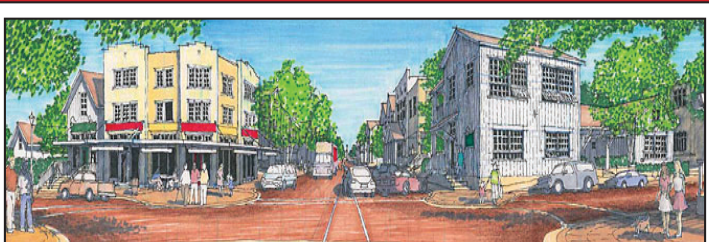
2014 Bicycle and Pedestrian Count Report



Sonoma County Transportation Authority

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Contents

Executive Summary 1
Automated Counts 3
Manual Counts 5
Land Use and Connectivity 8
Post Count Analysis
- Cloverdale 9
- Cotati 11
- Healdsburg 13
- Petaluma 15
- Rohnert Park 17
- Santa Rosa 19
- Sebastopol 23
- Sonoma 27
- Sonoma County:
  - Boyes Hot Springs 31
  - Guerneville 33
  - First Street Bridge 35
  - Joe Rodota Trail 37
  - Stony Point Road 39
- Windsor 41

Appendices 43

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Executive Summary

Annual bicycle and pedestrian counts have been conducted by the Sonoma County Transportation Authority (SCTA) since 2009 in Santa Rosa, Cotati, Rohnert Park, Cloverdale, Petaluma, Windsor, Sonoma, Sebastopol, Healdsburg, and the unincorporated areas of the county. The information derived from these counts furthers the efforts of government agencies and non-profits in tracking and developing non-motorized transportation systems; when planned and designed properly, these systems have the ability to offer convenient alternatives to automobile use. By creating a safe and efficient network of bicycle and pedestrian facilities, Sonoma County can significantly reduce its greenhouse gas emissions, improve public health, enhance recreational opportunities, and preserve its unique sense of place. With the use of alternative modes of transportation on the rise in the county, it is imperative for SCTA to expand its vision of the county's growing bicyclist and pedestrian community.

The data collected from bicycle and pedestrian counts is volumetric, and gives an idea of the amount of bicyclists and pedestrians that utilize city and county streets. A subsequent side-by-side analysis of these raw numbers presents SCTA with a generalized depiction of non-motorized transportation trends over the years. These trends have been used to validate SCTA's travel demand model (TDM), which extrapolates transportation and land use data over many years to predict changes in the county-wide transportation network. The forecasts generated by the TDM are important because they serve as the foundation for grant applications, which can be used to fund infrastructure improvements, planning, and research. The count results also feed into updates for SCTA's Countywide Bicycle and Pedestrian Master Plan, and help evaluate current bicycle and pedestrian facilities and the fiscal impacts of planned projects.

The manual bicycle and pedestrian count program began as a pilot and has continued for several years at various scales, with variation in the count locations and the number of locations each year. The number of manual counts in 2014 was reduced to 15 locations, from 22 locations in 2013, due to significant staff time spent on initiating the automated counter pilot program coupled with a lack of funding to hire outside staff to perform counts. In previous years SCTA has hired interns to perform manual counts or has had a Climate Corps fellow with full availability to manage the program.

The average manually observed bicycle count per location was 46% lower in 2014 than in 2013 and the average manually observed pedestrian count per location was 1% lower. However, some of the individual count locations experienced a significant increase in bicycling and walking across the years. These differences can be attributed to several factors, including weather, time of year, and variation in locations counted. Because manaul counts only capure four hours of data at each location per year, it is difficult to capture a representative average and long-term trends. The 2014 Bicycle and Pedestrian Count Report is an important tool in addressing these concerns.

In 2014, SCTA began an automated bicycle and pedestrian count pilot program with the purchase of four Eco-counter infrared bicycle and pedestrian counters, and four Eco-counter selective bicycle tube counters. The automated counters were installed and tested in various locations in Santa Rosa and the County. A report on the development of the program and equipment testing is included as Appendix F. Automated counters capture data

24 hours a day for a period of approximately two weeks, depending on how long they are deployed. The automated counting method provides a more complete picture of where, when, and how much people are biking and walking than the four peak hours counted manually. With the completion of the automated count pilot program and equipment validation, the SCTA bicycle and pedestrian count program can fully transition to using automated counters in 2015. SCTA staff will continue to provide technical assistance with count methodology to agencies wishing to perform manual counts in their jurisdictions.

The 2014 bicycle and pedestrian count program was managed by SCTA staff. Manual counts were performed by community volunteers, Climate Corps Bay Area (CCBA) fellow Jeremey Arroyo, and SCTA staff. Automated counter installation and validation was performed by SCTA staff, City of Santa Rosa Public Works staff, Sonoma County Public Works staff, and CCBA fellow Adriana Stagnaro.

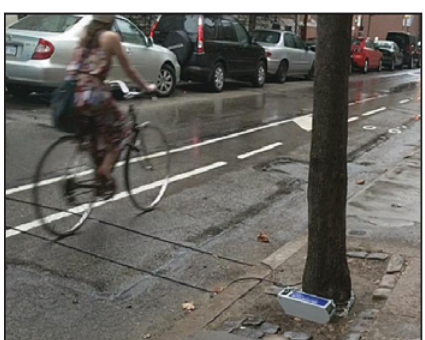
Utilizing community volunteers not only contributed to the success of this program, but also helped strengthen the relationship between SCTA and the public. The Sonoma County Bicycle Coalition (SCBC), a high-profile bicycle advocacy group in the region, assisted in providing much needed outreach to their members and the general public. In addition to SCBC volunteers, members of the Countywide Bicycle and Pedestrian Advisory Committee (CBPAC) came forward to assist in the counts. All of the participants were instrumental in the timely and accurate completion of the counts. The volunteers lessened the burden on SCTA staff and geographical constraints (Sonoma County is a sizeable region) and also brought with them an enthusiastic attitude and genuine interest in the project and its impact on greenhouse gas reductions. Without these dedicated volunteers, it would have been challenging to complete this project in a timely manner.

Automated Counts

Automated bicycle and pedestrian count technologies provide an efficient way to collect bicycle and pedestrian activity data over longer periods of time allowing daily, weekly, and monthly variations in non-motorized travel to be identified. SCTA purchased 4 infrared sensors and 4 pneumatic tube systems in the summer of 2014. This technology has been successfully deployed in other areas of the region, but is new to Sonoma County. SCTA tested the equipment at 6 locations during the months of July, August, and September in order to determine the best way to deploy the equipment (including installation procedures, locations, etc.) and to assess the accuracy of the data collected.

Infrared Sensors

Infrared sensors detect radiation emitted from human bodies as they pass in front of the sensor's lenses, and can be mounted to street poles or encased in metal or wooden posts. These counters can log the direction of travel, but are not able to distinguish between pedestrians and bicyclists.



Pneumatic Tubes

Pneumatic tubes are laid across streets and register the pressure and direction of bikes when they pass over. Tubes are temporary and can be moved as needed, but are also susceptible to vandalism. False counting may occur if the tubes are placed on a street where there is a potential for two cars to pass over them simultaneously.

Multi-Use Systems

Multi-use systems are simply combinations of the above listed technologies that can differentiate between user modes and determine direction of travel. A typical system would include an infrared sensor to count pedestrians, and an inductive loop to log bicyclists. This type of set-up is ideal for measuring bicycle and pedestrian activity on multi-use pathways such as the Joe Rodota Trail.

Data Collection

Automated tube and infrared counters were installed at various locations by affixing to utility poles or sign posts. Data is reported in 15 minute intervals and can be summarized by day of week, time of day, direction of travel, and travel mode (bicycle or pedestrian). Data can be downloaded from the counters at any time using a blue-tooth equipped laptop or tablet that has the Eco-counter Eco-link software installed. Additional detail about data collection is provided in Appendix G.

Data Validation

SCTA staff validated the data reported from the automated counters by performing controlled evaluations at selected test locations. Controlled evaluations are conducted by comparing manual counts to automated counter output in a number of prescribed test situations to evaluate equipment performance.

The maximum range is approximately 15 feet for the infrared sensors and total tube length for bicycle tube counters. The following variables did appear to have an impact on counter performance:

1. Group Spacing: Bicyclists or pedestrians may not be counted if they pass the sensor or ride over a pneumatic tube at the same time or if they pass the sensor spaced 1 foot or lower from one another. Group spacing of greater than 1 foot does not appear to have a large impact counter accuracy.
2. Group Size: Larger groups appear to lead to undercounting, due to group spacing. Larger groups appear to lead to a higher incidence of missed counts. Larger groups are also subject to human error with manual counts.

Travel speed did not have an impact on accuracy, unless the subject was going extremely fast or so slow that they could loose balance. Proper equipment mounting height is also correlated with count accuracy. Additional detail about data validation is provided in Appendix G.

General Automated Count Observations

Automated counters are ideal for counting bicycles and pedestrians on Class I pathways and at locations where the flow of bicycles and pedestrians is continuous (i.e., mid-block locations). Counts are more accurate when installed in areas with well defined bicycle and pedestrian routes where travelers are not stopping and milling about frequently. Additional observations and conclusions are provided in Appendix G.

- **A total of 70,204 pedestrians** were counted at Humboldt Street and Spencer Avenue in Santa Rosa, the Joe Rodota Trail at Merced Avenue, and the Santa Rosa Transit Mall.

- **The Santa Rosa Transit Mall had the highest daily average pedestrians**.

- **9,529 bicycles** were counted at Humboldt Street south of Spencer Avenue and Mendocino Avenue north of McConnell Avenue in Santa Rosa, and the Joe Rodota Trail at Merced Avenue and Stony Point Road at Saint Olga Court in Sonoma County.
- **The Joe Rodota Trail had the highest daily average bicyclist**.

Manual Counts

Methodology

The manual bicycle and pedestrian counts were conducted on Tuesdays, Wednesdays, and Thursdays at 15 locations throughout Sonoma County and each of its nine cities. Each location was staffed by an SCTA employee or community volunteer for one day between the hours of 7:00 a.m. and 9:00 a.m., and from 4:00 p.m. to 6:00 p.m. These hours represent peak commute times as dictated by the National Bicycle and Pedestrian Documentation Project (NBPDP)*, which also provided the data forms and collection methods employed by SCTA.

Once at their locations, SCTA employees and community volunteers tallied the number of bicyclists and pedestrians using the facility, making note of the gender of each user and the turning movements of bicycles as they passed through the intersection.

The gender of observed pedestrians and bicyclists, although not required by NBPDP, was recorded as a means of tracking female bicycling trends. Male bicycle usage is generally higher than that of females; by analyzing gender statistics, SCBC and other organizations can better direct outreach efforts towards female commuters who would otherwise not bike for transportation.

* A joint project developed by the Institute of Transportation Engineers and Alta Planning + Design that will create a comprehensive national database of bike/ped usage statistics.

Data Variability

It is expected that a change in count numbers will occur each year. However, there are no controlled environments in bicycle and pedestrian count projects, such that each location can be adversely affected by unforeseen elements that vary from year to year. Some of these factors include:

- Weather
- Daylight savings
- Community events (i.e. farmers markets, parades, fairs, bike-to-work days, etc.)
- Construction projects
- Infrastructure changes
- Traffic accidents
- Retail sales
- Recreational events
- Political protests

These occurrences cannot always be planned for; and due to the limited availability of staff and volunteers, it is unlikely that they can be avoided. In addition, the counts cannot always be performed during the same months each year, which causes variability from year to year.

Data Collection

Manual counts have been performed for the last six years at various locations in Sonoma County. Some locations were counted across multiple years, while other locations were new in 2014 or were only counted in certain years (Appendix A). Out of the 15 locations counted in 2014, three have been counted consistently since 2009, five have been counted consistently since 2010, and five were counted consistently since 2011, 2012 or 2013. This limits the ability to compare county-wide data across the years. Consistent data is useful for analysis of overall change in bicycle and pedestrian activity, and for measuring the impact of new projects.

General Manual Count Observations

• **513 bicycle riders** were counted during a 10 week period from mid-October to mid-December of 2014.

• **63% of all observed bicycle trips** in 2014 were made during the 4 p.m. – 6 p.m. count period.

• In 2014, **24% of all observed bicycle riders were female.**

• **The highest bicycle count in 2014 was obtained in Rohnert Park**, followed by Sonoma County and Sebastopol.

• **2,855 pedestrians** were counted during a 10 week period from mid-October to mid-December of 2014.

• In 2014, **52% of all observed pedestrians were male.**

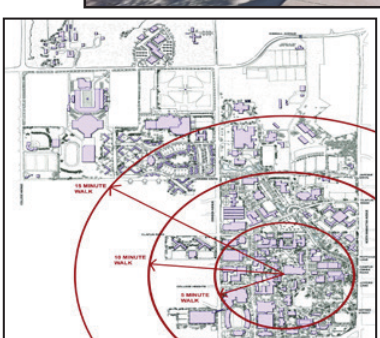
• **62% of all observed pedestrian activity** in 2014 took place from 4 p.m. - 6 p.m..

• **The highest pedestrian count in 2014 was obtained in Sebastopol**, followed by Sonoma County and Rohnert Park.

Land Use and Connectivity

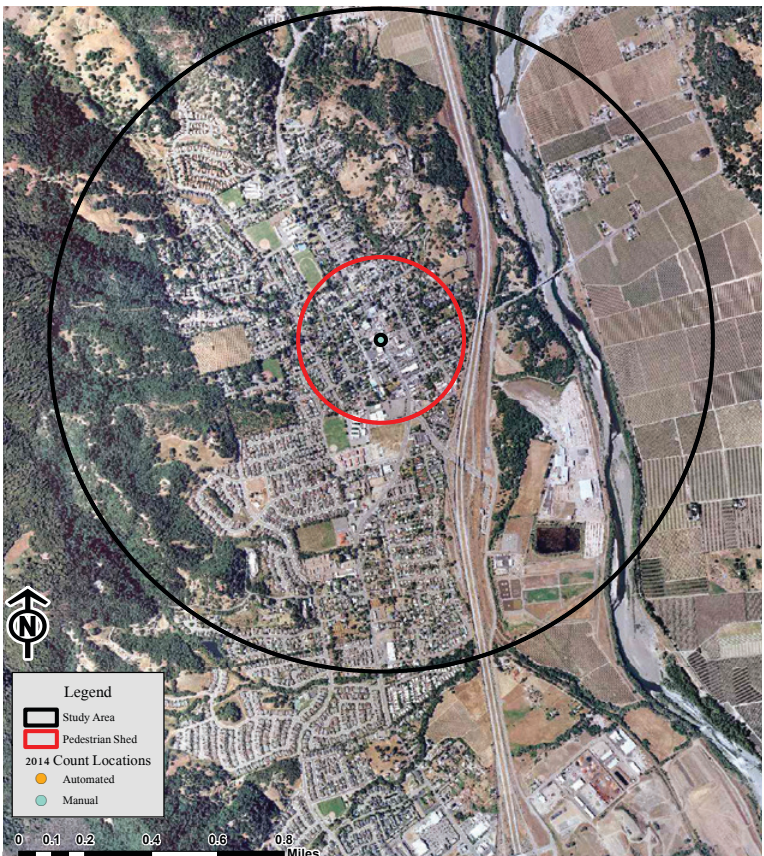
Land use and transportation are inexorably linked. The best laid bike and pedestrian plans can fall short if they do not factor in land use and the daily needs of people living in the community, i.e. their proximity to retail, public spaces, residential neighborhoods and institutions, also called a "pedestrian shed."[1] Although more commonly employed by urban designers, a pedestrian shed is an excellent way of assessing the connectivity of a neighborhood and the daily needs of its residents.

Although a thorough examination of the land uses and densities surrounding count locations is beyond the scope of this report, these characteristics are important in deriving conclusions about bicycle and pedestrian travel. Each location where the counts were performed has unique qualities relating to the natural and built environment surrounding it, which influence the demand and desirability of travel by bicycle or foot.



1 A concept used in the 1929 New York City Regional Plan to describe the 5-minute walk, or the maximum distance a pedestrian should have to travel to access an amenity.

Cloverdale


N
Legend
Study Area
Pedestrian Shed
2014 Count Locations
Automated
Manual
0 0.1 0.2 0.4 0.6 0.8
Miles

Observations

A manual count was performed on Cloverdale Boulevard in downtown Cloverdale. This is the first year that this location has been included in the bicycle and pedestrian count program.

Cloverdale Boulevard at Broad Street
Bicycle Count: 8
Pedestrian Count: 214

• Speed limit: Cloverdale Blvd: 25 MPH

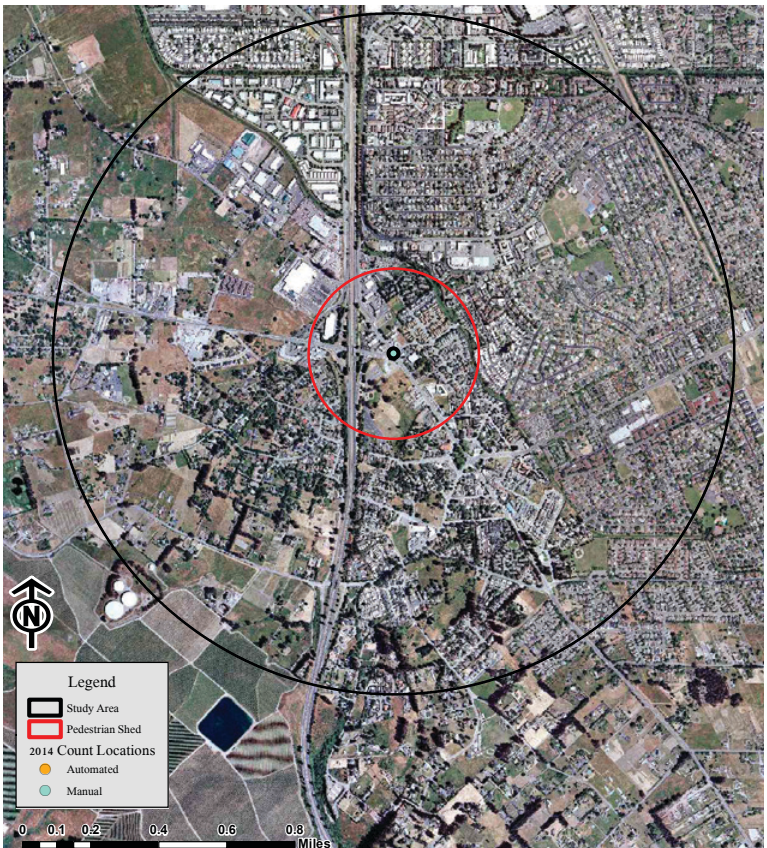
• Cloverdale Boulevard is main thoroughfare through the city, extending from the northern to southern edges of Cloverdale through downtown.

• Cloverdale Boulevard at Broad Street is adjacent to the City Hall Plaza. Broad Street does not go through to Cloverdale Boulevard, but pedestrian access to Broad Street is provided through the Plaza. A bus turnout and pedestrian crossings are located where Broad Street would cross if it continued through.

• A mix of civic, commercial, and residential uses are present within the pedestrian shed of this location.

• Pedestrian and bicycle counts were higher in the evenings.

Cotati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Legend
Study Area
Pedestrian Shed
2014 Count Locations
Automated
Manual
0
0.1
0.2
0.4
0.6
0.8
Miles

Observations

Manual counts were conducted on Highway 116 and Commerce Boulevard in Cotati just east of Highway 101, which pushes high levels of automobile traffic onto and off of Highway 116 and into the City of Cotati. Data has been collected at this location consistently since 2010.

Highway 116 & Commerce Boulevard
Bicycle Count: 12
Pedestrian Count: 26

- Speed limits
  - o Commerce Blvd: 30 MPH
  - o Hwy. 116 east of Hwy 101: 45 MPH

- Major land uses within this pedestrian shed include single-family homes, multi-family homes, and commercial centers.

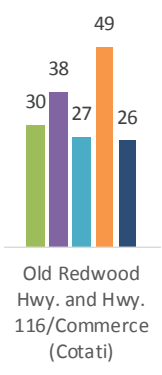
- The number of observed bicyclists and pedestrians was the same during the peak morning and evening time frames.

- As shown in the 5-Year Pedestrian Data graph, there has been some variation in observed activity over the years with no distinct pattern.

- Class II bicycle lanes are present on both Highway 116 and Commerce Boulevard near this intersection and pedestrian islands provide refuge when crossing the busy streets.

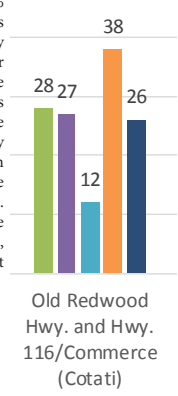
52

5-Year Pedestrian Data

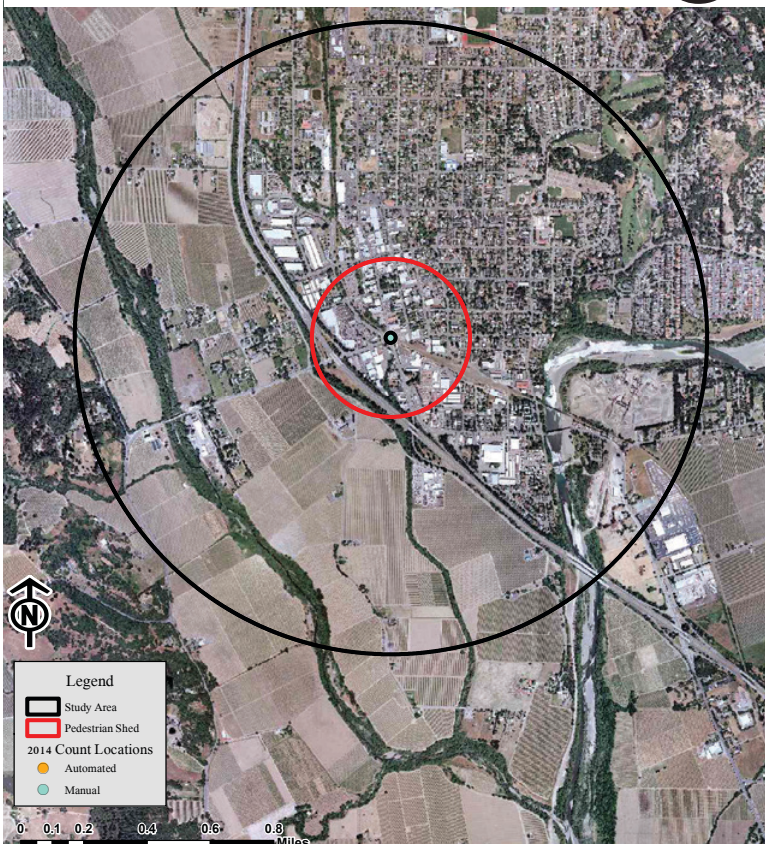


- There was a 68% decrease in bicyclists and a 47% decrease in pedestrians since 2013. This is likely due to the time of year that the counts were taken. In 2013, the counts at this location were done in May when it was likely warmer and lighter than early December when the counts were done in 2014. However, as shown in the 5-Year Bicycle Data graph, there has been significant variation over the years.

5-Year Bicycle Data



Healdsburg


Legend
Study Area
Pedestrian Shed
2014 Count Locations
Automated
Manual
0 0.1 0.2 0.4 0.6 0.8
Miles

Observations

Manual counts were conducted in the City of Healdsburg's at the five-way intersection of Healdsburg Avenue, Vine Street, and Mill Street.

Healdsburg Avenue/Vine Street/Mill Street
Bicycle Count: 27
Pedestrian Count: 119

- Speed limits
  - o Healdsburg Ave: 25 - 30 MPH
  - o Vine St: 25 MPH
  - o Mill St: 30 MPH

- The Vine Street/Mill Street pedestrian shed encompasses the Healdsburg Plaza and downtown area. Land use in the area is generally designated as downtown commercial, service commercial, downtown, and mixed use.

- There are no sidewalks on the south-eastern side of Healdsburg Avenue or on the southern side of Mill Street. Pedestrian access on the west side of Healdsburg Avenue ends north of the five-way intersection

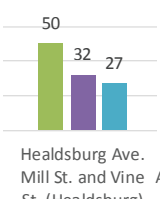
- The intersection receives large amounts of vehicular traffic emanating from the Highway 101 off-ramps to the South and West.

- Many pedestrians were observed avoiding the intersection completely by jaywalking on Healdsburg Avenue between Vine Street and the plaza.

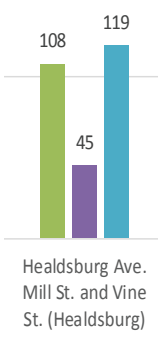
- The City of Healdsburg is currently working on a design to improve this intersection; the Healdsburg Avenue Improvements Project. The design will address pedestrian safety and vehicular capacity, aesthetic form, and integration of signalization required by the future SMART train that will cross the intersection.

- Bicycle activity on the days of observation was at its highest from 4 p.m. - 6 p.m., while pedestrian activity was higher from 7 a.m. - 9 a.m. There were 164% more pedestrians observed in 2014 than in 2013 and 16% fewer bicyclists.

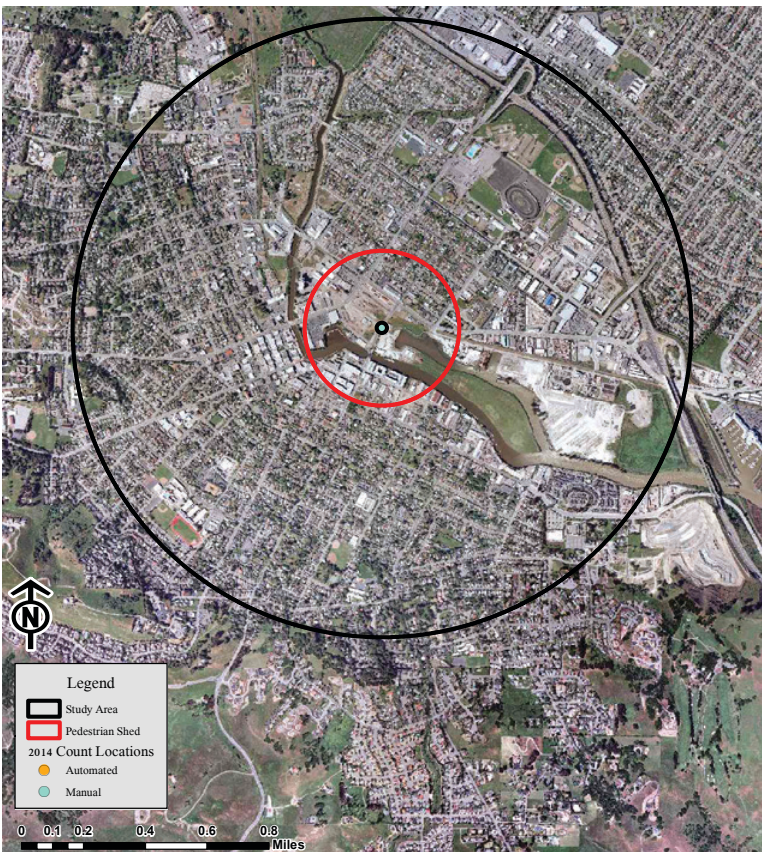
3-Year Bicycle Data



3-Year Pedestrian Data



Petaluma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Legend
Study Area
Pedestrian Shed
2014 Count Locations
Automated
Manual
0 0.1 0.2 0.4 0.6 0.8
Miles

Observations

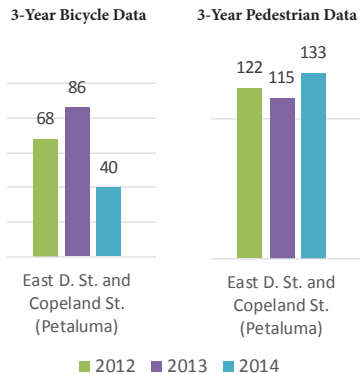
The Petaluma manual counts were performed at the city's transit mall (where the future SMART station will be) on Copeland Street, which lies in-between Highway 101 and the downtown core. The counts were performed at Copeland Street's intersection at East D Street.

East D Street & Copeland Street
Bicycle Count: 40
Pedestrian Count: 133

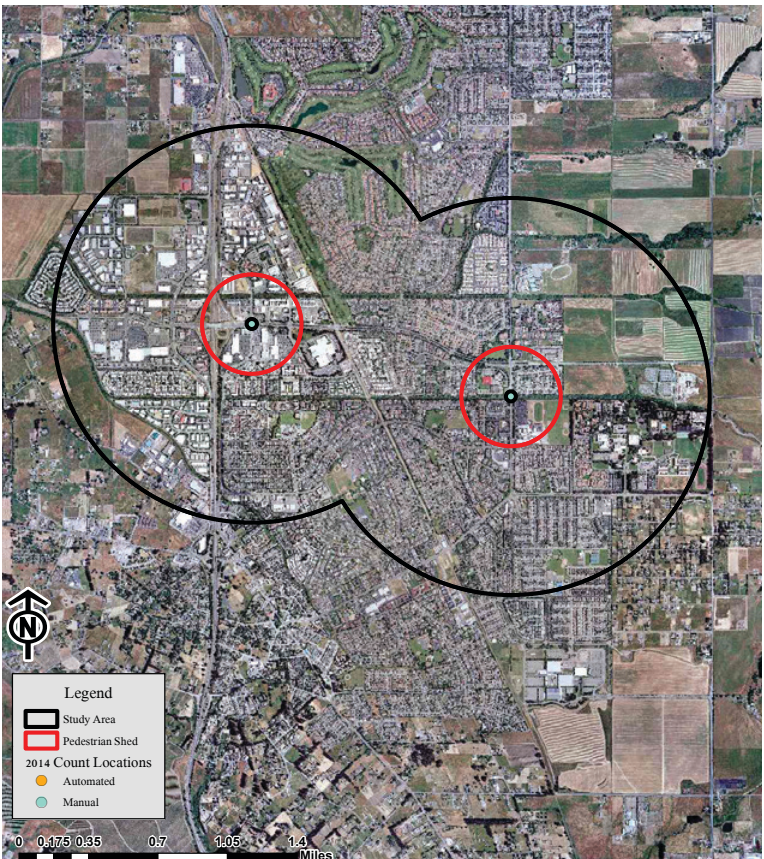
- Speed limits
  - o East D St: 25 - 40 MPH
  - o Copeland St: (Transit Mall): 25 MPH

- The majority of the land in the pedestrian shed is designated as mixed-use; however, current land uses include large areas of vacant land and strip commercial.

- Between 2013 and 2014, there was a 53% decrease in bicycle activity and a 16% increase in pedestrian activity. These numbers have varied drastically over the last three years, which could be the result of several factors including time of year, day of the week, or special events.



Rohnert Park



Observations

The Rohnert Park manual counts were conducted on Rohnert Park Expressway and Commerce Boulevard, and at Snyder Lane and the Copeland Creek bike path. These were chosen for their regional significance.

• Speed Limits
- o Commerce Blvd: 35 MPH
- o Rohnert Park Expressway: 35 MPH
- o Snyder Ln: 30 MPH

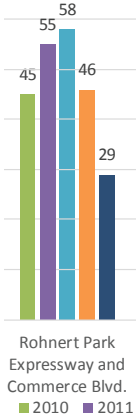
• Major land uses in the area include single-family housing, multi-family housing, and commercial centers.

Rohnert Park Expressway and Commerce Boulevard

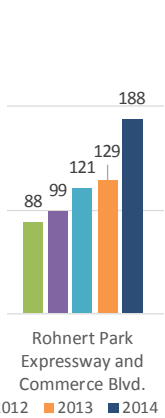
Bicycle Count: 29
Pedestrian Count: 188

• There were a total of 39 pedestrians in the morning and 149 in the evening at this intersection.

5-Year Bicycle Data



5-Year Pedestrian Data



Snyder Lane and Copeland Creek Bike Path

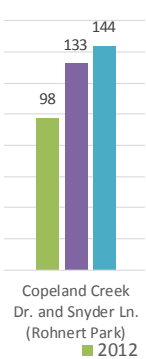
Bicycle Count: 144
Pedestrian Count: 181

• The main anchor points of this intersection are Rancho Cotati High School and Sonoma State University.

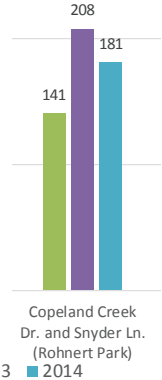
• The evening hours had high bicycle and pedestrian traffic at this intersection, with 98 bicyclists and 97 pedestrians from 4-6 p.m. Two well-marked "ladder" style crosswalks provide easy crossing for pedestrians.

• In addition to bicyclist and pedestrians, 17 skateboarders or scooter riders were counted in the morning and 3 were counted in the evening hours.

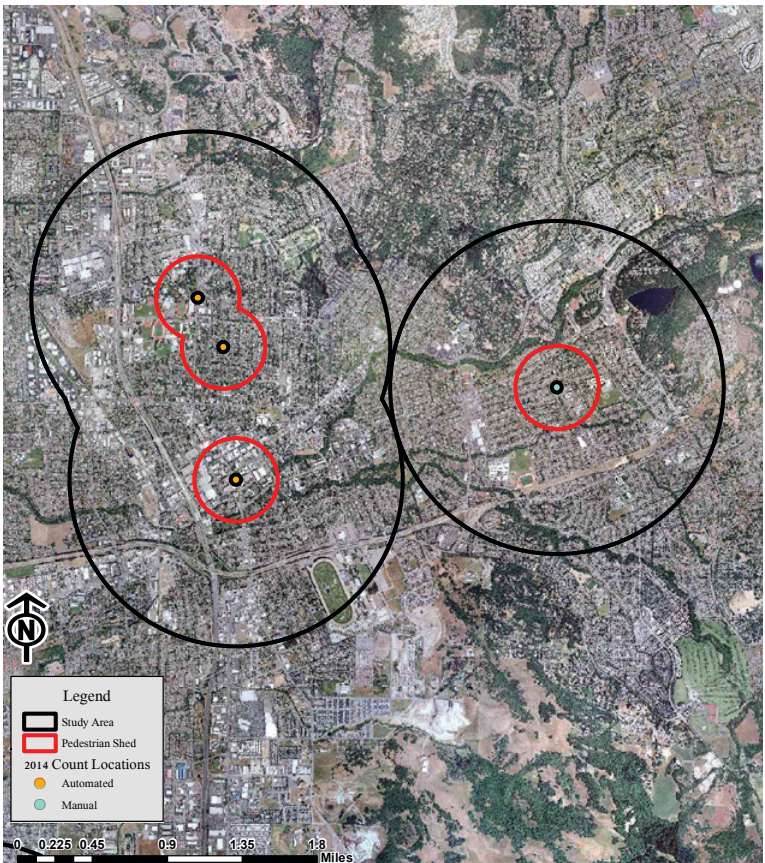
3-Year Bicycle Data



3-Year Pedestrian Data



Santa Rosa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Legend
Study Area
Pedestrian Shed
2014 Count Locations
Automated
Manual
0 0.225 0.45 0.9 1.35 1.8
Miles

Observations

In the City of Santa Rosa, automated bicycle and pedestrian counts were collected on Humboldt Street at Spencer Avenue, Mendocino Avenue and McConnell, and at the Santa Rosa Transit Mall. Manual counts were conducted at the intersection of Sonoma Avenue and Yulupa Avenue, a new location for 2014.

Automated Counts

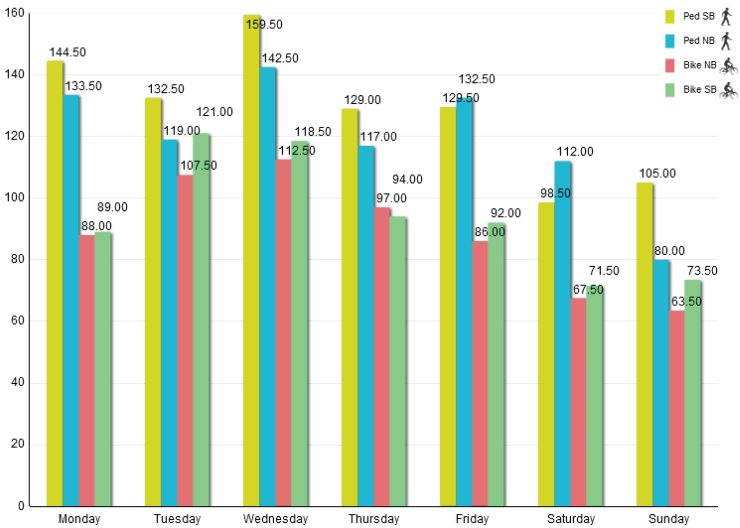
Humboldt Street at Spencer Avenue

Infrared pedestrian counters and tube bicycle counters were installed on Humboldt Street and Spencer Avenue from August 22 through September 3, 2014.

Key Figures

- Total Traffic for the Period Analyzed: 1,668
- Daily Average : 128
- Busiest Day of the Week : Wednesday
- Busiest Days of the Period Analyzed:
    1. Wednesday 03 September 2014 (164)
    2. Friday 22 August 2014 (162)
    3. Wednesday 27 August 2014 (155)

Humboldt Street at Spencer Avenue Counts by Day of Week



Mendocino Avenue and McConnell

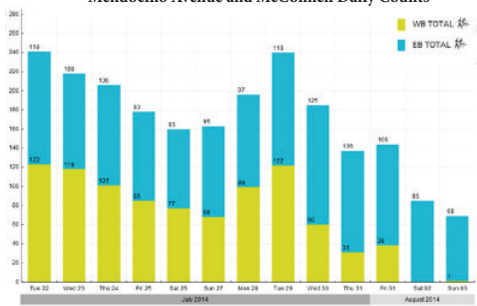
Tube bicycle counters were installed in the Class II bicycle lanes on Mendocino Avenue just north of McConnell Avenue from July 22 through August 3, 2014.

Key Figures

- Total Traffic for the Period Analyzed: 2,222
- Daily Average : 171
- Busiest Day of the Week : Tuesday
- Busiest Days of the Period Analyzed:
  1. Tuesday 22 July 2014 (241)
  2. Tuesday 29 July 2014 (240)
  3. Wednesday 23 July 2014 (218)

- Distribution by Direction:
  NB : 58%
  SB : 42%

Mendocino Avenue and McConnell Daily Counts



Santa Rosa Transit Mall

Infrared pedestrian counters were installed at the east and west gateways of the Santa Rosa Transit Mall from August 7 through August 19 2014.

East Gateway Key Figures

- Total Traffic for the Period Analyzed: 38,567
- Daily Average : 2,967
- Busiest Day of the Week : Friday
- Busiest Days of the Period Analyzed:
  1. Friday 08 August 2014 (3,980)
  2. Monday 11 August 2014 (3,823)
  3. Friday 15 August 2014 (3,377)

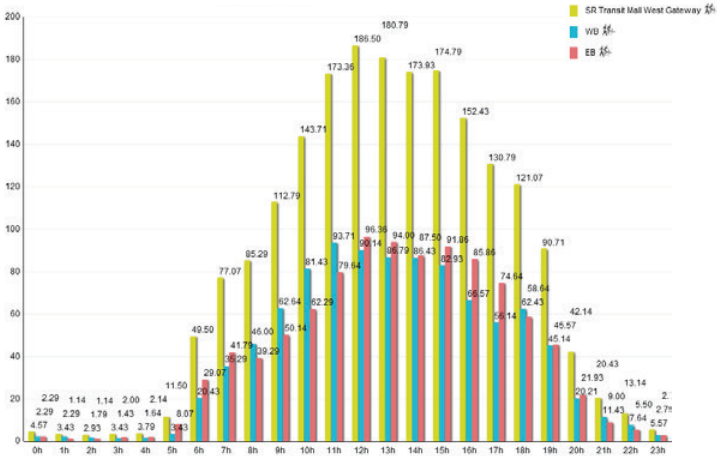
- Distribution by Direction:
  WB : 42%
  EB : 58%

West Gateway Key Figures

- Total Traffic for the Period Analyzed: 27,491
- Daily Average : 1,964
- Busiest Day of the Week : Thursday
- Busiest Day of the Period Analyzed:
  Wednesday 03 September 2014 (2,598)

- Distribution by Direction:
  WB : 49%
  EB : 51%

Santa Rosa Transit Mall Counts by Day of Week



Manual Counts

Sonoma Avenue and Yulupa Avenue

Bicycle Count: 46
Pedestrian Count: 70

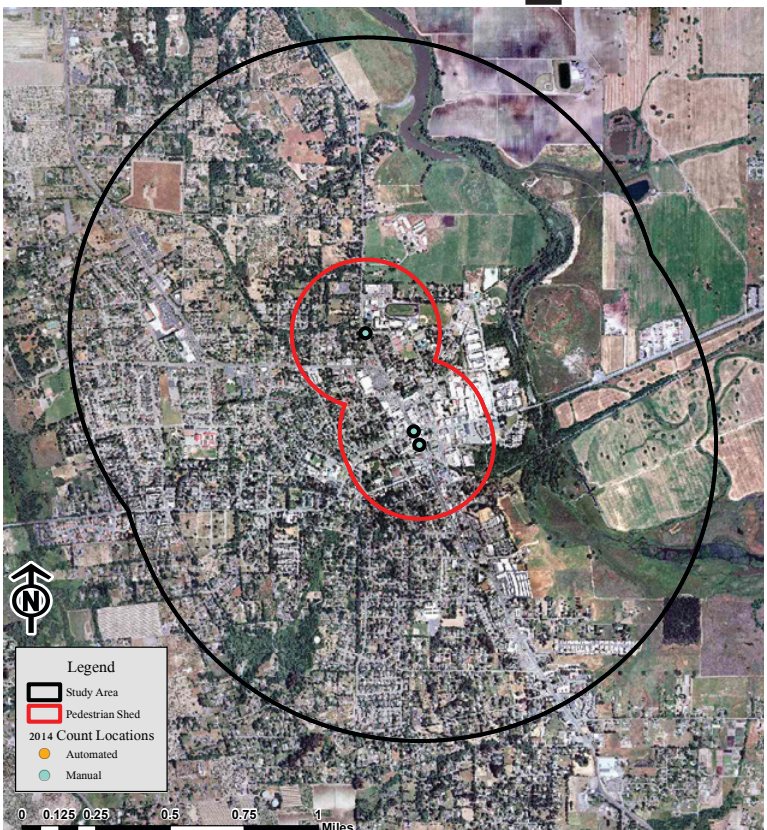
• Speed Limits
  o Yulupa Ave: 30-35 MPH
  o Sonoma Ave: 35 MPH

• Land use in the hed of this intersection is primarily single-family residential, with some commercial areas and parks nearby.

• Class II bicycle lanes are present along Yulupa Avenue and Class III markings are on Sonoma Avenue in this area.

• There were a total of 17 pedestrians in the morning and 29 in the evening at this intersection. Intermittent rains during the week of the counts likely discouraged many potential bicyclists.

Sebastopol


N
Legend
Study Area
Pedestrian Shed
2014 Count Locations
Automated
Manual
0 0.125 0.25 0.5 0.75 1
Miles

Observations

The City of Sebastopol's manual counts were conducted at the intersections of North Main Street and the West County Trail/Analy Avenue, at the intersection of South Main Street and Burnett Street, and at Main Street and Bodega Avenue.

North Main Street and West County Trail/ Analy Avenue

Bicycle Count: 44
Pedestrian Count: 328

- Speed limits
  - o North Main St: 25 MPH
  - o Analy Ave: 25 MPH

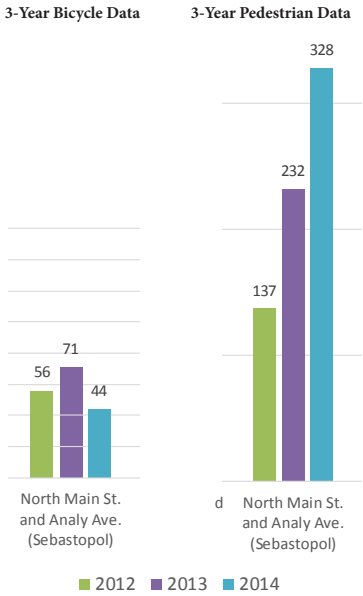
- The substantial amount of bicycle and pedestrian traffic at this location is due to its adjacency to the West County trail, Analy High School, and residential neighborhoods.

- Pedestrian counts increased 41% since 2013, while bicycle counts decreased 38%.

- Morning pedestrian activity was extremely high due to Analy High School students on their way to class. Pedestrian activity has increased significantly over the last three years (3-Year Pedestrian Data graph).

- Bicycle counts were higher in the evening hours.

North Main Street and West County Trail/ Analy Avenue



South Main Street and Burnett Street

Bicycle Count: 24
Pedestrian Count: 367

• Speed limits
  o South Main St: 25 MPH
  o Analy Ave: 25 MPH

• Located in downtown Sebastopol, most of the foot traffic in this area happens during the evening. Slightly more bicyclists were observed in the morning hours. However, historical data shows that activity varies quite drastically year to year.

• Since 2010, bicyclists observed at this location have varried with an overall downward slope. However, due to the variation on any given day that manual counts are performed, no conclusion should be made that there is a downward trend in bicycle usage at this intersection.

• Since 2010, pedestrians observed at this location have varried with the last two years being the highest. Due to the variation on any given day that manual counts are performed, no conclusion should be made about the trend in bicycle usage at this intersection.

Main Street and Bodega Avenue

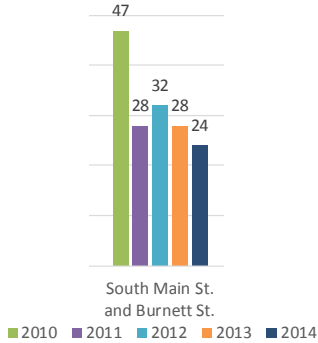
Bicycle Count: 25
Pedestrian Count: 454

• Speed limits
  o Main St: 25 MPH
  o Bodega Ave: 25 MPH

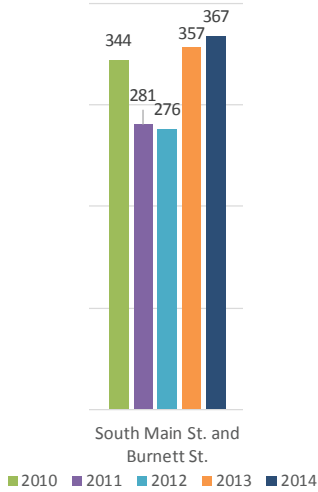
• Also in downtown Sebastopol, more foot traffic was observed during the evening. Significantly more bicyclists were also observed in the evening hours.

• This location has not been counted in previous bicycle and pedestrian count program years.

5-Year Bicycle Data



5-Year Pedestrian Data



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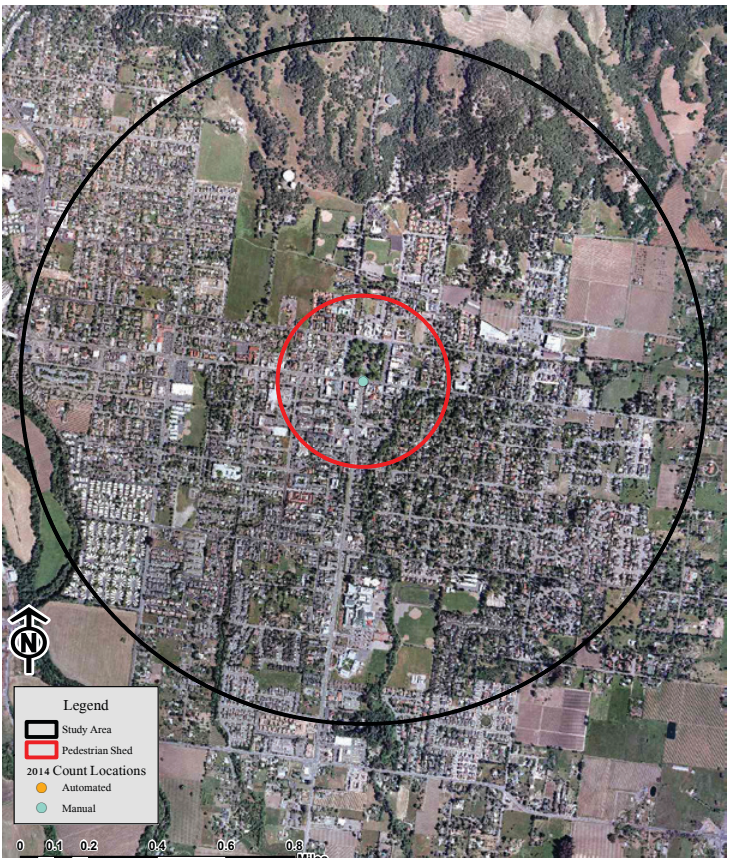
Sonoma


N
Legend
Study Area
Pedestrian Shed
2014 Count Locations
Automated
Manual
0
0.1
0.2
0.4
0.6
0.8
Miles

Observations

The City of Sonoma's manual counts were conducted on Broadway Street and East Napa Street at the Sonoma Plaza.

East Napa Street Location

Bicycle Count: 14
Pedestrian Count: 240

• Speed limits
  o Broadway Street: 25 MPH
  o East Napa Street: 25 MPH

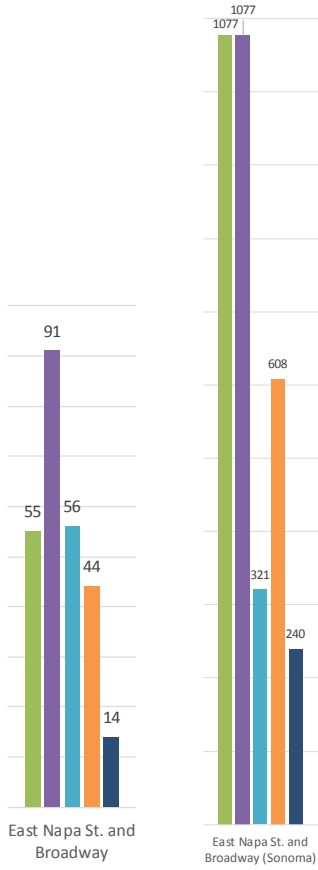
• The count location is situated on the South side of Sonoma Plaza, a main anchor point of the downtown neighborhood.
• Commercial establishments line the Sonoma Plaza but single-family homes dominate the surrounding area.

• The pedestrian shed includes the plaza, which has restaurants, bars, wine tasting, the Sebastiani Theater, specialty shops, and lodging.

• Although pedestrian counts were higher in this location than in many of the other count locations, there was a significant decrease in activity in 2014 due to rain on the day of the counts.

5-Year Bicycle Data

5-Year Pedestrian Data



Sonoma County

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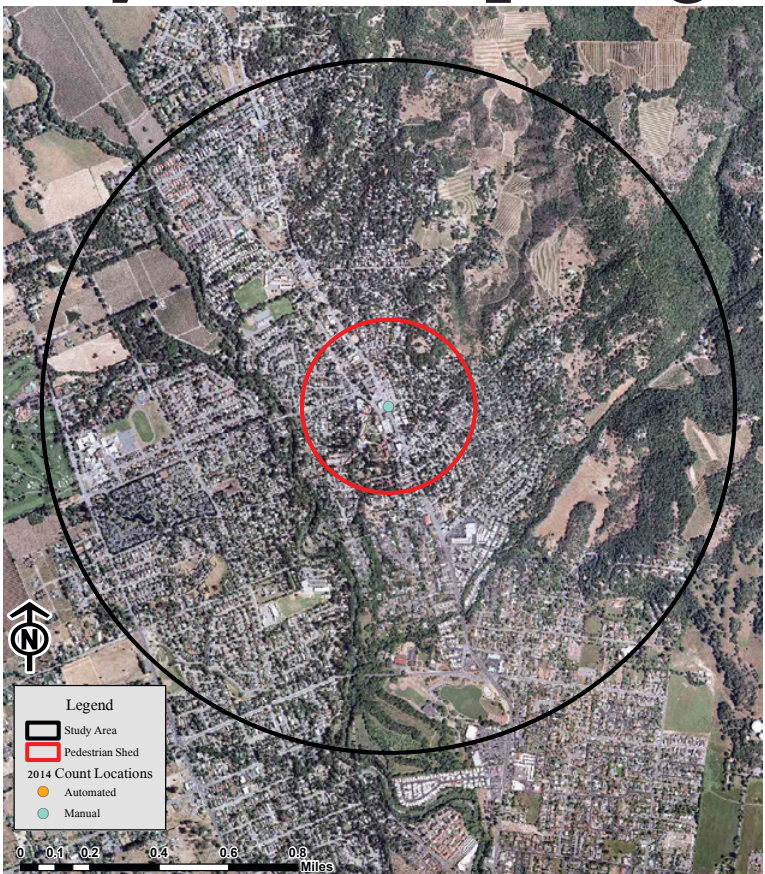
Boyes Hot Springs



Observations

The **Sonoma Highway and Boyes Boulevard** manual count location is in unincorporated Sonoma County.

Bicycle Count: 34
Pedestrian Count: 195

- Speed limits
  - o Hwy 12: 45 MPH
  - o Boyes Blvd: 40 MPH
  - o Vallejo Ave: 25 MPH

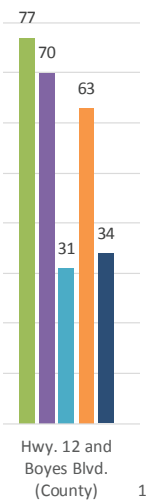
- This location is situated at a busy commercial intersection and is primarily surrounded by single-family housing.

- Between 2002 and 2010 there were 14 pedestrian collisions and 43 bicycle collisions within the 1 mile study area zone of this intersection. Twenty three of the bike-related incidents occurred on Highway 12, the main thoroughfare for the area. There were no bicycle collisions at this intersection itself.

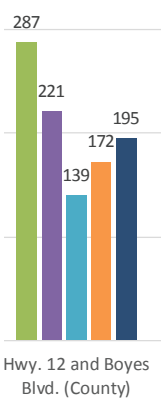
- The majority of the pedestrian activity occurred during the evening hours, while bicycle traffic was the same in the morning and evening.

- There was 46% decrease in bicycle activity and a 13% increase in pedestrian activity since 2013.

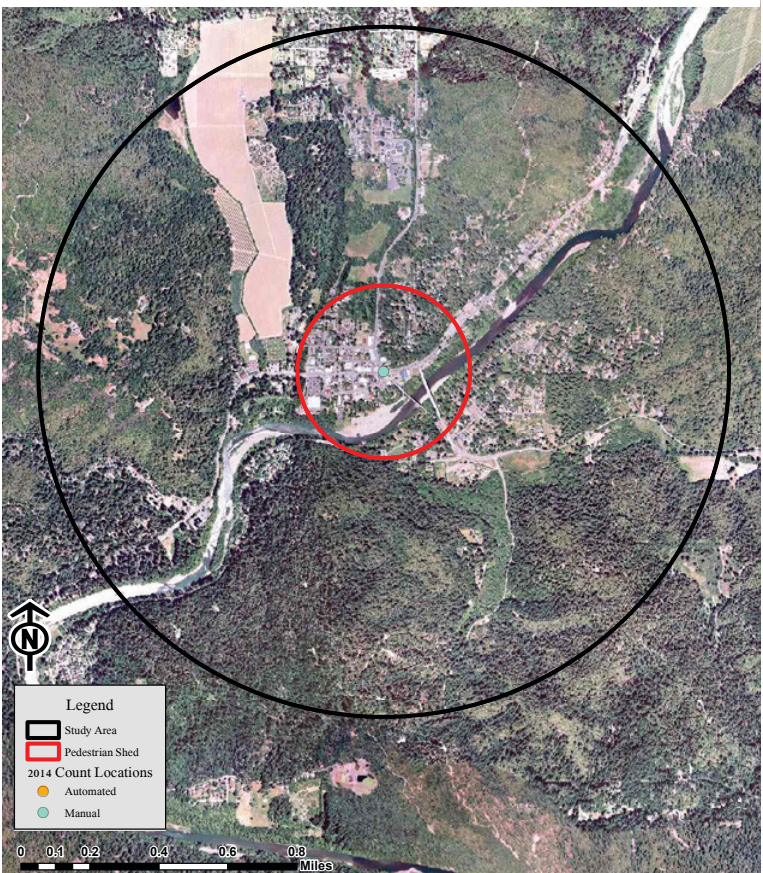
5-Year Bicycle Data



5-Year Pedestrian Data



Guerneville



Observations

Main Street and Armstrong Woods Road (Guerneville): this location represents the unincorporated Sonoma County.

Bicycle Count: 37
Pedestrian Count: 238

- Speed limits
  - o Main St: 25 - 35 MPH
  - o Armstrong Woods Rd: 30 MPH

- From 2002-2010 there were 9 reported bicycle collisions and 9 reported pedestrian collisions within the study area.

- The immediate area surrounding the count location consists of pedestrian oriented shops and restaurants. Land uses in the surrounding the area mostly consist of single-family homes and also include vacant land, multi-family homes, and agriculture.

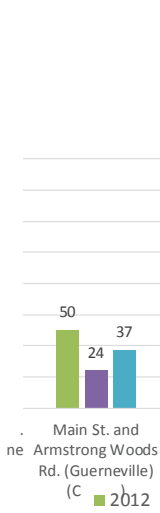
- Although agriculture makes up less than 5 percent of the total parcels in the study area, its total acreage is larger than any other zoning designation.

- The number of observed bicyclists and pedestrians was significantly higher during the 4 p.m. - 6 p.m. time frame.

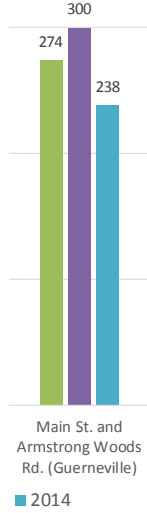
- This year the total amount of bicyclists was 37, which is a 54% increase since 2013.

- The three-year bicycle and pedestrian data do not show a particular trend.

3-Year Bicycle Data

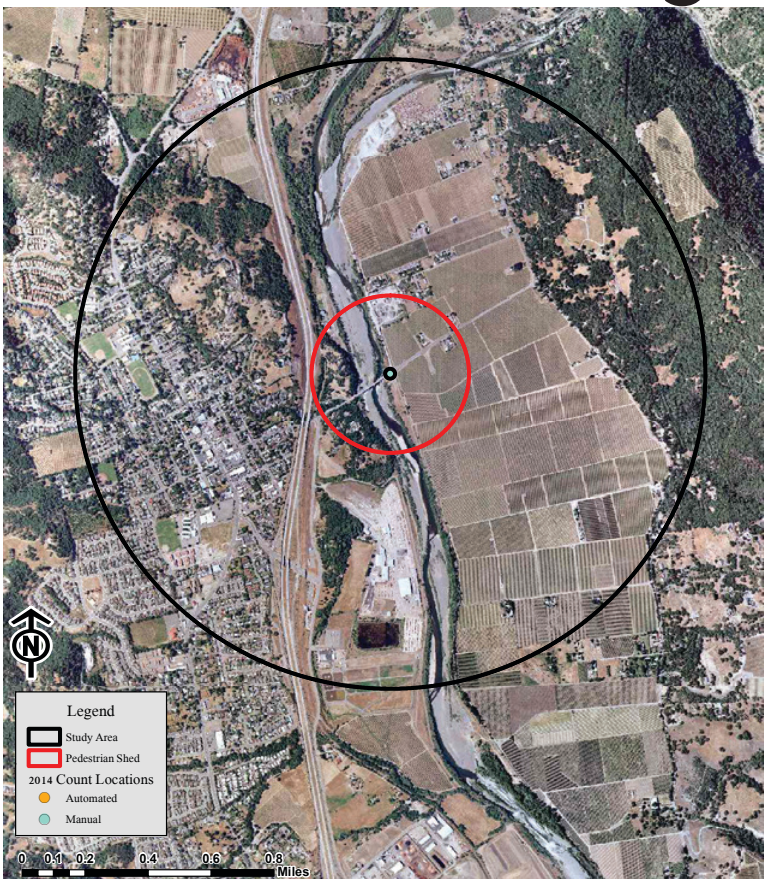


3-Year Pedestrian Data



2012 2013 2014

First Street Bridge



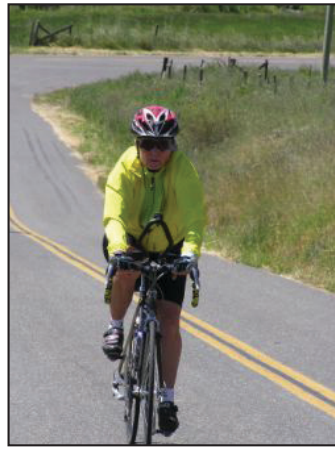
Observations

First Street and River Lane is located near the First Street Bridge over the Russian River just outside of Cloverdale in unincorporated Sonoma County. This location was manually counted in the morning peak hours only due to very low bicycle and pedestrian activity.

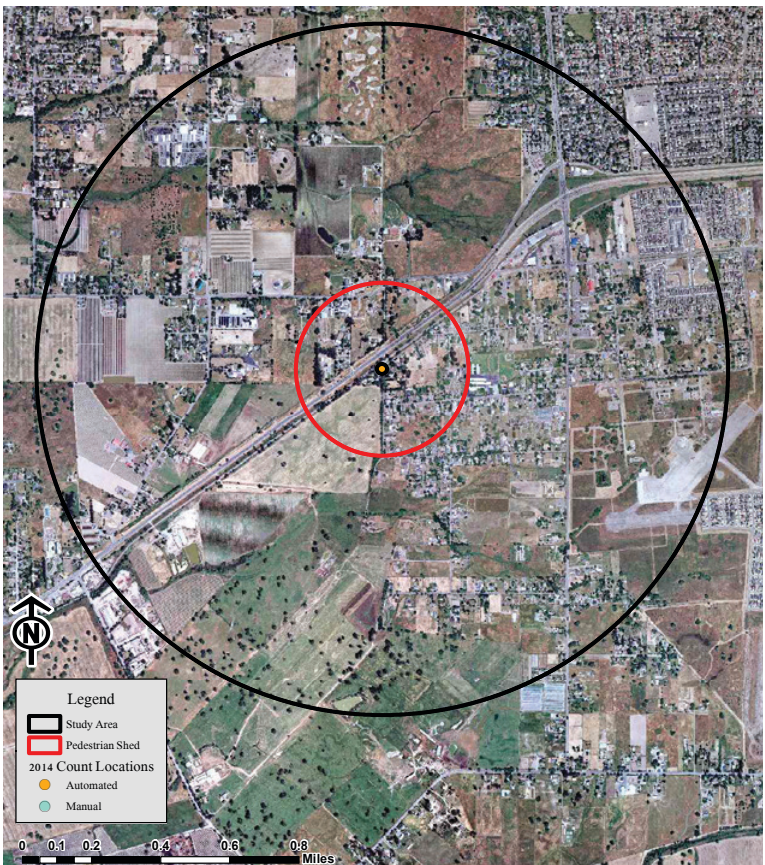
First Street & River Lane
Bicycle Count: 2
Pedestrian Count: 3

- Speed limits
    - o East First Street: 50 MPH
    - o First Street Bridge: 25 MPH

- There is no safe pedestrian or bicycle access across the First Street Bridge. Although concerns were raised about reported pedestrians crossing the bridge, very few were observed in the vicinity of the bridge at the time of the manual counts and none were observed crossing the bridge.



Joe Rodota Trail



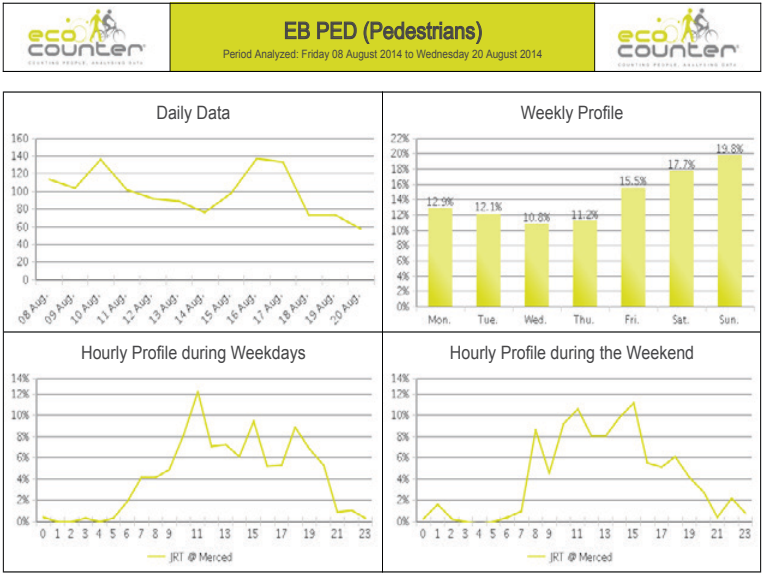
Joe Rodota Trail and Merced Avenue

Infrared pedestrian counters and tube bicycle counters were installed on the Class I Joe Rodota Trail west of Merced Avenue from August 8 through August 20, 2014. The graphs below show that the peak weekday travel is just after 10:00 a.m. and the peak weekend travel is just before 3:00 p.m. in the eastbound direction.

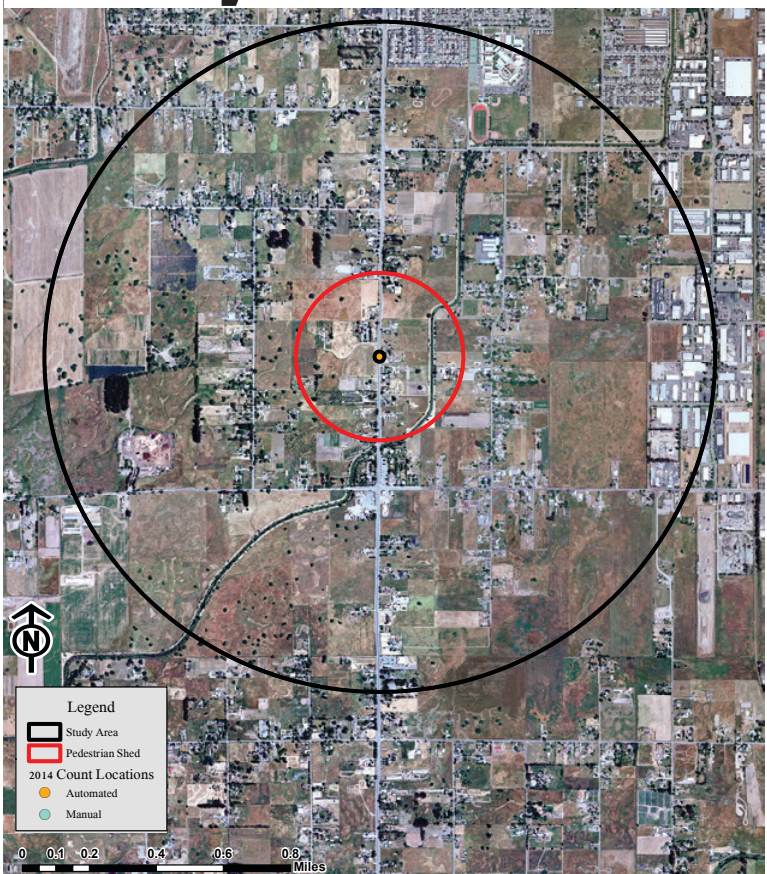
Key Figures

- Total Traffic for the Period Analyzed: 6,718
- Daily Average : 517
- Busiest Day of the Week : Sunday
- Busiest Day of the Period Analyzed: Sunday 10 August 2014 (718)

- Distribution by Direction:
  WB : 49%
  EB : 51%



Stony Point Road



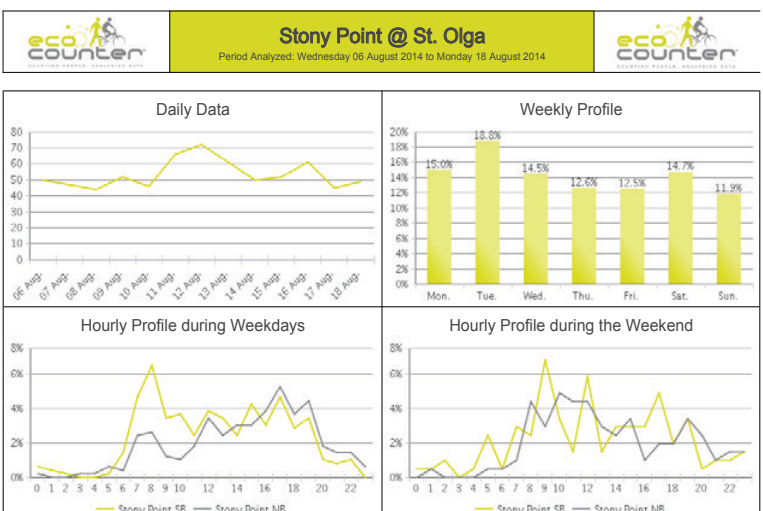
Stony Point Road and Saint Olga Court

Pneumatic tube bicycle counters were installed on Stony Point Road south of Saint Olga Court from August 6 through August 18, 2014. The graphs below show that the peak weekday activity is around 8:30 a.m. and the peak weekend activity is around 9:30 a.m.

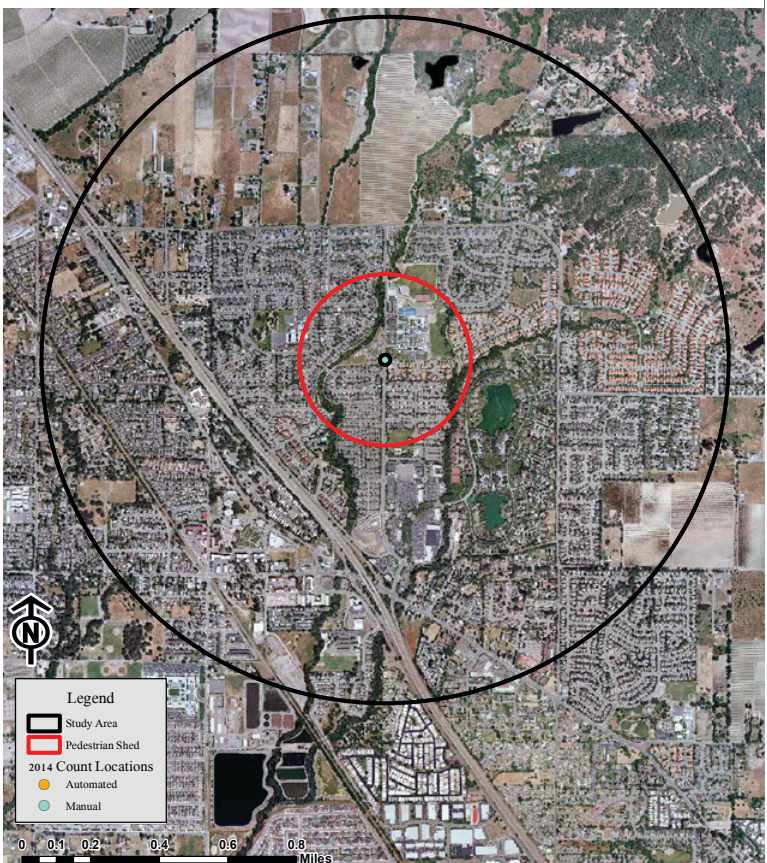
Key Figures

- Total Traffic for the Period Analyzed: 695
- Daily Average : 53
- Busiest Day of the Week : Tuesday
- Busiest Day of the Period Analyzed:
  1. Tuesday 12 August 2014 (72)
  2. Monday 11 August 2014 (66)
  3. Saturday 16 August 2014 (61)

- Distribution by Direction:
  SB : 54%
  NB : 46%



Windsor


N
Legend
Study Area
Pedestrian Shed
2014 Count Locations
Automated
Manual
0 0.1 0.2 0.4 0.6 0.8
Miles

Observations

The count location for the Town of Windsor was located on **Brooks Road and Foothill Drive**.

Bicycle Count: 27
Pedestrian Count: 165

• Speed Limits
  o Brooks Rd: 25 MPH
  o Foothill Dr: 25 MPH

• Single-family homes made up the majority of land uses in the study area, with most of the commercial centers located near Highway 101 and the Windsor Town Green.

• The pedestrian shed is composed primarily by residential neighborhoods and experiences heavy pedestrian traffic due to the presence of Brooks Elementary School.

• Class II bicycle lanes are present on Brooks Road. Access to the Class I Windsor Creek Trail is nearby this intersection.

• The morning time frame counted 110 pedestrians and dropped to 72 during the evening. School is dismissed at 3 p.m., so from 4 p.m. - 6 p.m. there was a substantially lower amount of activity than the morning and what would likely be experienced at 3 p.m.

• There were 8 bicyclists recorded from 7 a.m. - 9 a.m. and 19 from 4 p.m. – 6 p.m.

• There were 23% fewer bicyclists and 8% more pedestrians observed in 2014 than in 2013.

Appendix A — Data Collection by Location

City	Intersection	2009	2010	2011	2012	2013	2014
Cloverdale	Broad St. and Cloverdale Blvd.						X
Cotati	Commerce Blvd and Hwy 116		X	X	X	X	X
County/ Cloverdale area	First Street Bridge and River Lane						X
County/ Boyes Springs	Highway 12 and Boyes Blvd.		X	X	X	X	X
County/Guerneville	Highway 116 and Armstrong Woods Rd.			X	X	X	X
County/ Joe Rodota Trail	Joe Rodota Trail and Merced Avenue						X
County/ Stony Point Road	Stony Point Road and Saint Olga Court						X
Healdsburg	Healdsburg Ave, Mill St. and Vine St.				X	X	X
Petaluma	East D St. and Copeland St.		X		X	X	X
Rohnert Park	Copeland Creek Dr. and Snyder Ln.				X	X	X
Rohnert Park	RP Expressway and Commerce Blvd.	X	X	X	X	X	X
Santa Rosa	Humboldt Street at Spencer Avenue						X
Santa Rosa	Mendocino Avenue and McConnell						X
Santa Rosa	Santa Rosa Transit Mall						X
Santa Rosa	Sonoma Ave and Yulupa Ave						X
Sebastopol	North Main St. and Analy Ave.	X	X		X	X	X
Sebastopol	South Main St. and Burnett St.	X	X	X	X	X	X
Sebastopol	South Main St. and Hwy. 12						X
Sonoma	East Napa St. and Broadway		X	X	X	X	X
Windsor	Brooks Rd. and Foothill Dr.						X

Appendix B					2014 Manual Count Data
Jurisdiction	Intersection	Bicycles		Pedestrians	
		7 am - 9 am	4 pm - 6 pm	7 am - 9 am	4 pm - 6 pm
Cloverdale	Broad St. and Cloverdale Blvd.	3	5	87	127
Cotati	Commerce Blvd and Hwy 116	6	6	13	13
Healdsburg	Healdsburg Ave, Mill St. and Vine St.	3	24	70	49
Petaluma	East D St. and Copeland St.	17	23	57	76
Rohnert Park	Copeland Creek Dr. and Snyder Ln.	46	98	84	97
Rohnert Park	Rohnert Park Expressway. and Commerce Blvd.	12	17	39	149
Santa Rosa	Sonoma Ave and Yulupa Ave	17	29	37	33
Sebastopol	North Main St. and Analy Ave.	16	28	259	69
Sebastopol	South Main St. and Burnett St.	14	10	94	273
Sebastopol	South Main St. and Bodega Ave.	5	20	52	402
Sonoma	East Napa St. and Broadway	5	9	22	218
Windsor	Brooks Rd. and Foothill Dr.	8	19	109	56
County/ Boyes Springs	Highway 12 and Boyes Blvd.	17	17	71	124
County/ Guerneville	Highway 116 and Armstrong Woods Rd.	10	27	70	168
County/ Cloverdale area	First Street Bridge and River Lane	2	-	3	-
Total Observed		181	332	1067	1854
Total Bikes and Pedestrians		513		2921	

Appendix C							2013 - 2014 Percent Change
	Locations	Bicycles			Pedestrians		
City	Intersection	2013	2014	Percent Change	2013	2014	Percent Change
Cloverdale	Broad St. and Cloverdale Blvd.	-	8	-	-	214	-
Cotati	Commerce Blvd and Hwy 116	38	12	-68%	49	26	-47%
Healdsburg	Healdsburg Ave, Mill St. and Vine St.	32	27	-16%	45	119	164%
Petaluma	East D St. and Copeland St.	86	40	-53%	115	133	16%
Rohnert Park	Copeland Creek Dr. and Snyder Ln.	133	144	8%	208	181	-13%
Rohnert Park	Rohnert Park Expressway. and Commerce Blvd.	46	29	-37%	129	188	46%
Santa Rosa	Sonoma Ave and Yulupa Ave	-	46	-	-	70	-
Sebastopol	North Main St. and Analy Ave.	71	44	-38%	232	328	41%
Sebastopol	South Main St. and Burnett St.	28	24	-14%	357	367	3%
Sebastopol	South Main St. and Bodega Ave.	-	25	-	-	454	-
Sonoma	East Napa St. and Broadway	44	14	-68%	422	240	-43%
Windsor	Brooks Rd. and Foothill Dr.	35	27	-23%	153	165	8%
County/Boyes Springs	Highway 12 and Boyes Blvd.	63	34	-46%	172	195	13%
County/ Guerneville	Highway 116 and Armstrong Woods Rd.	24	37	54%	300	238	-21%
County/ Cloverdale area	First Street Bridge and River Lane	-	2	-	-	3	-

Appendix D				2014 Maual Count Genter Statistics	
Locations		Bicycles		Pedestrians	
Jurisdiction	Intersection	Female	Male	Female	Male
Cloverdale	Broad St. and Cloverdale Blvd.	0	8	99	115
Cotati	Hwy 116. and Commerce Blvd.	1	11	12	14
County/Boyes Springs	Sonoma Hwy. and Boyes Blvd.	8	26	80	115
County/Cloverdale area	First St Bridge and River Ln.	0	2	1	2
County/Guerneville	Hwy 116. and Armstrong Woods Rd.	4	33	92	146
Healdsburg	Healdsburg Ave. and Mill St.	3	24	30	40
Petaluma	East D St. and Copeland St.	8	32	39	94
Rohnert Park	Copeland Creek Path and Snyder Ln.	44	100	85	96
Rohnert Park	Rohnert Park Expressway and Commerce Blvd.	4	25	88	100
Santa Rosa	Sonoma Ave. and Yulupa Ave	10	36	37	33
Sebastopol	South Main St. and Hwy. 12	7	18	234	220
Sebastopol	South Main St. and Burnett St.	9	15	182	185
Sebastopol	North Main St. and Analy Ave.	15	29	162	166
Sonoma	Broadway St. and East Napa St.	4	10	132	108
Windsor	Brooks Rd. and Foothill Dr.	6	21	89	59
	Totals:	**123**	**390**	**1362**	**1493**

Appendix E		2013-2014 Manual Count Female Bicycle Usage		
Locations		Bicycles		
Jurisdiction	Intersection	2013	2014	Percent Change
Cloverdale	Broad St. and Cloverdale Blvd.	-	0	-
Cotati	Hwy 116. and Commerce Blvd.	1	1	0%
County/Boyes Springs	Sonoma Hwy. and Boyes Blvd.	10	8	-20%
County/Cloverdale area	First St Bridge and River Ln.	-	0	-
County/Guerneville	Hwy 116. and Armstrong Woods Rd.	3	4	33%
Healdsburg	Healdsburg Ave. and Mill St.	8	3	-63%
Petaluma	East D St. and Copeland St.	16	8	-50%
Rohnert Park	Copeland Creek Path and Snyder Ln.	36	44	22%
Rohnert Park	Rohnert Park Expressway and Commerce Blvd.	13	4	-69%
Santa Rosa	Sonoma Ave. and Yulupa Ave	-	10	-
Sebastopol	South Main St. and Burnett St.	5	9	80%
Sebastopol	South Main St. and Bodega Ave.	-	7	-
Sebastopol	North Main St. and Analy Ave.	13	15	-
Sonoma	Broadway St. and East Napa St.	6	4	-33%
Windsor	Brooks Rd. and Foothill Dr.	9	6	-33%
	Total	120	123	3%

Automated Bicycle and Pedestrian Counts – Program Development and Equipment Testing

DRAFT

January 2015

SCTA
sonoma county transportation authority

Table of Contents

Introduction 4
Existing and Emerging Automated Counter Equipment Technologies 6
Equipment Selection and Procurement 9
Equipment Field Test Procedure 10
Test Site Selection 12
Counter Installation 14
Field Data Collection and Testing 14
Validation – Controlled Evaluation Results 14
Test Site Descriptions and Manual Field Validation Results 18
Evaluation of Data Processing Tools 28
Validation – Equipment Field Test Overall Observations 31
Conclusions and Recommendations 33
References 34
Appendicies 36

List of Figures and Tables

Figure 1. Passive infrared counter on multi-use pathway 6
Figure 2. Pneumatic Tube Counter in urban bike lane..... 6
Figure 3. Inductive loop counter being installed on road shoulder 7
Figure 4. Pressure sensitive pad counting system..... 7
Figure 5. Infrared beam or laser counter system 8
Figure 6. SCTA Automated Counter Test Locations.....13
Table 1 . SCTA 2014 Automated Bicycle/Pedestrian Counter Test Locations and Installation Dates 13
Table 2. SCTA 2014 Automated Bicycle/Pedestrian Counter Test Program – Controlled Evaluation Test Results.....17
Figure 7. Mendocino Ave. at McConnell Ave. Test Location.....19
Table 3. Mendocino @ McConnell SRJC crosswalk – west side 19
Table 4. Mendocino @ McConnell SRJC crosswalk – east side.....20
Figure 8. Mendocino Ave. Class 2 Bike Lane Test Location.....21
Table 5. Mendocino Ave. SRJC Class 2 Bike Lanes 21
Figure 9. Stony Point Rd. Test Location 22
Table 6. Stony Point Rd. between Bellevue Avenue & Todd Road.....22
Figure 10. Santa Rosa Transit Mall Test Location – Southwest Corner.....23
Table 7. SR Transit Mall – NE Corner 24
Table 8. SR Transit Mall – SE Corner 24
Table 9. SR Transit Mall – NW Corner 24
Table 10. SR Transit Mall – SW Corner 24
Figure 11. Joe Rodota Trail Test Location.....25
Table 11. Joe Rodota Trail at Merced 25
Figure 12. Humboldt Street Test Location 26
Table 12. Humboldt at Spencer - North 27
Table 13. Humboldt at Spencer - South 27
Figure 13. Eco-Visio Daily Activity Report by Travel Mode 29
Figure 14. Eco-Visio Day of Week Activity Report by Travel Mode.....29
Figure 15. Eco-Visio Complete Count Period Report by Travel Mode 30
Figure 16. Eco-Visio Count Location Travel Mode Summary.....30

Introduction:

Bicycle and Pedestrian counts provide important information that is useful for non-motorized facility planning, implementing signal timing, building safety improvements, and prioritizing transportation projects. The data collected through the SCTA bicycle and pedestrian count program has been used for supporting grant applications, tracking trends on the use of non-motorized modes in the county, and improving the accuracy of the non-motorized portions of the countywide travel demand model. The data can also be used for determining the need for non-motorized facilities, identifying non-motorized conflict areas, and for providing input and background information for local, countywide, and regional plans.

The Sonoma County Transportation Authority (SCTA) has collected bicycle and pedestrian counts since 2009 using the National Bicycle and Pedestrian Documentation Project methodology (http://bikepeddocumentation.org/) for manual data collection. Counts have been collected on weekdays during peak commute periods (7-9AM and 4-6PM). Field data was generally collected on Tuesdays, Wednesdays, or Thursdays since these midweek days are regarded as having the most average travel patterns.

Manually collected data has provided information about the geographic distribution of non-motorized travel activity in Sonoma County, but data collected using the manual count method has the following weaknesses:

- The number of count locations is limited and the count durations are very short (4 hours per year, per location).
- Counts are only collected during peak commute periods. Traditional peak commute periods may not represent peak periods for non-motorized travel including recreational and tourist related travel.
- Counts are only collected for one day per location per year and non-motorized activity on the collection day may not represent typical or average non-motorized activity at each location and does not provide a statistically significant sample of activity at the location. The small amount of data collected also makes it very difficult to estimate non-motorized travel activity levels at a jurisdiction or countywide level.
- Weather or local impacts from special events, accidents, obstructions, or other factors can introduce significant bias into the data.

A number of approaches where used to improve the information provided by SCTA's bicycle and pedestrian count program. These included increasing the number of count locations, limiting count periods to late spring and fall months when schools are in session and non-motorized travel is believed to be at its peak, and counting at the same locations from year to year so that yearly trends could be observed. These approaches where not largely successful at improving the quality and utility of the data collected because of the variability in non-motorized travel behavior and the inherent errors and bias that could be identified in short-term manually collected data.

Automatic bicycle and pedestrian counting equipment is becoming more common and has been used and tested by jurisdictions in the San Francisco Bay Area such as San

Francisco, Oakland, and Berkeley. Other Bay Area agencies and academics have reported that data collected using automated counters can help provide a more complete picture of where, when, and how often people are biking and walking in their jurisdictions. This equipment is expected to provide cost-effective and more accurate methods for tracking non-motorized travel behavior over longer time periods.

SCTA staff began investigating the possibility of using automated counting technologies as part of the Sonoma County Bicycle and Pedestrian Count Program as a means to address the issues that have been observed with manually collected count data. SCTA purchased and field tested four sets of automated bicycle and pedestrian counters in the Summer/Fall of 2014. The results of the field test and recommendations for how to integrate the equipment into SCTA's bicycle and pedestrian count program are summarized in this report.

Existing and Emerging Automated Counter Equipment Technologies:

There are currently a variety of automated bicycle and pedestrian counting technologies available and being employed in the field. These include:

- *Passive infrared Counters* – These sensors detect heat or thermal signatures emitted by bicyclists or pedestrians. Can be permanent or temporary installations. Can log direction of travel but cannot distinguish between different user types.

Figure 1. Passive infrared counter on multi-use pathway.

- *Pneumatic tube counters* – Tubes are laid across a bicycle facility and count bicyclists based on air pulses that are triggered when a bicyclist passes over the tubes. Can log direction of travel but counts bicyclists only. Are temporary installations, but may be subject to wear and tear or vandalism.

Figure 2. Pneumatic Tube Counter in urban bike lane.

- *Inductive Loop Counters* – Inductive loops are installed in the pavement or surface of a bicycle lane or pathway and detect the electromagnetic signatures of bicycle wheels as they pass over the loop. Most are permanent installations due to the difficulty of installation and removal. Detects direction of travel and is very vandalism resistant, but cannot be easily moved to another location and counts bicycle traffic only.

Figure 3. Inductive loop counter being installed on road shoulder.

- *Piezoelectric or pressure sensitive pads* – Pads or plates set into a pathway, sidewalk, or bike lane count users based on pressure changes.

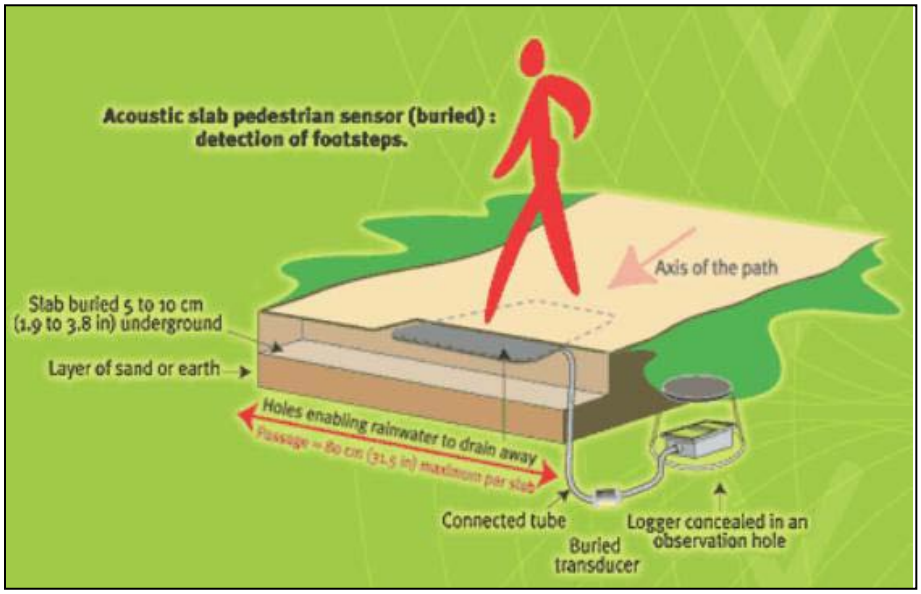


Figure 4. Pressure sensitive pad counting system.

- *Infrared beam/Laser counters* – Composed of a transmitter and receiver and continuous infrared or laser beam. A bicyclist or pedestrian is counted when the beam is broken.

Figure 5. Infrared beam or laser counter system

- *Video Capture Systems* – Consists of video surveillance equipment and video processing algorithms which recognize and count bicyclists and pedestrians observed in the recorded video stream.

A combination of different technologies may be used to track different types of users and to cover the weaknesses of certain systems and leverage the strengths of others. Combination approaches provide the most complete and reliable data, but are much more expensive to implement, maintain, and install.

Passive infrared, pneumatic tube counters, and Inductive loop counters are the most common technologies used to track non-motorized travel behavior in the San Francisco Bay Region.

Equipment Selection and Procurement:

Staff reviewed academic and agency research on automated counting equipment, and talked to other agencies that are currently collecting counts using automated counters as part of the equipment selection process. Eco-counter automated counters were recommended in the literature and by colleagues at other Bay Area agencies (SF MTA, SFCTA, University of California - Berkeley Safe Transportation Research and Education Center). SCTA hosted a number of webinars, or web demonstrations, providing detailed information on Eco-counter technology and equipment.

Eco-counter infrared sensors and pneumatic tube counters were selected as the preferred equipment for use in SCTA's bicycle and pedestrian count program because:

- Research had shown that this equipment is reliable and provides reasonably accurate measurements, and the vendor has a good track record of providing sufficient support for their product.[1]
- Eco-counter equipment has been successfully used by other agencies in the Bay Area, which provides a local resource for support and data sharing, and an opportunity to learn from what other agencies have learned deploying this equipment.[2]
- Eco-counter equipment is mobile and can be moved to different locations. Equipment installation and calibration is also relatively straight-forward and does not require intensive training.
- Battery life is long. Eco-counter data logger battery life is approximately 10 years.

SCTA purchased 4 Eco-counter Infrared bicycle and pedestrian counters and 4 Eco-counter pneumatic bicycle tube counters in the summer of 2014. SCTA tested the equipment at 5 locations during the months of July, August, and September in order to determine the best way to deploy the equipment (including installation procedures, locations, etc.) and to assess the accuracy of the data collected.

[1] Discussions with SFMTA and SFCTA staff and findins in: Greene-Roesel, Diogenes, Ragland, & Lindau (2008).
[2] San Francisco County Transportation Authority & SF Muni use Eco-counter equipment in San Francisco. SAFETREC (University of California/Berkeley – Safe Transportation Research and Education Center) has used Eco-counter equipment in the East Bay. Solano Transportation Authority is purchasing Eco-counter equipment for use in Solano County.

Equipment Field Test Procedure:

Since automated counters are a new technology and SCTA and local staff were unfamiliar with deploying and installing the equipment, a two month evaluation and test period was scheduled once the equipment had been received in July, 2014. The evaluation and test period allowed SCTA and local jurisdiction staff to:

- Learn how to install the equipment
- Determine the best locations to do automated vs. manual counting
- Test different equipment set-up configurations
- Test data collection accuracy in different settings
- Indentify possible sources of counting error (undercounting due to groups, interference due to reflective surfaces, vandalism/equipment tampering, etc.)
- Test data extraction processes
- Test data evaluation, reporting, and interpretation
- Help train local staff on equipment use and installation
- Determine which local permits or procedures may need to be followed when installing the counting equipment

A summary of the test period findings can be found in later sections of this report.

Recent research[3] recommends that automated bicyclist and pedestrian counters be evaluated in the field using two different types of accuracy assessments:

- **Controlled evaluations** are conducted by setting up a number of prescribed test situations and evaluating equipment performance in each of these different counting scenarios. Manual counts and observations are made for each of these test scenarios and are compared to the automated counter output. Possible test scenarios could include performing 30 evaluations of 2 people walking side-by-side in front of the sensor to determine count accuracy for group counts, or observing a bicyclist traveling over a tube counter at different speeds and determining equipment accuracy in different speed ranges.
- **Field evaluations** are used to determine counter accuracy at specific count locations or under different environmental conditions. No predetermined test scenarios are used, and manual counts and observations are compared to automated counts for a certain time period. Staff could test counter performance for different count location types including: class 1 multi-use pathways, class 2 bike lanes, rural roadways, busy pedestrian locations, bike boulevards, and residential areas.

[3] "Quality Counts for Pedestrians and Bicyclists: Quality Assurance Procedures for Non-Motorized Traffic Count Data", Turner, Shawn; Lasley, Philip, Texas Transportation Institute, The Texas A&M University System, College Station, Texas, Presented January 2013, at the Transportation Research Board's 92nd Annual Meeting.

Both controlled and field evaluations were used to determine counter accuracy in a range of different conditions.

The following variables were tested as part of the controlled evaluations:

- ***Group Spacing:*** two pedestrians observed at 0 to 5 ft. spacing to test for occlusion
- ***Walking Speed:*** test normal walking, jogging, and running speeds
- ***Bicyclist Speed:*** test from 5 to 25 mph
- ***Average distance from sensor:*** test from 0 to 13 ft.
- ***Equipment mounting height:*** Use eco-counter recommended mounting height, but test slight variations that might occur due to different field conditions.
- ***Air temperature/time of day:*** test in morning, midday, and evening during periods with different air temperatures and sun aspect.

Field evaluations and observations were used to assess how the following count location variables impact count accuracy:

- Average bike/ped. traffic (high, medium, and low flow of pedestrians or bicyclists)
- Width of facility (sidewalk, bike lane, class 1 pathway, etc.)
- Average traffic speed and amount of traffic for tube counter locations
- Type of facility
- Air temperature and ambient lighting conditions

Manual Counts were collected in order to determine counter accuracy at specific count locations. 1-3 Manual counts were collected for each test location. Counts were collected for 1 hour for different time periods including AM (between 6-9am), PM (between 3-6pm), and midday (between 11am-2pm) time periods. Manual counts are compared to automated counts for each time period later in this report.

In addition to performing the controlled and field evaluations described above, staff checked on the counters frequently during the test period to ensure that the equipment had not been tampered with and was working correctly. No equipment failure that impacted data collection was observed during the test period, but one counter was cosmetically vandalized, and pneumatic tubes came loose at two locations and needed to be secured with heavy duty asphalt tape.

Test Site Selection:

The test sites were selected by considering the following criteria:

- The test location should have bicycle or pedestrian facilities such as bike lanes, shoulders, sidewalks, or crosswalks.
- The test location should have relatively simple bicycle or pedestrian activity patterns. Irregular or weaving flows would be difficult to count using the automated sensors.
- The test location should have a secure mounting structure such as a light pole or sign post to affix counters to according to vendor specifications.
- Visibility: There should not be any physical objects such as trees or signs that block the clear line of sight of counting equipment.
- Safety: There should be a secure location onsite for staff to stand and collect manual counts for accuracy testing without disturbing normal traffic. The test location should include a safe space for device setup.
- Test locations should represent a variety of different type of potential count locations, including high/med/low volumes, facility types, and settings (urban/suburban/rural).
- Accessibility: Test locations should be located within an acceptable travel time of the SCTA offices.

Staff used these criteria to select 5 test locations in Sonoma County (*see Figure 6 and Table 1*). These locations were selected because most of them represent high activity locations with good bicycle and/or pedestrian infrastructure. The locations were also relatively close to the SCTA offices, which allowed staff to check on the field equipment more frequently. Staff visited each of these locations in the field and verified that the equipment would be able to be physically installed at each test site.

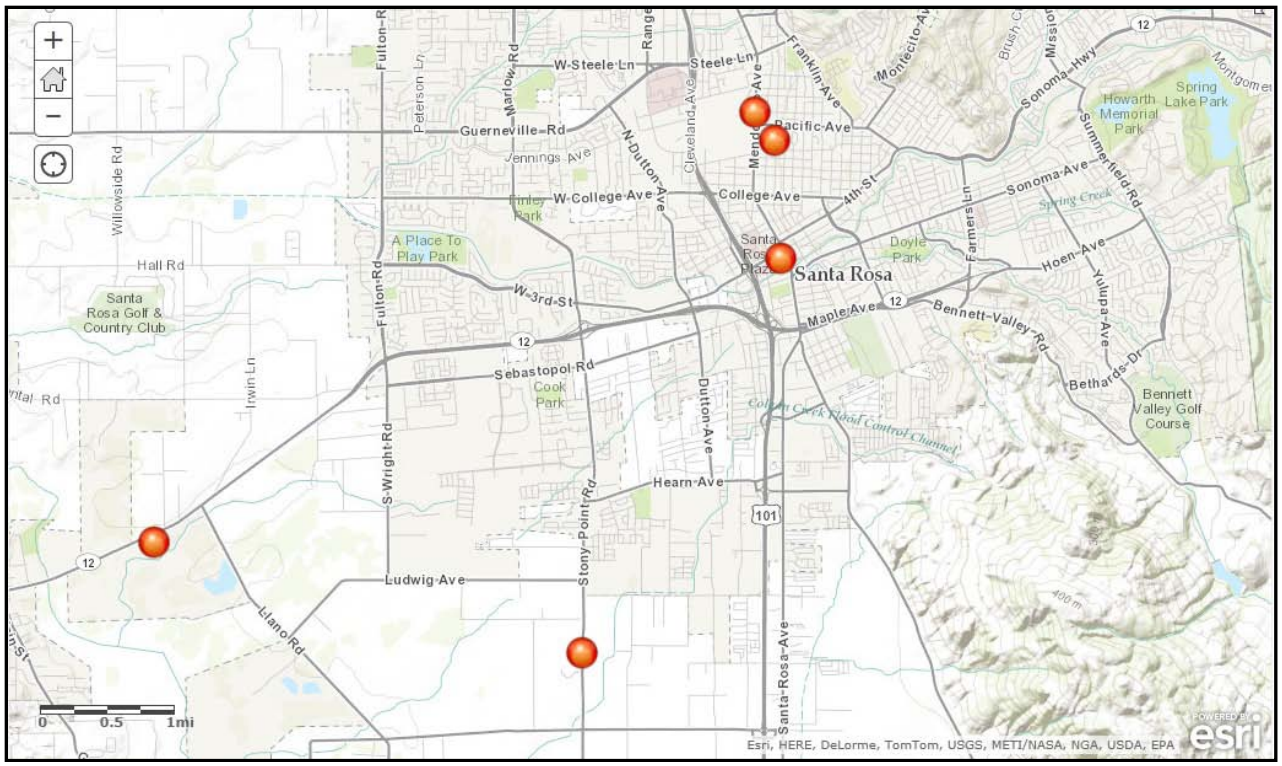


Figure 6. SCTA Automated Counter Test Locations

Location	Install Date	Retrieval Date
Mendocino @ McConnell SRJC crosswalk - west side	7/16/2014	8/4/2014
Mendocino @ McConnell SRJC crosswalk - east side	7/16/2014	8/4/2014
Mendocino Ave SRJC Class 2 Bike Lanes - west side	7/21/2014	8/4/2014
Mendocino Ave SRJC Class 2 Bike Lanes - east side	7/21/2014	8/4/2014
Stony Point Rd. @ St. Olga - west side	8/5/2014	8/19/2014
Stony Point Rd. @ St. Olga - east side	8/5/2014	8/19/2014
SR Transit Mall - Northeast Corner	8/6/2014	8/20/2014
SR Transit Mall - Southeast Corner	8/6/2014	8/20/2014
SR Transit Mall - Northwest Corner	8/20/2014	9/4/2014
SR Transit Mall - Southwest Corner	8/20/2014	9/4/2014
Joe Rodota Trail @ Merced - Tube Counter	8/7/2014	8/21/2014
Joe Rodota Trail @ Merced - Infrared Counter	8/7/2014	8/21/2014
Humboldt Bike Blvd @ Spencer St - North Leg - Infrared	8/21/2014	9/4/2014
Humboldt Bike Blvd @ Spencer St - North Leg - Tube	8/21/2014	9/4/2014
Humboldt Bike Blvd @ Spencer St - South Leg - Infrared	8/21/2014	9/4/2014
Humboldt Bike Blvd @ Spencer St - South Leg - Tube	8/21/2014	9/4/2014

Table 1. SCTA 2014 Automated Bicycle/Pedestrian Counter Test Locations and Installation Dates.

Counter Installation:

The counters were installed by 2 or more person teams composed of SCTA and/or local jurisdiction staff. One member was primarily responsible for watching for traffic and warning approaching pedestrians while the other person(s) installed the equipment following the instructions provided by Eco-counter (the equipment vendor). The following count location checklist was used when installing and monitoring the devices:

Count Location Checklist:

1. Check all equipment for proper operation.
2. Bring necessary accessories such as batteries, locks, nails, etc.
3. Identify required data collection before leaving.
4. Specify the counter placing location and adjust as necessary in the field.
5. Install and fasten counting sensors securely.
6. Start and test counter operation.
7. Periodically check the counter especially during poor weather conditions.
8. Record the checking results and recover the counter if it fails.

Field Data Collection and Testing:

Once field data collection was complete, staff downloaded all of the raw count data from the field devices. Data is collected in 15 minute intervals and can be summarized by day of week, time of day, direction of travel, and travel mode (bicycle or pedestrian).

Data can be downloaded from the counters at any time using a blue-tooth equipped laptop or tablet that has the Eco-counter Eco-link software installed. Eco-visio software provided by Eco-counter provides some reporting and data browsing functionality, but staff also examined the data using spreadsheet, database, and GIS software. During the data review process, staff looked for outliers that do not represent reasonable usage patterns for the specific type of facility and count location.

Validation - Controlled Evaluation Results:

SCTA staff performed controlled evaluations of the counters at the Joe Rodota Trail and Humboldt Street test locations. As discussed previously, controlled evaluations are conducted by setting up a number of prescribed test situations and evaluating equipment performance in each of these different counting scenarios. Manual counts and observations are made for each of these test scenarios and are compared to the automated counter output. At both test locations, one person monitored real-time count results using a tablet connected to the counter using a Bluetooth connection, while other staff and volunteers walked or biked past the counters testing how group spacing, group size, speed, and distance from the counter impacted count accuracy. Actual bike or pedestrian traffic and counter readings were recorded manually using the “Automated

Bicycle/Pedestrian Counter Controlled Evaluation" (See Appendix B) form developed by staff.

Counter performance and accuracy was evaluated by calculating the ratio of real-world observed activity to automated counts. This ratio is shown in the AVG. Error field in the table below. A score of 1.0 represents a perfect match between observed activity and automated counts. Scores below one indicate that the actual number of bicyclists or pedestrians passing the sensor was lower than counted by the automated counter and that the automated counters may be overestimating non-motorized activity. Scores above one indicate that the actual number of bicyclists or pedestrians passing the sensor was higher than counted by the equipment and that the counters may be underestimating walking or biking in certain circumstances.

The following test variables were tested as part of the controlled evaluations:

- ***Group Spacing:*** two pedestrians at 0 to 5 ft. spacing to test for occlusion
- ***Walking Speed:*** test normal walking, jogging, and running speeds
- ***Bicyclist Speed:*** test from 5 to 25 mph
- ***Average distance from sensor:*** test from 0 to 13 ft.
- ***Equipment mounting height:*** Use eco-counter recommended mounting height, but test slight variations that might occur due to different field conditions.
- ***Air temperature/time of day:*** test in morning, midday, and evening during periods with different air temperatures and sun aspect.

The automated counting equipment was able to perfectly count a single bicyclist or pedestrian under baseline conditions as shown in the "Baseline Walking" and "Baseline Biking" entries in the table below. Baseline conditions have been defined as being 5 feet from the sensor, traveling at average walking/biking speed, with no stopping in front of the sensor. Air temperature and time of day do not appear to have any impact on the counting equipment. As long as activity occurred within the maximum sensor range, distance from the counter did not appear to impact count accuracy. The maximum range for the sensors is 15 feet for infrared sensors and total tube length for bicycle tube counters. The following variables did appear to have an impact on counter performance:

1. **Group Spacing**: Bicyclists or pedestrians may not be counted if they pass the sensor or ride over a pneumatic tube at the same time or if they pass the sensor spaced 1 foot or lower from one another. Group spacing of greater than 1 foot does not appear to have a large impact counter accuracy.

2. **Group Size:** Larger groups appear to lead to undercounting. This error is related to group spacing and the occlusion that often occurs in bicyclist or

pedestrian groups. Larger groups appear to lead to a higher incidence of missed counts.

3. **Travel Speed:** Travel speed did not appear to have an impact on count accuracy with two significant exceptions. If an individual or group stood continuously in front of an infrared sensor, they would be counted over and over again, leading to over-counts. The controlled tests indicated that over-count errors due to stopped pedestrians could be relatively high. Because of this possible source of error, it is important that the equipment is installed in locations where travel would be continuously flowing past the sensor, and not in locations where there is frequent stopping or congregation. Very low bicycle speeds (almost stopped to the point of a bicyclist tipping over) were not counted by bicycle tube counters. These low bicycle speeds are not typical, so these type of missed bicycle counts are not expected under normal counting conditions.

4. **Equipment Mounting Height*:*** Device mounting height was tested during installation and mounting heights of lower than approximately 3 feet led to some over-counts. The sensor may count leg movements as separate individuals if the counter is mounted too low. Eco-counter recommends that infrared counters be mounted at approximately hip height in order to avoid these types of errors.

Automated Count Pilot - Controlled Evaluation Results

	Humboldt			Joe Rodota Trail			
	Eco Counter	Actual	Error	Eco Counter	Actual	Error	AVG. Error
Baseline Walking	8	8	1.00	8	8	1.00	1.00
Baseline Biking	8	8	1.00	8	8	1.00	1.00
Group Spacing							
0 ft	8	16	0.50	8	16	0.50	0.50
1 ft	15	16	0.94	15	16	0.94	0.94
> 1 ft	15	16	0.94	15	16	0.94	0.94
Group Size							
1	8	8	1.00	8	8	1.00	1.00
2	8	16	0.50				0.50
3	9	24	0.38	14	24	0.58	0.48
Pedestrian Speed							
Stopped	13	3	4.33	12	8	1.50	2.92
Walking	8	8	1.00	8	8	1.00	1.00
Jogging	8	8	1.00	8	8	1.00	1.00
Running	8	8	1.00	8	8	1.00	1.00
Bicyclist Speed							
Slow (0-5 MPH)	8	8	1.00	4	4	1.00	1.00
Moderate (5-15 MPH)	8	8	1.00	4	4	1.00	1.00
Fast (> 15 MPH)	8	8	1.00	4	4	1.00	1.00
Distance from Counter							
0-1 ft	8	8	1.00	4	4	1.00	1.00
2-3 ft	8	8	1.00	4	4	1.00	1.00
4-5 ft	8	8	1.00	4	4	1.00	1.00
6-7 ft	8	8	1.00	4	4	1.00	1.00
8-9 ft	8	8	1.00	4	4	1.00	1.00
> 9 ft	8	8	1.00	4	4	1.00	1.00

Table 2. SCTA 2014 Automated Bicycle/Pedestrian Counter Test Program – Controlled Evaluation Test Results.

Test Site Descriptions and Manual Field Validation Results:

Manual Counts can be compared to counts collected by automated counting equipment to evaluate how well the counters are able to track bicyclists and pedestrians using a certain facility or traveling through the count location. Manual counts are not 100% accurate[4]. Error can be introduced into manually collected data because count volunteers or staff may take unrecorded breaks, miss bicyclists or pedestrians because of fatigue or inattention, or because of difficulties counting at high activity locations or large groups, they may arrive to count locations late or leave early, or they may fail to follow counting protocol or instructions. Even though manually collected data may be inaccurate in certain cases, it is useful to compare a human count to the count generated by the counting equipment. This comparison can be used to assess equipment performance and accuracy.

Location specific performance of the automated counters was evaluated by calculating the ratio of manual counts to automated counts. This ratio is shown in the "Error" field of each location on the validations table provided below. A score of 1.0 represents a perfect match between manual counts and automated counts. Scores below one indicate that manual counts are lower than automated counts and that the automated counters may be overestimating non-motorized activity. Scores above one indicate that manual counts are high than automated counts and that the counters may be underestimating walking or biking at that location.

Counters may overestimate bicycling or walking if an individual stops and stands in front of the counter continuously. This is not an issue with the bicycle tube counters, but the passive infrared counters may keep counting the stationary individual over and over if they stand in front of the counter. In some circumstances thermal radiation produced by moving vegetation or being emitted from reflective surfaces may also lead to false counts. Over counts seen in the pneumatic tube counters are generally due to vandalism or tampering. Individuals may pull on or "snap" the tubes against the ground like a rubber band.

Undercounts are primarily occlusion errors. The sensors will often miss pedestrians if a large group passes by a counter, or if individuals walk past a sensor side-by-side. Tube counters may count only one bicyclist if 2 or more bicyclists ride over the pneumatic tubes at exactly the same time.

1-3 Manual counts were collected for each test location. Counts were collected for 1 hour time periods at different times of day including mornings, midday, and evenings. Manual counts are compared to automated counts and evaluated for each test location below.

[4] Studies have found that manual counting error can vary from 9-25%.

Mendocino Ave. at McConnell

This location is located at the "T" intersection of McConnell Ave. and Mendocino Ave. in central Santa Rosa at the southern end of the Santa Rosa Junior College Campus. A protected crosswalk on the southern leg of the intersection connects McConnell Ave. strip retail, and residential areas on the eastern side of Mendocino Ave. with the SRJC campus. This intersection was tested by installing infrared pedestrian counters on the eastern and western sides of the crosswalk. Three manual field validation counts were collected at this location during the morning and evening commute periods and midday/lunch time period.

Figure 7. Mendocino Ave. at McConnell Ave. Test Location.

The western side of the intersection (SRJC Campus side) experiences a relatively high level of non-motorized activity. The counter was installed so that the sensor would capture the flow of pedestrians and bicyclists as they approached the crosswalk. Using this configuration, the counter was able to reliably represent the activity that was observed during the manual count period with an average overall validation error of 1.03 for all test periods (See table 3). Under-counts due to group spacing and occlusion were likely offset by occasional pedestrians standing in front of the sensor and being over-counted.

Table 3. Mendocino @ McConnell SRJC crosswalk - west side

		Bicycles		Pedestrians		Total	Direction			Device Count			
Date	Time	Female	Male	Female	Male		WB	EB	Total	WB	EB	Total	Error
7/23/2014	7-8am	1	7	38	23	69	50	19	69	47	13	60	1.15
7/22/2014	4-5pm	6	12	21	29	68	31	37	68	37	35	72	0.94
7/18/2014	11:30-12:30	0	0	11	10	21	8	13	21	5	16	21	1.00
							Average Validation Error for Location						**1.03**

An infrared counter was installed on the McConnell Ave. side of the intersection on the southern sidewalk approaching the crosswalk leading to the SRJC campus. The counter was situated directly across from a cement building. The eastern side of the intersection experienced much lower levels of non-motorized traffic and the counter over-counted activity on this side of the crosswalk. Over-count errors at this location could be attributed to manual count error, pedestrians standing in front of the counter, or thermal radiation from the cement wall located across from the counter. Care should be taken to situate counters further away from intersections and make sure that surfaces across from the sensors are protected from constant sunlight and are not possible sources of thermal radiation that may cause counters to register false counts.

Table 4. Mendocino @ McConnell SRJC crosswalk - east side

		Bicycles		Pedestrians		Total	Direction			Device Count			
Date	Time	Female	Male	Female	Male		WB	EB	Total	WB	EB	Total	Error
7/23/2014	7-8am	2	0	2	3	7	7	0	7	16	1	17	0.41
7/22/2014	4-5pm	1	2	3	5	11	9	2	11	15	10	25	0.44
7/18/2014	11:30-12:30	0	1	0	9	10	6	4	10	7	7	14	0.71
							Average Validation Error for Location						**0.52**

Mendocino Ave. Class 2 Bike Lanes

Bicycle tube counters were tested in the class 2 bike lanes on Mendocino Avenue just north of McConnell Ave in front of the Santa Rosa Junior College Campus. This location represents a class 2 bike lane on major roadway where the bicycle travel flow is directional and constrained to a striped bicycle lane. Pneumatic tubes were installed crossing the complete width of the northbound and southbound bike lanes. Three manual field validation counts were collected at this location during the morning and evening commute periods and midday/lunch time period.

Figure 8. Mendocino Ave. Class 2 Bike Lane Test Location.

Overall, the tube counters at this location were able to accurately capture bicycle travel through this corridor (Average validation error of 1.18). Some bicyclists avoided traveling over pneumatic tubes, leading to slight undercounts. Where possible, tubes should be extended to reduce this kind of error.

Table 5. Mendocino Ave SRJC Class 2 Bike Lanes

		Bicycles		Pedestrians		Total	Direction			Device Count			
Date	Time	Female	Male	Female	Male		SB	NB	Total	SB	NB	Total	Error
7/24/2014	7:30-8:30am	5	3	0	0	8	3	4	7	1	4	5	1.40
7/23/2014	4-5pm	4	25	0	0	29	18	11	29	15	9	24	1.21
7/23/2014	11:30-12:30	1	16	0	0	17	10	7	17	10	8	18	0.94
							Average Validation Error for Location						**1.18**

Stony Point Rd. @ St Olga

Bicycle tube counters were tested in the class 2 bike lanes on Stony Point Rd. just south of St. Olga Court. This location represents a more rural location with class 2 bike lanes and relatively high traffic speeds. Pneumatic Tubes were extended the entire width of the striped bicycle lane. Because of the low non-motorized travel activity observed at this location only one field validation count was collected at this test site.

Figure 9. Stony Point Rd. Test Location.

The counters where able to perfectly capture the observed bicycle traffic at this location. This is most likely due to the relatively simple bicycle movements happening here and the low likelihood of bicyclists entering the regular traffic lane to avoid riding over the counter tubes.

Table 6. Stony Point Rd between Bellevue Avenue & Todd Road

		Bicycles		Pedestrians		Total	Direction			Device Count			
Date	Time	Female	Male	Female	Male		SB	NB	Total	SB	NB	Total	Error
8/6/2014	3:30-4:30	0	2	0	0	2	2	0	2	2	0	2	1.00
							Average Validation Error for Location						**1.00**

Santa Rosa Transit Mall

Infrared counters were installed in 2 phases at the east and then west end of the Santa Rosa Transit Mall, with one counter installed at each of the 4 corner entrances to the mall. Staff attempted to locate the counters in locations where pedestrians would not congregate or stop in front of the sensors. This location experiences very high pedestrian activity and was a good location to test the ability of the counters to distinguish between large groups of pedestrians passing by in rapid succession or very close together. In a few locations sensor field of view could be easily bypassed by bicyclists or pedestrians if they were to travel around the counter and into the street. Issues such as this make it difficult to capture non-motorized activity with automated counting equipment in areas with multiple paths of approach or ill-defined non-motorized travel lanes or patterns. Eleven manual field validation counts were collected at the four test locations at the transit mall.

Figure 10. Santa Rosa Transit Mall Test Location – Southwest Corner.

Automated counting equipment was able to do an adequate job of capturing non-motorized activity on the southern side of the traffic mall, but under-estimated activity at both test locations on the northern side of the traffic mall. The southern test locations were both located away from transit stops and had a clear field of view of well defined and distinct paths of travel. The northern test locations were closer to transit stops and the northeastern test location could be bypassed by cutting across a paved plaza area outside of the 15 foot detection range. Large groups would pass by or stop in front of the counters installed at the northern test sites. This led to under-counting at these locations. Based on the results of this validation exercise, future counts at the transit mall should be focused on one or both of the test locations on the southern side of the transit mall.

Table 7. SR Transit Mall - NE Corner

		Bicycles		Pedestrians		Total	Direction			Device Count			
Date	Time	Female	Male	Female	Male		WB	EB	Total	WB	EB	Total	Error
8/7/2014	3-4pm	0	0	49	66	114	54	60	114	8	53	61	1.87
8/14/2014	8-9am	0	0	25	62	87	34	53	87	10	28	38	2.29
8/14/2014	11-12pm	0	0	39	48	87	34	53	87	27	26	53	1.64
							Average Validation Error for Location						**1.93**

Table 8. SR Transit Mall - SE Corner

		Bicycles		Pedestrians		Total	Direction			Device Count			
Date	Time	Female	Male	Female	Male		WB	EB	Total	WB	EB	Total	Error
8/14/2014	11-12pm	0	0	39	83	122	64	59	123	77	70	147	0.84
8/14/2014	3:15-4:15pm	0	0	70	99	169	57	85	142	77	94	141	1.01
8/14/2014	8:00-9:00am	0	0	37	54	91	43	38	81	29	30	59	1.37
							Average Validation Error for Location						**1.07**

Table 9. SR Transit Mall - NW Corner

		Bicycles		Pedestrians		Total	Direction			Device Count			
Date	Time	Female	Male	Female	Male		WB	EB	Total	WB	EB	Total	Error
8/26/2014	8:00-9:00am	0	0	24	44	68	51	15	66	31	12	43	1.53
8/28/2014	3:15-4:15pm	0	2	91	89	182	103	80	183	29	44	73	2.51
							Average Validation Error for Location						**2.02**

Table 10. SR Transit Mall - SW Corner

		Bicycles		Pedestrians		Total	Direction			Device Count			
Date	Time	Female	Male	Female	Male		WB	EB	Total	WB	EB	Total	Error
8/26/2014	8:00-9:00am	0	0	16	24	40	23	17	40	19	23	42	0.95
9/2/2014	12:30-1:30pm	0	0	44	68	112	50	62	112	45	64	109	1.03
8/28/2014	3:15-4:15pm	0	1	32	83	115	57	58	115	59	73	132	0.87
							Average Validation Error for Location						**0.95**

Joe Rodota Trail

One infrared counter and one bicycle tube counter were installed on the west side of the intersection of the Joe Rodota Trail and Merced Avenue in unincorporated Sonoma County. This location is similar to many other Class 1 pathways or separated multi-use pathways in the county and is used by both pedestrians and bicyclists. Infrared counters counted all users and the pneumatic tube counter counted bicyclists only. This combination system allowed bicyclists and pedestrians to be differentiated at this location. Two manual field validation counts were collected at this location as part of the field validation process.

Figure 11. Joe Rodota Trail Test Location.

The bicycle tube counter and infrared sensor slightly over-counted the amount of non-motorized travel at this location. The automated counters performed very well at this location during controlled testing so the validation error reported is most likely due to a manual count human error. There is also a small possibility that the infrared sensor may have registered false counts due to nearby moving vegetation.

Table 11. Joe Rodota Trail @ Merced

		Bicycles		Pedestrians		Total	Direction			Device Count			
Date	Time	Female	Male	Female	Male		WB	EB	Total	WB	EB	Total	Error
8/12/2014	12-1pm	2	17	0	0	19	12	7	19	14	12	26	0.73
8/12/2014	3-4pm	6	16	4	5	31	12	19	31	15	17	32	0.97
							Average Validation Error for Location						**0.85**

Humboldt St. @ Spencer Ave

Infrared counters and bicycle tube counters were installed on Humboldt Street at Spencer Avenue in Santa Rosa. Infrared counters were installed on the northwestern and southeastern corners of this intersection in order to capture north/south pedestrian travel on the sidewalks. Tube counters were installed in the north and southbound travel lanes in order to count bicyclists traveling in the north/southbound directions on Humboldt Street. Only northbound and southbound travel movements were tracked using this configuration. Infrared sensors and bicycle tube counters would need to be installed on the Spencer Avenue legs of the intersection in order to capture the eastbound and westbound non-motorized travel flows at this location. Two manual field counts were collected at this location as part of the field validation process.

Figure 12. Humboldt Street Test Location.

Non-motorized activity recorded at this location by the automated counting equipment closely matched the validation counts that were collected manually. Device counts were in general lower than the observed number of bicyclists and pedestrians passing through the count location. These under-counts are most likely due to occlusion errors. The infrared sensors have trouble distinguishing different pedestrians when they pass through the sensor field of view close together. In one test period, the counters over-estimated non-motorized activity at this location when compared to manual observations. This error is most likely due to someone stopping in front of the sensor, or may be due to manual count, or human error.

Table 12. Humboldt @ Spencer - North

		Bicycles		Pedestrians		Total	Direction			Device Count			
Date	Time	Female	Male	Female	Male		SB	NB	Total	SB	NB	Total	Error
8/27/2014	7:45-8:45am	0	5	7	4	16	7	9	16	8	12	20	0.80
8/26/2014	3:30-4:30pm	2	12	9	6	29	4	25	29	2	19	21	1.38
									Average Validation Error for Location				**1.09**

Table 13. Humboldt @ Spencer - South

		Bicycles		Pedestrians		Total	Direction			Device Count			
Date	Time	Female	Male	Female	Male		SB	NB	Total	SB	NB	Total	Error
8/27/2014	7:45-8:45am	2	4	12	10	33	9	24	33	8	23	31	1.06
8/26/2014	3:30-4:30pm	2	6	1	4	13	1	12	13	1	12	13	1.00
									Average Validation Error for Location				**1.03**

Evaluation of Data Processing Tools:

Count data was downloaded from the automated counting equipment using a blue-tooth equipped tablet using Eco-counter Eco-link software. Data was then uploaded into Eco-counter's cloud based data management and analysis tool, Eco-visio, using a wireless network connection. Eco-visio software provides some useful reporting and data viewing functionality, but staff also exported the data so that it could be analyzed off-line using spreadsheet, database, and GIS software.

Eco-visio allows count sites and data to be managed and organized in a centralized location that can be accessed by offsite users. This tool can be used to generate customized reports for count locations. These reports can summarize data for specific time periods, specific modes, or exclude dates or times from the summary to screen out special events or other activities that could skew the data from the reported data. Eco-visio can be accessed through a web-browser using an online login has been provided by SCTA staff.

Data from the automated count pilot has been summarized in a variety of different ways. Data summaries, reports, and graphs available for each location include:

- Raw 15-minute count data by direction, and travel mode (bicycle or pedestrian) for the entire count duration. *Microsoft excel format*.
- Count location summary report. Includes total count, peak day, minimum day, and hourly, daily, and monthly biking and walking estimates. *Microsoft excel or PDF format.*
- Day of Week Report. Summarizes bicycle and pedestrian activity by day of week. *Image file.*
- Time of Day Report. Summarizes average bicycle and pedestrian activity by each hour of the day for the count period. *Image file.*
- Hourly summary graph. Shows hourly activity rates, by mode, during the entire count period. *Image file.*
- Mode share pie graph. Summarizes total recorded activity by mode for the entire count period. *Image file.*
- Overview Report. Summarizes key figures observed during the count period including total traffic, daily averages, busiest day of the week, busiest days of the count period, along with graphs outlining hourly profiles for weekdays vs. weekends and other summary graphs and figures.

Examples of these reports are shown on the following pages and can be provided upon request for each count location.

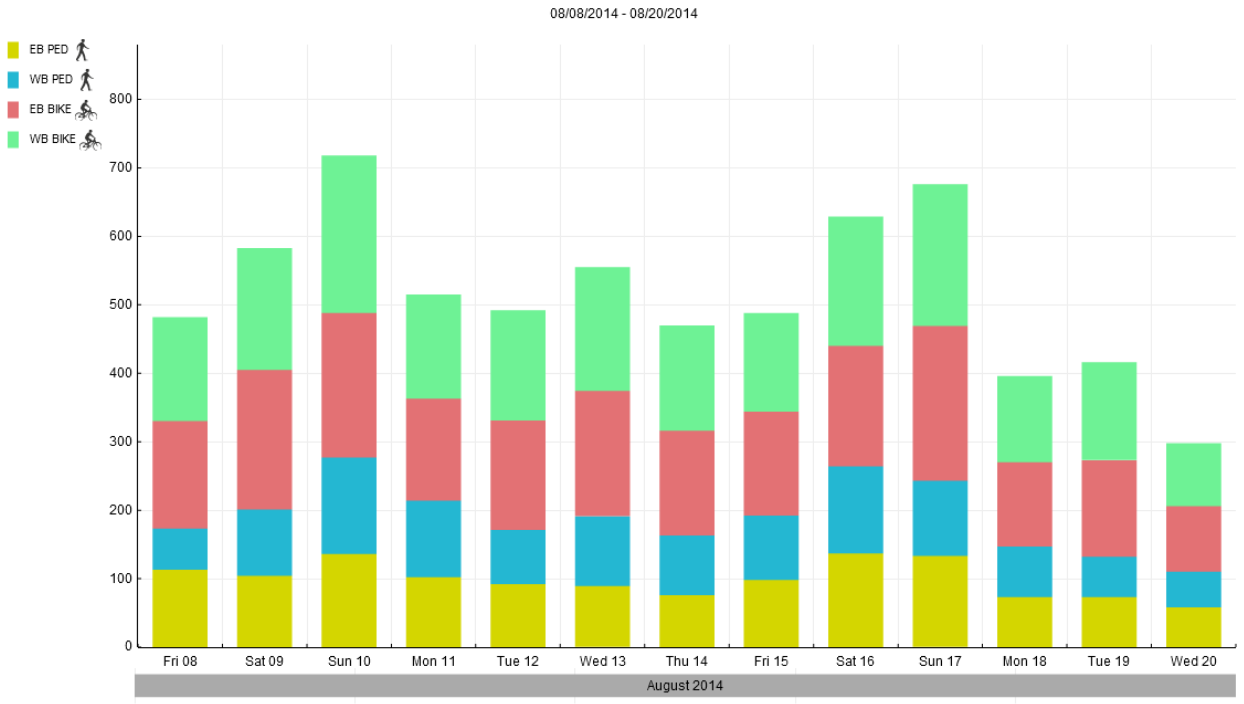


Figure 13. Eco-Visio Daily Activity Report by Travel Mode.

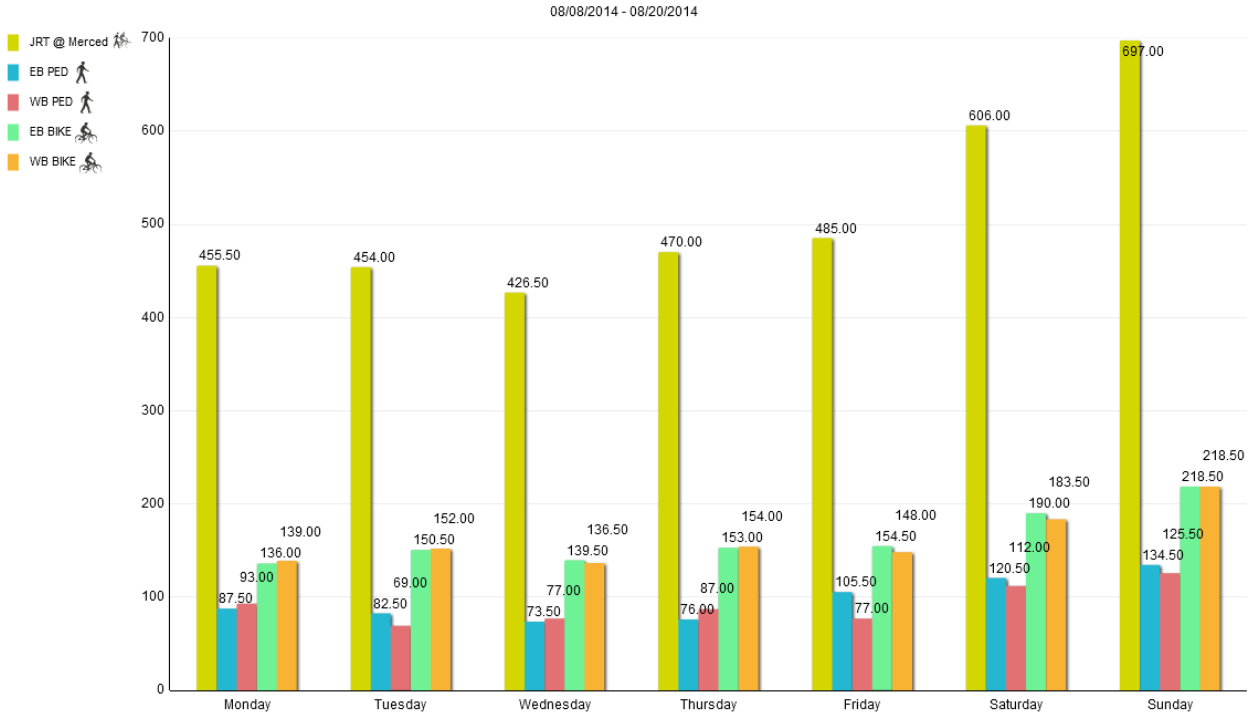


Figure 14. Eco-Visio Day of Week Activity Report by Travel Mode.

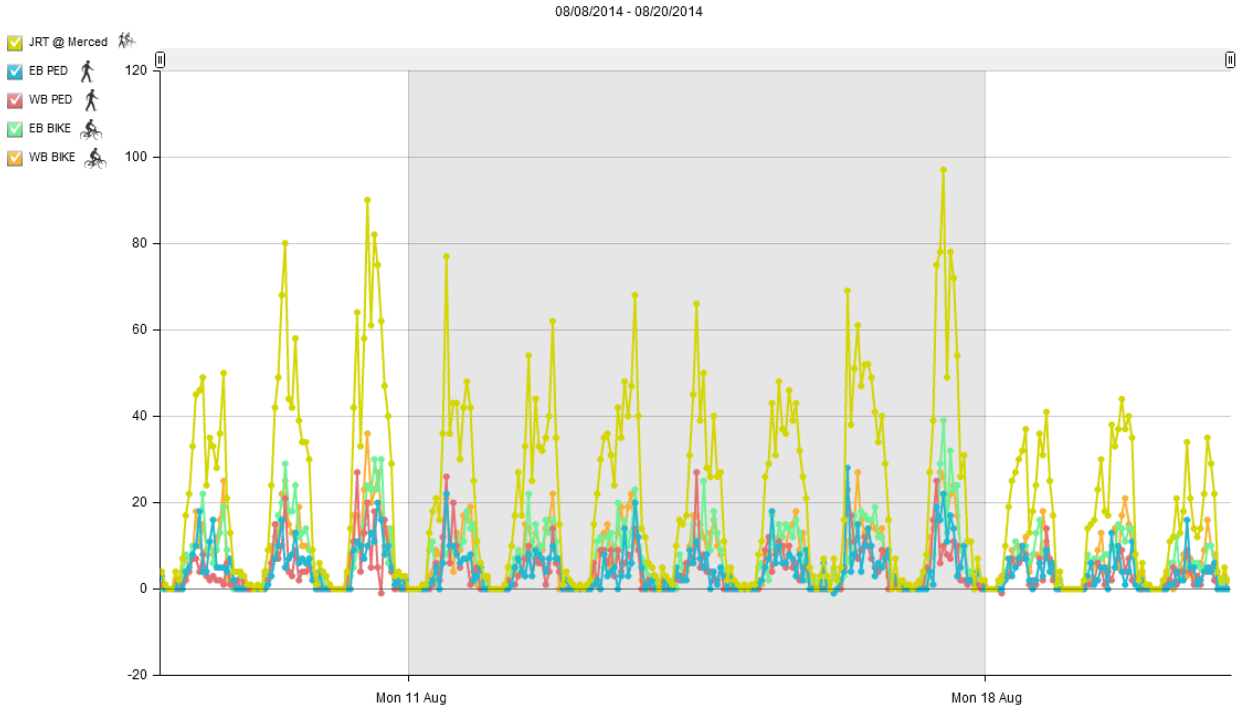


Figure 15. Eco-Visio Complete Count Period Report by Travel Mode.

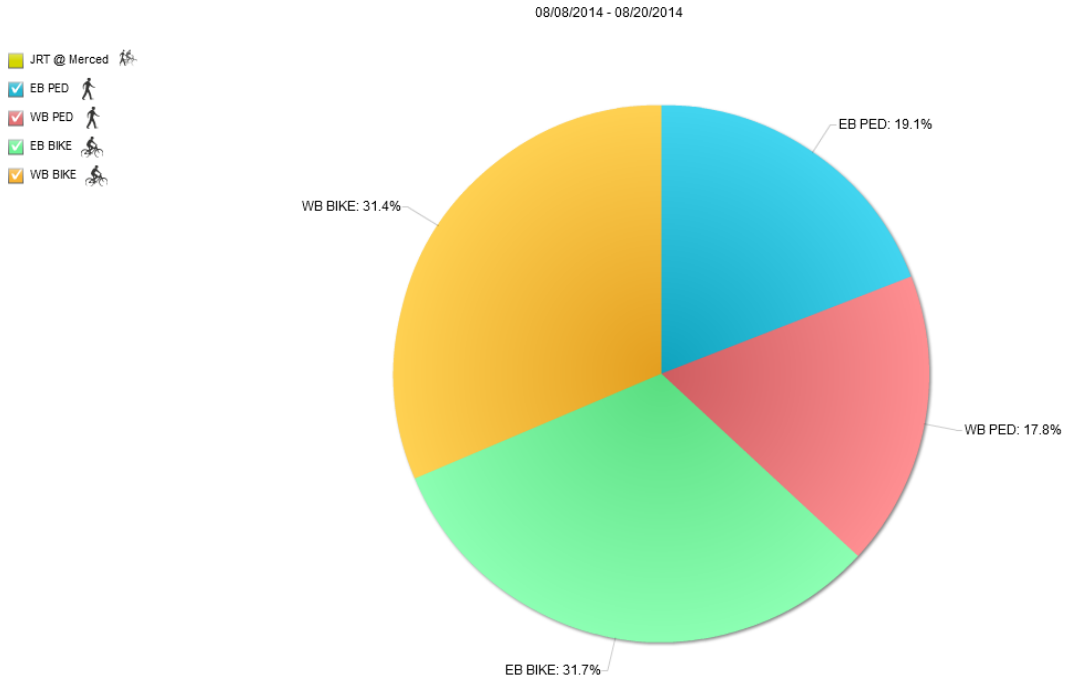


Figure 16. Eco-Visio Count Location Travel Mode Summary.

Validation - Equipment Field Test Overall Observations:

The equipment field test allowed staff to evaluate the performance of the bicycle and pedestrian counters in different circumstances and at different location types. The results of the tests have been generally positive, with the equipment being able to track bicycle and pedestrian activity reliably when compared to manual counts.

The field test highlighted count locations and situations that could provide over or under estimates of actual activity. Manual field counts, or calibration counts, should be performed in these circumstances. These calibration counts can be used to generate and apply correction factors that can be used to ensure that the raw count data more closely matches actual activity patterns.

The field test additionally highlighted the fact that counts collected manually may include higher rates of error than had previously been expected. Counts collected by automated counting equipment provide a way to assess the accuracy of manual counts.

The field test identified:

1. Issues with equipment installation and set-up:
    - Installing the infrared counters and pneumatic tube counters can require specialized equipment, and installing the equipment in areas with high vehicle traffic may require special safety training.
    - Installation is relatively simple with some training and when using the right tools.
    - Pneumatic tubes may need to be secured with special asphalt or duct tape or may need to be re-secured especially if installed on a facility with frequent or high speed automobile traffic.
    - Installation of pneumatic tubes in concrete (instead of asphalt) is problematic, securing hardware is difficult to install and remove.

2. The best locations to do automated vs. manual counting:
    - The counters are ideal for counting activity on Class 1 pathways.
    - The counters provide the best counts at mid-block locations or other locations where the flow of bicyclists and pedestrians is continuous. Counts are less accurate in locations with large crowds or in areas where crowds congregate.
    - Counts are more accurate when installed in areas where pedestrian and bicycle routes are relatively narrow and the flow of traffic is constrained into a distinct pathway. Counts may be off if people can easily avoid walking or biking past the sensors.

3. Different equipment set-up configurations: Infrared and pneumatic tube counters were tested individually and together and provided good results in both configurations.

4. Test data collection accuracy in different settings: The counters appear to provide the most accurate counts in areas with well defined bicycle and pedestrian routes and in locations where travelers are not stopping and milling about frequently. Temperature and weather conditions do not appear to have an impact on counts.

5. Possible sources of counting error:
    - The counters have trouble differentiating between pedestrians traveling in large groups or walking close together. The sensors can count the same person multiple times if they stand in front of the counter continuously.
    - One of the infrared counters was lightly vandalized but is still operational. Vandalism was cosmetic only and did not appear to impact count results.
    - Travel speed does not appear to impact count reliability.
    - Distance from the sensor does not appear to impact count reliability as long as activity occurs within the maximum range of the sensor (approximately 15 feet).

Conclusions and Recommendations:

SCTA has been collecting bicycle and pedestrian count data since 2009. These counts have been collected manually by volunteers or staff in the field. The data has been valuable for estimating non-motorized travel behavior at locations around the county. Local engineers and planners have used the collected data to support local and countywide planning and grant seeking activities.

A number of challenges have been identified with the existing count program. Limited funding and staff/volunteer resources have made it difficult to collect data that is complete and statistically reliable. Non-motorized travel is more variable and dispersed both temporally and spatially than motorized travel, making it more difficult to collect representative samples. The sample size of manually collected data is very small and small absolute changes or errors in the data can result in significant error or bias in the data. Manual counts include error that has not been documented in the past as part of the SCTA count program. Researchers have suggested that manual count and data entry error can introduce significant bias and error into manually collected data.

SCTA purchased automated bicycle and pedestrian counting equipment to address many of these challenges. Once installed, counting equipment can collect larger samples while consuming lower amounts of staff and volunteer time. Since the automated equipment can be left at a count location for weeks at a time, data gathered is much more representative of actual non-motorized travel at the location because of the larger sample size and ability to examine time of day and day of week variations in activity levels.

The validation tests performed as part of the automated counter test period have identified the relative accuracy of the counting equipment and possible sources of error. Locations that registered high error rates still provide valuable information about activity patterns at that location that has not been available in the past. Counts can be corrected using calibration count data for locations that had high under/over-count rates.

Based on the results of the test period and pilot program performed in 2014, SCTA staff recommends that the automated counting equipment be fully integrated into the annual bicycle and pedestrian count program in 2015. Automated counting equipment should be used at count locations that have a high likelihood of providing accurate counts such as class 1 multiuse pathways, separated/striped mid-block class 2 bike lanes, and selected intersection or high-activity pedestrian locations. Calibration counts should be collected at count locations so that correction factors can be applied if a high incidence of over or under-counting is expected to occur due to occlusion, individuals stopping in front of sensors, or other factors.

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APPENDIX:

Appendix A: Automatic Count Preparation Checklist

Appendix B: Automated Bicycle/Pedestrian Counter Controlled Evaluation Form

Appendix C: Automated Counter Field Validation Form

Automatic Count Preparation Checklist

Step	Check When Complete	Notes
1. Check all equipment for proper operation		
2. Be familiar with installation and operation procedures (review manual, installation videos)		
3. Bring necessary accessories such as batteries, locks, nails, magnetic key, laptop for count verification.		
4. Bring measuring tape for tube spacing/counter height verification.		
5. Identify count duration		
6. Identify desired data that will be collected		
7. Specify the counter-placing location and adjust as necessary in the field		
8. Install and secure counters/sensors securely		
9. Start and test counter operation		
10. Periodically check the counter especially during poor weather conditions.		
11. Perform field validation/manual counts during different time periods during the count period.		
12. Perform controlled tests during the count period.		
13. Retrieve count data and upload into count database.		
14. Retrieve counters from the field.		
15. Check collected data for outliers and errors.		
16. Apply correction factors where appropriate.		
17. Evaluate collected data.		
18. Report on results.		

Count Location:

Installation Date:

Name:

Automated Bicycle/Pedestrian Counter Controlled Evaluations

Test		Pass 1		2		3		4		5		6		7		8	
		EC	Actual	EC	Actual	EC	Actual	EC	Actual	EC	Actual	EC	Actual	EC	Actual	EC	Actual
Baseline Walking	Walking																
Baseline Biking	10 MPH																
Group Spacing (2 persons)	0 ft																
	1 ft																
	2 ft																
	3 ft																
	4 ft																
	5 ft																
Group Size	1																
	2																
	3																
	4																
	5																
Pedestrian Speed	Stopped																
	Jogging																
	Running																
Bicyclist Speed	5 MPH																
	15 MPH																
	20 MPH																
	25 MPH																
Distance from Counter	0-1 ft																
Pedestrians for Infrared	2-3 ft																
Bikes for Tube Counters	4-5 ft																
	6-7 ft																
	8-9 ft																
	10 -13 ft																

Counter Height _____

Counter Type _____

Counter Location _____

Automated Counter Field Validation Form

Name: _____

Location: _____

Date: _____ **Start Time:** _____ **End Time:** _____

Day of Week: _____

Counters installed: _____

	Bicycles		Pedestrians			Ped. Groupings			Device Count
	Female	Male	Female	Male	Other	Single	2	3+	
00-:15									
15-:30									
30-:45									
45-:60									
Total									

Sensor Mounting Height: _____

Approximate Air Temp: _____

Approximate Facility Width: _____

Facility Type (Class 1, 2, 3, etc): _____

Notes: _____