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Changes in Service and Associated Ridership Impacts near a New Light Rail Transit Line

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Abstract: Los Angeles (LA), for many years a city with limited rail transit, is substantially expanding its public transit system. This paradigm change in transportation policy and investment creates new requirements for monitoring. One area needing evaluation is whether new, high quality transit options, such as light rail, near existing transit services increase sustainable transportation mode shares and reduce car travel. Few studies have explored light rail's role as a catalyst to increase overall transit use and achieve sustainability goals within an auto-oriented city like LA. Metro's data show that trips taken on its bus and rail system dropped overall by 10.5% between 2009 and 2016, but its rail ridership grew 21% during the same period due to the debut of the Gold Line and Expo Line extensions. We analyze changes to bus service and associated ridership impacts that resulted from the opening of these two LRT lines in LA. The immediate effect of the city's bus service changes along the Gold Line light rail extension appear to be associated with a net "bus plus rail" ridership decline in that corridor. In contrast, the Expo Line corridor experienced an initial increase in ridership during the two years immediately after its opening, possibly because the bus service was not reduced by the same magnitude as along the Gold Line extension. Our findings indicate that changes in bus service made to coincide with the introduction of new light rail transit (LRT) can negatively affect the overall transit ridership in the corridor. Planners and policy makers should closely monitor changes in bus service and ridership associated with new rail transit to ensure investments results in an overall net increase in more sustainable travel.

Keywords: rail transit; bus transit; public transportation; ridership

1. Introduction

Los Angeles (LA) is pursuing possibly the most ambitious rail transit investment program in the United States. The LA Metropolitan Transportation Authority's (Metro) long-range plan committed funds to six new rail transit lines scheduled to open between 2011 and 2019. In total, those six lines will increase the LA Metro rail network from 73 to approximately 120 miles (116.8 km to approximately 192 km), making it larger than the current Washington DC Metro system. This impressive commitment to transit infrastructure is playing out in the context of ambitious state-level greenhouse gas (GHG) emission reduction targets to enhance sustainable urban development.

California's Sustainable Communities and Climate Protection Act of 2008, known as Senate Bill 375 (SB375), requires metropolitan planning organizations (MPOs) to develop coordinated land use–transportation plans that meet state GHG reduction requirements. The LA region's MPO, the Southern California Association of Governments (SCAG), through its Regional Transportation Plan/Sustainable Communities Strategy [1], has targeted increased development in transit corridors as a major component of its overall GHG reduction effort. In LA County, much of the funding for transit improvements has come from local sales tax increases approved by voters with two-thirds majorities, as required by state law. This infusion of capital has helped to remedy past budget uncertainties due to fluctuating transit funding commitments at the federal and state levels.

Recent studies have attempted to quantify the GHG reduction attributable to public transportation in the US. According to calculations by the US PIRG Education Fund [2], Metro's 2006 operations resulted in a net GHG reduction equivalent to 862 thousand metric tons of CO_2. This placed Metro 8th in the US, but at a level less than one-tenth of New York's system and less than half of Washington D.C.'s system. However, potential gains in GHG reductions and SCAG's planning for transit-oriented development stress the importance of understanding the impact of transit infrastructure and service provision on travel behavior.

There is debate about what form of urban transport system is more sustainable. This issue has been discussed at length in the literature (e.g., [3–9]). Many agencies nationally and internationally stated the need for urban transport to become more sustainable, providing a competitive alternative to car driving. There can be little doubt that certain transportation systems are more efficient in terms of reducing private automobile use or the related aim of reducing energy consumption or carbon dioxide emissions. One of critical issues in sustainable transport systems is whether high-quality public transport services can attract new ridership or solely draw ridership from existing transit users [10].

Questions remain, in particular, about light rail transit's (LRT) role as a catalyst to increase overall transit use and reach sustainability goals, at least in the context of an auto-oriented city like LA. The present studies demonstrated that U.S. public transit agencies, including the Los Angeles County Metro Transit, have invested to extend the infrastructures for public transport since 1990s but increasing investments could not necessarily increase ridership [11,12]. In its 2017 report, the LA Times stated that "since 2009, Metro has opened four new rail extensions at a cost of more than $4 billion. In the same period, rail ridership soared 21%, but bus trips—a much larger share of overall ridership—dropped 18%" [13]. Metro's data show that trips taken on the L.A. County Metro's bus and rail system dropped in 2016 by nearly 6%, largely due to continuing declines in bus patronage [14]. LA Metro system has experienced rapid growth of light rail ridership due to the debut of the Gold Line and Expo Line extensions but also a precipitous drop in bus ridership.

There are many plausible explanations for the overall drop in ridership even as new high-quality light rail service is coming online. One possibility is that the reduction in access points for bus versus LRT has reduced the overall transit service area in corridors in which bus routes were replaced by LRT. Another is that restructuring of lines that could serve as feeders to LRT have been less than optimal. A third possibility is that Metro is prioritizing service in LRT station areas where future transit oriented development is most likely. Advocacy groups have pointed out that Metro's restructuring has often been at the expense of bus riders, who tend to be poorer and include a higher percentage of ethnic minorities [15]. The first two possibilities raise questions about service design, while the last raises questions of equity.

This study explores some of the reasons for recent decreases in transit ridership that are related to changes in transit service. To examine the effects of the two most recently opened LRT lines, the Expo Line and the Gold Line, we compare key transit performance metrics before and after the opening of each of these lines. We first compare changes in total transit ridership of the Expo Line and the Gold Line extension to explore whether these LRT openings were associated with increased system-level transit ridership. Second, we examine trends in both bus and LRT ridership along the two corridors to identify corridor-wide changes to bus ridership. Third, we compare the changes in bus service system-wide against those in new LRT corridors to examine the effects of network

restructuring and service changes on performance. We also examine the potential changes in ridership associated with the new LRT service and corresponding changes to nearby bus service.

Our analysis and findings relate to an older literature on how agencies modify bus routes when LRT service opens (e.g., [16,17]). We add to the literature in two ways. First, our analysis updates this work at a time when cities worldwide are building or expanding LRT systems. Second, we document that the combined "bus plus rail" corridor transit ridership decreased along LA's Gold Line extension in the year following the opening of that LRT line, but total transit ridership initially increased along LA's Expo Line. We show associations between the net transit ridership gains or losses in the corridors and changes in bus service. This evidence, while descriptive, moves the literature forward in assessing the still somewhat under-studied question of how bus service changes (which are common when new LRT systems open) are associated with the sustainability characteristics (e.g., ridership) of the overall transit system. We also document that, after 2014, system-wide bus ridership declines have been larger than any ridership effects that are specific to either the Expo or Gold Line LRT corridors.

In the next section, we contextualize our research within the existing body of ridership research, focusing on LRT. This is followed by an overview of Metro's Expo Line and the 2009 Gold Line extension. Next, we evaluate ridership and service changes, before and after the opening of these LRT projects. Finally, we conclude with a discussion of some policy implications that flow from this research.

2. Literature Review

Much of the existing literature on the impacts of introducing a new LRT service focus on comparing ridership counts, capital and operating costs, and transit service and land use before and after light rail service introduction to provide insights into the actual ridership gains and costs, as well as impacts of major transit investments. Most studies of ridership impacts use traditional data, including questionnaires and travel surveys. They focus on ridership changes that occur with the introduction of new or improved transit services. These include work by Gomez-Ibanez [16] on the ridership and operating costs of new light rail services in San Diego, Calgary, and Edmonton, and work by Allen and Hufstedler [17] on the ridership characteristics of the transit systems serving large areas with relatively low population densities in Dallas and Houston, Texas.

Gomez-Ibanez [16] was one of the first to examine total (bus and rail) ridership changes in a new LRT corridor and to present results pointing to the possibility of varying impacts. After the introduction of an LRT line in San Diego, total transit ridership along the route increased by about 22% after accounting for new LRT ridership and reductions in ridership of bus routes that were eliminated or that competed with the new LRT line. The author found only 2% increase in total transit share of trips after the opening of a new LRT line in Calgary and concluded that LRT in Edmonton could have been associated with an increase in total transit ridership of between 9% and 19%, but the contribution of LRT remained unclear since the bus service in the area had been expanded two years before the LRT service began.

Allen and Hufstedler [17] compared ridership between the Dallas Area Rapid Transit (DART) bus-and-rail system and Houston's Metro bus system, using the National Transit Database for the period 1985 through 2003. Houston's approach, through 2003, had been the provision of a high level of bus service incorporating an extensive system of park-and-ride facilities, while DART's approach was the introduction of a light rail system complemented by bus service in the Dallas area. The authors found that Houston's commitment to its bus system achieved both higher service levels and higher bus ridership than DART achieved. DART's light rail system resulted in increases in system ridership although there was a downturn in bus system ridership. The authors attributed this decreased bus ridership to the restructuring of some bus routes during LRT implementation.

Other research on how bus or vehicle ridership changes with the implementation of rail transit has adopted a wide array of methodological approaches using statistical analyses, interviews, surveys, and geospatial tools. Research using statistical analyses typically focuses on evaluating the relative causal influences of internal and external factors on ridership [18–22]. Some studies,

however, conducted interviews with transit system managers and focused on how some agencies were more successful than others in increasing transit ridership and how the managers of transit systems perceive influences of various factors on ridership [23,24]. Other studies conducted attitudinal surveys of passengers to identify the factors influencing passenger satisfaction [25,26]. Some recent empirical studies examined the spatial patterns and interactions of ridership utilizing geospatial data. For instance, Li et al. [27] examined the interactions between a newly opened subway and taxi service in Wuxi, China from a spatial perspective using GPS trajectory data to explore taxi pathways relative to spatial effects of the subway. Zhang and Wang [28] used a network Kriging method to estimate the subway ridership of a new subway line, the Second Avenue Subway in New York City.

Overall, existing practice and research (e.g., [16]) indicate the potential that reductions in bus routes made to coincide with a new LRT service could countervail the new LRT ridership. The current study uses transit boarding data for bus and LRT to examine ridership changes adjacent to the Expo and Gold Lines. It provides important case studies that contribute to the literature because few studies have holistically examined the impact of a new LRT service on corridor-and system-wide ridership. Our findings expand the literature on the "total transit" impact of LRT by providing two illustrative case studies of recent LRT openings in a city that has traditionally been auto-oriented but has a maturing and rapidly growing rail transit system.

3. Ridership and Service Changes

3.1. Overview of the Expo and Gold LRT Lines

3.1.1. Expo Line

The Expo Line is an LRT line in the LA metropolitan area that extends south and west from downtown LA to downtown Santa Monica. The line was built in two phases. Phase 1, opened in April 2012, runs 8.7 miles (14 km) from downtown LA westward to Culver City near the junction of the I-405 and I-10 freeways (see Figure 1). Service began on the eastern portion of the Phase 1 section on 28 April 2012, and service was extended to Culver City on 20 June 2012. Phase 1 of the Expo Line has 12 stations, 10 of which were newly constructed (Figure 1). Phase 2 from Culver City to Santa Monica, which was a focus of this study, opened in May 2016.

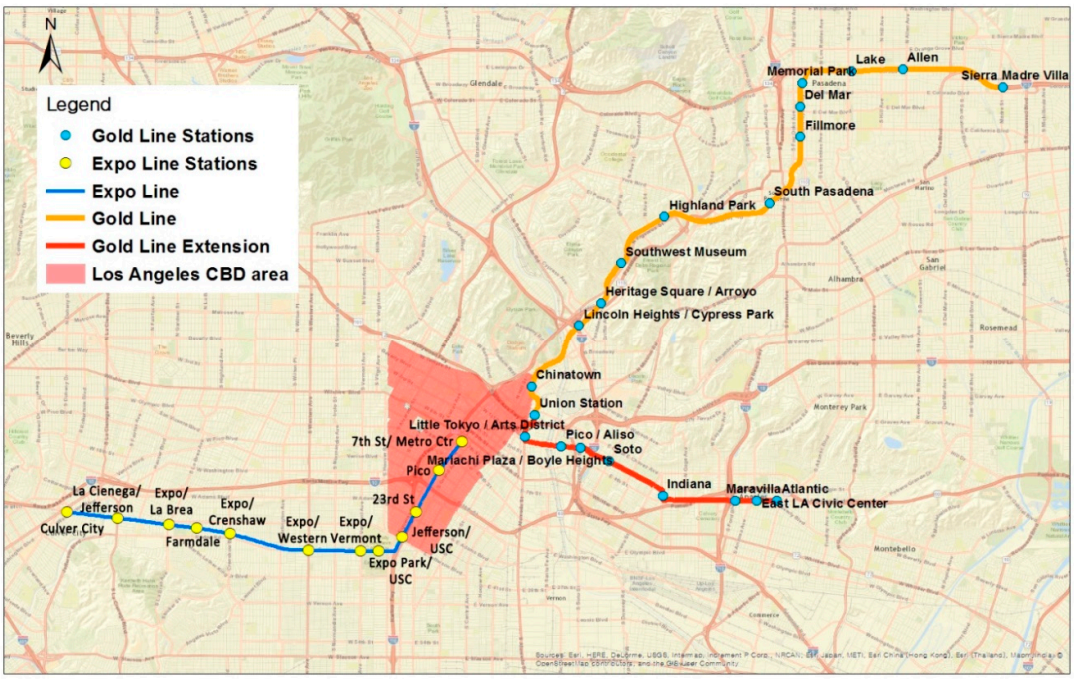


Figure 1. Expo Line Phase 1 and Gold Line Extension vicinity map.

Demographic characteristics for Expo Line Phase 1 corridor station areas (defined as half-mile-radius buffer areas from stations) were obtained from the 2010–2014 American Community Survey (ACS) block group data. The average population of the half-mile-radius areas of Expo Line Phase 1 stations was approximately 11,000 and the average annual household median income was approximately $36,000, but income levels varied between eastern and western portions of the corridor (Figure 2). Half of the Phase 1 corridor stations in the eastern portion of the line had an annual median household income level below $30,000 per year, but the westernmost station, Culver City, had an annual median household income of $65,000.

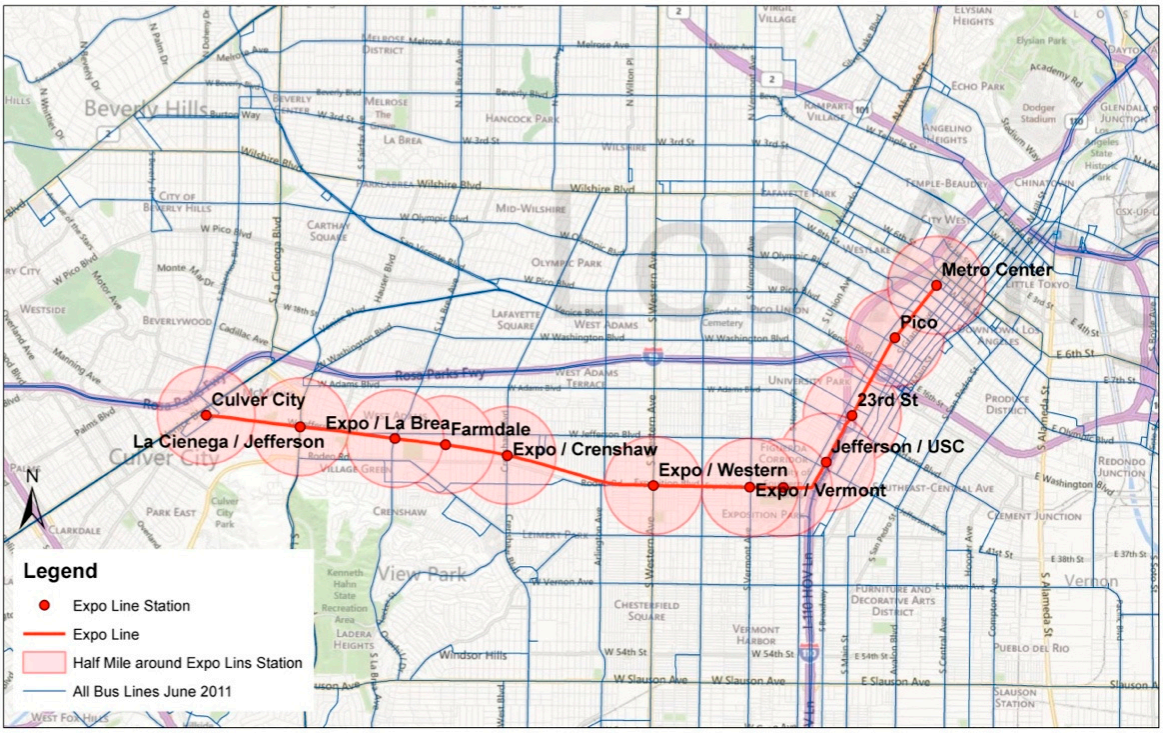


Figure 2. Half-mile-radius (0.8 km) buffer areas of Expo Line Phase 1 stations.

3.1.2. Gold Line and Gold Line Extension

The Gold Line runs from Pasadena to East LA via downtown LA. Phase 1 was comprised of twelve stations which began service in June of 2003 running from Union Station in downtown LA to east Pasadena. In November 2009, Metro opened the second phase of the Gold Line serving eight stations, from Union Station to Atlantic Station. This Gold Line Eastside extension, which is the focus of this study, is a six-mile (9.6 km) LRT line that serves ethnically diverse and culturally rich communities including the Little Tokyo–Arts District, Boyle Heights, and East LA (Figure 1).

The average population of the half-mile-radius areas around each Gold Line Eastside Extension station was approximately 10,500, similar to that of the Expo Line Phase 1 station areas (Figure 3). The average household median income of the Gold Line areas was $38,000, slightly higher than that of the Expo Line study areas. While income levels of Expo Line station areas varied between eastern (lower income) and western (higher income) areas, annual household income levels for the Gold Line station areas were relatively consistent, ranging between $30,000 and $44,000.

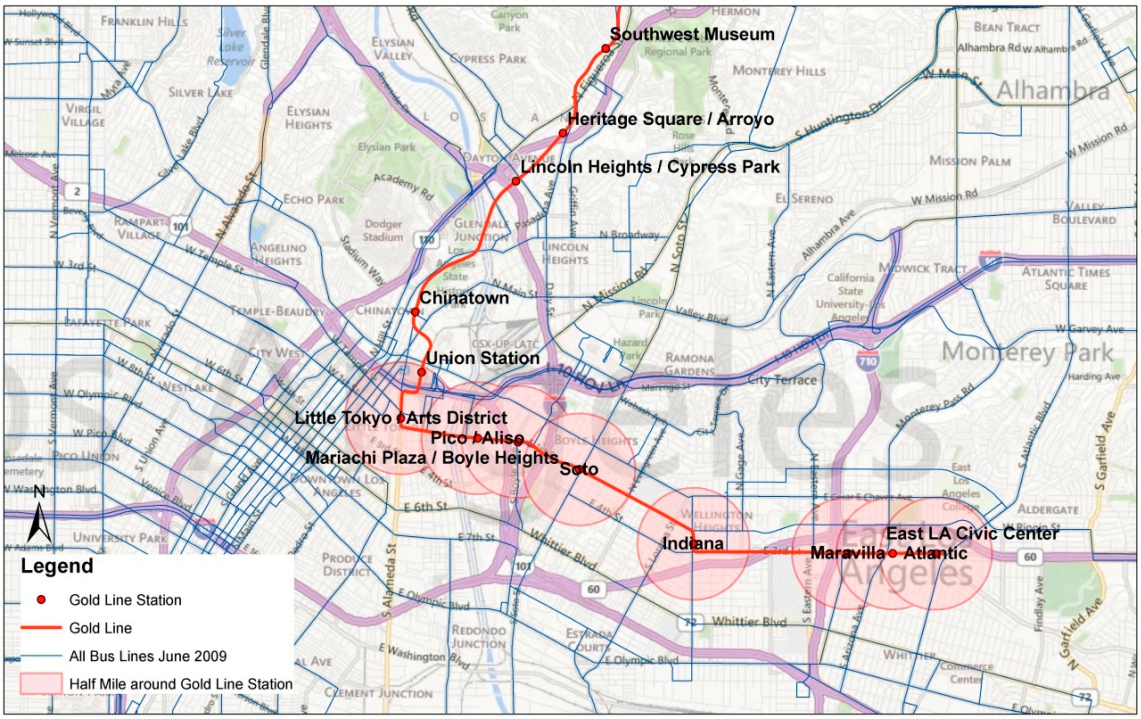


Figure 3. Half-mile-radius (0.8 km) buffer areas of Gold Line Extension stations.

3.2. *Bus Ridership Change after LRT Opening/Extension*

We compare ridership between the Gold Line extension and Expo Line Phase 1 and we examine patterns in both bus and LRT ridership along these corridors. Transit ridership data come from the LA County Metropolitan Transportation Authority (Metro) and the data are available in monthly mean format for weekday ridership [14]. The data indicate the total number of daily boardings that occur along the line, between the beginning and end of service on a typical business day not including Saturday, Sunday or holidays. Fluctuations are observed between the monthly ridership mean values and this ridership fluctuations resulted from the normal seasonal pattern. Data were reviewed for two periods: 2011 to 2016 (Corresponding with the Expo Line opening in April 2012) and 2009 to 2016 (Corresponding with the Gold Line extension opening in November 2009).

3.2.1. Expo Line

Sixty-six Metro bus lines traversed a one-mile (1.6 km) area around the Expo Line Phase 1 in 2011 before service began, including four types of Metro services: local, rapid, express, and shuttle buses (Figure 4). Metro local bus services entail frequent stops. Metro local buses operated 41 routes across the area in 2011. Among these 41 local bus lines, 30 lines ran through downtown LA and connected the Central Business District (CBD) area to Beverly Hills, Santa Monica, West LA, and the LAX/South Bay area. The other 11 local bus lines connected the non-CBD area to West Hollywood, Culver City, Inglewood, Norwalk, Athens, South Gate, Hawthorne, etc. Fifteen rapid buses, eight express buses, and two shuttle buses ran through the Expo Line corridor [29].

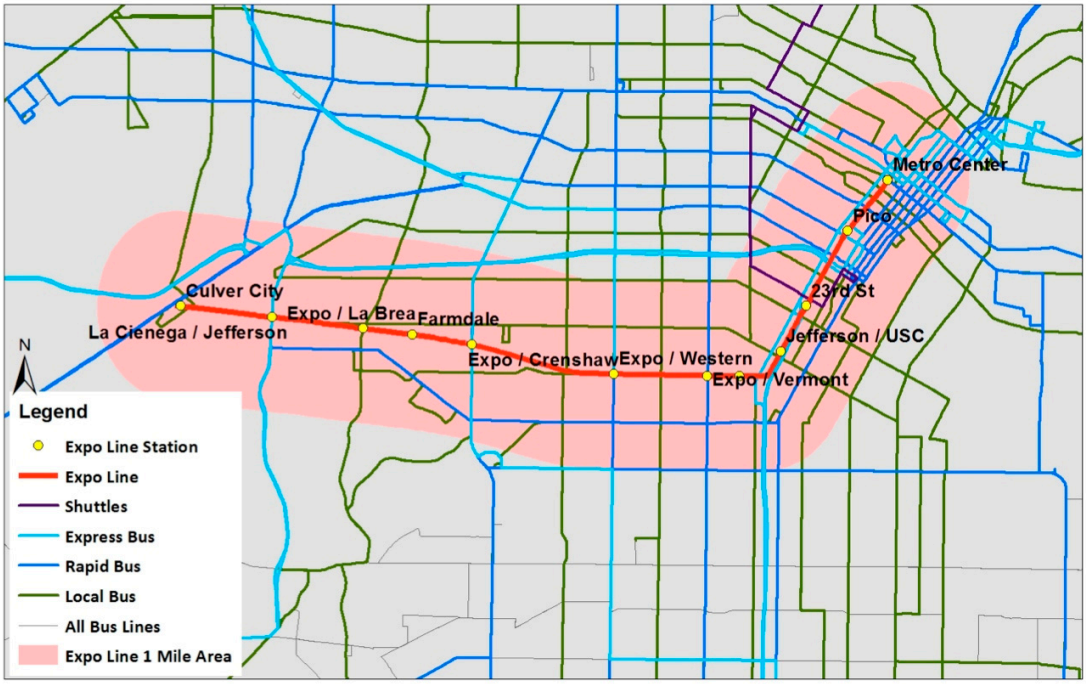


Figure 4. Bus lines traversing the Expo Line corridor.

Table 1 presents bus, LRT, and total transit (bus + LRT) average weekday ridership for five-month periods in 2011 through 2016. Figure 5 compares the average weekday ridership for bus (see Figure 5a), LRT (see Figure 5b), and total transit ridership (see Figure 5c) along the Expo Line corridor for each month (July through November) from 2011 to 2016. In addition, we compared this ridership along the Expo Line corridor with a system-wide ridership for Metro bus (see Figure 5d) and transit system (see Figure 5e) to assess whether the observed changes in boardings reflected an overall trend in system-wide ridership.

LRT ridership (Expo Line) greatly increased from a weekday average of approximately 18,000 in July 2012 to 48,000 during November 2016 after the opening of Expo Line in April 2012 (see Figure 5b). As shown in Table 1, transit ridership of the Expo Line corridor increased by approximately 19,800 riders per weekday between 2011 and 2013, but then decreased in 2014 to less than 30,000 riders. Since 2014, ridership decreased steadily. The net transit ridership of the Expo Line area for 2016 (LA County area) was 13% lower than the 2011 average before the introduction of the new light rail system.

On the bus side, ridership of the Expo Line corridor slightly declined by approximately 7600 from 2011 to 2013, 70,000 from 2014 to 2015, and 62,000 in 2016, leading to a total 18.6-percent reduction in weekday bus ridership, or about 140,000 riders, since the opening of the Expo Line. System-wide, Metro bus ridership dropped by 16.5% to roughly 187,000 riders between 2011 and 2016.

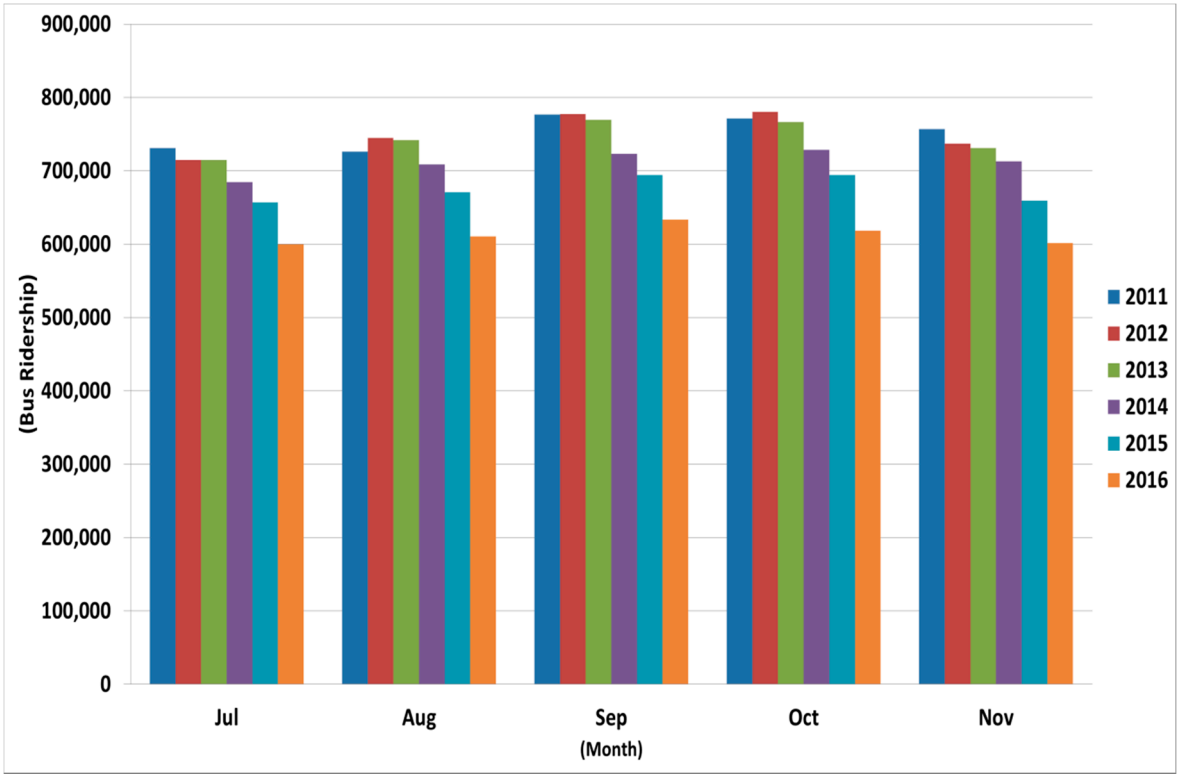
Net transit ridership peaked in 2013 with almost 772,000 unlinked passenger trips. However, the net ridership along the Expo Line corridor in "bus plus rail" ridership in 2014 decreased 3.8%, probably because Metro raised fares in September 2014 [30]. Concurrently, Metro's system-wide "bus plus rail" ridership decreased about 4.3% compared to the prior calendar year. This trend continued for the next two years, as the reduction in bus ridership exceeded the increase in the number of Expo Line riders.

Total transit ridership for lines traversing the corridor decreased by approximately 96,000 riders per day, which implies a 19% reduction in bus ridership of about 140,000 riders per day for the five years following the opening of the Expo Line in April 2012 (Table 1). This results in about a 13% loss of transit ridership along the Expo Line corridor over the five years. System-wide, overall Metro ridership of LA County decreased 10% and bus ridership decreased 17% for the same time period (2009–2016).

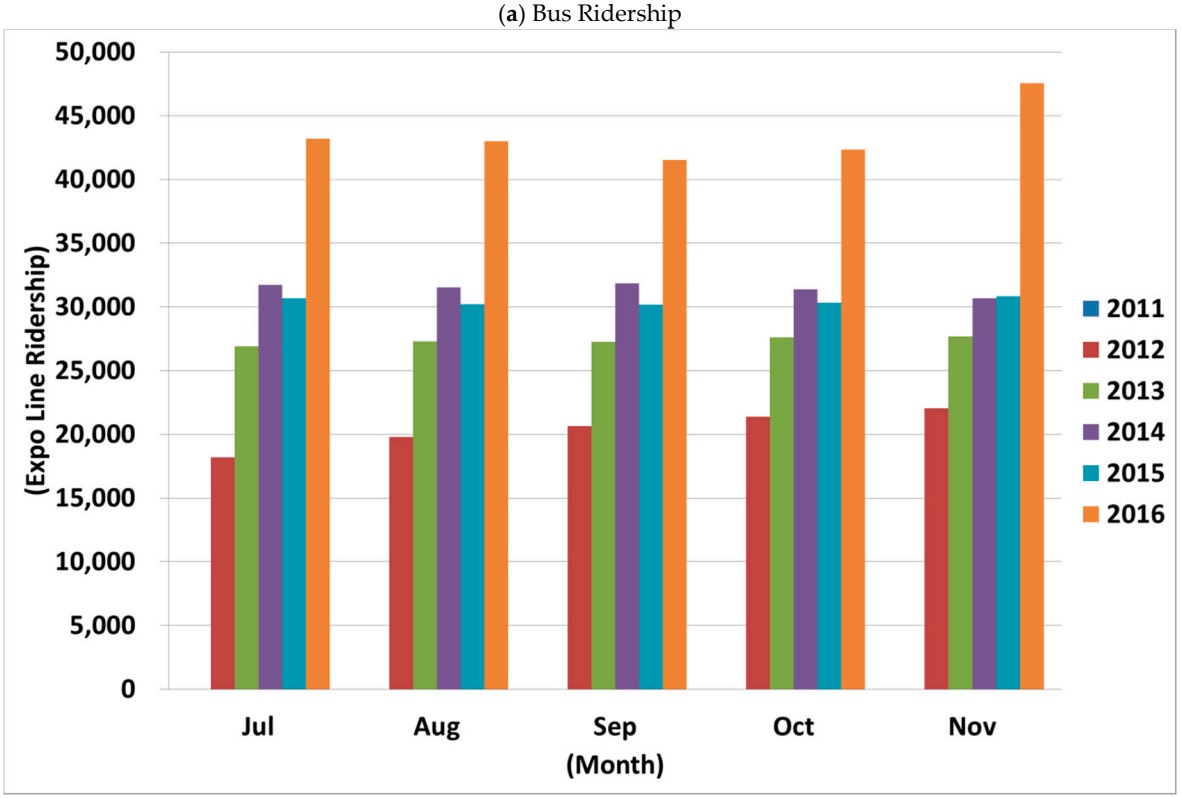
Table 1. Average weekday ridership and ridership changes in the Expo Line corridor.

		Expo Line Corridor						System-Wide			
		Bus		Expo Line		Transit		Bus		Transit	
		Average Ridership [b]	Change (Δ)	Average Ridership	Change (Δ)	Average Ridership	Change (Δ)	Average Ridership	Change (Δ)	Average Ridership	Change (Δ)
2011	Boarding [a]	752,175	--	--	--	752,175	--	1,133,182	--	1,450,971	--
2012	Boarding	750,583	−1592 (−0.2%)	20,412	--	770,996	18,821 (2.5%)	1,138,479	5297 (0.5%)	1,495,501	44,530 (3.0%)
2013	Boarding	744,623	−5960 (−0.8%)	27,348	6936 (34.0%)	771,971	975 (0.1%)	1,152,534	14,055 (1.2%)	1,521,456	25,955 (1.7%)
2014	Boarding	711,392	−33,231 (−4.5%)	31,430	4082 (14.9%)	742,822	−29,149 (−3.8%)	1,099,831	−52,703 (−4.6%)	1,455,822	−65,634 (−4.3%)
2015	Boarding	674,941	−36,451 (−5.1%)	30,443	−987 (−3.1%)	705,384	−37,438 (−5.0%)	1,043,255	−56,576 (−5.1%)	1,377,239	−78,583 (−5.4%)
2016	Boarding	612,568	−62,373 (−9.2%)	43,524	13,081 (43.0%)	656,092	−49,292 (−7.0%)	945,807	−97,448 (−9.3%)	1,302,465	−74,774 (−5.4%)
2011–2016	Total Change (Δ)	−139,607 (−18.6%)		43,524 (-)		−96,083 (−12.8%)		−187,375 (−16.5%)		−148,506 (−10.2%)	

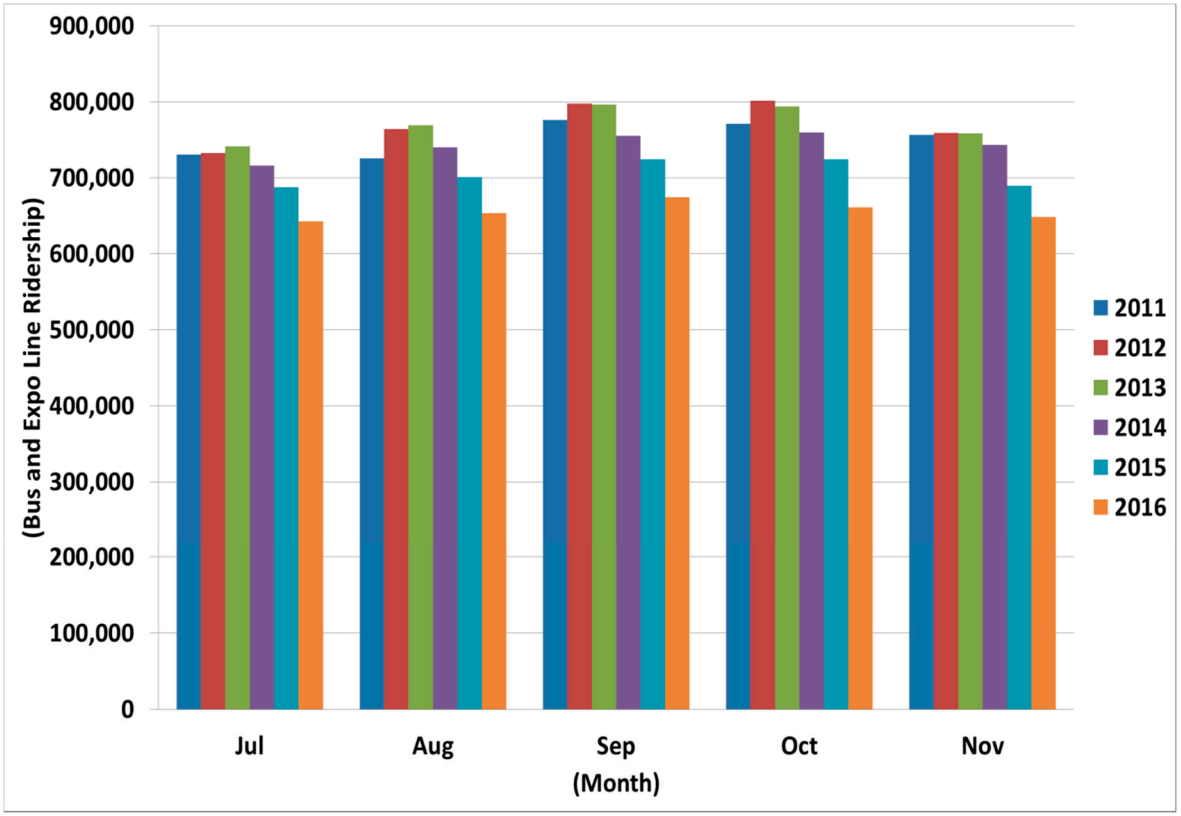
Note: [a] Boardings on bus represent unlinked trips for the entire bus routes traversing one-mile service area of the Expo Line (see Appendix A Table A1). [b] Average ridership represents five-month average weekday ridership for each year (July–November 2011, July–November 2012, July–November 2013, July–November 2014, July–November 2015, and July–November 2016). Source: LA County Metropolitan Transportation Authority. "Metro Ridership". http://isotp.metro.net/MetroRidership/IndexSys.aspx.



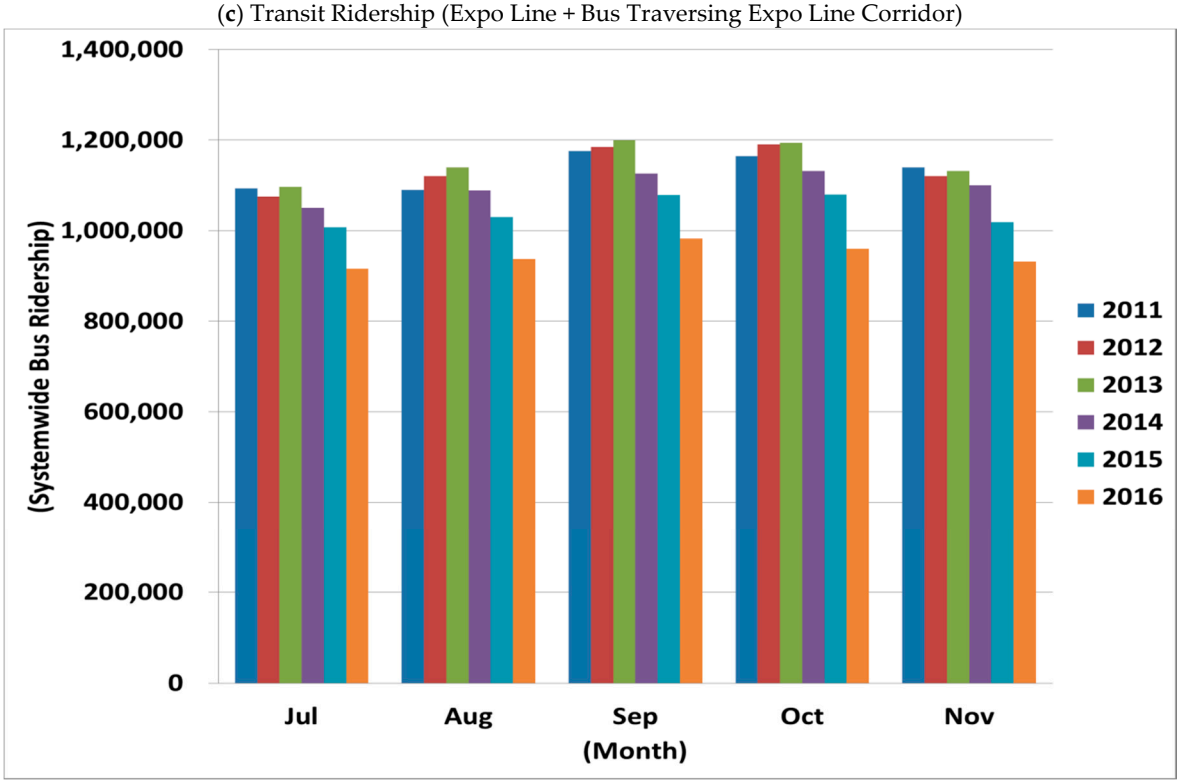
(**a**) Bus Ridership



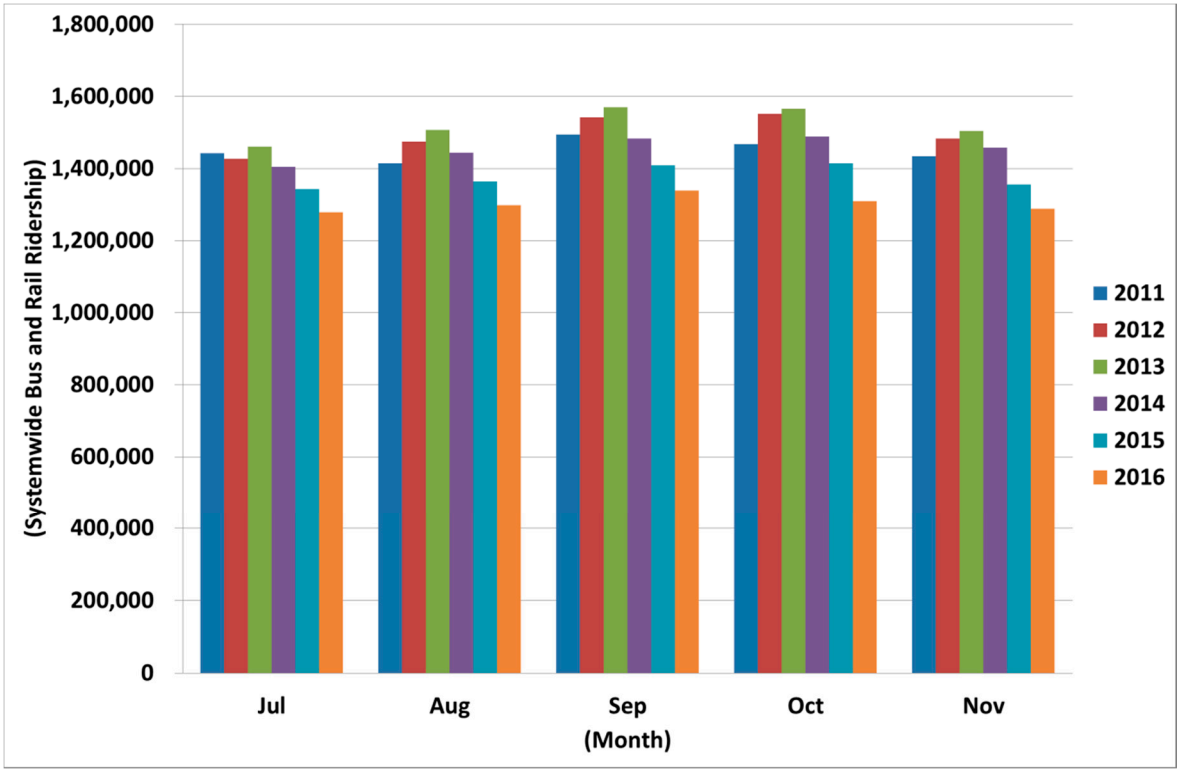
(**b**) Expo Line Ridership (Expo Line opening in April 2012)



(**c**) Transit Ridership (Expo Line + Bus Traversing Expo Line Corridor)



(**d**) System-wide Bus Ridership



(**e**) System-wide Transit (Bus Plus Rail) Ridership

Figure 5. Change in average weekday ridership in the Expo Line corridor by Month, 2011–2013. Note: Source: LA County Metropolitan Transportation Authority. "Metro Ridership." http://isotp.metro.net/MetroRidership/IndexSys.aspx.

3.2.2. Gold Line

The Gold line extension between Union Station and Atlantic Station was the focus of our ridership analysis. We analyzed the ridership patterns of Metro bus lines that traverse a one-mile (1.6 km) area around the Gold Line extension.

Sixty-four Metro bus lines traverse a one-mile radius around the Gold Line extension which opened in November 2009. Four types of Metro services—local, rapid, express, and shuttle buses—traverse this corridor (Figure 6). Metro local buses operated 38 routes across the corridor in 2009. Among these 38 routes, 31 ran through downtown LA and connected the CBD to West LA, Santa Monica, Burbank, Sun Valley, etc. The other seven local bus lines served north-south routes in non-CBD areas, and they connected the East LA, Compton, Pasadena, and Lynwood areas. Ten express bus lines, three shuttle lines, and 13 rapid lines ran through this corridor [29].

Table 2 presents bus, LRT, and total transit (bus + LRT) average weekday ridership along the Gold Line extension corridor for four-month periods in 2009 through 2016 and Figure 7 compares the average weekday ridership for bus (see Figure 7a), LRT (see Figure 7b), and total transit (see Figure 7c) of the Gold line extension corridor for each month (July through October) from 2009 to 2012. These patterns are compared with the system-wide ridership for Metro bus (see Figure 7d) and the overall transit system (see Figure 7e).

Table 2. Average weekday ridership and ridership changes in the Gold Line extension corridor.

		Extended Gold Line Corridor						System-Wide			
		Bus		Gold Line		Transit		Bus		Transit	
		Average [b] Ridership	Change (Δ)	Average Ridership	Change (Δ)	Average Ridership	Change (Δ)	Average Ridership	Change (Δ)	Average Ridership	Change (Δ)
2009	Boarding [a]	634,711	--	22,260	--	656,970	--	1,166,340	--	1,458,882	--
2010	Boarding	570,341	−64,370 (−10.1%)	34,905	12,645 (56.8%)	605,246	−51,724 (−7.9%)	1,122,758	−43,582 (−3.7%)	1,427,349	−31,533 (−2.2%)
2011	Boarding	543,794	−26,547 (−4.7%)	39,305	4400 (12.6%)	583,099	−22,147 (−3.7%)	1,131,160	8402 (0.7%)	1,455,116	22,767 (1.9%)
2012	Boarding	540,912	−2882 (−0.5%)	43,056	3751 (9.5%)	583,968	869 (0.1%)	1,162,986	31,826 (2.8%)	1,498,741	43,625 (3.0%)
2013	Boarding	539,408	−1504 (−0.3%)	44,254	1198 (2.8%)	583,661	−307 (−0.1%)	1,157,626	−5360 (−0.5%)	1,525,836	27,095 (1.8%)
2014	Boarding	507,819	−31,589 (−5.9%)	43,692	−562 (−1.3%)	551,511	−32,150 (−5.5%)	1,099,563	−58,063 (−5.0%)	1,455,459	−70,377 (−4.6%)
2015	Boarding	482,650	−25,169 (−5.0%)	44,739	1047 (2.4%)	527,338	−24,123 (−4.4%)	1,049,210	−50,353 (−4.6%)	1,382,515	−72,944 (−5.0%)
2016	Boarding	434,930	−47,720 (−9.9%)	51,248	6509 (14.5%)	486,178	−41,210 (−7.8%)	949,226	−99,984 (−9.5%)	1,306,117	−76,398 (−5.5%)
2009–2016	Total Change (Δ)	−199,781 (−31.5%)		28,988 (130.2%)		−170,792 (−26.0%)		−217,114 (−18.6%)		−152,765 (−10.5%)	

Note: [a] Boardings on bus represent unlinked trips for the entire bus routes traversing one-mile service area of the Gold Line (see Appendix A Table A2). [b] Average Ridership represents four-month average ridership for each year (July–October 2009, July–October 2010, July–October 2011, and July–October 2012). Source: LA County Metropolitan Transportation Authority. "Metro Ridership". http://isotp.metro.net/MetroRidership/IndexSys.aspx.

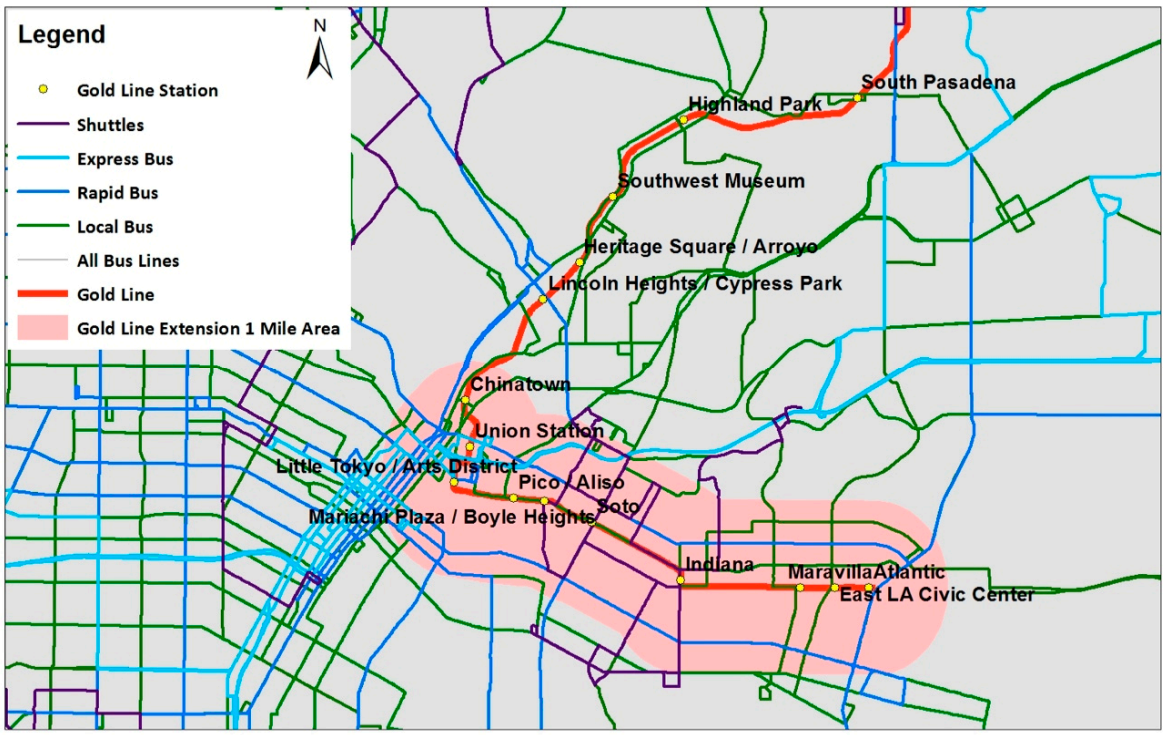


Figure 6. Bus lines traversing Gold Line extension corridor.

Metro opened the second phase of the Gold Line on 15 November 2009. The average weekday ridership of Gold Line rapidly increased from 21,000 (October 2009) to 28,500 (November 2009) concurrent with this extension. The Gold Line ridership continued to increase and by 2013 had almost doubled (99% increase, 44,250 trips) since 2009. The average weekday Gold Line ridership grew from 22,000 in 2009 to 51,000 in 2016, an increase of (unlinked) about 29,000 trips.

Although the Gold Line extension resulted in rapid increases in LRT ridership, the net transit ridership continued to decrease after the line was extended in November 2009. Total transit (bus plus rail) ridership in Gold Line extension corridor decreased about 8% despite the increase (57%) in Gold Line ridership between 2009 and 2010. This trend continued in 2011, as the reduction in bus ridership exceeded the increase in the number of Gold Line riders. Overall, total transit ridership for lines traversing the corridor decreased by approximately 171,000 riders per day, which implies a 31.5% reduction in bus ridership of about 200,000 riders per day for the seven years following the opening of this second phase of the Gold Line (Table 2). This results in a loss of ridership of about 26% along the extension corridor of Gold Line over the seven years. System-wide, overall Metro ridership in LA County decreased 10.5% and bus ridership decreased 18.6% for the same time period (2009–2016).

3.3. Service Change after LRT Opening/Extension

Of particular interest for this research is whether changes in bus service made to coincide with the opening of new LRT service impact ridership. In order to evaluate whether changes in our study areas reflect unique service changes in those areas, or parallel broader system-wide service changes, we examine Metro's system-wide bus service levels along both the Expo Line and Gold Line extension corridor compared to system-wide service changes. As seen in a number of before-and-after studies completed per Federal Transit Administration's requirements, it is not unusual, or unexpected, for transit agencies to make changes to bus services coincident with the opening of a new rail service. Bus lines running along the same corridor as the new rail service are often eliminated, with the rail service replacing the previous bus service. In addition, agencies often re-route, or increase bus service to serve as feeders into the new rail line.

During the period after the Expo Line opened, the bus service changes were implemented in June 2012. Table 3 compares Metro's system-wide service changes with changes within the Expo Line corridor between 2011 and 2012. During the morning peak period, essentially no change in bus service occurred system-wide, however, service within the Expo Line corridor decreased very slightly. During the afternoon peak period, both system-wide and Expo Line bus service levels declined by an identical percentage. The Expo Line corridor saw an increase in base period bus service level compared to system-wide changes, while the late night "owl" service decreased similarly for the study area and system-wide.

Vehicle revenue hours of service and vehicle revenue miles of service were 0.3% and 1.5% lower, respectively, in 2012 than they were in 2011. System-wide, vehicle revenue hours of service remained almost the same but vehicle revenue miles of service decreased by approximately 1% (Table 4).

Table 3. Service changes for system-wide bus lines and bus lines traversing Expo Line corridor.

		AM Peak		Base		PM Peak		Owl		Total	
	Date	Runs	Percent Change 2011–2012	Runs	Percent Change 2011–2012	Runs	Percent Change 2011–2012	Runs	Percent Change 2011–2012	Runs	Percent Change 2011–2012
System-Wide [a]	June 2011	1847	0.1%	1008	0.6%	1940	−2.2%	60	−1.7%	4855	−0.8%
	June 2012	1848		1014		1897		59		4818	
Expo Line Area [b]	June 2011	1188	−1.6%	647	1.9%	1223	−2.2%	51	−2.0%	3109	−1.1%
	June 2012	1169		659		1196		50		3074	

Note: [a] System-wide bus line service change, June 2011–June 2012; [b] Service changes for individual bus lines traversing Expo Line corridor (within one mile of the line) June 2011–June 2012. Source: Service performance analysis from Metro (Scheduled service operating cost factors report No. 4–24, June 2011, June 2012).

Table 4. Service changes for system-wide bus Lines and bus lines traversing Expo Line corridor.

	Date	Vehicle Hours		Vehicle Miles	
		Revenue	Percent Change 2011–2012	Revenue	Percent Change 2011–2012
System-Wide [a]	June 2011	19,690.0	−0.1%	220,372.8	−0.9%
	June 2012	19,677.6		218,475.4	
Expo Line Area [b]	June 2011	12,751.4	−0.3%	137,363.5	−1.5%
	June 2012	12,709.3		135,356.1	

Note: [a] System-wide bus line service change, June 2011–June 2012; [b] Service changes for individual bus lines traversing Expo Line corridor (within one mile of the line) June 2011-June 2012. Source: Service performance analysis from Metro (Scheduled service operating cost factors report No. 4–24, June 2011, June 2012).

Following the opening of the Gold Line extension, the bus service changes were implemented in June 2010 and bus service frequencies decreased as shown in Table 5. The system-wide service level decreased almost 5% between 2009 and 2010. However, bus service level decreases within the Gold Line extension corridor were substantially larger. Overall, Metro decreased the number of buses traversing the Gold Line extension corridor by 13%, with the largest decreases occurring during the morning and afternoon peak times (−14.3% and −13.0%, respectively). Base period bus service levels decreased in the study area by nearly 11%.

Table 5. Service changes for system-wide bus line and bus lines traversing Gold Line extension corridor.

	Date	AM Peak		Base		PM Peak		Owl		Total	
		Runs	Percent Change 2009–2010	Runs	Percent Change 2009–2010	Runs	Percent Change 2009–2010	Runs	Percent Change 2009–2010	Runs	Percent Change 2009–2010
System-Wide [a]	June 2009	2206	−5.4%	1125	−6.0%	2333	−3.7%	61	−3.3%	5725	−4.8%
	June 2010	2087		1057		2247		59		5450	
Gold Line Area [b]	June 2009	1214	−14.3%	636	−10.8%	1285	−13.0%	45	−4.4%	3180	−13.0%
	June 2010	1040		567		1118		43		2768	

Note: [a] System-wide bus line service change, June 2009–June 2010; [b] Service changes for individual bus lines traversing Gold Line area (within one mile of the line) June 2009–June 2010. Source: Service performance analysis from Metro (Scheduled service operating cost factors report No. 4–24, June 2009, June 2010).

In terms of vehicle revenue hours and miles, both system-wide and Gold Line bus service levels declined, but the decreases for the Gold Line extension corridor were larger as a percentage of June 2009 levels. Vehicle revenue hours of service and vehicle revenue miles of service for buses in the Gold Line corridor were 13% and 16% lower, respectively, in 2010 than they were in 2009. System-wide, vehicle revenue hours of bus service and vehicle revenue miles of bus service decreased 5.5% and 6%, respectively (Table 6).

Table 6. Service changes for system-wide bus line and bus lines traversing Gold Line Area.

	Date	Vehicle Hours		Vehicle Miles	
		Revenue	Percent Change 2009–2010	Revenue	Percent Change 2009–2010
System-Wide [a]	June 2009	22,138.2	5.5%	257,463.4	−6.1%
	June 2010	20,916.1		241,663.1	
Gold Line Area [b]	June 2009	12,668.1	−12.9%	142,768.3	−15.9%
	June 2010	11,035.0		120,070.6	

Note: [a] System-wide bus line service change, June 2009–June 2010; [b] Service changes for individual bus lines traversing Gold Line area (within one mile of the line) June 2009–June 2010. Source: Service performance analysis from Metro (Scheduled service operating cost factors report No. 4–24, June 2009, June 2010).

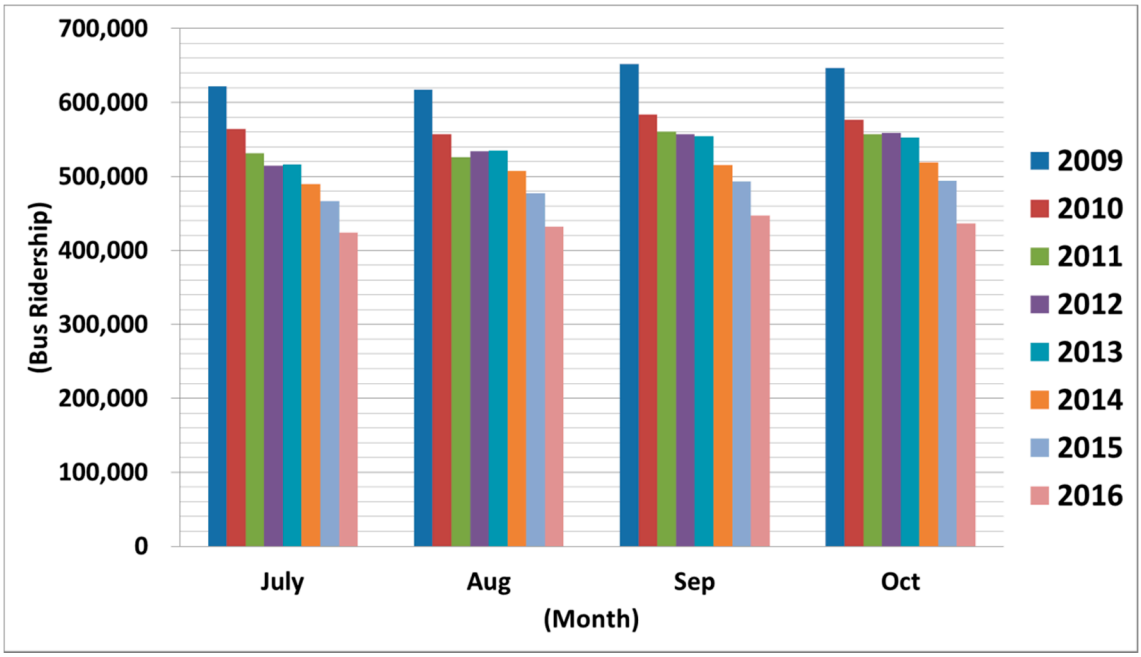
After the Gold Line extension and the Expo Line openings, Metro also implemented several bus route service changes. After the Expo Line opening in 2012, Metro made route changes to lines 550 (express) and 740 (rapid bus), eliminating service into West Hollywood and the Central Business District area. Metro extended the 30 and 102 local lines to West Hollywood and LA International Airport (LAX) and doubled the number of vehicles serving those lines (Figure 8). These four lines experienced the largest individual changes in ridership with lines 30 and 102 showing noticeable increases in ridership, while lines 550 and 740 experienced declines (Table 7).

Table 7. Service changes for individual bus lines traversing Expo Line corridor (within one mile of line), June 2011–June 2012.

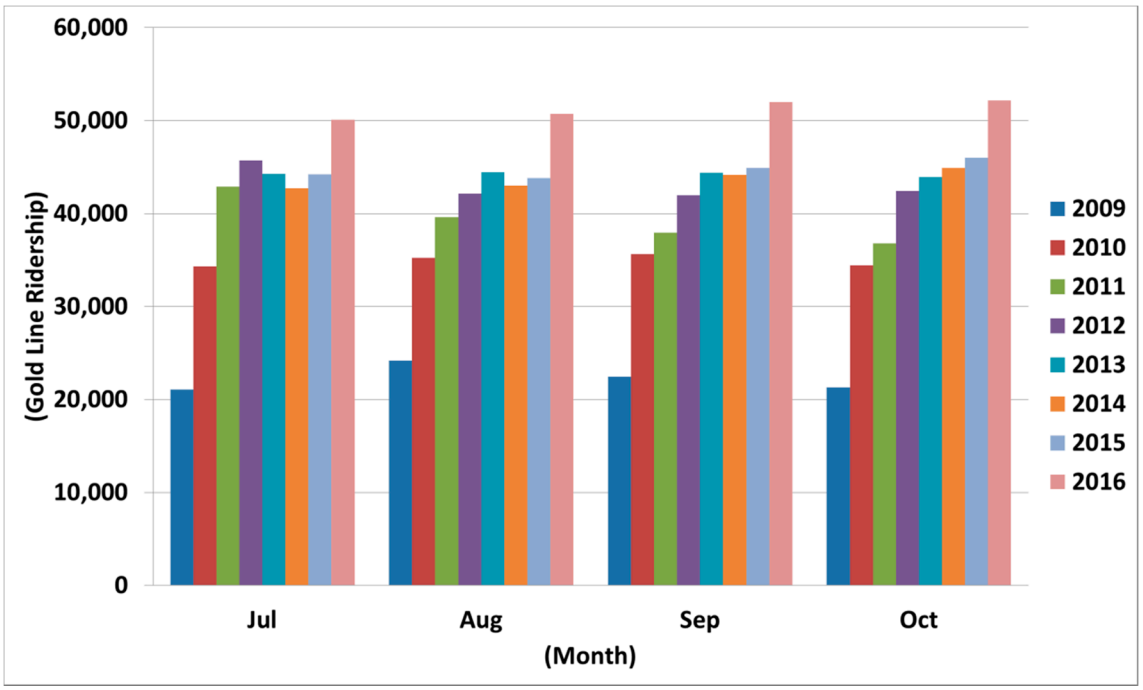
Bus #	Date	Number of Runs for the Route (2011–2012)				Ridership Change	
		AM Peak	Base	PM Peak	Owl	Average Difference	% Difference
# 30	June 2011	15	10	19	2	5791	44.4%
	June 2012	23	19	25	2		
# 102	June 2011	3	3	3		860	52.7%
	June 2012	6	6	6			
# 550	June 2011	7	5	9		−1527	−47.4%
	June 2012	5	2	5			
# 740	June 2011	17	7	16		−3760	−48.1%
	June 2012	12	6	13			

Note: The table shows the bus routes with the largest changes, not all bus lines in the corridor. Source: Service performance analysis from Metro (Scheduled service operating cost factors report No. 4–24).

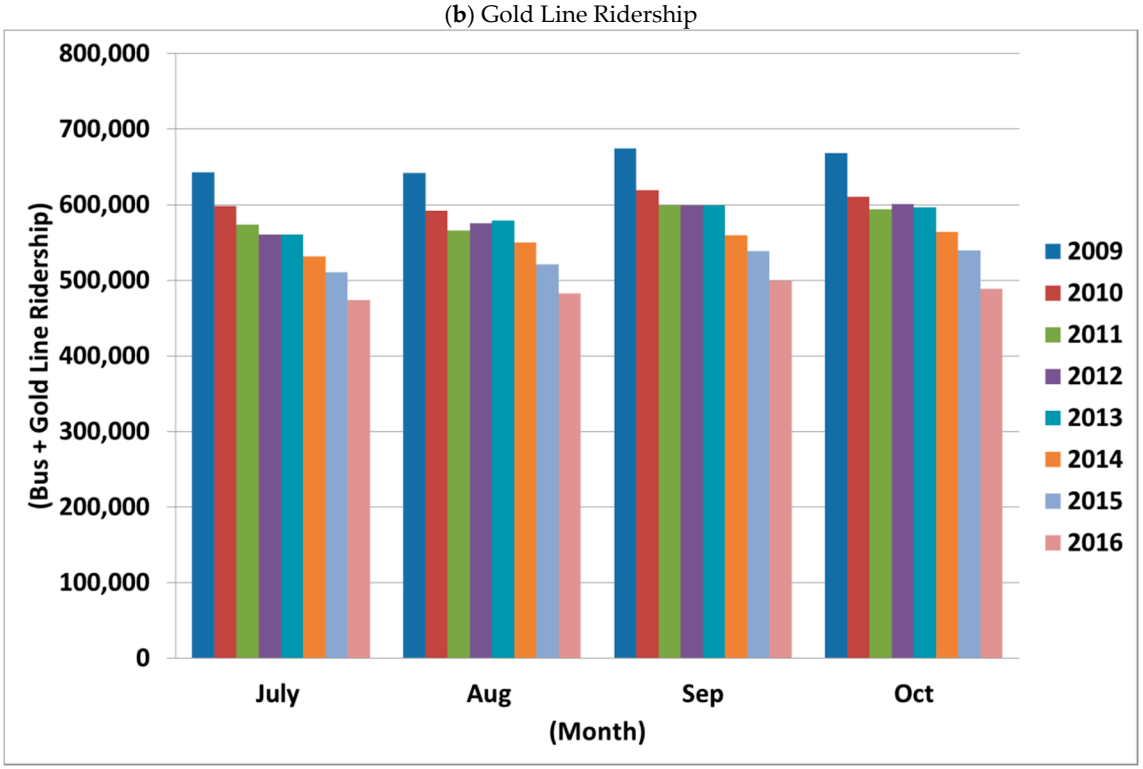
The Federal Transit Administration [31] states that "service on one bus route was dropped east of the Indiana Street station". We found that Metro made a change to Line 30, eliminating the easternmost portion of the route and reducing the number of vehicles with the extension of the Gold Line in 2009. In addition, four of the limited express bus services (number 444, 445, 484, and 490) were discontinued, concurrent with opening of the second phase of Gold Line (see Figure 9 and Table 8). Although these four lines were not bus services directly aligned with the Eastside Extension project, these four lines were bus services that traversed the corridor within a 1-mile radius of the Gold Line eastside extension.



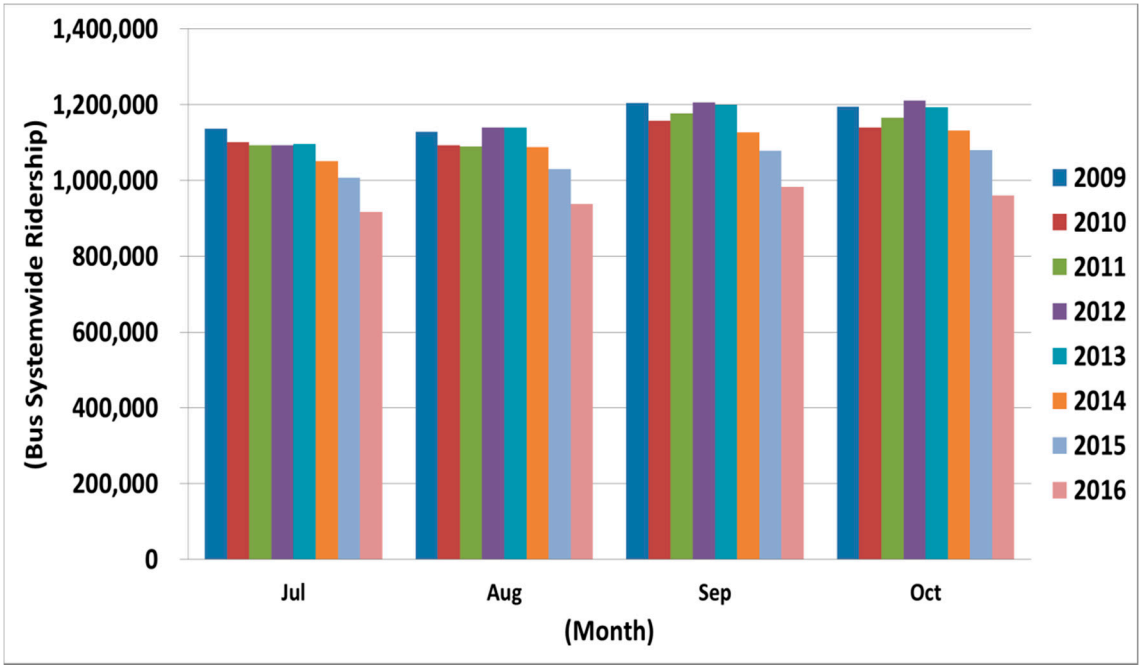
(**a**) Bus Ridership



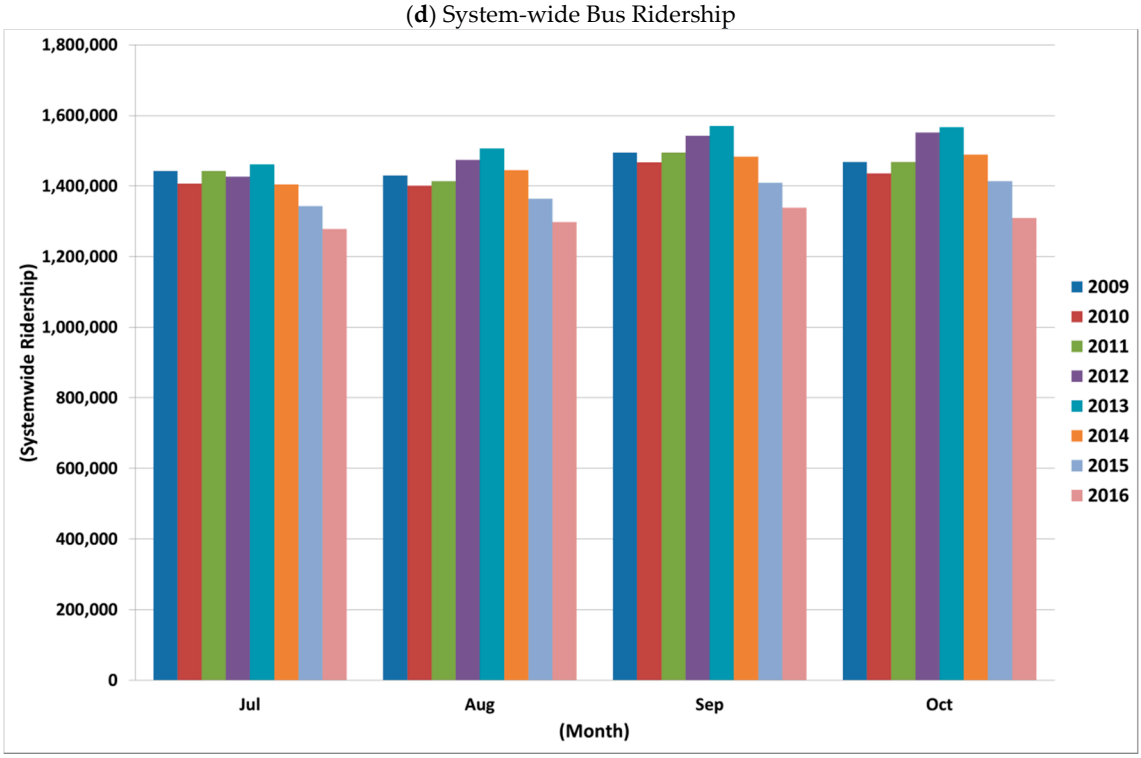
(**b**) Gold Line Ridership



(**c**) Transit Ridership (Gold Line + Bus Traversing Gold Line extension corridor)



(**d**) System-wide Bus Ridership



(**e**) System-wide Transit (Bus Plus Rail) Ridership

Figure 7. Change in average weekday ridership in the Gold Line extension corridor by Month, 2009–2011. Source: LA County Metropolitan Transportation Authority. "Metro Ridership". http://isotp.metro.net/MetroRidership/IndexSys.aspx.

In sum, Metro eliminated four bus routes, cut the service hours by 13%, and shortened service routes by 16% along the Gold Line extension corridor in 2010. Overall transit (bus plus LRT) ridership of this corridor fell over 8% in 2010, despite a record number of riders who used the Gold Line system. This decline is much higher than Metro's system-wide decline of about 2% in 2010.

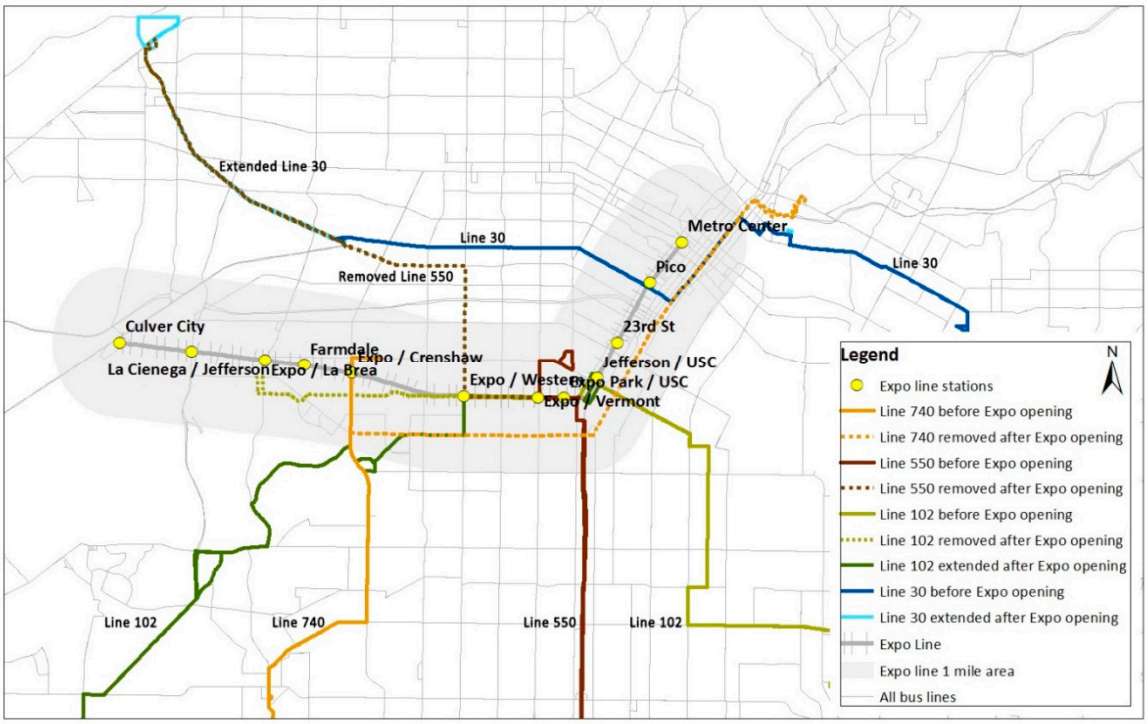


Figure 8. Route service changes of bus lines traversing the Expo Line corridor. Source: Metro's Shakeup GIS files (Post June 2011, Post June 2012).

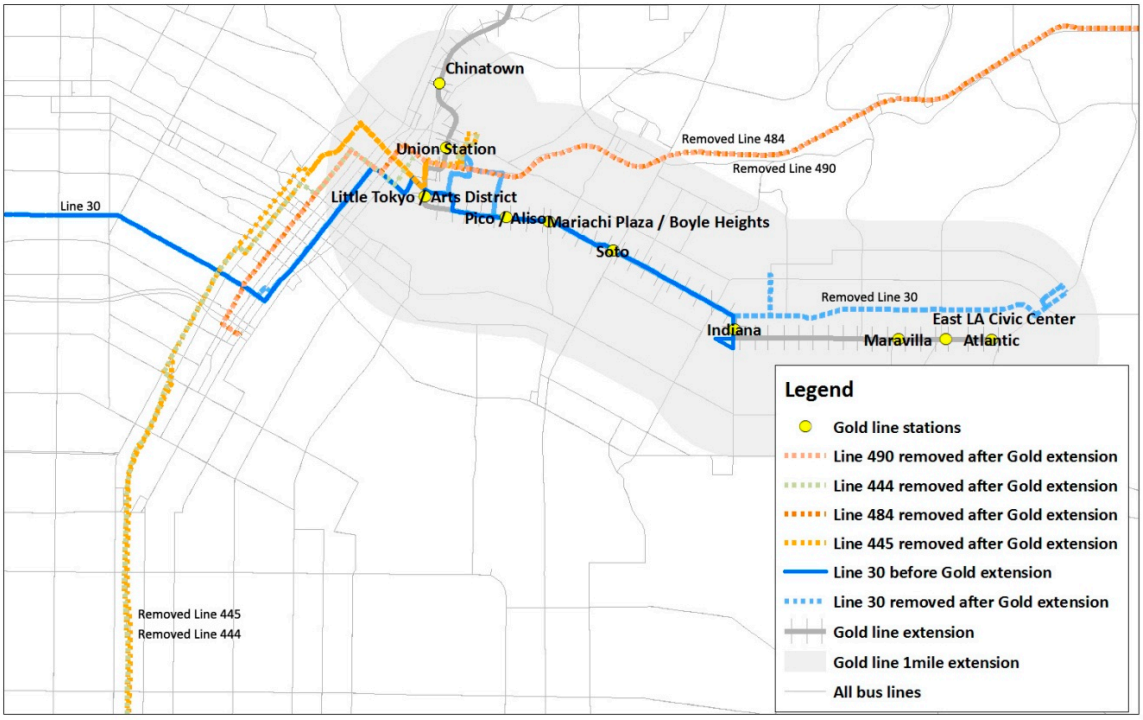


Figure 9. Route Service Changes of Bus Lines Traversing Gold Line extension corridor. Source: Metro's Shakeup GIS files (Post June 2009, Post June 2010).

Table 8. Service Change for Individual Bus Lines Traversing Gold Line extension corridor (within one mile of line), June 2009–June 2010.

Bus #	Date	Number of Runs for the Route (2009–2010)				Ridership Change	
		AM Peak	Base	PM Peak	Owl	Average Difference	% Difference
# 30	June 2009	20	13	24	2	−3555	−21.5%
	June 2010	16	10	19	2		
# 444	June 2009	16	4	11	-	−3010	-
	June 2010	-	-	-	-		
# 445	June 2009	7	3	8	-	−142	-
	June 2010	-	-	-	-		
# 484	June 2009	26	10	25	-	−7324	--
	June 2010	-	-	-	-		
# 490	June 2009	23	6	24	-	−6010	--
	June 2010	-	-	-	-		

Note: The table shows the bus routes with the largest changes, not all bus lines in the corridor. Source: Service performance analysis from Metro (Scheduled service operating cost factors report No. 4–24).

4. Conclusions and Policy Implications

This study examines aggregate data to track changes in ridership before and after the opening of new LRT services with an emphasis on how changes to bus service and routing may impact travel.

The results underscore two important, and related, points. First, changes in bus service made to coincide with the introduction of new LRT can negatively affect the overall transit ridership in the corridor. Although the Expo Line and Gold Line extension areas had similar demographic and socio-economic characteristics, the net transit ridership effect along these corridors differed during the years immediately after LRT service began. Expo LRT service began in April 2012 and resulted in 2013 net transit ridership increasing to its highest level. However, a year-to-year Gold Line LRT ridership comparison shows a dip in net corridor transit ridership between 2009 and 2010, although gas prices in the region rose after the Gold Line was extended to the Eastside in 2009. This pattern is probably in part because the entire system suffered service reductions during this period. However, bus service decreased substantially more within the Gold Line extension corridor compared to the countywide decrease in bus service. This change along the Gold Line extension appears to be related to a net "bus plus rail" ridership decline (over 8%) in that corridor, which was greater than Metro's system-wide "bus plus rail" ridership decrease of about 2% for the same period, 2009 to 2010. The results of this research suggest that there was a large reduction in bus service concurrent with the opening of the Gold Line LRT extension in 2009.

Second, the results of our Expo Line analysis show that the ridership decline is not attributable to any single factor. The net transit ridership along the Expo Line corridor slightly increased in "bus plus rail" ridership until the end of 2013, after the rail line opened in April 2012, possibly because the bus service was not reduced by the same magnitude as along the Gold Line extension from 2009 to 2010. However, ridership along the corridor in 2014 was down 4%, concurrent with the 4% decrease in the Metro's system-wide ridership compared to the prior calendar year. This decrease occurred after Metro raised fares in September 2014. It shows that predicting and increasing ridership are complex tasks, but fares and service cuts likely play key roles in increasing or decreasing ridership.

In terms of policy implications, our results give reasons for transit agencies to think carefully about bus and rail transit service, particularly when new LRT is introduced. Light rail runs along the street—often along heavily traveled bus routes—and it seems intuitive to eliminate some bus routes to optimize the system once the new LRT service commences. This study does not argue against such efforts, but based on our findings, we suggest some caution. Changes in bus service, on net, can be consistent with increases in transit ridership (as in the Expo Line corridor in the first two years after that LRT line opened) or decreases in transit ridership (as in the Gold Line corridor

immediately following 2009). More importantly, system optimization might affect a wide range of travel behavior. Eliminating bus stops (and other related reductions in service) could suppress ridership among households near eliminated bus stops along the new light rail corridor. This study suggests that transit agencies should take a more holistic view of travel impacts, and that changes to bus service should be carefully crafted to maximize the use of new LRT service and facilitate changes in travel behavior that are consistent with a shift away from automobility.

Looking more generally, the results of this study touch on broader issues of sustainability and transit. The LA case illustrates three issues that require further research. First, how do rail and bus transit jointly affect sustainability goals? In the Gold Line corridor in LA, the initial opening of rail service was associated with both service reductions and decreases in bus transit ridership. The net GHG emission impact of those trends would be complex, and would depend on the overall travel behavior changes of riders, power generation and fuel sources for the bus and rail systems, and occupancy levels of both the bus and rail lines. For LA, some summary information is available from previous research. Chester et al. [32] give data on per-mile carbon emissions of several bus and rail lines in major U.S. cities, and those data, for LA, indicate that the Gold Line has emissions averaging 124.02 g of CO_2 per passenger, while the Orange Line Bus Rapid Transit (BRT) line in LA has emissions averaging 68.54 g of CO_2 per passenger. If the Orange Line BRT is reflective of other bus service (Chester et al. do not report emissions for other LA bus lines), this raises the possibility that a shift of riders from busses to LRT along the Gold Line corridor may be a move from low to higher emission transit systems. Recently Metro's Board approved the purchase of 95 electric buses which will run along the Orange and Silver Line busways. An ambitious goal set forth by L.A.'s mayor would electrify the entire fleet by 2030 [33]. This could make buses even lower GHG which makes the recent drop in bus ridership more problematic. We caution that the specific net emission change will depend on circumstances of the lines and passenger travel behavior, but as cities worldwide expand rail transit systems, more careful assessment of how changes in overall transit ridership affect GHG emissions should be pursued.

Second, travel behavior itself should be an object of study as cities open new rail transit systems [34,35]. While we document changes in bus ridership associated with the opening of new LRT lines in LA, it is still unclear from this study to what extent bus riders are shifting to new LRT service, and there is no a priori reason to expect such shifts to be one-for-one. We suggest future research that continues to explore how LRT and bus service changes are associated with changes in transit ridership.

Third, changes in urban development that are associated with new and expanded transit systems should be studied in future work. The evidence that we document, on changes in bus and LRT ridership, are short-term effects, soon after the new LRT service opened. Longer-term land use changes could reinforce or modify the ridership patterns observed in this study. While our goal was not to study how the city and metropolitan area are coordinating land use near transit, as cities worldwide are embarking on rail transit expansions, such studies are increasingly important. We note that, from our results, questions of the interaction of new LRT service with bus service are important, and to date the literature has focused almost exclusively on the role of land use and development only in relationship to rail transit.

To recap our main findings, bus service changes and total corridor transit ridership were strongly associated in the first approximately two years after each LRT system opened. The Gold Line saw a large reduction in bus service and immediate (in 2010) reductions in bus ridership that more than countervailed the increase in LRT ridership. The Expo Line corridor had almost no net change in bus service and an initial increase in total transit ridership. In the most recent years, approximately since 2014, system-wide bus ridership declines appear to swamp any corridor specific effects. By suggesting a more holistic view, we encourage transit agencies to be more alert to both bus service and overall system factors. The large reductions in bus service along the Gold Line corridor are associated with overall transit ridership declines in the same corridor, and we suggest that agencies be alert to the links from bus service to transit ridership changes. However, clearly broader, systemic factors are also important in ridership, as the data from 2014 forward

indicate. Our study was not designed to illuminate those systemic factors, although the bus fare increases and gas price declines of recent years are factors that warrant further study [25,36]. Overall, we conclude that changes in service, particularly those associated with new LRT, can change travel behavior. Transit agencies and future research should be more alert to before-after evaluations of new service. Insights drawn from the current study can serve as an example of the importance of such evaluations and we suggest that this approach should become a standard part of agency operations.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Detailed Ridership Data for Expo and Gold Lines

Table A1. Ridership data for bus lines traversing the Expo Line corridor (within one mile of the line).

Line #		July 201	August 2011	September 2011	October 2011	November 2011	July 2012	August 2012	September 2012	October 2012	November 2012	July–November 2011	July–November 2012	Average Difference	Difference (%)
Local through CBD	2	19,417	18,868	20,324	20,380	19,523	19,249	19,838	20,515	20,779	19,345	19,702	19,945	243	1.2%
	4	20,582	20,294	21,573	21,645	21,315	20,963	22,200	22,388	22,254	21,036	21,082	21,768	686	3.3%
	10	11,994	11,785	13,914	13,868	13,295	11,463	12,924	13,919	13,959	12,890	12,971	13,031	60	0.5%
	14	19,166	19,476	21,919	22,112	21,458	19,040	20,595	22,244	22,376	20,498	20,826	20,951	124	0.6%
	16	25,509	25,214	26,739	27,103	26,924	24,415	25,506	25,995	26,082	25,089	26,298	25,417	−880	−3.3%
	18	24,678	24,314	25,695	25,528	24,901	23,654	24,554	24,821	24,827	23,996	25,023	24,370	−653	−2.6%
	20	17,161	17,177	17,558	17,409	16,792	17,215	17,684	17,773	17,791	16,654	17,219	17,423	204	1.2%
	28	7902	7784	8148	8047	7942	8535	8571	8793	8834	8371	7965	8621	656	8.2%
	30	13,045	13,090	13,237	13,048	12,868	18,511	18,703	19,317	19,377	18,337	13,058	18,849	5791	44.4%
	33	12,418	12,173	12,906	12,700	12,586	12,744	13,546	13,727	13,686	12,874	12,557	13,315	759	6.0%
	35	12,050	11,872	13,627	13,441	13,279	10,655	11,655	12,877	12,932	12,004	12,854	12,025	−829	−6.5%
	40	24,022	23,790	25,133	25,254	25,126	22,546	23,521	24,408	24,010	22,728	24,665	23,443	−1222	−5.0%
	45	21,908	21,668	22,901	22,641	22,366	20,296	21,107	22,026	22,207	21,126	22,297	21,352	−944	−4.2%
	51	27,074	27,606	29,068	28,905	28,639	27,509	28,459	29,517	30,080	28,743	28,258	28,862	603	2.1%
	53	13,342	13,299	14,623	14,536	14,338	13,408	14,102	15,122	15,300	14,339	14,028	14,454	427	3.0%
	55	9094	9034	10,270	10,308	9934	8501	9520	10,682	10,657	9759	9728	9824	96	1.0%
	60	19,809	19,864	20,749	20,252	19,992	20,093	20,918	21,163	21,610	20,767	20,133	20,910	777	3.9%
	62	4851	5041	5190	5103	5076	5056	5189	5339	5380	5113	5052	5215	163	3.2%
	66	19,684	19,314	19,516	19,442	19,246	18,394	18,765	18,828	18,782	17,812	19,440	18,516	−924	−4.8%
	70	12,368	12,341	12,731	12,606	12,443	12,371	12,443	12,916	13,064	12,229	12,498	12,605	107	0.9%
	71	1663	1670	1879	2037	2010	1839	1959	2128	2284	2113	1852	2065	213	11.5%
	76	10,829	10,711	11,231	11,078	10,963	10,429	10,206	10,740	10,690	10,174	10,962	10,448	−515	−4.7%
	78	11,573	11,465	12,113	11,885	11,710	11,690	11,767	12,425	12,515	12,053	11,749	12,090	341	2.9%
	81	15,870	15,987	17,357	17,161	16,757	15,374	16,112	17,336	17,276	16,543	16,626	16,528	−98	−0.6%
	83	4034	3918	4189	4107	3996	3368	3406	3514	3581	3306	4049	3435	−614	−15.2%
	84	9182	8612	9691	9524	9360	8559	8730	9565	9593	8963	9274	9082	−192	−2.1%
	90	5911	6113	6982	6772	6626	6406	6478	7791	7589	7084	6481	7070	589	9.1%
	92	5771	5661	5855	5827	5916	5468	5525	5714	5747	5597	5806	5610	−196	−3.4%
	94	6644	6517	6669	6553	6522	6221	6242	6545	6492	6142	6581	6328	−253	−3.8%
	96	1631	1607	1651	1628	1516	1676	2030	1743	1690	1533	1607	1734	128	8.0%
Local through non-CBD	102	1556	1590	1752	1685	1579	2274	2442	2609	2605	2532	1632	2492	860	52.7%
	105	11,668	11,833	12,746	12,557	12,850	12,496	13,265	13,569	13,725	13,032	12,331	13,217	887	7.2%
	200	14,790	14,846	15,714	15,752	15,231	15,170	15,852	16,235	16,063	15,405	15,267	15,745	478	3.1%
	204	26,770	26,616	29,340	29,259	28,810	25,772	27,904	29,287	28,949	26,899	28,159	27,762	−397	−1.4%
	206	12,940	12,738	14,083	14,149	13,688	12,951	13,767	14,341	14,057	13,289	13,520	13,681	161	1.2%
	207	23,766	22,945	24,847	24,093	23,455	21,491	22,855	23,738	23,252	21,761	23,821	22,619	−1202	−5.0%
	209	850	875	1040	1049	1033	895	1034	1177	1173	1044	969	1065	95	9.8%
	210	14,576	14,359	15,931	15,404	14,897	14,772	15,398	16,840	16,942	15,967	15,033	15,984	950	6.3%
	212	13,132	13,249	14,181	14,395	14,125	14,303	14,935	15,492	15,402	14,645	13,816	14,955	1139	8.2%
	217	8063	8132	8336	7994	8022	8545	8889	9066	9160	8699	8109	8872	762	9.4%
	220	289	267	269	252	264	280	301	295	307	273	268	291	23	8.6%
Limited Express	305	2606	2580	2762	2651	2775						2675			
	439	428	443	470	453	429						445			
	442	228	241	268	277	256	249	252	274	283	281	254	268	14	5.4%
	450	1389	1396	1495	1567	1545	1635	1618	1704	1771	1723	1478	1690	212	14.3%
	460	4586	4683	4620	4528	4432	4862	4874	4950	4896	4637	4570	4844	274	6.0%
	487	3825	3779	4103	4285	4092	3840	3798	4198	4437	3982	4017	4051	34	0.9%
	534	3002	3015	3114	2975	2908	2853	3005	3094	3032	2873	3003	2971	−31	−1.0%
	550	3176	3136	3316	3289	3190	1618	1664	1789	1747	1655	3221	1695	−1527	−47.4%
Shuttle	603	6555	6455	7014	6921	7111	6403	7330	7435	7279	6764	6811	7042	231	3.4%

	607	42	43	50	51	61	63	52	75	67	66	49	65	15	30.8%
	705	7561	7741	8519	8418	8208	7347	7626	8099	8241	7892	8089	7841	−248	−3.1%
	710	6977	6930	8155	8044	7905	7179	7605	8846	8873	8428	7602	8186	584	7.7%
	720	41,601	41,215	41,800	41,098	40,115	42,240	42,819	42,728	42,108	40,014	41,166	41,982	816	2.0%
	728	6747	6563	6833	6723	6551	5724	5771	6102	6236	6009	6683	5968	−715	−10.7%
	730	4695	4606	4800	4644	4673						4684			
	733	13,119	12,621	13,146	12,975	12,507	12,085	12,730	12,861	12,885	11,785	12,874	12,469	−404	−3.1%
	740	7520	7541	8097	8073	7894	3643	3868	4270	4368	4175	7825	4065	−3760	−48.1%
Rapid	745	6843	6727	7316	7302	7172	6430	6615	6923	7080	6736	7072	6757	−315	−4.5%
	754	20,304	20,137	22,390	22,271	21,793	20,049	20,890	22,263	22,468	21,108	21,379	21,356	−23	−0.1%
	757	12,527	12,730	13,702	13,700	13,754	12,897	13,486	14,497	14,861	13,829	13,283	13,914	631	4.8%
	760	6486	6594	6855	6723	6589	5816	6082	6304	6198	5978	6649	6076	−574	−8.6%
	770	8786	8554	9207	9037	8982	8527	8405	9188	9292	8836	8913	8850	−64	−0.7%
	780	9854	9534	10,837	10,881	10,614	10,100	10,246	11,266	11,425	10,495	10,344	10,706	362	3.5%
	794	4953	5105	5438	5462	5144	5120	5334	5421	5598	5480	5220	5391	170	3.3%
	910	9480	9730	10,414	11,234	10,648	11,206	11,449	12,197	13,765	13,515	10,301	12,426	2125	20.6%
EXPO	806						18,181	19,776	20,656	21,382	22,066				
Buses		730,872	725,814	776,398	771,071	756,721	714,483	744,416	777,004	779,989	737,025	752,175	750,583	−1592	−0.2%
Total		730,872	725,814	776,398	771,071	756,721	732,664	764,192	797,660	801,371	759,091	752,175	770,996	18,820	2.5%

Table A2. Ridership data for bus lines traversing the Gold Line area (within one mile of the line).

Line #		July 2009	August 2009	September 2009	October 2009	July 2010	August 2010	September 2010	October 2010	July–October 2009	July–October 2010	Average Difference	Difference (%)
	2	22,080	21,620	22,595	22,626	19,656	20,105	20,348	20,654	22,230	20,191	−2040	−9.2%
	4	20,630	20,404	21,651	21,418	19,375	19,031	19,548	19,313	21,026	19,317	−1709	−8.1%
	10	12,902	12,810	14,567	14,387	11,934	11,666	13,302	13,060	13,667	12,491	−1176	−8.6%
	14	16,346	16,187	18,158	18,285	16,477	16,251	17,561	17,322	17,244	16,903	−341	−2.0%
	16	26,511	26,311	27,332	27,485	25,169	24,974	26,101	26,248	26,910	25,623	−1287	−4.8%
	18	26,783	26,533	27,869	27,740	24,853	24,581	25,590	25,192	27,231	25,054	−2177	−8.0%
	20	17,569	17,550	18,128	17,794	16,789	16,689	16,812	17,036	17,760	16,832	−929	−5.2%
	26	27,413	27,259	28,363	28,777	27,744	27,495	28,450	28,167	27,953	27,964	11	0.0%
	28	9470	9581	9545	9520	8400	8092	8317	8656	9529	8366	−1163	−12.2%
	30	16,898	16,565	16,574	16,202	13,221	12,843	13,042	12,913	16,560	13,005	−3555	−21.5%
	33	23,214	22,931	23,475	22,922	11,637	11,299	11,430	11,396	23,136	11,441	−11,695	−50.6%
	35	8853	8503	9911	10,011	7919	7857	9008	9085	9320	8467	−852	−9.1%
	38	5779	5758	6460	6476	5459	5393	6092	5887	6118	5708	−411	−6.7%
	40	17,677	17,344	18,409	18,449	17,551	17,038	17,722	17,115	17,970	17,357	−613	−3.4%
	42	4859	4703	5120	5122	4589	4529	4755	4813	4951	4672	−280	−5.6%
Local through CBD	45	20,841	20,594	21,751	21,351	20,922	20,728	21,883	21,530	21,134	21,266	132	0.6%
	53	10,389	10,348	11,226	10,922	10,603	10,423	10,970	10,914	10,721	10,728	6	0.1%
	55	10,358	9827	11,265	11,454	9487	9538	10,411	10,340	10,726	9944	−782	−7.3%
	60	17,642	17,585	17,704	17,767	18,096	18,094	18,163	17,649	17,675	18,001	326	1.8%
	62	4244	4367	4404	4472	4647	4727	4874	4724	4372	4743	371	8.5%
	66	23,231	23,285	23,489	23,489	20,769	20,518	20,617	20,429	23,374	20,583	−2790	−11.9%
	70	13,301	13,365	13,916	13,743	11,922	11,781	12,215	11,693	13,581	11,903	−1679	−12.4%
	76	10,679	10,553	11,047	10,894	10,439	10,387	10,884	10,708	10,793	10,605	−189	−1.7%
	78	11,457	11,402	11,806	11,589	11,341	11,241	11,777	11,345	11,564	11,426	−138	−1.2%
	81	16,903	16,727	17,815	17,742	15,961	15,859	16,903	16,816	17,297	16,385	−912	−5.3%
	83	5710	5548	5958	5965	4770	4618	4952	4862	5795	4801	−995	−17.2%
	84	9222	9119	10,181	9834	8777	8329	9121	9100	9589	8832	−757	−7.9%
	90	6034	6011	6541	6496	5883	5753	6579	6225	6271	6110	−161	−2.6%
	92	5675	5720	5966	5989	5783	5767	5890	5764	5838	5801	−37	−0.6%
	94	6837	6849	6987	6924	6135	6105	6314	6108	6899	6166	−734	−10.6%
	96	2407	2389	2339	2098	2334	2307	2501	2455	2308	2399	91	3.9%
Local through non-CBD	251	10,073	10,064	10,294	10,123	9631	9691	9781	9378	10,139	9620	−518	−5.1%
	252	2786	2590	3274	3231	2722	2817	3025	3210	2970	2944	−27	−0.9%

	254	599	662	727	691	725	715	759	763	670	741	71	10.6%
	256	1497	1384	2038	1735	1426	1359	1667	1658	1664	1528	−136	−8.2%
	258	1612	1651	1776	1730	1499	1542	1689	1626	1692	1589	−103	−6.1%
	260	11,447	11,264	12,475	12,185	11,688	11,616	12,951	12,629	11,843	12,221	378	3.2%
	287	1775	1751	1875	1900	1976	1926	2008	1923	1825	1958	133	7.3%
Limited Express	439	914	972	971	1006	1111	1095	1144	1105	966	1114	148	15.3%
	442	209	209	240	242	205	214	219	237	225	219	−6	−2.8%
	444	2982	3008	3026	3024					3010		−3010	
	445	1314	1339	1361	1380	1200	1173	1226	1228	1349	1207	−142	−10.5%
	446	4122	4023	4324	4386					4214		−4214	
	460	4238	4412	4367	4171	4516	4375	4323	4172	4297	4347	50	1.2%
	484	6975	7021	7415	7884					7324		−7324	
	485	2931	2818	3042	3283	2447	2270	2541	2810	3019	2517	−502	−16.6%
	487	3862	3743	4179	4185	3553	3461	3856	3869	3992	3685	−308	−7.7%
	490	5548	5690	6283	6517					6010		−6010	
Shuttle	605	2339	2371	2847	2533	1998	1950	2376	2378	2523	2176	−347	−13.8%
	620	646	657	761	774	731	716	709	740	710	724	15	2.0%
	665	813	789	949	1025	711	674	791	844	894	755	−139	−15.5%
Rapid	704	12,479	12,384	13,311	12,628	12,171	12,071	12,818	12,798	12,701	12,465	−236	−1.9%
	714	3866	3729	4206	4197	3207	3224	3502	3541	4000	3369	−631	−15.8%
	720	38,405	38,367	38,370	37,141	37,787	37,798	38,003	36,898	38,071	37,622	−449	−1.2%
	728	8428	8562	8873	8611	8124	7900	8267	8323	8619	8154	−465	−5.4%
	730	4951	4900	5458	5262	4814	4558	4914	5031	5143	4829	−314	−6.1%
	740	9110	9039	9656	9705	8570	8404	8890	8640	9378	8626	−752	−8.0%
	745	7935	8003	8229	8288	7126	6974	7523	7422	8114	7261	−853	−10.5%
	751	5967	6229	6350	6335	6256	6060	6395	6068	6220	6195	−26	−0.4%
	753	3149	3042	3166	3320	2877	2844	2820	2840	3169	2845	−324	−10.2%
	760	8513	8536	8952	8764	8716	8754	8831	8619	8691	8730	39	0.4%
	762	5267	5251	6257	6165	4954	4647	5447	5274	5735	5081	−655	−11.4%
	770	9217	9151	10,134	10,153	9068	8718	9344	9188	9664	9080	−584	−6.0%
	794	6084	6387	6432	6442	5518	5676	5829	5643	6336	5667	−670	−10.6%
GOLD	804	21,065	24,175	22,476	21,322	34,285	35,247	35,649	34,440	22,260	34,905	12,646	56.8%
Buses		621,967	617,746	652,170	646,959	563,969	557,240	583,780	576,374	634,711	570,341	−64,370	−10.1%
Total		643,032	641,921	674,646	668,281	598,254	592,487	619,429	610,814	656,970	605,246	−51,724	−7.9%

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