Increased Onboard Bicycle Capacity Improved Caltrain's Performance in 2009

February 4, 2010

Prepared by:
BIKES ONboard Project
San Francisco Bicycle Coalition

Executive Summary

Caltrain implemented a modest increase in onboard bike capacity in 2009. Onboard bike capacity now varies from 40 to 80 bikes per train, compared with 16 to 64 bikes per train before the increase.

As a result of the increase in onboard bicycle capacity, Caltrain's fare-box revenue increased over $350,000 in 2009, and the payback period was less than six months. The bike capacity increase also enhanced Caltrain's service reliability, improved on-time performance, and reduced the number of automobile miles driven.

With such favorable outcomes from the bike capacity increase and with continued unmet demand for onboard bike space, we recommend that Caltrain improve service consistency by spring 2010, such that all trains can carry 72 to 80 bikes.

Service consistency can be achieved by replacing only 2% of seats with bike racks on existing rolling stock. No negative impact on total ridership is expected, because all but one train have at least 10% empty seats at peak load, and Caltrain predicts stagnant ridership through 2014.

Adding more bike capacity in 2010 is expected to improve Caltrain's performance akin to the performance improvements of 2009.

Table of Contents

1 Introduction

Caltrain is a commuter rail line that operates from San Francisco to San Jose, with limited service to Gilroy. Caltrain enables passengers to bring their bicycles onboard the train by providing bike racks on one or sometimes two cars per train. Caltrain increased onboard bicycle capacity in 2009 in response to customer demand.

This report is an analysis of Caltrain's performance in 2009, showing that increased bicycle capacity onboard Caltrain resulted in performance improvements including:

- better service reliability;
- decreased dwell times;
- additional passengers, hence higher fare-box revenue; and
- decreased use of motorized transportation, protecting the environment.

2 Caltrain Increased Onboard Bicycle Capacity in 2009

In response to strong customer input[a], Caltrain made a modest increase in bicycle capacity onboard trains as an interim step toward meeting demand. Table 1 shows the bicycle capacity improvements Caltrain made in 2009. Note that Caltrain operates 20 five-car train sets, five Bombardier style and fifteen gallery style. Each train set is used multiple times to accommodate the current schedule of 90 trains per day.

#	Improvement	% Increase in Bike Capacity	Work Commenced	Work Completed
1	Add 8 bike spaces to all gallery bike cars for a total of 40 bike spaces per bike car.	22.1%	April	May
2	Add 8 bike spaces to all Bombardier bike cars for a total of 24 bike spaces per bike car.	5.7%	July	August
3	Convert three Bombardier non-bike cars to bike cars with 24 bike spaces each.	7.4%	October	November
	Total	35.2%		

Table 1: Caltrain's interim, modest increase in bicycle capacity in 2009.

As of December 2009, all five Bombardier trains sets have two bike cars for a total of 48 bike spaces per train, and about half the gallery train sets have two bike cars for a total of 80 bike spaces per train. Bike capacity per train varies with 40, 48, and 80 bike spaces per train, compared with 16, 32, and 64 bike spaces per train before the bike capacity increase. Total bike capacity (ratio of bike spaces to seats) is now 9%.

[a] San Francisco Bicycle Coalition, *Plan for Bicycle Carriage on Caltrain*, December 29, 2008, pages 6 - 8, http://tinyurl.com/SFBC-Plan

3 Service Reliability Improved for Caltrain Passengers

We compiled the number of reported bumps (cyclists denied boarding due to insufficient bike capacity) from the Bike Correspondence packets provided at Peninsula Corridor Joint Powers Board (JPB) meetings, and plotted the bumps in Figure 1.

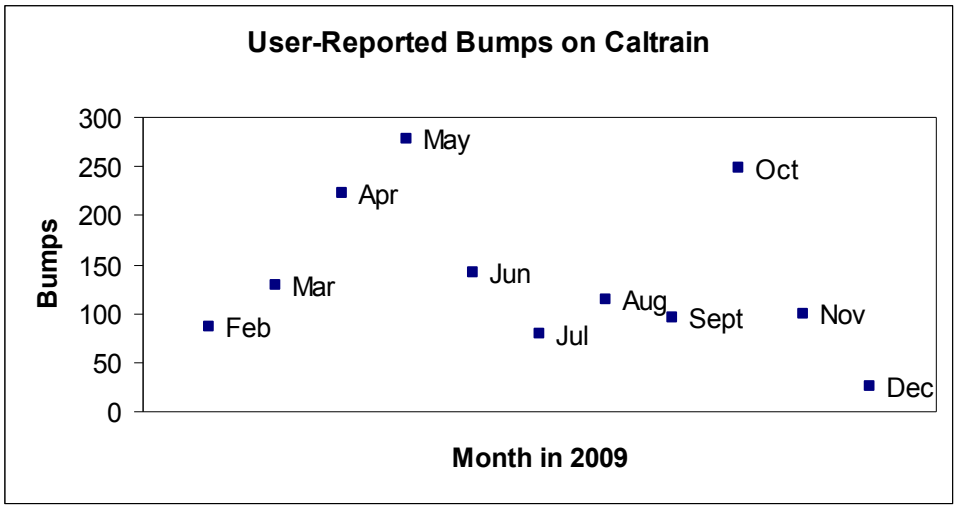

Figure 1: Number of cyclists bumped (denied boarding due to insufficient bike capacity) each month, as reported in Bike Correspondence packets provided at monthly JPB meetings. There was no Bike Correspondence packet provided in January 2009, so the data point for January is not available. The number of bumps shown each month is a lower bound, because not all bumps are reported.

The number of bumps was increasing rapidly as the summer months approached, but dropped off later in the year as Caltrain increased onboard bike capacity. Reported bumps were notably high in October, possibly due to various service interruptions causing trains that usually run with two bike cars to run with only one bike car. The lowest number of reported bumps was in December, after the bike capacity increase was completed. As expected[b], however, the modest increase in bike capacity was not enough to meet customer demand, so bumping continued even after the bike capacity increase.

Service reliability is a critical factor in commuters' decision whether to ride Caltrain. Without reliable service, many bicycle passengers will find other commute methods, and the majority of them drive alone.[c] Insufficient bike capacity drives away paying customers, because 80% of bicycle passengers rarely if ever ride Caltrain without bringing their bikes onboard.[c] Enhancing service reliability is paramount to Caltrain's success, so providing consistent bike capacity onboard all trains is crucial.

[b] San Francisco Bicycle Coalition, *Plan for Bicycle Carriage on Caltrain*, December 29, 2008, page 15, http://tinyurl.com/SFBC-Plan

[c] 2007 Caltrain Online Bicycle Survey conducted by Caltrain from May 21 to June 1, 2007. The number of respondents was 1571 including 1180 bike+Caltrain users, 169 former users, and 222 potential users.

4 On-Time Performance Improved in 2009

Caltrain has repeatedly expressed concern that increased bike capacity would result in longer dwell time, the time the train waits at a station stop, but the data show otherwise. On-time performance was higher in 2009 compared with 2008, even with more bicycle passengers in 2009.

There were 21.3% more bicycle boardings in February 2009 compared with February 2008.[d] While Caltrain did not track the exact increase in the number of bicycle passengers the remainder of 2009, bumping continued the entire year, suggesting the number of bicycle passengers increased another 35% by yearend, i.e., same as the increase in bike capacity. Even with the increased number of bicycle passengers, Caltrain's on-time performance improved in 2009, as shown in Table 2 and Figure 2. It is clear that increasing the number of bicycle passengers did not negatively impact on-time performance.

Year	On-Time Performance
2008	93.2%
2009	94.9%

Table 2: Caltrain's average on-time performance in 2008 and 2009.

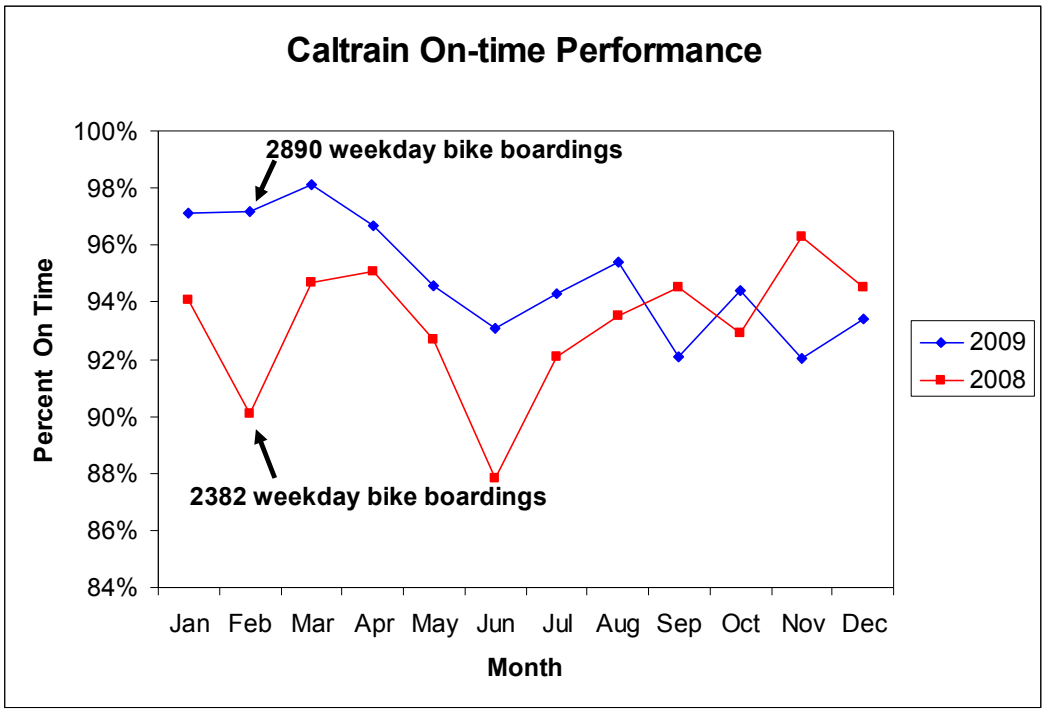

Figure 2: Comparison of Caltrain's on-time performance in 2008 and 2009. Bike boardings shown on the graph are from Caltrain's February Annual Passenger Counts.

[d] Key Findings, February 2009 Caltrain Annual Passenger Counts, p. 7.

Appendix A presents further analysis of on-time performance, showing that in the absence of extenuating circumstances such as fatalities, dwell time depends on total ridership. The more riders, the longer the dwell time, because it takes more riders longer to board.

One might expect that more bicycle passengers would increase dwell time, but in fact the opposite was observed. Importantly, the increase in bicycle passengers resulted from the increase in onboard bike capacity. The concurrent, seemingly anomalous improvement in on-time performance may be attributed to the following:

- **Less over-crowding in bike cars.** With the increase in bike capacity, there was more room to maneuver bikes in the bike car, smoothing boarding and exiting. Therefore, even with more bicycle passengers, on-time performance was not degraded.
- **Bike boardings distributed at more doors.** Some trains were specified to have two gallery bike cars starting March 2009. With two bike cars on specified trains, cyclists could regularly board at two doors instead one, reducing dwell time even with more bicycle passengers boarding.
- **Fewer total riders.** In total, there were 5.5% fewer passengers on Caltrain in 2009 compared with 2008,[e] and fewer passengers take less time to board. Appreciably more passengers brought a bicycle onboard in 2009 compared with 2008, but the number of bicycle passengers was inconsequential compared with total ridership with regard to impact on dwell time.

We recommend the following to improve on-time performance even more:

- **Improve consistency in bike capacity.** All trains should have more than one bike car, so cyclists can reliably board at more doors to shorten boarding time. If cyclists know there is more than one bike car, some cyclists will wait in the middle of the platform instead of the northern end, so conductors won't have to hold the train as cyclists rush to a 'surprise' second bike car. This would also improve safety, because cyclists would no longer need to sprint down the platform to a 'surprise' second bike car while trying to dodge passengers exiting the train.
- **Give cyclists priority boarding at bike cars.** Currently cyclists are required to board last. Priority boarding for cyclists would reduce dwell time, because walk-on passengers can choose to board other cars, distributing boarding at more doors to make boarding faster.

5 More Bicycle Passengers Enhanced Fare Box Revenue

Cyclists were denied boarding due to insufficient bike capacity throughout the year, so as soon as more bike capacity was added, it was promptly filled. Therefore, the increase in bicycle passengers tracked the increase in bike capacity. According to Caltrain's February 2009 Annual Passenger Counts, the number of weekday bike boardings was 2890 in February, before any increase in bike capacity. Using 2890 as a baseline, we assume the number of weekday bike boardings in subsequent months was proportional to the increase in bike capacity shown in Table 1. Table 3 shows estimated weekday bike boardings in 2009, along with the incremental change in bike boardings due to increased bike capacity.

[e] Calculated from total ridership provided in meeting minutes of the Peninsula Corridor Joint Powers Board, Board of Directors meetings, 2008 and 2009.

Month in 2009	Weekday Bike Boardings	Incremental Weekday Bike Boardings from Increased Bike Capacity	Incremental Monthly Bike Boardings
Feb	2890	0	0
March	2890	0	0
April	2890	0	0
May	2890	0	0
June	3529	639	12,780
July	3529	639	12,780
August	3529	639	12,780
September	3693	803	16,060
October	3693	803	16,060
November	3693	803	16,060
December	3907	1017	20,346
		Total	106,866
		Average Ticket Price[f]	$3.60
		Incremental Revenue	**$384,716**

Table 3: Estimated bike boardings in 2009. Bike boardings in February are from Caltrain's February 2009 Annual Passenger Counts. Bike boardings in subsequent months are calculated proportional to onboard bike capacity. Because increases in bike capacity occurred over time, increased bike boardings are assumed to occur the month after the retrofit was completed (see Table 1 for completion month). To be conservative, 20 weekdays per month were assumed.

Caltrain reported a cost of $350,000[g] to retrofit its rolling stock for the bike capacity increases in 2009. Based on the incremental increase in fare box revenue due to more bicycle passengers, Caltrain had already recouped more than the investment cost by the end of 2009, hence the payback period was less than six months.

6 Reduction in Automobile Miles Driven

The increase in bicycle capacity has enabled more people to choose a sustainable commute method by bringing their bikes onboard Caltrain, instead of driving their cars. It is straightforward to calculate the reduction in automobile miles driven using the following assumptions:

[f] Peninsula Corridor Joint Powers Board, Board of Directors meeting minutes for October 1, 2009 report monthly ridership of 1,060,624 and monthly revenue of $3,819,252 equating to an average ticket price of $3.60.

[g] Peninsula Corridor Joint Powers Board, Board of Directors meeting minutes for February 5, 2009 report a cost of $200,000 to add bike spaces to existing bike cars, and the agenda packet for June 4, 2009 reports a cost of $150,000 to convert three Bombardier non-bike cars to bike cars for a total of $350,000 to add bike capacity in 2009.

1. Weekday passengers ride Caltrain an average trip distance of 22.3 miles.[h]
2. Cyclists ride their bikes an average of three miles at both ends of their Caltrain trip.[i]
3. Incremental weekday bicycle passengers are proportional to the incremental increase in bike capacity, i.e., 20,384 passengers per month, as shown in Table 3.
4. Sixty-three percent of incremental bicycle passengers drove alone before they brought their bikes onboard Caltrain.[j]

Based on these assumptions, the bike capacity increase in 2009 eliminates over 4,350,000 miles of driving in single-occupancy vehicles each year. A reduction in automobile miles driven equates to important societal benefits including less pollution, less traffic congestion, and reduced fossil fuel usage.

7 Conclusion

Caltrain's interim, modest increase in bike capacity in 2009 showed a positive effect on Caltrain performance and customer experience. On-time performance was better in 2009 compared with 2008, more bicycle passengers resulted in more fare-box revenue, and more Caltrain passengers were able to 'green' their commutes. Caltrain spent $350,000 to retrofit cars to hold 35% more bikes, and the payback period was less than six months.

8 Recommendations

8.1 Improve Service Consistency

Insufficient, inconsistent bike capacity is the biggest challenge to providing reliable service to Caltrain's bicycle passengers. Bike capacity onboard Caltrain's fleet at the end of 2009 was inconsistent with 40, 48, or 80 bikes per train, as shown in Table 4.

Train Type	Trains in Service*	Number of Bike Cars	Bike Capacity per Train
Gallery	7	1	40
Gallery	8	2	80
Bombardier	5	2	48

*May vary slightly depending on maintenance schedule.

Table 4: Caltrain's onboard bike capacity at the end of 2009.

At its February 2009 board meeting, the Joint Powers Board directed Caltrain staff to run trains with two bike cars on high-demand trains. Caltrain does not have enough bike cars, however, so Caltrain staff designated less than half of commute-period trains to run with two bike cars starting March 2009, though service disruptions resulted in less than 100% predictability.

[h] Key Findings, February 2009 Caltrain Annual Passenger Counts, p. 5.

[i] Osborn, Lynn, (2003), "TDM Cost Effectiveness, How VMT Reduction Translates to Congestion Mitigation and Improved Air Quality", ACT International Conference, TDM Cost Effectiveness White Paper, p.7.

[j] 2007 Caltrain Online Bicycle Survey conducted by Caltrain from May 21 to June 1, 2007. The number of respondents was 1571 including 1180 bike+Caltrain users, 169 former users, and 222 potential users.

Consistency in bike capacity on all trains is particularly important during service disruptions, which often result in last-minute swaps of train sets. Unfortunately, service disruptions are not uncommon. For instance, one or more fatalities occurred eight months in 2008 and eight months in 2009.

To improve service consistency on high-demand trains, we recommend the following:

- Two bike cars on all gallery consists yielding 80 bike spaces per train.
- Three bike cars on all Bombardier consists yielding 72 bike spaces per train.

The following conversions achieve the objective:

- Convert five gallery trailer cars to bike cars, and put two existing spare bike cars into service.
- Convert five Bombardier trailer cars to bike cars.

Table 5 shows bike capacity per train after implementation of these recommendations. Once implemented, total bike capacity would be 11% compared with 9% today.

Train Type	Trains in Service	Number of Bike Cars	Bike Capacity per Train
Gallery	15	2	80
Bombardier	5	3	72

Table 5: Caltrain's onboard bike capacity after implementation of above recommendations to improve service consistency.

The recommendations can be achieved by replacing 2% of seats with bike racks on existing rolling stock. Caltrain predicts 1% ridership growth through 2014[k], and all trains but one have at least 10% empty seats at peak load[l], so replacing 2% of the seats with bike racks would be expected to have no negative impact on total ridership.

8.2 Benefits of Consistency

Service consistency is expected to further improve Caltrain's performance and customer experience. The benefits of providing consistent 72 to 80 bikes per train are as follows:

1. Simplify Caltrain operations, because any train set could run at any time.
2. Improve service reliability, better serving Caltrain customers.
3. Smooth boarding patterns, because cyclists would know where to stand on the platform to meet the arriving bike cars.
4. Improve platform safety, because cyclists would not need to sprint down the platform to a 'surprise' second bike car, dodging exiting passengers as the cyclists try to get to the second bike car before the conductor shuts the doors.

[k] Caltrain Short-Range Transit Plan, Fiscal Year 2009 through Fiscal Year 2018, p. 10.
[l] Key Findings, February 2009 Caltrain Annual Passenger Counts, p. 6.

5. Avoid under-utilization of the 'surprise' second bike car. When a second bike car unexpectedly shows up, the space generally gets under-utilized, quite wasteful of onboard real estate.
6. Increase ridership and fare-box revenue by increasing bike capacity to meet latent demand.
7. Less burden on conductors' time, because they would not need to guard the bike car door to deny service to paid customers.
8. Improve Caltrain's reputation as an environmentally friendly, forward-thinking transit agency.

The benefits are many, and the data in this report show the feared downsides did not materialize, so we recommend that Caltrain promptly convert trailer cars to bike cars to enable two bike cars on all gallery consists (80 bikes per train) and three bike cars on all Bombardier consists (72 bikes per train).

9 Appendix A: Analysis of Caltrain's On-time Performance

There was considerable variation in Caltrain's on-time performance in 2008 and 2009, from a low of 87.8% to a high of 98.1%. We examined Caltrain's on-time performance to elucidate causes for the variation. We plotted on-time performance as a function of total ridership in 2008 and 2009 to ascertain whether total ridership impacted on-time performance. As shown in Figure 3, there appears to be essentially no correlation between total ridership and on-time performance, so we needed to evaluate other factors.

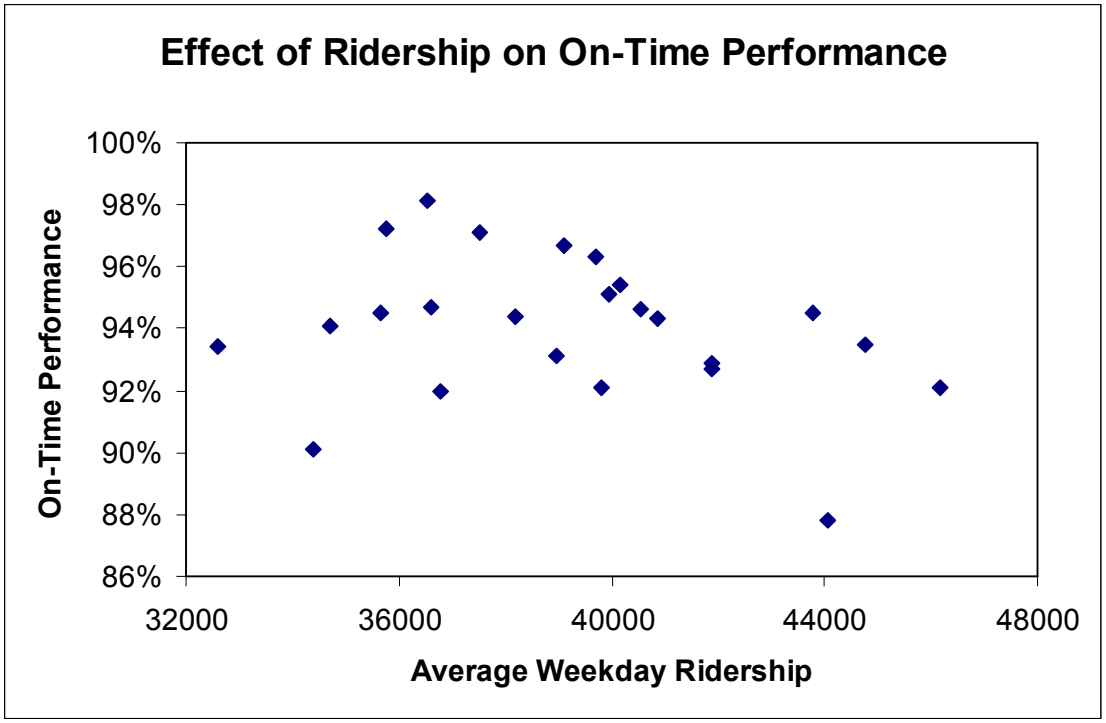

Figure 3: Caltrain's on-time performance as a function of average weekday ridership in 2008 and 2009, with each data point representing a month.

Based on our experience riding the trains, we know that fatalities due to Caltrain striking people and automobiles have a large negative impact on on-time performance. Therefore, we categorized the data into two groups, months with fatalities and months without fatalities, as shown in Table 6.

Year	Month	On-time Performance	Total Ridership	Fatality?
2008	Jan	94.1%	34,702	yes
2008	Feb	90.1%	34,399	yes
2008	Mar	94.7%	36,606	no
2008	Apr	95.1%	39,936	yes
2008	May	92.7%	41,892	no
2008	Jun	87.8%	44,079	yes
2008	Jul	92.1%	46,169	no
2008	Aug	93.5%	44,751	no
2008	Sep	94.5%	43,769	yes
2008	Oct	92.9%	41,893	yes
2008	Nov	96.3%	39,685	yes
2008	Dec	94.5%	35,672	yes
2009	Jan	97.1%	37,522	no
2009	Feb	97.2%	35,748	no
2009	Mar	98.1%	36,529	no
2009	Apr	96.7%	39,115	no
2009	May	94.6%	40,560	yes
2009	Jun	93.1%	38,979	yes
2009	Jul	94.3%	40,846	yes
2009	Aug	95.4%	40,154	yes
2009	Sep	92.1%	39,795	yes
2009	Oct	94.4%	38,174	yes
2009	Nov	92.0%	36,775	yes
2009	Dec	93.4%	32,597	yes

Table 6: Caltrain's on-time performance and average weekday ridership for each month in 2008 and 2009. The right-hand column indicates whether one or more fatalities occurred in that month, and the rows are color coded accordingly.[m]

Figure 4 shows on-time performance only in months in which fatalities occurred. There is no correlation between on-time performance and total ridership (correlation coefficient R^2 = 0.0027).

In contrast, Figure 5 shows significant correlation (R^2 = 0.7156) between on-time performance and total ridership in months without fatalities. Not surprisingly, more riders take longer to board, negatively impacting on-time performance.

[m] As reported by the *San Mateo Daily Journal* throughout 2008 and 2009.

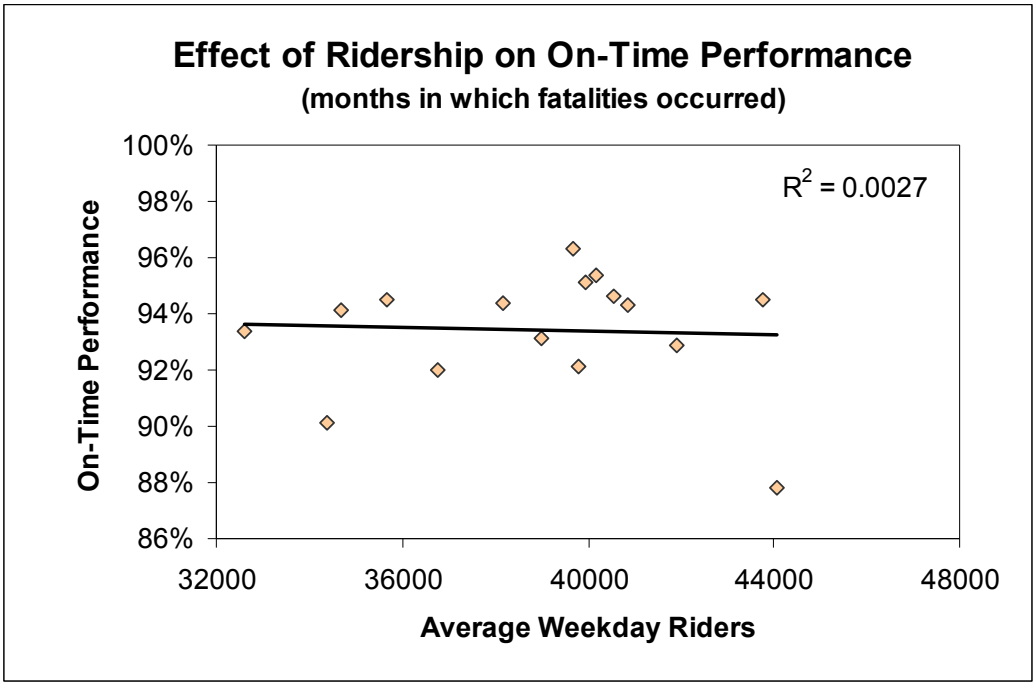

Figure 4: Caltrain's on-time performance as a function of average weekday ridership in 2008 and 2009, with each data point representing a month in which one or more fatalities occurred.

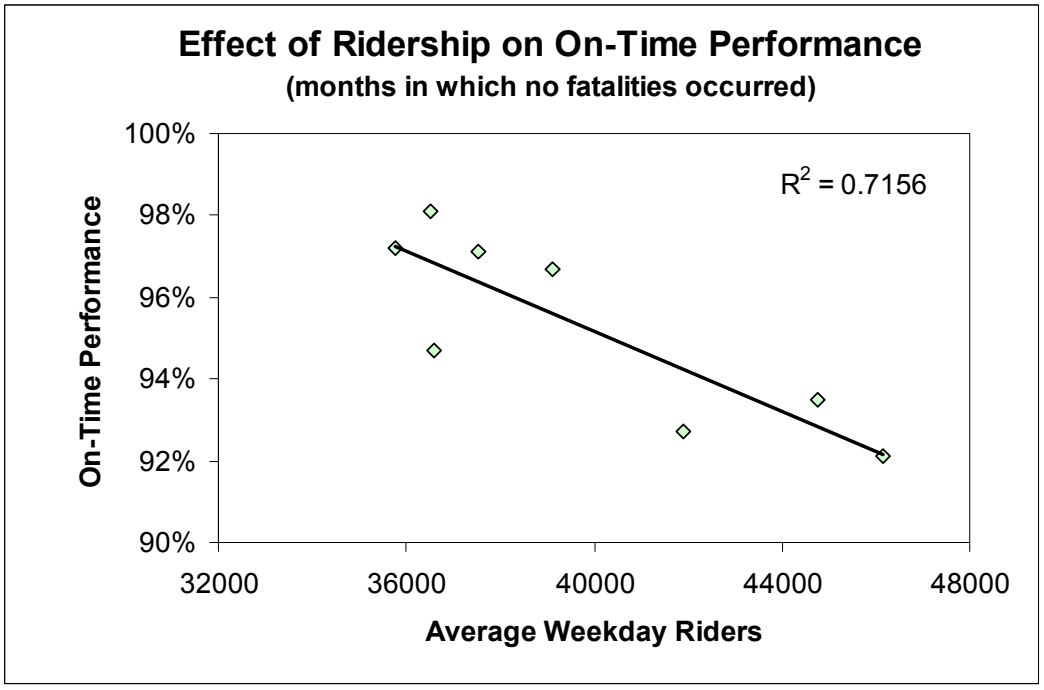

Figure 5: Caltrain's on-time performance as a function of average weekday ridership in 2008 and 2009, with each data point representing a month in which no fatalities occurred. The data show that more riders resulted in worse on-time performance.

We have shown that fatalities have a large impact on on-time performance, so to evaluate the impact of bike boardings on dwell time, we must find months in which no fatalities occurred to avoid biasing the results. March was the only month without fatalities in both 2008 and 2009. Table 7 shows that more bike boardings did not cause dwell time delays.

Month, Year	Average Weekday Ridership	Approximate Weekday Bike Boardings	On-Time Performance
March, 2008	36,606	2382	94.7%
March, 2009	36,529	2890	98.1%

Table 7: Comparison of on-time performance for the only month in both 2008 and 2009 without fatalities. Total ridership is within 100 passengers, but there were over 500 more bike boardings in 2009.[n] If bike boardings caused dwell time delays, on-time performance would be worse in 2009, but in fact, it is better.

There were the same number of months (four) in both 2008 and 2009 with no fatalities, as shown in Table 6. Therefore a comparison of 2008 and 2009 in total would also provide unbiased results. We have made such a comparison in Table 2, which likewise shows that bicycle boardings did not cause dwell time delays.

In summary, fatalities are the overriding factor causing dwell time delays. The next obvious factor is total ridership, because more riders take longer to board. The data show that cyclists are not responsible for dwell time delays.

The key to improving on-time performance is first to minimize fatalities, and second to distribute boarding more evenly at all cars. The latter can be facilitated by giving cyclists priority boarding at bike cars, because walk-on passengers can and probably will choose to board at other cars.

[n] Bike boardings are from Caltrain Annual Passenger Counts, which occur each February. We assume bike boardings in March are approximated by those in February.