

# Active Living Research

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RESEARCH BRIEF | February 2013



## Counting Bicyclists and Pedestrians to Inform Transportation Planning

### Introduction

Creating communities that support walking and bicycling is an important strategy for promoting health, reducing air pollution, and lessening our dependency on an auto-centric transportation system.<sup>1</sup> Yet the design of our cities, neighborhoods, and transportation systems often discourages people from walking or bicycling to places where they work, learn, play, or shop. Urban planners, transportation engineers, and other public health professionals need accurate counts of bicyclists and pedestrians to help inform transportation planning and investments that support physical activity, such as walkways and bicycle facilities.

In response to this need, the Federal Highway Administration, along with a number of states and localities, has launched initiatives to count bicyclists and pedestrians. These initiatives are based on a growing body of research that documents practical approaches to counting and ways that counts can be used in modeling, as well as other aspects of transportation and recreation planning.

Many technologies for counting bicyclists and pedestrians have been developed and researchers, engineers, and planners have obtained substantial experience using the counts for planning and evaluation. Technologies include simple manual counts by volunteers, infrared technologies installed on utility or signage poles, inductive loops that use wires embedded in pathways to count bicyclists, and video recordings that capture movements along roadway segments or in crosswalks.

This research brief describes types of technologies for counting bicyclists and pedestrians and the benefits and challenges associated with different approaches. It also explains how counting data can be used to inform transportation planning, presents trends in levels of bicycle and pedestrian activity, and illustrates one goal of non-motorized traffic monitoring, namely, estimating bicycle and pedestrian traffic on streets in cities and towns.

## Key Research Results

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**Many methods and technologies for counting bicyclists and pedestrians are available, and technologies are improving rapidly. Key factors to consider in selecting counting methods relative to bicyclists and pedestrians include the purpose of the count, the level of accuracy needed, and the overall cost.**

- Manual field observations and analyses of video imagery can yield highly accurate counts, but these initiatives are labor intensive and relatively costly. Counts obtained with other technologies, such as inductive loops or infrared sensors, may be less accurate but also less costly, especially if counts of long duration are required and geographic coverage is extensive.
- Accuracy of manual counts depends on the experience of the data collectors and their ability to concentrate, as well as the complexity and volumes of bicycle and pedestrian movements at a particular location.<sup>2</sup>
- Accuracy is generally higher for roadway and sidewalk segment counts than for counts at intersections that reflect turning movements. Researchers who have tested the various technologies have found that their accuracy varies, with potential for both undercounting or over-counting, depending on the technology and method of installation and maintenance.<sup>3</sup> For example, undercounting bicyclists and pedestrians by 2 percent to 20 percent occurs in many cases because users are clustered, and error rates of up to 50 percent have been reported for some technologies.<sup>4</sup> In one study that included validation counts of infrared sensors in San Francisco, California, the researchers found higher error rates when pedestrian clustering occurred and developed adjustment factors to estimate true counts.<sup>5</sup>

TABLE 1: **Considerations for Counting Bicyclists and Pedestrians**<sup>6–10</sup>

This table summarizes the level of accuracy and the costs associated with several methods of counting bicycle and pedestrian activity.

Count Methodology	Accuracy	Cost	Other Considerations
<b>COUNTING BICYCLISTS OR PEDESTRIANS</b>			
<b>Manual Counts</b>	Depends on training and experience (1%–25% subject to human error)	High (depending on duration of counts)	Few equipment costs; Labor intensive, requires trained observers; Impractical for long-term, comprehensive applications; Directional counts possible
<b>Video</b> (manual analysis)	High (subject to human error)	High (depending on duration of counts)	Costs of video camera installation and operation; Labor intensive; Can capture some user characteristics; Directional counts possible
<b>Active Infrared</b> (count is recorded when user breaks infrared beam)	Systematic undercounting (5%–15% due to clusters of people)	Low	Portable; Visual obstructions may affect counts; Can provide long-term, 24-hour counts
<b>Passive Infrared</b> (count is recorded when monitor senses temperature differential)	Systematic undercounting (5%–50% due to clusters of people)	Low	Widely tested and available; Directional counts possible
<b>Computer Visioning</b>	Depends on computer algorithms	Medium	Well-suited for crowded environments; Costs of video camera installation; Requires greater sophistication for analysis
<b>COUNTING BICYCLISTS ONLY</b>			
<b>Inductive Loops</b>	Varies depending on installation and maintenance of system	Depends on location of installation	Directional counts possible if maintained; Can provide long-term, 24-hour counts; Difficult to use in shared lanes
<b>Pneumatic Tubes</b> (commonly used to count cars)	High	Depends on location of installation	Requires trained personnel; Can provide long-term, 24-hour counts; Can provide estimates of speed; Poses problems for skaters on paths
<b>COUNTING PEDESTRIANS ONLY</b>			
<b>Piezometric Pads</b>	May not count groups accurately	High for installation, low for maintenance	Senses pressure when pedestrians step on sensor; Appear to be less widely deployed than infrared sensors

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**Counting initiatives show that levels of bicycle and pedestrian activity are increasing nationally but vary significantly, due to differences in infrastructure, neighborhood socio-demographics, urban design, land use, and other characteristics of the built environment.**<sup>11–24</sup>

- The 2009 National Household Travel Survey estimates that about 10 percent of all trips nationally are made by foot, and about 1 percent are made by bicycle. From 2000 to 2009, the average length of walking trips made by commuters increased from 0.83 miles to 0.98 miles, and the average travel time for walking trips increased from 9.8 minutes to 16.2 minutes.<sup>25</sup> There also has been an increasing trend in bicycle commuting—about 0.38 percent of workers regularly commuted to work by bike in 2000, that rate grew to 0.53 percent in 2010.<sup>26</sup>
- While pedestrians come from all socioeconomic strata, levels of walking for utilitarian purposes may be higher among lower-income populations who are less likely to own cars and more likely to use public transit. Multiple studies also report that bicyclists are more likely to be White, higher-income males.<sup>27–32</sup>
- Several studies show that adverse weather reduces active travel. For example, precipitation and winter months can reduce average hourly walking rates by up to 13 percent and 16 percent, respectively.<sup>33</sup> A study conducted in Canada found that temperatures higher than 30 degrees Celsius resulted in a 22 percent decrease in pedestrian activity at intersections.<sup>34</sup> In addition, analyses of bicycle and pedestrian counts from infrared monitors have shown that fewer people use urban trails as levels of ambient air pollution increase.<sup>35</sup>
- Bicycle and pedestrian travel also varies by the types of available facilities, including roadway classification and bus routes. For example, bicycle travel has been shown to be higher on streets with striped bike lanes than on streets without them.<sup>36–38</sup>
- The mix of bicycle and pedestrian travel on off-road bikeways, such as multi-use paths, varies significantly depending on location. For example, one study documented an average of 29 percent bicyclists and 60 percent pedestrians along four paths in Rhode Island.<sup>39</sup> That study also documented an average of 90 percent bicyclists and 10 percent pedestrians on a multi-use path in San Diego, California.

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**Measures of bicycling and walking patterns, such as peak hour traffic and average daily bicycle traffic, are commonly used in planning and management to estimate daily or annual traffic, compare mode share, or design facilities.**<sup>40–43</sup>

- Peak hour travel has been shown to correlate strongly with daily travel among both bicyclists and pedestrians, although the time of peak hour traffic varies by mode (walking vs. bicycling), facility type and location, day of week, and season. In Minneapolis, Minnesota, daily peak hour bicycle travel is higher on multi-use paths than on streets, due to increased recreational use after work hours, as well as commuting or utilitarian travel. Similarly, midday pedestrian trips on sidewalks are higher than midday bicycle travel on streets at the same location.<sup>44, 45</sup> The Metropolitan Council, which allocates funds to park districts in the Twin Cities region, bases allocations for trails partly on estimates of annual use derived from seasonal manual counts.

- Across entire cities, bicycling or walking counts during peak hours vary significantly. In San Diego, counts at pedestrian intersections during peak period (4:00 p.m. to 6:00 p.m.) ranged between 4 to 982 pedestrians.<sup>46</sup> In Minneapolis, two-hour segment counts ranged from 13 to 1,290 pedestrians.<sup>47</sup> These same studies also documented a wide range in bicycling levels at intersections during the peak two-hour evening period—from 3 to 140 cyclists in San Diego, and 23 to 598 cyclists in Minneapolis.
- The states of Colorado, Oregon, and Minnesota are working to develop adjustment factors that local planners and engineers can use to extrapolate peak hour counts of bicyclists and pedestrians to daily counts and to extrapolate daily counts to annual average bicycle and pedestrian traffic.

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**Counts of bicyclists and pedestrians can be used to estimate demand for facilities, the potential benefits of investments, and the need for traffic control modifications.**

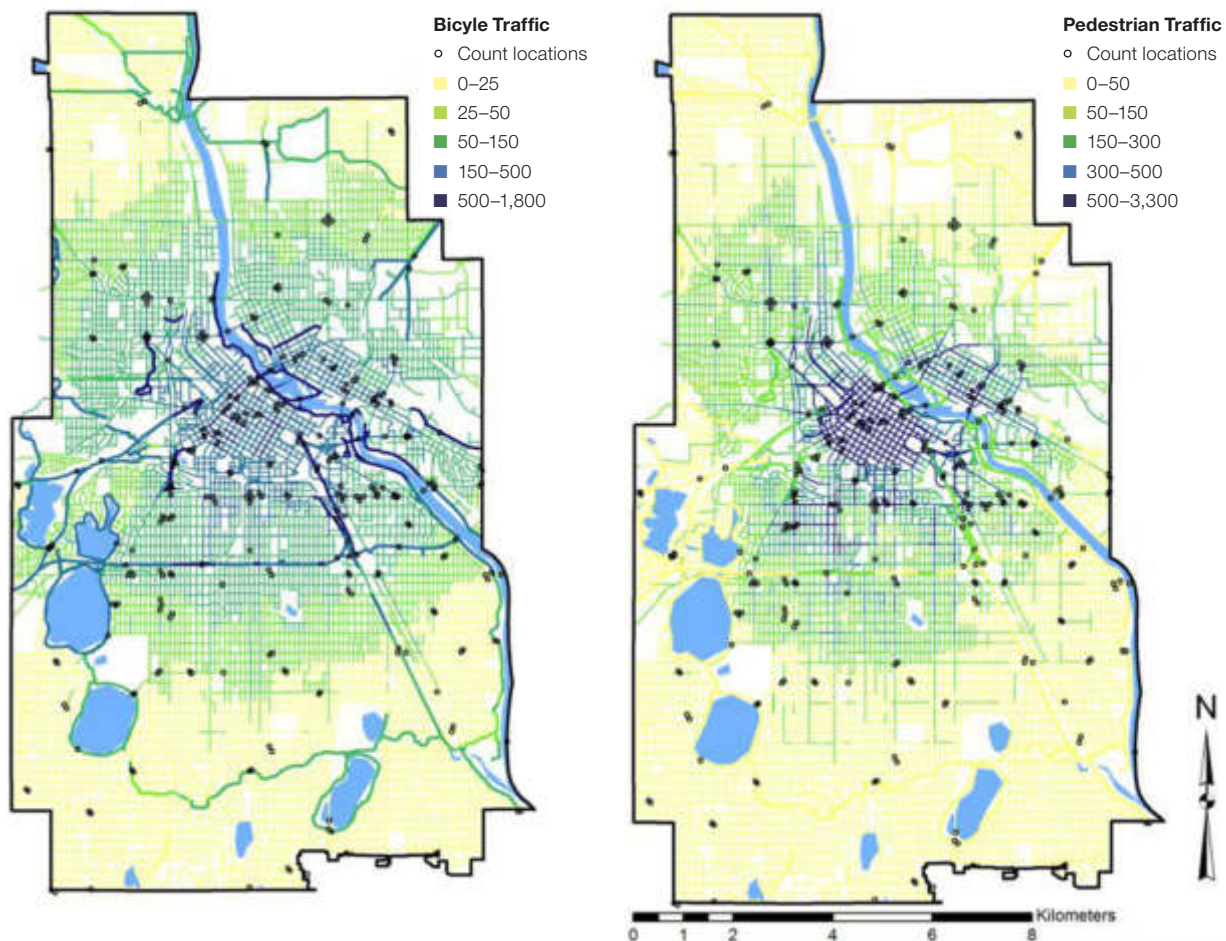
- Alameda County, California correlated count data with total population within a 0.5-mile radius, employment within a 0.25-mile radius, number of commercial retail properties within a 0.25-mile radius, and the presence of a regional transit station within a 0.1-mile radius of an intersection to predict pedestrian intersection volumes where counts were not taken. These estimated volumes subsequently were used to develop a pedestrian collision exposure model to help public officials and planners understand the risk of pedestrian collisions at various locations. Pedestrian exposure was calculated as the number of pedestrian collisions per estimated pedestrian crossing volume at the intersection.<sup>48</sup>
- A study in Indianapolis, Indiana, documented trail use and reported models that explained between 75 percent and 80 percent of the variation in daily mixed-mode (i.e., bicycle and pedestrian) volumes. These models correlated trail traffic volumes with weather, neighborhood socio-demographics, neighborhood land use and infrastructure, and trail characteristics.<sup>49, 50</sup> These findings informed decisions by municipal and nonprofit leaders to build the \$63 million Indianapolis Cultural Trail. A study in Santa Monica, California, was able to forecast 47 percent and 58 percent of peak evening hour bicycle and pedestrian intersection counts, respectively.<sup>51</sup>
- The Texas Transportation Institute, in collaboration with the Capital Area Metropolitan Planning Organization, modeled both bicycle and pedestrian supply and demand to identify unmet needs in the transportation network.<sup>52</sup> Many other bicycle and pedestrian master plans also have attempted similar efforts to model bicycle or pedestrian supply and demand from jurisdictions, including Sacramento and San Diego, California; Alexandria, Virginia; and Seattle, Washington. The plans noted that priorities for investments included eliminating bottlenecks and increasing connectivity within bicycle and pedestrian networks.
- The city of Minneapolis made several traffic improvements based on counts showing that traffic volume was higher on trails than on vehicular streets. The city eliminated stop signs on an urban, multi-use greenway trail at crossings with local residential collector streets and placed stop signs on crossing streets for vehicular traffic.<sup>53</sup>



- The Federal Highway Administration used models of bicycle and pedestrian traffic developed from counts taken by the Minneapolis Department of Public Works and the nonprofit Bike Walk Twin Cities in its report to the U.S. Congress on the outcomes of the \$25 million Nonmotorized Transportation Pilot Program.<sup>54–57</sup> The models, which predict bicycle and pedestrian traffic volumes in relation to roadway classification, land use mix, weather, and other variables, are supporting local efforts to expand bicycle and pedestrian facilities and make them safer. Figure 1 shows how the predicted volumes of bicyclists and pedestrians vary across Minneapolis. It also shows that factors, such as street type and land use mix, affect bicycle and pedestrian traffic differently. Such data indicate that separate planning is needed for bicyclists and pedestrians.

FIGURE 1: **Estimated Bicycle and Pedestrian Counts in Minneapolis**

Estimated bicycle and pedestrian counts in Minneapolis for a 12-hour period on a summer weekday show that both bicycle and pedestrian volumes are higher near the central business district and along trails that provide access to recreational areas.



## Conclusion

To meet the growing need for better measures of bicycle and pedestrian activity, national, state, and local initiatives have been launched to develop protocols and procedures for counting and for institutionalizing data collection and management. Yet existing evidence is limited, and several areas warrant future research. Among the topics that need study are the integration of automated and manual count programs; strategies for sampling traffic, including the minimum and optimal durations for counting; choice of counting locations across regions and within municipalities; and the development and application of adjustment factors for extrapolating short-duration counts to annual totals.

## Policy Implications

Transportation planning uses forecasting models based on detailed counts of vehicles. The federal government mandates that metropolitan regions conduct long-range planning for vehicular and transit systems, but does not require such planning for bicycle and pedestrian systems. As such, the data collection and analytic methods for non-motorized systems lag behind those for vehicular and transit systems.

In addition, the lack of routine traffic counts—or measures of demand for bicycling and walking—means these modes of travel have not been assessed adequately in long-range transportation plans. Policy-makers, transportation system managers, and researchers can use measures of active travel in a wide variety of applications, including facility and system planning, allocation of resources for infrastructure investment, evaluation of project and program alternatives, and assessment of traffic safety and management interventions.

New initiatives at the national level may reflect a sea-change in the status of bicycle and pedestrian data collection. The Federal Highway Administration for the first time is including guidance on monitoring non-motorized traffic in its authoritative *Traffic Monitoring Guide*.<sup>58</sup> The Federal Highway Administration also announced in 2012 that it will establish a repository for bicycle and pedestrian count data through its Travel Monitoring Analysis System. This new initiative would parallel the mandatory vehicle volume reporting system maintained by State Departments of Transportation and involves the same type of rigorous reporting standards. In 2011, the Transportation Research Board of the National Academies established the Bicycle and Pedestrian Data Subcommittee to develop national strategies and systems for standardized non-motorized traffic data collection and management.<sup>59</sup> The subcommittee has sponsored national workshops as part of its efforts to develop these strategies and systems.

There also are two research projects funded by the National Cooperative Highway Research Program of the Transportation Research Board that will support bicycle and pedestrian planning. The study, *Pedestrian and Bicycle Transportation Along Existing Roads*, which will be completed in 2013, will inform policy-makers about factors to consider when planning for non-motorized traffic.<sup>60</sup> Another study, *Methodologies and Technologies for Collecting Pedestrian and Bicycle Volume Data*, which will be released in 2014,<sup>61</sup> will review international best-practices and provide guidance for transportation practitioners about how to best collect data about bicycle and pedestrian volume.

Planners and advocates can use counts and models to estimate traffic on proposed new facilities, such as bicycle boulevards and multi-use trails, and to inform adjacent property owners about potential neighborhood impacts. Advocates also can use counts to encourage federal, state, and local officials to institutionalize commitments to counting and planning for infrastructure that supports bicycling and walking. As new research becomes available and state and local agencies initiate new traffic monitoring programs, public health professionals and policy-makers will be more empowered to make stronger arguments for investments in bicycling and walking facilities, as well as other interventions to increase active travel.

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For updates and a Web-based version of this brief, visit [www.activelivingresearch.org](http://www.activelivingresearch.org).

*Active Living Research*, a national program of the Robert Wood Johnson Foundation, stimulates and supports research to identify environmental factors and policies that influence physical activity for children and families to inform effective childhood obesity prevention strategies, particularly in low-income and racial/ethnic communities at highest risk. Active Living Research wants solid research to be part of the public debate about active living.

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