐ No (b)

7. If you were not walking for this trip, how would you be traveling?

☐ Car (a) ☐ Carpool (b) ☐ Transit (c) ☐ Bicycle (d) ☐ I would not make this trip (e)

8. Why are you using this route as opposed to walking somewhere else? *(please check all that apply)*

☐ Accessible/close (a) ☐ Direct (b) ☐ Lower traffic volumes (c) ☐ Heard about it through friends, media, etc.(d)

☐ Scenic qualities (e) ☐ Level (f) ☐ Personal safety (g) ☐ Connection to transit (h)

9. What would you like to see improved along this route (mark with an 'X') and community in general (mark with an 'O')? *(please check all that apply)*

☐ Wider sidewalks (a) ☐ Better surface (b) ☐ Better street crossings (c)

☐ More shade trees (e) ☐ Benches (f) ☐ Access to shops, etc. (g)

☐ More sidewalks (h)

10. What ethnic group do you belong to? *(please check all that apply) (optional)*

☐ Hispanic/Latino (a) ☐ African American (b) ☐ Anglo/Caucasian (c) ☐ Asian (d)

STANDARD BICYCLE SURVEY

Location: ______________________________________ Date: __________________ Time: _______________

Surveyor: ______________________________________ Weather: ____
(sunny, cloudy, rainy, windy, hot, and/or cold)

"Excuse me, but may I ask you a few questions? I'm with [name of NTPP agency] and we want to learn more about why people bike where they do. This will take less than two minutes and the information will be kept confidential."

1. What is your home zip code?

Home zip code: _______________

2. What best describes the purpose of this trip?

☐ Exercising (a) ☐ Work commute (b) ☐ School (c)

☐ Recreation (d) ☐ Shopping/doing errands (e) ☐ Personal business (medical, visiting friends, etc.) (f)

3. In the past month, about how often have you ridden a bicycle here?

☐ First time (a) ☐ 0 – 5 times (b) ☐ 6 – 10 times (c) ☐ 11 – 20 times (d) ☐ Daily (e)

4. Please check the seasons in which you bicycle.

☐ All Year (a) ☐ Summer (b) ☐ Fall (c) ☐ Winter (d) ☐ Spring (e)

5. What is the total length of this trip (start to finish)? *(complete one or more of the following)*

1. Distance: _______ miles (a)		***and / or***	***2. Time:*** _______ minutes (b)
and / or	***3. Origin (zip code)*** __________ (c) *Or location description other than zip code:** ________________________________ ** Address, intersection, landmark, etc.*	***and***	***Destination (zip code)*** __________ (d) *Or location description other than zip code:** ________________________________ ** Address, intersection, landmark, etc.*

6. Will any part of this current trip be taken on public transit?

☐ Yes (a) ☐ No (b)

7. If you were not biking for this trip, how would you be traveling?

☐ Car (a) ☐ Carpool (b) ☐ Transit (c) ☐ Walking (d) ☐ I would not make this trip (e)

8. Why are you using this route as opposed to riding somewhere else? *(please check all that apply)*

☐ Accessible/close (a) ☐ Direct (b) ☐ Lower traffic volumes (c) ☐ Scenic qualities (d)

☐ Level (e) ☐ Bike lanes (f) ☐ Wider lanes (g) ☐ Separation from traffic (h)

☐ Connection to transit (i) ☐ Heard about it through friends, media, etc. (j)

9. What would you like to see improved along this route (mark with an 'X') and community in general (mark with an 'O')? *(please check all that apply)*

☐ Bike lanes (a) ☐ Better surface (b) ☐ Shoulders (c) ☐ Less traffic (d)

☐ Signs/stencils (e) ☐ Better maintenance (f) ☐ Signal detection (g) ☐ Better crossings (h)

10. What ethnic group do you belong to? *(please check all that apply) (optional)*

☐ Hispanic/Latino (a) ☐ African American (b) ☐ Anglo/Caucasian (c) ☐ Asian (d)

ENCUESTA PEATONAL

Location: ______________________________ Date: _______________ Time: _____________

Surveyor: ______________________________ Weather: _______________________________
(sunny, cloudy, rainy, windy, hot, and/or cold)

"¿Perdone, pero le puedo preguntar algunas preguntas? Trabajo para [name of agency] y queremos aprender más acerca de por qué personas caminan donde ellos hacen. Esta tomará menos de dos minutos y la información será mantenida confidencial".

1. ¿Cual es el código postal de su domicilio?

Código postal _______________

2. ¿Qué describe mejor el propósito de este viaje?

☐ Para propósito ejercicio (a) ☐ Para ir/regresar del trabajo (b) ☐ Para ir/regresar a la Escuela (c)

☐ Para propósito recreativo (d) ☐ Para ir de compras o mandatos (e) ☐ Negocios personales (médicos, visitando amigos, etc.)(f)

3. ¿En el último mes, cuantas veces ha caminado aquí?

☐ Primera vez (a) ☐ 0 – 5 veces (b) ☐ 6 – 10 veces (c) ☐ 11 – 20 veces (d) ☐ Diario (e)

4. Por favor indique todas las estaciones en que usted camina.

☐ Todo el año (a) ☐ Verano (b) ☐ Otoño (c) ☐ Invierno (d) ☐ Primavera (e)

5. ¿Cuál es la distancia aproximada de este viaje (de principio a fin)? (complete uno o más de los siguientes)

	***1.** Distancia :* _______ millas	***y / o***	***2.** Tiempo:* _______ minutos
Y / o	***3. Origen (código postal)*** __________ *O descripción de ubicación de otra manera que código postal:** __________________________________ ** Dirección, intersección, punto de referencia, etc.*	***y***	***Destinación (código postal)*** __________ *O descripción de ubicación de otra manera que código postal:** __________________________________ ** Dirección, intersección, punto de referencia, etc.*

6. ¿Será tomada cualquier parte de este viaje sobre el tránsito público?

☐ Sí (a) ☐ No (b)

7. ¿Si no caminara para este viaje, cómo se viajaría?

☐ Automóvil (a) ☐ Carpool (b) ☐ Tránsito Público (c) ☐ Bicicleta (d) ☐ No me llevaría por este viaje (e)

8. ¿Por qué utiliza esta ruta en lugar de caminar en algún otro lugar? (indique todas los que aplican)

☐ Accesibilidad/proximidad (a) ☐ Directo (b) ☐ Menos volumen de tráfico (c)

☐ Lo oí por un amigo, los medios, etc., los medios, etc. (d) ☐ Calidad escénica (e)

☐ Plano (f) ☐ La seguridad (g) ☐ Conexión al tránsito público (h)

9. ¿ Qué le gustaría ver mejorado a lo largo de esta ruta (indique con un 'X') y de la comunidad en general (indique con un 'O')? (indique todas las que aplican)

☐ Banquetas más amplias (a) ☐ Mejor superficie (b) ☐ Mejores cruces peatonal (c)

☐ Mas árboles de sombreados (d) ☐ Bancos (e) ☐ Acceso a tiendas, etc. (f)

☐ Más banquetas (g)

10. ¿A qué grupo étnico pertenece usted? (indique todas las que aplican) (opcional)

☐ Hispano/Latino (a) ☐ Afro-Americano (b) ☐ Anglo/Caucásico (Blanco/No-Hispano) (c) ☐ Asiático (d)

ENCUESTA DE CICLISTA

Location: ______________________________ Date: ______________ Time: ______________

Surveyor: ______________________________ Weather: ______________________________
(sunny, cloudy, rainy, windy, hot, and/or cold)

"¿Perdone, pero le puedo preguntar algunas preguntas? Trabajo para [name of agency] y queremos aprender más acerca de por qué personas pasean en bicicleta donde ellos hacen. Esta tomará menos de dos minutos y la información será mantenida confidencial".

1. ¿Cual es el código postal de su domicilio?

Código postal _____________

2. ¿Qué describe mejor el propósito de este viaje?

- ☐ Para propósito ejercicio (a)
- ☐ Para ir/regresar del trabajo (b)
- ☐ Para ir/regresar a la Escuela (c)
- ☐ Para propósito recreativo (d)
- ☐ Para ir de compras o mandatos (e)
- ☐ Negocios personales (médicos, visitando amigos, etc.) (f)

3. ¿En el último mes, cuantas veces ha paseado la bicicleta aquí?

☐ Primera vez (a) ☐ 0 – 5 veces (b) ☐ 6 – 10 veces (c) ☐ 11 – 20 veces (d) ☐ Diario (e)

4. Por favor indique todas las estaciones en que usted usa la bicicleta.

☐ Todo el año (a) ☐ Verano (b) ☐ Otoño (c) ☐ Invierno (d) ☐ Primavera (e)

5. ¿Cuál es la distancia aproximada de este viaje (de principio a fin)? (complete uno o más de los siguientes)

	1. *Distancia :* _______ millas	***y / o***	***2.*** *Tiempo:* _______ minutos
Y / o	***3. Origen (código postal)*** __________ *O descripción de ubicación de otra manera que código postal:** ______________________________ ** Dirección, intersección, punto de referencia, etc.*	***y***	***Destinación (código postal)*** __________ *O descripción de ubicación de otra manera que código postal:** ______________________________ ** Dirección, intersección, punto de referencia, etc.*

6. ¿Será tomada cualquier parte de este viaje sobre el tránsito público?

☐ Sí (a) ☐ No (b)

7. ¿Si no usara la bicicleta para este viaje, cómo se viajaría?

☐ Automóvil (a) ☐ Carpool (b) ☐ Tránsito Público (c) ☐ Caminar (d) ☐ No me llevaría por este viaje (e

8. ¿Por qué utiliza esta ruta en lugar de pasear por algún otro lugar? (indique todas los que aplican)

- ☐ Accesibilidad/proximidad (a)
- ☐ Directo (b)
- ☐ Menos volumen de tráfico (c)
- ☐ Calidad escénica (d)
- ☐ Plano (e)
- ☐ Ciclovías (f)
- ☐ Vías más amplias (g)
- ☐ Separación del tráfico (h)
- ☐ Conexión al tránsito público (i)
- ☐ Lo oí por un amigo, los medios, etc. (j)

9. ¿ Qué le gustaría ver mejorado a lo largo de esta ruta (indique con un 'X') y de la comunidad en general (indique con un 'O')? (indique todas las que aplican)

- ☐ Ciclovías (a)
- ☐ Mejor superficie (b)
- ☐ Acotamiento (c)
- ☐ Menos trafico (d)
- ☐ Símbolos/plantillas (e)
- ☐ Mejor mantenimiento (f)
- ☐ Detectores en los semáforos para ciclistas (g)
- ☐ Mejores áreas de cruce ciclista (h)

10. ¿A qué grupo étnico pertenece usted? (indique todas las que aplican) (opcional)

☐ Hispano/Latino (a) ☐ Afro-Americano (b) ☐ Anglo/Caucásico (Blanco/No-Hispano) (c) ☐ Asiático (d)

Example from San Francisco "State of Cycling" Report.
Survey instrument for intercept interviews of bicyclists.

Phone Survey of Perceptions of Cycling on San Francisco Streets

Intro

Hello, this is ______ calling on behalf of the City of San Francisco. The City is conducting an important public survey to assess residents' perceptions and opinions about bicycling within the city. We are interested in your opinion regardless of whether or not you ride a bicycle. The information we gather will help improve city planning and traffic safety. This interview will take about ten minutes.

Is there a San Francisco resident over 18 in your household who may be willing to help?

1. Yes, that would be me - Go to Screener 1

2. Yes, hold on - Repeat Intro

2. Maybe, but you will have to call back - set callback

3. Household is not in SF - Code as Not Qualified - Not in SF

4. No one over 18 in this SF household - Code as Not Qualified - No adult in HH

Screener 1

I just need to verify that you are at least 18 years old and live in the City of San Francisco.

1. Yes - over 18 and lives in SF

2. Household is not in SF - Code as Not Qualified - Not in SF

3. No one over 18 in this SF household - Code as Not Qualified - No adult in HH

1. Do you own a bicycle in good working order or have regular access to one?
   - ☐ Yes
   - ☐ No

2. On average, how often do you bike per week, month or year? (enter "0" if you don't bike)

______ times	☐	per week
	☐	per month
	☐	per year

[if "0", skip to # 10]

3. Tell us about your most recent bicycle trip (or current trip if in-person interview)

   3a. At what zip code/address/location did you start? ____________

   3b. At what zip code/address/location did you end? ____________

   3c. How far was this trip in distance or time? (provide as many answers as you know)

   ____ Miles

   ____ Blocks

   ____ Minutes

   3d. What was the primary purpose of this bike trip?

   □ Work
   □ Exercise or Recreation
   □ Shopping/Errands
   □ School
   □ Access to transit
   □ Personal (medical, visiting friends, etc.)

   3e. If you were not riding, how would you have made this trip?

   □ Car
   □ Carpool
   □ Transit (ferry, bus, light rail, cable car)
   □ Walking
   □ I would not make this trip

4. In general, what is your motivation to bicycle? (check as many as apply)

   □ Environment/air quality
   □ Exercise
   □ Faster than transit
   □ Faster than driving
   □ Cheaper than driving/transit
   □ Identify as member of bicycling community
   □ Alone time/downtime
   □ Enjoy time outdoors

5. In which seasons do you bicycle? (check all that apply)

   □ All year
   □ Spring (March-May)
   □ Summer (June-August)
   □ Fall (Sept-Nov)
   □ Winter (Dec-Feb)

6. On a scale from 1 to 5, with 1 indicating strongly disagree and 5 indicating strongly agree, please tell us how do you feel about the quality of the bicycle facilities you use in San Francisco?

   Bicycle facilities include bicycle paths, bicycle lanes, and signed bike route streets.

There is enough room on most streets to bicycle	□ 1	□ 2	□ 3	□ 4	□ 5
I feel safe from traffic	□ 1	□ 2	□ 3	□ 4	□ 5
Facilities are well-marked with signs & stencils	□ 1	□ 2	□ 3	□ 4	□ 5
The pavement is in good condition	□ 1	□ 2	□ 3	□ 4	□ 5
Facilities are easy to get to from my home	□ 1	□ 2	□ 3	□ 4	□ 5
Facilities take me where I need to go	□ 1	□ 2	□ 3	□ 4	□ 5
If there were more bike lanes I would bike more	□ 1	□ 2	□ 3	□ 4	□ 5

7. Where do you prefer to ride?

   □ On roads with cars, even if there are no bicycle lanes
   □ On roads with cars, but only if there are bike lanes
   □ On paths that are separated from motor vehicles

8. Do you use a bicycle as your primary way of getting around?
   ☐ Yes
   ☐ No

9. When bicycling, do you… (please circle your response to each item below)

   …wear a helmet? Always – Mostly – Sometimes - Never

   …stop at traffic lights and stop signs? Always – Mostly – Sometimes - Never

   …obey other traffic laws? Always – Mostly – Sometimes - Never

10. Following is a list of barriers to cycling. On a scale where 1 indicates "not a barrier at all" and 5 indicates a "great barrier", please tell us how you feel about each.

Not enough time for biking	□ 1	□ 2	□ 3	□ 4	□ 5
I am worried about crime	□ 1	□ 2	□ 3	□ 4	□ 5
Not comfortable biking with cars	□ 1	□ 2	□ 3	□ 4	□ 5
Too difficult to cross major streets	□ 1	□ 2	□ 3	□ 4	□ 5
Not enough bike lanes	□ 1	□ 2	□ 3	□ 4	□ 5
Places are too far away	□ 1	□ 2	□ 3	□ 4	□ 5
Not enough light at night	□ 1	□ 2	□ 3	□ 4	□ 5
I have things to carry	□ 1	□ 2	□ 3	□ 4	□ 5
I need to travel with small children	□ 1	□ 2	□ 3	□ 4	□ 5
Hills/don't want to get sweaty before work	□ 1	□ 2	□ 3	□ 4	□ 5
Work hours change/are too early/late	□ 1	□ 2	□ 3	□ 4	□ 5

11. What is your zip code?

12. Age Group: 18-25 26-35 36-45 46-55 56+

13. Gender: Male Female Transgender

14. Race: Caucasian Asian African-American Native-American Other

15. Ethnicity: Hispanic Non-Hispanic

16. Household Income: < $30K $31K – $70K $71K – $100K $100K+

17. Please indicated any of the following information resources provided by the City of San Francisco with which are you familiar?

    □ City bicycling website
    □ City bike maps
    □ Cyclist safety training classes
    □ Research and reports
    □ Hotline
    □ Public outreach campaigns (billboards, bus ads, bus stop posters and stickers)

18. On a scale from 1 to 5, with 1 indicating strongly disagree and 5 indicating strongly agree, please answer the following:

Cyclists have a legal right to the road	□ 1	□ 2	□ 3	□ 4	□ 5	
Most cyclists obey traffic laws		□ 1	□ 2	□ 3	□ 4	□ 5
Most motorists respect the rights of cyclists	□ 1	□ 2	□ 3	□ 4	□ 5	

19. If you have witnessed a cyclist riding unsafely, what did you see?

    □ Riding against traffic
    □ Riding on the sidewalk
    □ Running stop sign/light
    □ "Darting out" into traffic
    □ Swerving (not riding in a straight line)
    □ Riding in the crosswalk
    □ Altercation with motorist (verbal or physical)
    □ Failure to yield to motorist
    □ Failure to yield to pedestrian
    □ Generally, riding recklessly or unpredictably
    □ Have not witnessed unsafe riding

20. If you have witnessed a cyclist riding unsafely, where did this occur?

    □ On a small neighborhood street
    □ On a larger, major street
    □ On a separated pathway/in a park
    □ Neighborhood: [code in SF neighborhood names]

21. If you have witnessed a driver behaving unsafely toward a cyclist, what did you see?

    □ Running stop sign/light
    □ Swerving

□ Altercation with cyclist (verbal or physical)
□ Failure to yield to cyclist
□ Unsafe passing
□ Driving or parking in the bicycle lane
□ Driver not using signals
□ Opening car door into cyclist path
□ "Right Hook" – driver turning right in front of cyclist
□ Generally, driving recklessly or unpredictably, endangering a cyclist
□ Have not witnessed driving that endangered a cyclist

21. If you have witnessed a driver behaving unsafely, where did this occur?

□ On a small neighborhood street
□ On a larger, major street
□ Neighborhood: [code in SF neighborhood names]

Trip Diary:

Intro:

We're almost done with the survey. We have a few more questions that should take only a couple more minutes.

In order to get an idea of the different modes of transportation that San Francisco residents use, and how frequently you use them, we're going to ask you to think about all the places you went yesterday. We want to know how you got there, including your primary destination and any other stops made along the way, and the mode of transportation you used to make the trip. We don't need to know the exact name or location of your destination, just a general description.

Here are a couple of examples. Let's say you went to work yesterday. If you drove

your child to school and from there drove to work, that would be two trips, one to drive your child to school and one to drive to work. Or, if you took MUNI to go shopping, you can just say, "took bus to go shopping."

So, think about where you went yesterday. What was the first place you went and what mode of transportation did you use?

Interviewer directions:

AFTER EACH TRIP, ASK: Did you then go home or did you go somewhere else?

IF WENT HOME: RECORD NEW TRIP WITH "RETURNED HOME" CODE AND RECORD THE SAME MODE AS WAS USED BEFORE.

THEN ASK: And what was the next place you went yesterday and what mode of transportation did you use? REPEAT PROBES FOR RETURN TRIP AS NECESSARY.

AS NECESSARY, CLARIFY WITH:

- What was the purpose of the trip?
- What mode of transportation did you use to get there?
- IF DROVE: Did you drive by yourself or was someone else in the car with you?

MAKE SURE RESPONDENT RETURNS HOME AS LAST TRIP.

EACH STOP QUALIFIES AS A TRIP.

RECORD PURPOSE AND MODE OF TRANSPORTATION OF EACH TRIP.

Purpose	**Trip1**	**Trip2**	**Trip3**	**Trip4**	**Trip5**	**Trip6**	**Trip7**
Work, or work related	1	1	1	1	1	1	1
School/education	2	2	2	2	2	2	2
Leisure (movie, eating, coffee, etc)	3	3	3	3	3	3	3
Shopping	4	4	4	4	4	4	4
Fitness, exercise (walk, walking dog, bike ride, etc)	5	5	5	5	5	5	5
Pick up/drop off (driving someone else, including child to school)	6	6	6	6	6	6	6
Return to work	7	7	7	7	7	7	7
Return home							
From work or work related	8	8	8	8	8	8	8
From school	9	9	9	9	9	9	9
From leisure	10	10	10	10	10	10	10
From shopping	11	11	11	11	11	11	11
From fitness, exercise	12	12	12	12	12	12	12
From pick up/drop off	13	13	13	13	13	13	13
Mode	**Trip1**	**Trip2**	**Trip3**	**Trip4**	**Trip5**	**Trip6**	**Trip7**
Auto (drive alone)	1	1	1	1	1	1	1
Auto (drive with or a passenger)	2	2	2	2	2	2	2
MUNI	3	3	3	3	3	3	3
BART	4	4	4	4	4	4	4
Bike	5	5	5	5	5	5	5
Walk	6	6	6	6	6	6	6
Motorcycle, scooter	7	7	7	7	7	7	7

REPEAT UNTIL ALL TRIPS DURING DAY ACCOUNTED FOR UP TO A MAXIMUM OF 20 TRIPS.

NOTE: If a person uses more than one mode of transportation for a trip, record using the following hierarchy. ANY TRIP INVOLVING A BICYCLE IS A BIKE TRIP.

1. Bike
2. Public Transportation
2. Motorized-private modes
3. Walk

For example, if they walk to MUNI or take bus to BART, record as using transit.
If they ride their bike to BART, then record as bike.

VI. Count Training Presentations

Count training presentations are available at http://bikepeddocumentation.org/.

Conducting Screenline Counts

Why Count?

- Better understand needs
- Understand what influences biking and walking
- Secure grant funding
- Support Bicycle and Pedestrian Documentation Project (www.bikepeddocumentation.org/)

Items to Bring

- Instructions
- Safety vest
- Location map
- Count forms
- Clipboard
- Pen or pencil and spare
- Watch or timer so you can record 15-minute intervals
- For questions contact _______________,
  Volunteer Coordinator at (123) 555-1234.
- Optional: hat, sunscreen, jacket, folding chair, snacks

Ready

Set

Go!

Screenline Count

Screenline

Count everyone who passes

Count Form

STANDARD SCREENLINE COUNT FORM

Name: ____________ Location: ____________

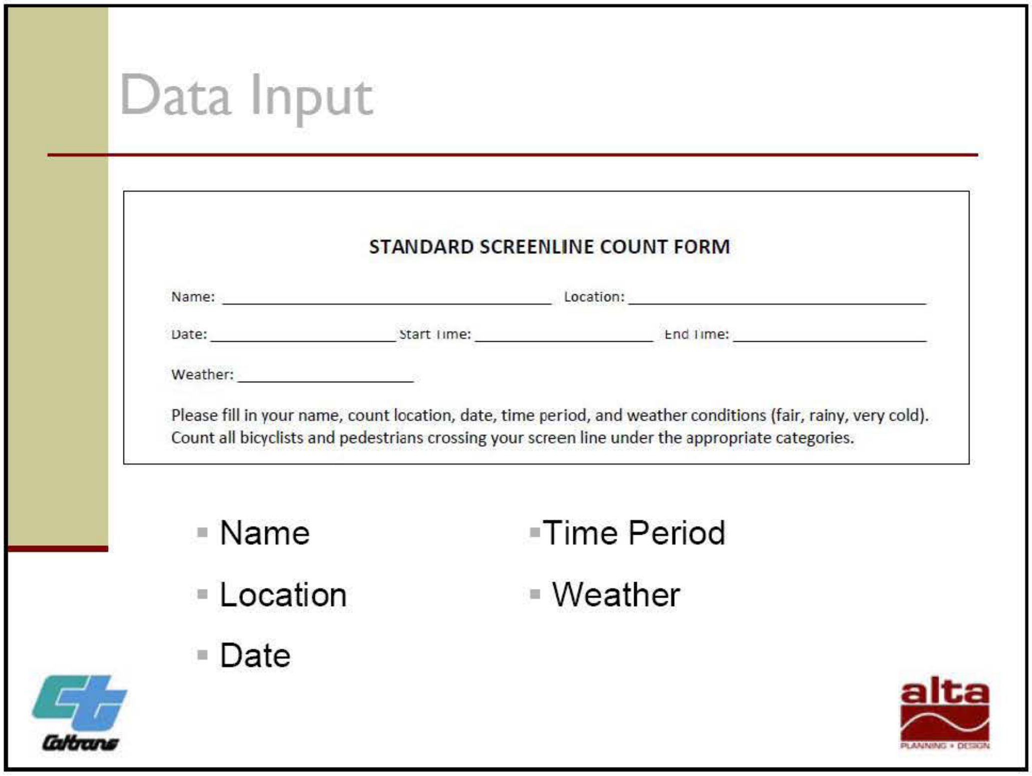
Date: ________ Start Time: ________ End Time: ________

Weather: ________

Please fill in your name, count location, date, time period, and weather conditions (fair, rainy, very cold). Count all bicyclists and pedestrians crossing your screen line under the appropriate categories.

- Count for two hours in 15 minute increments.
- Count bicyclists who ride on the sidewalk.
- Count the number of people on the bicycle, not the number of bicycles.
- Pedestrians include people in wheelchairs or others using assistive devices, children in strollers, etc.
- People using equipment such as skateboards or rollerblades should be included in the "Other" category.

	Bicycles		Pedestrians		Others
	Female	Male	Female	Male	
00-:15					
15-:30					
30-:45					
45-1:00					
1:00-1:15					
1:15-1:30					
1:30-1:45					
1:45-2:00					
Total					


Data Input
STANDARD SCREENLINE COUNT FORM
Name:
Location:
Date:
Start Time:
End Time:
Weather:
Please fill in your name, count location, date, time period, and weather conditions (fair, rainy, very cold).
Count all bicyclists and pedestrians crossing your screen line under the appropriate categories.
Name
Location
Date
Time Period
Weather
Caltrans
alta
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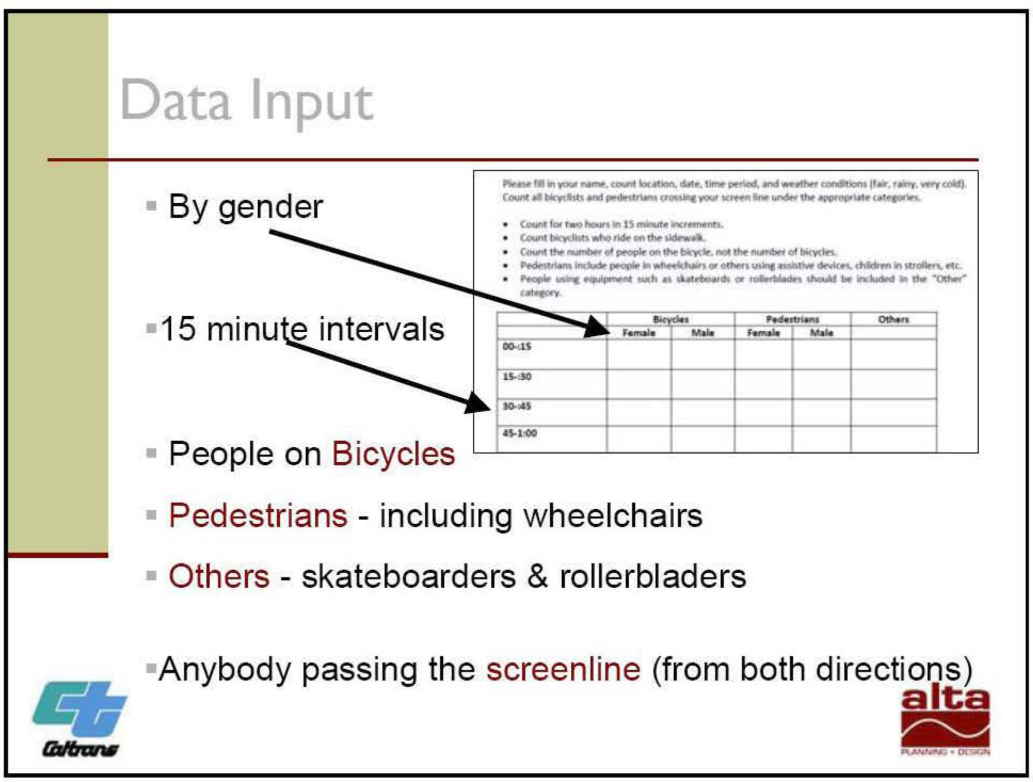
Data Input
By gender
15 minute intervals
People on Bicycles
Pedestrians - including wheelchairs
Others - skateboarders & rollerbladers
Anybody passing the screenline (from both directions)
Please fill in your name, count location, date, time period, and weather conditions (fair, rainy, very cold).
Count all bicyclists and pedestrians crossing your screen line under the appropriate categories.
Count for two hours in 15 minute increments.
Count bicyclists who ride on the sidewalk.
Count the number of people on the bicycle, not the number of bicycles.
Pedestrians include people in wheelchairs or others using assistive devices, children in strollers, etc.
People using equipment such as skateboards or rollerblades should be included in the "Other" category.
Bicycles
Pedestrians
Others
Female
Male
Female
Male
00-:15
15-:30
30-:45
45-1:00
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Data Input

	Bicycles	
	Female	**Male**
00-:15	4	9
15-:30	6	12
30-:45		
45-1:00		

Subjects

How do you count this?

How do you count this?

5!

How do you count this?

How do you count this?

2!

How do you count this?

How do you count this?

4!

How do you count this?

Caltrans

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How do you count this?

Other!

Caltrans

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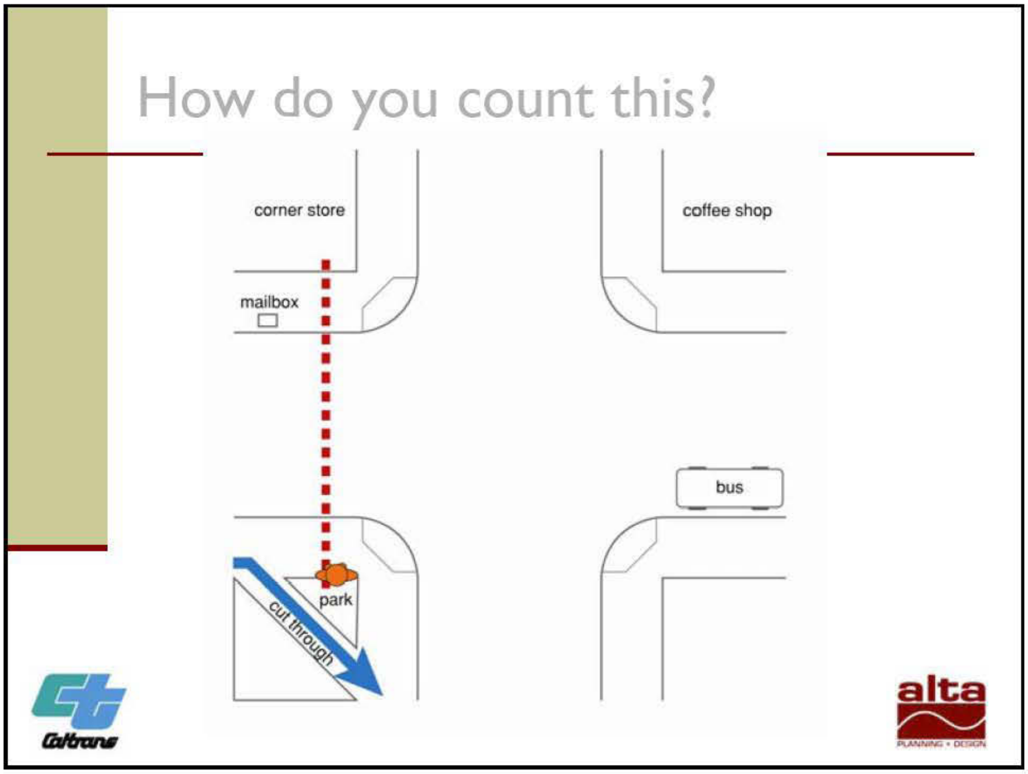
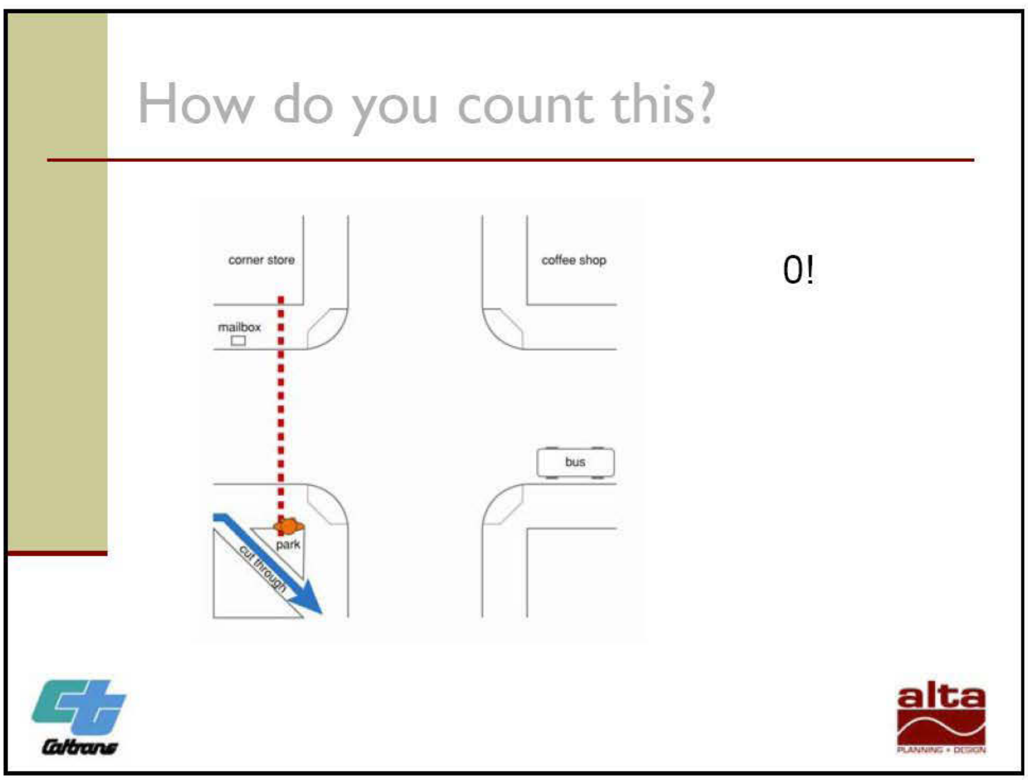
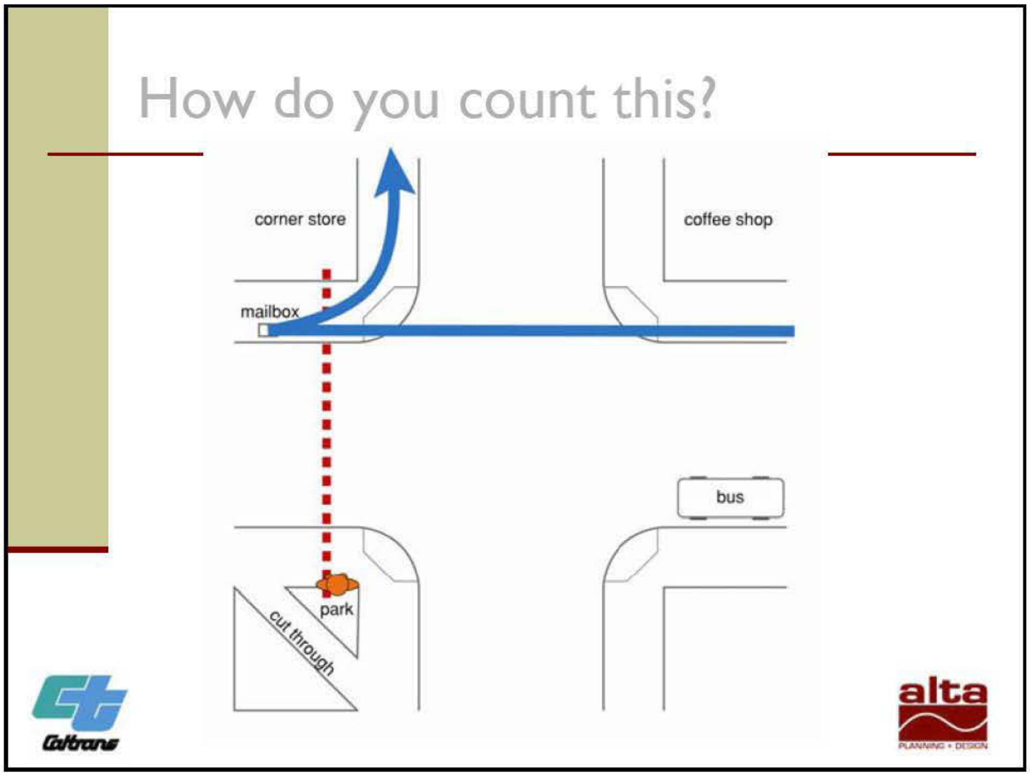
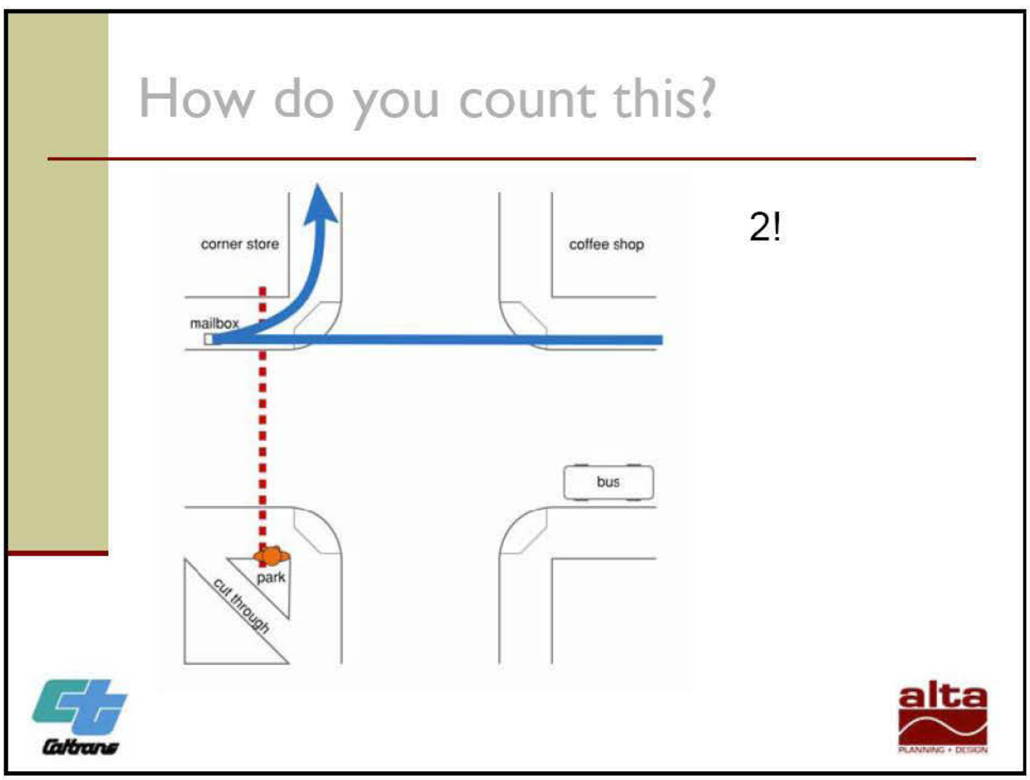
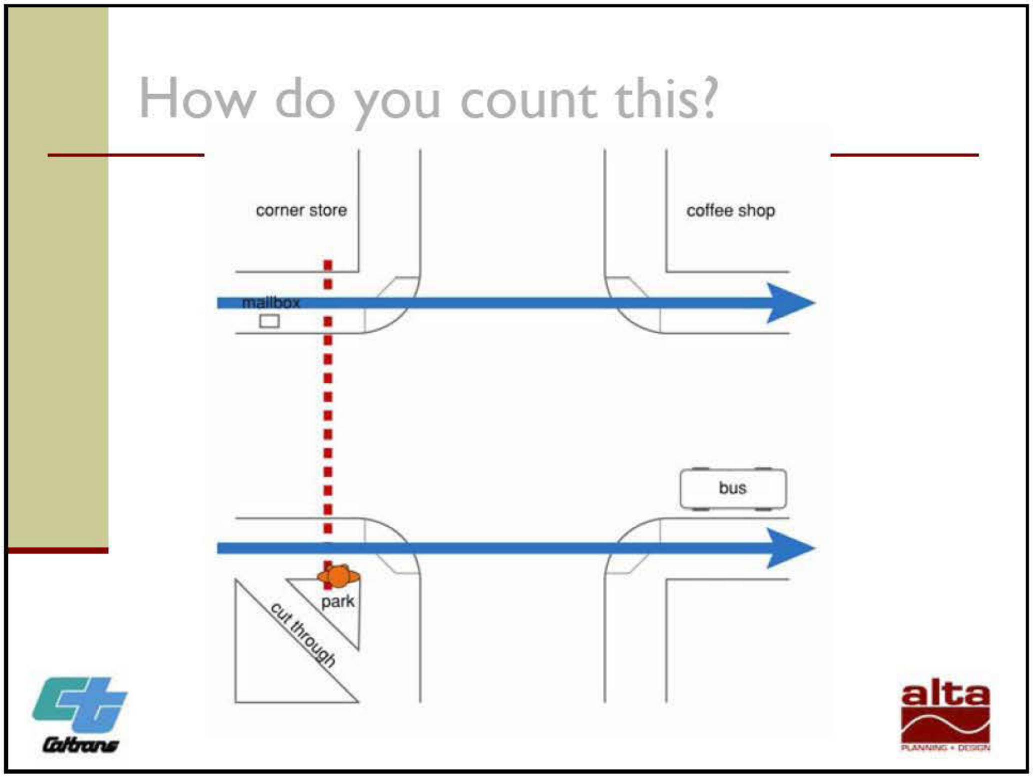
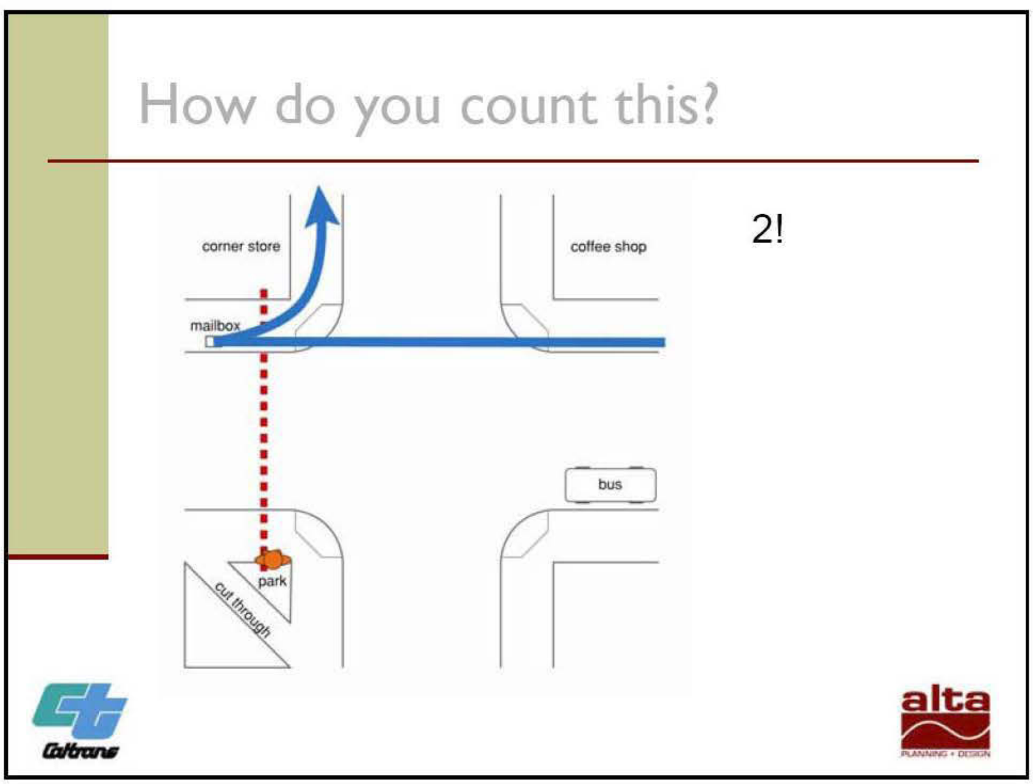

How do you count this?
corner store
coffee shop
mailbox
bus
park
cut through


How do you count this?
corner store
coffee shop
mailbox
bus
park
cut through
0!


How do you count this?
corner store
coffee shop
mailbox
bus
park
cut through


How do you count this?
corner store
coffee shop
mailbox
bus
park
cut through
2!


How do you count this?
corner store
coffee shop
mailbox
bus
park
cut through
Caltrans
alta


How do you count this?
corner store
coffee shop
mailbox
2!
bus
park
cut through
Caltrans
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End of Counts

When you have completed all of your count sessions, please return your count forms to the volunteer coordinator.

Conducting Intersection Counts

Why Count?

- Better understand needs
- Understand what influences biking and walking
- Secure grant funding
- Support Bicycle and Pedestrian Documentation Project (www.bikepeddocumentation.org/)

Items to Bring

- Instructions
- Safety vest
- Location map
- Count forms
- Clipboard
- Pen or pencil and spare
- Watch or timer so you can record 15-minute intervals
- For questions contact ______________, Volunteer Coordinator at (123) 555-1234.
- Optional: hat, sunscreen, jacket, folding chair, snacks

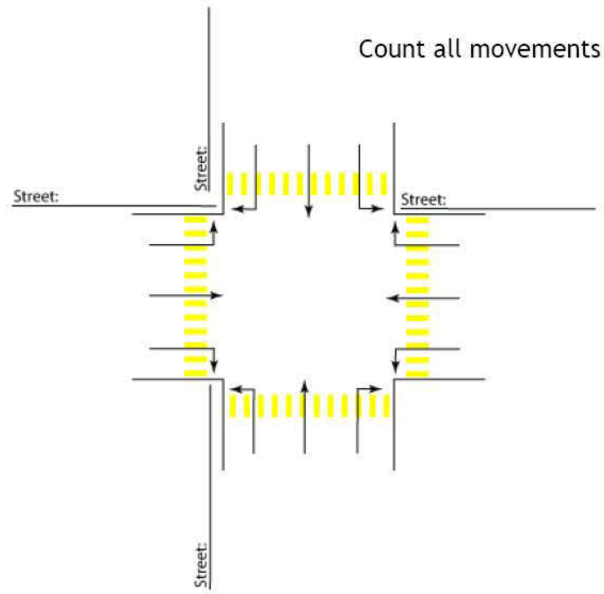
Ready

Set

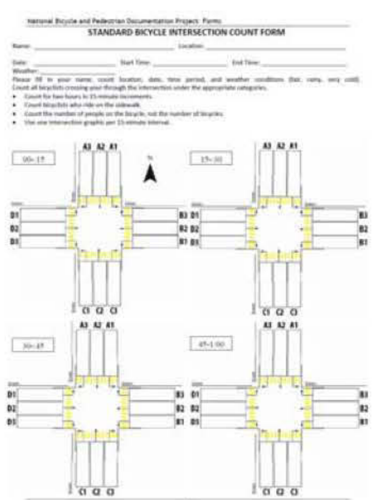
Go!

Intersection Count

Count all movements at the intersection



Count Form



- Does not differentiate by gender
- Allows counters to collect turning movements
- 15-minute intervals
- 2-hour period can be collected on 1 sheet

Data Input

National Bicycle and Pedestrian Documentation Project: Forms

STANDARD BICYCLE INTERSECTION COUNT FORM

Name: ______________________ Location: ______________________

Date: ______________ Start Time: ______________ End Time: ______________

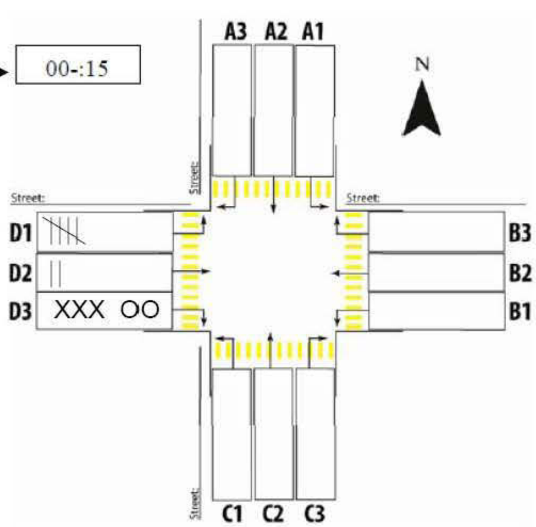
Weather: ______________

Please fill in your name, count location, date, time period, and weather conditions (fair, rainy, very cold). Count all bicyclists crossing through the intersection under the appropriate categories.

- Name
- Location
- Date
- Time Period
- Weather

Data Input

- 15 minute intervals
- Count each turning movement
- May use different symbols for male/female



Data Input: Tally the data

STANDARD BICYCLE INTERSECTION COUNT TALLY SHEET

Enter after field work

Time Period	Bicycle Counts											
	Leaving Leg A			Leaving Leg B			Leaving Leg C			Leaving Leg D		
	A1	A2	A3	B1	B2	B3	C1	C2	C3	D1	D2	D3
00-:15	24	17	21									
15-:30												
30-:45												
45-1:00												
1:00-1:15												
1:15-1:30												
1:30-1:45												
1:45-2:00												
Total												
Total Leg:												
Street Name A to C:							Location 1 (Total Leg A + Total Leg C) =					
Street Name B to D:							Location 2 (Total Leg B + Total Leg D) =					

Subjects

How do you count this?

How do you count this?

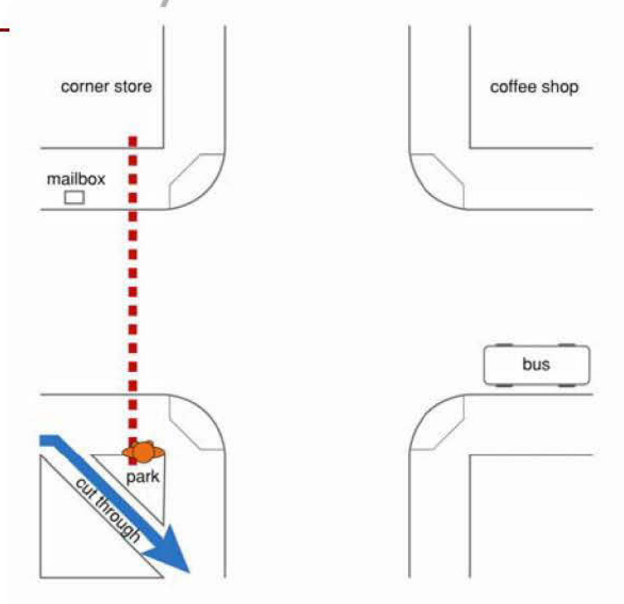
5!

How do you count this?

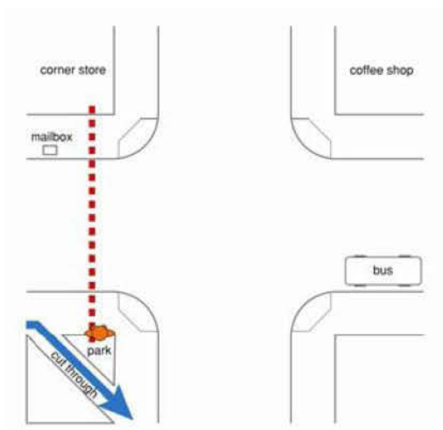
How do you count this?

2!

How do you count this?



How do you count this?



0!

End of Counts

When you have completed all of your count sessions, please return your count forms to the volunteer coordinator.

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VII. Survey Training Presentation

The survey training presentation is available at http://bikepeddocumentation.org/.

Conducting Surveys

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Why Survey?

- Better understand needs
- Understand what influences biking and walking
- Secure grant funding
- Support Bicycle and Pedestrian Documentation Project (www.bikepeddocumentation.org/)

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Items to Bring

- Instructions
- Safety vest
- Location map
- Survey forms
- Clipboard
- Pen or pencil and spare
- For questions contact ______________, Volunteer Coordinator at (123) 555-1234.
- Optional: hat, sunscreen, jacket, folding chair, snacks, sign/board identifying effort, water/snacks for participants

Survey Instructions

Positioning

1. Position yourself approximately 50 feet from the person conducting counts.

Survey Instructions

Engaging

2. Approach cyclists or pedestrians in a friendly and engaging manner. Without startling them, get their attention and ask…

Survey Instructions

"Hello, do you have time to answer a few questions about walking and biking?"

If yes:

"My name is __________ and I'm conducting this survey for _________________. The information will be used to better understand why people walk and bike where they do. The survey will take about 5 minutes.

"You don't have to answer all the questions, and you can stop taking the survey at any time. I won't ask for any personal information. Would you like to take the survey?

Survey Instructions

Data Entry

3. If you like, you can read the questions and options to them and record their responses

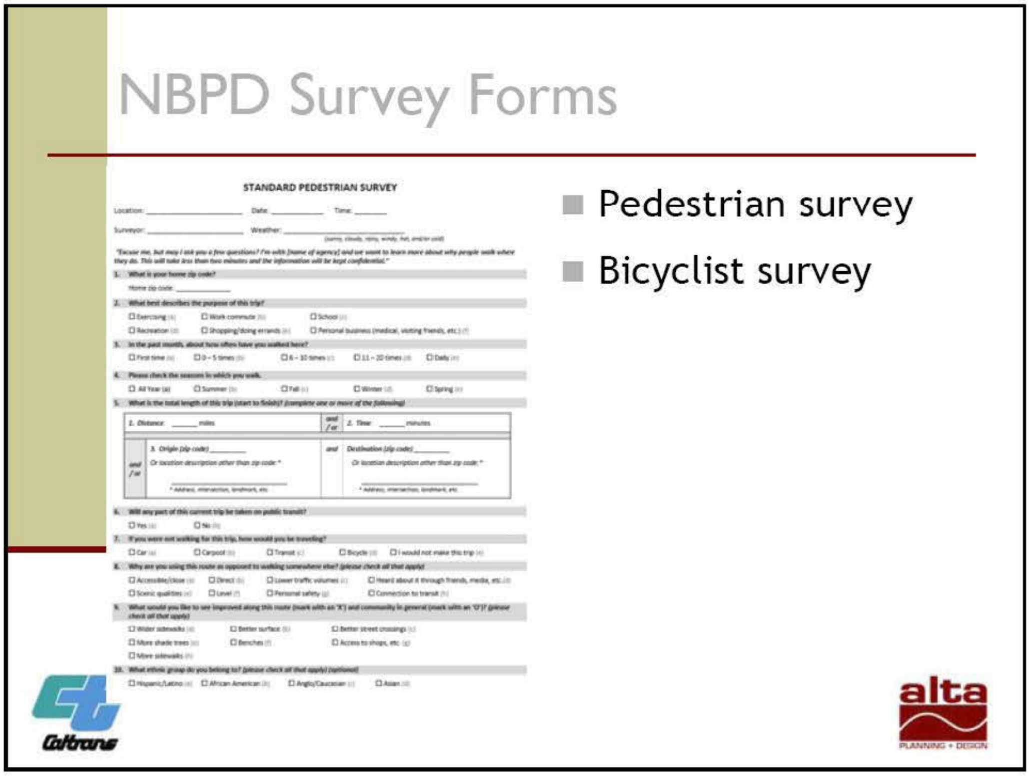
or

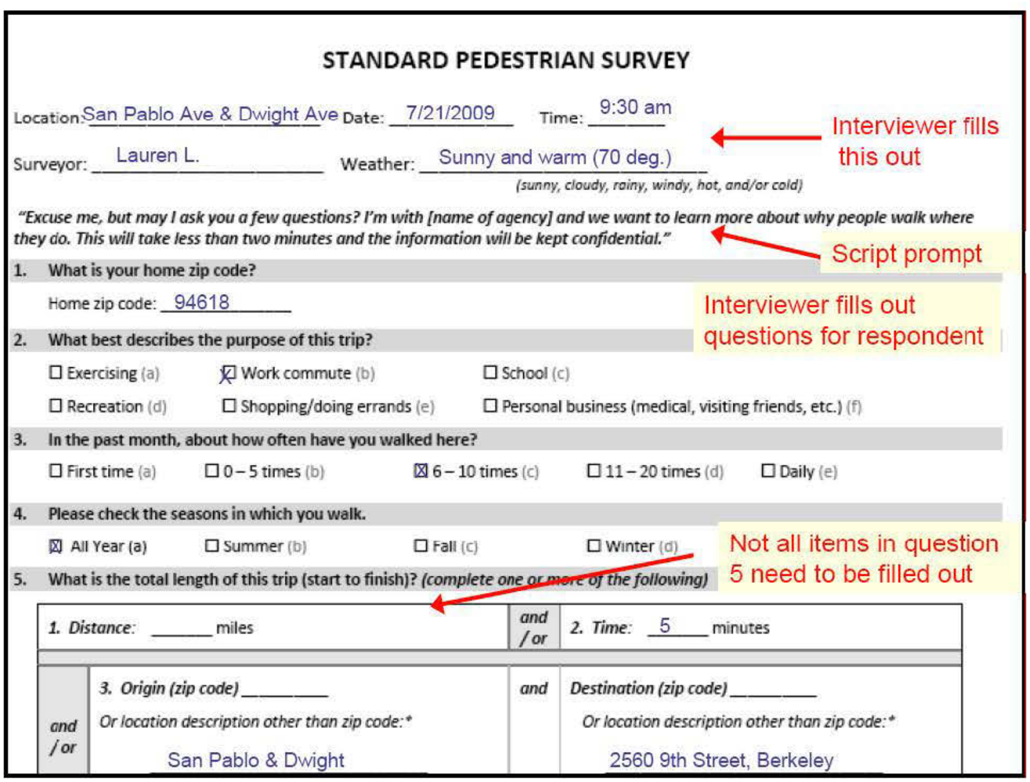
Provide them with a postcard directing them to the survey website.

Survey Instructions

Additional Information

4. After every question has been answered, fill out the additional information at the bottom of the survey.





STANDARD PEDESTRIAN SURVEY

Location: San Pablo Ave & Dwight Ave Date: 7/21/2009 Time: 9:30 am

Surveyor: Lauren L. Weather: Sunny and warm (70 deg.)

(sunny, cloudy, rainy, windy, hot, and/or cold)

Interviewer fills this out

"Excuse me, but may I ask you a few questions? I'm with [name of agency] and we want to learn more about why people walk where they do. This will take less than two minutes and the information will be kept confidential."

Script prompt

1. **What is your home zip code?**

   Home zip code: 94618

Interviewer fills out questions for respondent

2. **What best describes the purpose of this trip?**

   ☐ Exercising (a) ☒ Work commute (b) ☐ School (c)
   ☐ Recreation (d) ☐ Shopping/doing errands (e) ☐ Personal business (medical, visiting friends, etc.) (f)

3. **In the past month, about how often have you walked here?**

   ☐ First time (a) ☐ 0 – 5 times (b) ☒ 6 – 10 times (c) ☐ 11 – 20 times (d) ☐ Daily (e)

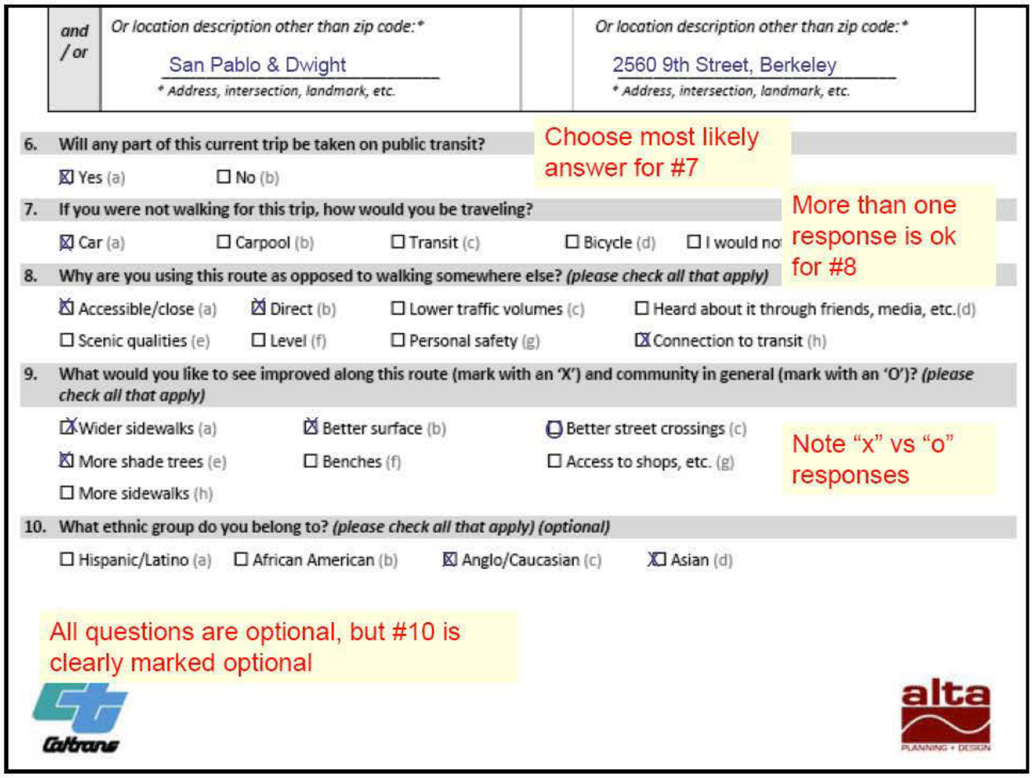
4. **Please check the seasons in which you walk.**

   ☒ All Year (a) ☐ Summer (b) ☐ Fall (c) ☐ Winter (d)

Not all items in question 5 need to be filled out

5. **What is the total length of this trip (start to finish)? *(complete one or more of the following)***

1. Distance: ______ miles		*and / or*	*2. Time:* 5 minutes
and / or	*3. Origin (zip code)* ________ *Or location description other than zip code:** San Pablo & Dwight	*and*	*Destination (zip code)* ________ *Or location description other than zip code:** 2560 9th Street, Berkeley



and / or — Or location description other than zip code:* San Pablo & Dwight
* Address, intersection, landmark, etc.

Or location description other than zip code:* 2560 9th Street, Berkeley
* Address, intersection, landmark, etc.

6. Will any part of this current trip be taken on public transit?
☒ Yes (a) ☐ No (b)

Choose most likely answer for #7

7. If you were not walking for this trip, how would you be traveling?
☒ Car (a) ☐ Carpool (b) ☐ Transit (c) ☐ Bicycle (d) ☐ I would not

More than one response is ok for #8

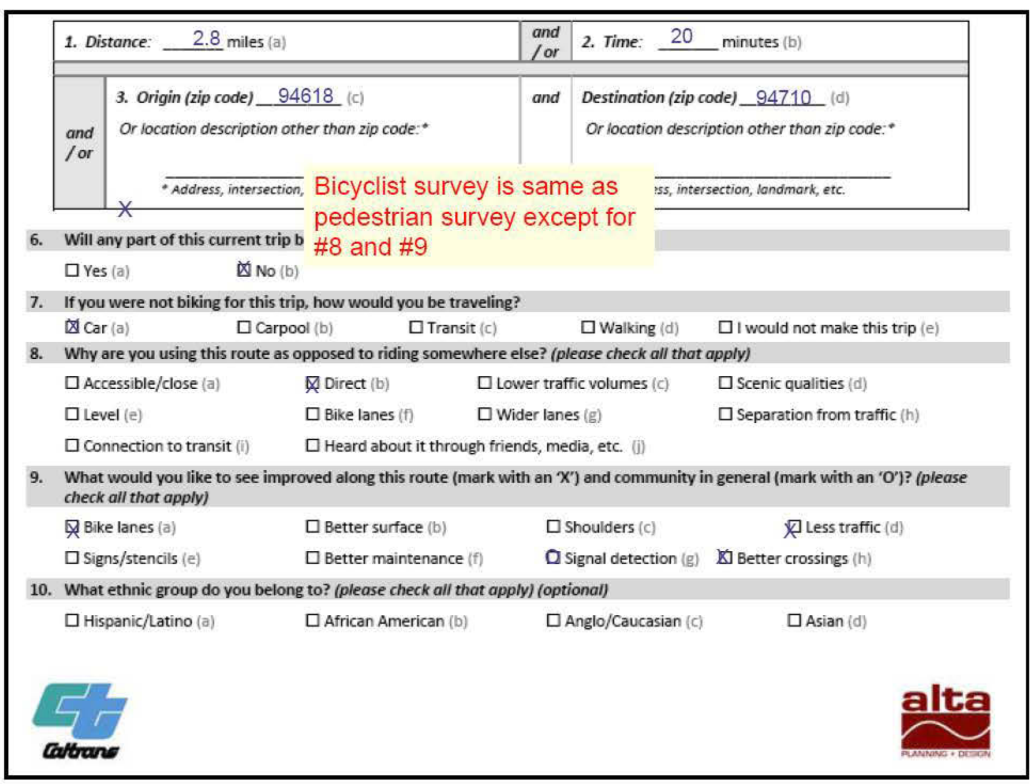
8. Why are you using this route as opposed to walking somewhere else? *(please check all that apply)*
☒ Accessible/close (a) ☒ Direct (b) ☐ Lower traffic volumes (c) ☐ Heard about it through friends, media, etc.(d)
☐ Scenic qualities (e) ☐ Level (f) ☐ Personal safety (g) ☒ Connection to transit (h)

9. What would you like to see improved along this route (mark with an 'X') and community in general (mark with an 'O')? *(please check all that apply)*
☒ Wider sidewalks (a) ☒ Better surface (b) ☐ Better street crossings (c)
☒ More shade trees (e) ☐ Benches (f) ☐ Access to shops, etc. (g)
☐ More sidewalks (h)

Note "x" vs "o" responses

10. What ethnic group do you belong to? *(please check all that apply) (optional)*
☐ Hispanic/Latino (a) ☐ African American (b) ☒ Anglo/Caucasian (c) ☒ Asian (d)

All questions are optional, but #10 is clearly marked optional



1. *Distance:* 2.8 miles (a) — *and / or* — 2. *Time:* 20 minutes (b)

3. *Origin (zip code)* 94618 (c) — *and* — *Destination (zip code)* 94710 (d)

and / or — *Or location description other than zip code:** — *Or location description other than zip code:**
* Address, intersection, landmark, etc.

Bicyclist survey is same as pedestrian survey except for #8 and #9

6. Will any part of this current trip b[e taken on public transit?]
☐ Yes (a) ☒ No (b)

7. If you were not biking for this trip, how would you be traveling?
☒ Car (a) ☐ Carpool (b) ☐ Transit (c) ☐ Walking (d) ☐ I would not make this trip (e)

8. Why are you using this route as opposed to riding somewhere else? *(please check all that apply)*
☐ Accessible/close (a) ☒ Direct (b) ☐ Lower traffic volumes (c) ☐ Scenic qualities (d)
☐ Level (e) ☐ Bike lanes (f) ☐ Wider lanes (g) ☐ Separation from traffic (h)
☐ Connection to transit (i) ☐ Heard about it through friends, media, etc. (j)

9. What would you like to see improved along this route (mark with an 'X') and community in general (mark with an 'O')? *(please check all that apply)*
☒ Bike lanes (a) ☐ Better surface (b) ☐ Shoulders (c) ☒ Less traffic (d)
☐ Signs/stencils (e) ☐ Better maintenance (f) ☐ Signal detection (g) ☒ Better crossings (h)

10. What ethnic group do you belong to? *(please check all that apply) (optional)*
☐ Hispanic/Latino (a) ☐ African American (b) ☐ Anglo/Caucasian (c) ☐ Asian (d)

Who to Survey

- Use a method to select who to survey
  - Ask every person who walks/bikes by
  - Ask every third person who walks/bikes by
  - Ask the next person who walks/bikes by after last survey is completed

End of Surveys

When you have completed all of your survey sessions, please return your forms to the volunteer coordinator.

C. INSTRUCTIONS FOR SENDING FUTURE DATA

Send count and survey data to:

data@bikepeddocumentation.org

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D. BICYCLE MODEL VARIABLES CONSIDERED

Table D-1: T-Test Results: AM and Midday High and Low Bicycle Count Locations

Variable	Bike Count Locations Mean		T-Score
	Highest 20	Lowest 20	
Built Environment			
Commercial/Office Acreage	16	19	-0.40
Total Employment	3401	2633	0.40
Employment Land Use Acres	32	51	-1.81
Employment Density	73	39	1.58
Attraction Acres	18	29	-1.65
Industrial Acres	3	9	-1.48
Population Density	10	10	0.17
Total Households	163	183	-0.24
Single Family Housing Units	132	127	0.07
Multi Family Housing Units	319	171	1.09
Total Housing Units	457	311	0.78
Total Housing Unit Density	27	18	1.00
Single Family Housing Unit Density	7	5	0.77
Multi Family Housing Unit Density	20	13	0.91
Residential Acres	60	71	-0.58
Half Mile Buffer Acres	200	221	-1.04
Transportation System/Travel Trends			
Max Daily Travel Volume	297	288	0.17
Half Mile Street Network Feet	41,390	36,175	0.77
Number of Crosswalks	2.2	2.4	-0.39
Transit Stops	8	10	-0.46
Transit Ridership	5245	4431	0.22
Half Mile Bike Network Feet	10,699	9,469	0.88
Commuters by Walking	18	16	0.16
Commuters by Transit	33	25	0.60
Commuters by Bike	7	1	**2.97***
Total Commuting Population	442	345	0.46
Average Daily Travel Volumes	125	145	-0.93
Socio-Economic Characteristics			
Minority Population	312	418	-0.44
Over 65 Population	87	99	0.29
Households Without Vehicle	69	47	0.61
Below Poverty Households	29	29	0.005
Under 18 Population	169	234	-0.52
Hispanic Population	260	327	-0.34
All Population	896	886	0.02

Table D-2: T-Test Results: AM High and Low Bicycle Count Locations

Variable	Bike Count Locations Mean Highest 20	Bike Count Locations Mean Lowest 20	T-Score
Built Environment			
Commercial/Office Acreage	19	28	-0.94
Total Employment	3,377	1,923	0.99
Employment Land Use Acres	38	55	-1.17
Employment Density	67	30	1.93
Attraction Acres	20	26	-1.19
Industrial Acres	3	7	-1.55
Population Density	11	9	0.77
Total Households	145	171	-0.41
Single Family Housing Units	109	105	0.90
Multi Family Housing Units	213	194	0.30
Total Housing Units	327	306	0.22
Total Housing Unit Density	27	65	-0.75
Single Family Housing Unit Density	7	31	-0.91
Multi Family Housing Unit Density	20	34	-0.57
Residential Acres	54	56	-0.18
Half Mile Buffer Acres	193	211	-0.63
Transportation System/Travel Trends			
Max Daily Travel Volume	326	291	0.62
Half Mile Street Network Feet	38,523	36,585	0.26
Number of Crosswalks	2.25	2.15	0.17
Transit Stops	10	11	-0.25
Transit Ridership	4,971	2,273	1.03
Half Mile Bike Network Feet	10,857	9,749	0.59
Commuters by Walking	16	13	0.63
Commuters by Transit	22	23	-0.08
Commuters by Bike	6	3	1.47
Total Commuting Population	351	303	0.44
Average Daily Travel Volumes	140	132	0.40
Socio-Economic Characteristics			
Minority Population	308	367	-0.27
Over 65 Population	59	95	-1.59
Households Without Vehicle	42	47	-0.20
Below Poverty Households	28	32	-0.16
Under 18 Population	175	217	-.38
Hispanic Population	249	314	-0.38
All Population	757	775	-0.06

Table D-3: T-Test Results: Midday High and Low Bicycle Count Locations

Variable	Bike Count Locations Mean		
	Highest 20	Lowest 20	T-Score
Built Environment			
Commercial/Office Acreage	18	21	-0.58
Total Employment	3,357	2,342	0.50
Employment Land Use Acres	32	43	-1.19
Employment Density	72	36	1.45
Attraction Acres	19	23	-0.68
Industrial Acres	1.19	3.37	-1.17
Population Density	10	12	-0.75
Total Households	128	240	-1.58
Single Family Housing Units	127	148	-0.41
Multi Family Housing Units	292	228	0.47
Total Housing Units	427	388	0.22
Total Housing Unit Density	72	18	1.10
Single Family Housing Unit Density	32	5	1.06
Multi Family Housing Unit Density	40	13	1.12
Residential Acres	62	76	-0.86
Half Mile Buffer Acres	192	212	-0.69
Transportation System/Travel Trends			
Max Daily Travel Volume	256	318	-1.18
Half Mile Street Network Feet	41,370	34,184	0.95
Number of Crosswalks	2	2.55	-1.07
Transit Stops	9	12	-0.49
Transit Ridership	3,675	4,115	-0.12
Half Mile Bike Network Feet	10,402	9,351	0.71
Commuters by Walking	17	12	1.07
Commuters by Transit	24	33	-0.46
Commuters by Bike	8	1	3.33
Total Commuting Population	407	405	0.008
Average Daily Travel Volumes	120	154	-1.41
Socio-Economic Characteristics			
Minority Population	158	572	-1.89
Over 65 Population	88	109	-0.55
Households Without Vehicle	52	67	-0.38
Below Poverty Households	10	50	-1.75
Under 18 Population	91	329	-2.28
Hispanic Population	128	450	-1.90
All Population	729	1,085	-0.90

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E. PEDESTRIAN MODEL VARIABLES CONSIDERED

Table E-1: T-Test Results: AM and Midday High and Low Pedestrian Count Locations

Variable	Pedestrian Count Locations Mean Highest 20	Pedestrian Count Locations Mean Lowest 20	T-Score
Built Environment			
Commercial/Office Acreage	24	13	**2.25***
Total Employment	5,334	875	**2.86***
Employment Land Use Acres	56	35	**2.18***
Employment Density	89	23	**3.26***
Pedestrian Attraction Acres	22	24	-0.32
Industrial Acres	8	5	0.58
Population Density	17.4	6.8	**4.51***
Total Households	330	112	**3.01***
Single Family Housing Units	242	82	**3.39***
Multi Family Housing Units	481	92	**3.35***
Total Housing Units	730	184	**3.67***
Total Housing Unit Density	31	58	-0.56
Single Family Housing Unit Density	7	29	-.88
Multi Family Housing Unit Density	23.9	28.9	-0.21
Residential Acres	93	62	1.86
Half Mile Buffer Acres	268	185	**3.17***
Transportation System/Travel Trends			
Max Daily Travel Volume	360	262	**2.01***
Half Mile Street Network Feet	64,310	25,578	**5.92***
Number of Crosswalks	3.45	1.8	**2.86***
Transit Stops	17.3	4.6	**5.25***
Transit Ridership	9,395	512	**3.07***
Half Mile Bike Network Feet	10,910	7,732	**3.08***
Commuters by Walking	42	7	**4.59***
Commuters by Transit	81	9	**3.37***
Commuters by Bike	7	.85	**3.73***
Total Commuting Population	765	195	**3.87***
Average Daily Travel Volumes	131	142	-0.57
Socio-Economic Characteristics			
Minority Population	861	199	**2.62***
Over 65 Population	156	65	**2.42***
Households Without Vehicle	151	20	**3.40***
Below Poverty Households	83	13	**2.34***
Under 18 Population	465	128	**2.53***
Hispanic Population	849	157	**2.65***
All Population	1,829	481	**3.68***

Table E-2: T-Test Results: AM High and Low Pedestrian Count Locations

Variable	Pedestrian Count Locations Mean Highest 20	Pedestrian Count Locations Mean Lowest 20	Variable
Built Environment			
Commercial/Office Acreage	25	18	0.90
Total Employment	6,385	1,404	**2.57***
Employment Land Use Acres	57	39	1.74
Employment Density	99	29	**2.94***
Pedestrian Attraction Acres	23	29	-0.93
Industrial Acres	4.45	3.44	0.33
Population Density	18	7	**3.62***
Total Households	341	98	**2.87***
Single Family Housing Units	238	94	**2.71***
Multi Family Housing Units	489	132	**3.15***
Total Housing Units	733	231	**3.25***
Total Housing Unit Density	34	61	-0.53
Single Family Housing Unit Density	6	31	-0.96
Multi Family Housing Unit Density	28	30	-0.07
Residential Acres	92	54	**2.29***
Half Mile Buffer Acres	267	193	**2.73***
Transportation System/Travel Trends			
Max Daily Travel Volume	357	253	1.82
Half Mile Street Network Feet	62,527	31,954	**3.21***
Number of Crosswalks	3.4	1.45	**3.34***
Transit Stops	19	6	**3.58***
Transit Ridership	11,886	1,170	**2.98***
Half Mile Bike Network Feet	11,429	10,092	.73
Commuters by Walking	40	11	**3.30***
Commuters by Transit	83	11	**3.16***
Commuters by Bike	7	4	1.54
Total Commuting Population	765	242	**3.30***
Average Daily Travel Volumes	137	115	1.47
Socio-Economic Characteristics			
Minority Population	891	133	**2.83***
Over 65 Population	159	60	**3.05***
Households Without Vehicle	159	23	**3.42***
Below Poverty Households	86	10	**2.33***
Under 18 Population	481	90	**2.59***
Hispanic Population	886	115	**2.77***
All Population	1,860	473	**3.38***

Table E-3: T-Test Results: Midday High and Low Pedestrian Count Locations

Variable	Pedestrian Count Locations Mean Highest 20	 Lowest 20	Variable
Built Environment			
Commercial/Office Acreage	35	11	**3.72***
Total Employment	5,790	877	**3.46***
Employment Land Use Acres	62	36	**2.85***
Employment Density	95	23	**3.82***
Pedestrian Attraction Acres	19	26	-0.82
Industrial Acres	5	6	-0.20
Population Density	17	7	**3.93***
Total Households	318	125	**2.71***
Single Family Housing Units	221	91	**2.95***
Multi Family Housing Units	509	97	**3.94***
Total Housing Units	734	202	**4.00***
Total Housing Unit Density	31	59	-0.59
Single Family Housing Unit Density	7	29	-0.89
Multi Family Housing Unit Density	24	29	-0.21
Residential Acres	88	63	**2.17***
Half Mile Buffer Acres	274	188	**3.83***
Transportation Systems/Travel Trends			
Max Daily Travel Volume	299	257	1.05
Half Mile Street Network Feet	66,845	26,221	**6.31***
Number of Crosswalks	3.1	1.8	**2.43***
Transit Stops	19	5	**5.83***
Transit Ridership	8,488	538	**2.99***
Half Mile Bike Network Feet	13,169	8,128	**2.98***
Commuters by Walking	39	6	**5.78***
Commuters by Transit	78	12	**3.21***
Commuters by Bike	8	1	**3.93***
Total Commuting Population	718	219	**3.66***
Average Daily Travel Volumes	109	141	-2.10
Socio-Economic Characteristics			
Minority Population	738	240	2.03
Over 65 Population	183	73	**4.04***
Households Without Vehicle	159	21	**4.24***
Below Poverty Households	75	13	**2.22***
Under 18 Population	418	145	2.03
Hispanic Population	835	183	**2.43***
All Population	1,700	539	**3.41***

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APPENDIX F: SUMMARY OF COMPARISON SURVEYS

NON-MOTORIZED TRANSPORTATION PILOT PROJECT

The objective of the Non-Motorized Transportation Pilot Project is to compare bicycling and walking levels in selected pilot communities throughout the United States. This data is hard to obtain and therefore two data collecting methods are utilized. The first method is a mail-out survey card sent to the residents of each community, requesting that they keep a travel diary. The second method is administering pedestrian and cyclist counts and surveys in each community, based on the National Bicycle & Pedestrian Documentation Project (NBPD) methodology.

Marin County and Minneapolis, Minnesota are two of the four communities selected to participate in the Non-Motorized Transportation Pilot Project.

MARIN COUNTY, CA & MINNEAPOLIS, MN

http://www.walkbikemarin.org/

http://www.tlcminnesota.org/Resources/Newsletters/May%202007/bwtcupdate.html

The objective of the NTPP Count/Survey program in Marin County, CA and Minneapolis, MN is two-fold. First, the program establishes a baseline of walking/bicycling activity at key locations, so that changes in activity levels can be measured in 2010 after NTPP programs and projects have been implemented. Second, the count/survey data provides better understanding of travel patterns. Data regarding where bicyclists and pedestrians live, trip purpose, trip length, travel frequency, alternate modes, factors for route choice, seasonal behavior, and desires for improvements and demographic data can help identify correlations and causations within travel behavior, leading to more informed modeling, along with facilities and programs that properly respond to community needs and conditions.

The survey questions developed for the NTPP and participating jurisdictions were customized from the NBPD by the four (4) pilot communities and the VTSC. The surveys were designed to be conducted in the field as intercept surveys, to maximize the statistical validity of the results. Mail-in, phone, and other surveys have shown to be heavily biased in past survey efforts. The surveys were conducted at selected count locations during or immediately before or after count periods. Surveyors were identified by a yellow jersey and name tag, and trained on how to ask questions.

NATIONAL BICYCLE & PEDESTRIAN DOCUMENTATION PROJECT

www.bikepeddocumentation.org

The NBPD is a joint national effort by the Institute of Transportation Engineers (ITE) Pedestrian & Bicycle Council, and Alta Planning + Design. The NBPD identifies a consistent count and survey methodology and count dates, collects count and survey data nationwide, and analyzes the data to identify walking and bicycling trends and patterns.

Thanks to the efforts of local agencies and organizations nationwide, the NBPD has been able to greatly expand its database of count and survey data and develop estimates of annual and peak period use and benefits. Some of the data were collected during the national count periods, while others were not. Together the data reveal trends and patterns that will be of interest to anybody working in the non-motorized field.

Counts and surveys taken on multi-use paths are the most commonly-available data, and are the subject of this initial analysis. Pedestrian and on-street bicycle use data and estimates will be forthcoming in future newsletters.

The data collected as part of this program are available free of charge to any public agency or research institution. Any local agency or organization can conduct counts and surveys.

THUNDERHEAD ALLIANCE "BENCHMARKING REPORT 2007"

http://www.thunderheadalliance.org/benchmarking.htm

The Thunderhead Alliance is a coalition of bicycling and walking advocacy groups promoting safe bicycling and walking. The Alliance is composed of over 120 member organizations in 49 states and one Canadian province.

The Thunderhead Alliance "Benchmarking Report 2007" establishes a benchmark for bicycling and walking levels in the United States. The objective of the Benchmarking Report was to promote data collection and availability. The report attempts to "fill in the gap" by measuring:

- Bicycling and walking levels and demographics
- Bicycle and pedestrian facilities.
- Bicycle and pedestrian policies and provisions.
- Funding for bicycle and pedestrian projects.
- Bicycle and pedestrian staffing levels.
- Written bicycle infrastructure including bike lanes, paths, signed bike routes, and bicycle parking.
- Bike-transit integration including presence of bike racks on buses, bike parking at transit stops, and hours per week that bicycles are allowed on trains.
- Public health indicators including levels of obesity, physical activity, diabetes, and high blood pressure.

Source: Thunderhead Alliance, "Bicycling and Walking in the U.S." (2007): 15.

The method of data collection utilized existing national data sources and a survey of the 50 most populated cities in the U.S. This survey was sent to leaders of Thunderhead Alliance organizations, government officials and advocates, capitalizing on the network and relationship between them to obtain the data relating to factors influencing bicycling and walking and the establishment of bicycling and walking levels. This report allows jurisdictions across the nation to compare their bicycling and walking statistics with each other.

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINSTRATION "NATIONAL SURVEY OF BICYCLIST AND PEDESTRIAN ATTITUDES AND BEHAVIORS"

http://www.nhtsa.dot.gov/

The "National Survey of Bicyclist and Pedestrian Attitudes and Behaviors" is jointly sponsors by the U.S. Department of Transportation's National Highway Traffic Safety Administration and the Bureau of Transportation Statistics. The goal of the survey was to understand the level of bicycling and pedestrian activity as well as attitudes towards bicycling and walking. The survey was designed to function as a benchmark.

The telephone surveys were conducted with 9,616 respondents 16 years or older in Summer 2002. The participants were asked to describe their bicycling and walking activities in the 30 days prior to the survey.

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APPENDIX G: BACKGROUND DATA

The research team has collected and summarized background data for each of the eighty count locations, for use in development of a bicycle and pedestrian demand model. The background factors, sources, and methodology for measurement are listed in this appendix.

Seamless Background Data
Metadata

Variable Type		Variable	Description	Data Sources	Field Header	Methods
Dependent Variables	**Weekday Bike Travel Demand**	**Trips per 2-Hour Peak Period** (7AM to 9AM or 4PM to 6PM) **Trips per Peak Hour** (four highest consecutive 15 minute intervals during the peak period)	Total adult and child bike trips at the intersection or path during a two hour AM or PM peak period, or an AM or PM peak hour.	Count conducted in the field	AM_Adult_Bike AM_Child_Bike AM_Adult_Bike_Peak AM_Child_Bike_Peak PM_Adult_Bike PM_Child_Bike PM_Adult_Bike_Peak PM_Child_Bike_Peak	Count fields with "Peak" as suffix represent the peak hour, which is the four highest consecutive 15-min intervals during the peak period. The other fields (i.e. without the "Peak" suffix) represent the 2-hour peak period count.
	Weekend Bike Travel Demand	**Trips per 2-Hour Peak Period** (12noon to 2PM) **Trips per Peak Hour** (four highest consecutive 15 minute intervals during the peak period)	Total adult and child bike trips at the intersection or path during a two hour peak period, or an midday peak hour.	Count conducted in the field	MID_Adult_Bike MID_Child_Bike MID_Adult_Bike_Peak MID_Child_Bike_Peak	Count fields with "Peak" as suffix represent the peak hour, which is the four highest consecutive 15-min intervals during the peak period. The other fields (i.e. without the "Peak" suffix) represent the 2-hour peak period count.

Variable Type		Variable	Description	Data Sources	Field Header	Methods
	Weekday Pedestrian Travel Demand	**Trips per 2-Hour Peak Period** (7AM to 9AM or 4PM to 6PM) **Trips per Peak Hour** (four highest consecutive 15 minute intervals during the peak period)	Total adult and child bike trips at the intersection or path during a two hour AM or PM peak period, or an AM or PM peak hour.	Count conducted in the field	AM_Adult_Ped AM_Child_Ped AM_Adult_Ped_Peak AM_Child_Ped_Peak PM_Adult_Ped PM_Child_Ped PM_Adult_Ped_Peak PM_Child_Ped_Peak	Count fields with "Peak" as suffix represent the peak hour, which is the four highest consecutive 15-min intervals during the peak period. The other fields (i.e. without the "Peak" suffix) represent the 2-hour peak period count.
	Weekend Pedestrian Travel Demand	**Trips per 2-Hour Peak Period** (12noon to 2PM) **Trips per Peak Hour** (four highest consecutive 15 minute intervals during the peak period)	Total adult and child bike trips at the intersection or path during a two hour peak period, or an midday peak hour.	Count conducted in the field	MID_Adult_Ped MID_Child_Ped MID_Adult_Ped_Peak MID_Child_Ped_Peak	Count fields with "Peak" as suffix represent the peak hour, which is the four highest consecutive 15-min intervals during the peak period. The other fields (i.e. without the "Peak" suffix) represent the 2-hour peak period count.
Independent Variables	**Socio-Economic Characteristics**	Hispanic	Hispanic population within ¼ mile or ½ mile of intersection	2000 Census	Hispanic_Pop_QM Hispanic_Pop_HM	Intersected CBG with site buffers, calculated through area apportioning
		Racial Minority	Blacks, Asians and Other Race within ¼ mile or ½ mile of intersection	2000 Census	Minority_Pop_QM Minortiy_Pop_HM	Intersected CBG with site buffers, calculated through area apportioning

Variable Type		Variable	Description	Data Sources	Field Header	Methods
		Poverty	Households below poverty within ¼ mile or ½ mile of intersection	2000 Census	Below_Poverty_Households_QM Below_Poverty_Households_HM	Intersected CBG with site buffers, calculated through area apportioning
		Youth	Population under 18 years within ¼ mile or ½ mile of intersection	2000 Census	Under_18_Pop_QM Under_18_Pop_HM	Intersected CBG with site buffers, calculated through area apportioning
		Elderly	Population over 65 years within ¼ mile or ½ mile of intersection	2000 Census	Over_65_Pop_QM Over_65_Pop_HM	Intersected CBG with site buffers, calculated through area apportioning
		Car Ownership	Households without a vehicle within ¼ mile or ½ mile of intersection	2000 Census	Households_No_Vehicle_QM Households_No_Vehicle_HM	Intersected CBG with site buffers, calculated through area apportioning
	Built Environment Characteristics	Population Density	Population per residential acre within ¼ mile or ½ mile of intersection	2000 Census; 2006 SANDAG Land Use Shapefile	Population_Density_QM Population_Density_HM See also: All_Population_QM Residential_Acres_QM	Population determined through area apportioning, divided by total residential acreage
		Housing Unit Density	Housing units per residential acre within ¼ mile or ½ mile of intersection	2000 Census; 2006 SANDAG Land Use Shapefile	Total_Housing_Unit_Density_QM Total_Housing_Unit_Density_HM See also: Total_Housing_Units_QM Residential_Acres_QM	Number of housing units determined through area apportioning, divided by total residential acreage

Variable Type		Variable	Description	Data Sources	Field Header	Methods
		MF Unit Density	Multi-family housing units per residential acre within ¼ mile or ½ mile of intersection	2000 Census; 2006 SANDAG Land Use Shapefile	MF_Housing_Unit_Density_QM MF_Housing_Unit_Density_HM See also: MF_Housing_Units_QM Residential_Acres_QM	Number of MF housing units determined through area apportioning, divided by total
		Employment Density	Employees per nonresidential acre within ¼ mile or ½ mile of intersection	SANDAG; 2006 SANDAG Land Use Shapefile	Employment_Density_QM Employment_Density_HM See also: Total_Employment_within_QM Total_Employment_within_HM Employment_LU_Acres_QM Employment_LU_Acres_HM	Intersected TAZ (with employment data) with site buffers, calculated through area apportioning
		Activity Centers	Number of Land Use polygons within the buffer of the count site	2007 SANDAG Land Use shapefile	Colleges Govt Hospt MjrEmpl MjrAttrct RgnlShop TotalActCn	Summarize the number of land use polygons by category within the buffer using GIS
		Pedestrian Generating and Attracting Land Uses	Acreage of pedestrian generating or attracting land use types within ¼ mile or ½ mile of intersection	2006 SANDAG Land Use Shapefile	Pedestrian_Attraction_Acres_QM Pedestrian_Attraction_Acres_HM	Combined acreages of schools, parks, civic facilities, neighborhood shopping, and beaches
		Industrial Acreage	Acreage of industrial land uses within ¼ mile or ½ mile of intersection	2006 SANDAG Land Use Shapefile	Industrial_Acres_QM Industrial_Acres_HM	Selected landuses with industrial attributes, calculated acres

Variable Type		Variable	Description	Data Sources	Field Header	Methods
		Residential Acreage	Acreage of residential land uses within ¼ mile or ½ mile of intersection	2006 SANDAG Land Use Shapefile	Residential_Acres_QM Residential_Acres_HM	Selected land uses with residential attributes, calculated acres
		Commercial/Office Acreage	Acreage of commercial land uses within ¼ mile or ½ mile of intersection	2006 SANDAG Land Use Shapefile	Comm/Office_Acres_QM Comm/Office_Acres_HM	Selected land uses with commercial/office attributes, calculated acreage
		Mixed Use Index	Counter was required to determine if area contained a mixture of land uses	Recorded by counter on checklist	Land Use Mix 1 – Mix of different land uses 0 – No mix of different land uses	Observation
		Street Network and Bike Network Connectivity	Calculated length of street network within buffer of site	2006 SANGIS Road Shapefile 2006 SANDAG bike paths.shp	QM_Street_Network_Feet HM_Street_Network_Feet QM_Bike_Network_Feet HM_Bike_Network_Feet	Calculation tool
	Travel Characteristics	Bicycle Commuters	Number Bicycle Commuters within ¼ mile or ½ mile of intersection	2000 Census	Commuters_by_Bike_QM Commuters_by_Bike_HM	Intersected CBG with site buffers, calculated through area apportioning
		Walking Commuters	Number Pedestrian Commuters within ¼ mile or ½ mile of intersection	2000 Census	Commuters_by_Walking_QM Commuters_by_Walking_HM	Intersected CBG with site buffers, calculated through area apportioning

Variable Type		Variable	Description	Data Sources	Field Header	Methods
		Transit Ridership	Average daily ons/offs at transit stops within ¼ mile or ½ mile of intersection	2005 SANDAG tcov file 2000 census	For average daily ons/offs, see: Ridership_QM Ridership_HM For commuters who commute by transit data, see: Commuters_by_Transit_QM Commuters_by_Transit_HM	Stops with on/off data joined to buffer, totals calculated Intersected CBG with site buffers, calculated through area apportioning
	Transportation Facility Characteristics	Traffic Volumes	Average and Maximum ADT within ¼ mile or ½ mile of intersection	2000 SANDAG hcov file	Average_ADTVL_QM Max_ADTVL_QM Average_ADTVL_HM Max_ADTVL_HM	Summarized traffic count data by averaging or finding maximum with intersection buffer
		Traffic Speeds	Posted Speeds	Collected in the field	ISPD N/S ISPD E/W	Data collected by some of the field workers is unreliable
		Presence of Sidewalk	Number of intersection approaches with sidewalks	Collected in the field	Total: Number_of_Sidewalks By approach: Sidewalk_N Sidewalk_S Sidewalk_E Sidewalk_W	Collected via field review

Variable Type		Variable	Description	Data Sources	Field Header	Methods
		Presence of Bike Lane	Number of intersection approaches with bike lanes	Collected in the field	Total: Number_of_Bike_Lanes By approach: Bike_Lane_N Bike_Lane_S Bike_Lane_E Bike_Lane_W	Collected via field review
		Presence of Bike Path	Number of intersection approaches with bike paths	Collected in the field	Total: Number_of_Bike_Paths By approach: Bike_Paths_N Bike_Paths_S Bike_Paths_E Bike_Paths_W	Collected via field review
		Presence of Signalized Control	Number of variable indicated	Collected in the field	Total: Number_of_Cross_Signals By approach: Cross_Signal_N Cross_Signal_S Cross_Signal_E Cross_Signal_W	Collected via field review
		Presence of Crosswalk	Number of intersection approaches with crosswalks	Collected in the field	Total: Number_of_Crosswalks By approach: Crosswalk_N Crosswalk_S Crosswalk_E Crosswalk_W	Collected via field review

Variable Type		Variable	Description	Data Sources	Field Header	Methods
		Transit	Transit Stops per acre within ¼ mile of intersection	2005 SANDAG Transit Stops shapefile	Transit_Stops_QM Transit_Stops_HM	Joined to site buffer, totaled
		Pathway Access	Number of access points to path within buffer area	SANDAG Bicycle Facilities shapefile and Google Earth aerial photography	Trail Access	Aerial photography data capture
		Pathway Length	Length in miles of pathway facility	SANDAG Bicycle Facilities shapefile	See: Street Network and Bike Network variable	
		Network Quality	Length in Feet of total pedestrian and bicycle transportation network	SANDAG Bicycle Facilities SanGIS roads layer	Class I_QM Class 2_QM Class 3_QM Roadway_QM Class 1_HM Class 2_HM Class 3_HM Roadway_HM	Used GIS to calculate total length of pedestrian and bicycle transportation network within ¼ and ½ mile (street network) buffer of site.
		Aesthetics	Aesthetics score is a composite total of points from checklist that counter was required to fill out (higher score equals "better" aesthetics)	Recorded by Counter on checklist	Aesthetics	Observation
	Natural Environment	Weather	Classified into three categories: sunny, overcast, or rainy	Recorded by Counter on checklist	Weather 1 – Sunny 2 – Overcast 3 - Precipitation	Observation

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