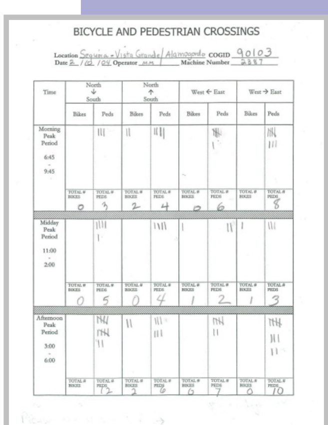
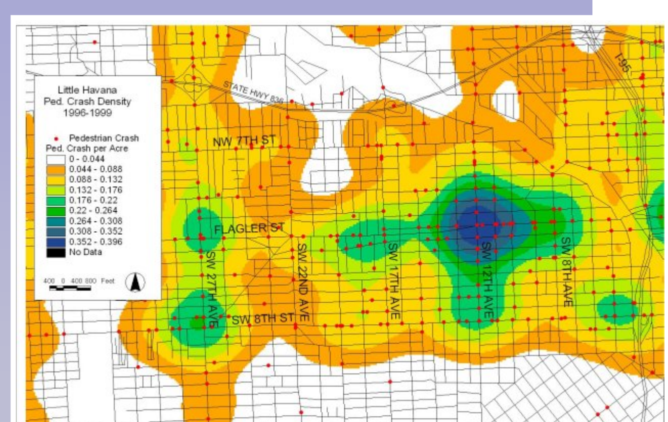
Pedestrian and Bicycle Data Collection

in United States Communities

Quantifying Use, Surveying Users, and Documenting Facility Extent

January 2005





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FHWA DISCLAIMER

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Pedestrian and Bicycle Data Collection in United States Communities: Quantifying Use, Surveying Users, and Documenting Facility Extent

SUMMARY

INTRODUCTION

Communities throughout the United States are implementing projects and programs to integrate pedestrian and bicycle travel into the transportation system. Under the Intermodal Surface Transportation Efficiency Act (ISTEA) and Transportation Equity Act for the 21st Century (TEA-21), Federal Aid Highway Program funding for pedestrian and bicycle facilities and programs increased from $17.1 in million in FY 1991 to $422.7 million in FY 2003 *(1)*. Greater funding has contributed to an increase in shared-use pathways, paved shoulders, bike lanes, sidewalks, and safer roadway crossings in many parts of the United States.

As pedestrian and bicycle transportation systems are improved, many communities have begun to ask questions about the use and extent of pedestrian and bicycle facilities:

- Where is pedestrian and bicycle activity taking place?
- What effect does facility construction have on levels of bicycling and walking?
- What are the demographic characteristics of non-motorized transportation users?
- How many pedestrian and bicycle facilities are available?
- Where are existing pedestrian and bicycle facilities?
- What is the quality of pedestrian and bicycle facilities?
- Where are pedestrian and bicycle crashes occurring?

This study was conducted to help practitioners determine the most accurate and efficient way to answer these questions in their own communities. It provides information such as methods and optimum timing for pedestrian and bicycle data collection; emerging technologies that can be used to gather and analyze data; and benefits, limitations, and costs of different techniques.

STUDY PURPOSE

Data on the use and extent of pedestrian and bicycle facilities have been collected by a number of local, regional, and state agencies. Information from these communities can begin to identify trends, increase national understanding about how and why communities collect pedestrian and bicycle data, and provide input for refining national data collection efforts. The purpose of this study is to share information about existing data collection efforts and provide the results to practitioners who want to collect pedestrian and bicycle data in their communities. It should be noted that this report presents information on the *methods* of data collection and not the data collected by the localities.

A case study approach was chosen to profile and evaluate different types of data collection efforts so that their successes (and lessons learned) could be shared with other communities. This report provides in-depth information about 29 different data collection efforts from local, regional, and state agencies in all parts of the United States. Each case study describes the history, purpose, methods, and lessons learned from the data collection project.

The first part of this report includes a summary of findings. This is followed with a discussion of how the case studies were solicited and written. The final section summarizes and critically assesses the 29 case studies.

NATIONAL DATA SOURCES

Although the purpose of the present study is to present local case studies, there are a number of national sources of data on bicycling and walking that should be discussed. Several Federal agencies gather pedestrian and bicycle data that can be useful for communities (see Table 1). Federal data sources include the U.S. Census (updated every 10 years) *(2)*, National Household Transportation Survey (NHTS) (updated every five to seven years) *(3)*, and the Omnibus Household Survey *(4)*. A National Survey of Pedestrian and Bicyclist Attitudes and Behaviors was implemented in 2002 *(5)*.

Data from the NHTS, Omnibus Household Survey, and the Survey of Pedestrian and Bicyclist Attitudes and Behaviors provide useful national information about the total number of trips, trip purposes, trip lengths, and opinions about pedestrian and bicycle travel. However, these data are generally not applicable at the local level (though the NHTS provides data for some metropolitan regions).

The Census provides pedestrian and bicycle commuting data for localized census block groups. However, Census data include only regular commuters—people making trips for non-work purposes, occasional pedestrian and bicycle commuters, and people who walk or bike for a portion of their commute are not considered.

There are several other sources of national pedestrian and bicycle data available from non-profit organizations. The Rails-to-Trails Conservancy maintains a TrailLink database, which provides the location, activities, and length of many of the country's major shared-use pathways *(6)*. A database of all programmed transportation enhancements projects is updated annually by the National Transportation Enhancements Clearinghouse *(7)*. The Coalition for Recreational Trails maintains a database of State trail projects that have received funding from the federal Recreational Trails Program *(8)*. All three databases are online and searchable, but include only major facilities.

SUMMARY OF FINDINGS

The 29 case study communities provided many insights into the current state of pedestrian and bicycle data collection in the United States. These findings are summarized below.

1. Many communities followed similar data collection processes, which included:

- Identifying the need for collecting data
- Planning the data collection process
- Collecting data
- Storing data
- Analyzing data
- Creating reports, including the results in plans and studies, and sharing the data with other staff, elected officials, granting agencies, and the public

2. Local representatives often cited a clear political purpose for their data collection projects to justify spending public resources on pedestrian and bicycle facilities. Communities have begun to see the value in tracking use over time to justify continued spending, particularly given budget constraints.

3. Communities have identified other benefits to collecting pedestrian and bicycle data. These include:

- Documenting changes in pedestrian and bicycle activity, safety, and facilities over time
- Determining peak hour and seasonal adjustment factors that can be used to estimate pedestrian and bicycle volumes
- Identifying locations for pedestrian and bicycle facility improvements
- Using data in pedestrian and bicycle planning documents
- Integrating non-motorized modes into multi-modal transportation models and analyses

4. Despite the benefits, the following reasons are often given for not collecting non-motorized data:

- The agency has a limited budget and staff resources for collecting data
- Departments charged with collecting data for the entire agency do not see pedestrians and bicycles as an important part of the transportation mix
- Data collection results could show too few pedestrians and bicyclists using facilities to justify spending on them

5. State, regional, and local agencies that collect pedestrian and bicycle data tailor their methodologies to meet the unique needs of their community. Therefore, there is no single best method of collecting use or facility data, rather a variety of different methods have evolved over time, based on the nature of local needs.

6. Many communities have found creative ways to reduce the cost of collecting bicycle and pedestrian data, such as incorporating automated technologies, using volunteer labor, and integrating non-motorized data into existing motor vehicle data collection programs.

7. There are some misconceptions about the cost of data collection for pedestrian and bicycle modes. For example, some automated counting technologies cost far less than practitioners expected, while some surveys and inventories required much more staff time than was expected.

8. Emerging technologies have improved the ability of agencies to collect data efficiently, but each technology was shown to have particular strengths and weaknesses.

9. As is the case for other modes of transportation, GIS (Geographic Information Systems) has had a tremendous impact on pedestrian and bicycle data collection methods. For example, GIS has made it possible to analyze spatial distributions and identify concentrations of pedestrian crashes in Miami-Dade County, FL.

10. Coordination between pedestrian and bicycle staff and data collection departments is critical. When staff members who do not normally work on pedestrian and bicycle transportation issues assist with data collection, analysis, or dissemination, it is critical that they understand the overall purpose of the data collection project.

11. Communities experienced varying levels of success in disseminating data. Many data collection projects are done by agency staff. It has been a challenge to find resources to formalize results and make them available publicly.

12. The localities collected pedestrian and bicycle use, survey, and facility data either on a one-time basis to answer a specific question or on a recurring basis to determine changes in trends over time.

13. Data collection that is repeated over time has been used to benchmark progress in building a pedestrian or bicycle system. Institutionalized data collection programs also produce data at regular intervals so they are available to agency staff, elected officials, and the public when a relevant issue about non-motorized use or facilities is raised.

METHODOLOGY

Selection of Case Study Communities

Information for the case studies was originally solicited by the project team in February 2004 by sending an e-mail request to the listservs of the State Bicycle and Pedestrian Coordinators, the Association of Pedestrian and Bicycle Professionals, and the American Planning Association. Descriptions of 64 data collection efforts were received. An additional 15 communities were contacted to provide adequate representation of exemplary data collection methods. Twenty-nine efforts were chosen for analysis.

It is important to note that this study does not represent an exhaustive analysis of *all* data collection efforts in the U.S. While some critical analysis was done to select the particular case studies profiled in this report, their inclusion depended to a great extent on the agency's interest and willingness to share detailed information about their data collection program.

The 29 case studies describe each of the profiled data collection efforts in detail (the full-length case study reports are available in the second section of this report). A list of other pedestrian and bicycle data collection examples in the United States is provided in Appendix A.

Characteristics of Case Study Communities

Communities throughout the United States provided information for the 29 pedestrian and bicycle data collection case studies. These data collection projects have been done by different types of governments, including cities, townships, counties, regional councils of governments, Metropolitan Planning Organizations (MPOs), and states. The communities collecting bicycle and pedestrian data range from small towns (Sandpoint, ID, population 6,000) to metropolises (New York, NY, population 8,000,0000). Of the completed case studies, 9 agencies are state, 7 are county/region/MPO, and 13 are town/city (see Table 2). The 29 final case studies include communities from 20 different states and the District of Columbia.

Case Study Format

A consistent structure was used to profile each of the 29 data collection efforts. The local contacts for the case studies provided information in each of the following categories:

- Purpose of Collecting Data
- Geographic Area Description
- Methodology
    - History of data collection effort
    - Data collection
    - Data storage
    - Data maintenance and management
    - Data analysis
    - Data dissemination
- Innovations and Accomplishments
- Lessons Learned
- Cost of Data Collection Effort
- Contact Information

After each case study had been drafted by the research team, the local contacts provided a quality control review to ensure accuracy. Local agency contact information is provided with each case study report.

ANALYSIS OF PEDESTRIAN AND BICYCLE DATA COLLECTION EFFORTS

The 29 efforts that have been profiled offer insights into the state of pedestrian and bicycle data collection in the United States. In the following section, the case studies are analyzed 1) by data collection category and 2) as a whole.

Data Collection Categories

The wide variety of pedestrian and bicycle data collection methods currently being used in the United States can be grouped into several broad categories. These categories include 1) quantifying use, 2) surveying users, and 3) documenting facility extent. These main categories can be divided into smaller categories, which are described briefly below. Many of the case studies could be included in more than one category, but they are grouped into the most representative category for the data collection effort as a whole (see Table 3).

1. Quantifying Use

1a. Manual Counts—Counts taken by field data collectors.

1b. Automated Counts—Counts taken using specialized equipment, such as active and passive infrared sensors, video cameras, Piezo film, in-pavement loop detectors, and pneumatic tubes. Data from these counters must be downloaded for analysis.

2. Surveying Users

2a. Targeting Non-Motorized Users—Surveys offered to people participating in pedestrian, bicycle, or other non-motorized activities. They are typically done in the field, and are different than general population surveys because they exclude people who are not participating in non-motorized activity at the time of the survey.

2b. Sampling a General Population—Random-sample surveys where all members of a community have an equal chance of being selected to participate. They include calling residents using random-digit dialing techniques, mailing paper surveys to a random sample of addresses, or other methods that provide a representative sample of the entire population of a community.

3. Documenting Facility Extent

Documenting facility extent involves several different types of data collection and analysis which may vary widely in scope and level of detail. Two methods used to document facility extent are implementing facility inventories and conducting spatial analyses. Facility inventories and spatial analysis can be complementary. For example, St. Petersburg, FL, Loudoun County, VA, and Maryland stored the results of roadway inventories in databases. All three agencies analyzed the data and then displayed the results on geographic information systems (GIS) maps.

3a. Inventories—Gathering information about roadway segments, crosswalk locations, property parcels, intersections, or other pedestrian and bicycle features. Facility inventories can be done in the field, through remote sensing (e.g., aerial photographs, video recordings, and satellite images), or gathered from secondary sources. These data are often stored in databases. Examples include inventories of road segments and property parcels.

3b. Spatial analyses—Displaying the extent of facilities on maps. Mapping software such as computer aided design (CAD) and GIS can be used to analyze and display facility data. CAD is commonly used to document and analyze features at a site. It can display and produce very accurate measurements. GIS includes both database and mapping capabilities. It is used to display the characteristics of databases in a spatial format, such as showing inventory results on maps and performing queries to identify facilities with specific characteristics. Typically, GIS is used as a planning tool to display data at a wider geographic scale and with less precise measurements than CAD.

Analysis by Data Collection Category

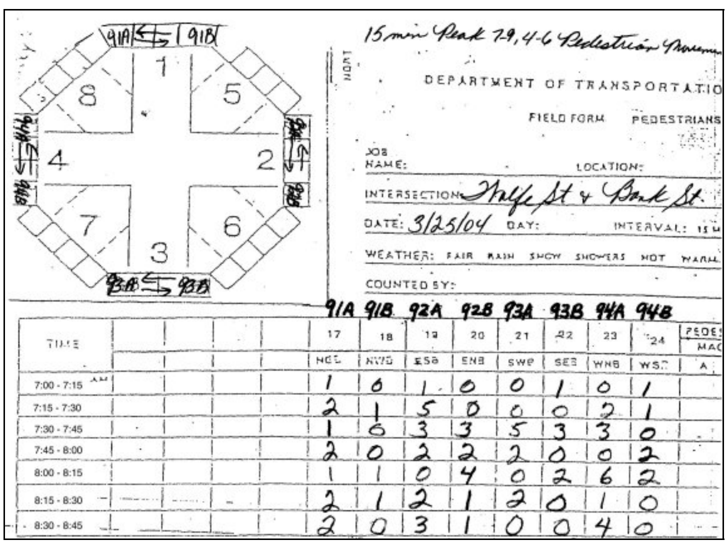
Grouping the 29 case studies into data collection categories makes it possible to compare similar types of techniques. Lessons learned in each of the data collection categories are listed below.

Manual Counts

Key Findings:

- 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)

Communities such as Albuquerque, NM, Baltimore, MD, and Washington, DC have included manual pedestrian and bicycle counts with existing motor vehicle counts to collect non-motorized data at little or no additional cost. Baltimore and Washington have institutionalized their counts over more than a decade, and Albuquerque and the New York Region (New York Metropolitan Transportation Council) plan to continue their counting efforts into the future.


15 min Peak 7-9, 4-6 Pedestrian Movement

DEPARTMENT OF TRANSPORTATIO

FIELD FORM PEDESTRIANS

JOB NAME: LOCATION:

INTERSECTION Wolfe St & Bank St.

DATE: 3/25/04 DAY: INTERVAL: 15 M

WEATHER: FAIR RAIN SNOW SHOWERS HOT WARM

COUNTED BY:

TIME	91A 17 NEL	91B 18 NWB	92A 19 ESB	92B 20 ENB	93A 21 SWB	93B 22 SEB	94A 23 WNB	94B 24 WSB	PEDES MAC A
7:00 - 7:15 AM	1	0	1	0	0	1	0	1	
7:15 - 7:30	2	1	5	0	0	0	2	1	
7:30 - 7:45	1	6	3	3	5	3	3	0	
7:45 - 8:00	2	0	2	2	2	0	0	2	
8:00 - 8:15	1	1	0	4	0	2	6	2	
8:15 - 8:30	2	1	2	1	2	0	1	0	
8:30 - 8:45	2	0	3	1	0	0	4	0	

Manual pedestrian count field data collection sheet (Geraldine Wilson, City of Baltimore, MD)

These counts are typically done by teams of two field data collectors, but Baltimore City staff suggested that there may be a need for three data collectors at intersections with heavy traffic, many turning vehicles, and high volumes of pedestrians.

Because the counts are done manually, both Baltimore and the New York Region have been able to incorporate additional observations, including the type of user (bicyclist, in-line skater/scooter, jogger, walker with dog, walker with stroller, walker only, or wheelchair user), bicyclist helmet use, drivers running red lights, and bicyclists riding in the proper direction. However, the manual counts are labor-intensive, which limits the number of locations where counts can be taken.

Automated Counts

Key Findings:

- Technologies can significantly reduce labor costs
- Settings and positioning of devices must be adjusted to maximize accuracy
- Accuracy of the counting device should be determined and reported along with the results
- Placement should minimize interference with pedestrians and bicyclists and potential for vandalism
- Most technologies work in rain and a wide variety of temperatures
- Most technologies do not count all types of non-motorized users and few can be used to observe behaviors

Technologies such as active and passive infrared sensors, Piezo film, time-lapse video, in-pavement loop detectors, and pneumatic tubes have reduced labor costs for simple counting efforts. Communities were generally happy with their count results, while recognizing some limitations of using automated methods.

Most of the agencies reported that they were able to purchase their automated counting device at a reasonable cost, and that it has resulted in overall cost savings for the data collection effort. Madison, WI and Boulder, CO installed loop detectors for under $1,000. The cost of each infrared sensor (Cheyenne, WY; Licking County, OH; Massachusetts), pneumatic tube (North Carolina), and strip of Piezo film (Iowa) ranged between $1,000 and $3,000. Davis purchased its time-lapse video system (camera, playback system, and videotapes) for about $7,000. These costs include the cost of the counting technology and supporting devices, but do not include equipment maintenance or data analysis.

Simple, inexpensive counters provide only gross-level measurements of users; they cannot determine whether a path user is a pedestrian or a bicyclist, whether a pedestrian is male or female, or whether a bicyclist is wearing a helmet. Some of these technologies can also generate inaccurate counts. Infrared sensors may count leaves and animals in addition to path users. In-pavement loop detectors must be properly located and carefully calibrated to detect all types of bicycles. In-pavement loop detectors, Piezo film, and pneumatic tubes can not be used to count pedestrians. Only active infrared sensors and video technology can be used to determine user type. Yet, both technologies are more expensive and still require staff to interpret the data before counts can be made. In the future, they may become more practical for non-motorized data collection.


In-pavement loop detector for automated bicycle counts (Michael Gardner-Sweeney, City of Boulder, CO)

Automated counters must be adjusted to proper settings in order to provide good data. This includes the amount of delay before the device can count another user, the angle of the video camera or infrared sensor, and the sensitivity of an in-pavement loop detector or pneumatic tube. These types of adjustments should be included when developing a plan for data collection.

Communities using automated counters installed them in ways that minimized their impact on pedestrians and bicyclists. Precautions were also taken to prevent vandalism. Nearly all the automated counting technologies worked in rain and a variety of temperatures[1].

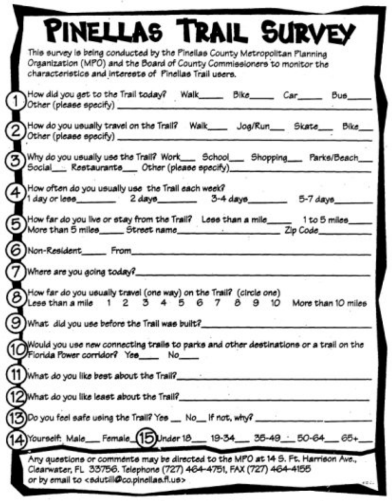
Surveys Targeting Non-Motorized Users

Key Findings:

- Can obtain detailed characteristics about people who make non-motorized trips
- Can provide baseline and follow-up data about non-motorized users
- Differences between survey participants and the overall population are important to recognize
- Survey instrument must be designed so that it is simple to understand and can be completed quickly
- Pre-planning and survey distribution logistics are critical to the quality of the survey
- Distribution of the survey should be done in a consistent way for all participants
- Labor costs can be high, unless volunteers are recruited

The non-motorized user surveys in Pinellas County, FL and Rhode Island were both distributed to shared-use path users. Findings were valuable to a wide range of local agencies and organizations. In both cases, surveys were given to path users on-site and interviewers recorded responses. Results of these surveys provided evidence that the facilities were being supported by many community members.

[1] Researchers in Massachusetts believed that heavy precipitation could obstruct and scatter active infrared beams.



PINELLAS TRAIL SURVEY

This survey is being conducted by the Pinellas County Metropolitan Planning Organization (MPO) and the Board of County Commissioners to monitor the characteristics and interests of Pinellas Trail users.

1. How did you get to the Trail today? Walk____ Bike____ Car____ Bus____ Other (please specify) ____
2. How do you usually travel on the Trail? Walk___ Jog/Run___ Skate___ Bike___ Other (please specify) ____
3. Why do you usually use the Trail? Work___ School___ Shopping___ Parks/Beach___ Social___ Restaurants___ Other (please specify)____
4. How often do you usually use the Trail each week? 1 day or less____ 2 days____ 3-4 days____ 5-7 days____
5. How far do you live or stay from the Trail? Less than a mile____ 1 to 5 miles____ More than 5 miles____ Street name____ Zip Code____
6. Non-Resident____ From____
7. Where are you going today?____
8. How far do you usually travel (one way) on the Trail? (circle one) Less than a mile 1 2 3 4 5 6 7 8 9 10 More than 10 miles
9. What did you use before the Trail was built?____
10. Would you use new connecting trails to parks and other destinations or a trail on the Florida Power corridor? Yes___ No___
11. What do you like best about the Trail?____
12. What do you like least about the Trail?____
13. Do you feel safe using the Trail? Yes __ No__ If not, why? ____
14. Yourself: Male___ Female___ 15. Under 18___ 19-34___ 35-49___ 50-64___ 65+___

Any questions or comments may be directed to the MPO at 14 S. Ft. Harrison Ave., Clearwater, FL 33756. Telephone (727) 464-4751, FAX (727) 464-4155 or by email to <sdutill@co.pinellas.fl.us>

Left: Field Interview for Shared-Use Path User Survey (Volunteers-in-Park Program; Steve Church, Rhode Island Department of Transportation); Right: Trail User Survey Instrument (Susan Dutill, Pinellas County, FL)

Both efforts required a large amount of staff and volunteer time to survey users in the field. The agencies found that coordinating the many different data collectors was challenging. In addition, inviting path users to participate in the survey in a consistent way without introducing bias into the study required good training and oversight of the volunteer data collectors.

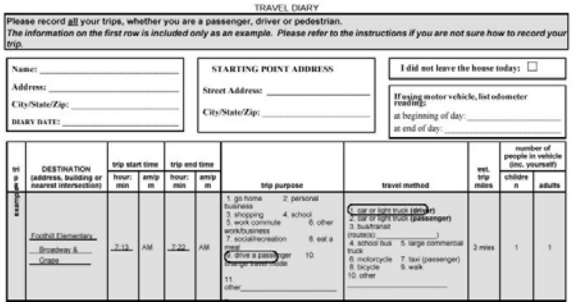
Ideally, the number of people who choose to participate in the survey and the number that refuse should be reported. However, this adds an additional task for the surveyor to remember, and may not be accurate if trail users are approached by more than one surveyor. Neither survey documented the survey response rate in the field.

Surveys Sampling a General Population

Key Findings:

- Results of well-executed random-sample surveys are representative of the entire community
- Can provide baseline and follow-up data for the community as a whole
- Potential participants should be identified using a random selection procedure
- Pre-planning and survey distribution techniques are critical to achieving a high response rate and representative results
- Survey instrument must be designed so that it is simple to understand
- Can be labor-intensive to gather responses and analyze the data

Boulder, CO and California conducted random sample surveys of the general population to gather information about non-motorized trips and user characteristics. Collecting community-wide data (including people who don't bicycle and walk) has made it possible for Boulder to find out what portion of all trips are made by pedestrians and bicyclists. The baseline data from 1990 has been compared with follow-up surveys to identify how mode split is changing in Boulder over time. California's pedestrian survey has been structured so that it can track changes in pedestrian activity and opinions over time.



TRAVEL DIARY

Please record all your trips, whether you are a passenger, driver or pedestrian.
The information on the first row is included only as an example. Please refer to the instructions if you are not sure how to record your trip.

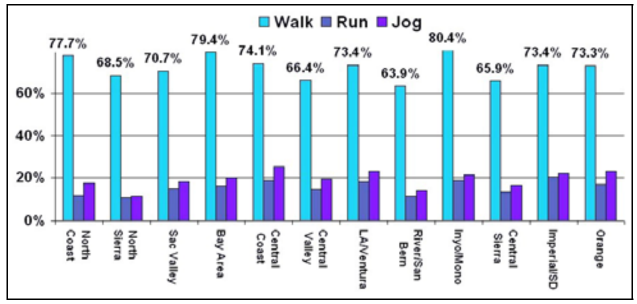
Name:
Address:
City/State/Zip:
DIARY DATE:

STARTING POINT ADDRESS
Street Address:
City/State/Zip:

I did not leave the house today:

If using motor vehicle, list odometer reading:
at beginning of day:
at end of day:

trip	DESTINATION (address, building or nearest intersection)	trip start time hour: min	am/pm	trip end time hour: min	am/pm	trip purpose	travel method	est. trip miles	number of people in vehicle (inc. yourself) children	adults
example	Foothill Elementary Broadway & Grape	7:13	AM	7:22	AM	1. go home 2. personal business 3. shopping 4. school 5. work commute 6. other work/business 7. social/recreation 8. eat a meal 9. drive a passenger 10. 11. other	1. car or light truck (driver) 2. car or light truck (passenger) 3. bus/transit (route(s)) 4. school bus 5. large commercial truck 6. motorcycle 7. taxi (passenger) 8. bicycle 9. walk 10. other	3 miles	1	1



Left: Travel diary (Modal Shift in the Boulder Valley: 1990 to 2000: Travel Diary Study (CO)); Right: Pedestrian survey results by region (California Department of Transportation and Public Health Institute Survey Research Group)

Sample sizes and response rates are important considerations for communities using population-based surveys. This information was documented in both the Boulder and California surveys. Only a portion of people who are invited to participate in a random survey will actually complete and return it. Therefore, non-response should be considered when the original sample of potential participants is selected. This will ensure that the number of people who do respond is large enough to represent the community at a certain statistical confidence level. Further, some survey methods have built-in biases *(9)*. For example, e-mail and phone surveys automatically leave out people who don’t use these technologies. Random-sample survey methods should be designed to reduce bias as much as possible to ensure that the characteristics of the respondents represent the community as a whole. Potential biases should always be presented when results are discussed.

Inventories

Key Findings:

- Pre-planning is critical for efficient data collection
- All needs should be anticipated before beginning to collect the data
- Data collectors should be trained immediately prior to the project to increase the efficiency and accuracy of data collection
- Data should be checked after a pilot data collection phase, especially if more than one person or team are collecting data
- A comments section should be included in the inventory sheet so that data collectors can note unusual cases

Several methods were used by case study communities to inventory facilities. Most of the case study communities took field measurements (Florida; Lexington-Fayette, KY; Loudoun County, VA; Maryland; New York City, NY; Sandpoint, ID; Seattle, WA; St. Petersburg, FL), while others collected information about facilities from video tape (Washington State), aerial photographs (Columbia, MO) and secondary sources (Miami-Dade County, FL; New Jersey; Portland, OR). These inventories gathered data on both the location and the quality of non-motorized facilities.

Seg_id	Road Name	From (N or W)	To (S or E)	Juris-dic-tion	Len-gth (L_s) (mi)	Existing Lanes (L) Th #	Existing Lanes (L) Con	Existing Traffic Volume (ADT) (Exit)	Post. Spd. (SP_p) mph	Width Of Pavement W_t (ft)	Width Of Pavement W_l (ft)	Width Of Pavement W_{ps} (ft)	Occ. Park. (OSPA) (%)	Bike Lane Mark? (Y/N)	Buff. Width (ft)	% With Sidewalk N/EB	% With Sidewalk S/WB	Swalk Width (ft)	Tree Spcg. in Buffer (ft/ctr)	Existing Ped. LOS Value	Existing Ped. LOS Grade (A..F)	Needs Ranking Data 100% DPLOS (0.50)	Needs Ranking Data 100% LOS (0.50)	Needs Priority Value	Needs Priority Level (I..III)
2002.0	7th Avenue N	North Shore Dr	Bayshore Dr	CI	0.11	2	U	5,000	25	10.0	0	0	0	N	0	0	0	0	0	3.99	D	41	88	64	I
26.0	22 Avenue N	PARK Street N	66 Street N	CI	1.65	2	U	20,805	35	11.5	0	0	0	N	10	65	100	5	0	4.61	E	59	67	63	I
80.1	PARK Street S	PASADENA	05 Avenue S	CI	0.41	2	U	8,759	30	12.0	0	0	0	N	0	0	0	0	0	4.39	D	53	72	62	I
255.0	09 Avenue N	22/Street N	16 Street N	CI	0.50	4	U	14,335	35	10.5	0	0	0	N	0	100	0	5	0	3.78	D	36	88	62	I
101.2	16 Street N	04 Avenue N	09 Avenue N	CI	0.33	4	U	15,168	35	13.0	0	0	0	N	0	100	10	5	0	3.60	D	31	87	59	I
406.0	05 Avenue N	01 Street S	BEACH DR	CI	0.17	4	U	10,293	30	11.5	0	0	0	N	0	100	0	4	0	3.41	C	25	92	59	I
32.0	30 Avenue N	58 Street N	60 Street N	CI	0.24	2	D	9,546	35	14.5	0	0	0	N	8	0	100	5	0	3.58	D	30	86	58	I
101.1	16 Street N	BURLINGTON Avenue N	04 Avenue N	CI	0.18	4	U	15,168	35	13.0	0	0	0	N	0	0	100	5	0	3.67	D	33	83	58	I
150.0	04 Street S	54 Avenue S	45 Avenue S	CI	0.56	2	U	16,398	40	10.0	0	0	0	N	30	50	10	6	0	5.09	E	72	42	57	I
92.0	58 Street N	09 Avenue N	22 Avenue N	CI	0.76	4	U	21,523	35	10.0	0	0	0	N	0	10	100	5	0	4.18	D	47	67	57	I
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Pedestrian facility inventory database (Michael Frederick, City of St. Petersburg, FL)

Careful planning is a key element of a good inventory effort. At the beginning of the process, the agencies determined the specific data that would be collected. The communities that used data collectors trained them before they began collecting and recording data to reduce errors and ensure that consistent measurement methods were used. Agencies that used multiple data collection teams to conduct field inventories had difficulty with consistency and coordination. Maryland and Florida used different data collection teams to take measurements in different areas. As a result, both conducted extra data checks to improve the quality of the data collected by certain teams.

Well-designed data collection sheets can make it easier for data collectors to gather good field measurements. The Florida ADA inventory included pictures of specific curb ramp characteristics for field data collectors to identify. Seattle provided data collectors with a list of elements that should be included in hand-sketched drawings of intersections and crosswalks.

Field measurements were recorded on paper forms and then entered into electronic databases. Future field data collection efforts may take advantage of portable digital assistants (PDAs) to eliminate the need to transfer hand-recorded data to electronic format.

Several agencies suggested that they would collect additional data if they update the inventory in the future. St. Petersburg would consider adding intersection characteristics to its bicycle and pedestrian level of service inventory and Lexington-Fayette would add ADA compliance issues to its pedestrian facility inventory.

Spatial Analyses

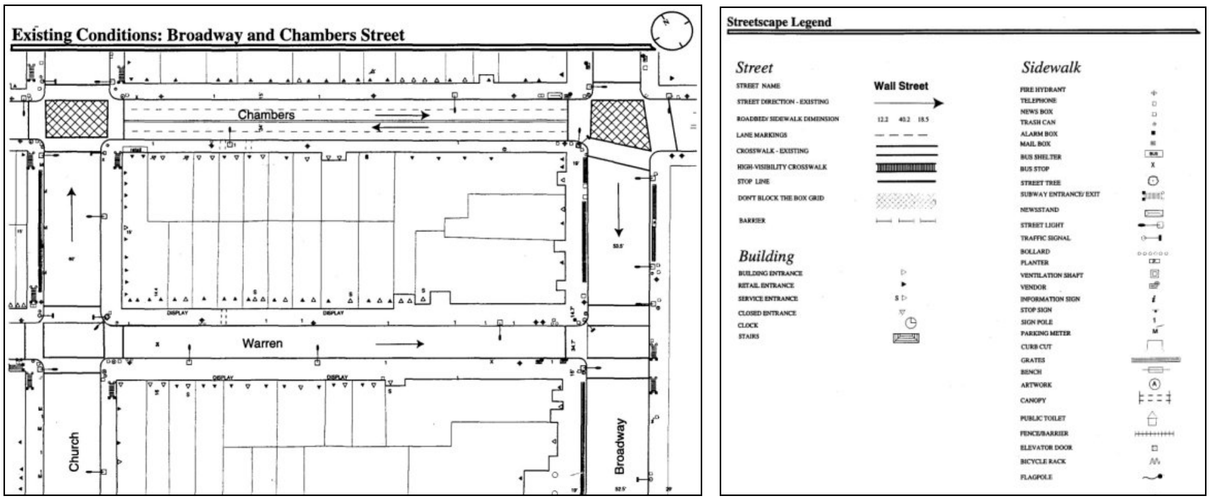
<u>Computer Aided Design (CAD)</u>

Key Findings (CAD):

- Typically used for site-level analysis
- Good for displaying detailed features and accurate measurements
- Can be used for ADA inventories and streetscape inventories
- Requires specialized training to operate software

The most frequent use of CAD for data collection projects is where detailed features need to be assessed through a precise site-level analysis. New York City, NY uses AutoCAD to display the results of detailed streetscape inventories. These inventories identify the locations of over 30 different types of street, building, and sidewalk features on AutoCAD maps. The detailed maps are useful for pedestrian flow analyses because they show sidewalk widths and the spatial arrangement of obstacles to pedestrian movement.

Other potential CAD applications include ADA inventories, analyzing pedestrian and bicycle access at intersections, and locating specific pedestrian and bicycle facilities at transit stations.



AutoCAD map and legend of New York City, NY streetscape inventory (Scott Wise, New York City, NY)

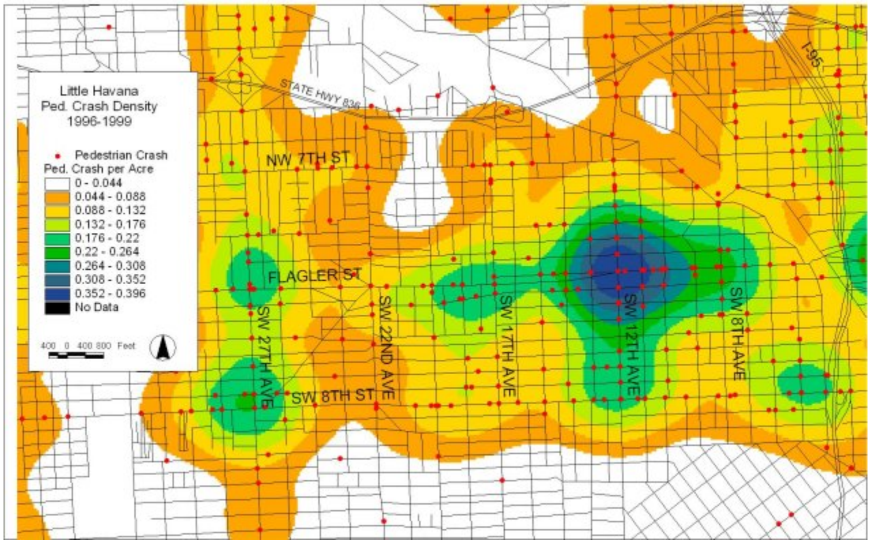
<u>Geographic Information Systems (GIS)</u>

Key Findings (GIS):

- Can be used to quickly create maps of different features on same base map
- Has sophisticated spatial analysis capabilities (e.g., spatial overlay, spatial query, density mapping)
- Relates spatial features to database attributes
- Data entry can be labor-intensive
- Requires specialized training to operate software

GIS has increased the efficiency and expand the scope of pedestrian and bicycle data analysis. It was incorporated into many data collection efforts (Columbia, MO; Lexington-Fayette, KY; Loudoun County, VA; Maryland; Miami-Dade, FL; New Jersey; Portland, OR; Seattle, WA; St. Petersburg, FL; Washington State).

GIS has allowed practitioners to perform many different types of analyses. This tool has been used to identify roadway segments with specific characteristics, such as having a striped bike lane or speed limit of over 35 miles per hour (see Lexington-Fayette, KY; Maryland; Seattle, WA; and Washington State case studies). GIS overlay techniques can also show relationships between different pedestrian and bicycle data layers (see Columbia, MO and Portland, OR case studies). Miami-Dade County, FL took advantage of sophisticated GIS spatial analysis techniques to show concentrations of pedestrian crashes in different parts of the community.



GIS map of pedestrian crash concentrations (David Henderson, Miami-Dade MPO (FL))

Though GIS can be a helpful analytical tool, the process of GIS data entry can be difficult and time-consuming (see Columbia, MO; Miami-Dade County, FL; and New Jersey case studies).

Overall Analysis

Considering the 29 case studies as a whole provides information about the benefits of pedestrian and bicycle data collection, reasons why communities do not collect data, the efficiency of data collection processes, staff coordination, the scope of data collection efforts, and the institutionalization of data collection programs, both locally and nationally.

Benefits of Pedestrian and Bicycle Data Collection

Communities have found that collecting pedestrian and bicycle data is a valuable activity. Some of the benefits documented in the case studies include:

- Providing objective evidence that people are using sidewalks, bike lanes, shared-use paths, and other facilities that have been constructed with public funds (Cheyenne, WY; Iowa; Licking County, OH; Madison, WI; Massachusetts; North Carolina; Portland, OR; Rhode Island)
- Documenting changes in pedestrian and bicycle crash rates over time by accounting for pedestrian and bicycle exposure when analyzing crash data (Portland, OR)
- Identifying locations where facilities should be added or upgraded (many communities)
- Calculating the economic impact of pedestrian and bicycle facilities (North Carolina)
- Establishing baseline data to document changes in use and facility development over time (Boulder, CO; Madison, WI; Portland, OR)
- Setting facility quality standards for accommodating pedestrians and bicyclists in the transportation system (Loudoun County, VA)
- Providing objective data to answer questions about use and facilities from citizens, the business community, and elected officials (many communities)
- Evaluating the need for new or improved facilities based on existing travel patterns (Baltimore, MD; Washington, DC; Licking County, OH; New York, NY)

- Using data in pedestrian and bicycle planning documents (many communities)
- Integrating non-motorized modes into transportation models and analyses (Albuquerque, NM; Boulder, CO; Licking County, OH)

Case study agency representatives often cited a clear political purpose for their data collection projects to justify spending public resources on pedestrian and bicycle facilities. Communities have begun to see the value in tracking use over time to justify continued spending, particularly given budget constraints.

Reasons Why Communities Do Not Collect Pedestrian and Bicycle Data

While there are many benefits to collecting pedestrian and bicycle data, many communities throughout the country do not gather this information. Reasons that have been cited for not collecting non-motorized data included:

- The agency has limited funding and staff resources for collecting data
- Spending resources on data collection will reduce the amount of resources available for planning and implementing other pedestrian and bicycle projects and programs
- Collecting data would raise the profile of pedestrian and bicycle projects, which could cause opponents to take money from the pedestrian and bicycle budget and use it for other modes
- Departments charged with collecting data for the entire agency do not see pedestrians and bicycles as an important part of the transportation mix
- Data collection results could show too few pedestrians and bicyclists using facilities to justify spending on them

Efficiency of Data Collection Processes

The case studies provide numerous examples of communities that have used creative approaches to reduce the cost and increase the efficiency of data collection methods. These approaches include:

- Utilizing volunteer and intern labor
- Piggybacking pedestrian and bicycle observations onto existing data collection programs
- Using automated counting technologies (infrared sensors, pneumatic tubes, video, etc.)
- Using technology for data analysis (spreadsheets, AutoCAD, GIS, etc.)

Volunteers and student labor can reduce the cost of data collection. Local pedestrian advocates volunteered to do the sidewalk inventory in Sandpoint, ID. The 40 volunteers made it possible to inventory all city streets and reduced the public cost of the project. Rhode Island used students to help distribute path-user surveys. However, this was difficult because it was a challenge for the students to find large blocks time for survey distribution.

Piggybacking non-motorized counts and inventories with existing data collection efforts can also save time and money. Most communities already obtain counts and inventory facilities for motor vehicles. By coordinating with these existing efforts, pedestrian and bicycle data can be collected at a minimal additional cost. Pedestrian and bicycle counts were added to intersection counts that had previously been done only for motor vehicles in Albuquerque, NM, Baltimore, MD, and Washington, DC. Maryland plans to update its pedestrian and bicycle inventory using the state video log. Characteristics relevant to motor vehicle travel, such as the number of roadway lanes, speed limit, and pavement condition, can be collected at the same time as shoulders and sidewalks.

Using technology for field data collection and analysis can improve the efficiency of data collection efforts. Counting technologies such as infrared sensors, Piezo film, and pneumatic tubes reduce the need for manual labor. However, these technologies occasionally produce inaccurate counts, and certain technologies are limited to counting but not classifying different types of users or behaviors. Time-lapse video and active infrared sensors can be used to collect certain user characteristics, but can still require significant staff time to record and interpret the data (see discussion above on "Automated Counts").

Technologies such as electronic databases and mapping software have made it possible to complete many data collection efforts that once were time consuming, expensive, or unmanageable. Electronic databases make it easy to store facility inventory information. Instead of looking through paper files, analysts can sort roadway segments electronically to identify specific segments with common characteristics, such as those without sidewalks on both sides. Analysts can also use spreadsheets to do complex calculations for thousands of roadway segments at the same time, producing results such as Pedestrian and Bicycle Level of Service or Bicycle Compatibility Index grades. Before GIS was available, it would not have been possible to generate pedestrian crash concentration maps like those produced by the Miami-Dade MPO. However, entering data into databases and GIS can be time-consuming and requires some level of skill in GIS applications.

Staff Coordination

Coordination between pedestrian and bicycle staff and data collection departments is critical. In many of the 29 agencies that were profiled, the data collection effort was initiated by the pedestrian and bicycle coordinator, but it required assistance from maintenance or traffic management departments.

When staff members who do not normally work on pedestrian and bicycle transportation issues are asked to assist with data collection, analysis, or dissemination, it helps for them to understand the overall purpose of the data collection project. In a number of examples, this coordination has made it possible to achieve much more than was originally envisioned for the data collection effort. Conversely, where this coordination has not been effective, the data collection effort has not been as successful as it could have otherwise been.

Scope of Data Collection Efforts

The 29 case study data collection efforts ranged in scope from using a simple methodology to using multiple methods. The time periods for data collection also varied. Some simple methodologies tended to be used by agencies that needed to gather a specific piece of data or answer a specific question (see case studies on North Carolina Outer Banks; Sandpoint, ID; and Columbia, MO). For others, a simple methodology was chosen so that data could be gathered over time (see case studies on Albuquerque, NM; Baltimore, MD; Madison, WI; and Portland, OR; and Washington, DC). Manual non-motorized user counts have been taken in Baltimore, MD, Portland, OR, and Washington, DC for more than 10 years. While Baltimore and

Washington have not done trend analyses, Portland documented significant increases in bicycle travel over its four downtown bridges since the 1970s.

A few of the case study communities have used multiple data collection methodologies to gather information. Multiple data collection methods have allowed agencies to understand the relationship between pedestrian and bicycle use and the quality and extent of facilities. Boulder CO's multi-modal travel survey is complemented by bicycle counts taken by in-pavement loop detectors and documentation of locations of pedestrian and bicycle facilities (maps of these facilities are available online in both static and interactive format *(10)*). New York City, NY inventories detailed streetscape features, takes peak-hour pedestrian volumes, calculates pedestrian level of service, and gathers pedestrian crash statistics for localized pedestrian studies. In some studies, the City has collected video data on pedestrian behavior and characteristics. Both communities have produced comprehensive reports using the results of these efforts.

Data Collection Process

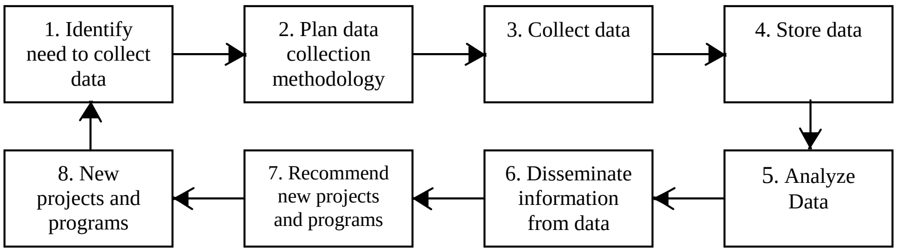
Many communities followed a similar data collection process, which included:

- Identifying the need for collecting data
- Planning the data collection process
- Collecting data
- Storing data
- Analyzing data
- Creating reports, including the results in plans and studies, and sharing the data with other staff, elected officials, granting agencies, and the public

Case study communities experienced varying levels of success in disseminating data. Many data collection projects are done by agency staff. It has been a challenge for some agencies to find resources to formalize results and make them available publicly. While all of the communities profiled in the case studies had collected and stored their data, many were still in the process of analyzing or disseminating the data (see case studies on Albuquerque, NM; Baltimore, MD; Boulder, CO (in-pavement loop detector counts); California; Columbia, MO; Davis, CA; Iowa; Lexington-Fayette, KY; Licking County, OH; Sandpoint, ID; Washington, DC). Agencies may have concerns about publicizing results if they feel that they are not complete, are not representative of the community, lead to an unpopular conclusion, or suggest a lack of progress.

Communities that completed this entire process found that data helped provide a basis for recommending new projects. Implementation of these projects and programs results in the need for evaluation and for collecting more data (see Figure 1). Repeating this cycle over time has led several communities to institutionalize their data collection programs.

Figure 1. Typical Data Collection Process



Institutionalization of Data Collection Programs

Several communities profiled in this study have institutionalized pedestrian and bicycle data collection programs. Establishing consistent methods of data collection and repeating them over time has the following benefits:

- Provides communities with data to benchmark progress in building a pedestrian and/or bicycle system
- Produces data at regular intervals
- Data are available to agency staff, elected officials, and the public when a relevant issue about non-motorized use or facilities is raised
- Agency does not need to develop a data collection program from scratch every time there is a need for data
- The data collection process tends to become more efficient each time it is repeated

Examples of institutionalized data collection efforts are the bicycle counting/facility mapping program in Portland, OR, the bicycle counting program in Madison, WI, the travel survey incorporating non-motorized users in Boulder, CO, the pedestrian crash analysis in Miami-Dade County, FL, and the intersection pedestrian counts in Baltimore, MD and Washington, DC.

One key to institutionalizing pedestrian and bicycle data collection is determining an appropriate interval for repeating the data collection effort. Too much time between data collection intervals can make it difficult to identify emerging trends or allow data to become outdated. However, collecting data too frequently can drain staff resources.

IMPROVING NON-MOTORIZED DATA COLLECTION AT THE NATIONAL LEVEL

This detailed evaluation of 29 data collection efforts from around the country shows that communities use many different methods to quantify pedestrian and bicycle use and the extent of pedestrian and bicycle facilities, and that each particular methodology is designed specifically to meet local needs.

Improvements in non-motorized data collection at the national level would make it easier for practitioners to:

- Aggregate data on use and facilities at the regional, state, and national level
- Compare uniform data on use and facilities between communities and regions
- Establish, measure, and monitor consistent benchmarks for non-motorized travel and facilities
- Share innovative methods for collecting non-motorized data

Research for this project has suggested several ways to improve non-motorized data collection at a national level.

Increase the quality and quantity of non-motorized data in established national surveys

The questions and summary data for the National Household Transportation Survey and U.S. Census should be reviewed to ensure they provide the most pertinent pedestrian and bicycle data needed at the national, state, regional, and local levels. Pedestrian and bicycle practitioners who use the data from these surveys regularly should be involved in the evaluation process. Revisions should be coordinated with the U.S. Bureau of the Census, the Federal Highway Administration, and the U.S. Bureau of Transportation Statistics.

Create a national online library for non-motorized data collection reports

Local, regional, and state agencies that have completed count, survey, or facility inventory projects should be able to submit their summary reports to a national online library. This repository would be available for practitioners to access information about non-motorized data collection efforts in other communities. The contents of the repository could be organized by data collection type, geographic region, length of study, or other typology.

Establish simple pedestrian and bicycle data collection methodologies that will provide consistent local data for a national database

Consistent methodologies are needed in order to compare pedestrian and bicycle data between communities. The federal government should work with practitioners to develop these simple, consistent methodologies—for quantifying use, for surveying users, and for documenting facility extent. Once the national methodologies are established, local communities would be encouraged (though not required) to collect pedestrian and bicycle data in these basic formats. The national methodologies should be designed so that communities can easily expand them to meet additional local objectives.

In the future, local data that are collected using the national data formats could be submitted to a national database. The Federal Transit Administration's (FTA's) National Transit Database (NTD) may be a good model for how to design and maintain this non-motorized transportation database. Established in 1978, the NTD requires all local transit agencies receiving federal transit funding to submit data to the FTA *(11)*. These local transit agencies provide data such as daily and yearly ridership, funding sources, and operational and maintenance costs in a consistent format. Most agencies submit data on an annual basis, while others complete reports every three to five years.

Compile state-level pedestrian and bicycle facility data on an annual basis.

Another potential national data collection strategy would be to enlist the assistance of state pedestrian and bicycle coordinators. The coordinators would be asked to submit basic pedestrian and bicycle facility data to FHWA on an annual basis (this would be a voluntary program). FHWA could use the data to benchmark the extent of pedestrian and bicycle facilities in the United States. Before establishing an official annual reporting program, FHWA would work with state pedestrian and bicycle coordinators to determine how data would be reported. Potential measurements include miles of bike lanes, miles of shared-use paths, and miles of sidewalks on state-owned roadways.

Differences in the amounts and types of roads owned by the states (vs. local governments) would present a challenge for this type of uniform data collection. An alternative would be to invite a sample set of states and regions to provide facility data on an annual basis. Sample communities should represent all parts of the country and a range of socioeconomic and environmental characteristics.

Further Investigation

The possibilities for an increased federal role in non-motorized transportation data collection will require further investigation. While national coordination is needed, it is necessary to minimize added burdens to local communities. Because local governments would be asked to gather data to serve a national purpose, it will be important to explore:

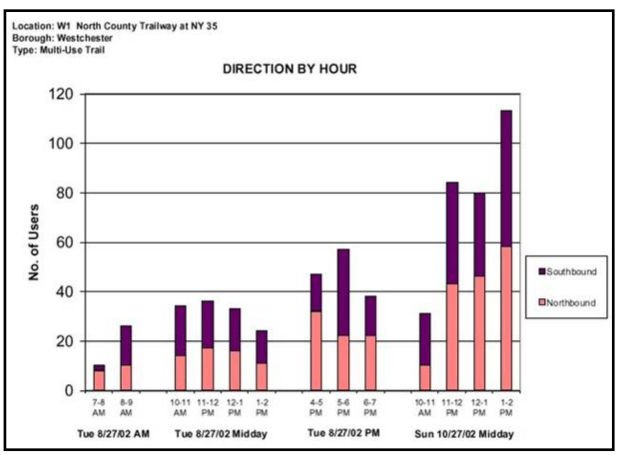
- the benefits and potential structure of each program
- implications for local and state practitioners and agencies
- technical and logistical issues that would need to be solved
- incorporation of federal funding and local flexibility into the initiatives

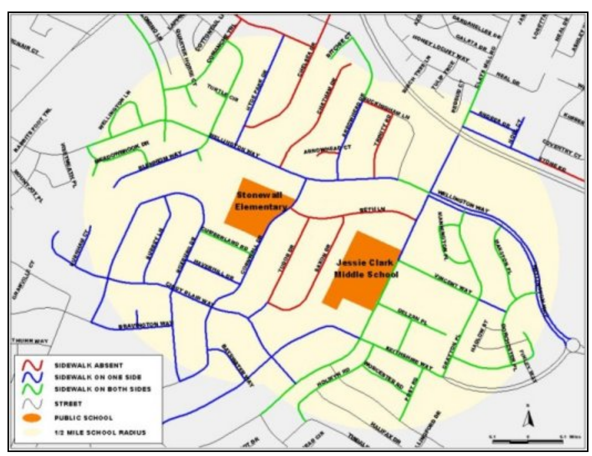
CONCLUSION

The information in this report is a useful guide for practitioners who are interested in developing or improving a pedestrian and bicycle program in their own community. Many communities throughout the United States are collecting data on pedestrian and bicycle use and facilities. The 29 case studies show that agencies are:

1) counting users on non-motorized facilities;
2) gathering information about people using non-motorized modes of transportation;
3) recording locations of existing non-motorized facilities and identifying where improvements are needed; and
4) documenting changes in the amount of use, characteristics of users, extent of facilities, and crash rates over time.

Data collection results have provided valuable information to practitioners and agencies, and have also helped secure public support for pedestrian and bicycle facilities.





Left: Users per hour in each direction (Howard Mann, New York Metropolitan Transportation Council (NY)); Right: Sidewalk coverage near schools (Kenzie Nelson, Lexington-Fayette, KY)

USAGE DOCUMENTATION

INTERSECTION BICYCLE AND PEDESTRIAN COUNTS

Albuquerque, New Mexico

Mid-Region Council of Governments (MRCOG)

Data Collected

- Collect bicycle and pedestrian counts at all signalized intersections in Albuquerque (500+) on a three-year cycle. (Sixty-eight intersections have been counted as of February 2004). Data is recorded for the a.m. peak period, midday, and p.m. peak period.

Highlights

- Added the task of collecting pedestrian and bicycle counts to existing motor vehicle counting program because there was no additional funding for a new data collection program dedicated strictly to the bicycle and pedestrian modes.
- Developed in-house software for compiling manually collected counts.
- Displayed summary data in a Geographic Information System (GIS).

Purpose of Collecting Data

The need for general, baseline bicycle and pedestrian usage data was the primary factor motivating the Mid-Region Council of Governments' (MRCOG) to add bicycle and pedestrian counts to their intersection turning movement data collection effort. Because no other bicycle or pedestrian usage information is available, this data will allow the pedestrian and bicycle modes to be integrated into the multi-modal transportation model that MRCOG is developing for long-range transportation planning. MRCOG also plans to use this data in combination with bicycle and pedestrian crash statistics for use in safety analysis.

Geographic Area Description

Albuquerque, New Mexico (population 450,000) is the largest city in the state.

Methodology

History of data collection effort

MRCOG began taking counts in April 2002. Originally, MRCOG planned to collect bicycle and pedestrian counts at a sample of intersections in the traffic count program. After learning that pedestrian and bicycle volume counts at the sample intersections were often too low for effective analysis or application, MRCOG modified its collection program in 2003 to include the bicycle and pedestrian counts at all signalized intersections in its existing traffic counting program. The intersection traffic counting program is conducted for the City of Albuquerque's Traffic Engineering office in the Department of Public Works.

Data collection

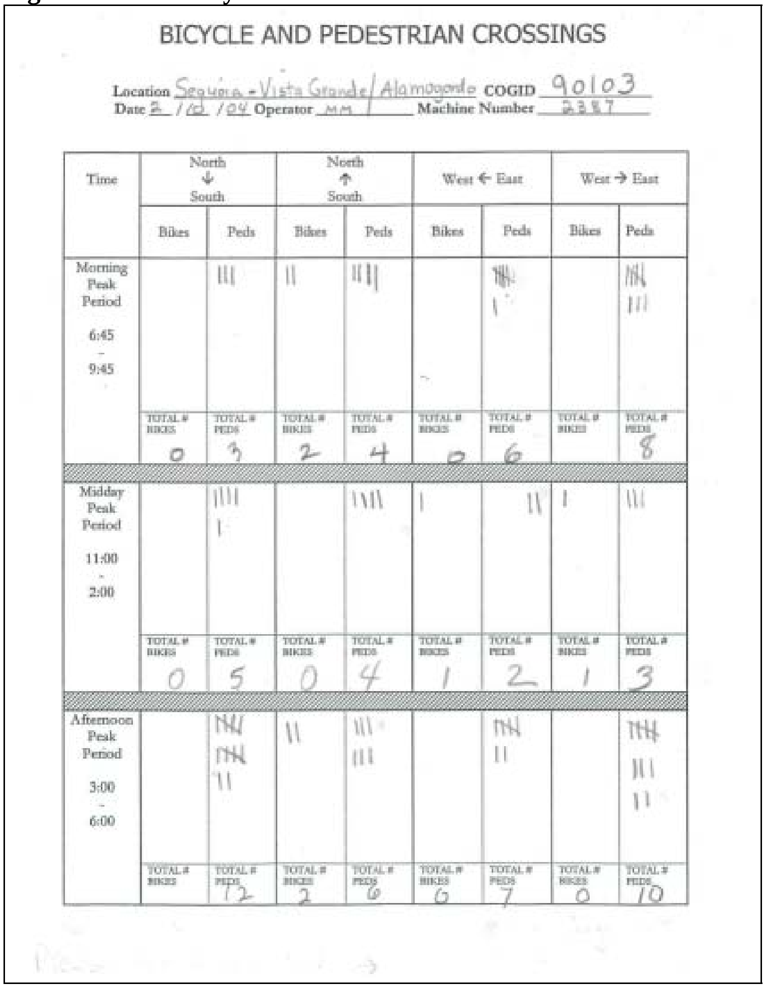
MRCOG staff data collectors work in teams of one or two depending on the intersection's overall traffic volume. The vehicular tallies capture through and turning movement counts during three peak time periods—6:45 – 9:45 am, 11:00 am to 2:00 pm, and 3:00 to 6:00 pm, using hand held electronic counting boards. Manual bicycle and pedestrian counts are recorded on tally sheets at the same time (see Figure 1). Bicycle and pedestrian tallies are recorded in one of four potential directions of travel through the intersection. Only crossing movements are counted. Pedestrians who change directions at the intersection but do not cross a street are not counted. Bicyclists who turn left are counted and tallied on the street they entered the intersection. Right turning bicyclists are not counted.

Data are collected throughout the year as described above at approximately four to eight intersections per week. Data are not collected if inclement weather delays or closes schools, nor is it collected when major special events are scheduled that would create unusual volumes of traffic. Seasonal and weather variations that might affect bicycle and pedestrian volumes are recorded in the notes field of the full turning movement count report for that one-day intersection count.

Data Storage

Data counts are transferred into a computer using a data entry program that MRCOG staff developed with Visual Basic (see Figure 2). This software compiles and stores the data in ASCII files. The data are subsequently geo-coded for use in a GIS.

Figure 1. Field Tally Sheet

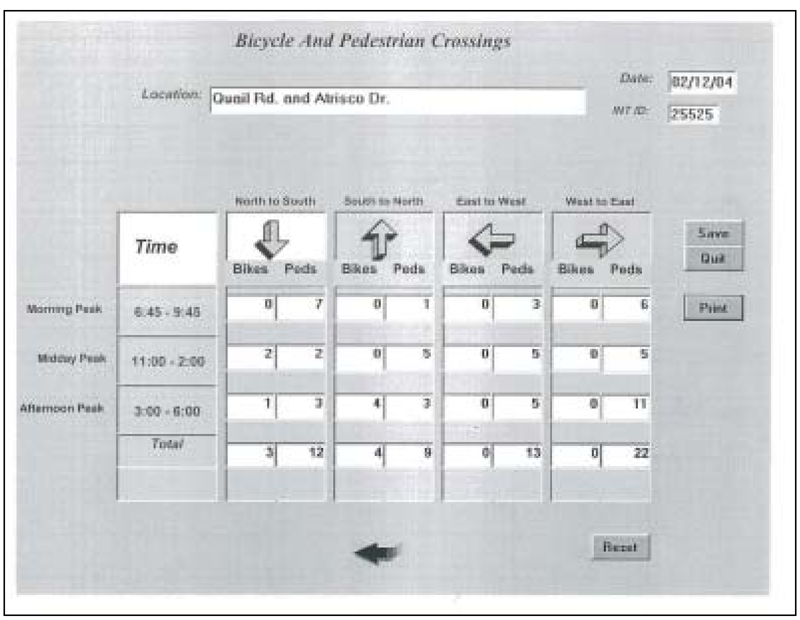


BICYCLE AND PEDESTRIAN CROSSINGS

Location Sequoia - Vista Grande/Alamogordo COGID 90103
Date 2 / 10 / 04 Operator MM Machine Number 2387

Time	North ↓ South		North ↑ South		West ← East		West → East	
	Bikes	Peds	Bikes	Peds	Bikes	Peds	Bikes	Peds
Morning Peak Period 6:45 - 9:45	TOTAL # BIKES 0	TOTAL # PEDS 3	TOTAL # BIKES 2	TOTAL # PEDS 4	TOTAL # BIKES 0	TOTAL # PEDS 6	TOTAL # BIKES	TOTAL # PEDS 8
Midday Peak Period 11:00 - 2:00	TOTAL # BIKES 0	TOTAL # PEDS 5	TOTAL # BIKES 0	TOTAL # PEDS 4	TOTAL # BIKES 1	TOTAL # PEDS 2	TOTAL # BIKES 1	TOTAL # PEDS 3
Afternoon Peak Period 3:00 - 6:00	TOTAL # BIKES	TOTAL # PEDS 12	TOTAL # BIKES 2	TOTAL # PEDS 6	TOTAL # BIKES 0	TOTAL # PEDS 7	TOTAL # BIKES 0	TOTAL # PEDS 10

Figure 2. Data Entry Screen



Bicycle And Pedestrian Crossings

Location: Quail Rd. and Atrisco Dr.
Date: 02/12/04
INT ID: 25525

	Time	North to South Bikes	North to South Peds	South to North Bikes	South to North Peds	East to West Bikes	East to West Peds	West to East Bikes	West to East Peds
Morning Peak	6:45 - 9:45	0	7	0	1	0	3	0	6
Midday Peak	11:00 - 2:00	2	2	0	5	0	5	0	5
Afternoon Peak	3:00 - 6:00	1	3	4	3	0	5	0	11
	Total	3	12	4	9	0	13	0	22

Data Analysis

Data can be analyzed in a variety of ways for a variety of purposes. Summary statistics are extracted from the database and saved into one of two "summary files." Data saved to these files include the summary of morning, mid-day and evening volumes by direction for bicycles and pedestrians separately. The data can also be compiled and displayed on charts and graphs to make comparisons that are useful for analytical purposes (see Figure 3). Repeating the counts on a regular basis will also allow MRCOG staff to identify trends over time.

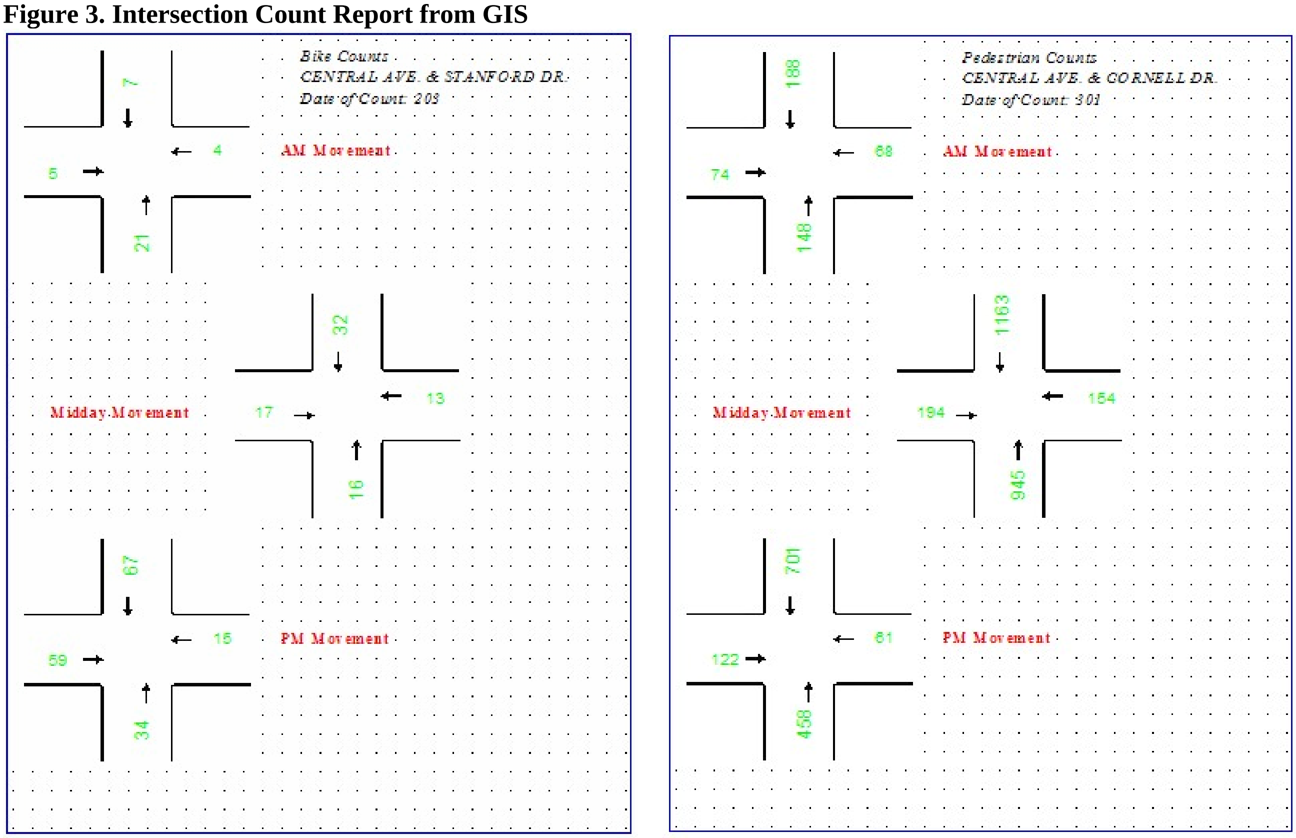
Data Maintenance and Management

The MRCOG staff maintains and manages the data. The counts will be updated regularly (on a three-year cycle) as a part of the larger traffic turning movement counts program.

Data Dissemination

Data are currently used by MRCOG and shared with the City of Albuquerque. Though the counts are still too recent to analyze trends over time, the data can be used for current planning activities and to simply provide information about the level of pedestrian and bicycle usage in the area. The data have also been shared with the bicycling and walking community that is active in MRCOG's transportation planning activities. MRCOG plans to make the data available on the internet and disseminate them more widely once a critical mass of data is collected and some initial analysis has been conducted. Staff also works to show transportation professionals and the public the most appropriate ways that the data can be used to avoid misinterpretation or misapplication of the data.

Figure 3. Intersection Count Report from GIS



Innovations and Accomplishments

By using the skills of a variety of staff within the agency a new dataset has been added to the overall set of transportation planning resources at no additional cost. Collection of data for the non-motorized modes has been well received and MRCOG staff look forward to using it for a variety of analytical purposes that will strengthen the region's ability to integrate bicycling and walking into ongoing transportation planning processes.

Lessons Learned

Staff are considering supplementing the intersection counts with mid-block counts. The thought of automating the data collection has also been raised, but MRCOG believes that this could increase the cost.

Educating transportation professionals, elected officials, non-motorized transportation advocates and the public about the benefits and limits of any bicycle and pedestrian data should be considered an essential component of the collection and dissemination effort. Some local bicycle and pedestrian advocates raised concerns that the counts will document low volumes of bicycle and pedestrian usage in many places, and that this information could be used to negatively impact efforts to improve bicycling and walking in the region. This possibility underscores the importance of ensuring that proper interpretation of the data is included at the time it is more widely distributed.

Cost of Data Collection

Because MRCOG incorporated the pedestrian and bicycle counts into its routine traffic count program, there were no additional labor costs to gather the data. Some staff time was required to develop the approach and format for the counts, program software, and enter the count data. Funding for the counts was provided through the City of Albuquerque's intersection turning movement count program.

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11-HOUR MANUAL INTERSECTION PEDESTRIAN COUNTS

Baltimore, Maryland

Department of Transportation

Data Collected

- Routinely count the number of pedestrians crossing in each direction on all legs of street intersections
- Record counts every 15 minutes and aggregate data by two-hour morning peak, two-hour mid-day peak, two-hour evening peak, and entire day

Highlights

- Take manual pedestrian counts in conjunction with 11-hour motor vehicle turning counts
- Use data to evaluate traffic and pedestrian signal timing
- Display count locations and results of counts in a Geographic Information Systems (GIS) database

Purpose of Collecting Data

Traffic engineers in Baltimore often request counts to obtain background data on pedestrian activity. The data are used for traffic engineering studies and signalization studies at specific intersections. Pedestrian counts are also requested to aid decisions about providing crossing guards near schools, marking new crosswalks, and widening sidewalks during roadway reconstruction projects. Both pedestrian and motor vehicle counts have been used for commercial market analyses.

Geographic Area Description

Several areas within the City of Baltimore (population 650,000) have very high pedestrian volumes. These include the central business district, the Inner Harbor area, neighborhoods near John's Hopkins University, and other commercial districts.

Methodology

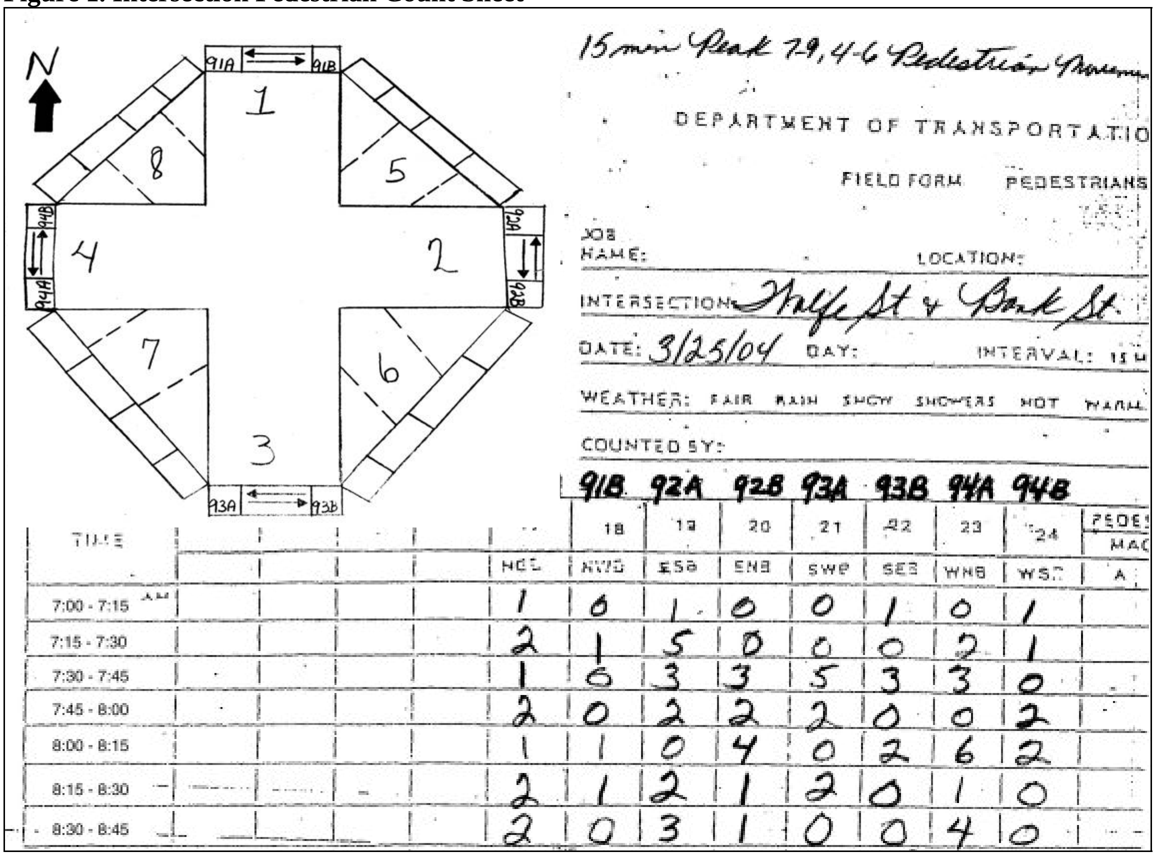
History of data collection effort

Thousands of intersection pedestrian counts have been taken in Baltimore since 1986. Prior to this time, only motor vehicles were counted at intersections. Adding pedestrians to the intersection counts was relatively easy for the City because the data collectors were already out in the field and could handle doing more observations.

Data Collection

A team of two data collectors takes counts at each intersection. The data collectors observe pedestrians going in both directions in all four crosswalks and all of the turning and through movements for motor vehicles. The data collectors determine how to share the task of counting all pedestrian and motor vehicle movements most efficiently when they start the day in the field. Counts are taken over an 11-hour period between 7 a.m. and 6 p.m. They are taken on Tuesday, Wednesday, and Thursday, unless there is a special request for another day of the week. Monday and Friday are avoided because travel patterns on these days can be more sporadic and may not be representative of a typical weekday. The data collectors use manual clickers to count each pedestrian in each direction, and then record their counts on a paper sheet after each 15-minute period (see Figure 1).

Figure 1. Intersection Pedestrian Count Sheet*



15 min Peak 7-9, 4-6 Pedestrian Movem...

DEPARTMENT OF TRANSPORTATIO

FIELD FORM PEDESTRIANS

JOB NAME: LOCATION:

INTERSECTION: Wolfe St & Bank St

DATE: 3/25/04 DAY: INTERVAL: 15 M

WEATHER: FAIR RAIN SNOW SHOWERS HOT WARM

COUNTED BY:

TIME						91B	92A	92B	93A	93B	94A	94B	PEDES
						18	19	20	21	22	23	24	MAC
					HCL	NWB	ESB	ENB	SWB	SEB	WNB	WSB	A
7:00 - 7:15 AM					1	0	1	0	0	1	0	1	
7:15 - 7:30					2	1	5	0	0	0	2	1	
7:30 - 7:45					1	6	3	3	5	3	3	0	
7:45 - 8:00					2	0	2	2	2	0	0	2	
8:00 - 8:15					1	1	0	4	0	2	6	2	
8:15 - 8:30					2	1	2	1	2	0	1	0	
8:30 - 8:45					2	0	3	1	0	0	4	0	

*The numbers 5, 6, 7, and 8 in the diagram represent diagonal streets. When there are diagonal streets at the intersection, the data collectors note them on the diagram and record the diagonal pedestrian movements in extra columns.

In addition to the raw counts of each movement, data collectors record important supplemental information on their data collection sheet:

- location of the intersection
- names of the intersecting streets
- date
- day of week
- weather (fair, rain, snow, showers, hot, warm, cold)
- data collectors' names

Count locations are chosen by request. Requests typically come from project managers within the Department of Transportation, the Department of Planning, and their consultants.

Data storage

Information from paper field data sheets is entered into a Lotus database by a staff member in the Traffic Engineering Department. The counts are summarized (see Data Analysis, below) and stored electronically on diskette and in paper form in binders in the Traffic Engineering Department. The City is planning to upload the electronic spreadsheets to a mainframe computer in the future.

Data analysis

A traffic count summary computer program is used to analyze the raw counts. The computer program produces a report that includes pedestrian counts for each crosswalk and direction of travel. Each of these movements is summarized by two-hour morning peak, two-hour mid-day peak, two-hour evening peak, and 11-hour daily count. It also includes supplemental information, such as weather condition (see Figure 2). The movements are also listed by 15-minute period throughout the day, and the program allows analysts to identify off-hour peaks (i.e. the highest pedestrian volume is for the 60 minutes between 7:15 a.m. and 8:15 a.m.).

Figure 2. Pedestrian Count Summary Report

DEPARTMENT OF TRANSPORTATION
TRAFFIC ENGINEERING - SIGNAL ANALYSIS SECTION

PEDESTRIAN MOVEMENT COUNT - SUMMARY

Intersection of: WOLFE ST.
and: BANK ST.
Counted by: WILSON / GIZZI

Requeste : MIKE HARRINGTON
Day : THURSDAY
Weather : RAIN
Entered by: GERALDINE WILSON
Date : 25-Mar-04

TIME	PEDS ALONG NORTH LEG on: WOLFE ST.			PEDS ALONG EAST LEG on: BANK ST.			PEDS ALONG SOUTH LEG on: WOLFE ST.			PEDS ALONG WEST LEG on: BANK ST.			TOTAL N + S + E + W
CODE	EASTBD 91A	WESTBD 91B	TOTAL	SOUTHBD 92A	NORTHBD 92B	TOTAL	WESTBD 93A	EASTBD 93B	TOTAL	NORTHBD 94A	SOUTHBD 94B	TOTAL	
AM													
07-08	6	1	7	11	5	16	7	4	11	5	4	9	43
08-09	5	3	8	5	6	11	3	5	8	13	3	16	43
09-10	1	2	3	2	1	3	0	0	0	3	2	5	11
10-11	0	0	0	1	2	3	5	4	9	6	4	10	22
11-12	8	0	8	4	0	4	2	10	12	2	3	5	29
12-01	6	2	8	3	5	8	7	8	15	3	3	6	37
01-02	8	13	21	2	8	10	9	7	16	5	2	7	54
02-03	4	8	12	7	12	19	6	5	11	12	8	20	62
03-04	6	6	12	3	3	6	2	8	10	2	4	6	34
04-05	3	8	11	9	7	16	9	5	14	3	9	12	53
05-06	6	4	10	2	4	6	3	4	7	6	1	7	30
PM													
11 HOUR TOTALS	53	47	100	49	53	102	53	60	113	60	43	103	418
COMBINED TOTALS - VARIOUS PERIODS													
MORNING PEAK 07-09	11	4	15	16	11	27	10	9	19	18	7	25	86
EVENING PEAK 04-06	9	12	21	11	11	22	12	9	21	9	10	19	83
MIDDAY PEAK 11-01	14	2	16	7	5	12	9	18	27	5	6	11	66
6 HOUR TOTALS 07-09,11-01,04-06	34	18	52	34	27	61	31	36	67	32	23	55	235

After the data have been summarized, they are used for specific purposes, such as checking to see if the pedestrian volumes meet either the Pedestrian Volume or the School Crossing traffic signal warrants in the Manual on Uniform Traffic Control Devices (MUTCD). The warrant analyses are done by spreadsheet.

Data maintenance and management

The City of Baltimore takes intersection counts on an as-needed basis. New counts are taken when there are no existing counts or when existing data are two or more years old. The City has not undertaken a systematic effort to analyze pedestrian volumes at the same locations over time. Traffic counts are taken every two to three years by Baltimore's regional agency (the Baltimore Metropolitan Council) at 90 screen line locations in the City, but these counts do not include pedestrians or bicyclists.

Data dissemination

The pedestrian count data are provided to engineers, planners, consultants, and others doing transportation projects in Baltimore. Businesses and neighborhoods also use the counts. Though the City does not publish reports of the pedestrian counts or document the counts over time, the data are useful for specific studies and roadway improvement projects.

Innovations and Accomplishments

Pedestrian counts are used most often within the City of Baltimore government for transportation planning and engineering projects, but the detailed data have also been used by other groups. Consultants who are doing proposals for or working on transportation projects in the City have also requested the intersection count data. The City has received requests for pedestrian counts from local businesses and other businesses from all over the United States and Canada that are interested in locating in Baltimore. These businesses use the available data to evaluate volumes of potential customers who may walk by a storefront. City Council members occasionally request counts at certain locations to obtain the most current data on pedestrian activity.

Lessons Learned

With data collection occurring since 1986, the process has been refined a number of times to improve the consistency and efficiency of data collection. Baltimore continues to look for ways to improve their pedestrian counting procedure. At some intersections with heavy pedestrian and motor vehicle volumes, there has been a need for a third data collector to keep up with all the traffic. Data collectors have been used to observe behavior at some locations, which increases the overall value of the collection efforts by providing a wider range of information to potential users of the data. These behaviors include:

- Drivers running red lights
- Motor vehicle passengers wearing seat belts
- Counting child pedestrians as a distinct group

There may be potential to add other behavioral observations to the counting procedure. If funding becomes available in the future, the City may also add bicyclists to the types of users that are counted.

Cost of Data Collection Effort

Each intersection count requires 11 hours of time for both field data collectors and approximately 2 hours of computer data entry for the Traffic Engineering staff member (each count generates both motor vehicle and pedestrian movements). Two to three days of additional time is required to do field observations and analysis for pedestrian signal warrants.

Contact

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10-HOUR INTERSECTION PEDESTRIAN COUNTS

Washington, District of Columbia

District Department of Transportation

Data Collected

- Count pedestrians crossing each leg of approximately 100 intersections in the District of Columbia each year.
- Determine peak hour pedestrian volumes for each intersection from 10 hours of data collected on a single weekday (Monday through Thursday)

Highlights

- Data collection integrates pedestrian counts with 10-hour motor vehicle turning counts
- Regular pedestrian data collection is viewed as an essential element in a large city transportation program

Purpose of Collecting Data

The District Department of Transportation (DDOT) includes pedestrian counts as a standard component of its intersection counting program. In addition, pedestrian counts are often taken at the beginning of roadway and land use development projects to provide baseline information to planners and engineers. This helps ensure that pedestrians are accommodated appropriately in construction projects. The counts also make it possible to evaluate traffic signal warrants and to prioritize locations for improvements, such as new pedestrian crossing signs, more visible crosswalk markings, and better lighting.

Geographic Area Description

The District of Columbia has an area of 67 square miles and a population of 570,000 and serves as the nation's capitol. The District features high levels of pedestrian activity because of its urban land use pattern and because many of the approximately 18 million tourists who visit the District each year to visit memorials and museums around the National Mall walk during their visits. Pedestrian activity in the District may also be encouraged by the complex traffic network and a subway system.

Methodology

History of data collection effort

The District of Columbia Department of Transportation has been taking pedestrian counts at intersections and other pedestrian crossing locations for over 20 years. Counts are currently on file for approximately five to ten percent of the 13,000 intersections in the District. While most counts have been taken in and around the central business district, the District has also taken counts in residential and neighborhood commercial areas and in School Zone areas. Intersections are evaluated for specific projects and upon request from government agencies and the public. Therefore, there has not been any effort to review pedestrian counts at a consistent set of locations and document pedestrian volumes over time.

Data Collection

Counts are taken manually by a team of two to three people, depending on intersection volume. The counts are collected from 7 a.m. to 1 p.m. and from 2 p.m. to 6 p.m. (see Figure 1). Each of the data collectors takes one 15-minute break in the morning and one 15-minute break in the evening. These breaks are staggered so that the counts can be done continuously.

Pedestrian movements are counted by crosswalk, not by travel direction. Therefore, people traveling in either direction across a crosswalk are included in the same count. Typically, one data collector observes the north and east crosswalks (and north- and east-bound traffic), while the other data collector observes the south and west crosswalks (and south- and west-bound traffic). The data collectors use clicker boards to keep a tally of each pedestrian and motor vehicle at the intersection. Each movement has its own clicker, so the individual counts are shown separately. Counts from the clicker boards are written down on a paper data collection form every 15 minutes. The data collectors also record the type of intersection control, parking characteristics, number of roadway lanes, date of the counts, day of the week, and weather condition on the data collection form.

Figure 1. Intersection Pedestrian and Motor Vehicle Count Data Entry Spreadsheet

10/2/2003 **16TH STREET, NW & FULLER STREET**

VEHICLE AND PEDESTRIAN COUNT
DISTRICT OF COLUMBIA
DEPARTMENT OF PUBLIC WORKS
BUREAU OF TRAFFIC SERVICES

		South Side						North Side						West Side		East Side					
		Motor Vehicles					Peds	Motor Vehicles					Peds	MV	Peds	Motor Vehciles					Peds
						COUNTER-FLOW						COUNTER-FLOW		COUNTER-FLOW						COUNTER-FLOW	
		Left	Thru	Right	TOTAL		A	Left	Thru	Right	TOTAL		B		C	Left	Thru	Right	TOTAL		D
	Time	W	N	E		S	11	E	S	W		N	11	W		S	W	N		E	
ENTRY LOG	7:00		82		~~~~~~	~~~~~~	1	5	519	11	~~~~~~	~~~~~~	15	~~~~~~	4	2		1	~~~~~~	~~~~~~	17
date	7:15		96		~~~~~~	~~~~~~		6	496	14	~~~~~~	~~~~~~	27	~~~~~~	7	3	1	2	~~~~~~	~~~~~~	26
10/ 2/ 2003	7:30		75		~~~~~~	~~~~~~	4	5	542	9	~~~~~~	~~~~~~	30	~~~~~~	4	2		6	~~~~~~	~~~~~~	32
	7:45		117	1	~~~~~~	~~~~~~		8	569	11	~~~~~~	~~~~~~	31	~~~~~~	3			3	~~~~~~	~~~~~~	29
	8:00		126		~~~~~~	~~~~~~		7	576	7	~~~~~~	~~~~~~	19	~~~~~~	6			4	~~~~~~	~~~~~~	41
	8:15	2	97		~~~~~~	~~~~~~	5	4	549	6	~~~~~~	~~~~~~	29	~~~~~~	2	1	2	5	~~~~~~	~~~~~~	27
	8:30	3	133	2	~~~~~~	~~~~~~	3	6	562	6	~~~~~~	~~~~~~	25	~~~~~~	3	1	3	7	~~~~~~	~~~~~~	30
	8:45	3	93	2	~~~~~~	~~~~~~	8	4	559	11	~~~~~~	~~~~~~	15	~~~~~~	9	4	4	5	~~~~~~	~~~~~~	9
	9:00	2	99	7	~~~~~~	~~~~~~	8	13	543	9	~~~~~~	~~~~~~	7	~~~~~~	10	1	2	1	~~~~~~	~~~~~~	15
	9:15	6	105	1	~~~~~~	~~~~~~	4	3	411	12	~~~~~~	~~~~~~	5	~~~~~~	12	1	2	4	~~~~~~	~~~~~~	9
	9:30		79		~~~~~~	~~~~~~	7	13	380	6	~~~~~~	~~~~~~	9	~~~~~~	9			7	~~~~~~	~~~~~~	13
	9:45		73		~~~~~~	~~~~~~	8	2	308	10	~~~~~~	~~~~~~	3	~~~~~~	7			9	~~~~~~	~~~~~~	8
	10:00	1	82		~~~~~~	~~~~~~	6	9	294	5	~~~~~~	~~~~~~	8	~~~~~~	9			5	~~~~~~	~~~~~~	10
	10:15		112		~~~~~~	~~~~~~	11	11	270	9	~~~~~~	~~~~~~	7	~~~~~~	6			4	~~~~~~	~~~~~~	5
	10:30	1	120		~~~~~~	~~~~~~	10	5	221	6	~~~~~~	~~~~~~	9	~~~~~~	8			4	~~~~~~	~~~~~~	8
	10:45		134	1	~~~~~~	~~~~~~	13	2	199	3	~~~~~~	~~~~~~	7	~~~~~~				3	~~~~~~	~~~~~~	8
	11:00	5	115	1	~~~~~~	~~~~~~	8	4	194	3	~~~~~~	~~~~~~	7	~~~~~~	3	2	2	2	~~~~~~	~~~~~~	6
	11:15	1	124		~~~~~~	~~~~~~	12	6	177	7	~~~~~~	~~~~~~	5	~~~~~~	1		2		~~~~~~	~~~~~~	9
	11:30	2	112		~~~~~~	~~~~~~	8	5	241	7	~~~~~~	~~~~~~	7	~~~~~~	3			1	~~~~~~	~~~~~~	3
	11:45	2	115		~~~~~~	~~~~~~	9	1	227		~~~~~~	~~~~~~	2	~~~~~~			1		~~~~~~	~~~~~~	12
	12:00	4	110		~~~~~~	~~~~~~	4	3	219	2	~~~~~~	~~~~~~	6	~~~~~~	2	2			~~~~~~	~~~~~~	6
	12:15	3	122		~~~~~~	~~~~~~	5	1	209	1	~~~~~~	~~~~~~	4	~~~~~~	3	3		2	~~~~~~	~~~~~~	15
	12:30	2	124		~~~~~~	~~~~~~	3	2	183	3	~~~~~~	~~~~~~	11	~~~~~~	4				~~~~~~	~~~~~~	13
	12:45	1	114	2	~~~~~~	~~~~~~	9	3	227	7	~~~~~~	~~~~~~	3	~~~~~~	2	2		1	~~~~~~	~~~~~~	6
	2:00	1	158	1	~~~~~~	~~~~~~	4	7	184	3	~~~~~~	~~~~~~	3	~~~~~~		1		2	~~~~~~	~~~~~~	14
	2:15	1	149	3	~~~~~~	~~~~~~	4	5	162	5	~~~~~~	~~~~~~	2	~~~~~~	3	3		1	~~~~~~	~~~~~~	7
	2:30	1	208	4	~~~~~~	~~~~~~	9	4	210	4	~~~~~~	~~~~~~	11	~~~~~~		1		1	~~~~~~	~~~~~~	8
	2:45	3	180		~~~~~~	~~~~~~		7	195	4	~~~~~~	~~~~~~	6	~~~~~~	2	3		3	~~~~~~	~~~~~~	8
	3:00	1	192	2	~~~~~~	~~~~~~	4	6	216	3	~~~~~~	~~~~~~	9	~~~~~~	2	1		2	~~~~~~	~~~~~~	6
	3:15	1	222	3	~~~~~~	~~~~~~	5	3	220	5	~~~~~~	~~~~~~	8	~~~~~~	1	4		1	~~~~~~	~~~~~~	5
	3:30	2	210	3	~~~~~~	~~~~~~	9	4	235	4	~~~~~~	~~~~~~	9	~~~~~~	3	1		2	~~~~~~	~~~~~~	8
	3:45		250	3	~~~~~~	~~~~~~	10	5	241	3	~~~~~~	~~~~~~	7	~~~~~~				3	~~~~~~	~~~~~~	7
	4:00	4	223	1	~~~~~~	~~~~~~	5	6	252	8	~~~~~~	~~~~~~	5	~~~~~~	4			3	~~~~~~	~~~~~~	15
	4:15	2	199	2	~~~~~~	~~~~~~	10	6	251	1	~~~~~~	~~~~~~	9	~~~~~~	5			4	~~~~~~	~~~~~~	13
	4:30		216	1	~~~~~~	~~~~~~	6	5	249	2	~~~~~~	~~~~~~	4	~~~~~~	4			5	~~~~~~	~~~~~~	10
	4:45		210		~~~~~~	~~~~~~	14	3	240	3	~~~~~~	~~~~~~	6	~~~~~~	5	2		13	~~~~~~	~~~~~~	13
	5:00		221		~~~~~~	~~~~~~	8	4	247	4	~~~~~~	~~~~~~	7	~~~~~~	10	1		8	~~~~~~	~~~~~~	15
	5:15		217		~~~~~~	~~~~~~	4	5	230	5	~~~~~~	~~~~~~	9	~~~~~~	6			2	~~~~~~	~~~~~~	14
	5:30		211	1	~~~~~~	~~~~~~		6	237	4	~~~~~~	~~~~~~	6	~~~~~~	5			4	~~~~~~	~~~~~~	12
	5:45		179	3	~~~~~~	~~~~~~		6	229	5	~~~~~~	~~~~~~	4	~~~~~~	4			3	~~~~~~	~~~~~~	9

Data Storage

Until the early 1990s, the counts were stored in paper files. Over the past decade, they have been stored electronically in spreadsheets. Each intersection count is stored in a separate spreadsheet file and indexed by intersecting street name; DDOT plans to enter each of the intersection counts into a geographic information system (GIS) in the future so that all of the count locations can be referenced on a map.

Data analysis

Each of the ten-hour intersection counts is analyzed to identify the peak hour for pedestrians and the peak hour for motor vehicles (see Figure 2). Peak hours vary by count location. The data are used for other types of analysis on a project-specific basis. These analyses include:

- Evaluating the intersection for a traffic signal based on the Manual on Uniform Traffic Control Devices (MUTCD) Pedestrian Volume signal warrant
- Conducting safety studies at intersections by comparing the pedestrian volumes to total pedestrian crashes at intersections to account for exposure

Figure 2. Ten-Hour Pedestrian and Vehicle Count Spreadsheet

10/2/2003 **16TH STREET, NW & FULLER STREET**

VEHICLE AND PEDESTRIAN COUNT
DISTRICT OF COLUMBIA
DEPARTMENT OF PUBLIC WORKS
BUREAU OF TRAFFIC SERVICES

		Time	South Side Motor Vehicles Left	Thru	Right	TOTAL	COUNTER-FLOW	Peds A	North Side Motor Vehicles Left	Thru	Right	TOTAL	COUNTER-FLOW	Peds B	West Side MV COUNTER-FLOW	Peds C	East Side Motor Vehicles Left	Thru	Right	TOTAL	COUNTER-FLOW	Peds D	TOTALS MV	TOTALS Peds
			W	N	E		S	11	E	S	W		N	11	W		S	W	N		E			
DAY -	THURS	7:00		82		82	521	1	5	519	11	535	83	15	11	4	2		1	3	5	17	617	37
WEATHER -	CLEAR	7:15		96		96	499		6	496	14	516	98	27	15	7	3	1	2	6	6	26	612	60
POSTED BY -	JONES	7:30		75		75	544	4	5	542	9	556	81	30	9	4	2		6	8	5	32	631	70
INTERSECTION ID	10160280	7:45		117	1	118	569		8	569	11	588	120	31	11	3			3	3	9	29	706	63
CONTROLLED BY		Hr Tot		370	1	371	2133	5	24	2126	45	2195	382	103	46	18	7	1	12	20	25	104	2566	230
STOP SIGN ON FULLER ST		8:00		126		126	576		7	576	7	590	130	19	7	6			4	4	7	41	716	66
		8:15	2	97		99	550	5	4	549	6	559	102	29	10	2	1	2	5	8	4	27	658	63
		8:30	3	133	2	138	563	3	6	562	6	574	140	25	12	3	1	3	7	11	8	30	712	61
		8:45	3	93	2	98	563	8	4	559	11	574	98	15	18	9	4	4	5	13	6	9	672	41
		Hr Tot	8	449	4	461	2252	16	21	2246	30	2297	470	88	47	20	6	9	21	36	25	107	2758	231
		9:00	2	99	7	108	544	8	13	543	9	565	100	7	13	10	1	2	1	4	20	15	673	40
		9:15	6	105	1	112	412	4	3	411	12	426	109	5	20	12	1	2	4	7	4	9	538	30
		9:30		79		79	380	7	13	380	6	399	86	9	6	9			7	7	13	13	478	38
		9:45		73		73	308	8	2	308	10	320	82	3	10	7			9	9	2	8	393	26
		Hr Tot	8	356	8	372	1644	27	31	1642	37	1710	377	24	49	38	2	4	21	27	39	45	2082	134
		10:00	1	82		83	294	6	9	294	5	308	87	8	6	9			5	5	9	10	391	33
		10:15		112		112	270	11	11	270	9	290	116	7	9	6			4	4	11	5	402	29
		10:30	1	120		121	221	10	5	221	6	232	124	9	7	8			4	4	5	8	353	35
		10:45		134	1	135	199	13	2	199	3	204	137	7	3				3	3	3	8	339	28
		Hr Tot	2	448	1	451	984	40	27	984	23	1034	464	31	25	23			16	16	28	31	1485	125
		11:00	5	115	1	121	196	8	4	194	3	201	117	7	10	3	2	2	2	6	5	6	322	24
		11:15	1	124		125	177	12	6	177	7	190	124	5	10	1		2		2	6	9	315	27
		11:30	2	112		114	241	8	5	241	7	253	113	7	9	3			1	1	5	3	367	21
		11:45	2	115		117	227	9	1	227		228	115	2	3			1		1	1	12	345	23
		Hr Tot	10	466	1	477	841	37	16	839	17	872	469	21	32	7	2	5	3	10	17	30	1349	95
		12:00	4	110		114	221	4	3	219	2	224	110	6	6	2	2			2	3	6	338	18
		12:15	3	122		125	212	5	1	209	1	211	124	4	4	3	3		2	5	1	15	336	27
		12:30	2	124		126	183	3	2	183	3	188	124	11	5	4					2	13	314	31
		12:45	1	114	2	117	229	9	3	227	7	237	115	3	8	2	2		1	3	5	6	354	20
		Hr Tot	10	470	2	482	845	21	9	838	13	860	473	24	23	11	7		3	10	11	40	1342	96
PEDESTRIANS (10hr)	1326	2:00	1	158	1	160	185	4	7	184	3	194	160	3	4		1		2	3	8	14	354	21
10- HR FACTORS	(default=.6)	2:15	1	149	3	153	165	4	5	162	5	172	150	2	6	3	3		1	4	8	7	325	16
X =	0.60	2:30	1	208	4	213	211	9	4	210	4	218	209	11	5		1		1	2	8	8	431	28
Y =	0.60	2:45	3	180		183	198		7	195	4	206	183	6	7	2	3		3	6	7	8	389	16
Z =	0.60	Hr Tot	6	695	8	709	759	17	23	751	16	790	702	22	22	5	8		7	15	31	37	1499	81
W=	0.60	3:00	1	192	2	195	217	4	6	216	3	225	194	9	4	2	1		2	3	8	6	420	21
PEAK HOURS SUMMARY:		3:15	1	222	3	226	224	5	3	220	5	228	223	8	6	1	4		1	5	6	5	454	19
AM PkHr. (starting)	7:45 AM	3:30	2	210	3	215	236	9	4	235	4	243	212	9	6	3	1		2	3	7	8	458	29
AM PkHr Vol =	2818	3:45		250	3	253	241	10	5	241	3	249	253	7	3				3	3	8	7	502	24
AM PkHr Factor =	.97	Hr Tot	4	874	11	889	918	28	18	912	15	945	882	33	19	6	6		8	14	29	26	1834	93
AM LOS =		4:00	4	223	1	228	252	5	6	252	8	266	226	5	12	4			3	3	7	15	494	29
AM V/C =		4:15	2	199	2	203	251	10	6	251	1	258	203	9	3	5			4	4	8	13	461	37
AM PkHr %OF24 =	9.0%	4:30		216	1	217	249	6	5	249	2	256	221	4	2	4			5	5	6	10	473	24
PM PkHr (starting)	3:45 PM	4:45		210		210	242	14	3	240	3	246	223	6	3	5	2		13	15	3	13	456	38
PM PkHr Vol =	1945	Hr Tot	6	848	4	858	994	35	20	992	14	1026	873	24	20	18	2		25	27	24	51	1884	128
PM PkHr Factor =	.96	5:00		221		221	248	8	4	247	4	255	229	7	4	10	1		8	9	4	15	476	40
PM LOS =		5:15		217		217	230	4	5	230	5	240	219	9	5	6			2	2	5	14	457	33
PM V/C =		5:30		211	1	212	237		6	237	4	247	215	6	4	5			4	4	7	12	459	23
PM PkHr %OF 24 =	6.2%	5:45		179	3	182	229		6	229	5	240	182	4	5	4			3	3	9	9	422	17
		Hr Tot		828	4	832	944	12	21	943	18	982	845	26	18	25	1		17	18	25	50	1814	113
10 HOUR TOTAL			54	5804	44	5902	12314	238	210	12273	228	12711	5937	396	301	171	41	19	133	193	254	521	18613	1326
A M PEAK HOUR			5	473	3	481	2258	8	25	2256	30	2311	492	104	40	14	2	5	19	26	28	127	2792	253
P. M PEAK HOUR			6	888	7	901	993	31	22	993	14	1029	903	25	20	13			15	15	29	45	1930	114
24 Hr (estimate)			90	9673	73	9837	20523	397	350	20455	380	21185	9895	660	502	285	68	32	222	322	423	868	31022	2210

Thus far, the raw data have been collected for specific locations, and they have been analyzed and summarized in spreadsheets.

Data dissemination

Raw spreadsheets and peak-hour summaries are provided to several different groups. The pedestrian counts are used by the Metropolitan Police Department, other branches of the Department of Transportation, and the Office of Planning. They are also given to the Federal government, District contractors, and the District's Advisory Neighborhood Commissions. Count data are used to evaluate sidewalk needs, pedestrian signal timing, pedestrian safety, and for other types of analysis.

DDOT cites the counts in internal plans and other project documents. DDOT does not produce an official document to report the counts but the data are available to the public and private upon request for nominal fee.

Innovations and Accomplishments

The pedestrian count data are considered to be essential elements of the District's multi-modal transportation program. Baseline data on all modes of transportation, including pedestrian travel, are used in planning and engineering analysis. Intersection level-of-service analysis requires pedestrian counts, and the counts have been very useful in determining the appropriate signal timing at intersections in the District. The pedestrian counts have also been very useful for understanding pedestrian and vehicle conflicts and analyzing pedestrian safety at different locations around the City.

Lessons Learned

The District's manual pedestrian counts have been very reliable. The District prefers manual counts over completely automated counting methods because automated devices have varying degrees of reliability for detecting pedestrians and motor vehicles and can lose data if the machine malfunctions. However, the District plans to automate one aspect of the manual counting process. DDOT field data collectors will soon use hand-held electronic counting boxes instead of traditional clicker boards to save time and reduce errors in transferring the data between field data sheets and office computers.

Several aspects of the current counting methodology can be problematic. Because counts are taken only during daytime hours on Mondays through Thursdays, the data may not represent the true peak hour pedestrian counts in locations where the highest amounts of walking occur on Fridays, at night, or on weekends. For example, much of the tourist traffic is in the evenings, on weekends, and on holidays, which is outside the normal data collection times. In addition, morning or afternoon peak-hour data may not be useful and can be misleading when trying to address pedestrian safety or sidewalk capacity in areas with a spirited nightlife. Many pedestrian crashes in these areas occur at night. DDOT does night or weekend counts only if a specific request is made. However this requires special funding.

The District is considering ways to improve the intersection counting methodology. Currently, counts end at 6 p.m., which is still considered to be a part of "rush hour" in the District. Extending the count period until 7 p.m. could provide more accurate data about peak hour conditions in some locations. The District has also found that the lunch break hour of 1 p.m. to 2 p.m. can be in some cases the peak period for the pedestrian counts, and should be considered for inclusion in the count program.

The intersection observations may also be improved by documenting pedestrian and driver behaviors when counts are taken. These behaviors include:

- Drivers yielding to pedestrians in crosswalks
- Aggressive driving or driving through the intersection at an excessive speed
- Drivers running red lights
- Drivers "blocking the box"
- Pedestrians crossing against the traffic signal
- Pedestrians crossing outside of marked crosswalks

In the future, district education and enforcement programs to improve these types of behaviors could be evaluated using behavioral data from the intersection counts.

The District also plans to improve the way the pedestrian counts are stored. The count spreadsheets are currently indexed by intersecting street name, but this makes it very difficult to find all the counts in a specific neighborhood or corridor study area. Entering the count data into GIS will make it much easier to find and analyze the data.

Cost of Data Collection Effort

Each intersection count costs approximately $400 to $500. This includes the cost of labor for pedestrian and motor vehicle counts and the cost of entering the field data into spreadsheets in the office.

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MANUAL NON-MOTORIZED USER COUNTS

New York Metropolitan Region, New York

New York Metropolitan Transportation Council

Data Collected

- Routinely count bicyclists, pedestrians, and other non-motorized transportation users manually at 100 locations in the New York metropolitan region (began routine counts in 2002)
- Obtain counts at each location during three different time periods on a weekday and/or a mid-day time period on a weekend day

Highlights

- Institutionalizing non-motorized data collection in the region—are collecting data at an additional 200 locations in 2004
- Standardizing non-motorized data collection—member governments in the region use similar methods of counting and analyzing count data
- Observed helmet use, gender, age, proper use of facility, time of day
- Noted locations and will eventually put data into a GIS database

Purpose of Collecting Data

As the regional Metropolitan Planning Organization (MPO), the New York Metropolitan Transportation Council (NYMTC) collects and analyzes data to make decisions about future transportation projects. While data on motor vehicle travel have been collected for decades, similar historical data have not been collected for non-motorized modes of transportation.

Formalizing the process of non-motorized transportation data collection across the New York metropolitan area will help guide decisions on where to locate new shared-use paths, bike lanes, and other non-motorized transportation facilities. Counts are also used to verify or refute assumptions about non-motorized transportation volumes in certain locations and to document non-motorized use before and after new facilities are provided.

Geographic Area Description

NYMTC is the Metropolitan Planning Organization for the 10-county New York metro region (population 12,000,000). It includes the five boroughs of New York City and five surrounding suburban counties. The region covers 2,346 square miles and has an overall population density of 5,144 persons per square mile.

Methodology

History of data collection effort

Previous efforts to collect non-motorized transportation data in the region had been conducted by New York City agencies and a New York City advocacy organization. To formalize the process of collecting non-motorized data, NYMTC initiated a regional counting effort in 2002. NYMTC contracted with a consultant to develop the counting program, collect the data, and organize a training session on non-motorized counting methods for all the member governments. Counts were then taken at 100 locations in 2003. The non-motorized counting program is becoming institutionalized in the region—in 2004, counts will have been taken at about 200 locations.

Data Collection

Non-motorized counts were taken in all five New York City boroughs and all five suburban counties in the NYMTC region. The counts were taken on one weekday or one weekend day or both a weekday and weekend day at 100 different locations. Weekday counts were taken from 7 a.m. to 9 a.m., 10 a.m. to 2 p.m., and 4 p.m. to 7 p.m. Weekend counts were taken from 10 a.m. to 2 p.m.

Weather conditions were considered in the counting process. Counts were taken only on days with non-inclement weather (days where it was raining or threatening to rain and days with hot and humid weather were avoided).

All of the counts included several common aspects (see Figure 1):

- Counted total number of each type of user (bicyclist, in-line skater/scooter, jogger, walker with dog, walker with stroller, walker only, wheelchair user)
- Identified direction each user was traveling
- Estimated age of user (child or adult)
- Observed gender of user
- Noted helmet usage
- Noted compliance with proper use of the facility (e.g., noted if a bicyclist riding down a street with a bicycle lane was in the bicycle lane, in the travel lane, or on the sidewalk)

Figure 1. Completed Field Data Collection Sheet

NYMTC Bicycle Data Collection Program: Phase I
Multiuse Path Counts

Surveyor Name: Mashhood Siddiqui
Date: Tue 6/10/03
Weather: Warm, Sunny
County: New York Manhattan
Location: East River Esplanade at 120th Street
GPS Reference: x=-73.9629 y=40.7886

	Mode							Direction						Age		Gender		Helmet			
Time	Bicycle	Rollerblades/ Skates/Scooter	Jogger	Walker with Dog	Walker with Stroller	Walker Only	Wheelchair User	NB through	SB through	Overpass to NB	Overpass to SB	NB to Overpass	SB to Overpass	Adult	Child	Male	Female	Yes	No	Group	Comments
7:00			1					1						1			1		1		
			1					1						1			1		1		
						1		1						1		1			1		
						1			1					1		1			1		
						1			1					1		1			1		
7:15	1									1				1		1			1		
			1						1					1		1			1		
						1		1						1		1			1		
						1			1					1			1		1		
						1		1						1		1			1		
7:30			1						1					1		1			1		
				1							1			1			1		1		
			1						1					1			1		1		
			1						1					1		1			1		
					1			1						1			1		1		
				1					1					1			1		1		
7:45				1				1						1			1		1		

Data storage

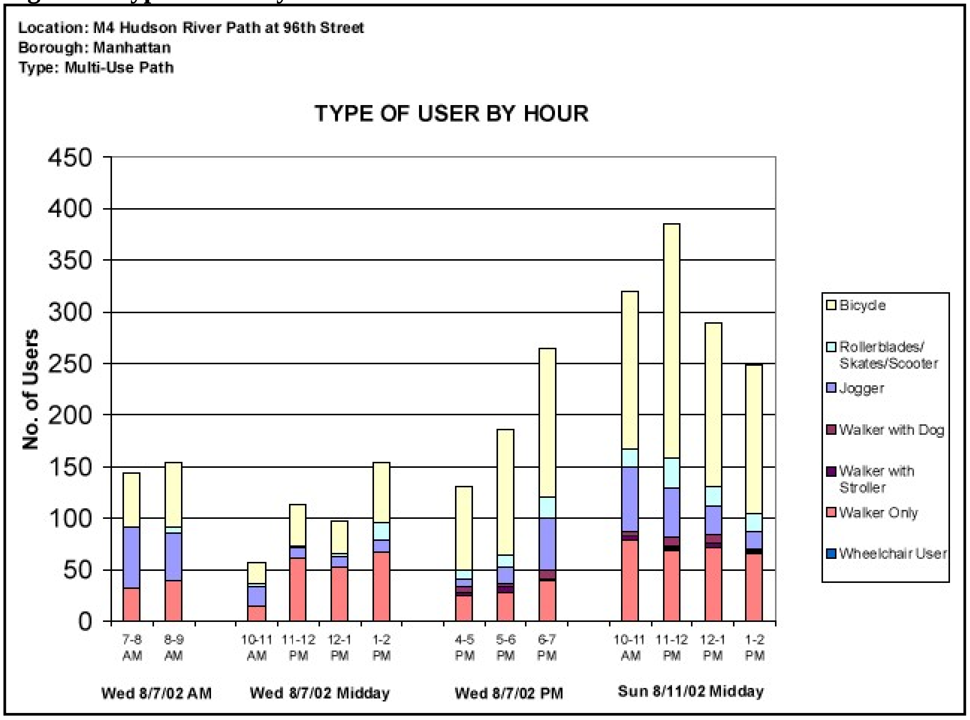
NYMTC keeps counts from throughout the region in a single spreadsheet database. This database has not been entered into a Geographic Information System (GIS), but it includes the latitude and longitude of each count location so that the bicycle counts can be viewed and analyzed on maps in the future.

Data analysis

The counts from each location were analyzed in the same way. Data were entered into spreadsheets, and tables and charts were produced (see Figure 2, Figure 3, and Figure 4). The data were analyzed to show:

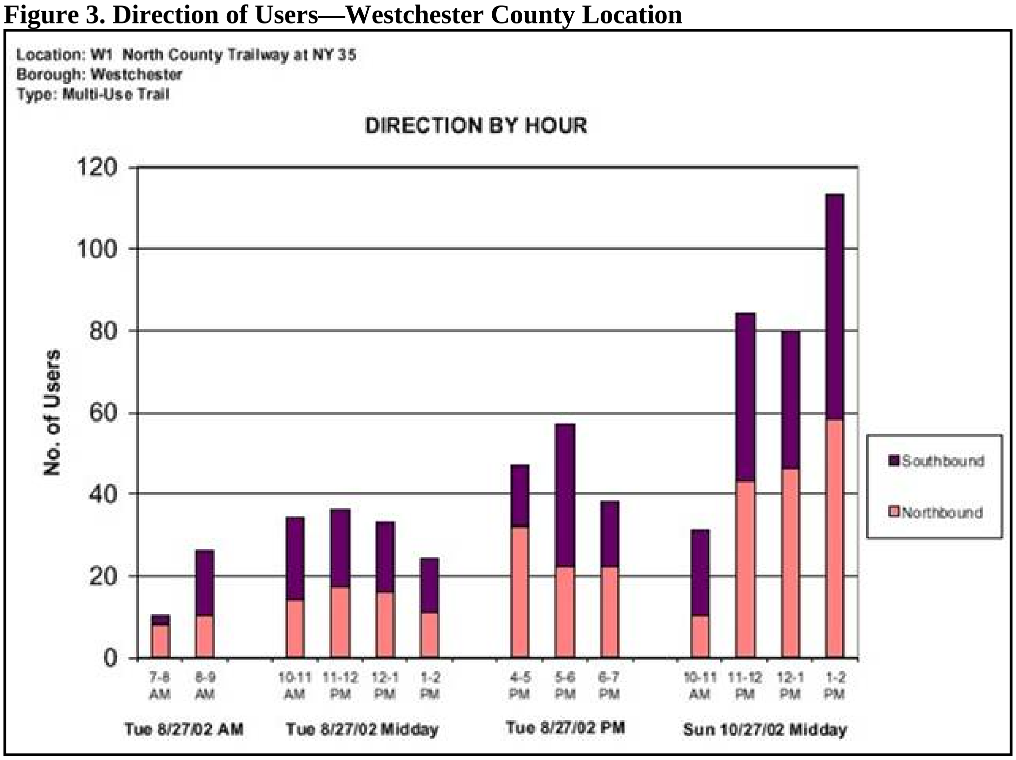
- Type of user by hour
- Direction of users' travel by hour
- Helmet usage (percent of total users)
- Gender (percent male/female at location)
- Age (percent children/adults at location)
- Use of facility (referred to as "compliance")

Figure 2. Type of user by Hour—Manhattan Location



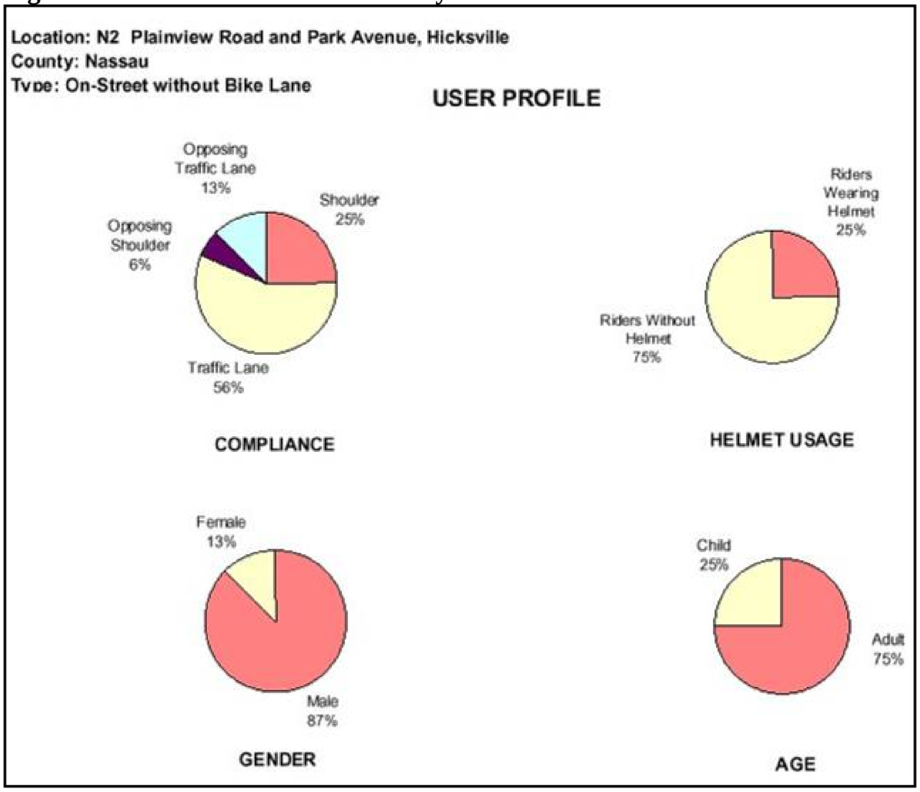
Source: *Summer/Fall 2002 Data Collection Report, Volume 1: New York City Five Boroughs*, New York Metropolitan Transportation Council, Draft Report, May 2003.

Figure 3. Direction of Users—Westchester County Location



Source: *Summer/Fall 2002 Data Collection Report, Volume 2: New York City Suburbs: Nassau, Suffolk, Westchester, Putnam, and Rockland Counties*, New York Metropolitan Transportation Council, Draft Report, May 2003.

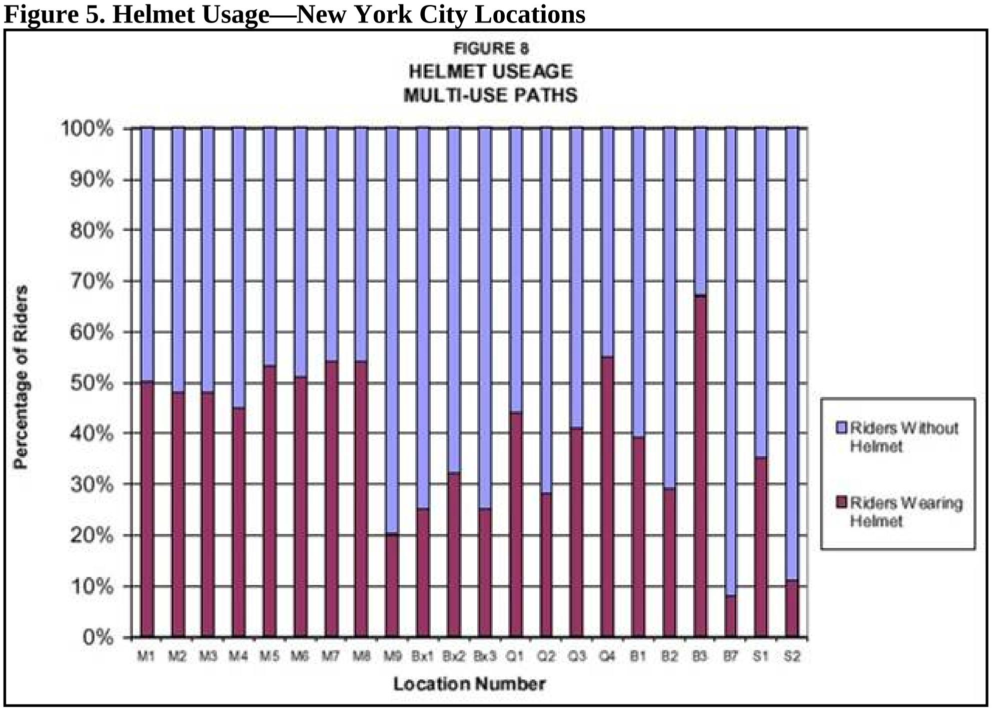
Figure 4. User Profile—Nassau County Location



Source: *Summer/Fall 2002 Data Collection Report, Volume 2: New York City Suburbs: Nassau, Suffolk, Westchester, Putnam, and Rockland Counties*, New York Metropolitan Transportation Council, Draft Report, May 2003.

Charts were also created to summarize the average number of users per hour, helmet usage, gender, and helmet usage by gender in different locations (see Figure 5).

Figure 5. Helmet Usage—New York City Locations



Source: *Summer/Fall 2002 Data Collection Report, Volume 1: New York City Five Boroughs*, New York Metropolitan Transportation Council, Draft Report, May 2003.

Data dissemination

NYMTC produced two volumes of its *Summer/Fall 2002 Data Collection Report*, one for the five boroughs and one for the suburban counties. The agency plans to continue producing non-motorized data collection reports on an annual basis.

Innovations and Accomplishments

Formalized counts have made basic data about bicycle use available in a consistent format. Facilities that cross jurisdiction boundaries can be compared using the same data, which will help NYMTC generate better information about non-motorized trips throughout the region. The consistent counts also make it possible for the MPO to evaluate the impacts of non-motorized facility projects in different parts of the region using similar data. Member jurisdictions are very pleased that NYMTC has coordinated bicycle counting efforts across the region, as shown by their willingness to continue the counting effort and expand the number of locations for taking counts.

New York City Department of City Planning (DCP) Transportation Division counted bicyclists at 43 different locations in 1999, 2000, and 2001 as an adjunct simultaneously and in coordination with NYMTC's regional data collection program. DCP continues to conduct annual bicycle counts at the locations that were counted in 1999, 2000, and 2001. Several of these counts have been instrumental in showing the value of constructing new non-motorized transportation facilities.

All types of non-motorized users were counted on the Hudson River Trail before and after construction of a section of the path between West 12th Street and West 55th Street. Two count locations were along this section of the path, one at West 17th Street and the other at West 34th Street. In September 2000, an interim path served these locations. It was only five to ten feet wide, had many 90 degree turns, and was lined with concrete barriers and chain-link fences. The interim path ended at West 55th Street, about one mile north of the West 34th Street count location. By April 2001, the new wide, straight pathway was available for use at the West 17th Street and West 34th Street locations. In addition, a new section of path had been completed between West 55th Street and West 72nd Street.

Follow up counts were taken in April 2001 after the pathway improvements had been made. Weekday six-hour counts (7:30 a.m. to 9:30 a.m., 12:00 p.m. to 2:00 p.m., 4:30 p.m. to 6:30 p.m.) increased from 731 to 2,056 (up 181%) at West 17th Street and from 319 to 1,248 (up 291%) at West 34th Street. Weekend six-hour counts increased from 1,986 to 4,498 (up 126%) at West 17th Street and from 868 to 3,474 (up 300%) at West 34th Street[2].

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[2] For more information, see *New York City Bicycle Lane and Trail Inventory: Phase II*, New York City Department of City Planning, October 2001

Lessons Learned

Standardizing the data collection methodologies among NYMTCs 10 counties is critical to providing useful regionwide information. This requires consistency in the length and dates of counts. Some locations were counted only on one weekday and others were counted only on one weekend day. Often, weekend non-motorized transportation volumes may vary considerably from weekday volumes (see Figure 1 and Figure 2, for example). Therefore, the counts in locations where data was collected only on a weekday may not be appropriate to compare to counts in locations where data was collected only on a weekend.

NYMTC avoided counting on days where it rained or that were judged to be too hot and humid, as these conditions are thought to significantly reduce the number of bicyclists, but weather conditions on counting days did vary from cool to warm and from sunny to cloudy. NYMTC may be able to develop weather adjustment factors by analyzing different counts in various types of weather over time.

NYMTC plans to improve the efficiency of the counts in the future by using automated data collection methods. The regional agency may purchase infrared sensors that can be used to reduce the manual labor required for the counts. It may also supply PDAs to data collectors so that counts can be recorded electronically, reducing the time required to transfer the data from paper data collection sheets to a computerized database.

Cost of Data Collection Effort

Developing the counting methodology, training member jurisdictions, taking the counts in the field, compiling the raw counts, and analyzing the data took approximately one year and cost about $300,000. Taking additional counts in the future will cost less because the data collection and analysis methods have already been developed.

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INFRARED LASER COUNTS OF GREENWAY USERS

Cheyenne, Wyoming

City Government of Cheyenne, Wyoming

Data Collected

- Counted the number of pedestrians and bicyclists on the Cheyenne Greenway starting in the late 1990s
- Divided counts into 4-hour time segments, as well as morning and afternoon periods

Highlights

- Used infrared laser counter to count Greenway users
- Boy Scouts performed interviews and other data collection along the trail to supplement the counts
- Identified peaks in pedestrian and bicycle counts over a weekly period and over an annual period
- Used counts to help justify construction of shared-use paths and the counts contributed to approval of a locally-funded $4.5 million Greenway and Trail System

Purpose of Collecting Data

In the 1990s, path opponents challenged providing public funding for Cheyenne's Greenway system. This small, but vocal group charged that the Greenway was not being used enough to warrant the funds that it received. The City took manual and automated counts in order to obtain an objective analysis of path usage levels.

Geographic Area Description

Cheyenne (population 53,500) is the capital of Wyoming. It is located 100 miles North of Denver, near the Front Range of the Rocky Mountains. The Greater Cheyenne Greenway consists of 12 miles of greenway paths alongside City drainage ways. It includes the Dry Creek Greenway path in the northern and the Crow Creek Greenway path in the southern part of the city.

Methodology

History of data collection effort

Construction of the Greater Cheyenne Greenway began in 1990. In the early 1990s, a small, but vocal group of citizens challenged the funding that the Greenway received. In response, the City of Cheyenne undertook an effort to study levels of use on the Greenway. Local Boy Scouts observed and recorded trail users in 1996 and 1997. Infrared laser counters were purchased in 1998 to increase the time periods that could be included in the counts and to reduce the manual labor required for the counts.

Data Collection

The initial data collection effort involved local Boy Scouts taking manual counts of path users and documenting different path uses, such as walking, cycling, jogging, and in-line skating.

Greenway users were counted by the Boy Scouts on 40 separate occasions. Each of the observations was made simultaneously at two locations, one on each of the greenway trails. The 40 counts were conducted in a wide variety of weather conditions, including rain, wind, and even during a tornado warning. The counts were taken for various lengths of time between 6:00 a.m. and 7:30 p.m. between July 1996 and September 1997.

The data collection periods were limited to times when Boy Scouts were available to observe the path. To overcome this limitation, an infrared laser counter was purchased to take the path counts. The City installed the counter in a weatherproof, vandal-resistant box along the Dry Creek Greenway (see Figure 1). The infrared laser counter recorded the date and time that any type of path user or other object broke the infrared laser beam that extended across the path. City staff downloaded the raw data from the infrared counter in the field every one to three weeks.

Figure 1. Infrared Laser Counter in Weatherproof Box

Though the infrared laser sensor provided raw Greenway counts, City staff determined that manual counts were still needed to gain a better understanding of path user characteristics. Because of this, the Boy Scouts continued in their efforts to document Greenway use.

Data Storage

An electronic record of the counts is created by the trail counter in the field. Infrared count data are stored in the machine until they are downloaded by City staff.

Data Analysis

The Boy Scout counts were stratified by location and user type. Analysis of 1,684 path users from 1996 and 1997 found that more than three times as many people used the Dry Creek section of the Greenway than used the Crow Creek section.

The following percentages of each user type were observed for the Greater Cheyenne Greenway:

52% bicyclists
35% walkers
6% skaters
4.5% joggers
2.5% baby carriers/strollers

One person in a wheelchair was also observed. According to the City, skateboarders also used the Greenway, but they were not observed on the days of the counts.

Infrared counter data were grouped by 4-hour periods, morning and afternoon periods, and 24-hour periods. The total number of users in each period was reported.

Data Maintenance and Management

Infrared laser counts have been analyzed only when information has been needed in the past several years. A new Greenways Coordinator is being hired in summer 2004, which may make it possible to resume the regular counts.

Data Dissemination

Greenway annual reports were produced in the late 1990s, and they included summaries of Greenway use and counts. The counts were also presented to the City Council and were included in several local newspaper stories. Annual reports have not been produced over the past five years because the City has the previous reports and feels that it can get adequate data from intermittent infrared user counts.

Innovations and Accomplishments

The counts gave the City budget committee concrete evidence that the Greenway was used by a significant number of citizens, which warranted further funding for the Greenway. A new section of the Greenway was constructed in 2003. The infrared counts also helped justify to residents that the Greenway was being used by many people. In a 2003 vote, funding for the Greenway was supported through approval of a countywide tax.

Lessons Learned

Though the infrared laser counter could count all day in all types of weather, more information was needed about the types of users on the path (age, gender and experience, user mode, etc.) and the types of trips that the path is used for (recreation, commuting to work, going to friends' houses, shopping, etc). The Boy Scouts' research provided some of this information, but more user characteristics could be collected in the future and shared with interested citizens, politicians, and staff to increase their awareness of Greenway issues. This information could provide additional justification for Greenway spending and could be used to apply for more funding from grant sources.

The infrared laser counter provided the City with raw path user counts. An advantage of the laser counter over pneumatic tubes, Piezo film, and in-pavement loop detectors is that it can count all types of path users (not just bicyclists). However, it also counts animals and objects like deer and leaves.

Cost of Data Collection

Because local Boy Scouts provided volunteer labor to observe and record users, the initial counts in 1996 and 1997 were conducted with no direct costs, other than incidental staff time. The infrared trail counter was purchased for approximately $1000 through a grant from the Dupont Greenways Awards Program. The cover for the infrared counter was made locally at a small additional cost. Downloading the data from the trial counter in the field and analyzing the data took approximately two to three hours of staff time per week.

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TIME-LAPSE VIDEO USED FOR BICYCLE COUNTS

Davis, California

City of Davis, Department of Public Works

Data Collected

- Counted bicycles, motor vehicles and pedestrians at select locations along shared use paths, at roadway intersections and at potential mid-block crossings using time-lapse video technology.

Highlights

- Found that *time-lapse video* technology is a cost-effective way of gathering reliable bicycle traffic counts for a variety of locations and purposes.
- Took accurate counts and observed other traffic factors, such as pedestrian movements, vehicle compliance with stop signs and signals, bicycle crashes and bicyclist travel behavior on various facility types.

Purpose of Collecting Data

The Public Works Department uses bicycle count data primarily to analyze bicycle access and traffic engineering issues (such as at intersections, or along shared use paths) for the purpose of locating and planning improvements for bicycle and other traffic. The data are also used to provide background information to support bicycle project funding requests.

Geographic Area Description

Davis, California (population 62,000) is located 11 miles west of Sacramento. The University of California at Davis has 26,000 students, and is the community's major employer. Davis has 50 miles of bike lanes and 50 miles of bike paths. More than 80 percent of all collector and arterial streets within the city have bike lanes and/or bike paths, the highest such ratio of any city in the country. In 1990, 20 to 25 percent of all trips in the city were made by bicycle.

Methodology

History of data collection effort

The Department began using time-lapse video for counting bicycles in 1996. Prior to this time, manual counts and tube counters (shared use paths only) were used to gather bicycle counts. The Department switched to video technology in 1996 to save time and money, and to increase the types of traffic and bicycle information that could be collected. Initially, one camera was purchased along with special playback equipment (originally, it was purchased jointly with a neighboring city for cost savings). In addition to bicycle counts, it is used for pedestrian and motor vehicle traffic data collection.

Data collection

For bicycle counts, the camera is mounted 8 to10 feet off the ground on an existing pole in the public right of way. Using battery power, it can record 24 hours of video in both daylight and nighttime conditions, and functions well in any type of weather. It is typically used for 24-, 48- or 72-hour counts.

It takes two public works technicians approximately one hour to set up and one hour to take down the video camera. An intern or technician can record counts for a 24-hour session in 1.5 to 2 hours. Special playback technology allows review at adjustable tape speeds and easy skipping of time periods of with little or no volume, such as in the middle of the night. The video is time stamped, which allows counts to be broken out by time periods of varying durations, i.e. fifteen minutes, half hours or hours.

The camera can be set up to capture a video image of one or two legs of an intersection at a time. From the videotape, bicycle counts taken at intersections are broken out by turning movement--right, left and straight. Attention is taken to control for factors that could skew data that is collected on different days of the week, such as weather or differing daily travel patterns.

Data Storage, Maintenance and Management

The raw videotape is stored in a videotape library. Compiled data is stored in electronic spreadsheet files. Maintenance and management of the data is easy and accomplished at virtually no cost.

Data Analysis

Data are compiled from the videotape by technicians or interns. The Bicycle and Pedestrian Program Coordinator and traffic engineers within the Department analyze the data and display the data in charts and tables. Before-and-after conditions have also been analyzed. For example, the Department compared bicycle use of a road that crossed a major highway both before and after a tunnel/underpass was installed to determine how the total number of bicycle crossings changed and how the presence of the new tunnel affected bicyclists' use of the roadway overpass.

Data Dissemination

Data results are typically shared with the appropriate project stakeholders, such as Department of Public Works and other city staff, elected officials, and the public on an ad hoc basis, or as part of a project's public planning process. The data are also used in funding requests and shared with state agencies and regional organizations as background and justification for various city bicycle initiatives. The data are not compiled in a standard format for routine dissemination.

Innovations and Accomplishments

Solid bicycle counts have been instrumental in demonstrating to Public Works Department staff and other city officials that investment in bicycle accommodations is prudent and cost effective, and should be a routine part of providing transportation facilities. Bike counts have also proven essential for the City to make an effective case at the state level for approval of new or uncommon bicycle treatments, as was the case regarding use of bicycle signal-heads at signalized intersections. Time-lapse video technology has allowed the Bicycle and Pedestrian Program to generate counts at less cost than using manual counts and with greater accuracy than using tube counters.

Previously, a bike count at an intersection might take a team of 2 manual data collectors 18 hours each to develop a 16-hour count in the field. Additional work hours would be required to compile and record the data in electronic format. Now, a 24-hour intersection count can be assembled by installing a video camera (which requires only 4 hours of labor for equipment set-up and retrieval) and spending about two hours recording and compiling the data. Even with just one camera, the time-lapse video has proven reliable, accurate, and effective for a variety of different situations and locations throughout the city.

Having bicycle count data has been central to obtaining funding (and meeting reporting requirements for the funding) from the Air Quality Management District. Bicycle projects that have been funded through this agency include assistance for Bike Commute Day, installation of bike racks and lockers at the new intermodal facility, and purchase of new bicycles for the city's "motor" pool, including two cargo bikes.

Lessons Learned

The availability of only one camera (which can cover only half of an intersection at a time) has not proven an impediment to doing full intersection analysis or multi-location counts that need comparable data for analysis purposes. The biggest barrier is the staff time it takes to analyze the data and organize it into a meaningful format that can be shared effectively with staff and other communities who often contact Davis, as a leading bicycling city, and want information about their bicycle and pedestrian programs.

The video system makes it possible to evaluate the data further in the future. In addition to counts, other information about bicyclists could be tabulated and analyzed with minimal additional effort, such as gender, helmet use, compliance with traffic regulations, observation of bicycle type, etc. However, the Davis Bicycle and Pedestrian Program has not yet had the need to gather this type of data from the videotape.

An unforeseen benefit of using this technology for counts has been the video recording of bicycle crashes. Having videotape of actual incidents has allowed the Department to understand why certain types of bicycle crashes happen, and what measures can be taken to prevent them in the future. The Department has also been able to observe bicyclist, motorist and/or pedestrian compliance with traffic signs or signals in various settings, which has also lead to a better understanding of what causes a variety of bicycle and pedestrian crashes.

Cost of Data Collection

Direct labor costs consist of approximately six person-hours per count location for a 24 hour count: four hours to install and retrieve camera, two hours to review, compile and analyze 24 hours of data. The camera, playback equipment, and videotapes were originally purchased in 1998/1999 for $7,000. There are no additional management costs; management is part of the

Bicycle and Pedestrian Coordinator's job. Funds for the data collection project come from the City's transportation budget.

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PASSIVE INFRARED SENSOR SHARED-USE PATH COUNTS

Licking County, Ohio
Licking County Area Transportation Study

Data Collected

- Routinely use infrared sensor to count shared-use path users (since 2002)
- Count path users from Tuesday afternoon to Thursday afternoon or from Friday afternoon to Monday afternoon at 25 locations

Highlights

- Counts are taken at all times of day (24-hour counts)
- Use automated counting system
- Create charts of 24-hour counts
- Long-term plans are to repeat counts at 11 locations each year and will take counts at 15 to 20 other locations based on requests and potential projects
- Used the counts to justify expansion of the shared-use path system
- Use GPS to inventory entire bicycle and pedestrian system

Purpose of Collecting Data

The Licking County Area Transportation Study (LCATS) began collecting shared-use path user counts in 2002 in order to provide data for a comprehensive bicycle and pedestrian plan. After collecting sufficient long-term data, the County will compare traffic counts on parallel roads and bicycle and pedestrian facilities to estimate motor vehicle trips removed from the roads when new alternative facilities are provided. This information will be used for Congestion Mitigation Air Quality (CMAQ) eligibility requests. Planners also used Global Positioning Systems (GPS) to conduct an inventory of the entire bicycle and pedestrian system in Licking County, including all intersections. These locational data will be used in CMAQ requests, mode change estimates, and general mapping. Licking County is also collecting counts to find out where the greatest demand for pedestrian and bicycle trips exists so that they can construct shared-use path connections that serve the most people.

Geographic Area Description

The Licking County Area Transportation Study (LCATS) is a Metropolitan Planning Organization and cooperative transportation decision-making body that serves 648 square miles and over 125,000 residents in central Ohio. Five separate shared-use path systems exist currently in Licking County.

Methodology

History of data collection effort

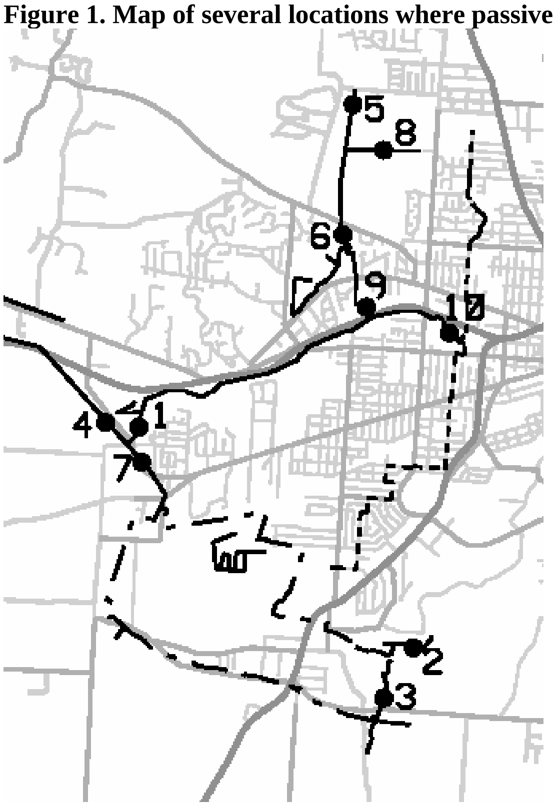
As an MPO, the Licking County Area Transportation Study (LCATS) is responsible for preparing a transportation plan for the region. As part of that process, the LCATS Policy Committee instructed staff to develop a bicycle and pedestrian element of the transportation plan.

LCATS staff began bicycle and pedestrian data collection activities in 2001, when they used GPS to begin mapping the entire shared-use path system in their jurisdiction. The system map was completed and updated in 2002 and 2003, and will undergo another update in 2004. LCATS began taking pedestrian counts at intersections in 2002. In 2003, the counts were collected using three TRAFx automatic counters. Data collection at the same locations will be repeated in 2004. The data collection effort has been adjusted continuously to improve methods.

Data Collection

LCATS has identified 11 locations where infrared shared-use path counts will be repeated each year. Counts are also taken at 20 to 50 other locations each year, with sites selected based on requests or locations where pedestrian and bicycle facilities are planned in the future (see Figure 1). The counts require the approval of the LCATS Policy Committee each year.

Figure 1. Map of several locations where passive infrared sensors have been used.

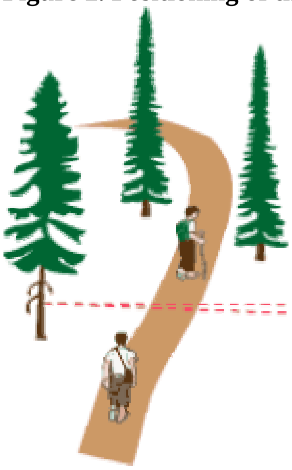


Counts are taken between May and September. Data are collected during 48-hour periods from Tuesday afternoon to Thursday afternoon to establish average weekday use, and during 72-hour periods from Friday afternoon to Monday afternoon to establish average weekend use. LCATS has experimented with aggregating the counts over 1 day, 4 days, one week, and one month.

The TRAFx infrared counting device is 3” x 5” x 0.75”, slightly larger than a deck of cards. To reduce the potential of losing or damaging the device, the sensor is hidden under branches, poison ivy, or under other camouflage, provided there is a direct line of sight to the shared-use path (see Figure 2).

The counting device uses passive infrared technology to detect body heat from passing shared-use path or sidewalk users. Each user is registered with a time stamp. The counters can be set to take hourly or daily time stamps, and can count up to 8,000 shared-use path users before the data must be retrieved. LCATS gathers counts from the sensor at least once every 24 hours.

Figure 2. Positioning of the Passive Infrared Sensor



Data storage

The TRAFx device includes a docking module and related cables for connecting to a laptop computer. Using the included "TRAFx Reporter" computer program to manage the download, LCATS staff take a laptop into the field, connect to the counter, and download the count data from the device. Raw data is entered directly into a spreadsheet for analysis.

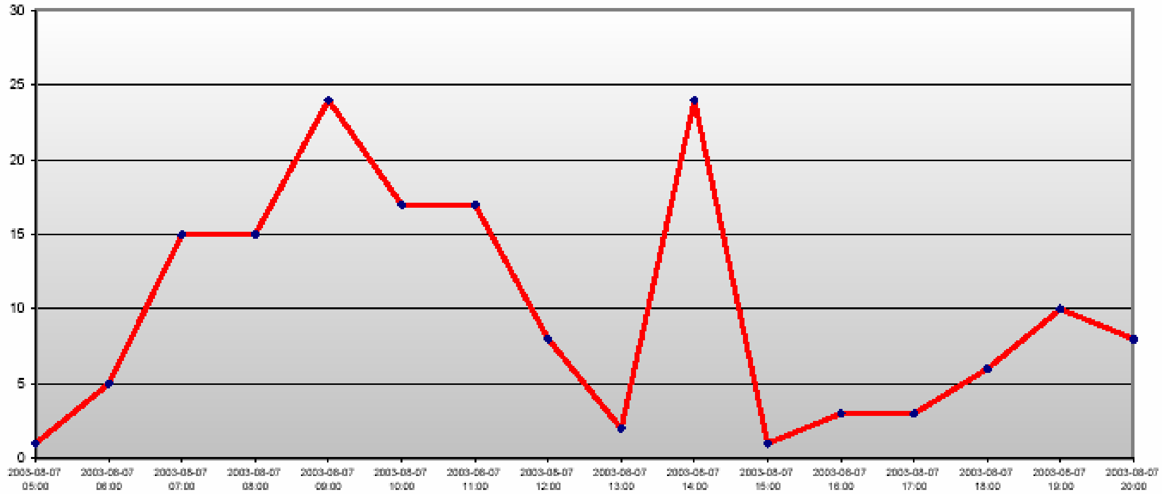
Data analysis

For initial data analysis, use counts were downloaded to a spreadsheet, and then graphed to show counts by time-of-day (see Figure 3). This process identified peak morning and afternoon travel periods, which may indicate commuter use on the facilities.

Figure 3. Daily Shared-Use Path Count: 5 a.m. to 10 p.m.

TRAFx REPORT:

Project:		Start:	2003-08-07 05:00	Location:	
Counter:	LCATS 2	Finish:	2003-08-07 20:00	Comment:	



Total Counts:	**159**	Daily Mean Weekday:	159.0
Total Periods:	**16**	Daily Mean Weekend:	#N/A
Period Length:	**1 hour**	Mean Monday	#N/A
Mean:	**9.9**	Mean Tuesday	#N/A
Mode:	**1.0**	Mean Wednesday	#N/A
Median:	**8.0**	Mean Thursday	159.0
Standard Deviation:	**7.8**	Mean Friday	#N/A
Maximum:	**24**	Mean Saturday	#N/A
Minimum:	**1**	Mean Sunday	#N/A
Total Weekday:	159		
Total Weekend:	0		
Daily Max/Min Weekday:	159 / 159		
Daily Max/Min Weekend:	#N/A		

LCATS eventually intends to compare known traffic volume on roads parallel to pedestrian and bicycle paths to *estimate* the number of motor vehicle trips converted to non-motorized trips when a new bicycle or pedestrian facility is built parallel to it. The table shown in Figure 3 could be compared with a similar table for vehicle trips to begin this estimation.

By dividing the number of users by the interval between time stamps, analysis also allows LCATS to identify the average time gap between users (this can be used to find a mean hourly gap for path users). This information may enable transportation planners to make level-of-service estimates for specific locations, such as intersections.

Data dissemination

The overall data collection effort his been conducted to support the non-motorized section of the LCATS Long Range Transportation Plan, where it will provide baseline data and indicate where new non-motorized infrastructure should be provided. Data will be disseminated to justify the future expansion of the LCATS path network and identify future needs, as well as provide information to other jurisdictions. Although LCATS has not conducted a public information campaign, data are provided to jurisdictions within the LCATS area for their use in bicycle and pedestrian planning.

Innovations and Accomplishments

LCATS staff members were in need of reliable data collection methods that could cover a relatively extensive system of pedestrian and bicycle facilities. The LCATS Policy Committee approved the use of the passive infrared counters, realizing the value of a low-cost, automated collection method. The shared-use path counts have been complemented by GPS-based mapping. Both technologies have allowed LCATS to collect a large amount of detailed data at low cost. Because these data collection efforts have been successful, LCATS will be able to continue this low-cost data collection.

Although the data collection process is an ongoing activity, initial analysis has exceeded expectations. LCATS found that there were peak periods on shared-use paths that corresponded with typical a.m. and p.m. roadway peak periods, which suggests to LCATS that bicycle and pedestrian facilities are used for commuting, rather than just recreation. Cities and villages within the LCATS area use the data to support their requests/grant applications for new shared-use path projects.

Maps and count data have been used to determine where limited funds can best be spent to eliminate gaps in the Licking County shared-use path system.

Lessons Learned

LCATS staff found unexpected applications for the data generated from this program, including prioritization of capital improvements to the County's path system. Early data analysis also allowed staff to identify the unexpected trend of peak hour (commuter) usage of the pedestrian and bicycle network.

However, LCATS has found several limitations to using TRAFx passive infrared counter:

- It does not differentiate between bicyclists, pedestrians, and animals such as deer and raccoons. All of these warm-blooded animals generate body heat and are picked up by the sensor.
- The characteristics of passive infrared data collection raise some reliability concerns, although LCATS staff compared the infrared data to manual counts and found that the automated counts were at least 90% accurate.
- The counter requires a delay between incidents. LCATS used a 0.25 second delay for the sensor, so that after the sensor is tripped, it is not able to take another count until 0.25 seconds later. This causes inaccuracies when, for example, path users are side-by-side or pass each other in opposite directions at the location of the beam.
- The counter may not properly capture users that are side-by-side. LCATS staff attempted to fix this by aiming the infrared beam at a 45-degree angle to the shared-use path, but did not get significantly better results. Staff speculated that there must be a similar amount of shared-use path users that are staggered slightly as are side-by-side, so the angled measurement encountered the same limitation.

Most of these limitations, such as the required delay between registering incidents, angled measurements, and non-human heat sources also apply to other semi-automated or automated data collection devices. Overall, the LCATS staff is satisfied with the data collection and analysis that has been possible with the passive infrared sensor.

Cost of Data Collection Effort

Each TRAFx infrared package costs $2,200, including three sensors, equipment to connect to a computer, user manual, and software. Other costs include the time required to download and analyze the data.

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IN-PAVEMENT LOOP DETECTOR BICYCLE COUNTS

Madison, Wisconsin

City of Madison Department of Transportation

Data Collected

- Routinely use in-pavement loop detectors to count bicyclists on seven shared-use paths and two pairs of bike lanes
- Have collected bicycle counts consistently since 1991

Highlights

- Found that loop detectors were less expensive than manual counts
- Have shown increases in bicycle use over time
- Use data to show seasonal variations in bicycle ridership

Purpose of Collecting Data

The City of Madison collects bicycle use data to justify using city funding to provide bicycle facilities. In addition to providing evidence of people using bicycle facilities, the counts are analyzed in planning and traffic engineering studies and made available for use by businesses.

Geographic Area Description

Madison (population 210,000) is the capital of Wisconsin and home to the University of Wisconsin-Madison. The State Capitol, many government buildings, and the University are located in the downtown area and attract many bicycle trips. Madison has one of the highest bicycle commute mode shares of any city in the United States (3.2%).

Methodology

History of data collection effort

After counting bicyclists manually and with pneumatic tubes for several years, Madison chose to install in-pavement bicycle loop detectors in 1991 at two locations to reduce the amount of labor required to collect counts. The locations included a shared-use path and a bike lane (one detector for the westbound bike lane and the other detector for the eastbound bike lane). Since 1991, loop detectors have been installed in six other shared-use path locations and one other bike lane.

Data Collection

The in-pavement loop detectors count bicyclists by detecting the iron and steel of the bicycle as it passes over the loop (see Figure 1). When the magnetic flux of the in-pavement loop changes, the count is registered in a traffic signal box near the site. The sensitivity of the loop detector depends on the configuration of the loop and the depth of the loop below the pavement surface. Bicycles, strollers, in-line skates or other objects used along a path are more likely to be detected when they have iron components, when they pass directly over the edge of the loop, and when they are traveling at a faster speed.

The City found that it is beneficial to locate the loop detectors in locations that are near an existing traffic signal box, because bicycle count data (and other traffic data) from the existing traffic signal boxes are collected continuously through a master controller at the traffic signal shop. The data are downloaded directly from this master controller several times per day and are not collected in the field. In locations without a permanent traffic signal box nearby, a portable traffic signal control box is used to log the data. The data must be downloaded in the field when the portable traffic signal control box is used. Madison has installed new permanent traffic signal boxes with several construction projects so that only one of the loop detector locations requires a portable traffic signal control box.

Figure 1. Loop Detector in Shared-Use Path Pavement

Data storage

At eight count locations, data are downloaded from the master controller; at one location the data are downloaded from the portable traffic signal control box. The raw data are in binary format. They show the number of bicyclists that were detected over 15-minute intervals. Minitab software is then used to convert these data into a usable form (an ASCII text file). Finally, the text file is converted into spreadsheet format and the data are aggregated into hourly counts for analysis (see Figure 2). The data are stored in computer spreadsheets kept at the traffic signal shop.

Figure 2. Bicycle Count Spreadsheet (Two Days of Data)

LOCATION JOHN NOLEN BIKE PATH [MONTHLY]
STATION # 3014
DIRECTION BY STATION
REMARKS
START TIME 0 on 04/06/04
END TIME 0 on 04/08/04

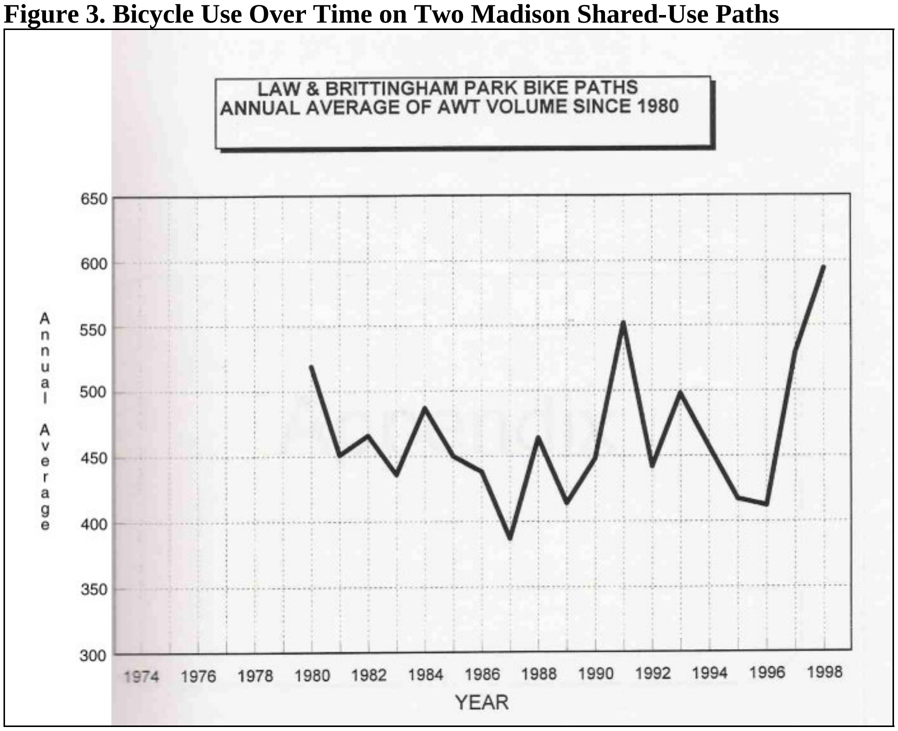
TRAFFIC ENGINEERING DIVISION
CITY OF MADISON, WI
AUTOMATIC TRAFFIC COUNTER RECORD

Day Date	Monday 12 Apr	Tuesday 06 Apr	Wednesday 07 Apr	Thursday 08 Apr	Friday 09 Apr	Saturday 10 Apr	Sunday 11 Apr	TOTAL M-F Volume	AWT Volume	ADT Volume
AM 12-1		2	2					4	2	2
1-2		5	1					6	3	3
2-3		0	0					0	0	0
3-4		0	0					0	0	0
4-5		2	3					5	3	3
5-6		9	7					16	8	8
6-7		31	42					73	37	37
7-8		68	110					178	89	89
8-9		40	71					111	56	56
9-10		27	55					82	41	41
10-11		20	39					59	30	30
11-12		38	45					83	42	42
PM 12-1		63	56					119	60	60
1-2		111	77					188	94	94
2-3		100	120					220	110	110
3-4		153	125					278	139	139
4-5		212	169					381	191	191
5-6		246	179					425	213	213
6-7		236	131					367	184	184
7-8		84	62					146	73	73
8-9		27	20					47	24	24
9-10		14	18					32	16	16
10-11		5	10					15	8	8
11-12		6	5					11	6	6
24 HR TOTAL		1499	1347					2846	1429	1429

Data analysis

The bicycle count data can be analyzed by hour, day, month, or year to indicate trends in bicycle use over time (see Figure 3), seasonal variations in bicycle activity, or peak hour bicycling volumes.

Figure 3. Bicycle Use Over Time on Two Madison Shared-Use Paths



Data maintenance and management

Spreadsheets with historic bicycle counts are kept by the City of Madison Department of Transportation. City staff plan to continue counting bicyclists with loop detectors in the future, to continue tracking trends over time.

Data dissemination

The bicycle counts are summarized in annual reports and will be referenced in the next update of the City Bicycle Plan.

Innovations and Accomplishments

An engineer at the University of Wisconsin conducted an independent study on the in-pavement bicycle loop detectors in the early 1990s and found that they were effective in providing accurate bicycle counts. According to the study, the loop detectors provide more consistent, continuous count data than temporary counts collected manually or with pneumatic tubes.

The in-pavement loop counts have been useful during times when the City has faced opposition to bikeway funding. The counts are also used during roadway design and land development projects.

Lessons Learned

Though the bicycle loop detectors detect most bicyclists, they do not detect all path or bike lane users. It is likely that strollers are counted, but unlikely that in-line skaters and pedestrians are counted. Even if all of these users were detected, the counts would not be able to classify them by user type.

Because the City uses bicycle loop detectors to take counts, it does not use field data collectors to document helmet use by bicyclists, count pedestrians, or observe bicyclist and pedestrian behavior—all of which could be collected during a manual count. While the City would like to record this information, it does not have the resources to use field data collectors to make these observations.

The City of Madison could use the loop detector counts to develop a method of generating an estimate of total shared-use path volume based on the proportion of users that are bicyclists. City staff intend to take manual counts of in-line skaters, pedestrians, bicyclists, and other users to determine what percentage of trail users are counted by the loop detectors. They can then use a factor to convert the loop detector counts to total path volume. This factor would change based on variations in surrounding land uses, characteristics of nearby residents, and weather conditions.

Cost of Data Collection Effort

In locations where the in-pavement bicycle loop detector is installed near an existing traffic signal, the cost of collecting bicycle counts is low: approximately $500 for the in-pavement loop, three to four hours of labor for installing the loop, and less than one hour of labor to download and analyze the data. A portable signal controller can serve locations that are not near an existing traffic signal box, but at a cost of $3000 to $4000.

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COUNTING AND CLASSIFYING PEDESTRIANS AND BICYCLISTS WITH AN ACTIVE INFRARED SENSOR

State of Massachusetts

Massachusetts Highway Department and
University of Massachusetts Transportation Center

Data Collected

- Tested active infrared sensor to measure pedestrian and bicycle use on one path in a pilot study of an automated counting methodology

Highlights

- Classified pedestrians and bicyclists using an infrared sensor
- Detected bicyclists' speeds
- Achieved the accuracy of typical automated traffic counting devices
- Investigated other technologies for counting and classifying pedestrians and bicyclists

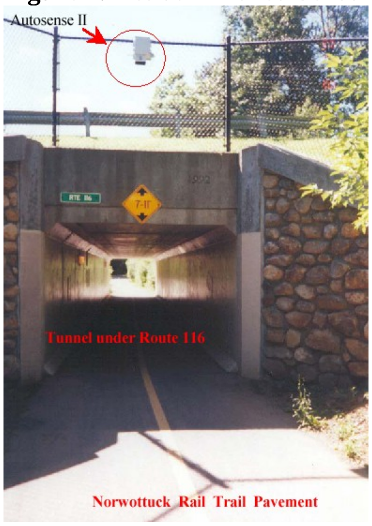
Purpose of Collecting Data

The Massachusetts Highway Department determined that more accurate usage data were needed on the pedestrian and bicycle facilities that have been constructed in the state. Therefore, the Department undertook a study to identify a cost-effective method of counting and classifying pedestrians and bicyclists. This study compared automated methods of data collection and tested the most promising method. The Massachusetts Highways Department intends to use the counter mainly on roadways. It can also be used on sidewalks and pathways throughout the State. Existing limitations to the technology made it made it necessary to conduct the test on a shared-use path.

Geographic Area Description

The Norwottuck Rail Trail is 8.5 miles long and links Northampton (population 29,000), Hadley (population 4,800), Amherst (population 35,000), and Belchertown, MA (population 13,000). It passes within one mile of the University of Massachusetts Amherst campus. The shared-use path is well-used by pedestrians and bicyclists—some locations receive an estimated 1,200 to 1,400 users per day during peak use and 500 to 600 users on typical spring, summer, and fall days. For data collection, an active infrared sensor was placed above the Norwottuck Rail Trail at the end of the Route 116 underpass in Amherst, MA (see Figure 1).

Figure 1. Active Infrared Sensor Over the Norwottuck Rail Trail at Route 116 Underpass



Methodology

History of data collection effort

The Massachusetts Highway Department worked with the University of Massachusetts Transportation Center (UMTC) on a review of various automated counting technologies in 2000 to select the most promising method for a pilot study. These technologies included:

- Microwave detection
- Ultrasonic detection
- Acoustic detection
- Video image processing
- Piezoelectric detection (measure electricity created by weight pressure on a piezo cable)
- Passive infrared detection (senses infrared light reflected off of objects)
- Active infrared detection (produces an infrared beam and senses the reflection of the beam off of objects)
- Magnetic detection
- Inductive loop detection
- Pneumatic traffic detection and classification (tube counters)

These technologies are evaluated in detail in the research paper, *An Evaluation of Technologies for Automated Detection and Classification of Pedestrians and Bicyclists*[3]. The research team found that active infrared detection was the most promising technology for counting and classifying pedestrians and bicyclists.

The Massachusetts Highway Department purchased an Autosense II Active Infrared Imaging Sensor from Schwartz Electro-Optics Inc., of Orlando, Florida in 2001 (Figure 2). Though this technology had been developed for counting and classifying high-speed, one-way, motorized

[3] Noyce, David A. and R. Dharmaraju. *An Evaluation of Technologies for Automated Detection and Classification of Pedestrians and Bicyclists*, Federal Highway Administration, Massachusetts Highway Administration, and University of Massachusetts Transportation Center, May 2002.

traffic, its method of detection and algorithms appeared to be applicable for pedestrians and bicyclists. For example, the device could detect motorcycles, which have a similar shape as bicycles. The Norwottuck Rail Trail pilot test was the first time that the device had been used for non-motorized modes.

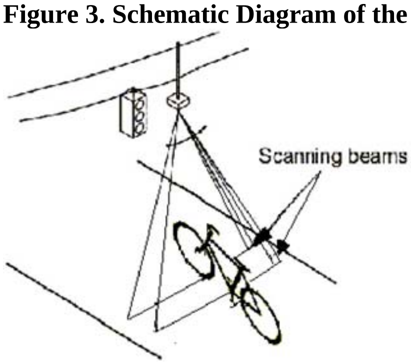
Figure 2. Autosense II Active Infrared Imaging Sensor

Data Collection

Fencing over the underpass structure at the Route 116 tunnel test site provided a relatively secure location for the sensor. Setting up the active infrared sensor was not labor intensive, requiring less than 30 minutes for either installation or removal. Two people were needed to install the device. Power for the sensor was taken from a nearby warehouse using outdoor power cables. The sensor can operate from an AC power source of 90-130 VAC with any frequency from 47 Hz to 440 Hz. The research team alerted all public agencies about the field data collection activity by obtaining a 'Special Permit' from the Amherst Regional Office of the Department of Conservation Resources.

The active infrared sensor detected pedestrians and bicyclists with two separate infrared beams (see Figure 3). The device was mounted approximately 18 feet above the shared-use path surface and tilted forward five degrees (incident angle). When the Autosense II is installed at the manufacturer's recommended height of 23 feet, the distance between the two beams projected on the surface is four feet (1.2 meters). At the study site, the distance between the two beams was three feet, one inch.

Figure 3. Schematic Diagram of the Active Infrared Sensor Scanning Beams



When a pedestrian or bicyclist passed under the sensor, infrared beams sent from the device were shortened, and the user was detected. Algorithms within Autosense II determined the time gap between when the first and second beams were broken and the total amount of time it took for the user to pass through the first beam. This raw detection data was sent to the computer, which processed it using special software. The computer calculated the user height, vertical profile, width, length, and speed and used these data to determine the final classification of the user. It also captured data that were used to produce false-color images of pedestrians and bicyclists (see Figure 4).

Figure 4. False-Color Images of a Bicyclist (left) and a Pedestrian (right)

Data storage

The raw data output from the Autosense II device is converted to a text file by the supporting software package. This text file can then be exported in several forms to a Microsoft Access database.

Data analysis

A total of 357 pedestrians and 924 bicyclists were observed by the active infrared sensor at the Norwottuck Trail study site over several days during the summer and fall of 2001. Observations occurred during daylight and night, on different days of the week, and in sunny and cloudy conditions over a 4-week period. The data obtained from Autosense II were compared with simultaneous manual counts to evaluate the performance of the device. Results of the experiments are summarized in Figure 5.

Figure 5. Comparison of Automated and Manual Counts

Trail User	Automated Count	(Automated vs. Manual Count)	
		% of Users Counted Correctly	% of Users Classified Correctly
Bicyclists	924	97%	77%
Pedestrians	327	92%	N/A

Autosense II was very effective at detecting pedestrians and bicyclists. Ninety-seven percent of the bicyclists and 92 percent of pedestrians counted manually were detected by the infrared sensor. However, only 77 percent of the bicyclists detected were classified in a way that they could be distinguished as bicycles (the software output listed them as “motorcycles”). The sensor did not classify pedestrians.

Data dissemination

In addition to the research report cited above, the Massachusetts Highway Department and UMTC presented the research as a technical paper at the Institute of Transportation Engineers Conference in 2001. The second phase of the study is being conducted between March 2004 and March 2006. The second phase will test a number of modifications identified in the pilot test phase. If the second phase is successful, more devices may be acquired, and counts may be taken on a consistent basis on pedestrian and bicycle facilities throughout the state.

Innovations and Accomplishments

The research study found that, with some modifications, active infrared technology is capable of detecting and classifying pedestrians and bicyclists. The AutosenseII device can gather information without being as intrusive as collecting data through video imaging, because no identifiable characteristics are collected. In addition, the sensor requires less than one hour of total setup and takedown time to gather data over an entire day. It is also easy to relocate. This method has the potential to be more cost-effective than counting and classifying pedestrians and bicyclists manually.

The active infrared sensor was also very reliable. Light and temperature conditions did not affect the performance of the device. No problems occurred in light conditions that ranged from dusk to bright sunlight and temperature conditions that ranged from 35 to 80 degrees Fahrenheit. Heavy precipitation may affect performance because it could obstruct and scatter the infrared beams. The effects of heavy precipitation were not field tested because of wiring and computers at the test site.

Lessons Learned

Two problems resulted from the Autosense II device's original design to detect motor vehicles traveling in one direction in a single lane. First, the algorithms used in the software calculated the user's length only when the first beam was cut before the second beam. Therefore, users passing in the reverse direction were detected, but were not profiled and classified. Second, user classification was not determined unless both beams were simultaneously cut at some point in time, so pedestrians were not classified because they were not long enough to cut both beams at once.

Hardware Modifications

The mounting height of the equipment may be reduced from the recommended 23 feet (7 meters) to approximately 12 feet (3.6 meters) so that a pedestrian passing underneath the sensor can simultaneously cut both active infrared beams. Alternatively, the angle between the two beams may be reduced to decrease the beam separation. Application of the sensor is dependent on finding a structure that the device can be mounted to, at the appropriate height, directly above the surface where pedestrians and bicyclists travel.

The device now operates at the high scan rate of 720 scans per second, as it was designed to work with fast moving vehicles. For pedestrians and bicyclists, the scan rate may be reduced without compromising accuracy. With the lower scan rate, the computer would have fewer computations to complete with each observation and would run faster.

In this experiment, the device took 30 measurements as a beam moved across the width of the pavement. These 30 "range" measurements generally produce an accurate profile for motor vehicles, which tend to have a simple shape. Yet, 30 range measurements may not be sufficient for pedestrians and bicyclists. Increasing the number of range measurements to 45 may enhance the accuracy of classification.

Software Modifications

The algorithms currently used are not capable of calculating the length of a pedestrian or bicyclist if the second beam is cut before the first beam. Changes should be made to the algorithms so that length and speed can be calculated in both directions.

Current algorithms divide path users into the categories of "motorcycle", "other", and erroneous data. Bicyclists were identified by the software as motorcycles. The "other" users in this study were generally assumed to be pedestrians. In the future, algorithms may be created to create specific categories for pedestrians, in-line skaters, and other types of users.

Several other problems require further consideration. When pedestrians and bicyclists passed under the device simultaneously, they were often classified incorrectly by the algorithm. It may be possible to solve this problem by analyzing the false color image data created during the event.

Many of the suggested modifications are being tested in the second phase of the study.

Cost of Data Collection Effort

The total budget for the study was $50,000. The Autosense II Active Infrared Imaging Sensor was purchased for this research project for approximately $2,000, including sensor and software. Future price will depend on modifications in technology and mass production of the device.

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PNEUMATIC TUBE BICYCLE COUNTS

Outer Banks, North Carolina

North Carolina Department of Transportation

Data Collected

- Used pneumatic tubes to count cyclists at 3 shared-use pathway and 8 paved shoulder locations
- Compiled hourly/daily counts over one week in Summer 2003

Highlights

- Used automated counting technology
- Used count data in an economic development study
- Obtained counts at all times of day, and found surprisingly high levels of bicycling at night

Purpose of Collecting Data

The North Carolina Department of Transportation (NCDOT) wanted to identify the economic impacts of bicycle facilities in the northern Outer Banks region. This analysis required user counts on existing bicycle facilities in the area. NCDOT used the information to estimate the total number of people bicycling annually and during the tourist season.

Geographic Area Description

The Outer Banks are a string of barrier islands on the east coast of North Carolina (Dare County, which includes the Outer Banks, has a permanent population of 29,000 and a seasonal population of 200,000 to 225,000). The northern part of Outer Banks includes the communities of Corolla, Manteo, Nags Head, and Kitty Hawk. This section of the Outer Banks attracts about 4 million tourists in a typical year; about 85 percent of these tourists visit between the months of May and September. Bicycle counts were taken at 11 separate locations in this part of the Outer Banks. The northernmost counters in Corolla were approximately 25 miles from the southernmost counters in Manteo.

Methodology

History of data collection effort

The Outer Banks bicycle counts were one part of a broader economic impact study that was commissioned in February 2003. The study, *The Economic Impact of Investments in Bicycle Facilities: A Case Study of the Northern Outer Banks*, was sponsored by the North Carolina Department of Transportation Division of Bicycle and Pedestrian Transportation and was performed by the Institute for Transportation Research and Education (ITRE) at North Carolina State University (NCSU). The North Carolina Bicycle Committee advocated for bicycle counts as a part of the study, which was performed by a NCDOT unit that regularly does motor vehicle counts.

Data Collection

Pneumatic tubes were used on three shared-use paths and on eight roadway shoulders for a one-week period during the height of the Outer Banks tourist season. The tubes used on the shoulders were placed in pairs on opposite sides of the roadway in order to collect information about each direction of travel. The tubes counted users continuously over the entire week of Tuesday, July 29th through Monday, August 4th, 2003.

The NCDOT Traffic Survey Unit had previously used two different sizes of pneumatic tubes to count motor vehicle traffic on roadways. NCDOT used the smaller of the two tube sizes for the bicycle counts. The pneumatic tubes were placed perpendicular to the direction of travel and detected bicyclists when air in the tubes was compressed. The compressed air was detected by a sensor, which was programmed so that it only counted a user if there were two pulses of air within a certain time interval (created by two wheels of a bike going over the tube). The number of bicyclists per hour was recorded in a small electronic device attached to the pneumatic tube.

Figure 1. Pneumatic Tube Counter

Researchers distributed a survey to bicyclists during summer 2003 to supplement the tube counts. This survey provided information about bicyclists' vacation purposes, spending habits, bicycle riding habits while on vacation, and opinion of bicycle facilities in the northern Outer Banks area. Surveys were also given to tourists at visitor centers who were not on bicycles, residents of the northern Outer Banks, and owners of Outer Banks campsites, and bed and breakfasts.

Data storage

Recorders attached to each pneumatic tube registered and stored the count data. At the end of the week, the data were downloaded to a laptop and converted to spreadsheet format.

Data analysis

The raw data spreadsheet included counts per hour at each location. These data were used to show total counts by location (see Figure 2), by day of the week (see Figure 3), and by hour (see Figure 4).

Figure 2. Bicycle Counts by Location

Location	Average/Day	High	Low	% of Total
Corolla North, N. Shoulder	132	237	1	5%
Corolla North, S. Shoulder	64	119	34	2%
Corolla South, N. Shoulder	262	369	161	9%
Corolla South, S. Shoulder	117	169	81	4%
Duck, N. Shoulder	810	1182	530	28%
Duck, S. Shoulder	262	399	189	9%
Duck, Sidepath	791	1277	529	28%
Manteo, Sidepath	76	99	59	3%
Nags Head, Sidepath	250	327	167	9%
Nags Head, N. Shoulder	43	70	3	2%
Nags Head, S. Shoulder	63	87	31	2%
Total	2872			100%

City	Average/Day	High	Low	% of Total
Corolla	144	369	1	15%
Duck	621	1277	189	65%
Manteo	76	99	59	8%
Nags Head	119	327	3	12%
Total	960			100%

Figure 3. Total Bicycle Count by Day (all 11 count locations)

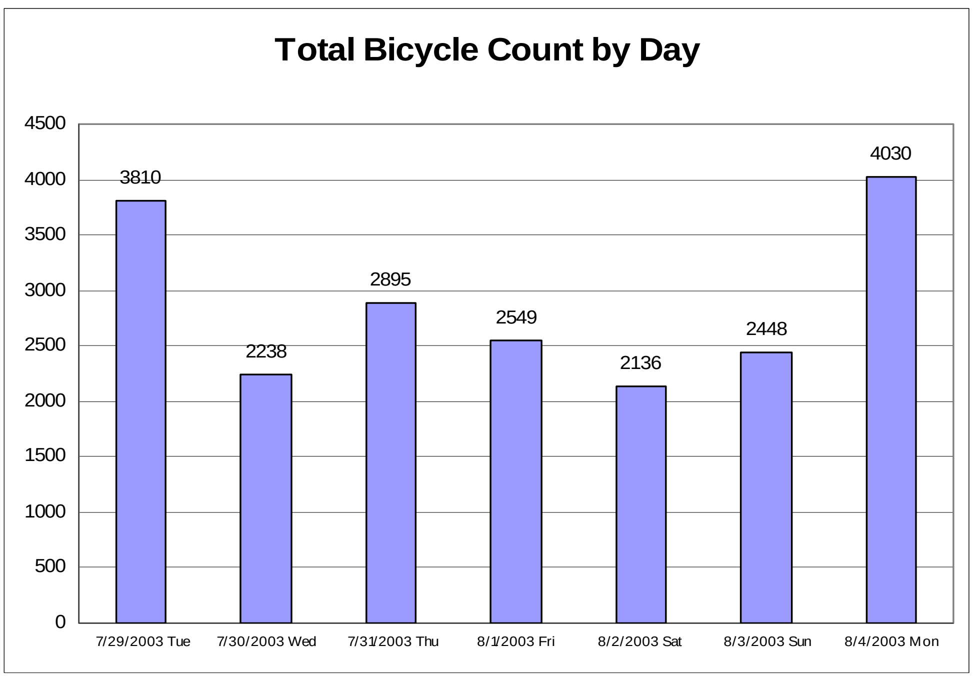
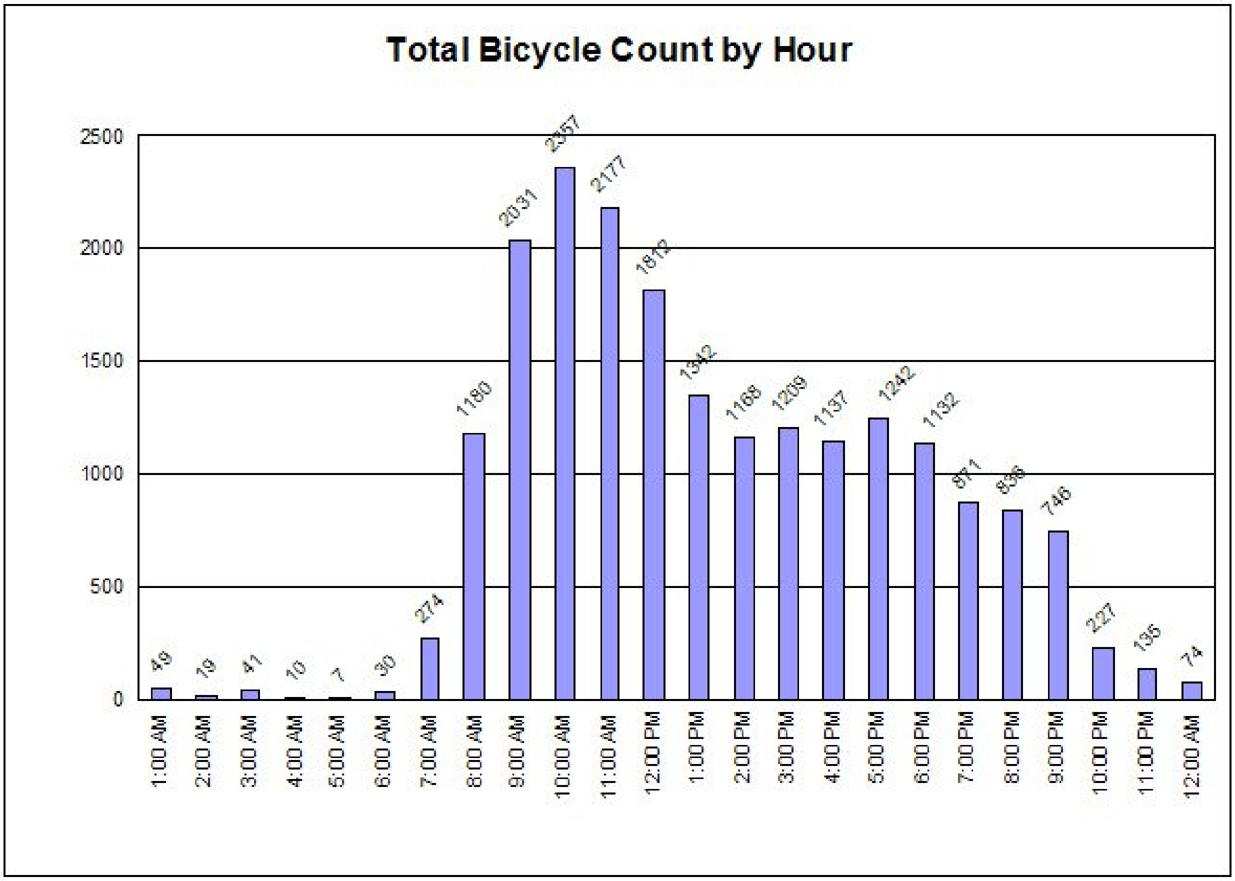


Figure 4. Total Bicycle Count by Hour (all 7 days at all 11 count locations)



The count data were used to estimate the number of people that ride bicycles in the Outer Banks each year. Because the data were collected over a one week period at 11 different locations, a series of adjustments were required to convert the counts to an estimate of annual bicycle riders. The following adjustments were used to estimate the average number of different bicyclists in the Outer Banks on a typical July or August day:

- bicyclists who were on round trips (divided total count number by two)
- bicyclists who may have ridden over multiple traffic counters (divided the total count number in each municipality by the number of counters in the municipality—assumed each rider was counted by all tubes in the municipality)
- bicyclists who rode on multiple days during the study (divided by 5.4, the average number of days per week each bicyclist in the survey reported riding during their trip to the Outer Banks)

After deriving the average riders per day, this number was extrapolated to an annual number of bicyclists using the relative rates of room occupancy per month from the Outer Banks Visitor Bureau.

Data maintenance and management

NCDOT and ITRE have kept the raw counts on file. There are no immediate plans to take follow-up bicycle counts, but they are interested in gathering more data in the future. Similar tube counts may be used by NCDOT in another part of the state.

Data dissemination

NCDOT has recently concluded the full bicycle facility economic impact study report. A summary of the report is available on the NCDOT website at http://www.ncdot.org/transit/bicycle/safety/safety_economicimpact.html. The summary document reports that about 680,000 people bicycle in the northern Outer Banks region each year. It also estimates that the economic impact because of bicycling from tourists who choose to vacation or extend their vacation in the Outer Banks is about $60 million per year. Charts and graphs of bicycle usage by day, hour, and location are included in the full report.

Innovations and Accomplishments

The pneumatic tube counts produced valuable results for NCDOT. Together, the eleven counters were tripped several thousand times each day. Counts were collected continuously and covered an entire week. Manual counts would have required many more hours of labor than the tube counts. In addition, the pneumatic counters provided counts throughout the day and night, while manual counts are usually only done during peak usage periods.

The counts revealed that there are a fair number of bicyclists who ride at night. Many of these people may work at restaurants or bars that close late in the evening. Maintaining the counters throughout the week also showed that almost all of the weekdays had even higher bicycle volumes than Saturday and Sunday. The lower counts on weekends may be explained by the fact that most people visiting the area rent a house or condo for the week and are checking in/out and getting settled over the weekend. Had the counts been done manually, NCDOT may not have been able to provide labor to collect counts over long enough time periods to identify these trends.

Lessons Learned

Researchers found that while the pneumatic tube counts were a useful starting point for estimating the number of bicyclists in the Outer Banks each year, the tubes did not provide a completely accurate count. In particular, the raw data did not identify when a bicyclist tripped more than one tube or was counted more than once on a single tube over the seven day counting period. In an effort to prevent the overcounting of bicyclists, NCDOT used a double count adjustment, multiple counter hits adjustment, and multiple riding days adjustment. These adjustment factors were applied to produce a conservative estimate of the number of annual bicyclists in the Outer Banks, but their necessity can be evaluated through future research.

Another potential problem with pneumatic tube counters is that they do not differentiate the type of wheeled user that is counted (bicyclist, stroller, etc.). In addition, the tubes do not provide accurate counts of pedestrians, because the tubes only register a user when they sense two pulses within a short time period (both bike tires going over the tube). Even if a tube was adjusted to register a user for a single pulse (foot stepping on the tube), it is likely that some pedestrians would not step on the tube. When the pneumatic tubes are used on roadway shoulders, some bicyclists (especially more serious riders) may avoid riding over them while some motor vehicles may stray onto the shoulder and be counted. The on-site study team observed this behavior and estimated that the number of cyclists who avoided counters was roughly equivalent to the number of cars, strollers, roller blades, and skate boards that tripped the counters.

The effects of rain were considered by the researchers. Afternoon thunderstorms, typical in the summer season, occurred on each of the three days the study team was in the area to conduct the intercept surveys. To determine whether or not rain was a significant factor over the week, the team checked radar data from the NCSU Marine, Earth, and Atmospheric Sciences Department to identify days when it rained at each count location. Analysis of the bicycle counts showed that there was only a one percent difference between bicycle ridership on days with and without rain. Therefore, the researchers did not adjust the traffic counts for rain when calculating the average number of bicyclists per day. The relationship between bicycle ridership and rain intensity was not examined.

Some of the assumptions used to convert the July 29th through August 4th bicycle counts to the annual number of bicyclists could be researched and refined. A key assumption is that the number of people riding bikes as a percentage of tourists is constant throughout the year. In reality, a greater percentage of visitors may bicycle during months when the weather is warm than in months when the weather is cold or very hot. In addition, the researchers did not determine if the amount of rain during the week of the counts was representative of a typical week in the Outer Banks. If rain does influence bicycle ridership, an atypical amount of rain during the week of the counts could skew the annual estimate.

The 11 tube counters were placed in locations where high volumes of bicyclists were expected. In hindsight, some of the counters could have registered more bicyclists if they had been in different locations. Even if the counters had been placed in the 11 highest locations for bicycle use, bicyclists who chose to ride in other locations would not have been counted. Therefore, the overall estimates of bicycle ridership in the Outer Banks are likely to underestimate the total number of cyclists. More accurate estimates can be made if additional counts are taken in the future.

Cost of Data Collection Effort

Tube counters can be set up in about 15 minutes and removed in about the same amount of time. A team of two transportation data collectors spent one 8-hour day to set up and a second 8-hour day to remove the tubes at the 11 locations in the northern Outer Banks region. Much of this time was spent driving between count sites. An additional day in the middle of the counting period was spent checking on the condition of the tubes. The total cost for this labor was about $3,000. Because the pneumatic tubes had never been used for this type of data collection before, set up took a little longer. The type of pneumatic tube and count recorder set used by NCDOT costs $1,600. It records information electronically which allows for processing into a software program for analysis. The software comes with the unit and is included in the price. A basic unit can be purchased for approximately $300, but records only limited intervals and must be read and recorded manually.

Analysis of the count data for the economic analysis report required several weeks of staff time, and was not included in the costs listed above. The cost of the analysis was included in the overall cost of the economic impact study, which included developing a survey instrument, coordinating the survey distribution, entering and analyzing data, and producing a final report. The budget for the economic impact study was $26,500.

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PIEZO FILM BICYCLE COUNTS

State of Iowa

Iowa Department of Transportation

Data Collected

- Used Piezo film to count bicyclists on shared-use paths
- Collected data at 20 to 30 locations per year since 2002

Highlights

- Used automated counting technology
- Determined Piezo film was a more effective counting method after trying infrared sensor
- Have identified advantages and disadvantages of taking counts with Piezo film

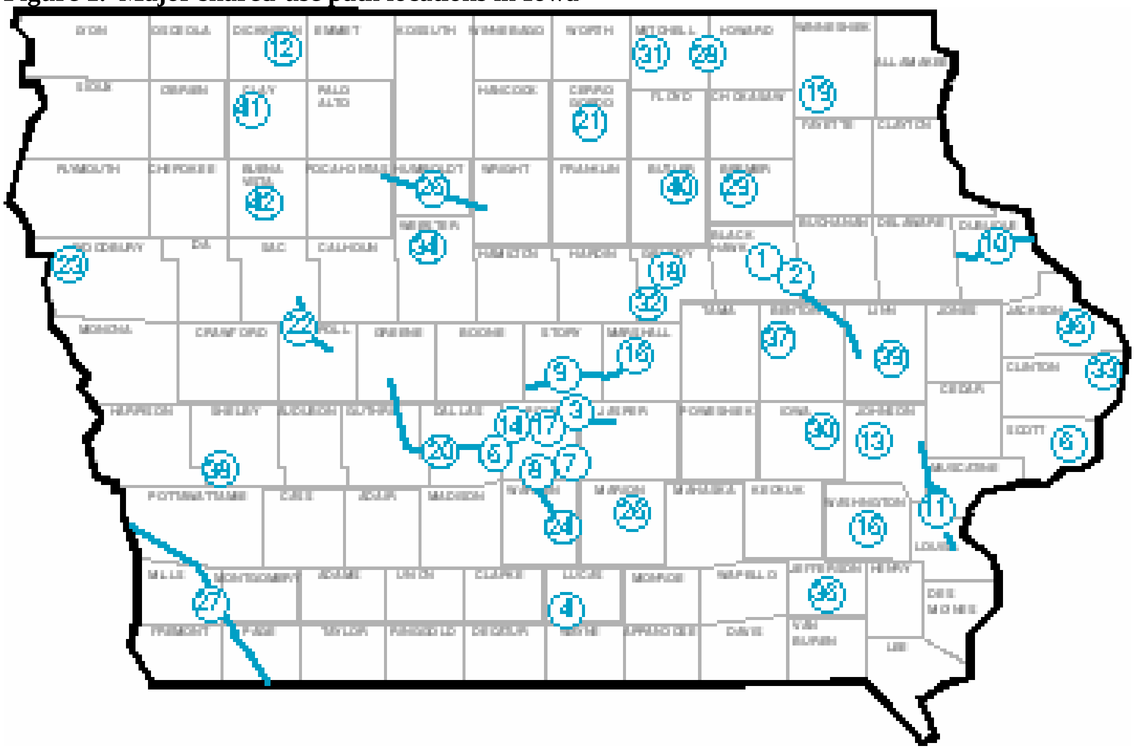
Purpose of Collecting Data

As the Iowa DOT became more proactive in long-range planning for bicycle transportation, the lack of information related to bicycling was evident. Data were needed relative to use, trip origins and destinations, and travel forecasting. As a first step, the department began an annual program to collect usage data on several of Iowa's shared-use paths. This information will not only be useful in ongoing planning activities, but may also raise the profile of trails in future funding decisions made by state officials. Iowa's State Recreational Trails Program has not received a funding appropriation in recent years. Iowa DOT hopes the user data will help to justify spending on facilities and promote future funding and development of trail networks.

Geographic Area Description

Shared-use paths are located throughout the state of Iowa (population 2,930,000), but there is a particularly dense concentration in the central part of the state. For both highway traffic counts and bicycle data collection, Iowa DOT divided the state into quadrants to narrow the scope of collection efforts on a yearly basis. Approximately 20-30 shared-use path locations are observed each year. Quadrants are observed every four years. The number of counter locations per shared-use path varies. Depending on the length of the shared-use path, there may be one counter at a key central location or counters at entry points. The map below identifies the locations of major shared-use paths in Iowa (see Figure 1).

Figure 1. Major shared-use path locations in Iowa



Methodology

History of data collection effort

In the summer of 2000, Iowa DOT decided to test a variety of counting technologies, including passive and reflective infrared, fiber optic, microwave radar, pneumatic road tube counting devices, video imaging, and Piezo film. Video imaging was problematic for obtaining nighttime counts, failed during bad weather, and lost quality when spiders built webs on the lens. Fiber optic counters were too fragile. Infrared counters generated data that were not reliable because objects other than bicyclists were able to set off the counter, including leaves and animals. In addition, the infrared counters were very costly. Pneumatic tubes did not register all the bicyclists that rode over them. The tubes were also viewed as a potential hazard because there have been rare occasions when a tube has bounced up after the front tire passes over it and the tube catches a pedal in the down position, causing a crash. Iowa DOT eventually chose Piezo film because it proved to be the most consistent and effective device, counting every bicycle during testing. Piezo film is a tough, flexible, lightweight engineering plastic – a natural polymer that produces electrical current.

While data collection efforts have been going on for several years, changes in technology and DOT staff have limited the effectiveness of these counts. Once data from all four quadrants are collected and stored in a database, the Office of Systems Planning will analyze the data, report on the number of people using shared-use paths and unique factors about each trail, and disseminate information to outside agencies and the general public. While data maintenance will be ongoing, Iowa DOT plans to report on initial results in 2005.

Data Collection

The first step in data collection involves setting up the equipment in a strategic location where workers can lay a lead wire across a shared-use path, avoiding interference with other objects. The Piezo film itself is about ½-inch wide and is placed in a sleeve that is 3- to 4-inches wide and 10-feet long. The sleeve is then connected to a control unit that compiles the counts and is placed across the pathway, perpendicular to the direction of travel. The sensors are locked securely to a tree and clearly identified to discourage tampering.

Because Iowa DOT is currently interested in bicycle counts only, the Piezo film sensor is configured so it counts 2 pulses as 1 bike. It will not count other shared-use path users unless they create two pulses over a similar time period as bike tires.

Observing one quadrant of the state each year, Iowa DOT collects data in approximately 20 to 30 shared-use path locations. Aside from usage gathered from the sensors, Iowa DOT also gathers information on shared-use path characteristics, including length, width, paving material, and location.

Data storage

Piezo film devices are usually controlled by microprocessors. Data is gathered, grouped by the hour, and downloaded to a computer hard drive as ASCII data. According to Iowa DOT, this form of data storage gives Piezo film an advantage over infrared sensors. Infrared sensors were not able to group the data by the hour; they merely counted continuously with one final number for the entire data collection period.

Data analysis

Bicycle counts are analyzed by identifying peaks in shared-use path use and reporting the distribution of users over days of the week and months of the year. This is similar to the way Iowa DOT analyzes vehicle counts.

Because bicycle usage rates differ significantly due to weather and data is collected only once per year in the summer, Iowa DOT could analyze the summer data with several other observations at different times of year to find a seasonal factor. This seasonal factor could be used to calculate total yearly volume. Iowa DOT has not yet analyzed any of the data collected. They are soliciting feedback on additional analysis that could be helpful for interested stakeholders.

Data maintenance and management

Iowa DOT plans to conduct these bicycle counts every summer in a different quadrant of the state. Therefore, the counts in each quadrant will be updated every four years by DOT staff. Data are collected by the Office of Transportation Data and then stored for analysis by the Office of Systems Planning, which is also responsible for state-level bicycle and pedestrian planning.

Data dissemination

Because data collection began in 2002 and is on a four-year cycle, data is relatively incomplete and has yet to be analyzed. As susch, data dissemination efforts are a few years away. Iowa DOT has plans to develop an interactive web-based map that would allow users to find information on bicycle trails, characteristics of the trails and usage rates. The maps would be supported by a database in-house and located on the Iowa DOT website. Considering the high demand for the data collection effort, Iowa DOT will also likely disseminate results in the form of a report to other state government agencies, MPOs, and local municipalities.

Innovations and Accomplishments

While Iowa DOT is still in the process of collecting data, the agency has developed an effective statewide counting methodology using Piezo film technology. By dividing the state into quadrants and conducting the shared-use path counts in conjunction with highway traffic counts for each quadrant, Iowa DOT is able to be more efficient, concentrating their time in one part of the state and reducing time commitment while collecting information every four years (a reasonable amount of time between observations). Plans for disseminating information are innovative. Interactive web-based maps will provide users with information on current use and characteristics of facilities and promote further use of these trails. Iowa DOT is also using digital photography to provide high quality visuals of the topography around trail sites.

Lessons Learned

After evaluating several technologies, Iowa DOT chose to use Piezo film for its shared-use path counts. While the infrared sensors were the easiest technology to use among those tested, the infrared sensors experienced inaccuracies because they counted branches, leaves, deer and other animals. The infrared sensors also caused problems because trail users did not understand what the sensors were being used for. In one case, a sensor with no identification was found by trail users who contacted police. A police bomb squad eventually blew up the infrared sensor when they were unsure of the nature of the device. Since that incident, Iowa DOT has labeled all its counting devices. While the Piezo film works on hard surfaces counting axles, it too can be triggered by objects other than bicyclists. With additional funding in the future, Iowa DOT is looking to use a more sophisticated kind of infrared sensor that produces imagery identifying the object setting off the counter.

Cost of Data Collection Effort

The cost of purchasing the full array of Piezo film sensors tested and used on shared-use paths in Iowa came to roughly $400. Portable control units that accompany the sensors cost $900. Deep cell marine batteries used in data collection cost $100. One advantage to this type of data collection is the limited amount of time involved. Actual set-up time for each counter takes approximately 30 minutes.

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IN-PAVEMENT LOOP DETECTORS USED FOR BICYCLE COUNTS ON SHARED USE PATHS

Boulder, Colorado

City of Boulder, Division of Transportation

Data Collected

- Routinely use in-pavement loop detectors to count bicycles at 12 locations along Boulder's shared use path system and network of bike lanes.

Highlights

- Data used to develop baseline and trend information describing bicycle travel in Boulder.
- Loop detectors can store continuous counts 24 hours a day for seven days a week for approximately three months.

Purpose of Collecting Data

The Transportation Division initiated the loop detector counting program to develop a better understanding of overall bicycle travel patterns. The goal is to develop sufficient baseline data and adjustment factors as a means of accurately projecting spot counts over larger periods of time, and in similar geographic settings. Spot counts are used primarily to analyze bicycle access, route choice and traffic engineering issues during design projects. The data are also used to evaluate city-wide bicycle use trends over time, understand basic origin and destination flows within the city, and provide background data to use in city-sponsored bicycle/trail project funding proposals. The data are also used to assist city officials in setting bicycle project funding priorities.

Geographic Area Description

Boulder, Colorado (population 120,000, including resident students) is located 30 miles northwest of Denver. The University of Colorado campus (30,000 students) is located in center of the city and is the community's major employer. Bicycling is important in Boulder; according to the Chamber of Commerce website, *"Bicycling is so highly regarded in Boulder that sometimes the city plows the Boulder Creek bike path before it plows the streets."* In 2003, 21 percent of all trips to places of employment were made by bicycle, up 6 percent from 2000.

Figure 1. In-pavement loop detectors installed in shared use paths and bike lanes.

Shared Use Path | Shared Use Path | Bike Lane

Methodology

History of data collection effort

The City of Boulder initiated the automated loop-based count program in 1998. Establishing the system involved two steps. First, locations for loop installation were identified to create a representative sampling of the off-street and on-street bicycle system (see Figure 1 for example sites. Second, deployment of the off-street system required the installation of entirely new infrastructure (cabinet, power drop, loop amplifiers, loops, etc.). The infrastructure was installed in 1998 and 1999.

To date, the on-street locations have not been brought on-line because the required software modifications for the signal system have not been acquired and installed. In the future, the on-street stations will use the traffic signal system infrastructure, and the data at these sites will be collected through the signal system computer.

Manual bicycle and pedestrian peak hour counts (AM, Noon and PM, including turning movements) are gathered at all signalized intersections in the city (130 locations) every third year as a part of routine intersection data collection. One-hour pedestrian crossing counts are also collected at three separate high-volume locations in the city every month.

Data collection

For several years data were gathered from loop detector counting locations on the off-street trail system. The data were then downloaded, compiled, and analyzed. An intern was charged with these tasks, but they were discontinued due to limited staff resources and other priorities. The existing data set is not complete, and the current status of the data stream is unclear, but data continue to be collected. Data are lost when the number of events that are counted exceeds the memory capacity of the loop amplifiers before it is downloaded. The data are stored in volatile memory, so the data are lost when the loop counter loses power due to a local power outage or being struck by a vehicle.

Data Storage, Maintenance and Management

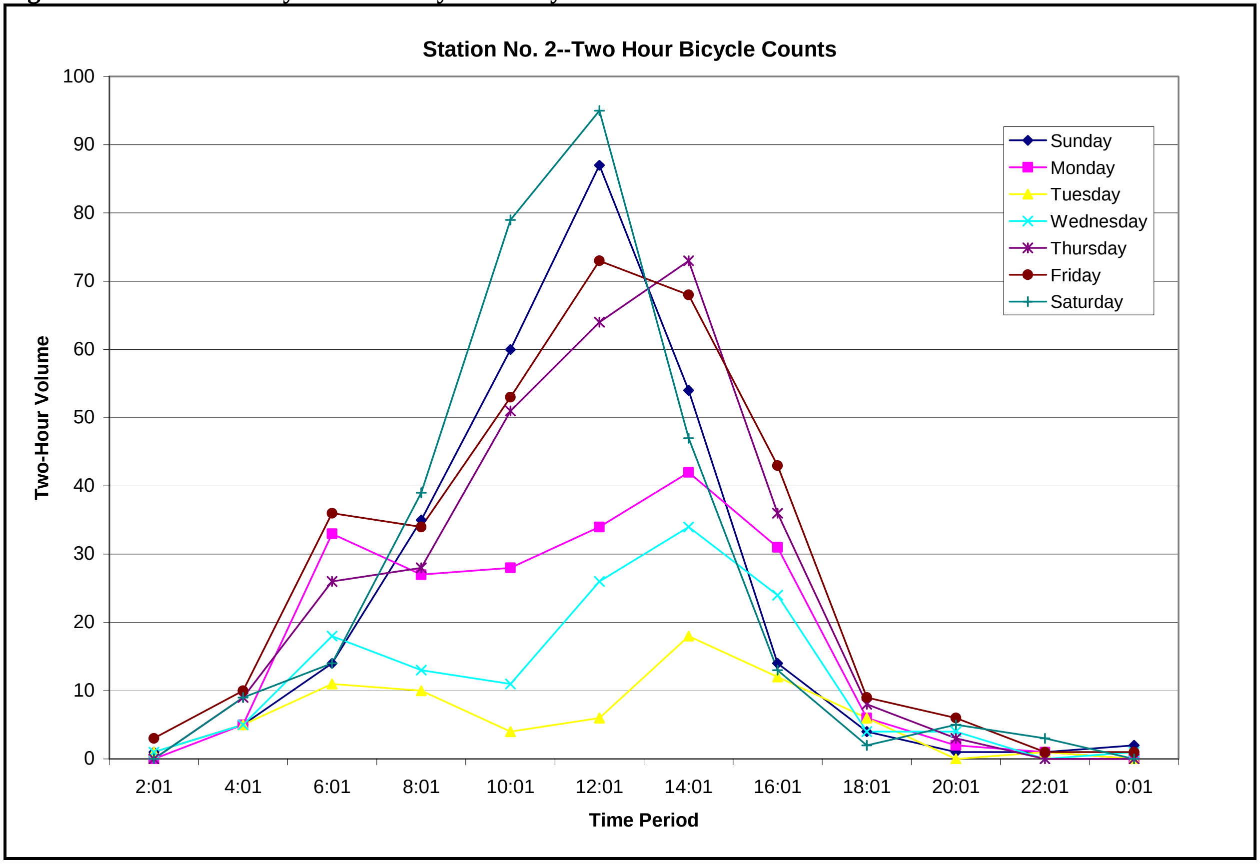
The data are currently stored in electronic format on a network hard drive. The long term strategy is to automatically download the data at regular intervals using traffic signal system software and to off-load the data storage to a high-capacity mass storage device.

Data Analysis

Data gathered over a number of months have been subject to preliminary review and analysis by City staff. Charts and graphs were created for use within the Division of Transportation to make it easier to interpret and share the data. While compilation and analysis of the data have been limited to date, City staff has made the following observations:

- Bike travel characteristics differ from other vehicles.
- While bike travel characteristics differ from other vehicle travel, peaking rates for bicycle traffic are similar to motor vehicle traffic in the same neighborhoods, both average about 21% to 22% of the total daily traffic at that location.
- There is a high inverse correlation between the adversity of weather conditions and volume bike travel.
- Weekly bike travel behavior characteristics differ from other vehicle traffic. Other vehicle traffic characteristics are very similar for a weekday excluding Monday AM and Friday PM from the sampling. Bike traffic shows more weekday variation with days later in the week (Wednesday, Thursday, Friday) experiencing more bike traffic than early in the week (see Figure 2).
- Weekday versus weekend bike travel behavior characteristics differ from other vehicle traffic. Generally, in the city, average weekday motor vehicle traffic exceeds weekend traffic. For bike traffic, Saturday and Sunday traffic exceeds weekday traffic levels.
- Daily peaking characteristics for bike traffic varies from other vehicle traffic. Motor vehicle traffic experiences a building traffic pattern with AM being the smallest peak, Noon the next largest, and PM peak being the highest hourly volume. For bike traffic, the Noon-time peak period has the highest hourly traffic volumes.

Figure 2. Two-Hour Bicycle Counts by Weekday



Data Dissemination

Thus far, results are preliminary and have not been packaged for public consumption. The data have been subject to internal staff review and is made available to project planners and designers.

Innovations and Accomplishments

Through this data collection effort, the City of Boulder has applied the same level of rigor to the bicycle mode as is used for the motor vehicle traffic counts and travel studies. While an ongoing analysis program is not yet established, it remains a goal of the program. The data collection effort is intended to advance and evaluate progress towards the City's goal to reduce Single Occupant Vehicle (SOV) traffic and increase pedestrian, bicycle, transit, and multiple occupant vehicle trips.

Once an adequate amount of data are obtained, trend data can be used to develop adjustment factors for daily peaking, weekday variations, seasonal variations, and weather conditions. Adjustment factors make it possible to estimate the total number of bicyclists who will pass a specific location during a different time period or over a longer time period by counting at the location for only a few hours. For example, a count taken between 10 a.m. and 2 p.m. on a Tuesday afternoon could be multiplied by an adjustment factor to estimate the total number of bicyclists on that same day, on a different day of the week, or even over the entire week. Similarly, a count taken in the winter could be multiplied by an adjustment factor to estimate how many people would bicycle in that same location on a summer day. In this manner, the City can greatly reduce data collection costs over time.

Lessons Learned

The time investment required to advance bike counting is significant, and exceeds initial anticipations. Development of data management, compilation, and analysis is staff-intensive.

Cost of Data Collection

The City installed the bicycle loop counters and provides staff time to download, compile, and analyze the counts. Installation of loop counters at a single location costs approximately $720. This cost is covered by the City's annual transportation operating budget.

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USER SURVEYS

PINELLAS TRAIL USERS SURVEY

Pinellas County, Florida
Pinellas County Metropolitan Planning Organization

Data Collected

- Surveyed 1,518 trail users at six survey sites over two days to determine the level of trail usage for transportation purposes and amount of mode shift resulting from having a non-motorized transportation facility provided in an urban travel corridor.
- Surveyed trip characteristics, including mode of trail access, mode used on the trail, trip purpose, trip distance, frequency of use, current destination, residential proximity, activity replaced by trail use, and other factors.

Highlights

- Useful data were gathered to support ongoing use of federal and other transportation funds for Pinellas Trail upgrades and extensions, as well as for connecting trails that are identified in the Countywide Trail and Non-Motorized Transportation Plan.
- The findings of this study confirmed previous findings that a large portion of weekday trail users use the trail for transportation purposes: one-third in the previous study, and two-thirds in this study.
- The study concludes that a high percentage of trips on the Pinellas Trail represent mode shifts from motor vehicle to non-motorized modes.
- Findings also support assumptions that were made when the trail was initially planned - that transportation use would rise as the trail was extended to serve more communities and destinations, and as bridges and tunnels were installed over or under a number of major arterial roads to eliminate at-grade crossings.

Purpose of Collecting Data

The Metropolitan Planning Organization (MPO) needed an evaluation of trail uses and trip types to accurately gauge the public's desire for additional trail facilities throughout the County. Information was also desired to assist with design criteria for future trail facilities and amenities. Moreover, in order to qualify for federal funds, the MPO is required to show that the usage of the Trail as a transportation alternative remains one of its primary functions. After more than ten years of phased development (using primarily public funds) to create the 34-mile trail, area elected officials comprising the MPO were also interested in gauging community satisfaction with the Trail and its amenities.

Geographic Area Description

Pinellas County, Florida is located in the Tampa-St. Petersburg metropolitan area (county population, 870,000). The Pinellas Trail runs from St. Petersburg in the southern portion of the county to Tarpon Springs in the north, through each of the County's major incorporated cities—Seminole, Largo, Clearwater, and Dunedin. Beginning in 1987, the Pinellas Trail was planned and developed along an abandoned rail corridor, and currently serves approximately 100,000 bicyclists, walkers, runners and skaters per month. The trail is 15 feet wide, with an asphalt surface. In some locations, the trail is divided into separate treadways for pedestrians versus “wheeled users” (5 feet and 10 feet wide respectively).

Methodology

History of data collection effort

The Pinellas Trail has a long history of user counts since its construction in the early 1990s. A survey was conducted in December of 1993 to develop baseline data. At that time, the trail was only 23 miles long with a major gap in Clearwater. Data were collected at eight locations. In addition to these surveys, manual counts are conducted on a daily basis by Park Department staff. Manual user counts are taken at 3 locations on the trail for one hour a day. These counts are projected over the entire day and aggregated by month and year. They have been taken since 1991, and are used to track basic usage levels and overall trends.

The November 1999 Pinellas Trail Users Survey was designed and conducted by the Pinellas County Planning Department, on behalf of the Metropolitan Planning Organization. Planning Department staff developed the survey questions and instrument with input from the MPO representatives and staff from partner county and local government agencies. Planning Department staff organized the data collection effort, compiled and analyzed the data and prepared a written report describing the process and findings.

Data collection

Data was collected at six locations in November 1999 to ensure adequate coverage of variables such as demographic factors, user types and destinations served, along the 34-mile trail. A Friday and Saturday were selected for data collection to ensure that weekday and weekend usage patterns would be captured. Early November was selected as a time that would represent typical travel patterns.

Over 50 people were recruited to staff the six survey sites for an 11-hour period each day, from 7 am to 6:00 pm. Two or more people were on site at all times to ensure that breaks could be given to survey conductors and staffing was adequate for heavy usage periods (see Figure 1). Data collectors were recruited primarily from County agencies including the Planning Department, Parks Department, Sheriff’s Office, Community Development, and MPO Bicycle and Pedestrian Advisory Committees. Other volunteers included staff from city governments, volunteer trail rangers, AmeriCorps volunteers, criminal justice students and employees from local bicycle shops and other businesses located next to the trail.

Figure 1. Survey Shift Chart

1999 Pinellas Trail Survey Shift Chart

Friday, November 5, 1999 - 11 hours / 7 a.m. - 6 p.m.

FRIDAY					
SURVEY SITE	1 person per shift per site	1 person per shift per site			1 person per shift per site
		VOLUNTEER SHIFTS			
	morning staff 7am-12:30pm	7-11am	11am-2pm	2-6pm	afternoon staff 12:30 - 6pm
CURLEW CREEK ROAD	Susan Dutill (PD)	Don Pickett (AR)	David & Heather (Brake Time)	Tom Mahoney (City of Clw)	Brenda Holleron (PD)
MAIN STREET DUNEDIN	Linda Waldron (City of Dunedin)	Bert Marshall (BAC)	Diana Beland (Bicycle Outfitters)	Mike Ruban (AR)	Marc Hanger (PD)
DOWNTOWN CLEARWATER	John McGuiness (PD)	Yvonne, Jamie, & Andy Moore (BACS)	Ken Sides (City of Clw)	Janine Scott (Chain-wheel Dr.)	Carolyn Kuntz Colleen Tracy (PD)
TAYLOR PARK	Largo Police Department, Americor, Explorers, Criminal Justice Students				
SEMINOLE CITY HALL	Sandra Truby (PD)	Stan Barker (AR)	Fred Garfi (AR)	CPL Romero (SO)	Sandra Truby (PD)
AZALEA PARK	Michael Taylor (PD)	Michael Taylor (PD)	Herb Crawford (AR)	Kurt Polk (AR)	Michael Taylor (PD)

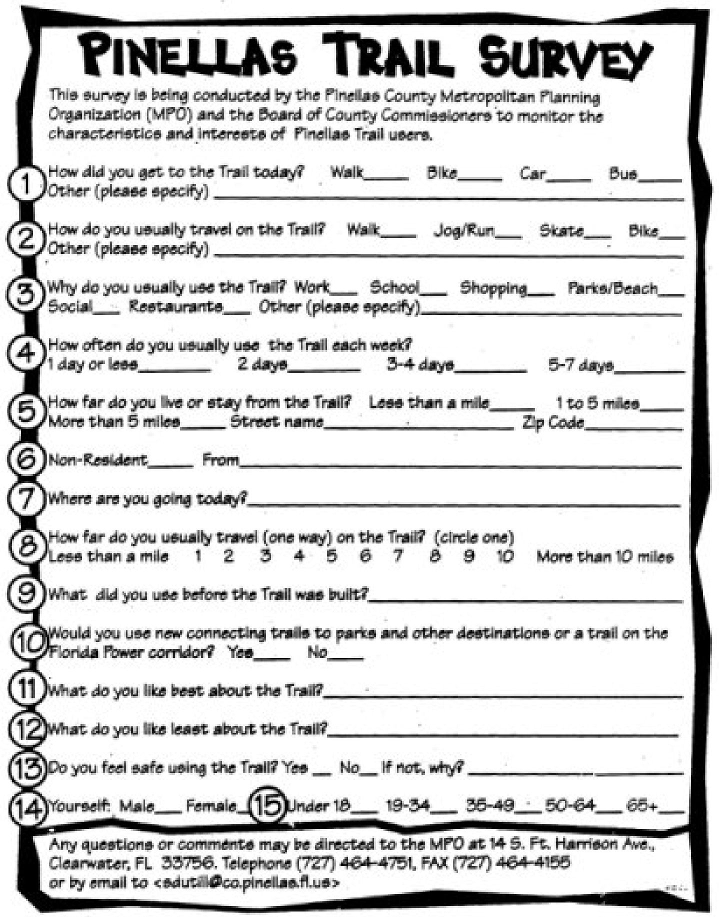
AR - Auxiliary Rangers
PD - Planning Department
BAC - Bicycle Advisory Committee
PTAC - Pedestrian Transportation Advisory Committee
SO - Sheriff's Office
CD - Community Development
BACS - Bay Area Commuter Services

Source: *Pinellas Trail Users Survey Report*, Pinellas County Metropolitan Planning Organization, May 2000

Survey sites were selected based on geographic coverage of the trail, as well as the presence of site conditions conducive to the survey process. Parking and restrooms were needed nearby for data collectors. Prior to the survey site, appropriate approach space was needed for the survey to be effectively announced to trail users with signs. Space was needed for tables where trail users could pull off the trail and fill out the survey form. Canopies were set up to provide shade where the trail users pulled off the trail, and information about the trail and survey was provided in these locations. Survey participants were self-selecting. Ballpoint pens with a safety message and bottled water were provided to trail users as an incentive for completing the survey.

The survey instrument included fifteen questions on one side of an 8.5" by 11" sheet of paper (see Figure 2). It took the average respondent 3 to 5 minutes to complete. Most surveys were completed on site, less than 1 percent were returned by mail.

Figure 2. Survey Instrument



PINELLAS TRAIL SURVEY

This survey is being conducted by the Pinellas County Metropolitan Planning Organization (MPO) and the Board of County Commissioners to monitor the characteristics and interests of Pinellas Trail users.

1 How did you get to the Trail today? Walk_____ Bike_____ Car_____ Bus_____
Other (please specify) ______________________________

2 How do you usually travel on the Trail? Walk____ Jog/Run___ Skate___ Bike___
Other (please specify) ______________________________

3 Why do you usually use the Trail? Work___ School___ Shopping___ Parks/Beach___
Social___ Restaurants___ Other (please specify)______________________

4 How often do you usually use the Trail each week?
1 day or less________ 2 days________ 3-4 days________ 5-7 days________

5 How far do you live or stay from the Trail? Less than a mile_____ 1 to 5 miles_____
More than 5 miles_____ Street name____________________ Zip Code__________

6 Non-Resident_____ From______________________________

7 Where are you going today?______________________________

8 How far do you usually travel (one way) on the Trail? (circle one)
Less than a mile 1 2 3 4 5 6 7 8 9 10 More than 10 miles

9 What did you use before the Trail was built?________________________

10 Would you use new connecting trails to parks and other destinations or a trail on the Florida Power corridor? Yes____ No____

11 What do you like best about the Trail?________________________

12 What do you like least about the Trail?________________________

13 Do you feel safe using the Trail? Yes __ No__ If not, why? ______________

14 Yourself: Male___ Female___ 15 Under 18___ 19-34___ 35-49___ 50-64___ 65+___

Any questions or comments may be directed to the MPO at 14 S. Ft. Harrison Ave., Clearwater, FL 33756. Telephone (727) 464-4751, FAX (727) 464-4155
or by email to <sdutill@co.pinellas.fl.us>

Source: *Pinellas Trail Users Survey Report*, Pinellas County Metropolitan Planning Organization, May 2000

Data Storage, Maintenance and Management

The data were tabulated and compiled in spreadsheet files.

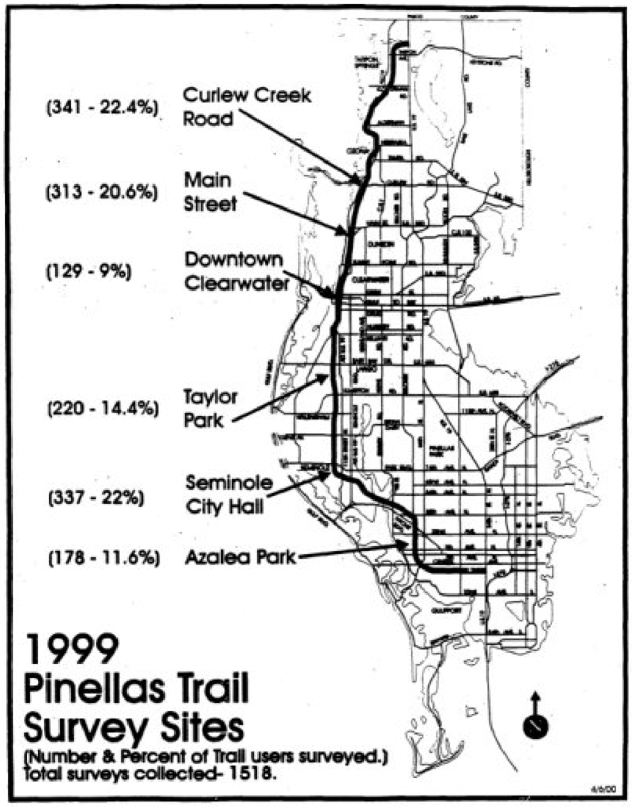
Data Analysis

The goal of the survey was to document transportation usage levels for the Trail. Tables and charts were prepared to illustrate the results of the survey. Using the data collected transportation usage levels can be compared between weekday and weekend timeframes, trip distance for transportation trips can be compared to that for recreational trips, and the Trail's impact on mode shift can be estimated.

Data Dissemination

Survey results were compiled in a report, the *Pinellas Trails Users Survey Report*, published by the MPO in May 2000 (see Figure 3). An executive summary highlighted key findings for each survey question. The results for some questions were combined to provide a simplified and more complete picture. The report includes a description of the survey methodology and a large set of appendices that provide the tabulated results for each question. It was distributed to the elected officials that make up the MPO, each of the partner agencies that assisted with conducting the survey, and the various private organizations and *Friends of the Trail* groups that assisted.

Figure 3. Response Rate Map from Survey Report



Source: *Pinellas Trail Users Survey Report*, Pinellas County Metropolitan Planning Organization, May 2000

The published report has been shared with the media and used in various news releases related to trail management and development issues. Results have also appeared in trail and local town newsletters, and a variety of other publications. Copies of the report are available upon request to members of the public or other interested parties.

Innovations and Accomplishments

The survey was accomplished using in-house staff resources and minimal out-of-pocket costs. A significant level of manpower was required. Because the Trail has many agency and other stakeholders, the burden of gathering data did not fall solely on the County agencies most directly involved with the trail Pinellas County Parks Department (the trail managers) and Pinellas County Planning Department (the regional and bicycle and pedestrian transportation planning agency).

Using a broad mix of stakeholders in designing the instrument and accomplishing data collection created a broad interest in the results and ensured that the findings were of interest to a wide range of local agencies and organizations.

Lessons Learned

The survey results provided the MPO with useful information about how the trail was used and showed that there was significant public support for additional trail facilities. Two-thirds of users surveyed were making utilitarian trips (trips to work, school, shopping, and social destinations, for example), while one-third were using the trail for exercise or recreation. Comparing the results of the 1999 survey with the baseline survey from 1993 showed that the expansion of the Pinellas Trail network was increasing its use as an alternative form of transportation. Results of the survey also showed that over half of the respondents used the trail three or more days per week and that 90 percent of respondents would use new connecting trails to parks and other destinations or a new trail in another corridor.

Even after spreading the effort over many government agencies and private organizations, the amount of hours required to organize and staff the survey sites was burdensome. In the future, consideration will be given to using local college students or hiring a consultant. The County expects that another survey will be needed in 2006 or 2007.

It was a challenge to ensure that bias did not enter into the data collection process because data collectors had a wide variety of educational and professional backgrounds, and came from agencies or organizations with different interests in the trail. Also, some data collectors were not very interested in the survey's purpose. In future years, more training in intercept and interview techniques may be employed. Development of appropriate responses for survey participant questions would ensure that each subject had the same understanding of the survey and why each particular question was included.

Cost of Data Collection

Implementing the survey involved a significant amount of labor. County and local community staff who worked at the six survey sites contributed over 300 hours of time during the two-day survey period (see description in the "Data Collection" section, above). In addition, more than 264 volunteer hours were used to conduct the surveys.

Direct expenses, including copies of the survey forms, some survey station supplies, and promotional items, totaled approximately $3,500. In addition, two county staff persons spent approximately 12 percent of their time during the year on this project. The survey was funded through the annual budgets of the Pinellas County Planning Department and MPO.

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SHARED-USE PATH USER SURVEY

State of Rhode Island

Rhode Island Department of Transportation
University of Rhode Island Transportation Center

Data Collected

- Conducted intercept survey and follow-up mail or online survey
- Gathered shared-use path (multi-use trail) user characteristics and opinions

Highlights

- Implemented a two-phase survey with large number of respondents
- Allowed survey participants to respond online and through the mail
- Recommended improvements based on survey results

Purpose of Collecting Data

The Rhode Island Department of Transportation (RIDOT) through a research project approved and funded by the University of Rhode Island Transportation Center (URITC) implemented the shared-use path user survey to increase the amount of information available about the people and trips on the State's growing system of shared-use paths. The Center is one of 33 national centers supported by the US Department of Transportation through the University Transportation Centers Program. Better data on path users will help RIDOT provide, improve, and maintain high-quality shared-use path facilities. This will support RIDOT's multi-modal approach to develop a balanced transportation system.

Specifically, RIDOT sought to solicit feedback from people who use shared-use paths and are familiar with multi-use trail issues. It would use this information to recommend changes to improve path safety, gauge maintenance concerns, identify user conflicts, and evaluate the potential of the paths to be tourism generators for the state.

Geographic Area Description

At 1,545 square miles, Rhode Island (population 1,000,000) is the smallest state in the Union. Because of the state's compact size, shared-use paths can serve as practical means of transportation in a number of locations. Rhode Island has developed four shared-use path facilities that have been built on abandoned rail lines. The East Bay Bicycle Path extends 14.5 miles; the Blackstone River Bikeway currently travels six miles, but will eventually traverse 17 miles; the Washington Secondary Bike Path travels ten miles, and will extend another ten; and the South County Bike Path extends for six miles.

Methodology

History of data collection effort

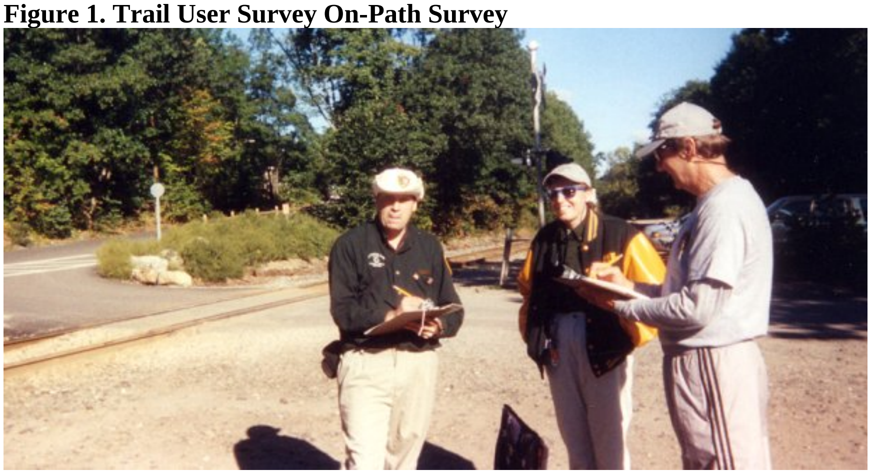
Rhode Island's first shared-use path survey was done in 1996 by the Rhode Island Department of Environmental Management (RIDEM) and Brown University. Researchers gave the survey to path users on the East Bay Bicycle Path, the only major shared-use path in Rhode Island at the time. Between 1996 and 2002, three additional paths were built: the Blackstone River Valley Bikeway, the Washington Secondary Bike Path, and the South County Bike Path. In 2002, RIDOT decided it was an opportune time to assess the success of existing shared-use paths, determine needed improvements, and generally determine user satisfaction in an effort to influence the design of future paths in Rhode Island. To accomplish this, RIDOT planned to survey path users, and submitted a research proposal for the survey to the URITC. The proposal was chosen for funding through a competitive process, and the joint survey project between RIDOT and URITC began in June 2002.

Data Collection

The survey process consisted of two phases. Phase I (on-path survey) was a short survey that bike path users were asked to fill out while they were using the path. Phase II (off-path survey) was a more extensive follow-up survey that trail users completed at home.

<u>Phase I:</u> The on-path surveys were distributed to 1,309 path users between August and October 2002. These surveys were conducted in multiple (between two and five) locations on each of Rhode Island's four major bike paths. URI students and volunteers conducted the interviews in teams (see Figure 1). The interviewers were given detailed instructions on interviewing techniques.

Figure 1. Trail User Survey On-Path Survey



The days of the week and times of day for the interviews were randomly selected. First, three weekdays were randomly selected for each bike path (without replacement). Then one of three time slots were selected for each day: 1) 7:00 a.m. to 11:00 a.m., 2) 11:00 a.m. to 3:00 p.m., and 3) 3:00 p.m. to 7:00 p.m. Two weekend times were also chosen randomly from the six time slots (three potential time slots on Saturday and three on Sunday). By the end of the first survey phase, each path had been sampled for twelve hours during the week and eight hours during the weekends for a total of eight weeks.

The on-path survey form was a single page that could be completed in one to two minutes (see Figure 2). The questionnaire included questions about:

- Age
- Mode of accessing the path (drive, bike, walk, or other)

- Mode of traveling on the path (bike, walk, skate, run)
- Reason for using the path

The on-path questionnaire also asked respondents to provide their street address or an e-mail address. This made it possible to mail a paper copy of the detailed off-path survey (with prepaid return envelope) or e-mail a link to an online version of the survey to all on-path respondents.

Figure 2. On-Path Survey Form

On Path Survey

In an effort to better understand the use of the Rhode Island Bikeways and to help in the future development of other bike paths in Rhode Island, the Department of Transportation and the University of Rhode Island Transportation Center are implementing a survey of path users. Please take time to fill out this short questionnaire.

1. What bikeway are you using today?
   - East Bay Bicycle Path
   - Blackstone River Bikeway
   - Washington Secondary Bicycle Path (Cranston, Warwick, West Warwick, Coventry Greenway)
   - South County
2. How are you using the path today?
   - bicycle
   - walking
   - jogging
   - rollerblading
   - scooters
   - wheelchair
   - handcycles
   - other: ________________
3. Why did you choose to use the path today?
   - commuting
   - health / exercise
   - recreation
   - run errands/shopping
   - other: ________________
4. How did you get to the path today?
   - motor vehicle
   - walked/jogged
   - bicycle
   - rollerblade / in-line skates
   - wheelchair
   - other: ________________
5. How many people from each of the following age categories are on the path with you today (including yourself)?

   (please write the number of people from each age group)

   ___ 15 and under
   ___ 16 to 35
   ___ 36 to 45
   ___ 46 to 65
   ___ over 65

We would like to learn even more about your use and your opinions of the RI Bikeways, but we don't want to interrupt your ride or walk any further. Therefore, we would like to send you a follow-up survey to be completed at your convenience. Would you be willing to give us your name and address so we can mail you a follow-up survey?

Name:

Street:

City: State: Zip Code:

Email:

How would you like us to send you the more comprehensive survey?
- Postage paid addressed envelope
- Electronically

THANK YOU VERY MUCH

Approximately 51 percent of on-path survey participants provided a street address to receive the Phase II follow-up off-path survey through the mail, 35 percent provided an e-mail address to receive a link to the online form (6 percent of these e-mail addresses resulted in "Return to Sender—Addressee Unknown" messages). Approximately 14 percent did not provide contact information.

Phase II: The off-path questionnaire asked detailed questions about users' experiences on each shared-use path. It was five pages long and included a cover letter (see Figure 3). Questions were designed to find information about:

- Demographic data (gender; age; home location by state or by city in Rhode Island)
- Path usage (mode used to access path; mode used on path; distance and time of travel on path; use per year, season, and week)
- Work and school commuting—not specific to the shared-use path facility (distance; reasons for commuting by non-motorized modes; potential to use bicycle-on-bus program)

- Infrastructure, operations, and maintenance (opinions about restroom and drinking water availability; dog issues; roadway intersections; trail vandalism; availability of trail information)
- Economic impact (money spent along path; attraction of tourists)

Figure 3. Off-Path Survey Form (example page)

BIKE PATH USER QUESTIONNAIRE

Rhode Island Department of Transportation
and
University of Rhode Island

PLEASE COMPLETE THE FOLLOWING QUESTIONNAIRE IN TERMS OF YOUR INDIVIDUAL USE OF THE BIKE PATH

Section 1 - Path Usage

In this section, we want to understand how the Rhode Island bike paths are used. In the questions that ask you to estimate time or distance, please try to be as accurate as possible.

1. Please select the bike path you use most often.
   - ☐ East Bay Bicycle Path
   - ☐ Blackstone River Bikeway
   - ☐ Washington Secondary Bicycle Path (Cranston, Warwick, West Warwick and Coventry Greenway)
   - ☐ South County Bicycle Path
2. How do you usually travel to and from the path?
   - ☐ motor vehicle
   - ☐ on foot
   - ☐ bicycle
   - ☐ rollerblade / in-line skates
   - ☐ wheelchair
   - ☐ other: ______________
3. What activities do you participate in on the path? (check all that apply)
   - ☐ walk
   - ☐ jog
   - ☐ rollerblade / in-line skates
   - ☐ bicycle
   - ☐ cross-country ski
   - ☐ wheelchair
   - ☐ other: ______________

   3a. If the bike path did not exist, would you still participate in these activities?
   - ☐ yes
   - ☐ no

   3b. Do you regularly wear a helmet while on a bicycle or using or operating a skateboard, rollerblades, scooter or in-line skates?
   - ☐ yes
   - ☐ no
   - ☐ not applicable
4. During a typical outing, how many miles do you travel on the path (*round trip*)?
   - ☐ 0 to 3 miles
   - ☐ 4 to 7 miles
   - ☐ 8 to 12 miles
   - ☐ more than 12 miles
5. How long do you typically stay on the path?
   - ☐ less than an hour
   - ☐ 1 to 2 hrs
   - ☐ more than 2 hrs
6. During what seasons (if any) do you use the path on a regular basis? (check all that apply)
   - ☐ Winter (Dec to Feb)
   - ☐ Spring (Mar to May)
   - ☐ Summer (Jun to Aug)
   - ☐ Fall (Sep to Nov)
   - ☐ none - not a regular user
7. When do you usually use the path? (check all that apply)
   - ☐ weekday mornings
   - ☐ weekday lunchtime
   - ☐ weekday afternoons
   - ☐ weekday evenings
   - ☐ weekends
8. About how many days have you visited a bike path in the last full year?
   - ☐ 0 to 10 times
   - ☐ 11 to 20 times
   - ☐ 21 to 30 times
   - ☐ more than 30 times
9. What are your reasons for using the path? (check all that apply)
   - ☐ recreation
   - ☐ health / exercise
   - ☐ commute to work / school
   - ☐ run errands / shopping
   - ☐ other: ______________
10. Do you view the bike paths as a mean to promote healthy lifestyle choices?
    - ☐ yes
    - ☐ no

The response rate for the mail surveys was higher than the online surveys. 64 percent of people who requested a paper survey returned it through the mail, while 57 percent people who provided an e-mail address completed an online survey.

Data storage

Responses for both surveys were compiled in a Microsoft Excel spreadsheet database so that summary statistics could be analyzed.

Data analysis

The responses to both surveys were summarized in bar and pie charts. Each question was analyzed for each of the four bike paths. For example, the mode of travel from the on-path survey was shown in a bar chart (see Figure 4). Bar charts were also used to represent responses to path usage and commuting questions in the off-path survey. Opinion questions in the off-path survey were represented in pie charts (see Figure 5).

Figure 4. Mode of Travel of Path Users (On-Path Survey)

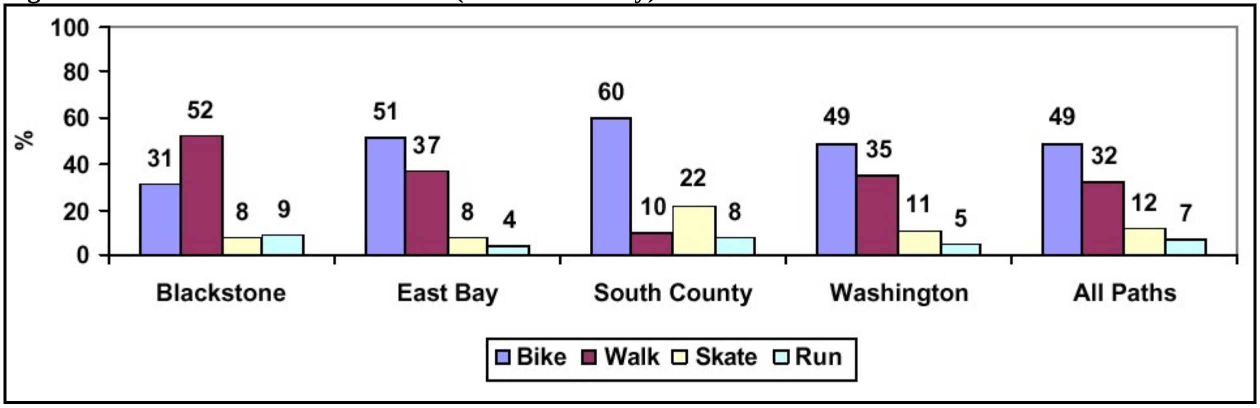
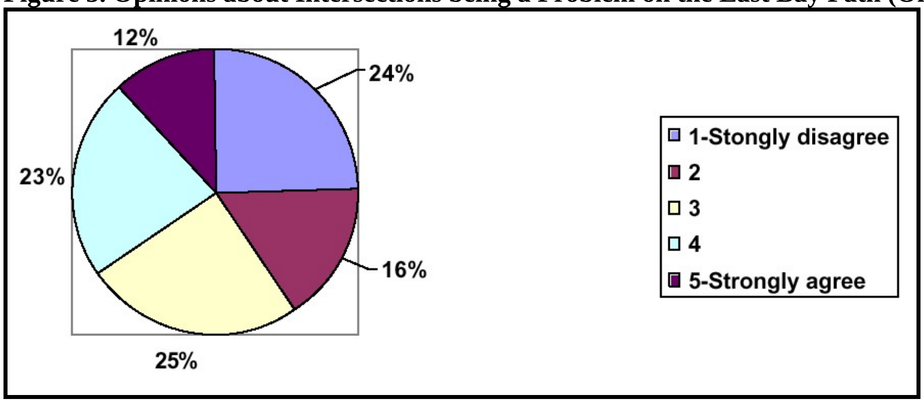


Figure 5. Opinions about Intersections being a Problem on the East Bay Path (Off-Path Survey)



Over 50 percent of East Bay Path users gave a "moderate", "agree", or "strongly agree" response to viewing intersections with motor vehicles as a problem.

Data dissemination

The survey methodology and results were documented by URITC and RIDOT in, *RIDOT 2001 Bicycle Transportation User Survey; Developing Intermodal Connections for the 21st Century*. This paper was issued as a US DOT Federal Highway Administration (FHWA) technical report and is posted on the web sites of URITC at http://www.uritc.uri.edu/ and RIDOT at http://www.dot.state.ri.us/WebTran/bikeri.html. Results were disseminated to a variety of agencies, including DEM, the state Department of Health, state tourism organizations, and cities and towns that maintain the Washington Secondary Bike Path and South County Bike Path.

Innovations and Accomplishments

The survey found strong support for path development 99.1 percent of respondents felt that shared-use path construction constituted a good use of tax dollars. Other survey results suggested potential improvements to the shared-use paths. Intersections with roadways were identified as a problem. Several of the shared-use paths were identified as needing more restrooms and drinking water. RIDOT has shared these results with RIDEM and the local communities who manage the trails, and improvements have been planned. RIDOT is also using the findings to get approval from FHWA to pilot test new trail intersection signals that may improve the safety of crossings at roadways.

RIDOT received praise from local bicycle advocacy groups for collecting path user information. In addition, the survey effort was highlighted in the official newsletter of the Ocean State Bike Path Association and the Providence Journal.

Lessons Learned

One challenge of the project was obtaining consistent help from student interns to conduct the on-path survey. Six students were hired to administer the survey. It was difficult to match the limited work hours of students with the randomly-selected four-hour data collection periods. In the future, RIDOT would prefer not to be as reliant on student labor.

The on-path survey methodology could be improved in the future. While RIDOT and URITC were able to find a large amount of useful information about the bike paths, bike path users were not counted during distribution times. All path users should be counted during the survey so that it is possible to report the percentage of path users who participated in the survey.

People who used the path in groups posed another sampling challenge. Only one member of a group was asked to complete a survey, though people most often rode or walked in pairs. This may have introduced bias to the survey because the most outgoing member of the group was more likely to take the survey. Groups that had split temporarily would have had greater representation, since a single group of friends could have responded several different times. Selecting group members randomly or asking all group members may avoid this problem in the future.

Cost of Data Collection Effort

The entire cost of this project was $35,000. The cost of data collection (student interns) was the most significant cost component. Other costs included staff time to enter the survey results into a database and analyze the data.

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MODAL SHIFT SURVEY TRACKS COMMUNITY-WIDE BICYCLE AND PEDESTRIAN USE

Boulder, Colorado

City of Boulder, Division of Transportation

Data Collected

- Routinely conduct a travel survey that includes non-motorized modes (conducted the survey every two years between 1990 and 2000, now on a three year schedule beginning in 2003)
- Analyze one-day travel diary of 1,200 residents including, trip counts, mode choice, miles traveled and a variety of other trip and demographic characteristics
- Include mode choice options of Single Occupant Vehicle (SOV), Multiple Occupant Vehicle (MOV), Public Transit, Pedestrian, Bicycle, and School Bus

Highlights

- Data are useful for identifying and evaluating trends in bicycle and pedestrian travel and comparing bicycle and pedestrian travel trends to trends in other modes and trends in national travel.
- Data are used to monitor progress toward achieving the City's mode shift goals: *To keep VMT stable at 1994 levels and to reach an SOV modal share target of 25% of all trips by the year 2020.*[4]

Purpose of Collecting Data

The City of Boulder initiated this biennial modal shift survey to provide the data necessary to support the long-term commitment to achieving a balanced and sustainable transportation system. The data are used primarily to evaluate and guide transportation policy and investment decisions made by the City. Specifically, changes in mode choice behavior over a time period can be evaluated to physical and programmatic changes made during that time period to determine the effectiveness of various transportation policies and investments.

Geographic Area Description

Boulder, Colorado (population 120,000, including resident students) is located 30 miles northwest of Denver. The University of Colorado (UC) campus (30,000 students) is located in center of the City and is the community's major employer. According to the Boulder Chamber of Commerce website, *"Bicycling is so highly regarded in Boulder that sometimes the city plows the Boulder Creek bike path before it plows the streets."* In 2003, 21 percent of all trips to places of employment were made by bicycle, up 6 percent from 2000.

[4] Achieving an SOV modal share of 25% by the year 2020 would mean a 19% shift in the proportion of SOV trips made from 1990 to 2020; an annual shift of 0.63% per year.

Methodology

History of data collection effort

The need to develop baseline and ongoing mode split data was identified in the City's 1989 transportation master plan. This plan established a goal to achieve a fifteen percent shift away from the Single Occupant Vehicle (SOV) mode into bicycle, pedestrian and transit modes. However, there was no data available locally or regionally by which achieving this goal could be measured.[5] At the time, travel mode share data available from the Denver Regional Council of Governments (DRCOG) assumed a combined one percent bicycle and pedestrian mode share, however this assumption was not based on actual counts.

As a result, the Boulder City Council recognized that if the City was going to make a long term commitment to increasing the mode share for bicycling, walking and transit, they needed baseline counts that accurately reflected current travel behavior for these modes. They committed to conducting a travel diary survey to establish a baseline, and to update it every two years to monitor progress toward achieving the goal. The first survey was completed in 1990. It has been updated every two years through 2000 (see Figure 1). The 2003 data will be available by mid-2004.

Figure 1. Boulder Modal Split for all Trips

Figure 1. Modal Split of Trips for Boulder Valley: 1990 to 2000

Travel Mode	Percent of Trips*						Modal Shift 1990-2000†
	2000 N=6793	1998 N-5990	1996 N=6454	1994 N=6723	1992 N=6681	1990 N=7355	
Single-Occupancy Vehicle	**41.5%**	**40.4%**	**41.5%**	**40.5%**	**42.3%**	**44.2%**	**-2.7%**
Multiple-Occupancy Vehicle	23.8%	25.1%	25.6%	25.6%	25.7%	26.3%	-2.4%
Foot	**19.8%**	**21.4%**	**20.4%**	**19.2%**	**17.1%**	**18.2%**	**+1.6%**
Bicycle	10.0%	8.2%	9.2%	11.3%	12.1%	9.1%	+0.9%
Transit	4.2%	4.1%	2.8%	2.9%	2.2%	1.6%	+2.6%
School Bus	0.7%	0.7%	0.5%	0.5%	0.7%	0.6%	+0.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	

** These estimates have a margin of error of ±1.3% using a 95% confidence interval.*
† Modes with shifts that are statistically significant between 1990 and 2000 are bolded and shaded.

Source: *Modal Shift in the Boulder Valley: 1990 to 2000*. City of Boulder, CO, February 2001.

Data collection

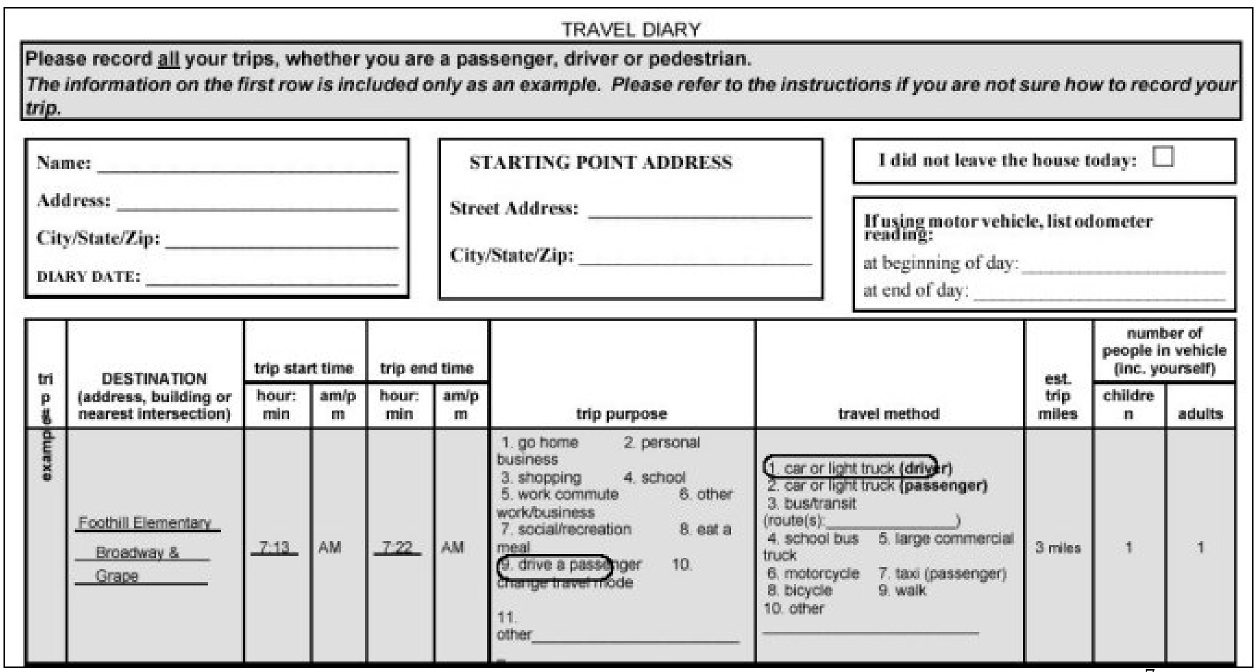
The Travel Diary Study data were collected from a random sample of Boulder Valley residents.[6] In the 2000 study, 6,532 households were contacted by mail and invited to have a household

[5] In 1996, the mode shift goal was revised, and a Vehicles Miles Traveled (VMT) goal was added as a result of adopting the 1996 the transportation master plan update (see Highlights section).
[6] Boulder Valley residents include residents of the city of Boulder and residents of Boulder County who live in close proximity to the city.

member participate. From the group of households, 1,957 participants (this represents 30 percent of the households that were contacted by mail) agreed to create and return a one-day travel diary. Participants within the household were self-selected. Of these, 1,241 usable travel diaries (63 percent of people who agreed to participate) were returned and tabulated. Households were stratified by location and household type to ensure that the sample is proportional to the City's overall population for these factors. Special methods were used to ensure appropriate representation from each of three Eco-Pass zones, from resident University students, and from rural mail routes.

Those who agreed to participate were randomly assigned a day during a week in September 2000. Their task was to record all of their travel for that one day in a specially designed travel diary (see Figure 2). The number of participants assigned to each day was roughly equal. Travel survey instructions were included with the forms that were used to record their travel diary. Assistance over the phone was offered to help with questions, and reminder calls were made to ensure that participants did not forget to execute their diary on their assigned day.

Figure 2: Example Section of Travel Diary
Source: *Modal Shift in the Boulder Valley: 1990 to 2000*. City of Boulder, CO, February 2001.


TRAVEL DIARY

Please record all your trips, whether you are a passenger, driver or pedestrian.
The information on the first row is included only as an example. Please refer to the instructions if you are not sure how to record your trip.

Name: ____
Address: ____
City/State/Zip: ____
DIARY DATE: ____

STARTING POINT ADDRESS
Street Address: ____
City/State/Zip: ____

I did not leave the house today: ☐

If using motor vehicle, list odometer reading:
at beginning of day: ____
at end of day: ____

trips	DESTINATION (address, building or nearest intersection)	trip start time hour: min	am/pm	trip end time hour: min	am/pm	trip purpose	travel method	est. trip miles	number of people in vehicle (inc. yourself) children	adults
example	Foothill Elementary Broadway & Grape	7:13	AM	7:22	AM	1. go home 2. personal business 3. shopping 4. school 5. work commute 6. other work/business 7. social/recreation 8. eat a meal 9. drive a passenger 10. change travel mode 11. other____	1. car or light truck (driver) 2. car or light truck (passenger) 3. bus/transit (route(s):____) 4. school bus 5. large commercial truck 6. motorcycle 7. taxi (passenger) 8. bicycle 9. walk 10. other ____	3 miles	1	1

Data collected included the starting point for the day, and the following data for each trip[7] taken:

- Destination
- Trip start time
- Trip end time
- Trip purpose
- Travel method (mode) (ten choices provided, plus "other" with a blank to fill in.)
- Estimated trip miles

[7] A trip was defined as "a one-way journey that takes you further than one city block (about 200 yards) from your original location."

- Number of people in vehicle

A household survey was also collected from each person who completed a trip diary (see Figure 3). This survey gathered the following data:

- Number of deliveries of goods or services received at your home or place of work
- Participation in telecommuting
- Location of employment (city) for all full or part-time workers in the household 16 years or older
- Most frequent travel mode for each full or part-time worker in the household
- Proximity to nearest bus stop
- Number of passenger cars normally available to the household.
- Number of bicycles available to the household
- Household income
- Type of residence and ownership status
- Age of household members
- Existence of mobility impairment among any household members
- University of Colorado student status
- Diarist's gender, age, race, ethnicity, education level, UC student status
- Diarist's possession of an Eco-Pass (annual pass that allows unlimited bus rides on local transit system)

Figure 3: Sample Section of the Household Survey

4. For all adult full-time or part-time workers (16 or older) living in your household, please check the box that indicates their **most frequently used travel mode**. (Please include yourself as Person #1.)

Most frequent work travel mode	Person #1	Person #2	Person #3	Person #4	Person #5
In an automobile with no passengers					
In automobile with at least one other adult					
In an automobile with child passengers					
Bicycle					
Bus					
Walk					
Other __________					

5. About how close is the nearest bus stop to your residence?

- ☐ less than 1 block
- ☐ 1 - 3 blocks
- ☐ 4 - 5 blocks
- ☐ 6 - 10 blocks
- ☐ 11 - 15 blocks
- ☐ 16 - 20 blocks

Household Information

6. How many passenger cars, vans and light trucks does your household own or normally have use of?

vehicles

7. How many bicycles does your household have?

bicycles

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Source: *Modal Shift in the Boulder Valley: 1990 to 2000*. City of Boulder, CO, February 2001

Data Storage, Maintenance and Management

The data were transferred from the trip diaries to coding sheets and then entered into a computer system. The data were processed by computer in a SPSS statistical processing software package and stored electronically. This software was used to generate a variety of raw summary tables. Spreadsheet software was then used to produce finished tables and charts.

Data Analysis

Data analysis was extensive and conducted by a consultant and city transportation planning staff. Gross mode shares were determined and compared to previous years to determine changes and long-term trends. Mode shares were broken out by trip type such as work commute, and by traveler type such as University of Colorado students. Trip characteristics for each travel mode were also analyzed (see Figure 4).

Figure 4: Pedestrian and Bicycle Travel Characteristics

Figure 35. Summary Trip Characteristics, Bicycle Trips

Summary Travel Characteristics	Year					
	2000	1998	1996	1994	1992	1990
average number of bicycle trips per day per person	.55	.45	.52	.65	.66	.50
percent of people making at least one bicycle trip	17.1%	15.0%	16.6%	19.8%	20.9%	15.2%
average number of bicycle trips per day per person who made at least one bike trip	3.24	3.00	3.16	3.28	3.14	3.28
average estimated bicycle trip length in miles	2.0	2.4	2.2	2.3	2.0	2.2
average estimated bicycle trip time in minutes	17.0	16.1	15.2	15.8	14.1	15.1
average miles per hour of bicycle trips	7.1	8.7	8.4	8.4	7.7	8.2

Figure 34. Summary Trip Characteristics, Pedestrian Trips

Summary Travel Characteristics	Year					
	2000	1998	1996	1994	1992	1990
average number of pedestrian trips per day per person	1.15	1.21	1.21	1.11	.97	1.04
percent of people making at least one pedestrian trip	36.9%	39.1%	39.9%	36.9%	34.8%	33.0%
average number of pedestrian trips per day per person who made at least one ped. trip	3.11	3.09	3.04	3.00	2.78	3.16
average estimated pedestrian trip length in miles	0.7	0.8	0.7	0.7	0.7	0.7
average estimated pedestrian trip time in minutes	14.8	15.3	15.1	15.1	13.6	14.4
average miles per hour of pedestrian trips	2.8	3.5	3.3	3.6	3.4	3.3

Source: *Modal Shift in the Boulder Valley: 1990 to 2000*. City of Boulder, CO, February 2001.

Other analyses included total miles traveled by mode, work commute miles traveled by mode, and total miles traveled by trip purposes. Mode split was shown for each demographic and other group as determined by answers to the household survey (see Figure 5). The report also provided cross-tab data by major demographic characteristics (student/non-home-owner/renter, etc.) in the appendix. Additionally, for a number of different travel measures, Boulder trends were compared to regional and national trends.

Figure 5: Mode Split by Answer to Household Survey Questions

Table II.2c Modal Split All Trips		SOV	MOV	us (transit)	school bus	bike	foot	Total	
Annual Household Income	under $50,000	37%	17%	6%	1%	13%	26%	100%	N=2724
	$50,000 +	45%	28%	3%	0%	8%	16%	100%	N=2882
Ratio of Autos to Drivers	less than 1 per driver	22%	19%	8%	1%	20%	30%	100%	N=1638
	1 or more per driver	49%	25%	3%	0%	7%	15%	100%	N=4751
HH own any bikes?	yes	40%	24%	4%	0%	12%	20%	100%	N=5599
	no	51%	21%	6%	1%	0%	22%	100%	N=848
Have an Eco-Pass?	no don't have	52%	27%	2%	1%	6%	13%	100%	N=3790
	yes, have Eco-Pass	27%	19%	8%	1%	17%	29%	100%	N=2768
Day of Week	weekend	40%	37%	1%	0%	7%	14%	100%	N=1424
	weekday	42%	20%	5%	1%	11%	21%	100%	N=5329

Source: *Modal Shift in the Boulder Valley: 1990 to 2000*. City of Boulder, CO, February 2001.

Data Dissemination

The data were compiled in a formal report, *Modal Shift in the Boulder Valley: 1990 to 2000*, which was distributed to elected officials, various city staff, regional and state transportation agencies, and the public. It is available on the City's website (http://www3.ci.boulder.co.us/publicworks/depts/transportation/master_plan_new/pdfs/diary2000.pdf). This report is about 70 pages long with a full set of appendices which include a description of the methodology, invitation letter to residents, travel diary form, travel diary instructions, etc.

Innovations and Accomplishments

The results from this survey provide planners, elected officials and the public with a common set of facts upon which existing transportation programs and investments can be evaluated. Mis-information and perspectives based on faulty assumptions tend to have less influence in the public debate when reliable facts are readily available. Making the data accessible on the internet has enabled the public to participate more effectively in the city-wide transportation master planning process.

Developing this rich data set with a multi-year history is a major accomplishment. City transportation planners and elected officials agree that it has enabled the City to conduct productive transportation master planning processes that achieve strong community support. These master plans have resulted in the adoption very strategic transportation goals and policies.

Additionally, data from this survey enables proposed new policies and initiatives to be more effectively targeted to constituencies and trip types where the mode shift can be most easily realized.

Lessons Learned

After the program began, the City of Boulder decided that drawing parallels between the travel characteristics and trends in Boulder to those of the wider Denver region and the nation would enhance opportunities to evaluate and share data. As a result, slight modifications in how the data was compiled and presented were made to enable comparisons on trend lines where regional and national data are already established.

Because mode shift is not changing at as rapidly as originally expected, the City has recently decided to conduct the survey every three years. The cost of the survey can now be spread out over more budget years.

The City geocoded in GIS software roughly eighty percent of the data from the 2000 study. City staff recognize how much more use they may be able to get out of the data once an entire annual survey data set is geocoded. For future studies the diary has been restructured to make it easier to geocode the information, and funding is being sought to add this task to the overall survey routine.

Cost of Data Collection

The Boulder travel survey typically costs about $42,000 per year. Data collection in the first year cost more to cover the cost of developing the survey instrument and planning the methodology to employ. Most of the management costs are included in the above figure. About one week of time (40 hours) of a professional senior transportation planner or analyst is needed to supplement the analysis phase and contribute to report preparation and dissemination. The survey is funded through the Annual City Transportation Budget.

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TELEPHONE SURVEY OF PEDESTRIAN HABITS AND BEHAVIORS

State of California

California Department of Transportation and Public Health Institute Survey Research Group

Data Collected

- Conducted random-digit dialing phone survey of over 12,000 California residents
- Documented the amount of time spent on pedestrian trips, and documented factors that influence pedestrian trips

Highlights

- Gathered a random sample of residents that was representative of the entire population of the state and that could be stratified by California Department of Transportation (CalTrans) District
- Generated results that were useful to both public health departments and transportation departments

Purpose of Collecting Data

CalTrans and California Epidemiology and Prevention for Injury Control (EPIC) developed the California Pedestrian Safety Survey to obtain population-based estimates of pedestrians' activity levels, barriers, and influences. The survey was designed to determine pedestrian activity levels and identify factors that influence pedestrian activity among various demographic groups of people.

Geographic Area Description

The telephone survey was conducted in the state of California (population 34,000,000). A statistically-representative sample was obtained in each of the 12 CalTrans Districts.

Methodology

History of data collection effort

The California Public Health Institute Survey Research Group (SRG) developed the survey instrument in early 2001. This instrument was reviewed by the California Pedestrian Safety Task Force. Calls were made by SRG over a one-year period between June 2001 and June 2002.

Data Collection

SRG used a 59-question survey instrument to structure the telephone interviews. Phone numbers were selected using random-digit dialing techniques, and the calls were placed by interviewers from a 50-person call center. On average, each phone survey took about 10 minutes to complete.

Calls were placed until there were enough responses in each the 12 CalTrans Districts to represent the total population of each District at a 95 percent statistical confidence level.

Approximately 785 survey responses were gathered in 10 of the Districts; more responses were gathered to represent the Los Angeles (2,452 respondents) and San Francisco (1,709 respondents) Districts. In all, 12,036 people responded to the survey.

Potential survey respondents were contacted through random-digit dialing. The response rate was 39 percent and the cooperation rate was 74 percent[8]. When a phone was answered, the SRG interviewer asked several questions that were used to randomly-select one of the adults (age 18 and older) in the household. This person was asked to respond to the entire 59-question survey.

The survey included questions about running, walking, jogging, and in-line skating activity levels and about factors that influenced participation in these pedestrian activities. It also included demographic and economic background questions.

A sample of questions about pedestrian activity included:

- Do you use anything to help you walk or get around, such as a (answer yes to any of the following): 1) cane, 2) seeing-eye dog, 3) wheelchair?
- In a typical week, on how many days do you (answer with a number for each): 1) take a walk, 2) run, 3) jog, 4) skate, roller blade, or in-line skate, 5) use a motorized scooter, 6) use a manual wheelchair, 7) use a motorized wheelchair?
- In a typical week, on how much time do you spend (answer with an amount of time for each): 1) taking a walk, 2) running, 3) jogging, 4) skating, roller blading, or in-line skating, 5) using a motorized scooter, 6) using a manual wheelchair, 7) using a motorized wheelchair?
- Do you engage in pedestrian activities (answer yes or no to all of the following): 1) at work, 2) on the way to or from work, 3) on the way to or from public transportation, 4) escorting children to or from school, 5) running errands or shopping, 6) exercising?
- Do you normally engage in these [pedestrian] activities (answer yes or no to all of the following): 1) at a park, 2) on a walking trail or path, 3) on school grounds or campus, 4) on sidewalks, streets or roads in your neighborhood, 5) on sidewalks, streets, or roads NOT in your neighborhood, 6) at your workplace?
- I'm now going to ask you about things that may keep you from doing more walking or other pedestrian activities. Please tell me if any of the following keep YOU from doing more walking or other pedestrian activities (answer yes or no to all of the following): 1) you're too busy, 2) you have poor health, 3) no one to go with, 4) dogs, 5) no nearby paths or trails, 6) no nearby parks, 7) no sidewalks, 8) unsafe street crossings, 9) no shops or other interesting places to go, 10) not enough people walking around, 11) fear of street crime, 12) too many cars, 13) fast traffic, 14) air pollution?
- I'm going to ask you about some things that you may THINK about when deciding where to walk or do other pedestrian activities. Please tell me if you consider any of the following when you choose where to walk or do other pedestrian activities (answer yes or no to all of the following): 1) painted crosswalks, 2) signs or signals that make drivers stop, 3) having other pedestrians nearby, 4) the existence of sidewalks, 5) things, such as

[8] The response rate is based on the American Association for Public Opinion Research (AAPOR) Response Rate Formula 4. The cooperation rate is based on the AAPOR Cooperation Rate Formula 4. More information is available in *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys, 2004,* produced by AAPOR. This document is available at http://www.aapor.org/pdfs/standarddefs2004.pdf.

telephone poles, that block passage on the sidewalks, 6) push buttons at crosswalk signals, 7) audio crossing signals, 8) curb cuts at corners or curb ramps, 9) the AMOUNT of traffic, 10) the SPEED of traffic, 11) traffic signs that tell drivers to slow down or watch for pedestrians?

Background questions included:

- Are you male or female?
- How old were you on your last birthday?
- How many children less than 18 years of age live in your household?
- What is the highest grade or year of school you completed?
- Which of the following categories best describes your annual household income from all sources?
- What county do you live in?
- Questions to determine the respondents racial background

A portion of the survey instrument used by the phone interviewers is shown in Figure 1.

Figure 1. Telephone Survey Instrument (sample section)

WALKMOST
23. Where do you do MOST of your pedestrian activities? Would you say...
1. at a park
2. on a walking trail or path
3. on school grounds or campus
4. on sidewalks, streets or roads in your neighborhood
5. on sidewalks, streets or roads NOT in your neighborhood
6. at your work place

7. Don't know/Not sure
9. Refused

I'm now going to ask you about things that may keep you from doing more walking or other pedestrian activities. Please tell me if any of the following keep YOU from doing more walking or other pedestrian activities.

	Yes	No	DK/NS	Ref	
24. You're too busy. Would you say yes or no?	1	2	7	9	KEEPF_A
25. You have poor health. Would you say yes or no?	1	2	7	9	KEEPF_B
26. No one to go with	1	2	7	9	KEEPF_C
27. Dogs	1	2	7	9	KEEPF_D
28. No nearby paths or trails	1	2	7	9	KEEPF_E
29. No nearby parks	1	2	7	9	KEEPF_F
30. No sidewalks	1	2	7	9	KEEPF_G
31. Unsafe street crossings	1	2	7	9	KEEPF_H
32. No shops or other interesting places to go	1	2	7	9	KEEPF_I
33. Not enough people walking around	1	2	7	9	KEEPF_J
34. Fear of street crime	1	2	7	9	KEEPF_K
35. Too many cars	1	2	7	9	KEEPF_L
36. Fast traffic	1	2	7	9	KEEPF_M
37. Air pollution	1	2	7	9	KEEPF_N

I would now like to ask you a few questions about yourself.

AGE
38. How old were you on your last birthday?

___ Enter age in years.

HISPANIC
39. Are you of HISPANIC ORIGIN such as Mexican American, Latin American, Puerto Rican or Cuban?

1. Yes
2. No

7. Don't know/Not sure
9. Refused

Additional clarification was given for some survey questions in order to minimize misunderstanding. For example, interviewers were instructed to explain, "By taking a walk, we mean walking for exercise or to get somewhere. This does not mean walking to answer the telephone, etc."

A diverse group of Californians were represented in the survey (see Table 1).

Table 1. Characteristics of Survey Respondents

Demographic	Sample size	Percent of Respondents	Census 2000 Percent*
Race/ethnicity			
White	8,372	69.9%	59.5%
Black	498	4.1%	6.7%
Hispanic	2,297	19.1%	32.4%
Asian/other	871	7.2%	10.9%
Sex			
Male	5,144	42.7%	49.7%
Female	6,894	57.3%	50.3%
Age			
18-29	2,033	16.9%	17.3%
30-39	2,587	21.5%	16.4%
40-49	2,639	21.9%	15.0%
50-59	2,019	16.8%	10.1%
60+	2,760	22.9%	14.0%

*Hispanics may be of any race, so they are also included in applicable categories

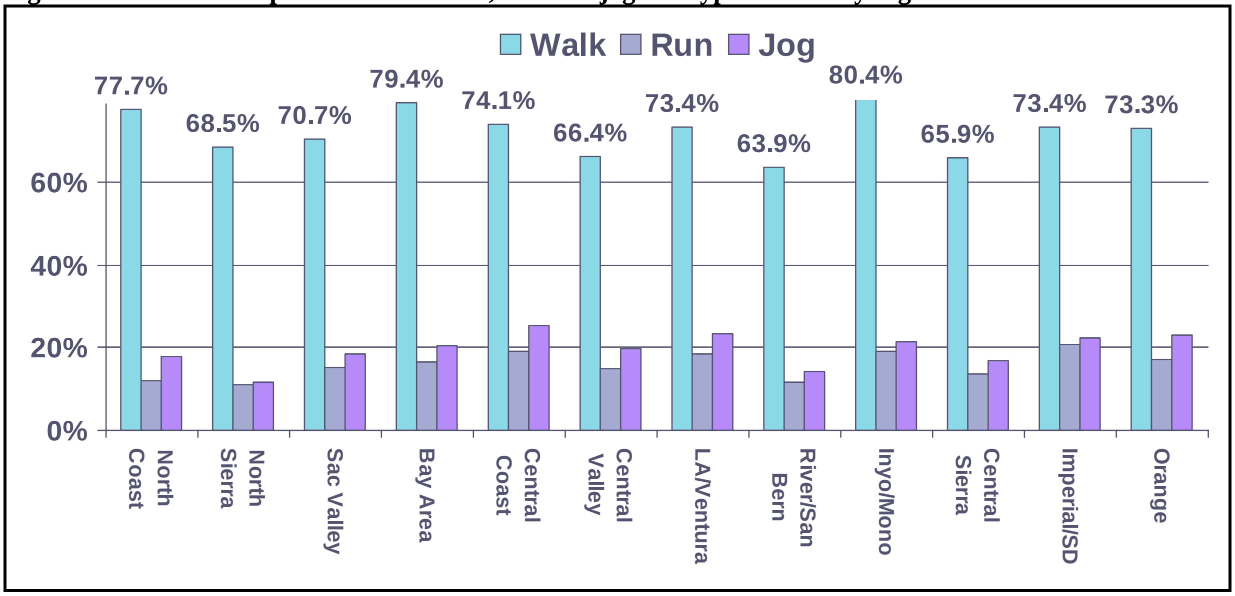
Data storage

Interviewers entered the responses of the participants directly into a database format during their phone conversation using special survey data collection software. When completed, the master database was analyzed with SAS statistical software.

Data analysis

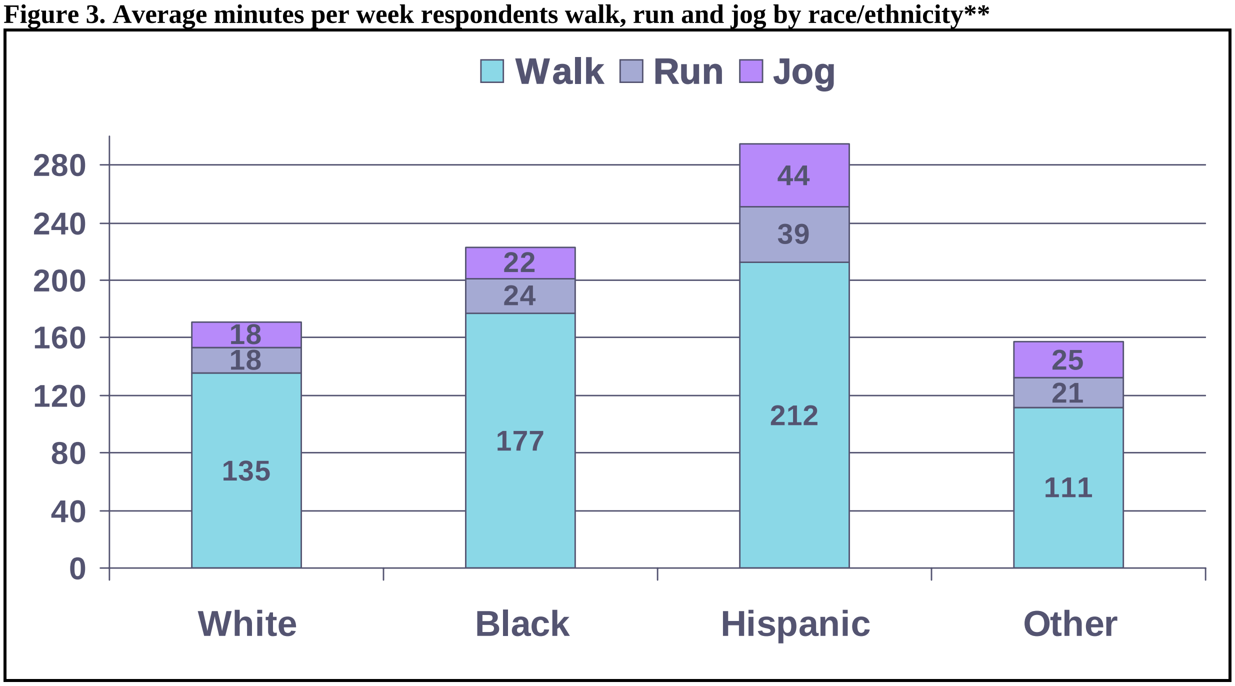
The analysis of basic descriptive statistics, such as point estimates, means, and 95% confidence intervals resulted in a 450 page document of both statewide and regional estimates. This information has been presented in charts and graphs (see Figure 2, Figure 3, and Figure 4). All analyses were adjusted for probability of selection in the household and weighted to the statewide and regional populations by age, race/ethnicity and sex. More statistical analyses, such as multivariate regression, may be conducted in the future.

Figure 2. Percent of respondents who walk, run and jog in a typical week by region**



California Department of Transportation
Source: Survey Research Group, Public Health Institute
Data is weighted to the 1990 California Population

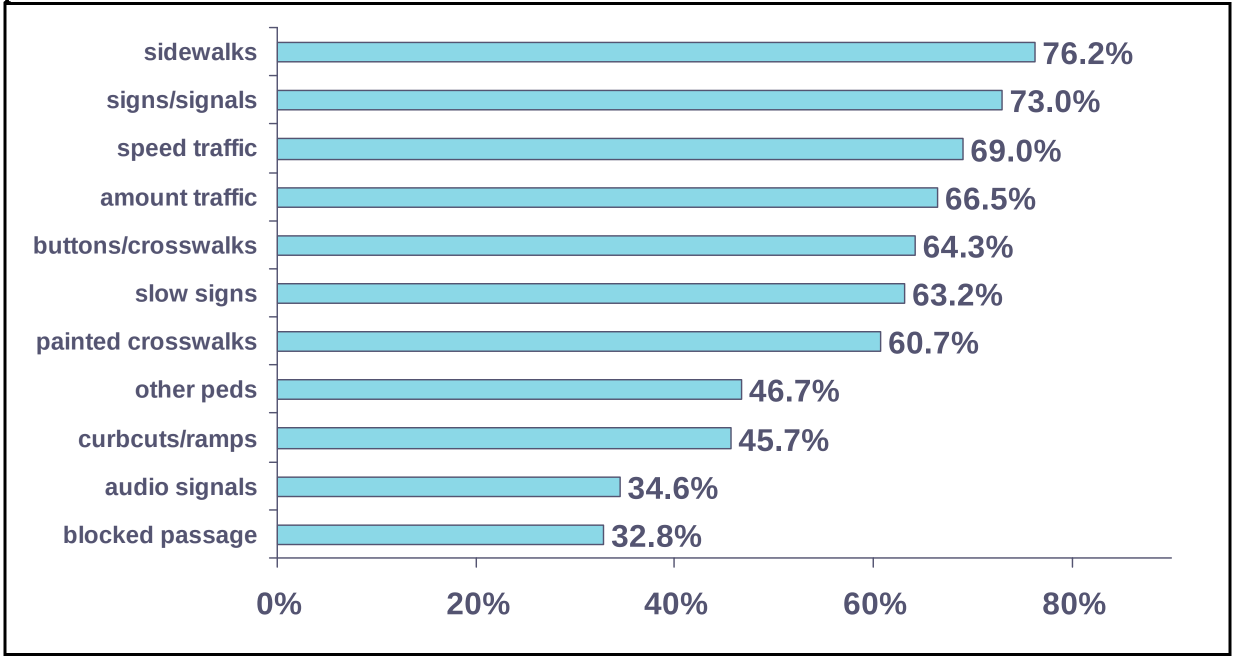
Figure 3. Average minutes per week respondents walk, run and jog by race/ethnicity**



California Department of Transportation
Source: Survey Research Group, Public Health Institute
Data is weighted to the 1990 California Population

**Approximately 5 percent of all respondents participated in in-line skating during a typical week (in-line skating is not shown on graphs)

Figure 4. Percent of respondents that consider or would consider each activity when deciding where to do pedestrian activities



California Department of Transportation
Source: Survey Research Group, Public Health Institute

Data dissemination

Preliminary survey results were presented to the California Pedestrian Safety Task Force in July 2003. The data were also used to produce an internal report for the California Office of Traffic Safety. CalTrans retains the data set, but does not plan any further reports on the topic at this time.

Innovations and Accomplishments

Reactions to the preliminary data and initial presentation have been positive. Though the results have not been released in an official report, early reviewers and users have found the initial results to be informative. The data show how often people walk, run, jog, or in-line skate for transportation and recreation. The 12,000 responses also provide statistical evidence of factors that support or prevent people from walking.

Lessons Learned

The researchers may conduct follow-up surveys to analyze changes in physical activity habits over time. In future surveys, an even larger sample size would be needed in each District to report statistically-valid results for different racial, gender, or age subgroups. For example, when the 785 responses in a District are divided into four racial groups, the estimates may be unstable due to small sample sizes; on cell sizes with less than 50 respondents, estimates shouldn't be made.

Some of the questions are likely to be modified for future surveys. This survey asked a hypothetical question about factors that people would consider when choosing whether or not to walk along a route. However, it did not ask about characteristics of the respondent's neighborhood and the specific choices that the person makes every day about walking. Questions that may be asked in the future include, "What factors in YOUR neighborhood would make you choose to walk more?" and "What factors in YOUR neighborhood keep you from doing more walking?"

Clarification was given for some survey questions to make them easier to understand, such as describing what qualifies as a walking trip. Yet, other subtle distinctions were not explained. For example, the difference between jogging and running may not have been understood by all respondents.

In addition, it may be difficult to compare the results of this survey to existing data about pedestrian activity. CalTrans' existing pedestrian volume counts are reported in terms of trips, while the survey results show pedestrian activity in terms of minutes per week. Asking questions about the number of distinct trips a respondent made during a day or a week would make the survey data easier to compare with existing data.

Researchers also felt that several of the questions with long lists that required "yes" or "no" responses may have led respondents toward a positive response. For example, interviewers asked about factors that people would consider when choosing whether or not to walk along a route. The list of factors included sidewalks, crosswalks, audio signals, etc. Some of these factors may have been overrepresented because respondents may have felt that saying "yes" was the "right" answer or simply because the interviewer asked about the factor.

Cost of Data Collection Effort

CalTrans and EPIC awarded a grant of $347,000 to Survey Research Group. This includes the cost of survey development, implementation, and analysis as well as overhead for phone service, office space, computer software, etc.

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FACILITY INVENTORIES

PEDESTRIAN FACILITY INVENTORY

Lexington-Fayette, Kentucky

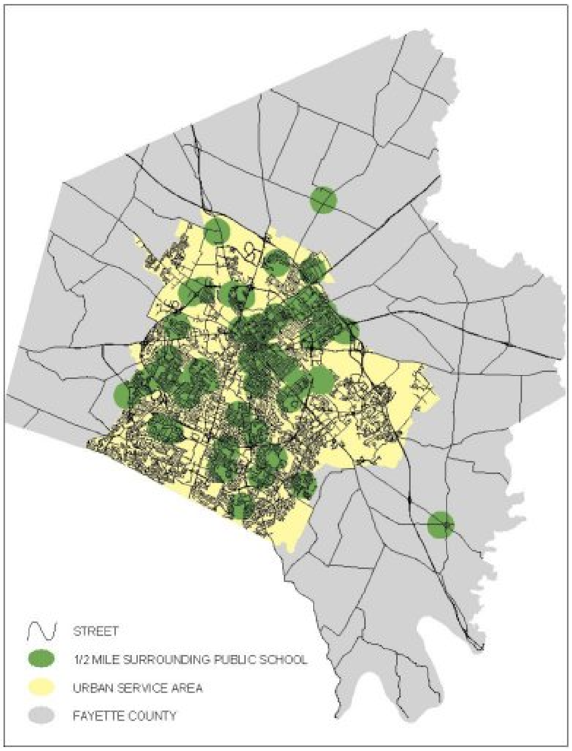
Lexington-Fayette Urban County Government, Division of Planning

Data Collected

- Conducted detailed inventory of pedestrian facilities at more than 1700 intersections over a one-year period.
- Conducted general sidewalk inventory along more than 850 miles of roadway over a one-year period.
- Focused on streets and intersections within 0.5 mile of public schools throughout the Urban Service Area of Lexington-Fayette County, approximately one-third of the total urbanized area of the county (see map below).[9]

Highlights

- Developed two effective manual data collection instruments; one instrument for sidewalk inventory and one for intersection inventory
- Inventoried a comprehensive and detailed set of elements such as pedestrian signals, curb ramps, curb bulbouts, overhead lighting, drainage inlets and grates, crosswalk type, width, pavement and striping conditions, stop bar setback, signage, presence of bus stop, shelter, bicycle lanes, etc.
- Stored data in Microsoft Access and Geographic Information System (GIS) databases
- Based data collection instruments and methodology on other successful efforts from around the country



Purpose of Collecting Data

Currently, the Division of Planning houses the city bicycle and pedestrian program and coordinator. The initial reason for undertaking the data collection project was to develop baseline data for use in an upcoming bicycle and pedestrian plan. Additionally the agency wanted to prepare for funding and implementation of a Safe Routes to School program. Other purposes included providing local agency and elected officials hard data about pedestrian and ADA access issues throughout the

[9] The Urban Service Area is 85 square miles. The inventory was completed for 30 sq. mi. or approx. 35% of the total Urban Service Area. There are no roadways with curb, gutter & sidewalks outside the urbanized area.

jurisdiction and enabling city agencies to more effectively prioritize and budget to remedy deficiencies. The data is also expected to be useful for bicycle and pedestrian project proposals for state and federal transportation funding.

Geographic Area Description

Lexington-Fayette, KY is a combined city and county jurisdiction (population 260,000). It is the second largest city in Kentucky and occupies a 283 square mile area. The greater metropolitan area population is almost 500,000 residents.

Methodology

History of data collection effort

In 1997, a simple sidewalk inventory had been started on select streets, but the project was abandoned before it was completed and useful information was never developed. In 2003, a small surplus of federal CMAQ funds in the city's Bicycle and Pedestrian Program allowed this pedestrian facility inventory effort to be initiated. The Division of Planning launched this data collection effort in a short timeframe. Because the agency and Bicycle and Pedestrian Coordinator had no prior experience with similar data collection, web searches and professional networking were used to investigate approaches and methodologies and eliminate "reinvention of the wheel." Useful models were found from Seattle, Washington and Duluth, Minnesota. Data were collected over a one-year period between the summer of 2003 and the spring of 2004.

Data collection

Using a GIS, streets within 0.5 miles of public schools were selected for sidewalk and intersection data collection. The resulting inventory was estimated to cover about 35 percent of the total street system within the urbanized portion of the jurisdiction.

Two undergraduate student interns were used as data collectors; one was already working in the Division of Planning and one was hired specifically for this task. One collector focused on the intersections, while the other focused on the sidewalk inventory. Data were collected through field inspections, either on foot or via windshield survey. Formal data collection sheets were used and data collectors received basic training to ensure accuracy and consistent quality.

Sidewalk data were collected by segment using an 8.5" x 11" data collection sheet. Three street segments could be logged on each sheet (see Figure 1). Physical characteristics noted in the field included the following:

- presence or absence of sidewalks and buffers on each side of the street,
- sidewalk and buffer width,
- minimum walkable width on each sidewalk,
- presence of related roadway elements such as bike lanes, shoulders, parking, or planting strips, and
- a qualitative evaluation of sidewalk condition (good, fair, bad).

Definitions of sidewalk quality were taken from the Duluth, Minnesota Sidewalk Inventory report (this report is available online at www.ardc.org/library/plans/mic/duluthsidewalk.pdf).

Figure 1: Sidewalk Inventory Sheet

Street: ____________________ From (street): ___________________ To (street): ___________________		
	Odd side	**Even side**
Sidewalk: Absent One side Both sides	Sidewalk width: ____ ft	Sidewalk width: ____ ft
Buffer: Absent One side Both sides	Buffer width: ____ ft	Buffer width: ____ ft
Minimum walkable width along sidewalk segment: (mostly in downtown areas where street trees, stairwells or other obstacles reduce the walkable area)	Min. walkable width: ____ ft	Min. walkable width: ____ ft
Present along road segment:	parking shoulder bike lanes planting strip	parking shoulder bike lanes planting strip
Sidewalk condition:	Good Fair Bad	Good Fair Bad
Addresses in poor cond. (if not continuous along street)		

Intersection data were collected on two data collection sheets, each 8.5” x 11” in size (see Figure 2). The intersection data collection sheets were modeled on instruments developed by the City of Seattle’s Bicycle and Pedestrian Program. Sheet one provided a generic intersection drawing upon which the data collector was asked to draw or spatially locate a variety of pedestrian elements such as crosswalks, number of traffic lanes, location of curb ramps, location of signs, etc.

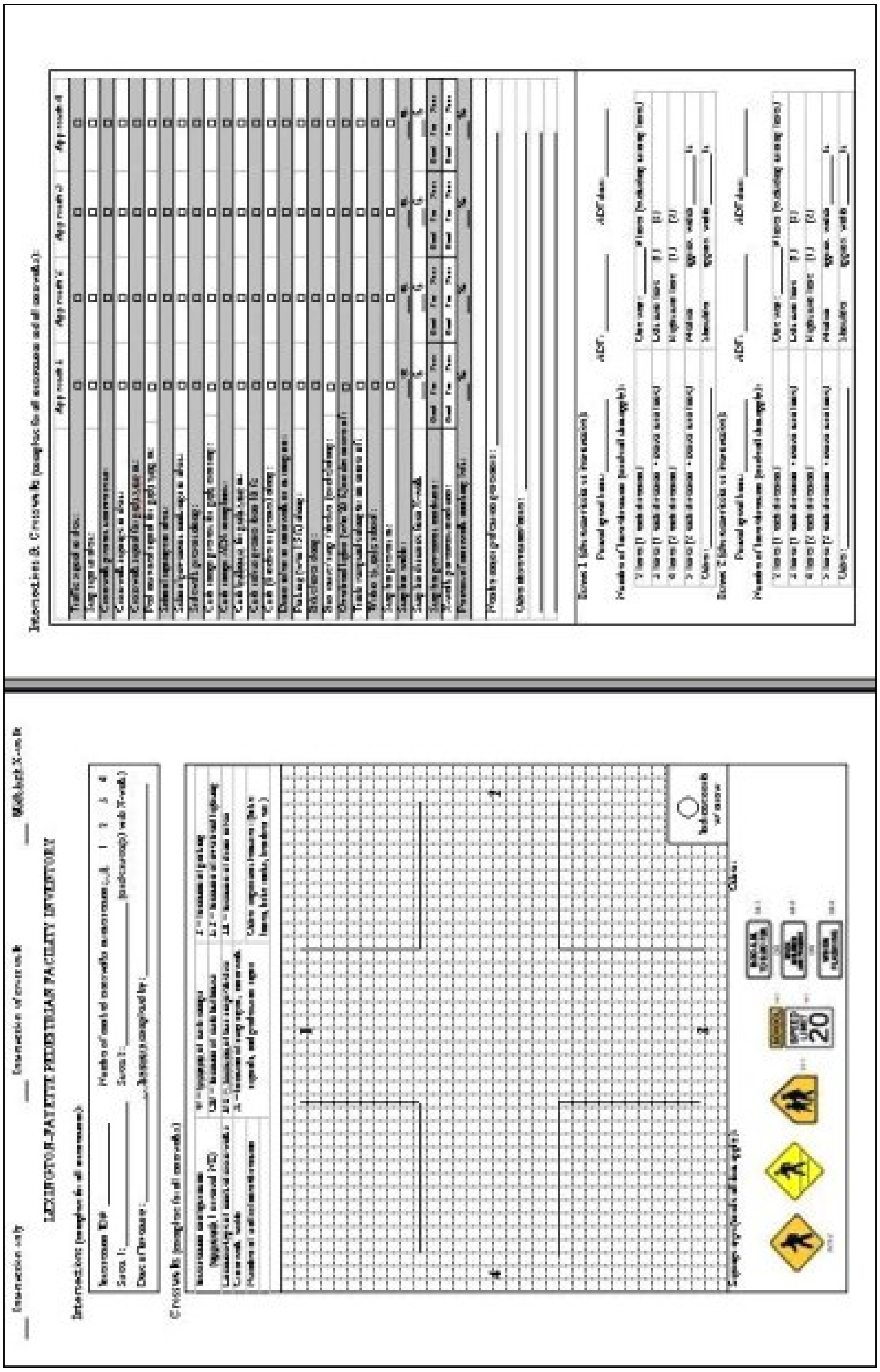
Sheet two included a checklist of 27 potential attributes for each of the four intersection approaches. A second section of sheet two included details about street design related to vehicular traffic, including lane counts, posted speed limit, average daily traffic counts and count date, and median and shoulder widths. Space for notes was also provided.

Data Storage

A GIS was used to store sidewalk data for each street centerline segment. The GIS was also used to store the intersection data. Some difficulties arose because the intersection data had more detail than typical GIS roadway databases are designed to accommodate. Some attributes pertain to the intersection as a whole and others apply only to one corner or one side of an approach street. The Division of Planning solved this problem by storing the intersection data in a Microsoft Access database and linking it to the GIS database using intersection ID numbers common to both databases. The Access intersection database was designed with five fields, one for each approach and one for the intersection as a whole. Mapping the data required a two-step process, first executing a query in the Access intersection database, and then mapping the result in GIS.

The intersection data collection sheets were saved in a hard copy file where the field notes and intersection drawings can be referenced. If time and resources permit, these drawings may be scanned and linked to the electronic databases so that the images can be accessed electronically.

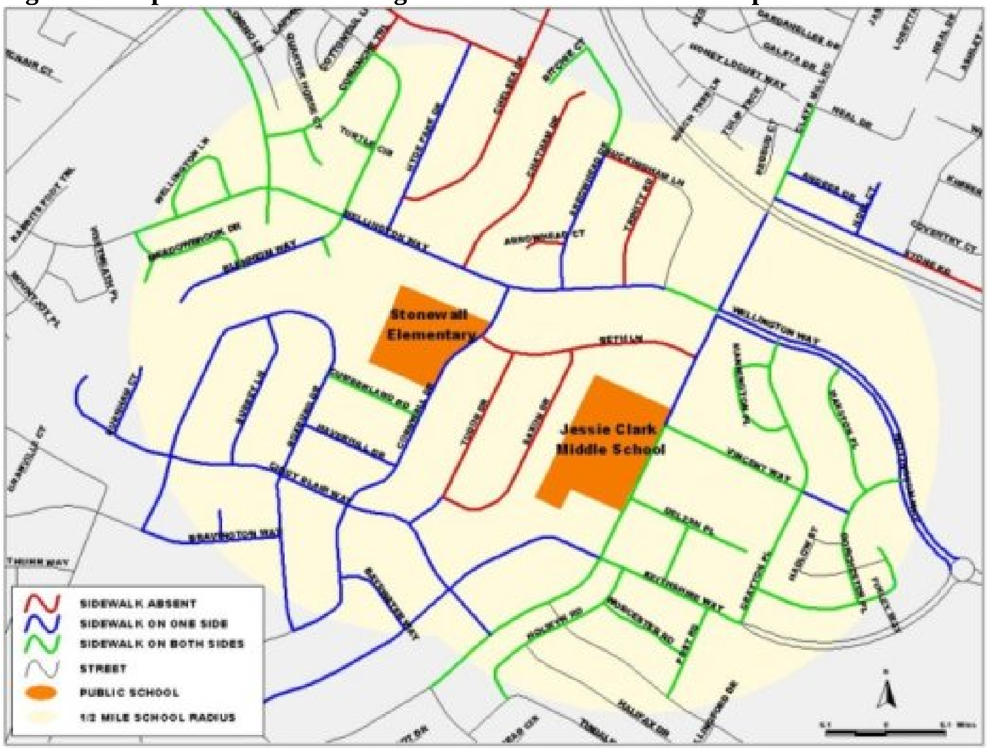
Figure 2: Intersection Data Collection Sheets



Data Analysis

With the level of detail developed in this data collection effort, the Division of Planning expects to be able to undertake a wide range of analytical tasks. Maps of sidewalk coverage can be created in the neighborhoods around schools (see Figure 3 below). Crosswalk marking conditions will be queried and can provide the basis for a maintenance policy that addresses budgeting and restriping tasks. Counts and locations of missing or deficient curb ramps can be analyzed to prioritize and budget funds for new curb ramp installation. Sidewalks in poor condition will be reported to the code enforcement agency for alerting commercial and residential property owners.

Figure 3: Maps of sidewalk coverage near schools were one of the products created from the inventory.



Data Maintenance and Management

A formal, city-wide data maintenance and management plan has not been developed. Currently the Bicycle and Pedestrian Coordinator in the Strategic Planning Office of the Division of Planning is guiding data collection and compilation. This office will undertake initial analysis and develop a report. When the Public Works Department implements site specific improvements, such as installation of curb ramps or restriping of crosswalks, they are reported to the Bicycle and Pedestrian Coordinator so that the database can be updated even while the data is still being collected.

Data Dissemination

An early step in data dissemination will be to load the data into the city's GIS intranet system so that appropriate agencies and staff can use it. Additionally, it is expected that the data will be compiled into a report that will be shared with agency and elected officials to request funding for proposed system improvements. The data will be shared with the Metropolitan Planning Organization to use in the update of the Long Range Transportation Plan and with the public for a jurisdiction-wide bicycle and pedestrian plan in 2004 and 2005.

Innovations and Accomplishments

A large amount of high-quality and detailed data has been collected at relatively low cost. By using web searches and information gathered at conferences, information and models from pedestrian data collection projects in other communities were identified and applied. Even with minimal local expertise in the area of pedestrian transportation, data collection and research, the Lexington-Fayette Urban County Government developed a highly useful product.

Success was achieved linking Microsoft Access database software with GIS to store the information and make it available for analysis and mapping. An unforeseen benefit was that some property owners mistook the data collectors for code enforcement officers and made repairs to sidewalks to avoid formal code enforcement actions. The inventory also increased communication and coordination among various agencies responsible for pedestrian facilities, including the Division of Planning, the Division of Public Safety's Code Enforcement office, and the Public Works Department's Streets and Roads, and Engineering offices.

Lessons Learned

In hindsight, it may have been desirable to invest the extra effort necessary to conduct a more detailed evaluation of ADA compliance issues along each sidewalk and at each intersection. This would have required addressing engineering details such as curb ramp slopes, the height of lips at surface joints, and other surface irregularities. Additional training of interns would have been necessary and special equipment may have been required, but the resulting data would have been more useful.

Although the data collection was structured to evaluate only a sample of the City's entire pedestrian system (based on proximity to schools), it will be analyzed to determine if it can support formal projections of findings across portions of the jurisdiction not covered by the inventory.

Cost of Data Collection

The project was funded with Federal Congestion Mitigation and Air Quality Improvement Program Funds (CMAQ). Labor for the inventory cost approximately $5,000 to $6,000. Other costs included driving between sites, vehicle maintenance, office space, etc. Project management was included in the regular duties of the existing Bicycle and Pedestrian Coordinator.

Contact

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AMERICANS WITH DISABILITIES ACT COMPLIANCE INVENTORY METHODOLOGY

State of Florida

Florida Department of Transportation (FDOT)

Data Collected

- Conducted ADA compliance inventory on a sample of state-owned urban roadways in 2002.
- Inventoried about 50 to 75 miles of roadways in each of Florida's seven DOT Districts.

Highlights

- Developed a simple checklist for use during field data collection
- Inventoried sidewalk width, surface uniformity, cross slope, curb ramps, gutter pan at curb ramp
- Used data to prioritize improvements to curb ramps, access to curb ramps, and sidewalks
- Used results to estimate budget needed to make entire urban system of state-owned roadways accessible

Purpose of Collecting Data

In 2002, Florida's Governor requested an assessment of the fiscal impact of bringing the entire state road system in urban areas into compliance with Americans with Disabilities Act (ADA) accessibility guidelines. This request was made as a part of the state's response to lawsuits brought in Miami and Tallahassee regarding accessibility on public rights-of-way.[10] With data from the assessment, the Governor and FDOT would have a more accurate scope of the problem system-wide, and could develop cost-effective strategies for bringing the state's urban road system into compliance. Prevention of future lawsuits regarding ADA accessibility was also a concern.

Geographic Area Description

Florida's population of 16 million includes the highest percentage of retirement-age people of any state in the U.S. (17.6 percent of Florida's population is over 64 years of age).[11] In Florida, the need for ADA access is greatest in urban areas where more people with disabilities live and work, and land uses and lifestyles make access to non-vehicular transportation a necessity. For this reason, FDOT began a statewide sampling of roadways that was focused on the largest urban areas. The sample included five percent of the non-limited access roadways within the five largest cities in each of FDOT's seven Districts. Each of the seven FDOT Districts were included to insure that the sample included roads in all parts of the state.

[10] Access Now vs. FDOT, Dade County, and City of Miami and Access Now vs. FDOT, Leon County and City of Tallahassee

[11] Year 2000 U. S. Census; the National average is 12.4 percent.

Methodology

History of data collection effort

As a result of lawsuit settlement agreements, FDOT completed assessment of 100% of the state road system within the city boundaries of Miami and Tallahassee. The state has 67 miles of non-limited access roadway in Miami and 219 miles in Tallahassee. For the statewide assessment, FDOT used the checklist and assessment methodology that was developed for the Tallahassee and other prior assessments.

Data collection

The first step in the data collection effort included minor updating and editing of the ADA compliance checklist[12] that had been developed for other assessments. This instrument was designed to enable field data collectors to log locations where existing roadway infrastructure does not meet ADA standards (see Figures 1-2). The four page checklist focused on three primary components of ADA compliance: Accessible Route (sidewalks), Street Crossings/Curb Ramps, and Pedestrian Controls (Clear Space/Reach Ranges/Force). It also included a selection of four key details for reference in the field.

Figure 1.: Survey Instrument, page 1

Street Name / No. Intersection No.

QUESTIONS	YES / NO	✔	POSSIBLE SOLUTIONS
Accessible Route (Sidewalks) People with disabilities should be able to use sidewalks as freely as everyone else. Sidewalks are primary components of a safe and accessible path for everyone.			
Route of Travel (ADAAG 4.3, 4.4, 4.5, 4.7) Is the route of travel (sidewalk, etc.) stable, firm and slip-resistant? (Even when wet?)		❑ ❑	Add non-slip surfacing. Replace gravel with hard top.
Is the route at least 36 inches wide and clear of obstructions? The route can be as narrow as 32" at a point not exceeding 24" wide (utility pole, equipment, etc.)	width	❑ ❑	Change or move landscaping, site furnishings, or other features that narrow the route of travel. Widen route.
Does the path of travel have a cross slope of 1:50 (2%) or less?	cross slope	❑ ❑ ❑	Reduce excessive cross slope - remove/replace existing surface - add 'level' surface
Are level changes 1/4" high or less, or if beveled edge, no more than 1/2" high? · Up to 1/4" change-in-level vertical · 1/4" to 1/2" requires 1:2 slope (max.) · Greater than 1/2" requires 1:12 slope	height	❑ ❑	If there is a level change greater than 1/4" up to 1/2", grind or otherwise modify this edge. If there is a single step with a rise of greater than 1/2", add a short ramp. (see Fig. 1)
Can all objects protruding into the circulation paths be detected by a person with a visual disability using a cane? In order to be detected using a cane, an object must be within 27" of the ground. Objects hanging or mounted overhead must be higher than 80" to provide clear head room. Objects that protrude less than 12" from a post may remain.	distance from post / height	❑ ❑ ❑	Move or remove protruding objects. Add a cane-detectable base that extends to the ground. Place a cane-detectable object on the ground underneath as a warning barrier.

Figure 2.: Survey Instrument, page 2

QUESTIONS	YES / NO	✔	POSSIBLE SOLUTIONS
Does the curb ramp junction with the gutter or roadway have a reasonable counter slope? A counter slope of greater than 11% may catch foot rests or back rollers on some wheelchairs.		❑ ❑	Add a 24" level landing at bottom of curb ramp. Reduce ramp slope to that counter slope is less that 11%. (see Fig. 3)
Pedestrian Controls – Clear Space / Reach Ranges / Force People with disabilities should be able to use sidewalks and pedestrian facilities at intersections as freely as everyone else. Sidewalks are key components of a safe and accessible path for everyone, including people with disabilities.			
Clear space (ADAAG 4.2) Does each pedestrian control have a 30" x 48" clear area in front for a person in a wheelchair to operate it? The clear area should accommodate the approach direction and be immediately in front of the control. Max. slope for clear area is 1:50 in any direction	length / width slope	❑ ❑	Add a clear area (1:50 max. slope) to the extent feasible. Relocate control to location with 30"x48" clear area. 30"x48" Pedestrian Control
Reach Ranges (ADAAG 4.2) Are controls located at an accessible height? Reach ranges: · The max. height for side reach is 54" · If over an obstruction, max. ht. is 46" · If over an obstruction max. horizontal reach is 10"	height	❑ ❑	Relocate pedestrian control. FDOT standard mounting height for pedestrian controls is 42" (see Fig. 4)
Ped Button ADAAG 4.27 Are controls relatively easy to operate? · Must be operable by a closed hand · ADAAG sets a limit of 5 lbf.	button type	❑ ❑	Adjust operating force. Replace control Recent revisions to the ADA recommend that pedestrian control be a 2" diameter raised button. This equipment is available and has been used on FDOT projects.

The following are example items taken from the checklist:

- Is the route stable, firm and slip-resistant?
- Is the route at least 36 inches wide and clear of obstructions?
- Is the cross-slope of the route 2% or less?

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[12] *A Checklist for Readily Achievable Barrier Removal for Sidewalks and Intersections*, State of Florida Department of Transportation, ADA Compliance Program, Special Structures Section, Structures Design Office, February 2002

- Are level changes ¼ inch high or less?
- Can all objects protruding into the circulation paths be detected by a person with a visual disability using a cane?
- At intersections, is there a curb, does it have a curb ramp? Does it meet design standards?
- Does the curb ramp have a detectable warning (tactile surface)?
- Does the curb ramp junction with the gutter or roadway have a reasonable counter slope?
- Does each pedestrian control have sufficient clear space to allow a person in a wheelchair to operate it?
- Are the controls located at an accessible height?
- Are controls relatively easy to operate?

Each element of the assessment included possible remedies for bringing a non-compliant location into compliance, for example, for the first item above, choices included *"Add non-slip surfacing."* or *"Replace gravel with hard top."* This was done to ensure that possible remedies were suggested at the time that data collectors were in the field actually reviewing the location and could make a more accurate assessment of what scope of response was needed.

Fourteen team leaders (two FDOT staff per District) were trained over the course of two days, in use of the checklist and measurement of infrastructure for ADA compliance (see Figures 3-4). The training included instruction on how to use basic tools such as levels and measuring tapes to make accurate measurements. The training also included an orientation to the ADA law, how it applies to public roadways, and how recent lawsuits in the state of Florida had made this issue of the utmost importance to state government, and to FDOT in particular.

Figure 3.: ADA Compliance Training Image

Figure 4.: Measuring Infrastructure Training Image

In most Districts, FDOT team leaders trained additional District level staff to conduct the assessments. Data collectors included staff with various backgrounds, including management engineers, design engineers, maintenance engineers, staff technicians, inspectors and others. In all, 28-35 staff persons were involved in the assessment of approximately 50 to 75 miles of urban state roadway per District (about 400 total miles throughout the state).

To select the actual road segments for assessment, teams in each District used FDOT system maps to randomly select a set of roads to meet their 5 percent goal. They were encouraged to select a variety of roadway types, focus on the urban and suburban areas within the city limits, and ensure that the mileage was distributed to a reasonable degree around the city. For efficiency in conducting the fieldwork, multi-mile sections of state roads were often selected.

In response to the urgency communicated in the Governor's request, FDOT was able to initiate and complete the assessment, data analysis and report in about six weeks. It took the data assessment teams about two to four weeks to complete data collection in the field.

Data storage

Each District selected a single staff person to compile the data from the sheets, which had been compiled manually in the field. Midway in the data compiling process, a spreadsheet created by one of the Districts was circulated as a template for others to use. All Districts, however, did not have the opportunity to compile their data in this uniform format. As a result, District data were compiled in spreadsheets and tables created in word documents. Data remains stored in these multiple formats.

Data analysis

Once the data were collected, counts could quickly be tallied for each possible solution and mileages and quantities applied. Using standard FDOT costs for each solution, gross cost estimates for the improvements were calculated.

The data were compiled and analyzed by the project manager and staff in the central FDOT office. Total costs to address deficiencies were calculated by city, by district and for the entire set of study roadway miles. This total cost for 5% of the FDOT urban system was then projected across the entire FDOT urban system.

Data maintenance and management

Because this research was conducted at special request, and is not part of an ongoing data collection effort, ongoing data maintenance and management is not currently a need.

Data dissemination

Results were compiled in a report for the FDOT Secretary and Governor.

Innovations and Accomplishments

FDOT developed a simple but effective method to assess a small percentage of state roadways, and use the results to develop a reasonable "ball park" projection of what it would cost in total capital investment to bring the entire urban system into compliance. This was also accomplished in a very short amount of time, however with a significant investment of staff-time from staff persons throughout the state.

The data gathered was found to be generally reliable and useful for prioritizing needed improvements and making a statewide cost estimate for legal and state level budgeting purposes. The data was also useful for planning for the most effective use of capital funds to improve conditions. FDOT has, to date, spent over $200 million in accessibility improvements on the state highway system and is committed to providing safe, functional transportation facilities that are accessible to all SHS users, including those with disabilities.

As a result of the assessment findings, and as an outcome of the lawsuits, all FDOT Districts are paying closer attention to project design to ensure that all new construction meets ADA standards. To achieve this, a variety of training efforts are underway to ensure that FDOT staff and consultants working in design, project management, construction, and inspection are all well-trained in understanding ADA standards and how and where they must be applied.

Lessons Learned

Adjustments to the data collection process will be necessary for future efforts. In some cases the data collectors had misunderstood how to take certain measurements. Some data was gathered or recorded incorrectly and needed to be adjusted. Despite a fairly rigorous training effort, the following approaches would be considered in future data collection efforts to ensure greater consistency among the data collectors and gathering of data with a higher level of accuracy:

- Have the state ADA Coordinator be more involved in screening those selected at the District level to do the data collection.
- Ensure that all data collectors participate in the training course.
- Increase the time provided during the training session for each data collector to practice data collection in real field conditions near the training site.
- Require the use of Smart Tool, or other modern slope gauges now on the market, which are highly accurate, and provide sufficient training regarding use of the tool.

Another modification to the research approach would be to include more suburban roadway mileage in the sample.

Finally, as a result of this research, the state ADA Coordinator has become aware of the need to integrate ADA assessment into the ongoing roadway maintenance rating plan. Maintenance staff could then include ADA assessment as a part of routine overall roadway evaluations, and calculate ADA-related deficiencies into the equation when determining whether a facility needs spot improvements, re-surfacing, rehabilitation or reconstruction. This integration would require additional training for FDOT staff and consultants.

Cost of Data Collection Effort

The cost of this data collection effort was not determined. It was conducted in-house by FDOT staff. A rough estimate of person hours is about 30 interns or mid-level staff working full-time for about four weeks, plus one person working full-time for six weeks as trainer, manager and report writer.

Contact

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CROSSWALK INVENTORY AND IMPROVEMENT PLAN

Seattle, Washington
City of Seattle

Data Collected

- Inventory of uncontrolled marked crosswalks (crosswalks at locations with no stop sign or stop light)

Innovative Aspects

- Completed a systematic, detailed inventory of marked crosswalks. Inventory items included marking type and quality, curb cuts and driveways, sight distance, street trees, lighting, signage, and characteristics of the arterial roadway within two blocks of the crosswalk.
- Prioritized marked crosswalk improvements based on an objective inventory
- Incorporated Geographic Information Systems (GIS) mapping techniques
- Used the recommendations of a pedestrian safety research study as a part of a comprehensive safety improvement strategy

Purpose of Collecting Data

The City of Seattle conducted this marked crosswalk inventory in order to assess the need for crosswalk safety improvements using objective methods. Analysis of the inventory data enabled the City to identify and prioritize locations where pedestrian crossings should be made safer. The resulting improvements are expected to reduce the total number of pedestrian crashes in the city.

Geographic Area Description

The marked crosswalk inventory took place in Seattle, WA (population 563,000). All 850 uncontrolled marked crosswalks in the city were inventoried. This included marked crosswalks on residential and arterial streets.

Methodology

History of data collection effort

FHWA's Safety Effects of Marked vs. Unmarked Crosswalks Study (2001)[13] analyzed five years of pedestrian crashes at over 1000 marked crosswalks and 1000 matched unmarked comparison sites. This federal research represents the most comprehensive analysis of crosswalks in the United States. Seattle's crosswalk inventory was implemented to demonstrate how the results of the study could be used in a practical way to improve pedestrian safety.

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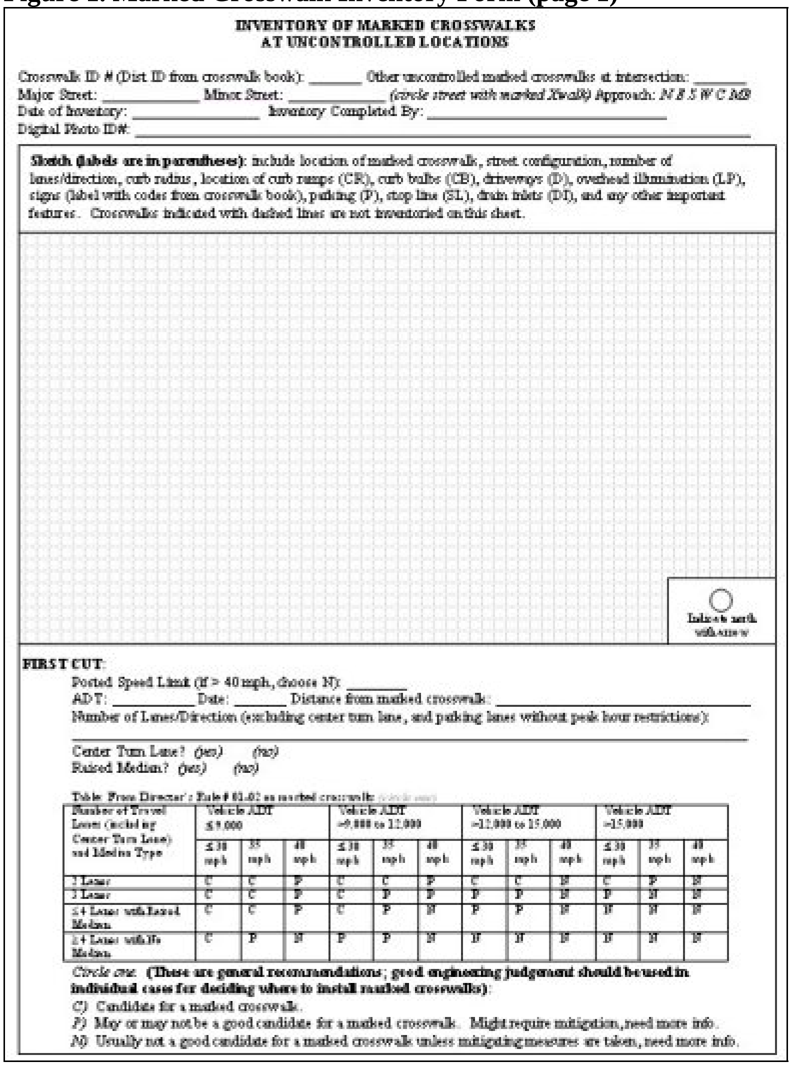
[13] C.V. Zegeer, J.R. Stewart, H.H. Huang, and P.A. Lagerwey. *Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations*, Federal Highway Administration, FHWA-RD-01-075, 2001.

Data Collection

All of Seattle's 850 uncontrolled marked crosswalks were inventoried over a three month period. Each inventory was done on a separate form that was completed in approximately 15 to 20 minutes by a graduate student intern. The form included space for sketching the intersection, characteristics of the crosswalk, and characteristics of the arterial street on which the crosswalk was located (see Figure 1).

Figure 1. Marked Crosswalk Inventory Form (page 1)



INVENTORY OF MARKED CROSSWALKS
AT UNCONTROLLED LOCATIONS

Crosswalk ID # (Dist ID from crosswalk book): ______ Other uncontrolled marked crosswalks at intersection: ______
Major Street: ____________ Minor Street: ____________ *(circle street with marked Xwalk)* Approach: *N E S W C MB*
Date of Inventory: ______________ Inventory Completed By: ______________________________
Digital Photo ID#: ____

Sketch (labels are in parentheses): include location of marked crosswalk, street configuration, number of lanes/direction, curb radius, location of curb ramps (CR), curb bulbs (CB), driveways (D), overhead illumination (LP), signs (label with codes from crosswalk book), parking (P), stop line (SL), drain inlets (DI), and any other important features. Crosswalks indicated with dashed lines are not inventoried on this sheet.

Indicate north with arrow

FIRST CUT:

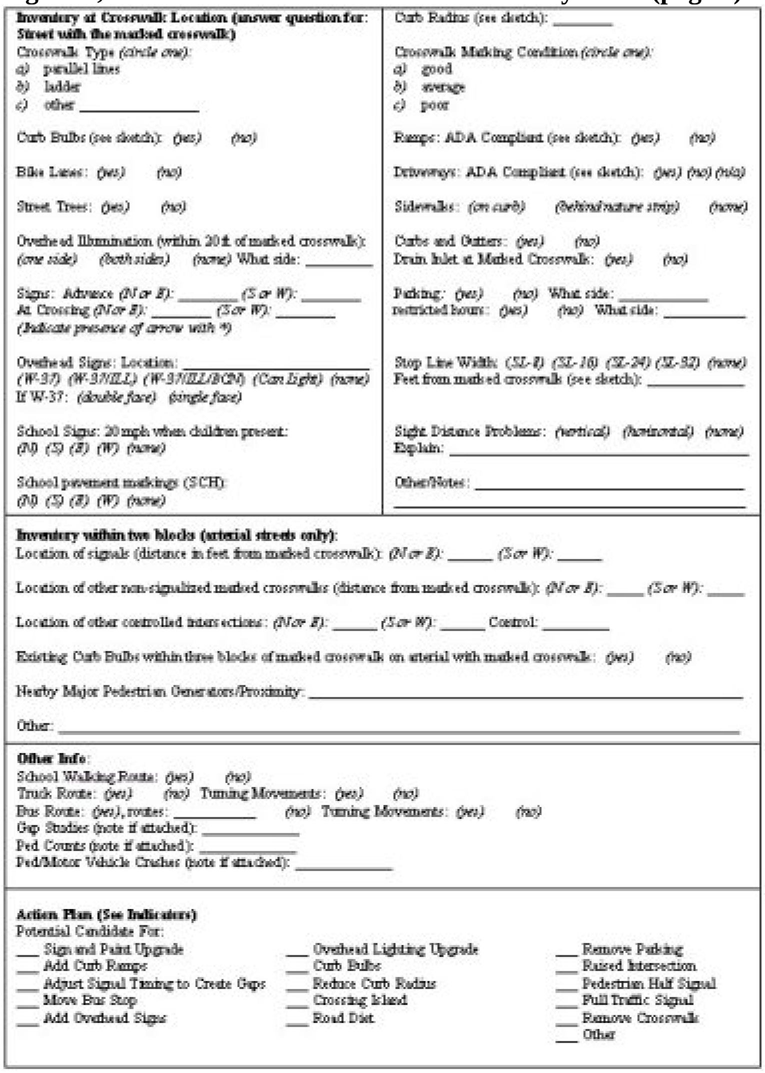
Posted Speed Limit (If > 40 mph, choose N): ________
ADT: __________ Date: ______ Distance from marked crosswalk: ____________________
Number of Lanes/Direction (excluding center turn lane, and parking lanes without peak hour restrictions):
____
Center Turn Lane? *(yes)* *(no)*
Raised Median? *(yes)* *(no)*

Table: From Director's Rule # 01-02 on marked crosswalks (circle one)

Number of Travel Lanes (including Center Turn Lane) and Median Type	Vehicle ADT ≤9,000			Vehicle ADT >9,000 to 12,000			Vehicle ADT >12,000 to 15,000			Vehicle ADT >15,000		
	≤30 mph	35 mph	40 mph	≤30 mph	35 mph	40 mph	≤30 mph	35 mph	40 mph	≤30 mph	35 mph	40 mph
2 Lanes	C	C	P	C	C	P	C	C	N	C	P	N
3 Lanes	C	C	P	C	P	P	P	P	N	P	N	N
≥4 Lanes with Raised Median	C	C	P	C	P	N	P	P	N	N	N	N
≥4 Lanes with No Median	C	P	N	P	P	N	N	N	N	N	N	N

Circle one. **(These are general recommendations; good engineering judgement should be used in individual cases for deciding where to install marked crosswalks):**
C) Candidate for a marked crosswalk.
P) May or may not be a good candidate for a marked crosswalk. Might require mitigation, need more info.
N) Usually not a good candidate for a marked crosswalk unless mitigating measures are taken, need more info.

Figure 1, continued. Marked Crosswalk Inventory Form (page 2)



Inventory at Crosswalk Location (answer question for: Street with the marked crosswalk)

Crosswalk Type *(circle one)*:
a) parallel lines
b) ladder
c) other ____________

Curb Bulbs (see sketch): *(yes)* *(no)*

Bike Lanes: *(yes)* *(no)*

Street Trees: *(yes)* *(no)*

Overhead Illumination (within 20 ft. of marked crosswalk):
(one side) *(both sides)* *(none)* What side: ________

Signs: Advance *(N or E)*: ______ *(S or W)*: ______
At Crossing *(N or E)*: ______ *(S or W)*: ______
*(Indicate presence of arrow with *)*

Overhead Signs: Location: ____________
(W-37) *(W-37/ILL)* *(W-37/ILL/BCN)* *(Can Light)* *(none)*
If W-37: *(double face)* *(single face)*

School Signs: 20 mph when children present:
(N) *(S)* *(E)* *(W)* *(none)*

School pavement markings (SCH):
(N) *(S)* *(E)* *(W)* *(none)*

Curb Radius (see sketch): ______

Crosswalk Marking Condition *(circle one)*:
a) good
b) average
c) poor

Ramps: ADA Compliant (see sketch): *(yes)* *(no)*

Driveways: ADA Compliant (see sketch): *(yes)* *(no)* *(n/a)*

Sidewalks: *(on curb)* *(behind nature strip)* *(none)*

Curbs and Gutters: *(yes)* *(no)*
Drain Inlet at Marked Crosswalk: *(yes)* *(no)*

Parking: *(yes)* *(no)* What side: ________
restricted hours: *(yes)* *(no)* What side: ________

Stop Line Width: *(SL-8)* *(SL-16)* *(SL-24)* *(SL-32)* *(none)*
Feet from marked crosswalk (see sketch): ________

Sight Distance Problems: *(vertical)* *(horizontal)* *(none)*
Explain: ____________

Other/Notes: ____________

Inventory within two blocks (arterial streets only):
Location of signals (distance in feet from marked crosswalk): *(N or E)*: _____ *(S or W)*: _____

Location of other non-signalized marked crosswalks (distance from marked crosswalk): *(N or E)*: ____ *(S or W)*: ____

Location of other controlled intersections: *(N or E)*: _____ *(S or W)*: _____ Control: ______

Existing Curb Bulbs within three blocks of marked crosswalk on arterial with marked crosswalk: *(yes)* *(no)*

Nearby Major Pedestrian Generators/Proximity: ____________

Other: ____________

Other Info:
School Walking Route: *(yes)* *(no)*
Truck Route: *(yes)* *(no)* Turning Movements: *(yes)* *(no)*
Bus Route: *(yes)*, routes: ________ *(no)* Turning Movements: *(yes)* *(no)*
Gap Studies (note if attached): ________
Ped Counts (note if attached): ________
Ped/Motor Vehicle Crashes (note if attached): ________

Action Plan (See Indicators)
Potential Candidate For:
___ Sign and Paint Upgrade
___ Add Curb Ramps
___ Adjust Signal Timing to Create Gaps
___ Move Bus Stop
___ Add Overhead Signs
___ Overhead Lighting Upgrade
___ Curb Bulbs
___ Reduce Curb Radius
___ Crossing Island
___ Road Diet
___ Remove Parking
___ Raised Intersection
___ Pedestrian Half Signal
___ Full Traffic Signal
___ Remove Crosswalk
___ Other

Data storage

Information about each of the crosswalks was stored in a GIS database.

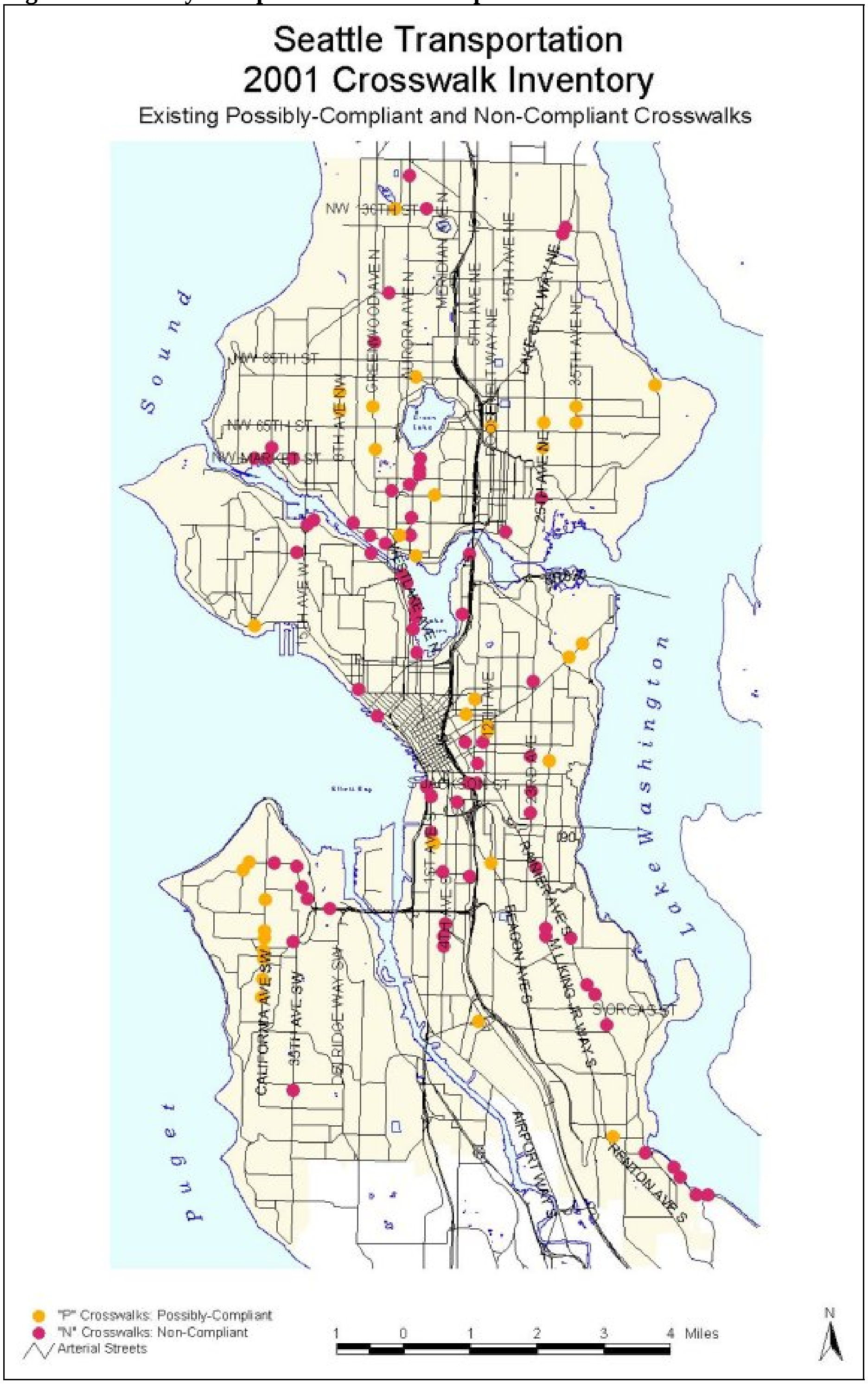
Data analysis

In general, the FHWA study suggests that sites with two lanes and low traffic volumes are places where marked crosswalks can be used without other supporting treatments; sites that have higher traffic volumes, multiple lanes, and high speeds are places where crosswalks should be supported by other features that improve pedestrian crossing safety, such as raised medians, curb extensions, and other methods. Seattle's crosswalks were divided into three categories. Approximately 730 of the inventoried crosswalks were classified as compliant (C) (i.e., met the criteria of the FHWA study suggesting the crosswalks could be marked without other supporting treatments); about 40 ranked as possibly-compliant (P); and about 80 were considered to be non-compliant (N).

The City of Seattle is attempting to improve pedestrian crossing conditions at crosswalks in the N and P categories—preferably not by removing crosswalks, but by finding engineering solutions that increase the visibility of the crossing, reduce pedestrian crossing distances, and slow motor vehicles.

Data analysis also showed that, regardless of its classification as C, P, or N, almost every crosswalk inventoried could benefit from at least one improvement such as re-marking crosswalks, providing better lighting, or installing curb ramps. In addition, displaying the locations of N and P crosswalks on a GIS map showed that "problem" crosswalks tended to cluster in about 12 corridors (see Figure 2). This provided the City of Seattle with opportunities to address all of the crosswalk problems in a roadway corridor with a single improvement project. For example, a road diet (the conversion of a four-lane road to two lanes plus a center turn lane) would reduce the number of lanes for pedestrians to cross. It would also provide additional space for pedestrian crossing islands, wider sidewalks, or other features to enhance pedestrian safety and comfort at the crosswalks.

Figure 2. Possibly-Compliant and Non-Compliant Crosswalks from Crosswalk Inventory



Data dissemination

Results of the inventory were incorporated into Seattle's crosswalk improvement plan. The inventory and plan were featured in a January 2004 *Institute of Transportation Engineers Journal* article, "The City of Seattle, WA, USA, Crosswalk Inventory and Improvement Plan."

Innovations and Accomplishments

The City of Seattle has used the crosswalk inventory to identify improvements, and is systematically making physical changes to reduce the risk of pedestrian crashes at crosswalks. To reduce the need for separate funding, the city plans to make improvements at the same time as yearly repaving and signal projects, neighborhood plan projects, state projects, and trail projects. In 2001 and 2002, 58 new curb ramps were installed at marked crosswalks, 800 school signs were replaced, eight sets of curb bulbs were added, two road diets were constructed, four new traffic signals were installed, and 12 new crosswalks were marked. Other improvements are being planned. Only three crosswalks were removed—one temporarily—until a traffic signal could be installed.

The inventory has enabled Seattle to make objective decisions about crosswalk improvements. Vocal neighborhoods are not given an advantage over less vocal neighborhoods in influencing which dangerous crossing should be fixed first. This also addresses the need to base decisions on more factors than just pedestrian crashes. While pedestrian crashes often result in serious injuries or fatalities, they are often random events that do not occur frequently enough to serve as a reliable indicator of crosswalk safety.

Lessons Learned

Land use and transportation system development may eventually lead to changes in motor vehicle volumes, pedestrian activity patterns, and roadway configuration. Over time, these changes may either improve or reduce the compliance rating of crosswalks. Therefore, City staff have determined that the inventory should be repeated periodically in the future. Though this inventory was useful, it did not include important characteristics of pedestrian crossings, such as sight distance and intersection configuration. Therefore, additional field data is needed to evaluate pedestrian safety in some crosswalks in the City. Seattle would also like to address safety issues at signalized crosswalks in a similar way in the future.

Cost of Data Collection Effort

A graduate student developed and completed the inventory with the assistance of another colleague. In addition to three months' salary of the two employees, costs included purchase of a digital camera; use of a computer to develop the form, download photos, and create GIS maps; and travel expenses to access the crosswalks.

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BICYCLE AND PEDESTRIAN LEVEL OF SERVICE INVENTORIES

Numerous communities across the country have completed inventories of Bicycle Level of Service (Bicycle LOS) and Pedestrian Level of Service (Pedestrian LOS). The following three case studies present examples from the City of St. Petersburg, Florida (2003), Loudoun County, Virginia (2002), and the State of Maryland (2001). Each of the three inventories involve a similar inventory and analysis methodology, but each community has used the results differently. The first section of the case study gives an overview of bicycle and pedestrian suitability analysis methods in general and then discusses the Bicycle LOS and Pedestrian LOS methodologies; the second section covers specific applications of Bicycle LOS and Pedestrian LOS in the City of St. Petersburg, Loudoun County, and the State of Maryland.

Bicycle and Pedestrian Suitability Analysis Methods

Most bicycle and pedestrian plans and projects require some knowledge of the existing conditions (or suitability) for bicycle and pedestrian travel. Communities in all parts of the country have developed methods of evaluating pedestrian and bicycle conditions. These fall into three general categories:

1) basic inventories of bicycle and pedestrian facilities, such as sidewalks and roadway shoulders;
2) subjective assessments of roadway conditions by transportation planners, engineers, or experienced bicyclists and pedestrians; and
3) LOS assessments: complex formulas that estimate the effects of different roadway characteristics on the comfort of bicyclists and pedestrians.

Level of Service (LOS) is one of the frameworks that transportation professionals use to describe the suitability of the roadway environment for bicycle and pedestrian travel. Several methods of bicycle and pedestrian LOS evaluation were developed in the 1990s using scientific experiments. These methods include the Bicycle LOS Model, the Pedestrian LOS Model, and the Bicycle Compatibility Index (BCI) Model.

The Bicycle LOS Model and Pedestrian LOS Model were developed from the real-time perceptions of bicyclists and pedestrians in live roadway conditions. The BCI Model was developed from the perceptions of bicyclists viewing video clips of roadway conditions (see NJDOT case study for an example of BCI application). All three models are mathematical equations that express how comfortable a roadway segment with a combination of measurable characteristics (e.g., shoulder width, speed limit, etc.) feels to a typical bicyclist or pedestrian. For each roadway segment, the model result reflects LOS, which is expressed on an “A” to “F” grading scale. Intersections are not measured in the field or included in the Bicycle LOS or Pedestrian LOS, or BCI analysis.

Some agencies have adopted alternative terminology for bicycle and pedestrian LOS models, such as Quality of Service (QOS) and Level of Comfort (LOC), but these still use the same mathematical equations as the Bicycle LOS and Pedestrian LOS Models.

Bicycle and Pedestrian Level of Service Analysis Methodology

Data Collection

While many transportation agencies have roadway databases, they do not typically include the necessary inputs needed to model Bicycle and/or Pedestrian LOS, such as shoulder width, pavement condition, sidewalk width, and the presence of street trees. Therefore, the agencies usually conduct a roadway inventory to develop a complete, current database in order to calculate Bicycle LOS and Pedestrian LOS for roadway segments in the study.

Agencies are typically interested in evaluating Bicycle and/or Pedestrian LOS on major streets (arterial and collector streets, and other local roads that provide significant connections) and in some cases on limited-access freeways where bicyclists and pedestrians are permitted.

The inventories are typically done by agency staff, volunteers, or consultants. Typically, teams of two (on occasion, one or three) data collectors drive all roadways in the study network and take one measurement for each segment. The data collectors seek to measure at a location that represents the typical cross-section of the roadway segment. Each team has a data collection map that shows the data collection segments by segment identification number. The number for each segment corresponds to a number on a paper or electronic spreadsheet where the measurements are entered.

Taking field measurements and entering the data into computerized spreadsheets can usually be done at a pace of 20 to 80 miles per day by a single data collection team, although urban areas tend to take longer than rural areas because the roadway analysis segments are shorter and there is more traffic to negotiate. St. Petersburg completed the measurements for its 224-mile study network in one week using two data collection teams. Loudoun County inventoried 736 miles of roads in about six weeks using one data collection team. Maryland inventoried 4,750 miles of roads—all state-owned roadways—in less than four months with two two-member data collection teams.

The following field observations are made for each roadway segment:

- Number of through travel lanes
- Lane configuration (divided, undivided, one-way, center turn lane)
- Posted speed limit
- Width of outside travel lane
- Width of paved shoulder
- Width of bicycle lane
- Presence of on-street parking
- Pavement condition of travel lane and shoulder
- Buffer width between curb face and sidewalk*
- Width of sidewalk*
- Spacing of street trees along the roadway*
- Roadside profile (rated area on the side of the roadway on how easy it would be to construct a sidewalk or sidepath)

*Additional items collected in order to calculate Pedestrian LOS.

In addition to the data that are collected in the field, data on Annual Average Daily Traffic Volume and the percentage of heavy vehicles are gathered for each roadway segment, usually from existing traffic databases.

Data storage

The field observations and existing data are entered into a database. One row is provided for each roadway segment (see Figure 1 and Figure 2). Formulas for the Bicycle LOS and Pedestrian LOS models are programmed in the spreadsheet so that the Bicycle LOS and Pedestrian LOS scores and grades can be calculated for each roadway segment. The spreadsheet database is then linked (using segment identification numbers) to a corresponding roadway layer in GIS so that results of the Bicycle LOS and Pedestrian LOS Model analysis can be displayed on maps.

Figure 1. St. Petersburg Bicycle LOS Database

Seg_id	Road Name	From (N or W)	To (S or E)	Length (Ls) (mi)	Dir. of Sur.	Existing Lanes (L) Th #	Existing Lanes (L) Con	Existing Traffic Data Volume (ADT) (Exit)	Existing Traffic Data Tks. (HV) (%)	Post. Spd. (SP_p) mph	Width Of Pavement W_t (ft)	Width Of Pavement W_l (ft)	Width Of Pavement W_{ps} (ft)	Occ. Park. (OSPA) (%)	Pave-con PC (1..5)	Pave-con PC (1..5)	Bike Lane/ Shldr. (Y/N)	Existing Bicycle LOS Score (1..7)	Existing Bicycle LOS Grade (A..F)	Needs Ranking data 100% DBLOS	Needs Ranking data 100% LOS	Needs Ranking data 100% Public	Available ROW? (Yes/No)	Planned Improvements (Yes/No)	Restripe Excess Pvmt.?	Restripe Excess Lanes?	Final Facility Selected
66.0	Park Street N	05 Avenue N	22 Avenue N	1.13	SB	4	U	18,122	4	40	14.0	0	0	0	2.5	0	N	4.99	E	81	98	9	No	No	Yes	No	Restripe-1
288.0	09 Street S	18 Avenue S	09 Avenue S	0.64	SB	4	U	18,321	3	35	16.0	0	0	0	2.5	0	N	4.34	D	60	84	73	No	No	Yes	No	Restripe-1
112.0	01 Avenue S	16 Street S	09 Street S	0.50	EB	4	OW	7,000	2	35	14.5	0	0	0	3.0	0	N	3.46	C	31	100	82	Yes	No	Yes	No	Restripe-1
291.0	01 Avenue S	Pasadena	SUNSET DR	0.53	EB	4	U	12,000	4	40	16.0	0	0	0	2.5	0	N	4.47	D	64	98	18	No	No	Yes	No	Restripe-1
272.0	Gandy B/N	28 Street N	16 Street N	1.05	EB	4	D	43,580	6	55	22.6	0	0	0	4.5	0	N	3.91	D	46	76	91	Yes	No	Yes	No	Restripe-1
275.0	Roosevelt B/N	16th Street N	28th Street N	1.27	NB	4	D	43,000	6	60	21.5	0	0	0	4.5	0	N	4.23	D	56	64	91	Yes	No	Yes	No	Restripe-1
222.0	Gandy B/N	San Martin B/NE	04 Street N	1.08	EB	4	D	38,057	5	55	15.0	0	0	0	4.5	0	N	4.96	E	80	38	91	Yes	No	Yes	No	Restripe-1
122.1	01 Avenue N	66 Street N	58 Street N	0.99	WB	4	OW	7,000	3	41	18.0	0	0	0	3.0	0	N	3.23	C	24	99	45	No	No	Yes	Yes	Restripe-1
135.0	64 Street N-S	07 Avenue S	01 Avenue N	0.61	NB	2	U	5,614	2	35	14.5	0	0	0	3.0	0	N	3.76	D	41	90	0	Yes	No	Yes	No	Restripe-1
84.0	04 Avenue N	05 Avenue N	09 Street N	0.69	EB	3	OW	18,306	3	30	17.5	0	0	5	3.0	0	N	3.74	D	40	100	0	Yes	No	Yes	No	Restripe-1
223.0	Gandy B/NE	San Martin B/NE	E TO Gandy Bridge	0.67	EB	4	D	24,571	5	60	16.0	0	0	0	4.5	4	N	4.66	E	78	24	91	Yes	No	Yes	No	Restripe-1
273.0	Gandy B/N	16 Street N	04 Street N	1.24	EB	4	D	22,132	5	55	22.0	0	0	0	4.5	0	N	3.40	C	29	58	91	Yes	No	Yes	No	Restripe-1
164.1	05 Avenue N	16 Street N	09 Street N	0.50	EB	3	U	9,123	2	35	14.0	0	0	0	4.0	0	N	3.40	C	29	99	9	No	No	Yes	No	Restripe-1
79.0	37 Street S	05 Avenue S	Central Ave	0.31	SB	2	U	4,551	2	30	14.0	0	0	0	3.0	0	N	3.59	D	35	84	18	Yes	No	Yes	No	Restripe-1
98.0	04 Avenue N	09 Street N	03 Street N	0.59	EB	3	OW	7,022	2	30	19.0	0	0	40	3.0	0	N	3.40	C	29	98	0	No	No	Yes	No	Restripe-1
271.0	01 Street N	62 Avenue NE	78 Avenue N	1.00	EB	2	U	5,946	2	25	15.0	0	0	0	4.0	0	N	2.99	C	16	59	100	Yes	No	Yes	No	Restripe-1
274.0	Roosevelt B/N	Gandy B/N	16 Street N	1.19	NB	4	D	17,324	4	60	21.5	0	0	0	4.5	0	N	3.15	C	21	58	91	Yes	No	Yes	No	Restripe-1
221.1	04 Street N	Gandy B/N	116 Avenue N	0.92	NB	4	D	12,632	4	55	18.0	0	0	0	5.0	0	N	3.56	D	34	44	91	Yes	No	Yes	No	Restripe-1

Figure 2. St. Petersburg Pedestrian LOS Database

Seg_id	Road Name	From (N or W)	To (S or E)	Jurisdiction	Length (Ls) (mi)	Existing Lanes (L) Th #	Existing Lanes (L) Con	Existing Traffic Volume (ADT) (Exit)	Post. Spd. (SP_p) mph	Width Of Pavement W_t (ft)	Width Of Pavement W_l (ft)	Width Of Pavement W_{ps} (ft)	Occ. Park. (OSPA) (%)	Bike Lane Mark? (Y/N)	Buff. Width (ft)	% With Sidewalk N/EB	% With Sidewalk S/WB	Swalk Width (ft)	Tree Spcg. in Buffer (ft/ctr)	Existing Ped. LOS Value	Existing Ped. LOS Grade (A..F)	Needs Ranking Data 100% DPLOS (0.50)	Needs Ranking Data 100% LOS (0.50)	Needs Priority Value	Needs Priority Level (I..III)
2002.0	7th Avenue N	North Shore Dr	Bayshore Dr	CI	0.11	2	U	5,000	25	10.0	0	0	0	N	0	0	0	0	0	3.99	D	41	88	64	I
26.0	22 Avenue N	PARK Street N	66 Street N	CI	1.65	2	U	20,805	35	11.5	0	0	0	N	10	65	100	5	0	4.61	E	59	67	63	I
80.1	PARK Street S	PASADENA	05 Avenue S	CI	0.41	2	U	8,789	30	12.0	0	0	0	N	0	0	0	0	0	4.39	D	53	72	62	I
255.0	09 Avenue N	22/Street N	16 Street N	CI	0.50	4	U	14,335	35	10.5	0	0	0	N	0	100	0	5	0	3.78	D	36	88	62	I
101.2	16 Street N	04 Avenue N	09 Avenue N	CI	0.33	4	U	15,168	35	13.0	0	0	0	N	0	100	10	5	0	3.60	D	31	87	59	I
406.0	05 Avenue N	01 Street S	BEACH DR	CI	0.17	4	U	10,293	30	11.5	0	0	0	N	0	100	0	4	0	3.41	C	25	92	59	I
32.0	30 Avenue N	58 Street N	60 Street N	CI	0.24	2	D	9,546	35	14.5	0	0	0	N	8	0	100	5	0	3.58	D	30	86	58	I
101.1	16 Street N	BURLINGTON Avenue N	04 Avenue N	CI	0.18	4	U	15,168	35	13.0	0	0	0	N	0	0	100	5	0	3.67	D	33	83	58	I
150.0	04 Street S	54 Avenue S	45 Avenue S	CI	0.56	2	U	16,398	40	10.0	0	0	0	N	30	50	10	6	0	5.09	E	72	42	57	I
92.0	58 Street N	09 Avenue N	22 Avenue N	CI	0.76	4	U	21,523	35	10.0	0	0	0	N	0	10	100	5	0	4.18	D	47	67	57	I
292.0	[illegible]	31 Street S	COUNTRY CLUB WS	CI	1.21	2	U	6,968	30	10.0	0	0	0	N	0	0	0	0	0	4.65	E	60	54	57	I
135.0	64 Street N-S	07 Avenue S	01 Avenue N	CI	0.61	2	U	5,614	35	14.5	0	0	0	N	0	10	10	5	0	3.80	D	36	77	57	I
18.0	09 Street N	83 Avenue N	62 Avenue N	CI	1.31	4	U	21,178	40	11.0	0	0	0	N	5	100	20	5	0	4.06	D	43	69	56	I
45.0	HAINES R/N	16 Street N	24 Street N	CI	0.72	2	U	5,525	35	12.0	0	0	0	N	5	0	40	5	0	3.78	D	36	75	55	I
263.0	16 Street N	09 Avenue N	13 Avenue N	CI	0.25	4	U	12,353	35	12.0	0	0	0	N	3	100	0	4	0	3.58	D	30	79	55	I
32.1	30 Avenue N	60 Street N	66 Street N	CI	0.75	2	U	9,546	35	16.0	0	0	0	N	26	0	100	5	100	3.12	C	17	91	54	I
59.0	28 Street N	30 Avenue N	40 Avenue N	CI	0.63	2	U	9,113	35	15.0	0	0	0	N	0	0	0	0	0	4.27	D	49	58	54	I
501.0	13 Avenue N	16 Street N	28 Street N	CI	1.01	2	U	1,984	30	16.5	0	0	0	N	8	70	0	5	0	2.74	C	7	100	53	I
200.0	04 Street S	62 Avenue S	54 Avenue S	CI	0.50	2	U	16,398	35	10.0	0.5	0	0	N	30	90	10	6	0	4.48	D	55	52	53	I
84.0	05 Avenue N	66 Street N	TYRONE BLD	CI	0.86	4	U	6,668	40	16.5	0	0	0	N	8	100	10	5	100	2.84	C	9	97	53	I

Data analysis

For both the Bicycle LOS Model and the Pedestrian LOS Model, the spreadsheets are programmed to produce quantitative results in the form of Bicycle and Pedestrian LOS scores. These scores are translated into service categories “A”, “B”, “C”, “D”, “E”, and F”. These categories are commonly referred to as Bicycle LOS and Pedestrian LOS grades. Grade “A” represents a roadway segment with the best conditions for bicycling and walking, and Grade "F" represents the worst conditions for bicycling and walking (see Figures 3 and 4).

Figure 3. Loudoun County Bicycle LOS Results

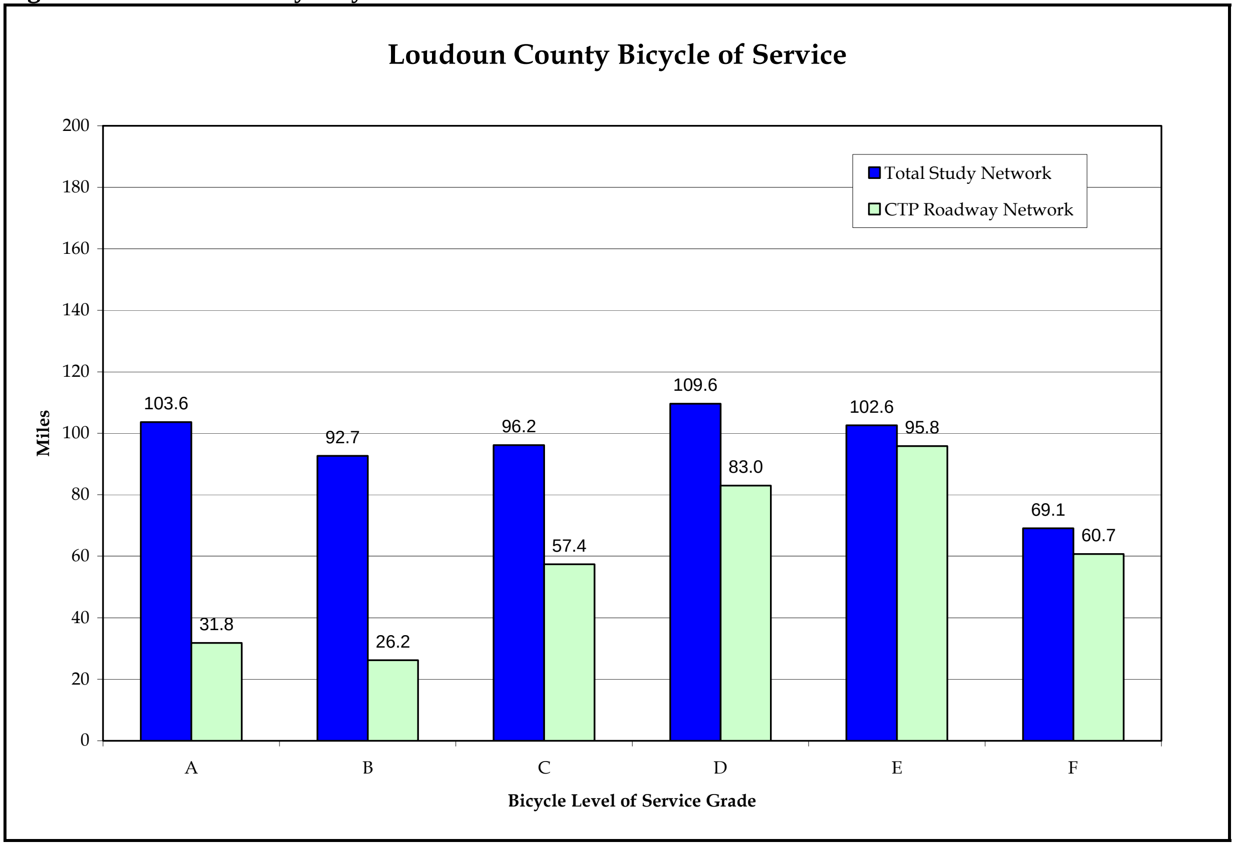
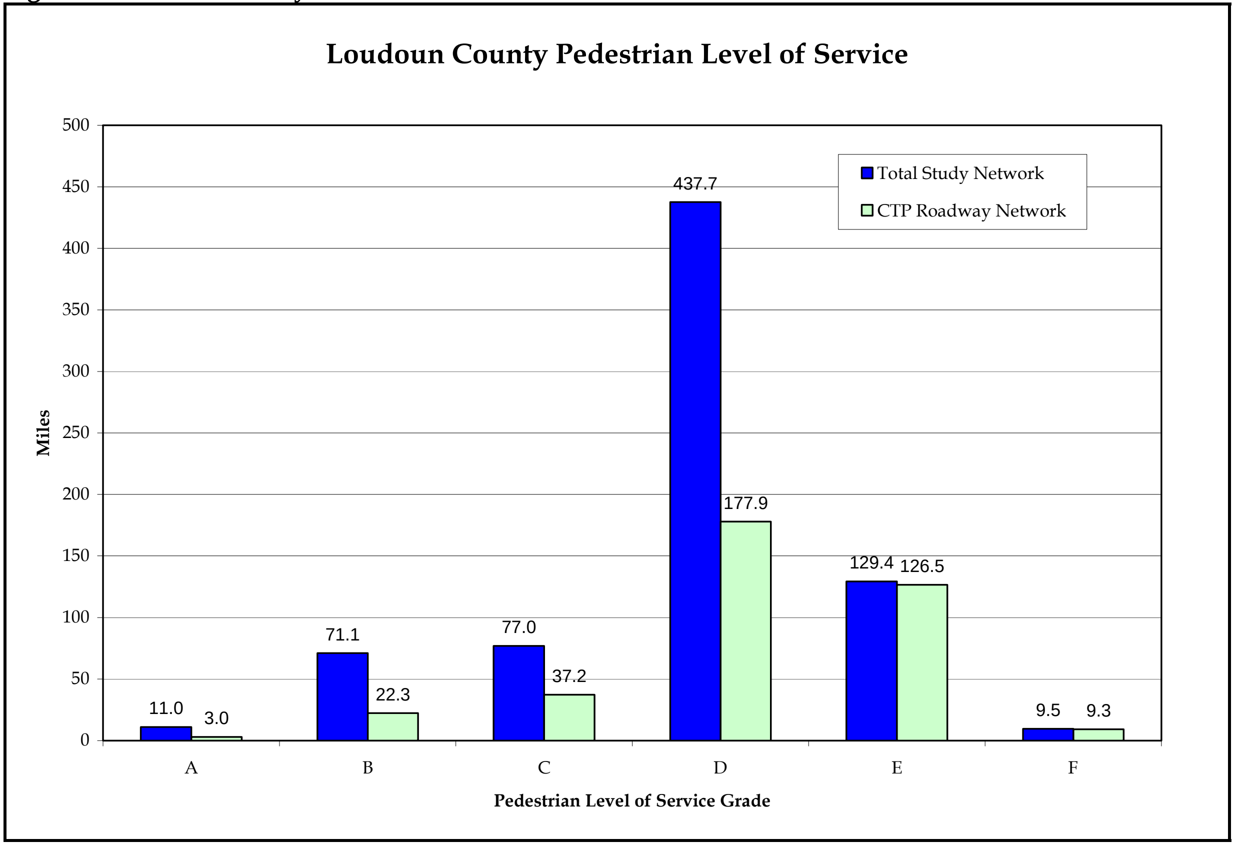
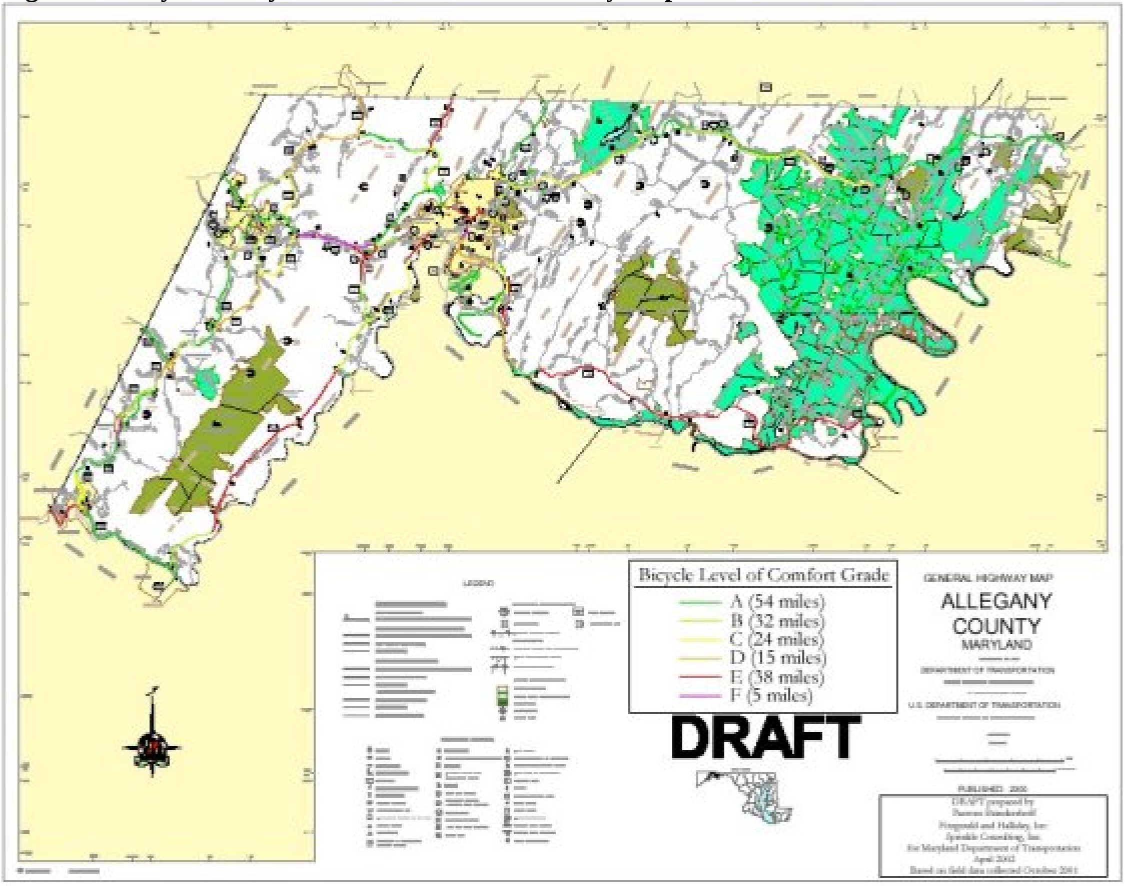


Figure 4. Loudoun County Pedestrian LOS Results



The roadway segments can then be mapped to show Bicycle LOS and Pedestrian LOS grades, producing a visual reference for current walking and bicycling conditions (see Figure 5). Bicycle LOS and Pedestrian LOS maps make it easier for communities to identify high priority areas objectively and make fair decisions when ideas for new projects are suggested by the public, agencies, organizations, or municipalities.

Figure 5. Maryland Bicycle Level of Comfort* County Map



*Bicycle Level of Comfort (Bicycle LOC) is equivalent to Bicycle Level of Service (Bicycle LOS)

Considerations

When presenting model results, it is important to explain that the Bicycle LOS and Pedestrian LOS models are based on user's perception of safety and comfort. While these models reveal characteristics about roadway condition and usage, they cannot be used to predict crashes or assess crash risk. In addition, intersection locations are not included in the inventory. Other strategies are used to evaluate the suitability of intersections for pedestrians and bicyclists. Finally, the Bicycle LOS Model cannot be used to evaluate suitability for riding on sidepaths.

Website

Summaries of the Bicycle LOS and Pedestrian LOS Models are provided by Florida Department of Transportation at http://www.dot.state.fl.us/planning/systems/sm/los/default.htm. An online calculator for both the Bicycle LOS and BCI Models is provided by the League of Illinois Bicyclists at http://www.bikelib.org/roads/blos/

St. Petersburg, Florida

City of St. Petersburg

Data Collected

- Inventoried characteristics of 224 miles of arterial, collector, and other significant local roadways in 2003
- Modeled bicycle and pedestrian suitability using Bicycle LOS and Pedestrian LOS

Highlights

- Prioritized roadways for pedestrian and bicycle features based on Bicycle LOS and Pedestrian LOS output, latent demand for pedestrian and bicycle travel, and public meeting preferences
- Used results of inventory to apply for a series of grants to improve bicycle and pedestrian safety in excess of $8 million

Purpose of Collecting Data

The greater metropolitan Tampa Bay area, which includes the City of St. Petersburg was identified as one of the most dangerous cities in the country for pedestrian crashes by the Surface Transportation Policy Project's *Mean Streets* report in 2001. In addition, the St. Petersburg Vision 2020 transportation planning process identified pedestrian and bicycle safety and comfort as important issues. Vision 2020 recommended a special assessment of pedestrian and bike safety and creation of a Bicycle and Pedestrian Master Plan. The goal of this plan was to *make St. Petersburg into the safest bike and pedestrian municipality in the country*. By collecting data on current conditions using Bicycle LOS and Pedestrian LOS, the City identified key areas for improvement.

Geographic Area Description

The City of St. Petersburg has a population of 248,232, and has experienced significant growth in recent years. The population of the St. Petersburg Metro region is close to 1 million people and there are 3 million people in the entire Tampa Bay area, which includes Tampa, St. Petersburg, Clearwater, and the surrounding suburbs. Because of the interconnections and travel between municipalities, it was important to consider the greater Tampa Bay area when analyzing roadway conditions and level of service.

Application of Bicycle LOS and Pedestrian LOS Model Results

A three-factor formula that was used to prioritize roadway segments for enhancements, consisting of 1) Bicycle and Pedestrian LOS, 2) latent demand for bicycle and pedestrian travel on each roadway segment, and 3) public preferences for roadway segments that should be considered (these preferences were gathered at public meetings).

The City has found that conducting a comprehensive roadway inventory is an intensive process. In an attempt to maintain data on roadway conditions, the City of St. Petersburg has committed to update Bicycle LOS and Pedestrian LOS in five years.

The City has set a target to maintain LOS B for both bicycle and pedestrian usage. This target can be achieved by implementing various enhancements to pedestrian and bicycle facilities at locations with low Bicycle and Pedestrian LOS grades.

Innovations and Accomplishments

The roadway inventory and analysis of Bicycle LOS and Pedestrian LOS has allowed the City of St. Petersburg has been able to gain political support and leverage funding for new bicycle and pedestrian facilities. The City will receive grants of $8,000,000 over five years from the State of Florida and will match these funds with $4,000,000 in contributions from its Capital Improvements Program to implement a comprehensive bicycle and pedestrian program. The City has also received support from the MPO and State as it begins to implement the Bicycle and Pedestrian Master Plan. Sidewalks have been constructed, pedestrian countdown signals and advance stop bars have been added at intersections, 20 overhead crosswalk warning signs are currently being installed on multi-lane roads, and 17 intersections are to be equipped with pedestrian countdown signals. The City also plans to create 93 miles of bike lanes and trails by 2008.

Lessons Learned

The City continues to explore ways to improve upon their efforts. To make the process more efficient, the City plans to use laptop computers in the field for data collection. In addition, the City currently addresses intersection conflicts when it designs bike and pedestrian facilities, but future inventory efforts may address Bicycle LOS and Pedestrian LOS at intersections.

Cost of Data Collection Effort

The City of St. Petersburg paid a consultant $200,000 to assist with the Bicycle and Pedestrian Master Plan. This total cost included data collection, analysis, and dissemination of results through reports, websites, public meetings, and the final plan document. The City was able to save money on data collection because the field inventory was done in-house. In addition, hiring an experienced full-time pedestrian and bicycle coordinator made the process run more efficiently. Actual City spending for implementing the plan has been reduced through outside funding sources. For example, the City applied for and received funding for several projects from the TEA-21 Congestion Mitigation and Air Quality (CMAQ) Improvement Program.

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Website

http://www.stpete.org/bikeped.htm

Loudoun County, Virginia

Loudoun County

Data Collected

- Inventoried 736 miles of the County's primary and secondary roadways, and used the measurements to calculate Bicycle and Pedestrian LOS on these roadways in 2002-2003.

Highlights

- Used Bicycle and Pedestrian LOS grades to set County policies to gain participation of developers in providing appropriate level of accommodation for bicyclists and pedestrians.
- Minimum Bicycle and Pedestrian LOS standards allowed flexibility in facility design, since there are different combinations of roadway characteristics that can be used to provide acceptable levels of bicycle and pedestrian accommodation.

Purpose of Collecting Data

The county inventoried primary and secondary roadways and analyzed Bicycle and Pedestrian LOS as a part of the *Loudoun County Bicycle and Pedestrian Mobility Master Plan.* The Bicycle and Pedestrian LOS calculations were used as a policy tool in the Plan to:

- Ensure that the newest roads built in the County had high-quality bicycling and walking conditions
- Ensure that bicycle and pedestrian conditions were improved when existing roads were upgraded
- Ensure that conditions near and within the walk zones of schools were adequate to encourage safe bicycle and pedestrian access for students and others
- Provide high quality bicycling conditions to the greatest extent possible in rural areas
- Protect and accommodate bicyclists and pedestrians in rural communities, especially in villages

Geographic Area Description

Loudoun County, VA had a population of 170,000 in 2000 and an estimated population of 204,000 in 2002. The County is located approximately 35 miles west of Washington, DC. While much of the County is rural with small villages, the eastern parts of the county are suburbanizing rapidly as the Washington metropolitan area expands westward. The County's population grew by 97 percent between 1990 and 2000, adding roughly 83,000 new residents during the ten-year period.

Application of Bicycle and Pedestrian LOS Model Results

Rapid growth has provided many opportunities for Loudoun County to include bicycle and pedestrian accommodations as new roadways are being built and old roadways are being upgraded. To ensure that County roads are planned and developed as multi-modal facilities, the Loudoun County Bicycle and Pedestrian Plan set guidelines for providing bicycle and pedestrian facilities based on Bicycle and Pedestrian LOS grades.

The Plan first describes the type of bicycle or pedestrian facility that is needed based on the functional classification of the road and the planning zone in which it is located. Figure 6 provides general guidelines for selecting the appropriate design treatment.

Figure 6. Bicycle and Pedestrian Facility Selection Guidelines

Secondary Road	Minor Collector	Major Collector	Major Collector	Minor Arterial	Principal Arterial	Limited Access
Sugarland Run Dr Rt. 722 2 lane	Ashburn Rd Cochran Mill Rd 2 lane or multi-lane	Snickersville Tpke Clarke's Gap 2 lane	Atlantic Blvd Potomac View Rd Sterling Blvd multi-lanes	Ryan Rd Belmont Ridge Rd 2 lane or multi-lane	Rt. 7 Rt. 50 4-6 lanes	Dulles Greenway Rt. 28
On-Road Bicycle Accommodation + Sidewalks [1]			**On-Road Bicycle Accommodation + Off-Road Shared Use Path and Sidewalk [1]**		**Off-Road Shared Use Path**	**Off-Road Shared Use Path, as permitted by state statutes**
See Design Toolkit for Typical Cross Sections						
See cross sections for each roadway type; use target Bicycle LOS and Pedestrian LOS to determine facility design.			**See cross sections for each roadway type; use target Bicycle LOS and Pedestrian LOS to determine facility design.**		**See cross section for road-way type; use target Ped LOS to deter-mine the character-istics of facility separation.**	
[1] Sidewalks shall be provided on both sides in Suburban Policy Areas, Transition Policy Areas, Joint Land Management Areas, and where feasible in Villages in the Rural Policy Area. Sidewalks will not typically be provided along rural road sections with no or few adjacent housing units.						

The next step outlined in the Loudoun County Plan is to determine the quality of accommodation that is desired for the roadway under consideration. The County set target minimum Bicycle and Pedestrian LOS grades that apply in specific situations (see Figure 7). The Plan requires developers who construct new or upgrade existing roadways to meet these standards. To allow necessary flexibility, the Plan provides several exceptions to these target minimum grades. The County determined that it was not practical to establish one threshold that would apply to all roadways because traffic volumes varied widely in different parts of the County.

Figure 7. Loudoun County Bicycle and Pedestrian Level of Service Target Minimums

	Applicability	Target Minimum Bicycle LOS	Target Minimum Pedestrian LOS	Bicycle LOS Exceptions	Pedestrian LOS Exceptions
Condition 1	New roads on new ROW, and in new developments throughout the County.	B	B	C acceptable in certain situations	C acceptable in certain situations
Condition 2	Improvements to Roads & Streets in Developed Areas: -Suburban Policy Area -Transition Policy Area -Joint Land Management Areas	C	B	Major Arterials can be D in certain situations; provision of a shared use sidepath is recommended in these cases	Major Arterials can be C in certain situations
Condition 2a	Roads & Streets within 1.25-mile radius of elementary, middle & high schools within Condition 2 Policy Areas	B	B	Major Arterials can be C	Major Arterials can be C
Condition 3	Improvements to Roads in the Rural Policy Area that have been selected for the Countywide Network	C	N/A	Highest Bicycle LOS that can be achieved or provision of an off-road pathway	N/A
Condition 3a	Designated Bike Route System within the Rural Policy Area	C	N/A	D and traffic calming, or route cannot be designated	N/A
Condition 3b	Rural Villages: Aldie, Bluemont, Lincoln, Lucketts, Paeonian Springs, Philomont, St. Louis, Taylorstown, Waterford	C	C	The highest Bicycle LOS feasible using traffic calming	The highest Pedestrian LOS feasible using traffic calming
Condition 3c (When applicable, this minimum prevails over 3, 3a, or 3b.)	All Roads & Streets within a 0.75-mile radius of all schools within the Rural Policy Area	B or 5 foot paved shoulder	B or 5 foot sidewalk or paved shoulder	Accommodations sufficient to create a “safe walking route” to school, as determined by the LCPS Transportation Dept.	Accommodations sufficient to create a “safe walking route” to school, as determined by the LCPS Transportation Dept.

Innovations and Accomplishments

Loudoun County evaluated the conditions of all its major roadways for bicycle and pedestrian travel. It used the Bicycle and Pedestrian LOS grades to help determine the roadways that were included in the Bicycle and Pedestrian Network in the final Plan. In rural parts of the County where most bicycle trips are made for recreation, bicycle routes were proposed on roadways with the highest Bicycle LOS grades. In more developed parts of the County, the analysis focused on roadways with poor Bicycle and Pedestrian LOS grades. Trails and sidepaths were recommended as alternatives to walking and bicycling on these roadways. Loudoun County also adopted official policies requiring developers to meet target minimum Bicycle and Pedestrian LOS grades. Through the planning process, the County developed exceptions to the minimum Bicycle and Pedestrian LOS standards that provide developers with flexibility in certain situations. While the standards help ensure roadways are constructed with bicycle and pedestrian accommodations, flexibility makes the target minimums realistic for developers to meet in more challenging situations.

Lessons Learned

Loudoun County has had difficulty holding developers responsible for meeting the minimum Bicycle and Pedestrian LOS targets. While the model formula and calculation spreadsheets are available to use, developers, county staff, and the state DOT have not calculated Bicycle and Pedestrian LOS grades as some roadway development and improvement projects have been planned and designed. One reason for this lack of compliance is that the Bicycle and Pedestrian LOS Models are complex and difficult to use without formal training. To address this challenge, the Loudoun County Planning Department will be hosting Bicycle and Pedestrian LOS training sessions for developers and for local, county, and state staff who typically work on roadway projects.

Cost of Data Collection Effort

The 736-mile field data inventory was conducted by consultants at a cost of approximately $20,000. Tasks included entering the data into spreadsheets and a GIS database. Additional time was spent analyzing the Bicycle and Pedestrian LOS results, creating Bicycle and Pedestrian LOS maps, and developing the target minimum Bicycle and Pedestrian LOS grades. The entire Loudoun County Bicycle and Pedestrian Mobility Master Plan process took one year and cost approximately $200,000.

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State of Maryland

Maryland Department of Transportation

Data Collected

- Inventoried all state-owned roadways and analyzed Bicycle and Pedestrian Level of Comfort (Bicycle and Pedestrian LOC—equivalent to Bicycle and Pedestrian LOS) for the entire system (4,750 miles of roads) in 2001

Highlights

- Prioritized roadways for bicycle improvements based on three factors: Bicycle LOC, Priority Funding Areas (areas where urban development exists or is planned), and local plan recommendations
- Created maps showing the Bicycle LOC grades on state-owned roadways for all 23 counties and the City of Baltimore
- Used available data to identify gaps in sidewalk coverage and justify new sidewalk projects
- Updating the Bicycle LOC and sidewalk inventory in 1/3 of the state every year using a video log

Purpose of Collecting Data

The Maryland Department of Transportation (MDOT) inventoried all of its roadways as a part of its *Twenty-Year Bicycle and Pedestrian Access Master Plan*, which was undertaken as a response to State legislation. One of the goals of the Plan was to expand the State's bicycle and pedestrian facilities. The facility inventory helped MDOT identify locations throughout the State that were most in need of bicycle and pedestrian improvements. It also provided a baseline of existing facilities that can be updated to show MDOT's progress improving bicycle and pedestrian transportation over time.

Geographic Area Description

The State of Maryland (population 5,300,000) includes the Baltimore Metropolitan Area and parts of suburban Washington, DC. It also includes medium-sized cities, small towns, and rural areas. The western part of the state is in the Appalachian Mountains and the eastern part surrounds the Chesapeake Bay. Nearly all of the state-owned roadways are urban arterial roadways or rural highways.

Application of Bicycle LOS and Pedestrian LOS Model Results

The Bicycle LOC Model was included in the policies and performance measures of the State Bicycle and Pedestrian Plan. All roadway and bridge projects must be scoped and designed with the goal of achieving a Bicycle LOC grade of "D" or better, at the most reasonable cost. This policy will be monitored in MDOT's Annual Attainment Report. To facilitate compliance with this standard, MDOT has given presentations on and provided spreadsheets of the Bicycle LOC Model to planners and engineers in District offices throughout the State.

Bicycle LOC was also one of the factors used in the Plan to prioritize road segments for bicycle improvements. A two-tier priority list was created. Tier 1 segments met all of the following three criteria:

- The road segment is recommended for improvement by a local government in a local or regional bicycle and/or pedestrian plan
- The road segment is within a Priority Funding Area (areas where development exists or is planned)
- The road segment has a current Bicycle LOC grade of “E” or “F”.

Tier 2 segments met either one of the following two criteria:

- The road segment is recommended for improvement by a local government in a local or regional bicycle and/or pedestrian plan
- The road segment has a current Bicycle LOC grade of “E” or “F”.

MDOT is in the process of updating the bicycle and pedestrian facility inventory with its video log of state-owned roadways. Though MDOT did its first detailed field inventory 2001, the agency has maintained the video log since the 1970s. This video log typically includes video footage of each roadway segment in both directions. MDOT plans to estimate roadway measurements from the video log and update the Bicycle LOC grades and sidewalk inventory for 1/3 of the state each year. MDOT will compare this updated data with the 2001 baseline data.

Innovations and Accomplishments

Covering nearly 5,000 miles, MDOT completed one of the most extensive Bicycle LOS-type inventory in the country. MDOT used the results of this inventory to produce Bicycle LOC maps for all 23 counties and the City of Baltimore. These maps have been a useful resource to planners and engineers in MDOT’s District offices, local governments, and bicycle advocates around the State.

Updating the inventory of bicycle and pedestrian facilities has also been valuable. MDOT has been able to document 40 miles of new bike lanes and 372 miles of new sidewalk since 2001.

Lessons Learned

The statewide field inventory included measurements to determine suitability for both bicyclists and pedestrians. While MDOT found the Bicycle LOC Model to be a useful tool for showing differences in bicycle comfort and for prioritizing roadways for improvement, it decided not to use the Pedestrian Level of Comfort (Pedestrian LOC) Model results. The A to F scale of the Pedestrian LOC model is based on characteristics from all types of roadways, from local residential streets to primary arterial highways. Most state-owned roadways in Maryland are major thoroughfares, and nearly all of these roadways (even those with sidewalks) received Pedestrian LOC grades of “D”, “E”, or “F”. Because the grades were universally low and lacked specific information on the locations of critical sidewalk gaps, MDOT chose not to use the PLOC for prioritization of pedestrian improvements. Instead, MDOT was able to identify sidewalk gaps from an existing GIS data layer that used lines to represent sidewalk locations.

Cost of Data Collection Effort

The 4,750-mile field inventory was completed by consultants in less than four months at a cost of approximately $140,000. This total cost includes entering the data into spreadsheets and a GIS database and creating county Bicycle LOC maps. The entire Plan was completed for approximately $400,000.

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STATEWIDE BICYCLE AND PEDESTRIAN FACILITY INVENTORY

State of Washington

Washington State Department of Transportation

Data Collected

- Inventoried all state-owned non-motorized facilities in 2002-2003, and continue to update the inventory as projects are completed
- Used photo log and performed in-field quality checks on some sections of roadway

Highlights

- Developed inventory format
- Stored data in GIS
- Used data to update non-motorized component of state transportation plan
- Compared locations of non-motorized transportation facilities with pedestrian and bicycle crashes

Purpose of Collecting Data

The Washington State Secretary of Transportation made non-motorized data collection a high priority for the Washington State Department of Transportation (WSDOT), in order to more effectively provide sidewalks, improve pedestrian and bicycle safety near schools, and make other improvements to non-motorized transportation facilities. The Washington State Bicycle and Pedestrian Program collected measurable data to help the Washington State Department of Transportation (WSDOT) make decisions about where and what types of bicycle and pedestrian facility improvements are needed. Better information about existing conditions was also needed for local Safe Routes to Schools projects because approximately half of the public elementary schools in Washington State are on state-owned roadways.

Geographic Area Description

There are over 7,000 miles of state-owned roadways in Washington State (population 5,900,000). This represents approximately nine percent of the state's total roadways. The western part of the state includes the Seattle metropolitan area.

Methodology

History of data collection effort

WSDOT keeps a video log of its entire state roadway system. About half of the state-owned roadways are videoed each year using a specially-equipped van. This van has a video camera that records an image of the roadway from a perspective similar to what a typical driver would see. Both directions of travel are recorded. The video recordings include the date that the roadway segment was observed. During 2002 and 2003, Bicycle and Pedestrian Program staff viewed the State Route Video Log to identify existing pedestrian and bicycle facilities.

Data Collection

The State Route Video Log was used to identify the locations of state-owned non-motorized transportation facilities. Two data collectors spent every day for two months going through the video log and recording characteristics of roadways. They identified the following features:

- Bike lanes
- Shoulders
- Shared-use pathways adjacent to the roadway
- Sidewalks
- Walking paths (not worn dirt paths)
- Signalized and unsignalized intersections
- Roadway medians
- Marked crosswalks
- Transit stops
- ADA facilities

After the facilities were identified from the video log, data collectors drove along a broad sample of the state highways to verify the data with observation. These field checks took an additional three months to complete.

Data storage

The locations of each type of facility are entered into a Microsoft Access database (see Figure 1), which is imported into GIS. The GIS database can be used to display the locations of one or more types of non-motorized facilities in a local area or for the entire state.

Figure 1. Roadway Inventory Database

Microsoft Access - [Crosswalks_12_02 : Table]

File Edit View Insert Format Records Tools Window Help

State Route	SRMP	PedCW	Sidewalk	Far	Near	Increasing	Decreasing	Description_Ped	Other	B	ARM	Region	Direction	Ov
2	0.03	No	Yes								0.03	1	RIGHT	CT
2	0.77	No	No								0	1	RIGHT	CO
2	0.77	No	No								0.77	1	LEFT	CO
2	1.53	No	No								0.76	1	RIGHT	CT
2	1.64	No	No								0.87	1	BOTH SIDI	ST
2	3.85	No	No								3.85	1	RIGHT	CO
2	10.08	No	No								10.03	1	LEFT	CO
2	10.55	No	No								10.5	1	LEFT	CO
2	12.95	Yes	Yes	1	1	1	1	Striped and Signalized			12.9	1	LEFT	CT
2	12.95	Yes	Yes					Striped and Signalized			12.9	1	RIGHT	CT
2	13.87	Yes	No								13.82	1	BOTH SIDI	CT
2	14.13	No	No								14.08	1	LEFT	CT
2	14.37	Yes	No	1		1	1	Striped and Signed			14.52	1	BOTH SIDI	CT
2	14.6	Yes	Yes	1	1	1	1	Striped and Signed	14.61 Tra		14.52	1	BOTH SIDI	CT
2	14.92	Yes	Yes	1	1	1	1	Striped and Signed			14.87	1	RIGHT	ST
2	14.92	Yes	Yes	1	1	1	1	Striped and Signed			14.87	1	LEFT	CT
2	15.15	No	Yes								15.1	1	LEFT	CT
2	15.15	No	Yes						15.12 Tra		15.1	1	RIGHT	CT
2	15.22	Yes	Yes	1	1	1	1	Striped and Signed			15.17	1	RIGHT	CT
2	15.22	Yes	Yes	1	1	1	1	Striped and Signed			15.17	1	LEFT	CT
2	16.98	No	No								16.93	1	RIGHT	CO
2	16.98	No	No								16.93	1	LEFT	CO
2	17.9	No	No								17.85	1	RIGHT	CO
2	18.09	No	No								18.04	1	LEFT	CO
2	18.67	No	No								18.62	1	LEFT	CO
2	20.12	No	No								20.07	1	BOTH SIDI	CO
2	21.57	No	No						Under Co		21.52	1	RIGHT	CT
2	21.57	No	No						Under Co		21.52	1	LEFT	CT
2	21.92	No	No						Bridge 22		21.87	1	LEFT	CT
2	22.25	No	No								22.2	1	LEFT	CT
2	22.3	No	No								22.25	1	LEFT	CT
2	22.37	No	No								22.32	1	RIGHT	CT
2	22.37	No	No								22.32	1	LEFT	CT
2	22.43	No	No								22.38	1	BOTH SIDI	CT

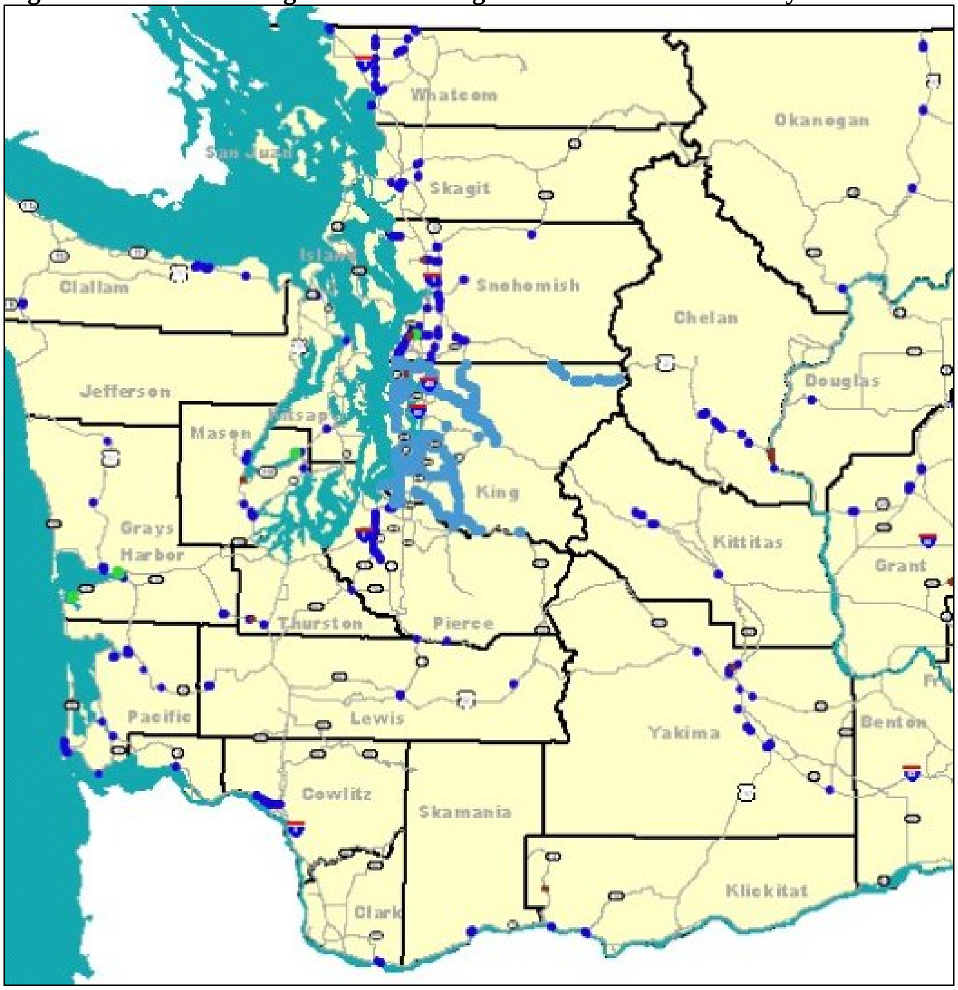
Record: 2 of 12256

Datasheet View

Data analysis

The Bicycle and Pedestrian Program produced a basic report to summarize the results of the facility inventory. This report summarized the miles of sidewalk within the state's urban growth boundaries, the average intersection spacing within central business districts, and other pertinent information (see Figure 2).

Figure 2. Marked and Signalized Crossings on State-Owned Roadways in Western Washington State



The pedestrian and bicycle facility data have helped WSDOT update its Non-Motorized Transportation Plan, which is a part of Washington's Transportation Plan (the statewide comprehensive transportation plan). WSDOT used the non-motorized facility inventory as a prioritization tool for the Non-Motorized Plan. The facility data helped planners identify projects that would have the greatest positive effects on bicycling and walking in Washington. Pedestrian and bicycle facility data were also compared to other state-owned roadway characteristics that had been documented in WSDOT's highway log.

Data maintenance and management

Non-motorized transportation facilities continue to be constructed throughout Washington State. The Bicycle and Pedestrian Program records the locations of new facilities using the standard forms that are submitted with every WSDOT project. As a result, the facility inventory has been updated periodically to include all new projects.

Data dissemination

Results of the facility inventory have been presented to the WSDOT Bicycle and Pedestrian Advisory Committee and a highway safety group within WSDOT. The highway safety group is interested in using the data to identify roadway characteristics that are related to pedestrian and bicycle crashes. They would like to use the data to predict high-risk areas for bicycle and pedestrian crashes so that injuries and fatalities can be reduced.

Innovations and Accomplishments

The non-motorized facility inventory has been useful for prioritizing improvements and analyzing safety. It has also been valuable to the Bicycle and Pedestrian Program because it has provided all WSDOT staff with concrete data on pedestrian and bicycle facilities. This has increased the awareness of state-owned non-motorized facilities throughout the agency.

Lessons Learned

WSDOT Bicycle and Pedestrian program staff anticipate updating the inventory every three to four years. Although the database is updated with new projects on a regular basis, a comprehensive inventory will pick up any projects that have been missed and identify facilities that have been lost during road widening or for other reasons.

Updating the inventory will also give WSDOT an opportunity to incorporate adjustments that will make the data more useful. For example, the data collectors could collect more information about maintenance issues, such as pavement repairs, debris removal, or other types of maintenance upgrades.

WSDOT staff have indicated the need to identify maintenance needs in a consistent way, and to ensure that people are aware of the limitations of using video to identify maintenance needs.

Cost of Data Collection Effort

Recording the characteristics of about 7,000 roadway miles from the video log took two staff members approximately two months (700 total hours of labor). Verifying the data in the field took the two-person team approximately three months (1000 total hours of labor). Analysis of the data required additional staff time.

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DETAILED STREETSCAPE INVENTORY

New York City, New York

New York City Department of City Planning, Transportation Division

Data Collected

- Collected and mapped detailed sidewalk and streetscape features on approximately 500 blocks in New York City since mid-1990s

Highlights

- Developed a consistent and easy-to-use inventory format
- Gathered exceptionally detailed sidewalk characteristics, including locations of signs, street furniture, light fixtures, crosswalks, stop bars, bus stops, etc.
- Produced detailed maps of sidewalk characteristics in AutoCAD
- Use of sidewalk characteristic data for city initiatives

Purpose of Collecting Data

New York City's exceptionally high pedestrian volumes require a higher level of attention to details of the streetscape environment. The Department of City Planning collects facility data on a project-by-project basis in order to conduct Pedestrian Level of Service analyses, analyze the causes of pedestrian congestion, and establish shared-use sidewalks for pedestrians and wheeled users. Increasing concerns about pedestrian issues among elected officials has given support to collecting data on streetscape characteristics. For example, the City has undertaken a "Clear Corners" initiative, which was intended to alleviate congestion and improve safety at street corners.

Geographic Area Description

New York City is the largest city in the United States (population 8,000,000). It also has the highest density of population and jobs in the country. Over 10 percent of workers walk to work. Another 53 percent of workers take public transportation, which involves walking for some part of the trip. Streetscape inventories have been done in several sections of the City with particularly high pedestrian volumes such as Manhattan and the central business districts of the outer boroughs.

Methodology

History of data collection effort

Because some New York City sidewalks are overcrowded with pedestrians, the City has focused on improving pedestrian flow in these areas. The Department of City Planning has analyzed the capacity of sidewalks using the Highway Capacity Manual's Pedestrian Level of Service method (based on the density of pedestrians) for several decades. In the mid-1990s, the City began to analyze more detailed characteristics of the pedestrian environment, including objects that can be barriers to pedestrian flow. City staff have refined their inventory methods over the last ten years so that the most useful features of the streetscape environment are collected.

Data Collection

The New York City Department of City Planning Transportation Division inventories sidewalk and street conditions using field data collectors. These data collectors measure the width of the sidewalk, width of street lanes, and total width of the street. Crosswalk marking types and stop lines are also noted. A wide variety of other sidewalk features are identified in a streetscape inventory (see Figure 1). These features include:

- Signs (regulatory, directional, and informational)
- Mass transit access facilities (subway entrance/exit stairwells, bus stops and shelters)
- Commercial activity (newsstands, news boxes, street vendors, loading/unloading areas)
- Building entrances
- Traffic signals
- Curb cuts and grates
- Other fixed objects (street lights, street furniture, street trees, trash cans, parking meters, fire hydrants, bollards, planters, fences, bicycle racks, etc.)

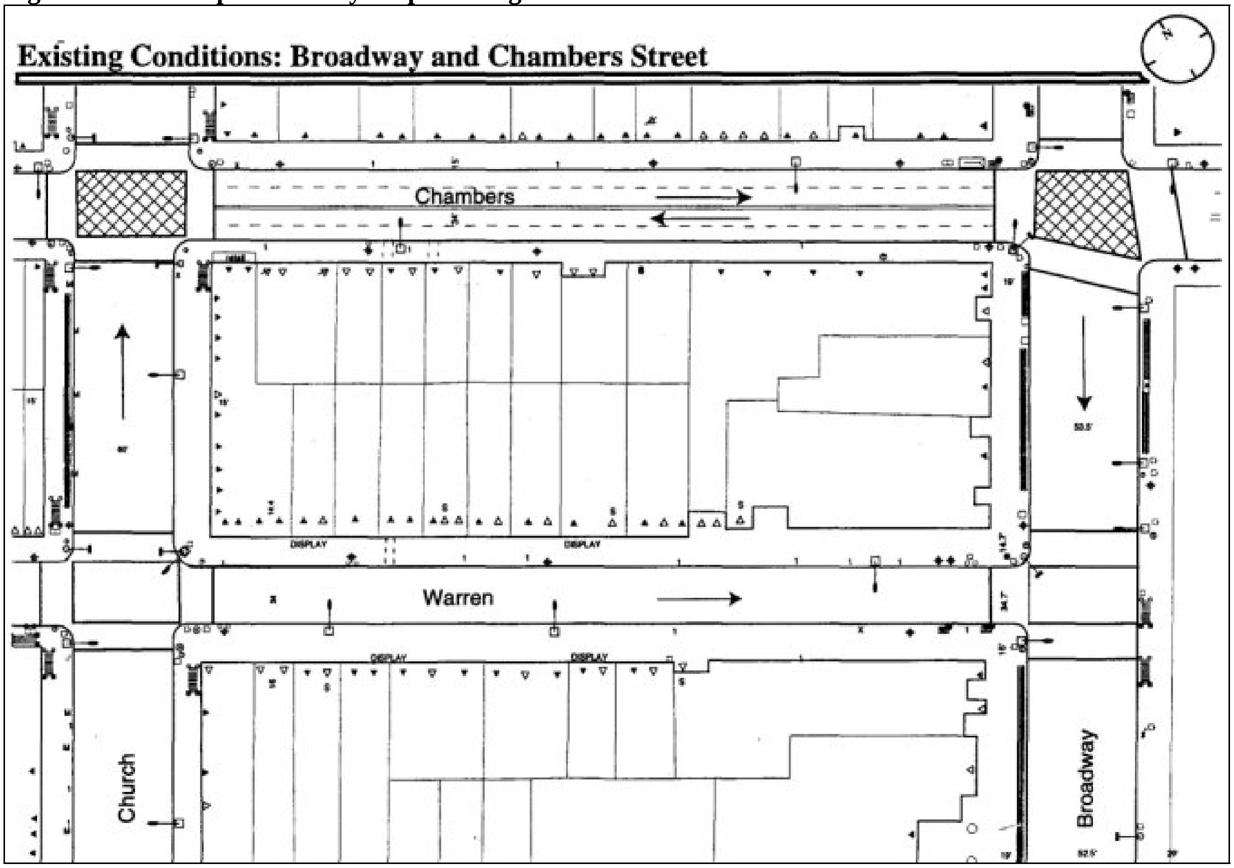
The data collectors use orthogonal photographs and base maps to identify features and record their observations in the field. When the data collectors observe a sidewalk obstruction, they estimate its location on the sidewalk and mark it on their field map. While the data collectors try to be as accurate as possible, the data are collected for planning purposes and are not used for engineering drawings.

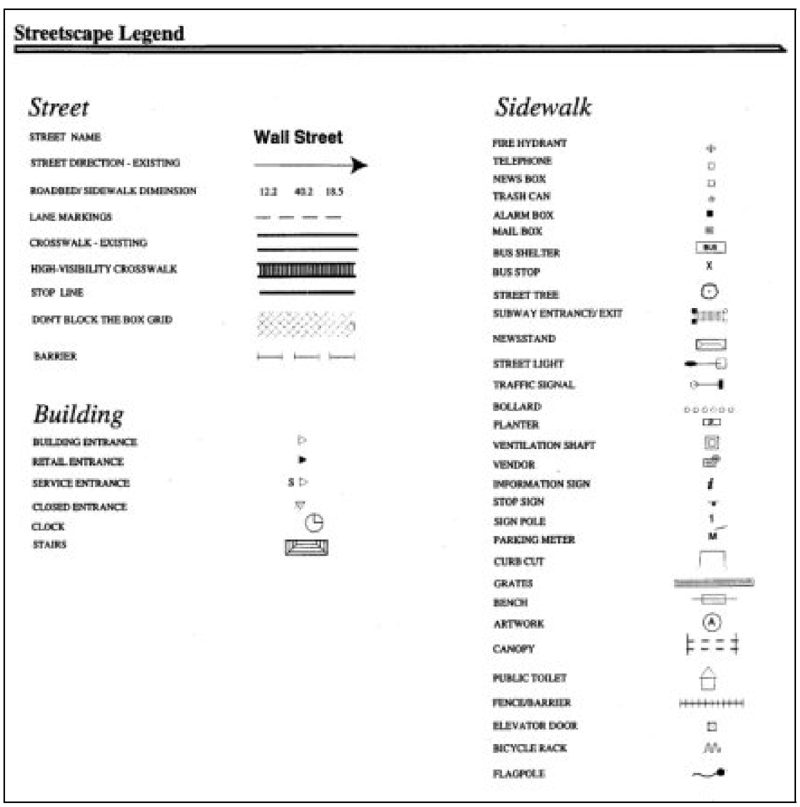
Typically, two data collectors collect the field data. It can take them approximately 15 to 30 minutes to inventory all the features on a typical block face. However, it can take up to one hour to make note of all streetscape features the block face, depending on the level of detail and accuracy required. Additional field checks are done in some locations as a project nears the final recommendations phase. Some projects may require an entire team (15 to 20 planners) to do the inventory and count pedestrians, depending on the priority of the project and time available to collect field data.

Data storage

All streetscape features from the inventory are entered and displayed in AutoCad. Signage is stored in a GIS database. The GIS database allows users to click on the location of a street sign and view a photo of it (the photos are taken by the data collectors in the field).

Figure 1. Streetscape Inventory Map and Legend





Source: *Lower Manhattan Pedestrianization Study*. City of New York, Department of City Planning, Department of Transportation, 1997

Data analysis

The facility data are essential to a comprehensive evaluation of the pedestrian environment of each street. Information on pedestrian crashes, parking, motor vehicle movements, mass transit boardings, and bus movements are also considered in developing recommendations to improve a street and sidewalk. The Transportation Division also projects future pedestrian volumes based on future land use characteristics. It uses the volume and facility data to analyze current and future Pedestrian Level of Service for a variety of alternatives. This information is considered when making recommendations for curb extensions, clear zones, or other types of pedestrian improvements.

Data maintenance and management

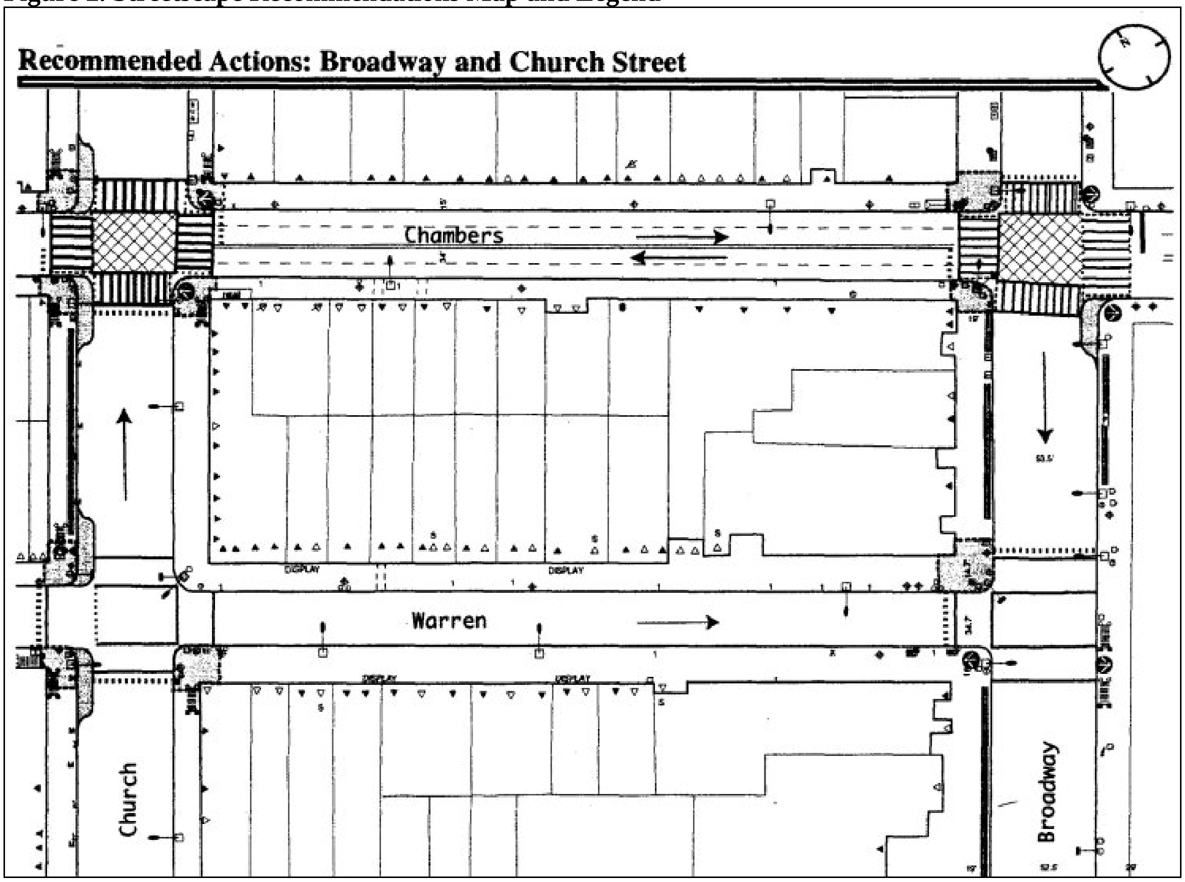
The Transportation Division maintains the data in computerized form and plans to continue conducting streetscape inventories on a project-specific basis in the future. While the AutoCAD maps and sign information are available electronically to other City departments, they are mainly used by the Transportation Division.

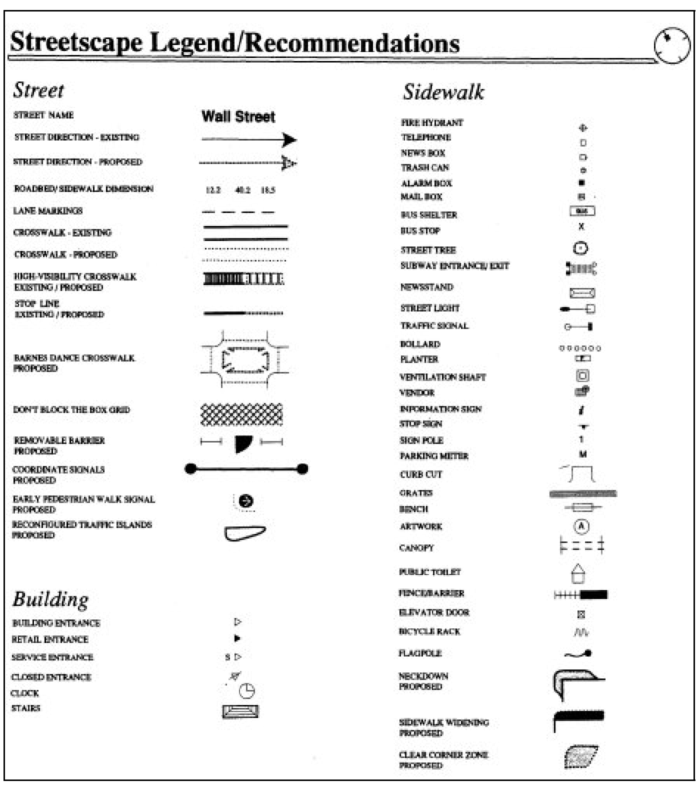
Data dissemination

Data from streetscape inventories have been used in public presentations, are posted online, are shared with consultants working on street projects, and are given to the Metropolitan Planning Organization. Streetscape information was featured in the *Lower Manhattan Pedestrianization Study* in 1997 (see Figure 2). This study analyzed pedestrian facilities and obstacles to develop recommendations for pedestrian improvements such as:

- Widened sidewalks
- Curb extensions (neckdowns)
- High-visibility crosswalks at high crash intersections
- Early pedestrian walk signals (leading pedestrian interval)
- Clear corner zones at congested and/or obstructed intersections
- Stop lines at controlled intersections
- One-way streets
- Physical barriers to channelize pedestrians to marked crosswalks
- Enforcement of “Don’t Block the Box” regulations

Figure 2. Streetscape Recommendations Map and Legend





Source: *Lower Manhattan Pedestrianization Study*. City of New York, Department of City Planning, Department of Transportation, 1997

Innovations and Accomplishments

Streetscape inventories have been very helpful for providing quantitative data for use in regulating sidewalk vendors and the expansion of sidewalk cafes. Many of the Business Improvement Districts are interested in the appearance and efficiency of the sidewalk area and they use the City's data to supplement their own streetscape inventories and pedestrian counts.

Lessons Learned

While the streetscape inventory has been an important part of the Lower Manhattan study and other projects that have been implemented, the inventory is not what drives improvements to the pedestrian environment. Most often, changes have been the result of pressure from Business Improvement Districts and civic groups that support pro-pedestrian Mayoral and City Council initiatives. Still, the data have been key to successful implementation of the projects.

Some of the pedestrian improvements that have been identified through the streetscape inventory would result in delays for motor vehicles. Because the City's environmental regulations prevent motor vehicle level of service from being degraded, options for improvements are often limited.

The Transportation Division analyzes crashes, pedestrian volumes, and turning movements, but it lacks adequate resources to analyze all data in detail, such as analyzing trends over time. Limited resources also prevent the Transportation Division from using surveys, video taping, and other data collection methods that could provide more information about pedestrian movements.

Cost of Data Collection Effort

The cost of a streetscape inventory varies by project. Typically, data collectors spend one to two hours completing the streetscape inventory for one block. This staff time costs the City approximately $50 to $100. Staff time is also needed to produce background maps, do follow-up field visits, and analyze the data. The City does not track the cost of streetscape inventory projects independently from other staff activities, so the total cost is unknown.

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COMMUNITY PEDESTRIAN FACILITY INVENTORY

Sandpoint, Idaho

City Government of Sandpoint, Idaho

Data Collected

- Inventoried sidewalks, curbs, curb ramps and their condition
- Supplemented inventory with public comments (citizens recorded where they walked, where they saw other people walking, locations without sidewalks, and locations where they would like to be able to walk)

Highlights

- Example of a data collection method appropriate for a smaller community
- Example of an active community contributing to evaluate and improve the town's pedestrian system
- Utilized volunteer labor to overcome budget limitations
- Noted sidewalk width and condition
- Mapped locations of sidewalks in AutoCAD
- Developed a prioritized list of improvements for a Safe Routes to Schools plan

Purpose of Collecting Data

Pedestrian conditions became a significant issue in the City of Sandpoint in the late 1990s. A Pedestrian Advisory Committee (PAC) of local residents was formed in 2002, and the members helped evaluate existing pedestrian facilities and prioritize locations needing new sidewalks, curb ramps, or sidewalk upgrades. The data gathered through this effort have been used to identify locations for new sidewalks and improve pedestrian comfort and safety.

Geographic Area Description

Sandpoint (population 6,000) is located in the northern panhandle of Idaho at the base of the Selkirk Mountains, 60 miles south of the British Columbia border and 75 miles east of Spokane, Washington. The City has a grid network of streets. There are many local neighborhood streets and several main arterial streets that serve as state and national highways. In general, the City's arterial streets carry high volumes of automobile traffic.

Methodology

History of data collection effort

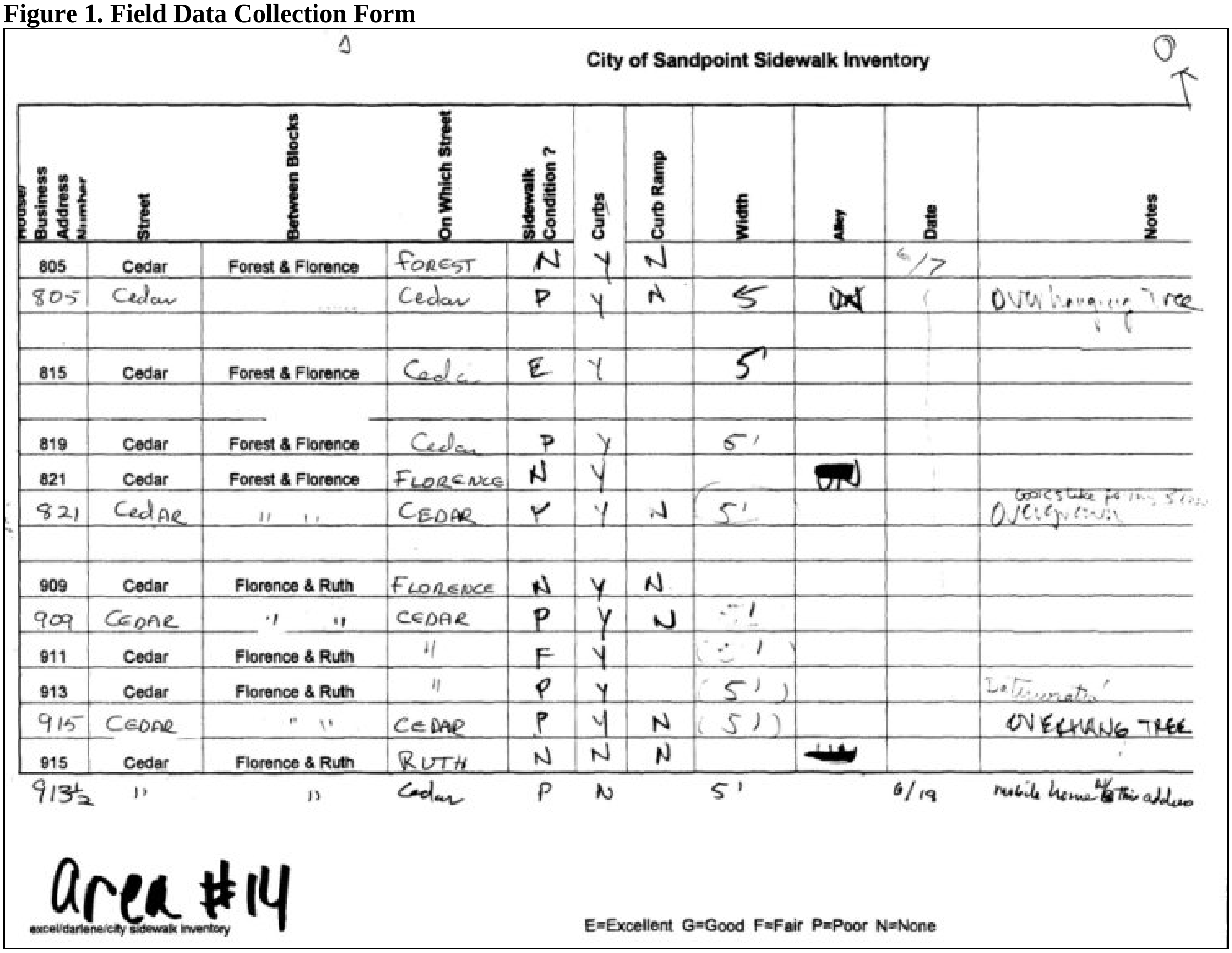
The survey was part of a pedestrian facility inventory conducted by the Sandpoint City Council in response to citizen activists concerned about the lack of pedestrian amenities and lack of attention to pedestrian safety and comfort in Sandpoint. The City Council had declared Sandpoint a "Walking Town", and had posted a sign at the main entrance to town to make this designation clear to residents and visitors. But according to the citizens, existing pedestrian conditions in Sandpoint did not qualify the City to be a "Walking Town", and they wanted to improve conditions to meet this pedestrian-friendly designation.

The citizen group was formalized as the City's Pedestrian Advisory Committee (PAC). They volunteered their time to complete a sidewalk inventory over a one-month period in 2002. This effort was followed by additional input and analysis. A prioritized list of locations for pedestrian facility improvements was adopted by the City Council in 2004.

Data Collection

At the beginning of the sidewalk inventory project, the PAC and 40 other volunteers attended a training session on the proper measurement of sidewalk characteristics. These volunteers were provided with data collection sheets listing the physical characteristics to be recorded including sidewalk condition, sidewalk width, and the presence of curbs and curb ramps (see Figure 1). This training session helped to keep measurements and qualitative assessments consistent among the many data collectors.

Figure 1. Field Data Collection Form



City of Sandpoint Sidewalk Inventory

House/ Business Address Number	Street	Between Blocks	On Which Street	Sidewalk Condition ?	Curbs	Curb Ramp	Width	Alley	Date	Notes
805	Cedar	Forest & Florence	FOREST	N	Y	N			6/7	
805	Cedar		Cedar	P	Y	N	5			Overhanging Tree
815	Cedar	Forest & Florence	Cedar	E	Y		5'			
819	Cedar	Forest & Florence	Cedar	P	Y		5'			
821	Cedar	Forest & Florence	FLORENCE	N	Y					
821	CedAR	" "	CEDAR	Y	Y	N	5'			[illegible] OVERGROWN
909	Cedar	Florence & Ruth	FLORENCE	N	Y	N				
909	CEDAR	" "	CEDAR	P	Y	N	[illegible]			
911	Cedar	Florence & Ruth	"	F	Y		[illegible]			
913	Cedar	Florence & Ruth	"	P	Y		(5')			Deteriorated
915	CEDAR	" "	CEDAR	P	Y	N	(5')			OVERHANG TREE
915	Cedar	Florence & Ruth	RUTH	N	N	N				
913½	"	"	Cedar	P	N		5'		6/19	mobile home @ this address

Area #14

excel/darlene/city sidewalk inventory

E=Excellent G=Good F=Fair P=Poor N=None

The volunteers walked every street in town and recorded the presence of sidewalks, curbs, and curb ramps and the width and condition of the sidewalks. Conditions were rated in three categories: good, fair, or poor. A poor sidewalk condition was defined as having a lip (or crack in the sidewalk) with a vertical displacement of over one-half inch.

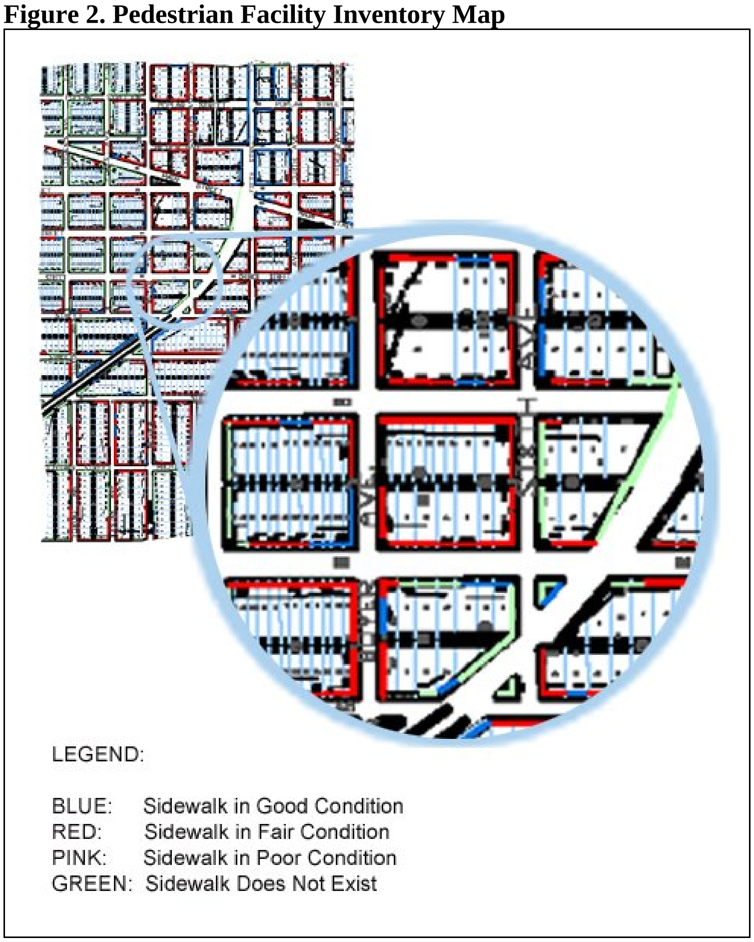
Following the completion of the pedestrian facility inventory, a series of meetings were held with school classes, mail carriers, and the city's "Monday Walkers" group. Each of these groups reviewed maps of Sandpoint, marking the streets where they walk or frequently see other people walking. Then using another color, they marked where they would like to walk but are unable because of a lack of sidewalks or other deficiencies.

The volunteers' intimate knowledge of pedestrian conditions was valuable to the process. The process allowed volunteers and local residents to identify several problem areas previously unknown to city staff.

Data Storage

The inventory data are stored in an Excel spreadsheet. Most of the data are attached to an AutoCAD map (and will soon be incorporated into the City's GIS system). The map is the most frequently used component of the data compilation. The City Council can view the map and quickly see which areas of town are most lacking in pedestrian amenities (see Figure 2). Paper maps with public comments were kept on file at the City.

Figure 2. Pedestrian Facility Inventory Map



Data Analysis

After the pedestrian facility inventory and public comments were displayed on maps, the streets were prioritized for future projects. The Pedestrian Advisory Committee reviewed the observations and comments for each street segment and entered all the data into a list. This list showed:

- street name
- sidewalk presence
- sidewalk condition (good, fair, poor)
- existing or potential pedestrian demand (based on comments on maps)

The PAC then voted on which street segments should be high, medium, or low priority for improvements. Streets with high potential pedestrian demand and poor pedestrian conditions were given the highest priority for improvements. After the PAC divided the streets into these categories, they ranked each street within each category.

The highest-ranked roadway needing pedestrian improvements is a state highway that runs east-west through Sandpoint. Because this roadway has been identified as the top priority in Sandpoint, the City will provide the State with significant input on the design of pedestrian facilities when it is reconstructed.

In order to use results of the pedestrian inventory for a Safe Routes to Schools program, a second phase of analysis was undertaken. During this phase, the PAC reprioritized the original list of pedestrian recommendations to give higher priority to streets near schools.

Innovations and Accomplishments

Broad citizen involvement in the inventory process helped generate a high level of public buy-in and civic pride. The local volunteers saved the City considerable staff time and money on the project, and were able to identify several pedestrian improvement opportunities that had not been previously recognized by the City.

One of the most valuable products of the effort was the priority list that was adopted by the City Council. This document prioritized streets that should be improved for pedestrian use and makes it possible for the City to require developers and the state DOT to provide pedestrian amenities. The list has also put Sandpoint in a good position to receive Safe Routes to School Funding when it becomes available.

The inventory helped created momentum for other pedestrian-oriented policies. The Sandpoint City Council has passed a frontage improvement ordinance that requires sidewalks to be provided as part of all new roadway construction and to be provided on commercial properties that receive a building permit for improvements in excess of $15,000.

Lessons Learned

The pedestrian facility inventory would not have happened without the effort of dedicated citizens. The Mayor and City Council were also very supportive of improving pedestrian conditions.

The data will be easier to access when the City enters it into a GIS database. This will make it possible to view the inventory and prioritization information for each street segment by clicking on a map, or to display all the street segments with similar characteristics on a map (such as all streets without sidewalks).

The volunteer effort was extremely valuable to the City. However, the process was time intensive and could have been more efficient if the City had been able to pay an official coordinator. In addition, the City could have gathered even more detailed information if an engineer or surveyor had worked on the project. This person could have measured street widths and road right-of-way, utility lines, fences, other existing features that could have a significant impact on the feasibility of sidewalk construction.

Cost of Data Collection

The cost of data collection was negligible since the PAC and other interested citizens volunteered their time to do the field work. The project was administered by a city engineer, and the field data was compiled in a Microsoft Excel spreadsheet by an administrative assistant.

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SIDEWALK INVENTORY USING DIGITAL AERIAL PHOTOGRAPHY

Columbia, Missouri

Columbia Area Transportation Study Organization (MPO)

Data Collected

- Identified presence and location of sidewalks on nearly 40,000 property parcels in the Columbia metro area

Highlights

- Used digital aerial photography to identify properties with and without sidewalks
- Utilized an automated method to enter a sidewalk presence attribute into GIS database
- Found that using GIS with digital aerial photo saved data entry time over field collection
- Eliminated the need for personnel to complete field collection of data

Purpose of Collecting Data

The Columbia Area Transportation Study Organization (Columbia MPO) provides transportation data to jurisdictions in the Columbia region. The organization updated its sidewalk inventory using digital aerial photography to show sidewalk presence. CATSO had previous experience using digital satellite imagery to improve the positional accuracy of the TIGER street centerline geography in the early 1990s.

The digital imagery was used along with tax parcel geography provided by the Boone County Assessor's Office. A method was devised to code the individual parcels to replace the previous street segment-based method. This provided improved accuracy and replaced collecting data in the field. The Columbia MPO plans to incorporate this current sidewalk information into a new sidewalk plan.

Geographic Area Description

The sidewalk inventory covered the entire Columbia, MO metro area (population 135,000). The metro area is located in Boone County, which covers 685 square miles in the center of the state. Columbia is home to the University of Missouri.

Methodology

History of data collection effort

The City of Columbia passed an ordinance in 1973 requiring sidewalks on all streets in new subdivisions. Over the next three decades, sidewalk coverage for the entire region was collected in the field and displayed on paper maps. Roadway segments with arbitrary starting and ending points were used as the units of analysis for the field data collection effort. Because the segment endpoints did not always correspond with the start or end of a sidewalk, it was difficult to determine the exact locations of sidewalks. This problem was solved in 2003 when the Columbia MPO purchased a digital aerial photograph of the metro region and used it for a parcel-based sidewalk inventory. Sidewalk presence was noted for all parcels in the metro region between October 2003 and February 2004.

Data Collection

Data were entered and stored using Maptitude GIS software. Digital orthophotos (.tif and .sid image formats) at 1"=100' and 1"=200' scale were used for the entire Columbia metro area. The 6" pixel resolution at the 1"=100' scale and one foot pixel resolution at the1"=200' was sufficient to readily detect the presence of sidewalks (see Figure 1). Tax parcel boundaries were displayed on top of the aerial photography, making it possible to select parcels where sidewalks were visible. Sidewalk presence was noted on all 39,862 land parcels in the region.

Figure 1. Digital orthophoto showing sidewalk presence

The digital aerial photograph was unable to show the sidewalk presence in areas with narrow streets, heavy tree cover, minimal building setbacks, and in areas with no buffer space between the street and sidewalk. The roughly 500 parcels featuring these characteristics were checked in the field and added to the database.

Data storage

The spatially-referenced database includes an identification number and attribute showing sidewalk presence for each parcel. Parcels with double street frontage were identified. Other items that can be used to prioritize a property for sidewalk improvements, such as the presence of a bus route and the traffic volume and speed of the adjacent roadway could be added to this parcel database.

Data maintenance and management

Because the sidewalk inventory was done comprehensively for all property parcels in the region, the Columbia MPO will not need to redo a region-wide inventory in the future. The database can be updated incrementally as new projects are completed to benchmark progress on implementing sidewalk plans.

Data analysis

In all, there were 17,174 parcels with sidewalks and 22,688 parcels without sidewalks in the Columbia metro region. The individual parcel data were used to analyze where sidewalks existed in specific street corridors and to suggest where new sidewalks could be constructed. The information has been particularly valuable for showing state transportation officials where sidewalks are needed on state-owned roadways when they are being reconstructed.

Data dissemination

The Columbia MPO is in the process of determining how to distribute its sidewalk data in a variety of ways. However, it is preparing to use the data in an upcoming sidewalk plan. The organization will also be using the data to prioritize locations for new sidewalk construction and to show sidewalk presence on neighborhood-level maps.

Innovations and Accomplishments

The parcel-based sidewalk inventory has received positive feedback within the MPO and from the local pedestrian advocacy group PedNet. Agency staff members were in need of accurate sidewalk data to use for neighborhood and roadway corridor projects. They also use the data for checking sidewalk compliance during rezoning issues. The PedNet group has been able to use sidewalk coverage data to advocate for the addition of new sidewalks on several street projects.

Lessons Learned

The sidewalk inventory was completed in six months, which is two to three times faster than evaluating each parcel in the field. Despite the speed of the process, it was a significant time investment for staff; the agency is considering using interns to complete the work in the future. Also, parcels were selected one-by-one for the first part of the project because the areas being inventoried contained a varied mix of sidewalks/no sidewalks.

In addition, using an aerial photograph for the inventory limits the types of data that can be collected. Sidewalk condition could not be identified using the aerial photographs. It would be useful to have information about cross-slope, sidewalk surface quality, and other micro-characteristics but this is not possible to include without field verification.

Cost of Data Collection Effort

The work, which consisted of identifying sidewalk presence for all parcels and entering the data into the GIS database took approximately 500 hours of staff time. The digital aerial photography cost $110,000, and was purchased by the Boone County Assessor’s office as part of their regular update cycle. The cost of the photography was shared by three different governmental entities within the MPO region - Boone County, the City of Columbia, and Boone Electric Cooperative.

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PEDESTRIAN CRASH MAPPING AND ANALYSIS

Miami-Dade County, Florida
Miami-Dade Metropolitan Planning Organization

Data Collected

- Mapped all pedestrian crashes in Miami-Dade County each year since 1996

Highlights

- Developed address matching methodology to convert police report location references to GIS points (the methodology was developed at the University of Florida and applied in Miami-Dade County)
- Analyzed clusters of crashes
- Created maps of different types of crashes
- Identified appropriate crash countermeasures
- Documented a reduction in crashes after pedestrian improvements at Miami International Airport

Purpose of Collecting Data

Pedestrian crash locations were mapped by the Miami-Dade Metropolitan Planning Organization (MPO) to identify the underlying nature of crash problems in the Miami area and to raise awareness of pedestrian safety issues. The crash data were analyzed by location, type, time, and pedestrian and driver characteristics to develop recommended countermeasures to make pedestrians safer.

Geographic Area Description

The highest population concentration in Miami-Dade County, Florida (population 2,250,000) is the City of Miami (population 375,000). Miami is an ocean-side tourist destination with large elderly, low-income and foreign-born populations.

Methodology

History of data collection effort

Efforts to analyze pedestrian crashes in the Miami-Dade region began in the mid-1990s. The MPO first attempted to collect data directly from the various local police departments in the region, but it was extremely difficult to coordinate the data because there was no uniform, consistent data source. A breakthrough occurred when the University of Florida developed an address matching tool in ArcView GIS to geo-reference police crash report locations. The University then obtained a database of address and intersection locations for all police reported crashes in the State from the Florida Department of Highway Safety and Motor Vehicles. Finally, the University used its address matching tool on this database to produce a GIS shape file of all the bicycle and pedestrian crashes in Miami-Dade County.

Data Collection

Traffic crash data are collected by local police departments (and the Florida Highway Patrol) and forwarded to the Florida Department of Highway Safety and Motor Vehicles (DHSMV) in Tallahassee. The DHSMV enters the information from the police report into a database. The database includes all of the information from the traffic crash report except the location of the crash. The Miami-Dade MPO obtains a digital copy of the crash database records that have been coded as involving a bicycle or pedestrian. Crash report numbers from these records are compiled into a list that is used to request paper copies of the reports. The University of Florida's address matching program is then used to match the crash database to specific latitude/longitude locations in GIS. This process can work in three ways: 1) by matching the actual address listed for the crash with a geographic point, 2) identifying the geographic location of an intersection of two roadways where the crash occurred, or 3) identifying a geographic point that is a specific distance and direction from an intersection. After the crash locations are geocoded the database is edited to include the key variables pertaining to pedestrian crashes so that it the data are easier for the MPO to analyze.

Data storage

The final crash database and the paper copies of the police reports are stored at the Miami-Dade MPO. Copies of the database are made available to other government agencies and transportation planners and engineers for their use.

Data analysis

Use of the crash database allows easy development of basic summary statistics and cross tabulations of specific characteristics, such as time of crash and pedestrian age at the county-wide, sub-area or corridor level.

The GIS crash layer is used to identify concentrations of pedestrian crashes. The ESRI ArcView GIS Spatial Analyst function is used to display areas with high densities of pedestrian crashes in bright colors (see Figure 1). These pedestrian crash "hot spot" maps are created for all crashes throughout the county, all crashes in specific neighborhoods (see Figure 2), and for crashes with specific characteristics.

Figure 1. Miami-Dade County Pedestrian Crash Density, 2001

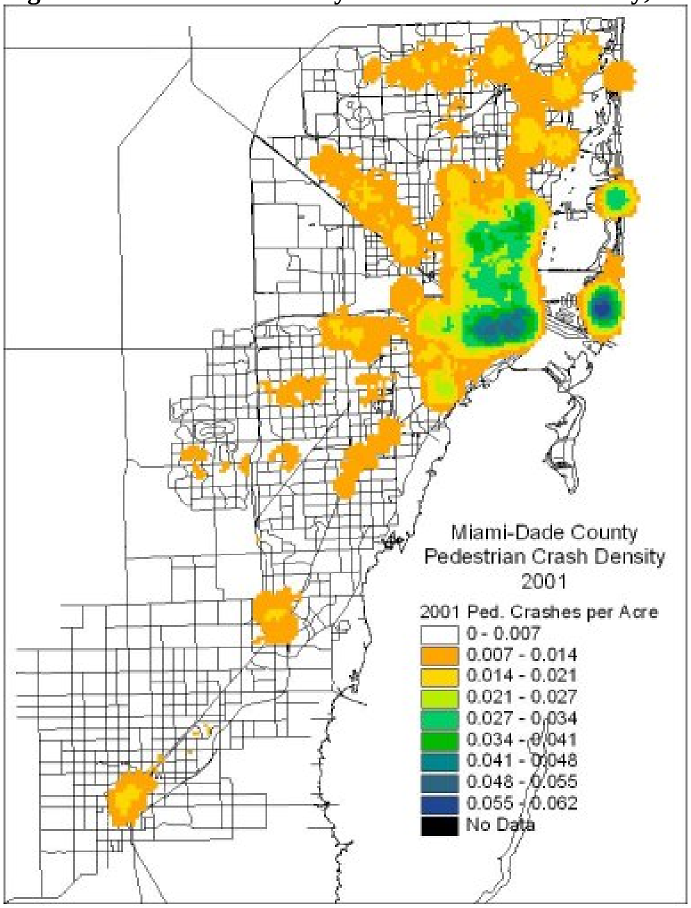
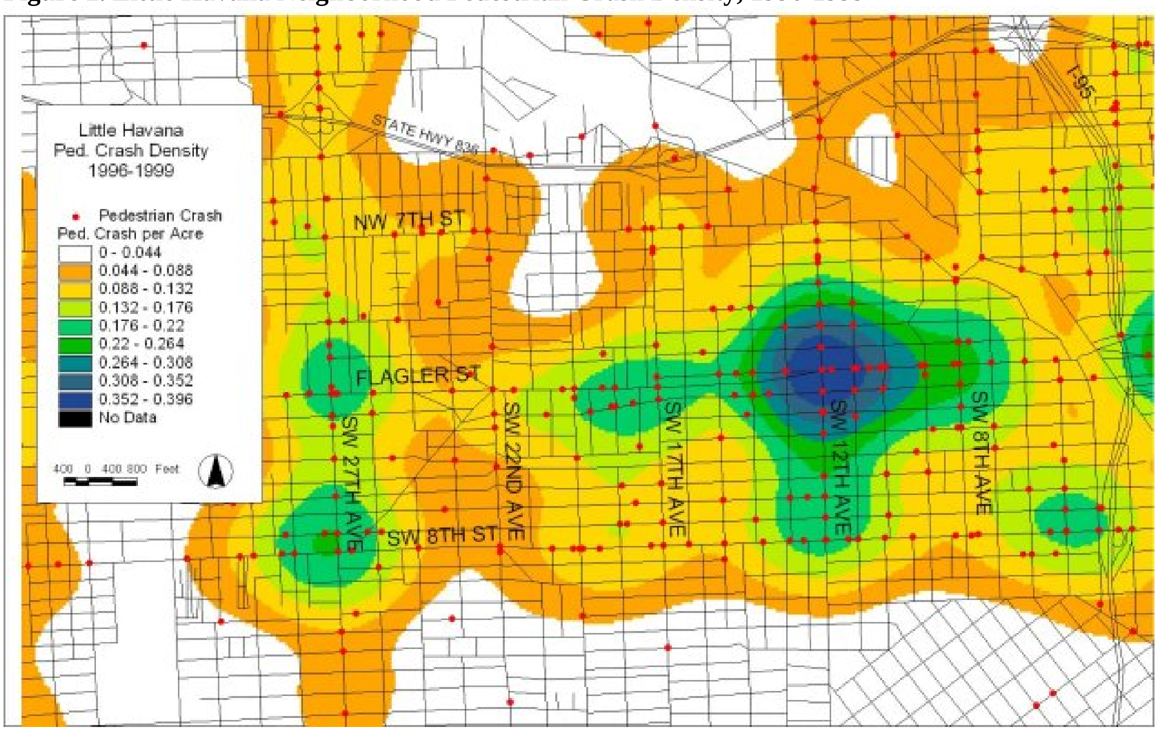
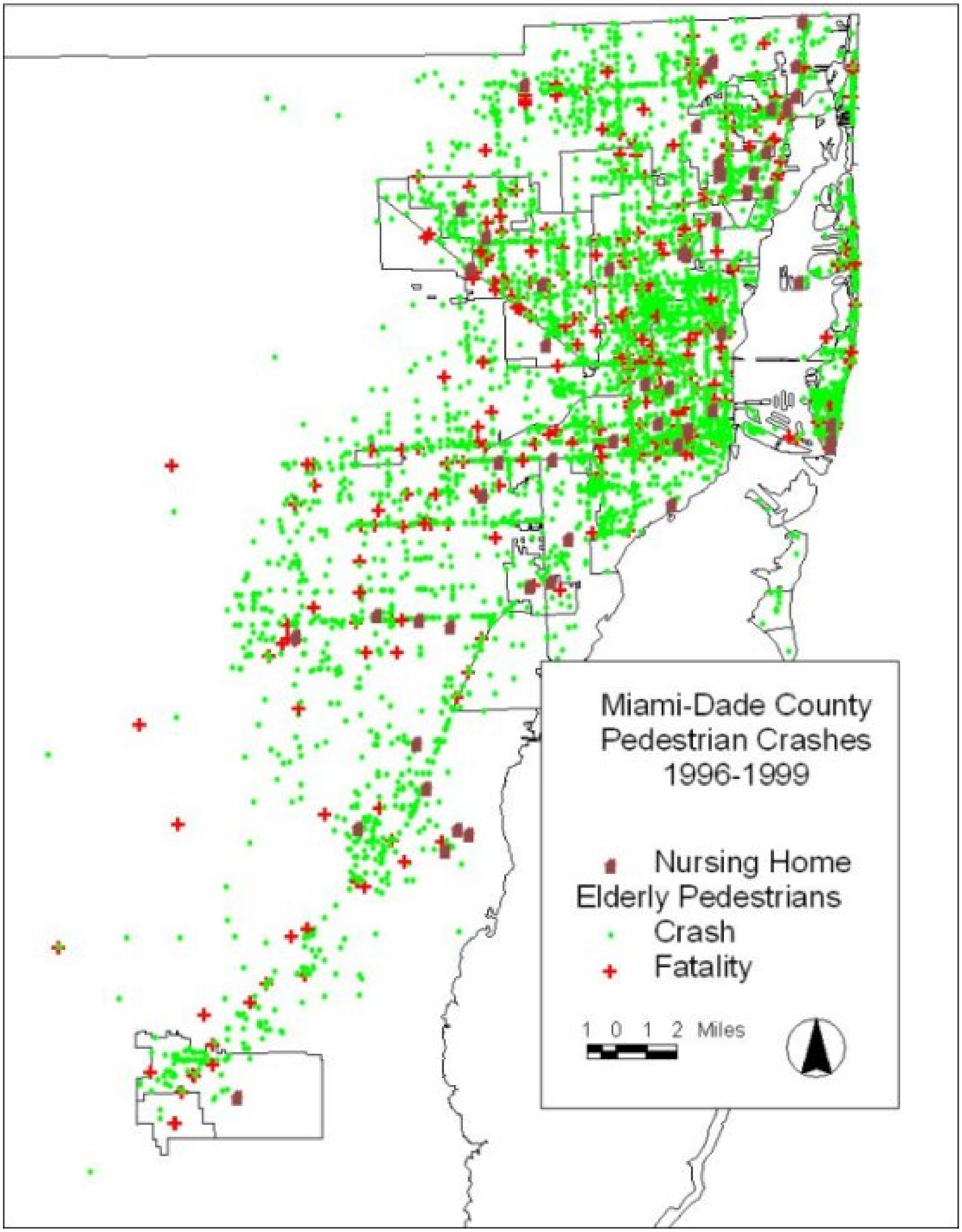


Figure 2. Little Havana Neighborhood Pedestrian Crash Density, 1996-1999



GIS pedestrian crash data are also displayed with other GIS layers, such as community centers, schools, and bus stops to identify correlations between specific land uses and transportation facilities (see Figure 3). These correlations may suggest specific safety problems, which can be addressed using appropriate crash countermeasures.

Figure 3. Crashes involving Elderly Pedestrians and the location of Nursing Homes, 1996-1999



Data maintenance and management

The pedestrian crash analysis methodology has been institutionalized at the MPO so that reported pedestrian crashes are added to the GIS database and analyzed every year.

Data dissemination

Results of the pedestrian crash analysis have been used in presentations within the MPO and to other local agencies. It has also been shared at national conferences. The GIS analysis is primarily an internal tool used by staff to identify pedestrian crash countermeasures. Copies of the database are made available to other government agencies and transportation planners and engineers for use in developing roadway safety projects.

Innovations and Accomplishments

Pedestrian crash mapping and analysis have raised awareness of pedestrian safety issues within the MPO, among local politicians, and with the public. Analysis of crashes by location and by characteristics shows the nature of pedestrian safety problems with a high level of specificity.

Analyzing pedestrian crashes is an objective way to identify locations with the greatest need for crash countermeasures. This prevents neighborhoods with more resources and political influence from receiving an unfair share of improvements. Spatial data on reported crashes helps equalize potential disparities in the public process.

Keeping track of reported crash data over time allows the MPO to document the affects of physical safety improvements. In 1999, Miami International Airport made improvements to pedestrian roadway crossings in the terminal area. The positive effect of these improvements was shown by the difference in crash maps showing crashes from before and after the changes. The 1996-1999 maps showed a concentration of crashes at the airport, but the crash concentration did not appear on maps after 1999.

Lessons Learned

The Miami-Dade MPO has found this method of crash analysis to be very useful for identifying pedestrian safety problems. It is important to note that the pedestrian crash concentrations shown on the maps are related to a combination of pedestrian safety problems and pedestrian exposure. All else equal, areas with higher numbers of pedestrians are more likely to experience a higher number of pedestrian crashes. However, the MPO seeks to improve pedestrian conditions wherever pedestrian crashes occur, regardless of the number of pedestrians in an area.

In addition, the Miami-Dade MPO has found that some locations are dangerous for pedestrians, but they have few pedestrian crashes (i.e. these locations do not show up as “hot spots” for pedestrian crashes on the crash maps). These locations may have few pedestrians because their land use patterns do not support walkability or because they are perceived as unsafe (a busy arterial highway, for example). To identify pedestrian problems and recommend appropriate countermeasures in these locations, other types of analysis may be needed.

The Miami-Dade MPO learned that the pedestrian crash data must be communicated effectively to the professional community. Planners, engineers, and politicians need to understand the process of pedestrian crash data capture and analysis and to avoid drawing conclusions from incomplete data. For example, pedestrian crashes tend to be underreported—not all pedestrian crashes are included in police reports. In addition, the intersection matching process is not able to assign all crashes in the database to specific points in space (parking lot locations are particularly difficult to identify). Though the percentage of crashes that are georeferenced may be improved in the future, the existing maps do not include all crashes that have occurred.

Cost of Data Collection Effort

Obtaining the data from police crash report databases each year is free. A temp worker is hired to copy all the crash reports, and address matching is done by a summer intern. Analysis of the data is done by a consultant for approximately $6,000 to $7,000 per year.

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NJ STATEWIDE BICYCLE AND PEDESTRIAN MASTER PLAN

State of New Jersey

New Jersey Department of Transportation

Data Collected

- Collected and mapped major bicycle facilities across state in 2001 and 2002
- Held meetings at each of the state's three Metropolitan Planning Organizations (MPOs) with all 21 counties to gather data about existing, programmed, and proposed bike facilities

Highlights

- Coordinated data collection effort with 21 counties, 3 MPOs, New Jersey DOT headquarters, and 4 local aid districts
- Entered data into GIS database
- Combined suitability and demand models such as bicycle compatibility index, bicycle demand analysis, pedestrian barrier analysis, and pedestrian demand analysis to develop initial priority segments on roadway network
- Enhanced model-based prioritization with analysis of gaps in facilities inventory and proximity to trip attractors.

Purpose of Collecting Data

Information about pedestrian and bicycle facilities was collected for the New Jersey Statewide Bicycle and Pedestrian Master Plan. At the beginning of the planning process, information about existing conditions was not available. The goal of the data collection effort was to inventory pedestrian and bicycle facilities and analyze model data to identify priority bicycle corridors and locations for improvements to pedestrian conditions. The inventory section of this case study focuses on the bicycle inventory. Although the New Jersey Department of Transportation (NJDOT) did not undertake a pedestrian inventory, the prioritization analysis addressed both pedestrian and bicycle needs.

Geographic Area Description

The Bicycle Facility Inventory and the model analyses were conducted throughout 21 New Jersey counties. The model analyses used the New Jersey Congestion Management System (NJCMS) as the base network. To provide a sense of the scale of the analysis, the NJCMS network – used by NJDOT in assessing suitability of roadways for bicycle use – contains performance and roadway characteristics data on almost 3,500 miles (5,635 km) of roadway represented as over 4,200 roadway links. The network covers all interstate and state highways, as well as major county roads.

Methodology

History of data collection effort

In response to mandates included in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), NJDOT completed its first Statewide Bicycle and Pedestrian Master Plan (Phase 1 Plan) in 1995. The Phase 1 Plan established a policy framework for future bicycle and pedestrian activity in the state and sparked an increased programmatic response. In 1998, the Governor announced a plan to implement 2,000 miles of bicycle accommodations in New Jersey over the next ten years.

While these efforts indicated future bicycle and pedestrian investment in New Jersey, carrying out commitments was hampered by an inability to determine priorities statewide. This gap motivated the development of the Phase 2 Update, which began in early 2001. Initiated by NJDOT, the process involved a collaborative project management team, consisting of representatives from NJDOT and all three MPOs in the state. NJDOT hired a consultant in May of 2001 to assist the team in deciding on appropriate analytical tools, developing a bicycle facilities inventory, and performing analytical modeling. Bicycle facility data collection was conducted through the fall of 2002. After extensive analysis, the final Phase 2 Master Plan is scheduled for completion in the summer of 2004. The Phase 2 Plan also updates the policy framework of the original 1995 Plan.

Data Collection

NJDOT took the lead on data collection efforts for the bicycle facilities inventory. Throughout 2001 and 2002, the consultant contacted county officials across the state for data on county roads, but met with limited success. In the fall of 2002, each of the three MPOs sponsored a workshop at which county officials from that MPO region, representatives of the MPOs, NJDOT, and the consultant team were able to work together to provide data for the county inventory maps. Overall, data on bicycle facilities came from three sources:

<u>Source 1</u>: 21 counties in New Jersey – NJDOT and the MPOs requested existing, programmed, proposed facility types and locations from county planning and engineering departments. The county staff members brought their county maps to the 3 meetings around the state.
<u>Source 2</u>: NJDOT State Headquarters – Provided data on state-operated roadways.
<u>Source 3</u>: State DOT local aid districts – NJDOT staff met with all 4 local aid districts to gather information about existing facilities or programmed projects that were funded through the Transportation Enhancements Program or the State's Local Aid Program.

*MPOs are not directly responsible for roadways in the state. However, they were able to provide contacts and information between the counties and NJDOT.

While there are several counties that maintain transportation data through Geographic Information Systems (GIS), a majority of counties possess only paper maps of bicycle facilities.

The consultant for the Plan entered data into a GIS database by digitizing paper map data and categorizing facilities according to existing, programmed, or proposed status.

The following types of bicycle facilities were noted:

- Signed and striped bike lanes
- Officially designated bike routes
- Multiuse paths (no width limitations), including width of path
- Bicycle Touring routes (shared roads and off-street paths)

There are fields available in the database for surface condition, surface type, width, and length of each of these facilities. While a majority of facilities do not have data for these fields, future inventory updates will add missing data to the extent feasible.

The database identifies three categories of facility status:

- Existing
- Programmed (funded, not constructed)
- Proposed (planned or suggested, but not funded—most proposed facilities were suggestions from counties)

The consultant also gathered data from a variety of sources on the locations of bicycle trip attractors. These attractors included recreation destinations, schools, colleges/universities, bus lines, rail stations, commercial areas, parks, and "designated centers" from the New Jersey Growth Management Plan.

Data storage

Bicycle facility and trip attractor data were entered into a GIS database developed by the consultant, which will be maintained by NJDOT.

Background on Models used in Data Analysis

Bicycle and pedestrian priorities were each determined using demand and suitability models. Bicycle and Pedestrian demand models are area based, usually at the census tract level, and indicate the propensity of bicycling or walking based on relevant data such as population, employment, college age population, and access to transit. These demand models have little or no relationship to roadway facility characteristics.

Suitability models assess the quality of the roadway facility for bicycling or walking, and are link-based. Both suitability models used the New Jersey Congestion Management System (NJCMS) as the primary source of data. For more information on the models, see Table 1.

Table 1. Analytical Methods Used to Identify Bicycle and Pedestrian Priorities

	SUITABILITY			DEMAND		
	Method	Inputs	Application Scale	Method	Inputs	Application Scale

Bicycle	Bicycle Compatibility Index, Bike Facilities Inventory	Shoulder and Curb Lane Widths; Curb Lane and Add'l Lane Volumes; Presence of Parking; Area Type (Residential or Commercial)	Network Roadway Sections	Bicycle Demand Model	Number of Workers; Bicycle Journey-to-Work Mode Share; School Age and College Age Population	Census Tracts
	Method	Inputs	Application Scale	Method	Inputs	Application Scale
Pedestrian	Pedestrian Barrier Analysis	Traffic Volume and Speed; Number of Travel Lanes and Shoulders; Presence and Type of Medians; Signalized Intersections	Network Roadway Sections	Pedestrian Compatibility Index	Population and Employment, Road Network Density; Transit Accessibility; Generalized Pedestrian Facilities Index (based on area type)	Census Tracts

The Bicycle Compatibility Index (BCI) is a model developed by FHWA to assess the suitability of a roadway for bicycling (or the level of comfort a bicyclist would feel bicycling along a road segment). It considers the effects of specific roadway characteristics on bicyclist comfort, using existing information in the NJDOT database (volume, lane width, speed limit). In addition to the primary variables, the BCI includes adjustment factors for the percentage of vehicles making right turns and on-street parking. NJDOT did not have these data available, and assessed that the lack of this data would not unduly harm the analysis. All other inputs listed in Table 1 were used in the NJDOT analysis.

Data analysis

NJDOT prioritized roadways for bicycle facility improvements by analyzing 1) modeling results from their own BDM and the FHWA BCI, 2) proximity to trip attractors, and 3) missing links from the bicycle facility inventory. The database allows future users to modify priorities based on local input and/or other factors.

Priority was determined according to a three-row by three-column matrix. Bicycle demand (from the BDM) for each segment was shown as low, medium, or high on one axis and bicycle suitability (from the BCI) for each segment was shown as low, medium, or high on the other axis. The highest priority routes had the highest demand and lowest suitability for bicycling, while the lowest priority routes had the lowest demand and highest suitability (see Table 2).

The initial model priority was enhanced by investigating the bicycle facilities inventory and trip attractor data. The priority of a roadway segment could increase or decrease depending on the number of nearby trip attractors and the proximity of the segment to existing bicycle facilities. This prioritization scheme is not intended to be permanent – rather, the database is adaptable so that users can develop different prioritization schemes according to their specific needs.

Table 2. Identification of Bicycle Priorities

Number Of Roadway Segments by Corridor Priority Level[a] and Bicycle Compatibility Index

	Bicycle Compatibility Index Model			
Bicycle Demand Model (# Bicycle Trips a Day)	Restricted Roads (Roads forbidding useage by any means other than motor vehicles)	Low Compatibility (E or F)	Medium Compatibility (D)	High Compatibility (A,B,C)
Low Demand[b] < 300 Trips/Day	Low (70[c])	Low (79)	Low (101)	Low (214)
Medium Demand 300-1000 Trips/Day	**High** (305)	Medium (473)	Medium (634)	Low (1021)
High Demand >1000 Trips/Day	**High** (264)	**High** (278)	**High** (351)	Medium (446)

a. Values of Low, Medium, and ***High*** *in the 12 table cells represent Corridor Bicycle Priority Levels.*

b. High, medium and low ranges for values such as demand and priorities were generally chosen in accordance with break points in the magnitude versus frequency curves of the variable under examination.

c. Indicates the number of road links in each cell. Road links average .7 miles each, but range in distance from less than one-tenth of a mile to approximately six miles in length. Links are segmented based on changes in roadway characteristics.

The analysis methodology for prioritizing pedestrian facilities was similar to the bicycle prioritization in that it involved combining demand and suitability model results. Like the BDM for bicycle travel, the Pedestrian Compatibility Index (PCI) measures the likelihood of pedestrian travel based on census data. However, because there was no statewide pedestrian facility inventory, the analysis did not include missing links. NJDOT also enhanced the initial model-based priority by investigating proximity to pedestrian trip attractors.

In investigating suitability of facilities for pedestrians, NJDOT was constrained by the lack of comprehensive sidewalk inventory and pedestrian count data. Because of these constraints, analyses regarding future sidewalk needs or other needs parallel to the roadway could not be performed. However, high-volume, multi-lane roadways are often barriers to pedestrians, preventing safe and efficient travel. NJDOT determined that data was available to evaluate the degree to which roadway segments could be crossed safely. At NJDOT's direction, the consultant team developed the Pedestrian Barrier Analysis (see Table 3).

Table 3: Pedestrian Barrier Analysis Elements

Estimating Pedestrian Behavior
Crossing width (number of lanes, shoulder width) Median width (divide road width in half if median is wider than eight feet) Walk Speed (assumes 4.4 feet per second)[d] Step Off Curb Interval (time needed to begin crossing) (2 seconds) Clearance Interval (time needed to complete crossing) (2 seconds)
Estimating Gaps in Traffic
Traffic Volume Number of Lanes in each direction Distribution of Traffic (assumes 2 second gap between cars)
Estimating Barrier Severity
Median Types: (presence of concrete medians >3 feet high or guide rails) Functional classification for roadways Presence of Noise Walls

The Pedestrian Barrier Analysis considers factors (crossing width, median width, assumptions about walking speed, etc.), gaps in traffic, and barrier severity, and uses these to generate a necessary pedestrian crossing time for each road segment in the CMS network. It assumes that if there is a median present that is 8 feet or wider, then a pedestrian will stop halfway before crossing the remaining distance. It assumes that vehicles arrive in a random pattern, and uses roadway width and number of lanes to determine the probability that a pedestrian would encounter adequate crossing time (stratified into easy, moderate, and difficult to cross). Interstate roadways, other freeways, and roads with raised median barriers or noise walls were determined to be uncrossable. High priority uncrossable segments would require further study and potentially a large investment to remedy.

A three-row by three-column matrix was also used to show priority for pedestrian improvements (see Table 4).

Table 4: Identification of Pedestrian Priorities

Number of Roadway Segments by Corridor Priority Level[e] and Road Compatibility Index				
	Pedestrian Barrier Analysis (% of Time that is available for Pedestrians to Cross)			
Pedestrian Compatibility Index (Amount Of Demand)	Uncrossable Segments (Noise Walls, Concrete Medians > 3 ft. high or guide rails, or Road Functional Class 1, 11, 12, 21, 26[f])	Low (0-33%)	Medium (34-66%)	High (67-100%)
Low Demand (0-13)	Low (435[g])	Low (83)	Low (516)	Low (545)
Medium Demand (14-43)	**High** (391)	Medium (147)	Medium (384)	Low (251)
High Demand (44-364)	**High** (672)	**High** (274)	Medium (767)	Low (422)

e. Values of Low, Medium, and ***High*** *in the 12 table cells represent Corridor Pedestrian Priority Levels.*

f. Road Functional Classes listed stand for Interstates, Parkways, The New Jersey Turnpike, and all state designated

g. Indicates the number of road links in each cell. Road links average .7 miles each, but range in distance from less than one-tenth of a mile to approximately six miles in length. Links are segmented based on changes in roadway characteristics.

Data maintenance and management

The initial statewide bicycle inventory effort was extensive. However, NJDOT plans to maintain and expand data collection efforts in the future. NJDOT plans to conduct sidewalk inventories and update all analyses. With the number of new improvements and added miles of facilities added within the last two years, NJDOT will also update the bike facilities inventory and trip attractor information. While digitizing facilities from paper maps is quite costly initially, it will be much less costly to update incrementally in the future.

Data dissemination

The results of the analysis will be distributed to the public and other agencies via the New Jersey Statewide Bicycle and Pedestrian Master Plan. The results will be used at NJDOT to prioritize future projects and as criteria for funding projects through the local aid program. MPOs will also be able to use the data to help determine their project priorities. Deliverables include:

- Executive Summary (brief synopsis of results intended for wide distribution)
- Master Plan Document (full document intended for transportation professionals, state/local officials, MPOs, and consultant community)
- Technical Memorandum (detailed information provided by consultant on analysis)

NJDOT plans to make the Master Plan available on CD. Deliverables will also be available to the public upon request.

Innovations and Accomplishments

For the first time, NJDOT has a statewide inventory of bicycle facilities and a consistent methodology for prioritizing bicycle and pedestrian projects. The prioritization of bicycle and pedestrian opportunities throughout the state into high, medium, and low priority may serve as an example for counties and other municipalities to use when they start to develop their own bicycle and pedestrian plans. Using the Master Plan data and analysis tools as a foundation, local governments can develop new projects that connect to a larger network. Some of the methods used in the analysis were developed by NJDOT. Accounting for pedestrian crossing difficulty through the Pedestrian Barrier Analysis is an innovative new approach to assess pedestrian problem areas at a system level.

One of the unique aspects of the project was that the three MPOs and NJDOT formed a project management team to guide and review all of the components of the Master Plan. With counties willing to participate across the state, inter-governmental collaboration helped make the process more productive and alleviated potential barriers to collecting information. Gathering representatives from all 21 counties, 3 MPOs, and NJDOT together for workshops in the fall of 2002 proved very efficient.

Lessons Learned

One of the main lessons learned through this project was that NJDOT could not map every local bicycle or pedestrian facility due to resource limitations. It was not possible with the available budget to digitize all facilities in the state. The agency decided to include longer distance routes and major facilities across the state rather than shorter facilities that served smaller areas. Therefore, not all municipal facilities were included in the inventory. Including shorter facilities with less statewide significance would have created a more geographically detailed inventory, but NJDOT may have had to limit the more detailed inventory to urban areas or only a portion of the state. Future efforts will attempt to conduct a more detailed inventory, which will include both bicycle and pedestrian facilities. An additional limitation was that the pedestrian barrier analysis, given its inherent system-level approach, could not consider the effects of signalized intersections. While NJDOT will use the bicycle and pedestrian analyses for their intended purposes, it will continue to investigate new approaches to quantify pedestrian needs.

Cost of Data Collection Effort

The total costs of the project are somewhere between $500,000 and $1 million. The scope and comprehensive nature of the project and the significant amount of interagency coordination contributed to this cost. Development of the bicycle facilities inventory made up the largest share of the costs.

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BICYCLE FACILITY INVENTORY AND USAGE TRENDS

Portland, Oregon
City of Portland

Data Collected

- Routinely update locations of bikeways as new facilities are constructed. The City has documented the locations of bikeway facilities since 1973 and mapped bikeways in GIS since 1994.
- Routinely count peak-hour bicyclists. The City has taken one afternoon peak hour count of bicyclists at 80-90 locations around the city each year since 1994.
- Routinely collect round-the-clock pneumatic tube counts on shared-use paths over weekly periods on key entries into Downtown.
- Mapped city bike commute data by census block group in 1990 and 2000.

Highlights

- Documented additions to the City's bikeway network each year since 1973
- Obtained bike counts consistently over a decade in many locations throughout the City
- Analyzed correlation between improvements to bikeway network and increased levels of bicycling

Purpose of Collecting Data

The City of Portland, Oregon is widely recognized to have one of the more extensive networks of bicycle facilities, as well as some of the most favorable bicycling-related policies in the United States. Collecting bicycle facility and count data in Portland has helped the City benchmark its progress on goals to improve bicycle transportation. For example, Policy 6.23 of the *Transportation Element* of the City's *Comprehensive Plan* is the following statement: "Make the bicycle an integral part of daily life in Portland, particularly for trips of less than five miles, by implementing a bikeway network, providing end-of-trip facilities, improving bicycle/transit integration, encouraging bicycle use, and making bicycling safer." To effectively plan for and accomplish this goal, the City needed to know where people ride, how many people are riding, and changes in bicycle travel over time. Similarly, one goal of the current bicycling master plan for Portland is "filling gaps in the existing bikeway network and expanding where possible." Collecting data about the bikeway network is necessary to accomplish this task.

Geographic Area Description

Portland, Oregon is a city of 545,000 located in northwest Oregon where the Willamette and Columbia Rivers meet. It covers approximately 369 square miles. One factor that encourages bicycling and walking year-round is the city's mild climate; another is its predominantly grid-based street layout. Portland also has the third highest area of parks and open space per resident in the nation, with over 26 acres per 1000 residents.

Methodology

History of data collection effort

The City of Portland maintains two basic databases related to bicycle use and facilities. Portland began collecting bicycle counts at four bridges in Central Portland in 1973. This data collection has continued and expanded, with over 80 locations currently targeted for bicyclist counts. In 1973 the City also completed its first inventory of bicycle facilities. This inventory was repeated in 1990, and it is regularly revised as new facilities are constructed.

Data Collection

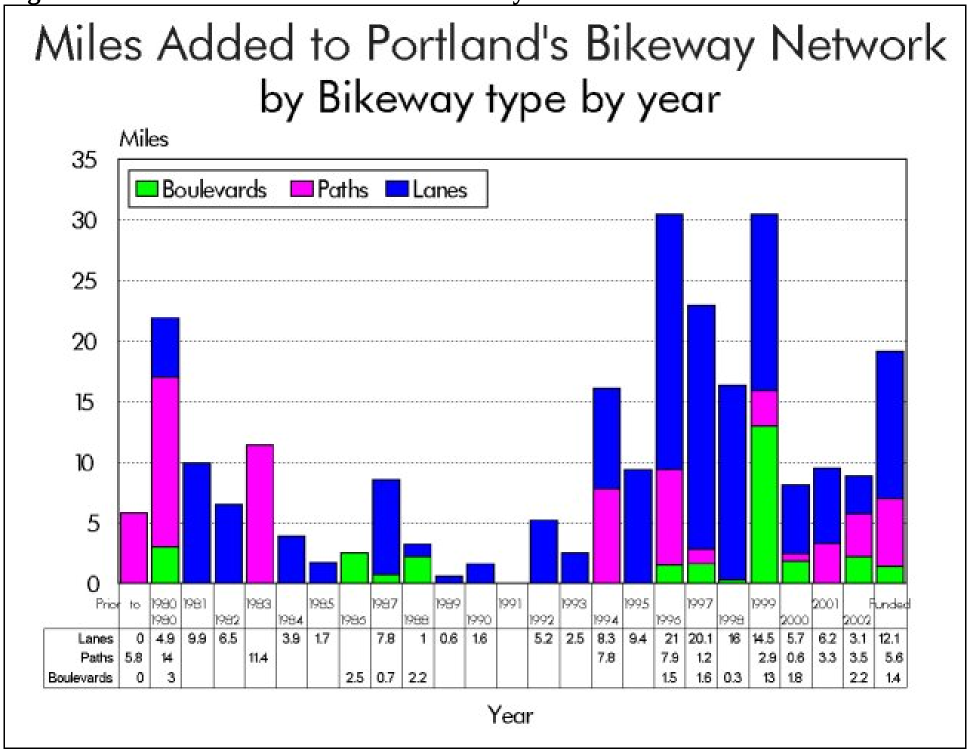
Bicycle counts are collected manually. One person at each count location records the number of bicycle movements through the intersection on a standard count recording form. At most of the 80 to 90 locations, counts are conducted during the two-hour afternoon peak period; for one-way inbound routes, counts are conducted during the two-hour morning peak period. Counts include total numbers of riders passing through the intersection, each rider's movement through the intersection (i.e., street and direction of approach, and street and direction of exit), gender, and helmet use.

Counts are taken one time per year at most locations, either during the spring, summer, or fall. The City takes the annual count at each location at roughly the same time each year. Weather conditions are recorded when the counts are made. When conditions are poor, the intersection is recounted at a later date. In addition, trips at some downtown locations are counted during the winter.

For off-street paths, counts are collected using a pneumatic tube counter. Tube counters collect counts 24 hours per day and report the data in 15-minute intervals. Data from the counters are collected on a weekly basis.

Locations of existing bicycle facilities in Portland have been collected since 1973 (see Figure 1). In 1994, the bicycle facility network was incorporated in Portland's geographic information system. Since then, new facilities are added to the GIS when construction is completed. Because the inventory was completed years ago, and new facilities are added when they are completed, the City has determined that it is not necessary to repeat a comprehensive inventory of facilities in the field.

Figure 1.: Miles Added to Portland's Bikeway Network



	Prior to 1980	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Funded
Lanes	0	4.9	9.9	6.5		3.9	1.7		7.8	1	0.6	1.6		5.2	2.5	8.3	9.4	21	20.1	16	14.5	5.7	6.2	3.1	12.1
Paths	5.8	14			11.4											7.8		7.9	1.2		2.9	0.6	3.3	3.5	5.6
Boulevards	0	3						2.5	0.7	2.2								1.5	1.6	0.3	13	1.8		2.2	1.4

Data storage

Once collected, all of the bicycle counts are entered manually into computerized spreadsheets.

Data analysis

Data analysis occurs in a number of ways:

- Two-hour peak counts are analyzed to estimate the total number of bicyclists passing through each intersection during the entire day.
- Total rider counts are compared to the miles of facilities to determine riders per mile of bikeway.
- The changes in the number of bicycle trips and facilities are compared over time to estimate the effect new facilities are likely to have on the total number of trips (see Figure 2).
- Bicycle trip counts are analyzed in conjunction with Census travel data to determine modal split for travel to work.
- Bicycle use has been compared with transit use and motor vehicle data to identify likely modal shifts for commuters.
- The annual number of reported bicycle crashes is indexed to the number of daily bicycle trips across the city's four main bicycle bridges to determine an annual crash rate that can be compared over yearly intervals.

In addition, the bicycle count data are freely available for other forms of analysis. For example, outside organizations have compared average rider counts at various locations to advocate for improvements to the bikeways network where gaps were perceived.

Figure 2. Bicycle Commute Mode Split: 1990 and 2000

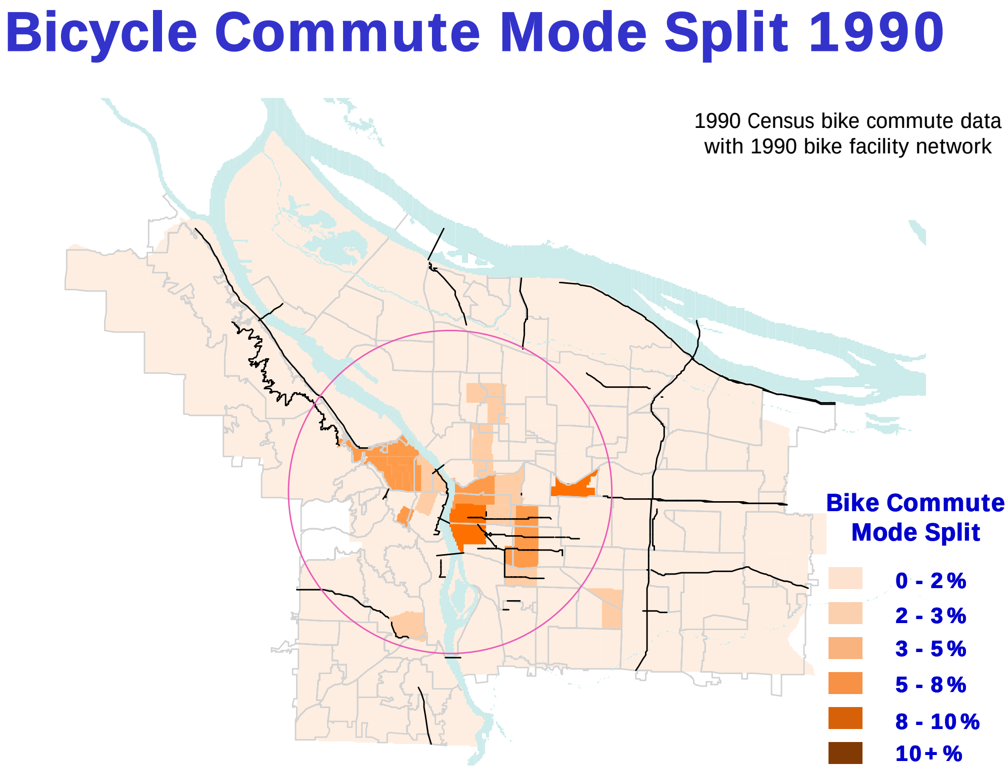


Figure 2 (continued). Bicycle Commute Mode Split: 1990 and 2000

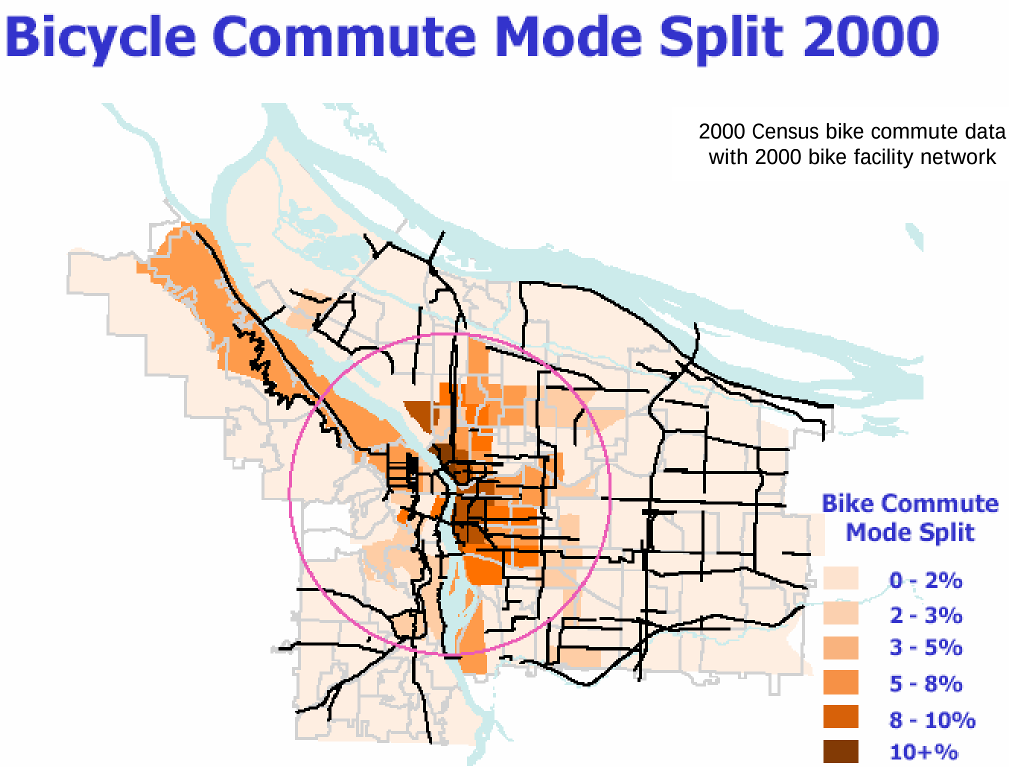


Figure 3. Change in Mode for Journey to Work, 1990-2000

Means of Transportation to Work 1990*	City-Wide		Within 4 miles of Burnside Bridge		Census Tracts with 2% Bike Mode Split or Higher in 2000		Census Tracts with 3% Bike Mode Split or Higher in 2000	
	Count	Mode Split	Count	Mode Split	Count	Mode Split	Count	Mode Split
SOV	167,196	68.8%	84,055	64.4%	39,029	60.0%	27,366	58.8%
Carpool	32,540	13.4%	16,608	12.7%	7,537	11.6%	5,540	11.9%
Bus	23,982	9.9%	16,776	12.8%	9,576	14.7%	7,542	16.2%
Other Transit	1,807	0.7%	652	0.5%	460	0.7%	306	0.7%
Motorcycle	1,077	0.4%	571	0.4%	351	0.5%	291	0.6%
Bicycle	2,556	1.1%	2,069	1.6%	1,333	2.0%	1,236	2.7%
Walked	12,687	5.2%	9,281	7.1%	6,550	10.1%	4,096	8.8%
Other	1,244	0.5%	609	0.5%	249	0.4%	128	0.3%
Sum:	243,089		130,621		65,085		46,505	

*Data from 1990 Census and reflects "usual" means of transportation to work for one week in April of census year.

Data maintenance and management

Data is stored in spreadsheets with no direct maintenance costs. Spreadsheets are shared between users so that anyone who needs or requests access, including outside organizations, may use them.

Data dissemination

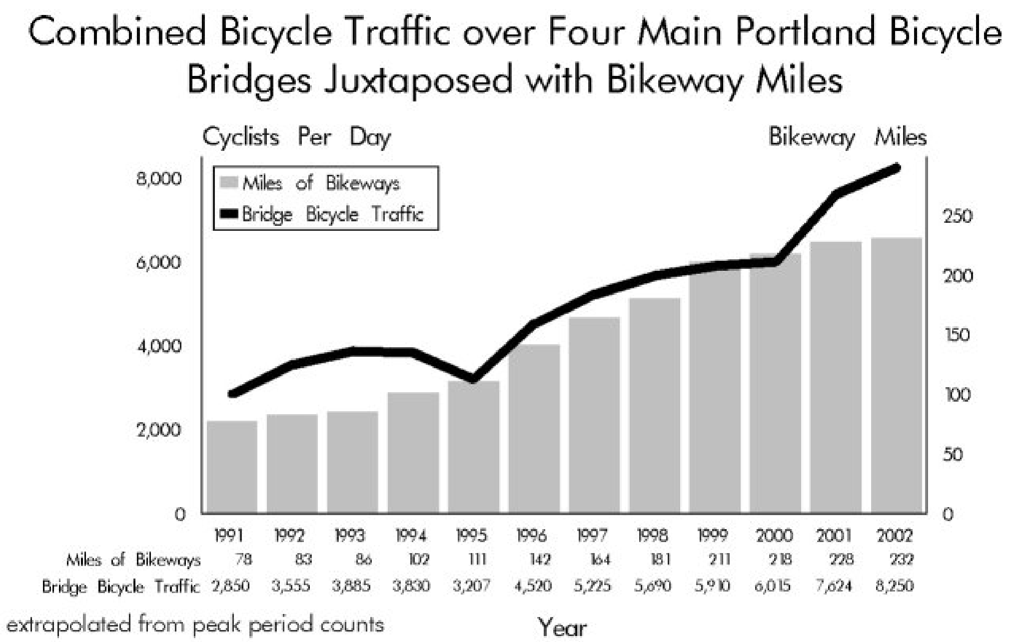
The data are used primarily to track progress and to maintain political and community support for improving bicycling conditions in Portland. Reports highlighting the results are released to the public and governing bodies.

Innovations and Accomplishments

Portland's data collection activities have been used in a number of innovative ways. Results of data collection showing growth in the number of bicycle trips have been presented to the Portland City Council and have been used to secure the Council's support for new bicycle transportation facilities and initiatives.

Collection of accurate data over a long-term period, combined with an accurate inventory of bicycle facilities, has allowed Portland to document the correlation between improvements to the network of bicycle facilities and increases in the number of bicycle trips throughout the City over time (see Figure 4). Although the data cannot show that there are more riders because of individual bicycle facilities, bike commuting and bicycle counts at most locations generally increased as the network grew.

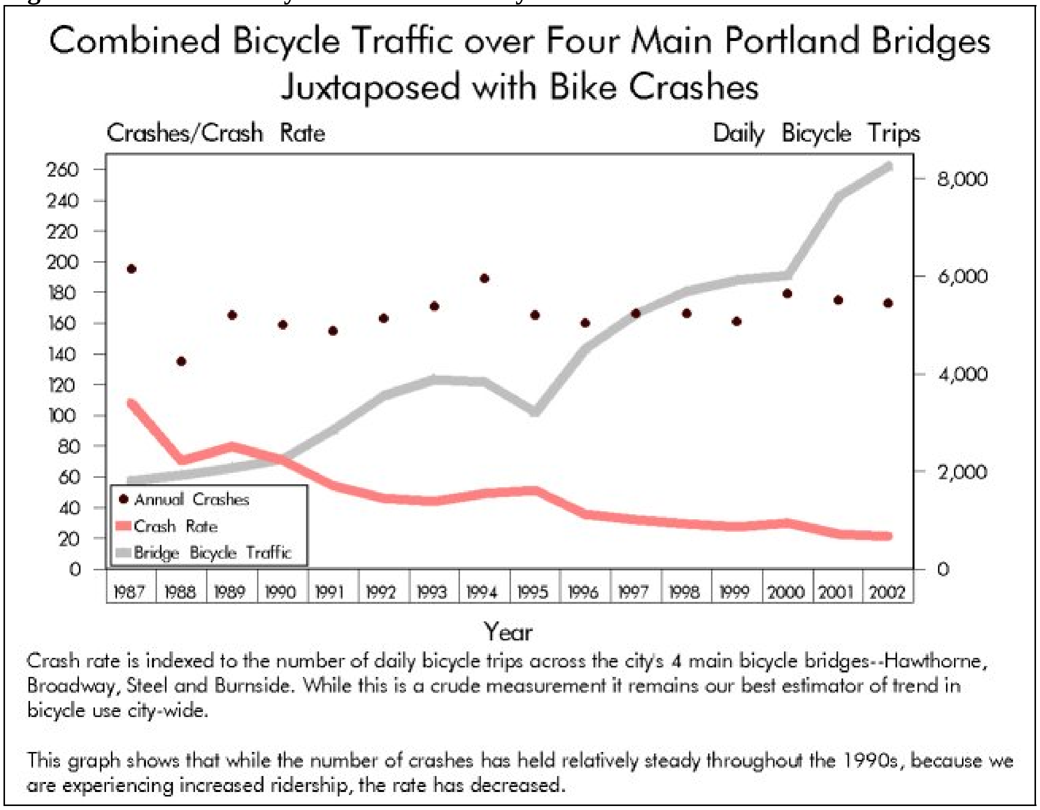
Figure 4.: Combined Bicycle Traffic over Four Main Portland Bicycle Bridges



Portland's Bikeway Network increased 197% between 1991 and 2002; during that same period, the number of bicycle riders daily crossing the four main bicycle bridges in Portland increased 190%. This increase was especially noticeable on the Broadway and Steel Bridges, where combined daily ridership went from 725 in 1991 to 3,600 in 2002. During this period, the bikeway network feeding these bridges were greatly improved, as were facilities on the Bridges themselves.

Improvements in Portland's bicycle safety have also been documented. By comparing the total number of trips to the number of crashes, a downward trend in the crash rate (crashes per bicycle trips) has been identified. While the total number of trips has increased, the number of crashes has remained mostly constant (see Figure 5).

Figure 5.: Combined Bicycle Traffic with Bicycle Crashes



The use of consistent counting methods for nearly three decades has allowed Portland to more accurately understand the nature and characteristics of bicycle use within the City. The shift towards computer-based analysis and geographic information systems has also improved the practical application of the data.

Lessons Learned

Over the three decades of data collection in Portland, a number of lessons have been learned:

- Manual counts of bicycle ridership are a labor-intensive process. One person can only count one location at time. Portland hires student interns to conduct the counts, but each can conduct only one morning count and one evening count per day.
- To fully understand the dynamics of a particular location or area within a bikeway network, counts must be conducted more frequently and focused on that area. For example, to effectively understand a bridge and the bikeways around it, staff will occasionally count all corridors that feed the bridge on a single day.
- To effectively understand the broad movement of riders, coordinated counts are sometimes necessary. Counts can be taken on parallel streets in a grid network on a single day to account for riders who can choose between alternative routes.
- The City has found two-hour peak counts to be reliable, representing about 20 percent of all bicycles that are counted in a 24-hour period.
- Bicycle riders travel at a different speed than motor vehicles, so the peak period of bicycle travel may change as distance from the city center increases (assuming that most bicycle trips are made to and from the city center). To effectively capture bicycle trips at

peak periods in locations further from the center of the city, it may be necessary to adjust the time of a count.

- Overhead imagery is useful for inventorying facilities. Portland has used ½ foot pixel images of the City to verify facilities.

Cost of Data Collection Effort

Portland's bicycle data collection costs an estimated $2000 to $4000 per year. The City typically hires three to four student interns at $12-14 per hour to conduct counts at the 80 to 90 locations over the summer (June to mid-September). About 25 to 50 percent of these interns' time is allocated to collecting bicycle counts. Off-season counts are conducted by student interns (when they are available), by City Staff, or using pneumatic tube counters.

Contact

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APPENDIX

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FEDERAL SOURCES OF DATA

Table 1. Federal Sources of Surface Transportation Use and Facility Data

					Type of Data Provided											
					Pedestrian and Bicycle				Automobile				Public Transit			
					Use Data		Facility Data		Use Data		Facility Data		Use Data		Facility Data	
Data Source	**Agency**	**Website**	**Description of Transportation Data Collected**	**Updates**	National	Local	National	Local	National	Local	National	Local	National	Local	National	Local
U.S. Census	US DOC, BOC	www.census.gov	Provides data on journey to work travel time and travel mode for workers age 16 and over. Data are collected in spring of the Census year.	Every 10 years	X	X			X	X			X	X		
National Household Travel Survey	US DOT, BTS	www.bts.gov/programs/national_household_travel_survey/	Surveys U.S. households to gather travel data. Data include mode, duration, distance and purpose of trips. Demographic and economic data are also included.	Every 5 to 7 years	X				X				X			
Omnibus Household Survey	US DOT, BTS	www.bts.gov/omnibus_surveys/household_survey/	Surveyed approximately 1,000 randomly selected households to gauge the public's satisfaction with the transportation system. Data included trip types, trip distances, and modes used.	Every 2 months; survey terminated in Oct. 2003	X				X				X			
National Survey of Pedestrian and Bicyclist Attitudes and Behaviors	US DOT, NHTSA and US DOT, BTS	www.bts.gov/omnibus_surveys/targeted_survey/2002_national_survey_of_pedestrian_and_bicyclist_attitudes_and_behaviors/	Surveys U.S. households to ascertain the scope and magnitude of bicycle and pedestrian activity and the public's behavior and attitudes regarding bicycling and walking.	First done in 2002	X											
National Transit Database	US DOT, FTA	www.ntdprogram.com/NTD/ntdhome.nsf/	Collection of transit agency statistics. Over 600 of the nation's transportation providers submit data to the NTD annually. Data include ridership statistics, operating expenses, and performance measures.	Every year									X	X		
National Transportation Atlas Databases	US DOT, BTS	www.transtats.bts.gov/mappingcenter.asp	Collection of transportation-related geospatial data for the United States. Data include transportation networks and transportation facilities. They can be viewed and downloaded from the internet.	Every year							X	X			X	X
Highway Performance Monitoring System	US DOT, FHWA	www.fhwa.dot.gov/policy/ohpi/hpms/	National-level highway information system that includes data on the extent, condition, performance, use, and operating characteristics of the Nation's highways. Local road locations are included.	Every year					X		X	X				

US DOC, BOC = United States Department of Commerce, Bureau of the Census

US DOT, BTS = United States Department of Transportation, Bureau of Transportation Statistics

US DOT, FHWA = United States Department of Transportation, Federal Highway Administration

US DOT, FTA = United States Department of Transportation, Federal Transit Administration

US DOT, NHTSA = United States Department of Transportation, National Highway Traffic Safety Administration

CASE STUDY COMMUNITIES CHARACTERISTICS

STATE AGENCIES			
Community *(Agency)*	**Population (2000)**	**Case Study Title**	**Case Study Category**
California *(California Department of Transportation and Public Health Institute Survey Research Group)*	34,000,000	Telephone Survey of Pedestrian Habits and Behaviors	Surveying Users--Sampling a General Population
Florida *(Florida DOT)*	16,000,000	Americans with Disabilities Act Compliance Inventory Methodology	Documenting Facility Extent--Inventories
New Jersey *(New Jersey DOT)*	8,410,000	New Jersey Statewide Bicycle and Pedestrian Master Plan	Documenting Facility Extent--Spatial Analyses
North Carolina *(North Carolina DOT)*	8,050,000	Pneumatic Tube Bicycle Counts	Quantifying Use--Automated Counts
Massachusetts *(Massachusetts Highway Department and UMass Transportation Center)*	6,350,000	Counting and Classifying Pedestrians and Bicyclists with an Active Infrared Sensor	Quantifying Use--Automated Counts
Washington State *(Washington State DOT)*	5,900,000	Statewide Bicycle and Pedestrian Facility Inventory	Documenting Facility Extent--Inventories
Maryland *(Maryland DOT)*	5,300,000	Bicycle and Pedestrian Level of Service Inventories	Documenting Facility Extent--Inventories
Iowa *(Iowa Department of Transportation)*	2,930,000	Piezo Film Bicycle Counts	Quantifying Use--Automated Counts
Rhode Island *(Rhode Island DOT and URI Transportation Center)*	1,050,000	Shared-Use Path User Survey	Surveying Users--Targeting Non-Motorized Users
COUNTY/REGION/MPO AGENCIES			
Community *(Agency)*	**Population (2000)**	**Case Study Title**	**Case Study Category**
New York City, NY Region *(New York Metropolitan Transportation Council)*	12,000,000	Manual Non-Motorized User Counts	Quantifying Use--Manual Counts
Miami-Dade, FL Region *(Miami-Dade MPO)*	2,250,000	Pedestrian Crash Mapping and Analysis	Documenting Facility Extent--Spatial Analyses
Pinellas County, FL *(Pinellas County MPO)*	921,000	Pinellas Trail Users Survey	Surveying Users--Targeting Non-Motorized Users
Albuquerque, NM *(Mid-Region Council of Governments)*	450,000	Intersection Bicycle and Pedestrian Counts	Quantifying Use--Manual Counts
Loudoun County, VA *(Loudoun County Planning Department)*	170,000	Bicycle and Pedestrian Level of Service Inventories	Documenting Facility Extent--Inventories
Columbia, MO *(Columbia Area Transportation Study Organization (MPO))*	135,000	Sidewalk Inventory using a Digital Aerial Photograph	Documenting Facility Extent--Spatial Analyses
Licking County, OH *(Licking County Area Transportation Study)*	125,000	Passive Infrared Sensor Shared-Use Path Counts	Quantifying Use--Automated Counts
TOWN/CITY AGENCIES			
Community *(Agency)*	**Population (2000)**	**Case Study Title**	**Case Study Category**
New York, NY *(NYC Department of Planning, Transportation Division)*	8,000,000	Detailed Streetscape Inventory	Documenting Facility Extent--Spatial Analyses
Baltimore, MD *(City of Baltimore Department of Transportation)*	650,000	11-Hour Manual Intersection Pedestrian Counts	Quantifying Use--Manual Counts
Washington, DC *(District Department of Transportation)*	570,000	10-Hour Intersection Pedestrian Counts	Quantifying Use--Manual Counts
Seattle, WA *(City of Seattle)*	563,000	Crosswalk Inventory and Improvement Plan	Documenting Facility Extent--Inventories
Portland, OR *(City of Portland)*	529,000	Bicycle Facility Inventory and Usage Trends	Documenting Facility Extent--Spatial Analyses
Lexington-Fayette, KY *(Lexington-Fayette Urban County Government, Division of Planning)*	260,000	Pedestrian Facility Inventory	Documenting Facility Extent--Inventories
St. Petersburg, FL *(City of St. Petersburg)*	248,000	Bicycle and Pedestrian Level of Service Inventories	Documenting Facility Extent--Inventories
Madison, WI *(City of Madison Department of Transportation)*	210,000	In-Pavement Loop Detector Bicycle Counts	Quantifying Use--Automated Counts
Boulder, CO *(City of Boulder, Division of Transportation)*	120,000	In-Pavement Loop Detectors Used for Bicycle Counts on Shared-Use Paths	Quantifying Use--Automated Counts
Boulder, CO *(City of Boulder, Division of Transportation)*	120,000	Modal Shift Survey Tracks Community-Wide Bicycle and Pedestrian Use	Surveying Users--Sampling a General Population
Davis, CA *(City of Davis, Department of Public Works)*	62,000	Time-Lapse Video Used for Bicycle Counts	Quantifying Use--Automated Counts
Cheyenne, WY *(City Government of Cheyenne)*	53,500	Infrared Laser Counts of Greenway Users	Quantifying Use--Automated Counts
Sandpoint, ID *(City Government of Sandpoint, ID)*	6,000	Community Pedestrian Facility Inventory	Documenting Facility Extent--Spatial Analyses