

# RAIL AND THE CALIFORNIA ECONOMY

A summary report of California's rail system and its economic impact on the state

University of California, Berkeley | 2017



## ACKNOWLEDGMENTS

This report summarizes research conducted by the Institute of Transportation Studies at the University of California, Berkeley. The project was commissioned by the California State Transportation Agency and California Department of Transportation (Caltrans).

The authors gratefully acknowledge the cooperation of numerous public and private agencies in the conduct of research and production of the report, including:

Caltrain  
Intermodal Association of North America  
LOSSAN Rail Corridor Agency  
Orange County Register  
Orange County Transportation Authority  
Pacific Maritime Association  
San Joaquin Joint Powers Authority



Cover: A Union Pacific freight train passes by Mormon Rocks near Cajon Pass in Southern California. Photo by Ron Kroetz at [www.ronkroetz.com](http://www.ronkroetz.com)

Below: A San Joaquins train passes through a lettuce field in the San Joaquin Valley. Photo © San Joaquin Joint Powers Authority, courtesy of the Altamont Corridor Express



# CONTENTS

Railroads and the Golden State 2

People-Moving: The Impacts of Passenger Rail 10

Hauling the Load: Freight Rail 16

Passenger-Freight Interactions 24

Rail and the Future of the California Economy 26





*“California has a premier, customer-focused rail system that successfully moves people and products while enhancing economic growth and quality of life.”*

– California State Rail Plan vision statement,  
California Department of Transportation, 2013

# RAILROADS AND THE GOLDEN STATE

## Introduction

The state of California has long been the economic leader of the United States. Its output is commonly compared not to its fellow states, but to countries, most recently ranking as the sixth largest economy in the world.<sup>1</sup> The nation's most populous state is home to five major metropolitan areas — Sacramento, San Francisco, San Jose, Los Angeles, and San Diego — and globally influential industries, including agriculture, high tech, defense, and entertainment.

A broad investment in all types of transport has been critical to California's economic success, and rail is a fundamental component of the transportation system. Rail has helped define California's history, with westward expansion creating communities and allowing for growth in agriculture, and other early drivers of the state's economy. With the coming high-speed rail system and record traffic in containerized freight, it is also helping to define the state's future.

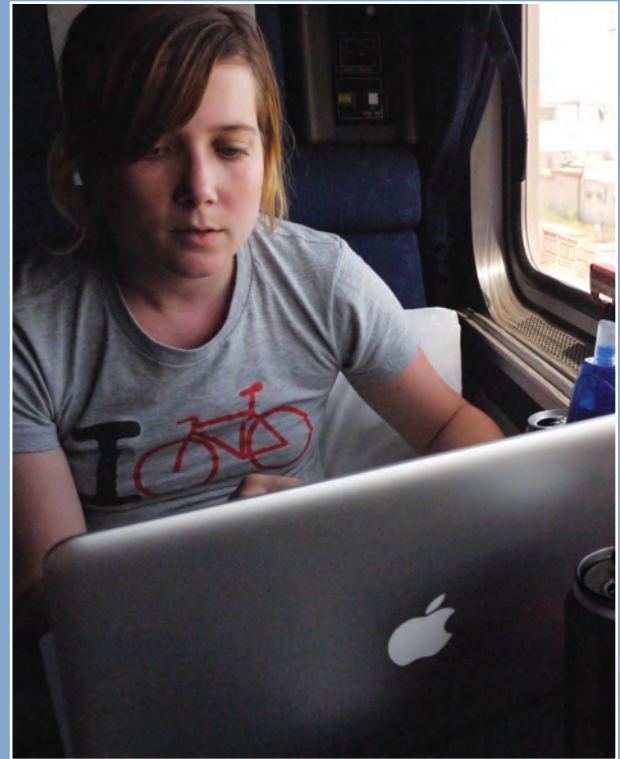
Within this broader context, *Rail and the California Economy* summarizes a California State Transportation Agency research project, led by the Institute of Transportation Studies at the University of California, Berkeley, investigating how the state's vast passenger and freight rail system contributes to the Golden State's economy today and what factors could impact these contributions going forward. Conclusions and assertions within this publication reference material sourced within this project, including existing and original research, publically available data, and stakeholder discussions throughout the state. Sources outside the project's research reports are footnoted.

California's transportation system is approaching capacity in many different locations. Multiple sources regularly rank segments of the state's freeways as among the worst for congestion and delays. Light rain or fog can cause numerous delays at our major airports. There are rail corridors where additional passenger service is not offered due to capacity constraints. California's population will grow from 39 million in 2015 to a projected 50 million residents by 2050, according to the Department of Finance estimates. So efficient movement of freight and people — while assuring safety, meeting air-quality goals and environmental standards, and avoiding unreasonable travel delays — is an ongoing challenge.

This report also supports two other transportation documents, the 2018 State Rail Plan and the California Transportation Plan 2040.

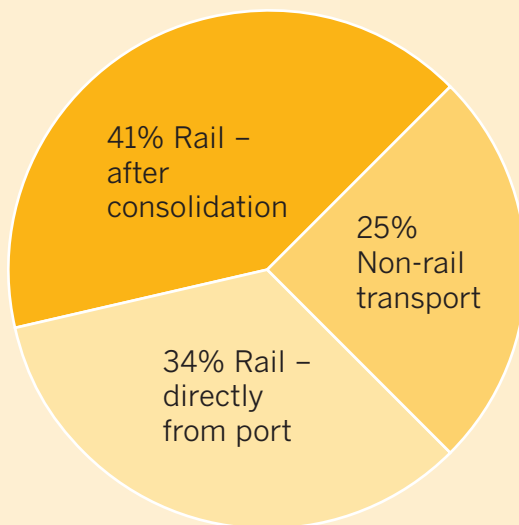
*Above: A passenger train moves through the Altamont Corridor. Photo © San Joaquin Joint Powers Authority, courtesy of the Altamont Corridor Express*

- ▶ California accounted for over \$400 billion of U.S. imports in 2015, about 18 percent of the national total.<sup>2</sup>
- ▶ In 2012, 27 percent of U.S. rail intermodal shipments originated in California, and 23 percent terminated there.<sup>3</sup>
- ▶ Among state-supported Amtrak services, 10 of the 20 busiest rail stations in the United States in 2015 are in California.<sup>4</sup>



Commuters enjoy productive travel time in the café car of the San Joaquins train. Photo by Ian Westcott @Flickr

## RAIL AND THE CALIFORNIA PORTS



**75% of containerized goods leaving the state are transported by rail**

In 2015, 75 percent of all containerized goods leaving the state were transported by rail. Of that 75 percent, 34 percent left the state directly from the ports and another 41 percent was consolidated at warehouses located outside the ports. For more information about warehouse consolidation, see "Changes in Shipping Strategy," page 20. Sources: Pacific Maritime Association and Intermodal Association of North America

## State of the System

California has one of the most diverse networks of rail in the United States, ranging from lightly-used branch lines in the northern interior to a heavily-trafficked triple-track mainline near downtown Los Angeles. Rail service stretches from the country's largest container port, located in Southern California's San Pedro Bay, and from below-sea level in the agricultural region of the Imperial Valley to the transcontinental crossing of Donner Pass at over 7,000 feet. Within this network are intercity passenger routes, regional rail corridors, long-haul interstate freight lines, and freight short lines. Together, this network moves thousands of passengers and millions of tons of cargo per day.

California has almost 4,000 miles of track owned by the two Class I railroads,<sup>5</sup> Union Pacific and BNSF, according to the 2013 California State Rail Plan. An additional 800 route miles are operated by short-line railroads — smaller operators covering short, often regionally based distances — or public agencies.

Three intercity passenger routes connect the major cities in the state. The *Capitol Corridor* runs from Auburn to San Jose, the *Pacific Surfliner* runs from San Luis Obispo to San Diego

via Los Angeles, and the *San Joaquins* runs from Oakland and Sacramento to Bakersfield. Four long-distance Amtrak services — *Sunset Limited*, *Coast Starlight*, *California Zephyr*, and *Southwest Chief* — supplement these corridors, arriving from outside the state. An extensive Amtrak Thruway motorcoach network connects 13 additional communities in every corner of the state to existing California Amtrak stations.

Intercity routes are supplemented by four major regional rail systems: Caltrain from Gilroy to San Francisco via San Jose, Altamont Corridor Express (ACE) from Stockton to San Jose, Coaster from Oceanside to San Diego, and the multi-line Metrolink network serving Los Angeles, Orange, Riverside, San Bernardino, and Ventura counties, as well as Oceanside in San Diego County.

While central to the economy of the regions, heavy rail or “metro” networks, such as BART or LA Metro, are outside the scope of this report, as are local light-rail services that serve Los Angeles, Sacramento, San Diego, San Francisco, and San Jose. Likewise, high-speed rail is not yet part of the existing system and thus not part of this evaluation.

Passengers board a San Joaquins train in Martinez. Photo © San Joaquin Joint Powers Authority, courtesy of the Altamont Corridor Express



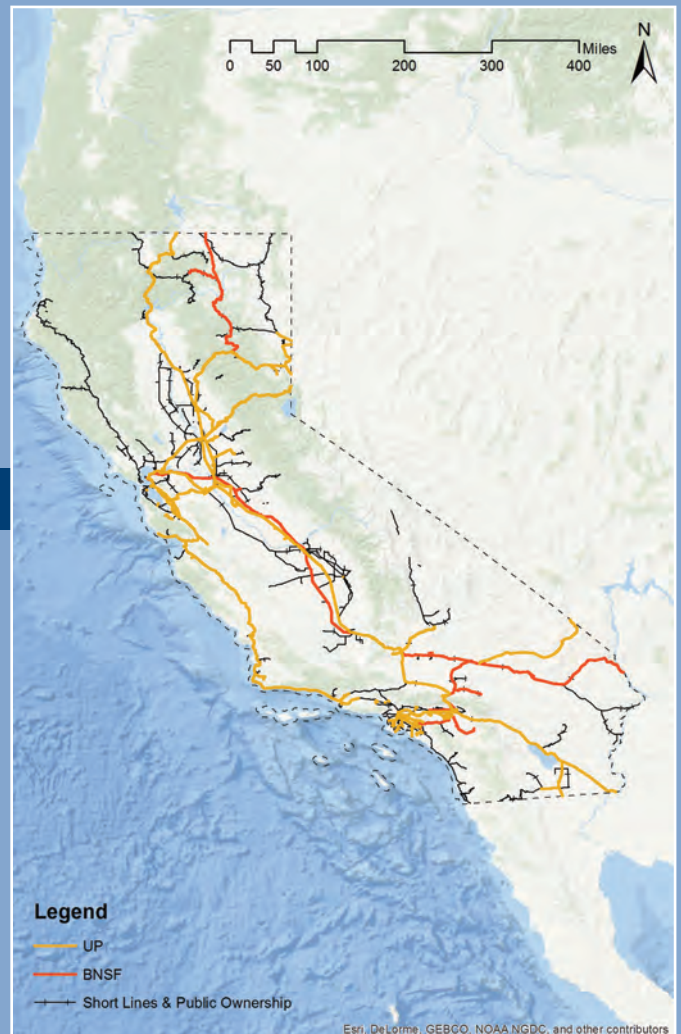


## PASSENGER RAIL LINES

Three state-funded intercity passenger routes connect the state's major cities, supplemented by four major regional rail systems and Amtrak's long-distance rail services.

## FREIGHT RAIL LINES

California is served by over 4,000 miles of track operated by the two long-haul interstate freight railroads, Union Pacific and BNSF, as well as an additional 800 miles operated by short-line railroads or public agencies.<sup>6</sup>



Graphics assembled by Evan Knopf for ITS Berkeley

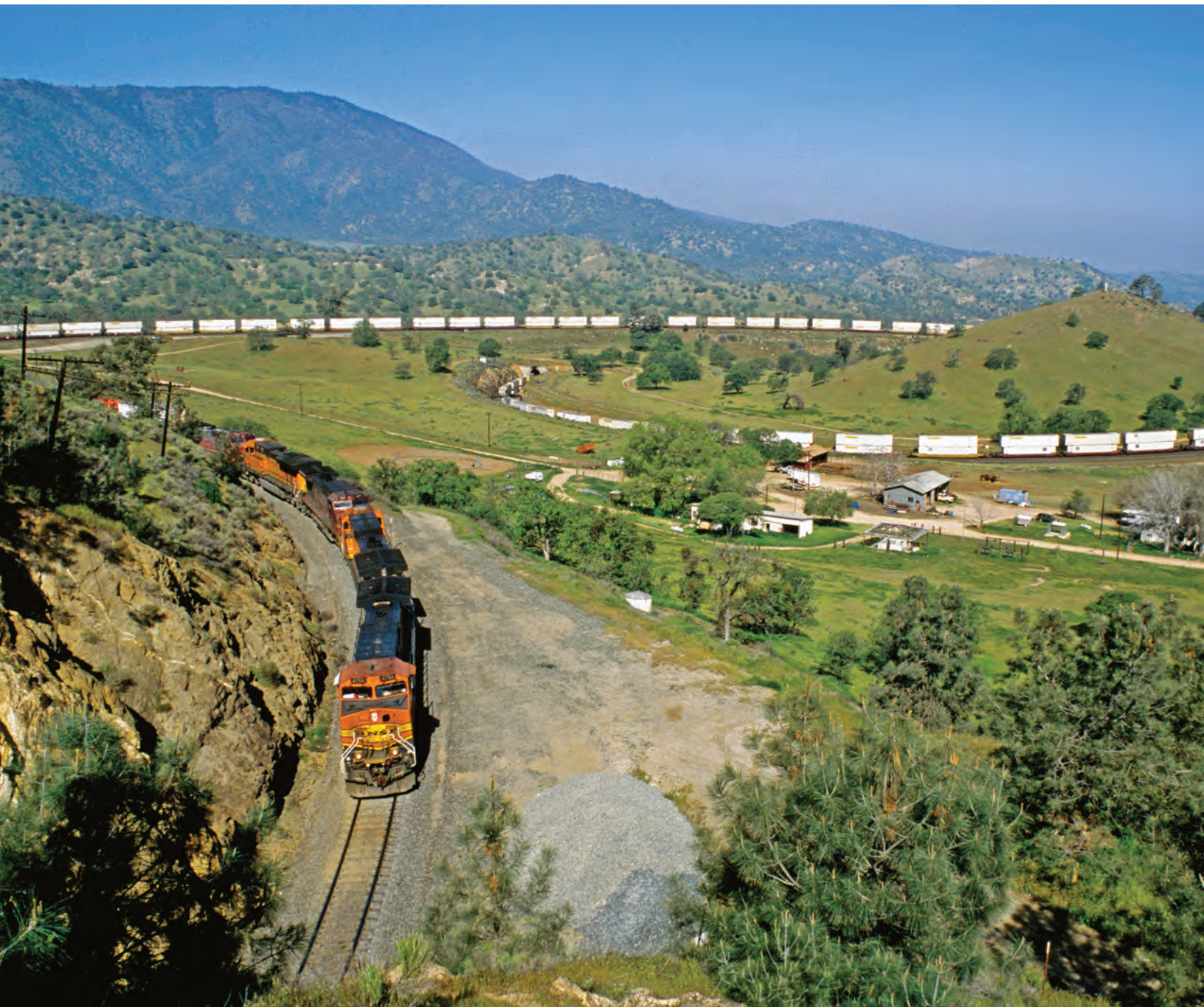
# How Railroads Serve the California Economy

Freight and passenger rail serve California in a variety of ways. Most directly, passengers and shippers who use rail can save money and time — savings that can often be directly measured by comparing the rail service with users' options on alternative modes. In many cases, however, trips or shipments made on rail would simply not be made if the service were not available, according to survey data. For freight, this is particularly the case for specific hazardous materials.

In addition, by redirecting traffic off of the roadways, rail use spares everyone from higher automobile and truck volumes, curtailing traffic congestion, air pollution, carbon emissions, road wear (and the costs associated with it), and crashes, and allows investments in roadway expansion, where it is even

possible, to be deferred. The numbers are extraordinary: A typical container train can haul the same load as 100 trailer trucks, while a rail trainset — a group of passenger cars coupled together — can serve more than 1,000 passengers at a time and is constrained mainly by platform length, which, in many cases, can be lengthened.

More fundamentally, the availability of rail service shapes California's economic landscape. From the South, where ports and warehouses handle massive import flows to be transported by rail around the country, to the North, where Caltrain offers commuters a reliable alternative to clogged Silicon Valley freeways, rail services enable industrial activities that generate employment, wealth, and innovation.





# Measuring Rail's Contribution

To study railroads' contribution to the California economy, researchers focused on four themes. Some core findings and examples from each theme help illustrate key economic benefits as well as several notable constraints within each arena. Themes are presented in descending order from direct to indirect benefits.

**MOBILITY** refers to savings by individual passengers in terms of time saved, access to employment, reduced travel costs, more productive use of travel time, and contributions to social equity by providing an affordable intercity mode of transport. In addition, it refers to freight rail's accommodation of shippers' needs by providing low-cost efficient service and by shipping and receiving bulk commodities that are difficult or expensive to transport by other means.

- During the peak travel periods in the heart of Silicon Valley, travel time between San Jose and San Francisco — in both directions — is greater when using a car than by traveling on the Baby Bullet, Caltrain's express service. In addition, Caltrain prevented 400 crashes from occurring on local freeways, saving an estimated \$18 million in crash-related costs, conservative estimates based on 2015 data show.<sup>7</sup>
- A 2014 survey reveals that Amtrak and commuter rail passengers are using personal electronic technology over 50 percent of the time they are traveling, up from about 30 percent in 2010.<sup>8</sup>
- Shipper benefits include reduced damage, reduced costs, faster service, and greater customer satisfaction compared to trucks. Carrier benefits include customer satisfaction, time savings, labor and equipment utilization, increased productivity, and fewer crashes. Compared to crashes between vehicles, the number of crashes involving freight rail is negligible.

**Constraints:** Rail service is restricted by right-of-way location, high costs associated with new construction, and the quality of existing track. Some rail corridors have weight and speed restrictions that can affect rail's competitiveness for both freight shipment and passenger travel time. Passenger rail in particular can be constrained by public-funding changes that affect service maintenance, service frequency, or the ability to make capital investments.<sup>9</sup> Benefits are limited if passenger service is infrequent, slow, unreliable, or has poor connections to regional and local transit. Benefits from freight service are limited by changes in supply-chain methods to which infrastructure and public policy have yet to fully adapt.

*Left: A BNSF train passes through the Tehachapi Loop in South-Central California. Photo by Robert Leachman*



**CAPACITY** refers to a range of benefits that derive from the ability of rail to transport large volumes of traffic per hour using limited space for right-of-way. Capacity benefits include passenger rail's ability to absorb urban and suburban growth without costly highway expansion; the role of container trains in moving freight traffic in and out of California's busy ports; and the higher level of service on roadways from rail diversion of automobile and truck volumes, both day-to-day and to address temporary shortfalls, such as extreme weather or maintenance-related road closures.

- A full freight train can carry different types of perishable produce in each car from California to points east, where loads can stay together in refrigerated warehouses at eastern terminals. Customers for these goods, such as supermarket wholesalers, only have to make one phone call to obtain orders of many different items as opposed to coordinating many different truck deliveries.
- The 1994 Northridge earthquake is an excellent extreme-event case study. A critical overpass from State Route 14 to Interstate 5 at the Newhall Pass Interchange collapsed, throwing the entire Antelope Valley region's commute into chaos. It took six months for the interchange to completely reopen. However, the nearby Metrolink route, the *Antelope Valley* line, quickly reopened and significantly expanded service, absorbing a large portion of the daily commute.<sup>10</sup>

*Above: A passenger uses a wheelchair lift on a state-supported Thruway bus, which connects remote areas and other communities with limited or no rail service with train stations. Photo courtesy of Caltrans*

**Constraints:** Capital costs for new service or system expansion may be beyond an operator’s financial capacity. Operating costs can constrain passenger service in particular because funding needed for annual operations is subject to significant fluctuation based on economic conditions that affect dedicated funding sources (such as sales taxes) or government budgets that provide funding on an annual basis. Based on capacity constraints, freight operators may prioritize high-value goods (petroleum, for example) over shipments that are more relevant to the California economy, such as processed agricultural products.

**AGGLOMERATION** refers to the clustering of people, firms, housing, goods, and services in a particular area such as a city, corridor, or transportation terminal. This concentration of interrelated businesses can foster collaboration, competitiveness, innovation, and have significant regional or megaregional economic impacts.

Transportation infrastructure, including highways and rail lines, can facilitate such concentrations by bringing people, goods, and places closer together. For passenger rail, this often is referred to as “transit-oriented development,” where a mix of compact higher-density housing, retail, and jobs located within close proximity to rail stations increases the efficiency of production or consumption. Agglomeration can have several positive economic outcomes:

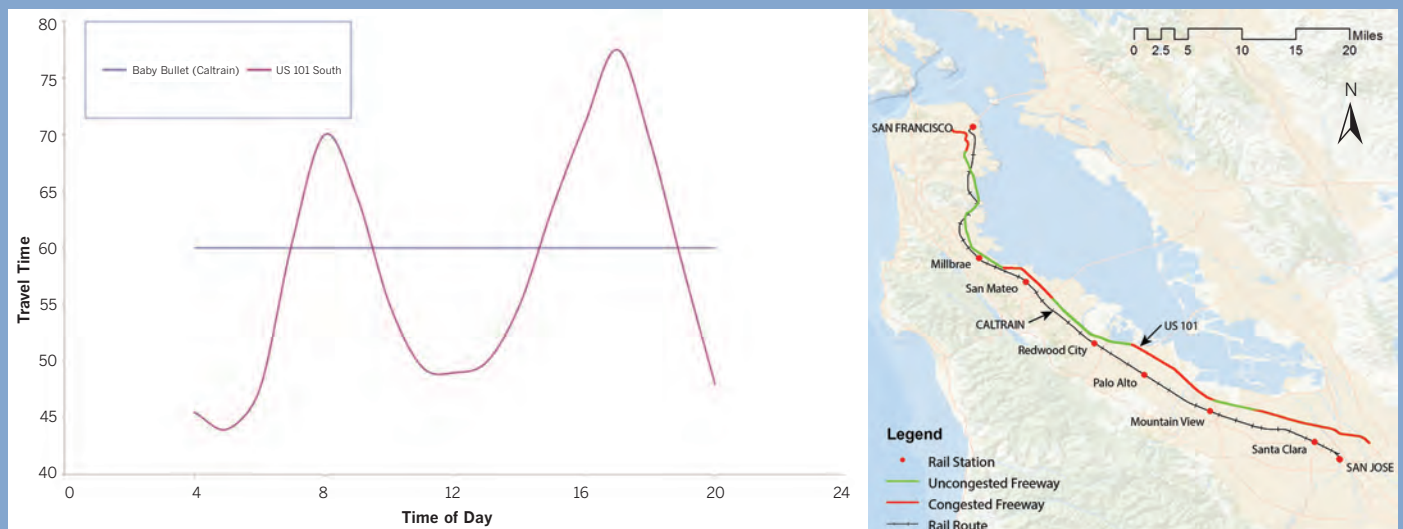
- One benefit arises from a financing tool called “value capture.” This is when a transit agency leverages a station’s created value by actively seeking to develop land it owns around a station for housing, retail, and other commercial uses. San Francisco’s new Transbay Terminal is one such project.

- Redwood City is an excellent example of how transit-oriented development can generate the benefits of an agglomeration economy. A historically working-class town compared to its Silicon Valley neighbors, Redwood City has Baby Bullet access and has been aggressive in pursuing a comprehensive high-density development plan anchored by its Caltrain station. The result has been explosive growth in the neighborhood surrounding the train station.<sup>11</sup>
- Agglomeration zones see greater concentrations of impacts and efficiencies. An inland port moves customs and associated truck congestion and pollution away from the dock itself and locates all the different logistics operators and shippers in one place. Careful siting of inland ports can mitigate their impacts and reduce the number of sites where railroads pick up cargo. Also, short lines (Class III railroads) can transport goods between inland ports and Class I railroads.

**Constraints:** Implementation of transit-oriented development is not without challenges. Local communities and their elected officials may voice objections to perceived fears of increased crime and traffic and negative impacts to schools and public services like police and fire that could result from higher-density housing and population increases, particularly affordable housing for lower-income residents. Additionally, some markets are so weak that there is literally no value capture. Without incentives, developers are unlikely to invest until it is a profitable market.

**ENVIRONMENTAL** benefits from passenger and freight rail are measured in terms of air and noise pollution mitigation, energy conservation, and broader life-cycle resource consumption that results from lower vehicle miles traveled, reduced highway damage and thus reduced maintenance.

## SILICON VALLEY TRAVEL TIMES: CALTRAIN VS. U.S. 101

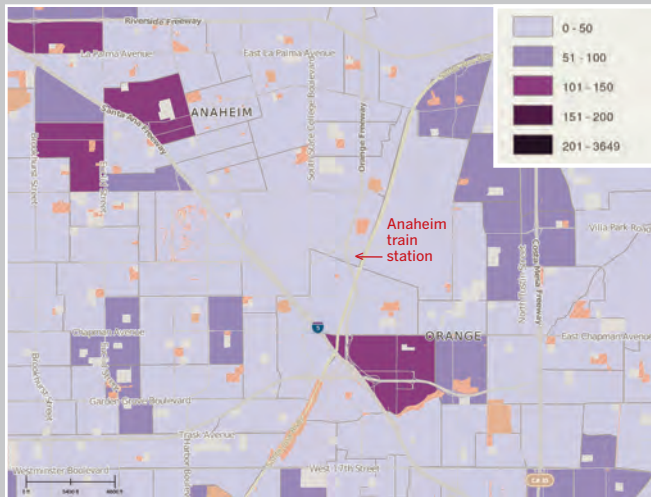


During key commute hours, Caltrain’s Baby Bullet service (graph, blue line) is normally faster than travel time on U.S. 101 South (red line) from San Francisco to San Jose, including a large five-hour block in the afternoon. Traffic congestion on those routes (right, Google traffic map) causes delays and unpredictable travel times. The Baby Bullet service has an on-time performance average (within 10 minutes of scheduled times) of 95 percent.

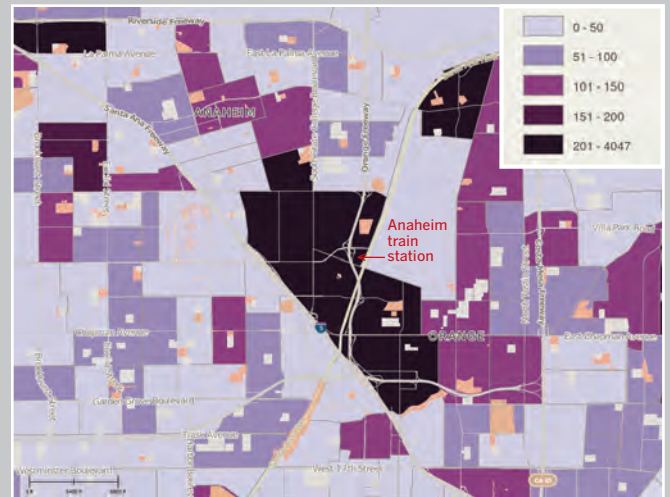


## TRANSIT-ORIENTED DEVELOPMENT IN ANAHEIM

2010



2015



The Platinum Triangle, a transit-oriented development project, has enabled the city of Anaheim (top) to show significant growth in residential units around the new Anaheim train station. Left: The 2010 Census Tract map showing densities of households in an economically stable rent category. Right: The 2015 Census Tract map shows significant increased densities following the project's implementation.<sup>12</sup> Photo by Joshua Seeherman

A few key findings include:

- Rail transport of freight and passengers is highly energy efficient when compared to highway modes such as trucking and driving, and the impacts of those efficiencies are multiplied across California's geographical expanse and major industries. A primary source of this advantage comes from the relatively low rolling resistance of steel wheels on steel rail, which requires a smaller amount of energy to pull passenger or freight cars than rubber-tired vehicles.<sup>13</sup>
- When traffic shifts from road to rail, benefits can be achieved not just from the greater environmental efficiency of rail, but also from reductions in congestion on the roadways, reducing pollution and energy use.
- Rail supports efficient (high density and compact) land use with reduced disturbances to natural and agricultural lands.

**Constraints:** Environmental benefits can be difficult to measure precisely, especially when taking into account life-cycle costs of new construction.

### SOURCES

Information in this section summarizes *Rail and the California Economy: Background and Literature Review*, by Joshua Seeherman, Karen Trapenberg Frick, and Mark Hansen, University of California, Berkeley, 2016.

### ADDITIONAL REFERENCES

1. Reported by the California Department of Finance, and confirmed by multiple news agencies, including the Associated Press, who compared World Bank 2016 rankings against state GDP data from the U.S. Bureau of Economic Analysis.
2. U.S. Census, 2015, foreign trade press release.
3. American Association of Railroads state rankings.
4. National Association of Railroad Passengers, Amtrak Fact Sheet/ State-Supported Sector.
5. Railroads are separated into classes based on the amount of revenue. A Class I railroad has revenue exceeding approximately \$400 million in 2011 dollars. Short line railroads are considered Class III. There are no Class II railroads in California. See also "Hauling the Load: Freight Rail," page 16.
6. California State Rail Plan, 2013.
7. <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812013>.
8. Schwieterman, Joseph P, Marisa Schulz, Justin Kohls, Noah Boggess: *The Personal Tech Tidal Wave*. DePaul University, 2014.
9. Caltrain ([www.caltrain.com](http://www.caltrain.com)).
10. Prior to the 1994 Northridge earthquake, the *Antelope Valley* line carried about 1,000 passengers per day. Less than a month after the earthquake, the same line was carrying 17,000 riders per day, with extra equipment borrowed from other railroads.
11. Myrow, Rachel: "Big Tech Changing Character of Downtown Redwood City," *The California Report*, KQED News, January 30, 2015.
12. SimplyMap GIS data visualization tool and U.S. census data.
13. On average, freight railroads move 473 ton-miles per gallon of fuel, four times as much as trucks.



# PEOPLE-MOVING: THE IMPACTS OF PASSENGER RAIL

## Connecting Californians

Nothing could be more influential to a state's economy than its people, and how we travel for both work and play impacts everything from work productivity to social mobility to the character of our communities. Californians move between cities and regions on the three state-supported intercity passenger rail routes, and within regions on four higher frequency regional rail routes that serve the major metropolitan areas of the state.

This report examines two specific passenger rail corridors, the Southern California rail corridor from San Luis Obispo to San Diego via Los Angeles, known as LOSSAN, and the Caltrain regional rail corridor from San Francisco to Gilroy via San Jose. Both of these corridors have outsized influences on their respective regions.

## State-Supported Intercity Rail

Passenger rail played a vital role in U.S. intercity travel and the associated economy in the early twentieth century. However, due to the advent of automobiles — and later — airplanes, passenger rail lost much of its dominance as the mode of choice for intercity trips. The establishment of Amtrak in 1971 and subsequent state-level support for Amtrak California intercity rail services helped preserve the passenger rail system and revitalize services that remain an integral part of the national multimodal transportation system.

Currently, the state provides financial support for three Amtrak rail routes in California: *Pacific Surfliner*, *San Joaquins*, and *Capitol Corridor*. The services are administered by three separate Joint Powers Authorities: the LOSSAN Rail Corridor Agency; San Joaquin Joint Powers Authority; and the Capital Corridor Joint Powers Authority, respectively. These services have enjoyed consistent ridership increases throughout their existence. Today, all three are in the top six Amtrak-affiliated corridors in the country for ridership.

*Above: California's Pacific Surfliner has overall ridership that is surpassed only by the Northeast Corridor. Reflecting the state's unique geography, the rail service moves people along a variety of round-trips between Los Angeles, San Diego, and mid-sized cities such as Santa Barbara, Anaheim, and Fullerton.<sup>1</sup> Photo by Nick Chill @Flickr*

- ▶ A total of 38.5 million passengers rode California's rails in 2015.<sup>2</sup>
- ▶ Nearly 40 percent of all of the venture capital invested in the United States in 2012 was invested in Silicon Valley companies located on the Caltrain corridor.<sup>3</sup>
- ▶ By moving Bay Area travelers from roads to transit, Caltrain prevented an estimated 400 crashes from occurring on Bay Area freeways, saving about \$18 million in crash-related costs.



Caltrain accommodates over 4,500 people per hour in each direction, the equivalent of adding an additional freeway with two lanes in each direction. Bicycle cars help commuters with first-mile/last-mile issues — the journey between stations and commute starting or ending points. Photo by Mark Doliner @Flickr

## LOSSAN CORRIDOR SPOTLIGHT: Amtrak Pacific Surfliner, Coaster, and Metrolink

Running through the heart of Southern California, the 350-mile Los Angeles–San Diego–San Luis Obispo rail corridor, known as LOSSAN, extends north to south from San Luis Obispo to San Diego, passing through the metropolitan areas of Santa Barbara, Ventura-Oxnard, Los Angeles, and Anaheim-Irvine.

This corridor supports the second busiest intercity rail service in the country, the *Pacific Surfliner*, as well as regional rail services — Metrolink from Ventura to Los Angeles (Ventura County line), Los Angeles to Oceanside (Orange County line), and Coaster from Oceanside to San Diego. Two LOSSAN stations, Los Angeles and San Diego, are in the top 10 nationally for ridership, and the corridor functions as the backbone of rail service throughout Southern California, with a number of major connections to other transportation services.



Metrolink runs the Angels Express special train, seen here at Irvine Station, along the LOSSAN corridor to the Anaheim Angels weekday-evening games, timed with the start and finish of the game. In 2013, over 90,000 people rode the train at approximately 1,500 people per game — the equivalent of 750 parking spaces. Photo courtesy of Orange County Transportation Authority

Passing through nearly every major coastal city, the LOSSAN corridor operation, which began service in 1971 under Amtrak from Los Angeles to San Diego as the *San Diegan*, has a positive economic effect on the Southern California region. LOSSAN stimulates growth in terms of residential, industrial, and commercial development. It provides riders with direct benefits such as fast and reliable travel times during peak hours and lower travel costs, and indirect benefits for drivers through congestion relief on nearby I-5.

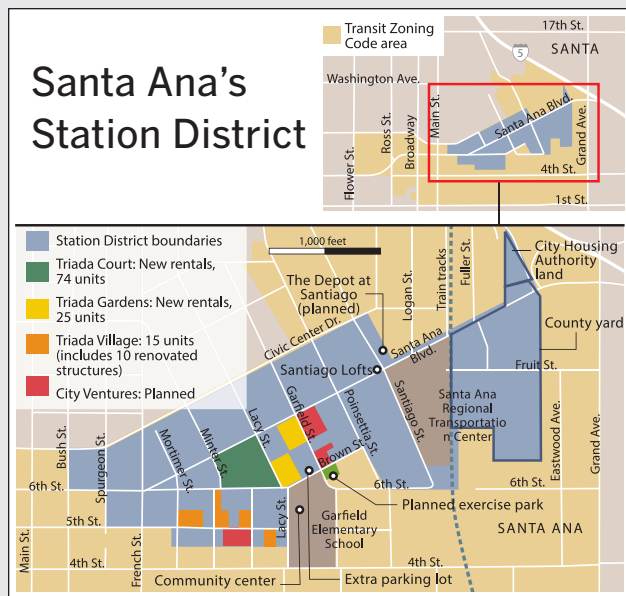
By virtue of its emissions profile, rail offers a transportation mode that produces substantially lower levels of greenhouse gases and airborne pollutants per passenger than automobiles. These benefits occur during both the daily commute and special events such as the Angels Express to Anaheim Angels games and the seasonal Del Mar Racetrack trains. The special trains not only reduce air pollution, they also provide additional transport capacity for large events without severely affecting the freeway system. Research showed that the 2013 Angels Express trains saved over 250 tons of greenhouse gases, the equivalent of driving an average car 600,000 miles or burning over 25,000 gallons of fuel.

Many different LOSSAN-corridor towns have sought to stimulate local growth by utilizing their existing stations as anchors for new transit-oriented development. In many instances throughout the corridor, new development has transformed station-based areas from just ten years ago, converting poorly occupied light-industrial areas to new mixed-use neighborhoods and improved overall city vitality. Two examples include the Platinum Triangle in Anaheim and the Station District in Santa Ana. As shown in the graphic on page 9, as recently as 2010 there were no residential units in the vicinity of the Anaheim train station with rents exceeding \$2,000 (a threshold planners consider desirable). After a concerted effort by the city of Anaheim to create a new residential district near the train station, by 2015 there were more than 200 units in that rent category, with hundreds of new units and thousands of square feet of office space under construction.

While Southern Californians are often stereotyped as auto drivers, an increasing proportion of travelers are choosing LOSSAN service, especially for weekend leisure travel. The competition among beach towns such as Santa Barbara, San Juan Capistrano, San Clemente, and Encinitas to get Californians to come to their community, spend tourist dollars, and contribute to local hotel taxes is particularly fierce, and a LOSSAN station is a key catalyst for economic development for these communities.

There are several opportunities for improvements in the LOSSAN corridor, stemming mainly from the three distinct agencies that operate on the corridor. Benefits could be realized through coordinated ticketing, intercounty coordination on funding and maintenance issues, and more consistent bus connections covering the first and last mile — the movements between stations and commute starting or ending points. Regional coordination on these issues would make rail service more attractive for commuters and leisure travelers alike. In the last year or so the agencies have made significant advances in cooperation, with a coordinated timetable that improved service performance and connections and increased collaboration on capital project funding requests.

These challenges notwithstanding, researchers found strong local stakeholder support for LOSSAN and optimism for rail's increasing profile in the Southern California transportation network.



The Station District near downtown Santa Ana is seeing a variety of new and rehabilitated housing options, as well as other improvements, including the recently opened Triada development. Graphic courtesy of The Orange County Register

## Regional Rail

Regional rail has the potential to generate beneficial economic impacts by increasing accessibility and mobility for travelers within a region. Efficient rail can provide time savings and emissions reductions for individual travelers, and the indirect reduction of congestion and travel time for travelers on other modes. Improved mobility allows for more efficient labor markets: Workers have a greater set of job opportunities, and employers enjoy a larger pool of potential employees within a reasonable commute.

Transit-oriented development also can occur around rail stations. This can increase economic activity around the station and in turn increase property values, which generally are considered beneficial because communities enjoy higher property-tax revenues and an improved standard of living, such as an increase in retail activity that produces more sales tax. Policies and programs such as targeted housing assistance can be employed to assist low-income residents to stay in place as prices go up.

These four services — Caltrain to San Francisco and San Jose; the Altamont Corridor Express, known as ACE, to San Jose; Metrolink to Los Angeles; and the Coaster to San Diego — are mainly unidirectional, that is, they provide inbound service during the peak morning commute to their respective terminals and outbound during the afternoon peak period. However, it's noteworthy that both Caltrain and the Metrolink service to Orange County also have significant ridership in the off-peak direction.

The state's four regional rail networks offer higher frequency service than state-supported intercity rail service, particularly during peak commute hours, and also have shorter stop spacing. In Southern California, where Metrolink and Coaster overlap with the *Pacific Surfliner* service in the LOSSAN corridor, regional rail acts a local service while the *Pacific Surfliner* operates as the express or limited service.

## RIDERSHIP LEADER

Of Amtrak's more than three hundred stations nationwide, California has six stations in the top twenty-five for passenger movement, the most of any state. Three — Sacramento, Los Angeles, and San Diego — are in the top ten.<sup>4</sup>

RANKING	STATION	RIDERSHIP
5	Los Angeles	1,589,391
7	Sacramento	1,027,013
10	San Diego	773,497
18	Emeryville	587,926
22	Bakersfield	513,884
25	Irvine	421,736

## REGIONAL RAIL SPOTLIGHT: Caltrain, San Francisco, and the Silicon Valley

Caltrain is one of the busiest regional rail services in the country with over 55,000 riders per weekday. By comparison, in 2013 the busiest line for the nation's largest regional rail system, the Babylon line of New York's Long Island Rail Road, had 65,000 riders per weekday. Coinciding with the rapidly growing technology sector within the corridor, Caltrain's ridership has experienced extraordinary growth since the mid 1990s — more than doubling in the past 10 years.

The service operates within one of the most robust economic regions of the United States along a 77-mile corridor that extends from San Francisco in the north, down through Silicon Valley, the heart of the United States' technology sector, to San Jose, and onward to Gilroy in the far southern suburbs of San Jose. The three counties of Santa Clara, San Mateo, and San Francisco have a combined 3.4 million people; with nearly 20,000 people per square mile, San Francisco is the second densest major city in the country after New York.<sup>5</sup>

Perhaps the most unusual regional characteristic for this corridor is the non-urban nature of many of the employment centers and how this creates reverse commutes and mid-route commutes. While the traditional commute into and out of San Francisco is still the oldest and strongest of all of the commute flows on Caltrain, morning commutes leaving from San Francisco and San Jose to intermediate stops have become significant and create different last-mile problems

than on typical suburban-urban regional rail, where jobs are concentrated near the urban endpoint of the system. For example, large Silicon Valley companies, including Google and Apple, own or operate all-inclusive campuses requiring company-run shuttles to move employees from stations to work campuses. Despite the challenges of accessing such jobs from Caltrain stations, Caltrain is used extensively to reach Silicon Valley campuses.

A subset of the system's twenty-nine stations are served by Caltrain's skip-stop service and the express service known as the "Baby Bullet," launched in 2004, which stops at only five or six critical stations between San Jose and San Francisco. With very high daily congestion on the peninsula's U.S. 101 and I-280 freeways, Caltrain has become a more important transportation platform because of its ability to absorb the increase in commuters. (See Measuring Rail's Contribution, page 7.)

The Caltrain system has significant economic benefits. It provides direct benefits to daily commuters, who enjoy travel times notably faster than driving on either I-280 or U.S. 101 between San Francisco and San Jose, as well as productive time while the train is in motion. As shown in the graphic on page 8, during the afternoon peak commute, travel times between San Francisco and San Jose can exceed 75 minutes while the Baby Bullet typically takes 60 minutes. Indirect benefits to motorists include travel-time improvements

### MAP OF LOSSAN STATIONS



*The segment of the Pacific Surfliner stretching from Los Angeles to San Diego has more high-volume stations — over 100,000 passenger movements per year — of any 100-mile segment within the Amtrak system.*

*Map created by Wenzhe Ding for ITS Berkeley, generated from data at the Caltrans GIS library*



resulting from reduced road traffic. At the height of the peak commute, there are six trains per hour, each accommodating 1,000 passengers or more with standees (trains have a seated capacity of 650; in 2015, maximum train loads exceeded 1,000). This correlates to a network capacity of over 4,500 people per hour in each direction — the equivalent of adding an additional freeway with two lanes in each direction.<sup>6</sup>

Caltrain stations often serve as the anchor for new transit-oriented development. The Bay Meadows infill development at Caltrain's Hillsdale station is an excellent example. Bay Meadows, one of California's oldest racetracks, closed its doors in 2008 and the 80-acre space near the station immediately became very desirable to developers. The final plan, approved within a year of the proposal, includes 1,100 units of residential, 800,000 square feet of office space, and 100,000 square feet of retail space in a new "transportation-oriented" community that features parks, restaurants, and offices. A large portion of the project has been completed, with the last set of townhouses going on sale in early 2017.

Environmental benefits from emissions reduction are significant. Each day, at the current ridership, Caltrain riders save over 200,000 kilograms, or 200 metric tons, of greenhouse gas emissions. Multiplied over the year, 50,000 metric tons of CO<sub>2</sub> will be saved, which equals over \$1 million on the California cap-and-trade market — the system in which companies in greenhouse gas-emitting industries such as oil refineries and power plants buy and trade permits based on their emissions. According to the EPA, this savings is the equivalent of removing more than 10,000 vehicles from the roadway network. While the riders themselves are contributing to the lowering of emissions and improvements in air quality, congestion mitigation also likely produces significant reduction in emissions. Caltrain also runs special trains for certain events such as San Francisco 49ers football games at Levi's Stadium and Stanford football games at Stanford Stadium. Multiplying savings over multiple trains and multiple games, these emission reductions add up to additional benefits.

Safety is another benefit of rail, which numerous studies have shown to be safer than automobile travel. Researchers



Interior of L.A.'s Union Station, California's busiest station and the hub of the Metrolink regional rail network. Photo by Atomic Hot Links @Flickr

calculated that this increased safety produced significant savings in terms of costs to riders, insurance companies, and society at large, which enjoys all the benefits of reduced traffic congestion when there are fewer crashes on the road. Approximately 400 crashes are avoided by travelers choosing Caltrain over driving, researchers found. Conservatively, assuming that the crashes are property damage only and cost \$5,000 each, the savings is \$2 million. However, taking into account that 25 percent of these crashes would have injuries (average cost of \$15,000), costs increase to \$3 million. If just one of these crashes involved a fatality, the average cost of just that one incident would reach into the millions by all estimates.<sup>7</sup>

Challenges include shared track use (see Passenger-Freight Interactions, page 24), unstable funding — a problem that has plagued Caltrain throughout its existence — and continuing first mile/last mile issues. Despite these challenges, the system is highly successful and provides commute-time savings and additional productive minutes to its riders, much needed emission reduction benefits, congestion relief, and both residential and commercial growth stimulation. Caltrain is currently planning a major electrification project that will cover a significant portion of the line. Upon completion of this project, Caltrain could become the busiest regional rail line in the United States.

## SOURCES

*Assessing the Impacts of State-Supported Rail Services on Local Population and Employment Within California.* Ahmadrza Talebian and Bo Zou, University of Illinois at Chicago. Mark Hansen and Joshua Seeherman, University of California, Berkeley, 2016.

*Caltrain Regional Rail: The High Capacity Artery of the World's Leading Technology Region.* Joshua Seeherman, Karen Trapenberg Frick, and Mark Hansen, University of California, Berkeley, 2016.

*The LOSSAN Corridor: Stimulating Development, Reducing Congestion, and Improving Air Quality.* Joshua Seeherman, Karen Trapenberg Frick, and Mark Hansen, University of California, Berkeley, 2016.

## ADDITIONAL REFERENCES

1. In terms of the number of Amtrak stations with over 100,000 passenger movements per year.
2. California State Rail Plan, 2013.
3. Florida, Richard. "America's Leading Metros for Venture Capital." Atlantic CityLab. June 17, 2013.
4. See <https://www.amtrak.com/national-facts>. From fiscal year 2015, Amtrak services only (excludes regional rail).
5. *Measuring Sprawl*, Smart Growth America, 2014.
6. Assuming 800 passengers x 6 trains per hour = 4,800. A freeway lane is 2,000–2,200 cars per hour.
7. *The Economic and Societal Impact of Motor Vehicle Crashes*, National Highway Traffic Safety Administration, 2010 (Revised May 2015).



# HAULING THE LOAD: FREIGHT RAIL

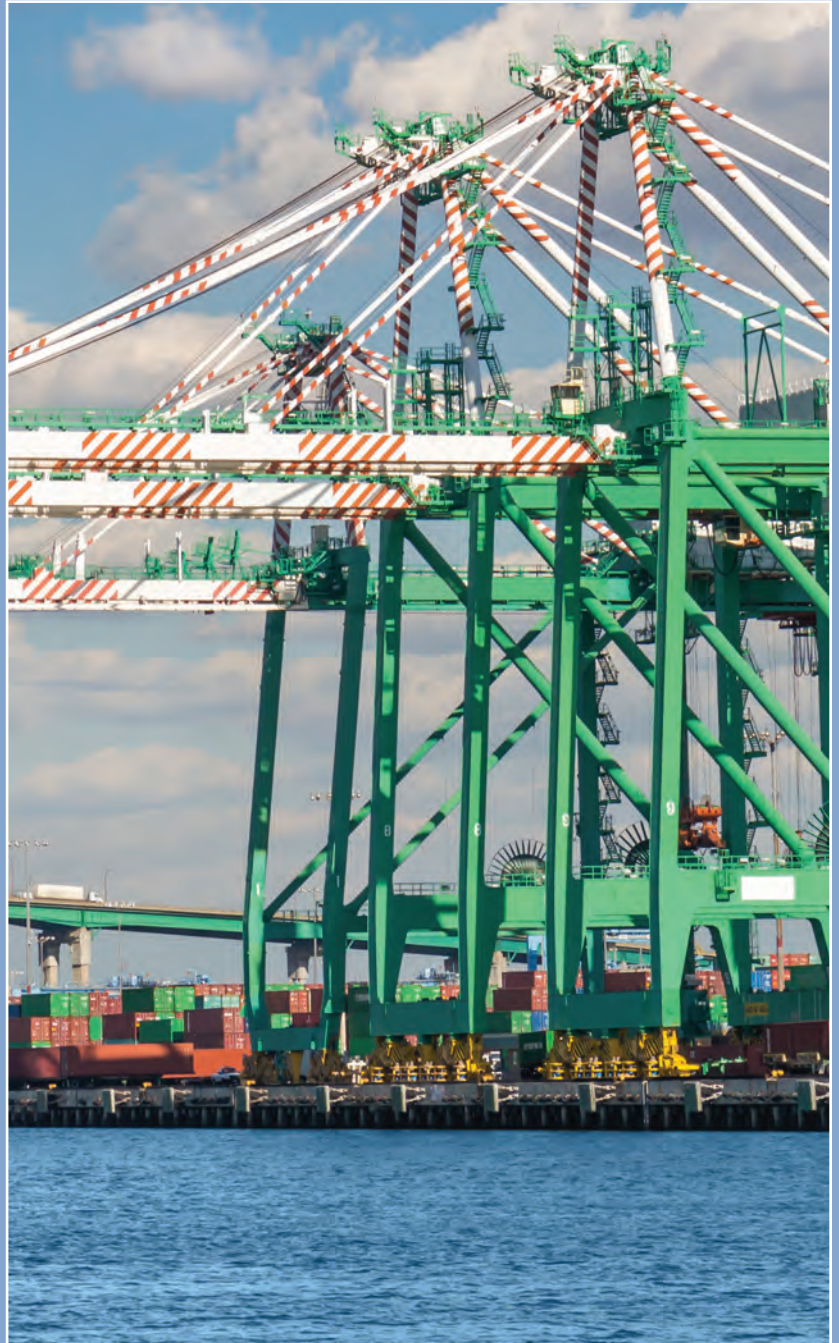
## Diverse Cargo and Services

Anyone waiting at a railroad grade crossing likely has been hypnotized by the rhythmic whoosh of a passing freight train. Some are characterized by the checkerboard pattern made by double-decker shipping containers, while some have discernable cargo such as petroleum or lumber. Some have regional-company logos while others seem destined for faraway ports.

Such commonplace sights provide a window into the many types of freight rail service in California. Cargo within the state can include intermodal container shipments moving to and from the ports; a unit train dedicated to a specific type of cargo, such as grain or crushed stone, going directly from origin to destination; or carloads, where shippers purchase space or provide individual boxcars based on the quantity they need to ship. As noted in State of the System, page 4, California has two types of freight rail service: Class I service provides long-distance hauls, and Class III railroads, generally called short-line railroads, can include regional lines and switching and terminal railroads such as the San Joaquin Valley Railroad or the Sacramento Valley Railroad. Much of the freight rail traffic in California crosses state boundaries. For example, freight rail almost exclusively moves processed foods like jarred tomato sauce out of the state's agricultural regions and brings in a significant percentage of raw materials for construction.

*Above: A BNSF train is pulled by four locomotives. Photo courtesy of Caltrans*

- ▶ California is ranked number one for tons of intermodal cargo entering and exiting a particular state — a direct consequence of hosting the two largest container ports in the country.
- ▶ Close to half of waterborne, containerized imports from Asia move through the Los Angeles and Long Beach ports.
- ▶ Without rail service to and from the ports of Los Angeles and Long Beach, container flows through these ports would be reduced by 38 percent, while port truck traffic would increase by 44 percent.<sup>1</sup>



Port of Los Angeles; Shutterstock

Two Class I railroads, Union Pacific and BNSF, operate in California and carry the bulk of the tonnage and virtually all of the intermodal containers — standardized boxes that can be handled on vessels, truck chassis, and rail cars — moving through California, and provide all of the connections beyond state borders.

California is the number-one state for originating intermodal containers, many of them continuing a journey that started in Southeast Asia. In 2012, these containers carried over 30 million tons of cargo, or about 27 percent of the national total, according to the American Association of Railroads. Additionally, California generated 3.3 million traditional carloads, ranking the state third in the nation, with 3.4 million carloads ending here, a second-place ranking.<sup>2</sup>

Freight rail produces numerous indirect benefits. Rail's emissions profile produces substantially lower levels of greenhouse gases and airborne pollutants than trucks per ton-mile and uses less energy — benefits to both the environment and public health sectors with large impacts on the economy. For example, climate change caused by greenhouse gas emissions has been found to increase the

incidence of major weather events, which create costly storm damage; and particulate matter from diesel emissions increases the incidence of asthma. Getting trucks off the road also reduces road traffic, curtailing congestion, road wear and associated road maintenance, and accidents. One train can make a big impact: A typical container train can haul the same load as 100 trailer trucks, and a unit train takes 120 trucks off the road.

California rail freight traffic takes a diversity of forms and includes many different commodities. There are literally dozens of stories concerning how railroads in the state have won and lost in individual freight markets, and the resulting impacts on California industry.

To understand the impact of freight traveling by rail in California, researchers focused on three different sets of commodities, each with a different level of railroad market penetration, as case studies. As described in this section, containerized traffic has deeply established rail connections, perishable produce was once a rail stronghold but is now limited, although there is opportunity for expansion, and wine is emerging as an area of growing potential.

## MILESTONES IN INTERMODAL SHIPPING

### 1951

The first container ship was built in Denmark in 1951. But with no landside truck and rail transportation for the new containers, cargoes destined for or originating outside the port had to undergo the expensive and time-consuming move between ocean-going containers and landside vehicles.

### 1956

A South Carolina-based trucking company developed a standardized box that could be handled on vessels, truck chassis, and rail cars, allowing shipments to use several transportation modes while remaining intact in the same box.

Two years later, the firm, by then international, was renamed SeaLand and settled on 35-foot standard containers.

### 1958

San Francisco-based ocean carrier Matson Navigation pioneered LCL (less than container load) shipments, which used 20-foot containers to consolidate multiple smaller shipments into full container loads, then de-consolidated and delivered the small shipments to consignees.

### 1960s

SeaLand and Matson grew to be the world's first large intermodal shipping companies, and with Oakland-based American President Lines, dominated containerized shipping across the Pacific. Over time, Japanese, European, Korean, and Chinese shipping companies also entered the business.



## CASE STUDY:

# California Ports and Containerized Shipping

To understand shipping in California, it's first necessary to appreciate the size and scope of the state's ports. The combined Los Angeles–Long Beach port is the largest container port in the United States and the tenth largest in the world, over triple the size of New York–New Jersey, the nation's next largest port. More than 14 million 20-foot container equivalents passed through the Southern California shipping hub in 2013, constituting the majority of the freight traffic that travels over rail in the region. Union Pacific has reported that one-fifth of all its U.S. intermodal lifts, that is, movement of containers on or off a train, occurs at the Los Angeles ports.

Until container ships came along in the 1950s, all ocean freight was either “bulk” — grain, coal, or oil, for example — or “break-bulk” — irregular-sized crates or loose items. It typically took teams of longshoremen longer to load and unload a vessel than it did to cross the ocean. But after World War II, the development of standard shipping containers launched intermodal shipping, which allows goods to move

easily from ports to cities on rail without ever facing highway congestion. California has been a leader in advancing intermodal shipping through innovations such as the double-stack rail car, on-dock rail intermodal terminals, and the Alameda Corridor, a large-scale express rail line connecting national freight lines to Los Angeles–area ports.

The establishment of Los Angeles and Long Beach as the preferred ports of entry for Asian-origin goods has a profound impact on the California economy, both in the Southland and statewide. Since 1990, the Los Angeles Basin has had a stronger employment base than either New York or even the Silicon Valley—inclusive San Francisco Bay Area. High-paying, locally-anchored blue collar jobs related to port operations, warehousing, and logistics are the engine driving this employment growth. Freight rail is the critical high-capacity mode for moving goods in and out of warehouse facilities to points inland, particularly the Midwest and Northeast.

### 1970s

SeaLand was the first ocean carrier to initiate trainload-based transcontinental movement of marine containers via rail, whereby multiple containerized shipments originating in Asia were moved in trainload quantities from the Port of Oakland to New Jersey.

### 1977

Prompted by SeaLand, Southern Pacific and the American Car and Foundry Company developed the first double-stack rail car, each holding two 40-foot containers, one stacked on top of the other.

### 1980s

Oakland's American President Lines introduced the first seamless intermodal container service using its own vessels together with container train service it contracted for with U.S. railroads.

### 1984

American President was the first steamship line to upgrade to double-stack container train service. Steamship lines introduced Inland Point Intermodal, or IPI, the first door-to-door service for international shipments to U.S. ports: In addition to rail service to inland points, contracts included truck delivery right to the consignee's dock.

### 2002

The ribbon was cut for the Alameda Corridor, a major transportation infrastructure project connecting U.S. railroad lines with the Los Angeles Area ports.



Left: A container ship in Istanbul. Baloncici, Shutterstock

Above: Double-stack container cars passing through Palm Springs, California. Hit1912, Shutterstock

## Changes in Shipping Strategy

Despite the revolutionary advances of intermodal transport, the changing nature of retailing in the United States in the late twentieth century has left existing infrastructure and public policies out of step with modern supply-chain methods for Asian-manufactured retail goods sold in the continental United States. Large national retailers like Walmart, Target, and Home Depot have changed the game, as have large original equipment manufacturers — companies that make parts, for example, for the automotive or electronics industries.

These large companies created economies of scale and of scope that generated a new and more efficient kind of supply chain in which goods do not move intact in marine containers from Asian factories to stores or regional distribution centers, but instead, parts are shipped and then unloaded and assembled in distribution centers established in the vicinity of the port of entry. These port-area distribution centers allow for goods to be assembled and sent to nationwide distribution points more nimbly — with the ebb

and flow of supply and demand — leading to shorter times between manufacturing and the sale of goods.

This new “push-pull” supply chain has sent employment numbers soaring, particularly in San Bernardino and Riverside counties, where many distribution centers supporting Los Angeles–area ports are located. However, it also generates considerable traffic on streets and highways near the ports of entry, a collective result of unloading and distribution at warehouses that take place outside port property. Virtually all of the large-scale import warehouses are typically located far from ports.

These modern supply chains have also led to a concentration of import volumes at the San Pedro Bay ports — almost ten times larger than Oakland, where import volumes have been reduced mainly to goods destined for western regional distribution centers that are unconnected to economically dominant national supply chains.

## A Vision for the Future of the Los Angeles Basin

Researchers suggest that consolidating warehouses close to San Pedro Bay port property is an economic opportunity for the state. Such consolidation would eliminate the need to truck goods from the port all the way to distribution warehouses in the Inland Empire — a significant distance — to be sorted or assembled and further transported via rail or truck. Thus, locating warehouses near the port would result in considerable public benefit — better land use, less truck pollution, less freeway congestion, and fewer trucks creating neighborhood congestion problems in the Inland Empire. However, such changes would likely require public-private partnerships to overcome institutional and contractual barriers. The major steps would include city or county

governments facilitating the development of import warehouses within the port itself and converting existing intermodal rail terminals to accommodate larger 53-foot domestic intermodal containers. If a sufficient number of large retailers were to commit to leasing or buying port-vicinity warehouses, truck traffic would be dramatically reduced and the Alameda Rail Corridor’s full capacity could be realized.

Carried to its furthest extent, warehousing consolidation could mean that imports moving east of the Rocky Mountains, which today are hauled by truck to off-site warehouses, would never get on a freeway, thus maximizing the considerable benefits associated with removing trucks from the road.

► **Containers that start their U.S. journey in California carried 27 percent of the national total of all container traffic.**

► **Approximately 3.3 million traditional carloads were generated in the state, ranked third in the nation, with 3.4 million carloads ending here, a second-place ranking.**

## CASE STUDY: Perishable Produce

Transporting perishable produce by rail can provide significant positive outcomes for the U.S. economy. To reap those benefits, 30 years of inertia must be overcome in a system geared toward truck transport. From 1955 to 1985, a vast majority of perishable produce transported out of California shifted from refrigerated box cars, called “reefers,” to trucks. Today, rail has a very small presence in perishable transport in California.

It wasn't always that way. Reefers revolutionized early twentieth-century farming. “If only I can keep it cold enough long enough,” Adam Trask emotes as he chomps on a piece of lettuce in Elia Kazan’s film of the John Steinbeck classic *East of Eden*. Despite turn-of-the-century failures like the fictional Trask’s ice-cooled railcars to transport his lettuce from the Salinas Valley to New York, reefers did, in fact, dominate perishable transport through the World War II years.

Three factors drove perishable transport away from rail. First, government-subsidized infrastructure, specifically the U.S. interstate highway system built following World War II, made shipping by truck more efficient, with greater flexibility and affordability than rail. Second, stringent regulations governing rail generally did not apply to small independent trucking operations, sparing them from fees and cumbersome rules. Energy was the third factor: Fuel costs were low in relation to labor, and labor costs of owner-operated trucking was much lower than the railroads.

Why return perishables to rail? Despite the inertia of an established system and some benefits, such as flexibility, that persist in trucking, there is compelling argument for moving at least some perishable produce back to rail. Four primary reasons are reduced congestion and pavement wear from lower truck volumes; reduced health care costs from lower

pollution rates; savings from greenhouse gas emission reductions; and fewer crashes from lower truck volumes (trucks crash at a significantly higher rate than trains, and each truck incident impacts other traffic on the roadway). These economic benefits are quantified in the commodity case study on wine (see *Rail and the Wine Revolution*, page 22).

Shipping produce by rail also benefits from the flexibility of trucking on either end of the rail journey, and such additional modes can lower risk and improve resiliency in a disaster.<sup>3</sup> Lastly, there are efficiencies for meeting demand as perishable shippers have produce of different types all in one refrigerated facility at the intermodal terminal site.

In the Central Valley, there are specific produce types, including as potatoes, carrots, and oranges, whose durability makes them suitable for rail transport. Significant financial investments to move these crops by rail have resulted in a small but notable modal shift. Intermodal opportunities such as Railex and TigerCool Express are emerging, although they are challenged by the threat of falling fuel prices and shippers’ inclinations to simply avoid complexity and backhaul issues by going with trucks the whole way. Railex has found that perishable boxcar carloads are likely to increase with increased fuel prices.

In the current climate, it appears that movement of perishables from truck to rail will result only from the combined effort of the railroads, the growers, the buyers, and the public collectively evaluating rail as a potentially more efficient transport solution. Improvements in reliability and speed by the railroads and a return to higher fuel prices will stimulate growth in perishable transport by rail, a change that will most certainly benefit the public as well as the stakeholders.



## CASE STUDY:

# Rail and the Wine Revolution

Worldwide wine production has experienced nothing short of a revolution in the 40 years since California demonstrated that wines of the highest quality could be produced outside Europe's traditional wine-producing regions. The United States is now the largest retail wine market in the world and one of the fastest growing markets in terms of production and consumption. California's production dominance is outsized in quantity as well as quality: On average, the state accounts for 90 percent of all wine produced in the country. U.S. production and consumption span the gamut of quality and price, from numerous wines under \$10 to Screaming Eagle Cabernet Sauvignon, which can sell for more than \$1,500 per bottle. This wide spectrum of quality and price points leads to a similar diversity of production and distribution models.

Rail is a highly viable, important, and growing option for overland shipping of wine. Its use in California has seen steady increase over the span of years, coinciding with the recent growth in the industry. Yet, there are opportunities for shipment by rail that remain unmet due to limitations with the current California and West Coast rail infrastructure.

Currently, the quality of rail transportation is competitive and viable, but as wine consumption moves toward more premium brands there will be an increasing emphasis on quality control, particularly related to temperature control. Innovation in this area will most likely be required to maintain or improve rail's market share of wine shipments.

Rail offers significant cost and environmental-impact advantages over truck-only shipping and, very dramatically, shipping involving an air-freight link. Rail also receives good marks relative to exposure to vibration and risk of product damage and, with the use of insulated box cars, is at least equivalent to truck-only options regarding exposure to extreme temperature.

Rail also has disadvantages relative to other options. Rail shipments in both multimodal boxes and box cars have average in-transit time that can be two to four times greater than truck-only solutions. This higher shipping time can reduce response time to customer orders compared with other options, while increasing the chance of exposing the wine to more sustained adverse temperatures. Significant volume is required for cost effectiveness, although this problem can be mitigated through the use of third-party logistics providers, private companies called 3PLs, which, among other transportation logistics services, consolidate multiple shipment requests into larger ones.

Rail is well positioned to take advantage of two emerging trends in the U.S. wine industry: the increasing emphasis on sustainable, environmentally friendly practices and the trend toward premium wines, with an associated greater emphasis on temperature management during shipment.

Many wine producers today have aggressively adopted sustainable growing practices and environmentally friendly production processes, and have made this a major focal point in their branding. Yet, there is little doubt that transportation and logistics represent a major share of the carbon emissions produced by wine. Rail offers a significant reduction in carbon emissions when compared to heavy diesel trucks for long-haul shipping and a dramatic reduction when compared to air shipment. The use of environmentally friendly transportation practices would seem to be an attractive feature for wine producers to add to their green portfolio, a point that 3PLs often emphasize in their marketing efforts.

*Below: Railways that pass through wine country could be used to increase the use of rail to move wine. Photo © San Joaquin Joint Powers Authority, courtesy of the Altamont Corridor Express*





Because wine is alive with micro-organisms that constantly change its nature, degradation due to temperature variation during shipping is the producers' major concern, particularly for premium brands. Innovations by non-rail shippers to address this issue could diminish rail's competitiveness. However, solutions to the temperature-control problem present an opportunity area for rail. Temperature-controlled rail cars or shipment containers are an obvious, although costly, solution. Insulated boxcars or containers reduce the high (and low) temperature exposure but can be limited in effectiveness in high-temperature situations. A third solution is an operational approach often used for long-haul trucking transport: carefully monitoring weather conditions along routes used and only shipping during acceptable temperature profiles.

Finally, some infrastructure and operations limit the use of rail by wine shippers today. Currently, wine shipments originating in California use rail almost exclusively for west-to-east shipping. But rail can also be viable for north-south shipments, for example, to the Pacific Northwest, or even among regions within California. Efforts that would make Class 1 north-south rail routes on the West Coast economically viable to rail should pay dividends, research suggests.

Some of the larger California wine producers are also wine importers and combine imported and domestic product in rail shipments from California. Today, wine imported into the Port of Oakland is trucked to the state's various major wine distribution centers at volumes that could make rail a viable option. But this movement is not supported by the current rail infrastructure. To mitigate this issue, 3PLs are continuously innovating in order to improve service and reduce costs. The degree to which the railroad industry makes it easier for 3PLs to work with them, the more likely it is that there will be growth in wine shipments via rail.

## ECONOMIC BENEFITS OF SHIPPING WINE BY RAIL

Between 2003 and 2013, 17 million tons of California wine left the state on rail, creating 34 billion ton-miles of freight-rail travel in the United States. Researchers quantified some key economic benefits that society enjoyed as a result of this use of rail over trucks.

**\$30 million**

saved in pavement repair costs from reduced trucking

**\$17 million**

saved in health care costs from reduced diesel pollution, particularly particulate matter

**\$72 million**

worth of greenhouse gases eliminated at current California cap-and-trade prices

**\$166 million**

in reduced costs from fewer crashes involving trucks

---

**\$285 million**

in a total savings to the California economy

### SOURCES

*Rail Transport of Containerized Imports Using California Ports: Past, Present and Future.* Robert C. Leachman, Institute of Transportation Studies, University of California, Berkeley, 2016.

*Case Study #1: (Opportunity), Perishable Produce.* Joshua Seeherman, Mark Hansen, and Karen Trapenberg Frick, University of California, Berkeley, 2016.

*Case Study: Use of Rail by the California Wine Industry.* Michael Ball, Karen Trapenberg Frick, and Joshua Seeherman, University of California, Berkeley, 2016.

### ADDITIONAL REFERENCES

1. Jones, Dean A., Julie L. Farkas, Orr Bernstein, Chad E. Davis, Adam Turk, Mark A. Turnquist, Linda K. Nozick, Brian Levine, Carmen G. Rawls, Scott D. Ostrowski, William Sawaya: "U.S. import/export container flow modeling and disruption analysis" in *Research in Transportation Economics*, 2011, vol. 32, issue 1, pages 3-14.
2. Surface Transportation Board 2012 Waybill Sample.
3. The Salinas Valley Report and San Joaquin Interregional Goods Plan.





# PASSENGER-FREIGHT INTERACTIONS

Passenger and freight rail lines don't operate in a vacuum; they often share tracks within corridors and can pass through multiple owners of right-of-way in one trip. Interactions between the two types of rail operators can affect overall rail operations, creating the potential for impacts on both current and future economic outcomes.

Caltrain is a good example from the arena of regional rail. In addition to providing passenger service, the Caltrain corridor is also an active freight line connecting the ports of Redwood City and San Francisco with points south. Much of the freight moves at night or when Caltrain is operating once-per-hour service. Approximately two million tons of cargo travels on the Caltrain corridor per year, according to a 2009 estimate. But there is tension between the needs of freight rail and Caltrain's need to continue improving service to the robust tech sector and other San Francisco Peninsula-region suburbs. For example, freight shippers are concerned that increased passenger service could reduce available time for freight shipments.

Throughout the entire LOSSAN corridor between San Diego and San Luis Obispo, there is shared use with freight ownership on significant segments. The rail corridor accommodates traffic to and from major deep-water ports, including Oxnard, Los Angeles, Long Beach, and San Diego, and carriers stimulate development along the line. Oxnard's Port of Hueneme, the only deep-water port between the larger West Coast ports of Oakland and Los Angeles/Long Beach, is an excellent example of such growth. Hueneme supports the export of strawberries and other produce grown in the Oxnard region, serves as a niche port for both the exporting and importing of automobiles, and supports offshore oil drilling in the Santa Barbara channel. Since its reactivation in 1998, the Ventura County Railroad, the port's short-line connection to LOSSAN, has moved approximately 2,000 carloads per year, according to the 2013 State Rail Plan.

*Above: Passengers exit the Sacramento Amtrak station, a busy corridor shared between Amtrak and Union Pacific. Photo © San Joaquin Joint Powers Authority, courtesy of the Altamont Corridor Express*

- ▶ Approximately two million tons of cargo travel on the Caltrain corridor each year.
- ▶ Since its reactivation in 1998 to serve Oxnard's Port of Hueneme, the regional Ventura County Railroad has moved 2,000 carloads per year to points inland.
- ▶ A \$12 million U.S. DOT economic development grant is dedicated to Port of Hueneme improvements across multiple modes.



This success has emboldened the port to improve rail infrastructure through on-dock safety improvements and grade crossings, which culminated in a \$12 million Transportation Investment Generating Economic Recovery, or TIGER grant, issued by the U.S. Department of Transportation in November 2015. This grant will go toward improvements across multiple modes; rail improvements for the port's shoreline include loading of ships directly from rail cars. On the other hand, port expansion could further exacerbate conflicts between freight and passengers operations on the LOSSAN corridor.

California's rail operations depend on shared-use corridors and the cooperation between public passenger operators and private freight operators. Successful collaborative relationships will need to be strengthened as passenger operators look to improve frequency and speed in areas of heavy freight traffic, and likewise, freight operations seek to increase their service through areas of public right-of-way ownership.

## SOURCES

*Caltrain Regional Rail: The High Capacity Artery of the World's Leading Technology Region.* Joshua Seeherman, Karen Trapenberg Frick, and Mark Hansen, University of California, Berkeley, 2016.

*The LOSSAN Corridor: Stimulating Development, Reducing Congestion, and Improving Air Quality.* Joshua Seeherman, Karen Trapenberg Frick, and Mark Hansen, University of California, Berkeley, 2016.

*Rail Transport of Containerized Imports Using California Ports: Past, Present and Future.* Robert C. Leachman, University of California, Berkeley, 2016.

Above: A BNSF freight train passes an Amtrak track at the Fullerton station, shared tracks within the LOSSAN corridor.

Photo by Thomas McCann



# RAIL AND THE FUTURE OF THE CALIFORNIA ECONOMY

Political, technological, demographic, and environmental forces will continue to drive change in the California economy, although it is impossible to predict what forms this change will take as we look forward several decades. The California rail system, despite its fixed guideway and relatively mature technology, has proven to be remarkably adaptable to economic and social change, and there is every reason to expect this to continue into the future. To highlight this resiliency, below we discuss how California railroads may adapt to several factors that are expected to reshape the California, national, and global economies over the next generation.

**CLIMATE CHANGE:** A good example of the multifaceted impacts of economic trends on rail is climate change. California remains committed to reducing carbon emissions, with a target first set forth in AB32, the California Global Warming Solutions Act, of having the same carbon emissions in 2020 as it did in 1990. Rail, as an energy efficient mode, will gain further competitive advantage as a result of market mechanisms and policies instituted to achieve the targets of AB32. But while rail plays a critical role in a low-carbon economy, it is also an enabler of an economy reliant on carbon fuels. It has been estimated that one third of CO<sub>2</sub> emissions from energy consumption result from carbon-based fuels — including coal and oil — transported by railways. The unique ability of railroads to haul loads in an energy-efficient manner gives them an important role in either a low-carbon or a high-carbon future.

**AUTOMATION:** Automated passenger vehicles also have conflicting implications for rail. One can imagine intercity travelers opting to use their personal automated vehicle for longer trips that might otherwise be made by rail, accessing many of the same amenities — such as high-speed Internet access and productive work time — that would otherwise give rail an advantage. But one can also imagine shared automated vehicles providing ready access between rail stations and trip and start-and-end points, while also eliminating the need for a private vehicle away from home. Moreover, users of private automated vehicles may be able to endure higher levels of traffic congestion by avoiding the stress of controlling the wheel, but, ironically, the consequence of that added endurance is that the increase in such vehicles is likely to create even more congestion. Thus, despite the potential for automated vehicles to divert some rail trips, passenger rail can be expected to thrive in a world of high vehicle automation.

Automation may also affect competition from trucking. Energy and labor must both be considered. The most important effect of automation on rail-truck competition is likely to be an increased in the energy efficiency of trucking. Truck platooning and elimination of side-view mirrors is likely to increase trucking energy efficiency on the order of 10 percent, reducing total operating costs by about 4 percent. This is likely to result in some traffic shifts, but is by no means a game changer.

- California's population is estimated to grow from 39 million in 2015 to 50 million in 2050, and the transportation system, including rail, will have to absorb that growth.
- Capacity on a freight line can double, from 30 to 60 trains per day, when double-tracking is expanded to 80 percent of the route.<sup>1</sup>
- If sea level rises by 1.4 meters by the year 2100, 280 miles of the state's railways would be at risk.

Automation may also increase labor productivity in trucking, but this is likely to be offset by similar improvements in rail. It should be noted that with its dedicated guideway, rail is in many respects more amenable to automation than trucking is.

**GLOBAL SUPPLY CHAINS:** As discussed in California Ports and Containerized Shipping, page 19, California railroads play an important role in globalized supply chains spanning from East Asia to the United States. Changes in the global supply network — whether evolutionary or disruptive — will require railroads to adapt. A fundamental question is how import and export volumes through California ports will change. Between 1990 and 2014, U.S. imports and exports have both substantially increased. Compared to 2000, the 2014 import volume increased by 33 percent, while the export volume increased by 52 percent. This imbalance poses challenges to freight rail transportation, particularly when it comes to filling freight cars heading back West following intermodal deliveries to the Midwest and East Coast. Future changes in both the volume and balance of trade will influence the demand for intermodal rail transport and the ability of railroads to efficiently serve it.

Expansion of the Panama Canal is expected to influence the entire U.S. intermodal system, including rail transport in California. The expansion will enable larger ships, up to 13,000–14,000 TEUs (a cargo capacity unit roughly based on a 20-foot cargo unit), to transit through the canal and ultimately reach U.S. East Coast ports. Since larger ships are more energy efficient than trains, the expansion would divert

some west-east freight demand from rail to maritime shipping. Recent estimates show that the Panama Canal expansion will shift about 10 percent of Asia-U.S. trade volume, equivalent to 1.2 million TEUs, between the West and East coasts.<sup>2</sup> Thus it is likely that the Panama Canal expansion will substantially influence freight rail demand in California.

Three-dimensional printing has the potential to change global supply chains even more drastically, enabling low-cost and highly adaptive manufacturing to take place close to the local market. The need to move large quantities of manufactured goods from the Far East to the U.S. domestic market may substantially decrease as a result of 3D printing. On the other hand, localized manufacturing increases the demand for moving raw or semi-raw materials to more places. In a 3D printing world, rail traffic may shift from containerized finished goods to the inputs required to make them locally.

**DEMOGRAPHICS:** Changing demographics are also a critical determinant of travel demand and potential rail ridership. California's population is estimated to grow from 39 million in 2015 to 50 million in 2050. In tandem, the U.S. population is aging and people aged 65 and over will increase from 43 million in 2012 to nearly 84 million in 2050, according to the U.S. Census. California Department of Finance projections show that the number of Californians over age 65 will increase 160 percent by 2050, from 4 million to 11 million.

The number of rail trips made by this elderly population will increase by 71 percent in 2040 as compared to 2015, researchers estimate. This increase takes into account the net effect of both the growing elderly population and the substantially lower demand for transportation in the aging population. Another demographic often pointed to anecdotally and in the media are millennials — young adults born between 1980 and 2000 — with claims that they are driving less and riding transit more. Recent research, however, points to factors such as declining employment due to the Great Recession as influencing these shifts.<sup>3</sup> With increased employment, millennials might start to travel more, but it is uncertain whether they will do so via car or transit. Thus, for millennials, the elderly, and travelers in between, passenger rail services could absorb some of the future growth in travelers if California and others continue to adequately plan for and invest in its provision.<sup>4</sup>

**HIGH-SPEED RAIL:** High-speed rail between Northern and Southern California will change the role of existing passenger services in the California economy. The legacy services will become feeders to the longer-haul high-speed service while continuing to accommodate their existing base of intra-regional trips. This, in addition to a growing population, is expected to lead to higher frequency service between destinations throughout the passenger system and encourage better schedule coordination between different rail operators. Legacy and high-speed rail services will work synergistically, each improving the other and accentuating their economic and environmental benefits.

**RESILIENCY AND RISK MANAGEMENT:** Finally, sea level rise, earthquakes, hurricanes, high winds, flooding, and other hazards can cause major damage and reduce the reliability and functionality of rail and the overall transportation system. Such damage can affect the tracks, shut down signaling systems, and blow down overhead lines, causing significant delays to electrified rail lines. Climate change increases the probability and intensity of such hazards. In California, if sea level were to rise by 1.4 meters by 2100, then 280 miles of railways would be at risk.<sup>5</sup> System interruptions and damaged tracks impose fiscal costs from lost revenue due to interrupted service and delays to dollars associated with reconstruction of damaged infrastructure. When considering the larger transportation network and potential damages to the road system in the event of a hazard, functioning rail can provide an alternative mode of transport, thereby providing redundancy in services. In the face of increasing intensity and probability of hazards and vulnerabilities, planning for a resilient and redundant system will be ever more critical if the state is to have a well functioning rail and intermodal transportation network. While rail is not immune from disruptive events, it can, by adding redundancy, increase the resilience of the state's transportation system as a whole.

While future trends related to global supply chains, technology, climate change, and hazards are difficult to predict, California can look to its foundational provision of rail as a core and necessary component of the state's transportation network. The state can continue to capitalize on rail as a means to efficiently move freight and people, provide redundancy in the transportation system, pursue air quality and environmental benefits, reduce travel delays and traffic congestion, and adapt to the evolving needs of the California economy.

## SOURCES

*Future Impact of Rail on California Economy.* Ahmedreza Talebian, Bo Zou, Joshua Seeherman, and Mark Hansen, University of California, Berkeley, 2016.

## ADDITIONAL REFERENCES

1. Sogin, Samuel L., Yung-Cheng (Rex) Lai, C. Tyler Dick, and Christopher P. L. Barkan, Comparison of Capacity of Single- and Double-Track Rail Lines, 2013.
2. Corbett, James J., Eric Deans, Jordan Silberman, et al, Panama Canal expansion: emission changes from possible US west coast modal shift, Carbon Management, 3:6, 2012.
3. Taylor, B.D. et al, 2013. "Who knows about kids these days? Analyzing the determinants of youth and adult mobility in the US between 1990 and 2009." *Transportation Research Part A: Policy and Practice*, 93, 39-54; McDonald, N. C.
4. Blumenberg et al, 2016. Are millennials really the "go-nowhere" generation? *Journal of the American Planning Association*, 81(2), 90-103.
5. Heberger et al., 2009. The Impacts of Sea-Level Rise on the California Coast. California Climate Change Center.



A conductor assists passengers on Amtrak's San Joaquins train, which runs between Northern and Southern California through the agricultural valleys. Photo © San Joaquin Joint Powers Authority, courtesy of the Altamont Corridor Express

*Rail and the California Economy* was produced by the Institute of Transportation Studies at the University of California, Berkeley. The report and the research that it summarizes were commissioned by the California Department of Transportation and the California State Transportation Agency as part of the 2018 California State Rail Plan. © 2017 by the Regents of the University of California. All rights reserved.

Principal Investigator: Mark Hansen  
Report Authors: Karen Trapenberg Frick, Ann Brody Guy, Mark Hansen, Joshua Seeherman  
Research Authors: Michael Ball, David Brownstone, Karen Trapenberg Frick, Mark Hansen, Robert C. Leachman, Samer Madanat, Joshua Seeherman, Ahmadrza Talebian, Bo Zou  
Managing Editor: Ann Brody Guy  
Associate Editor: Joshua Seeherman  
Designer: Betsy Joyce

*Below: Union Pacific train crossing a trestle as it climbs through the California foothills.*  
Photo by Robert C. Leachman



# RAIL AND THE CALIFORNIA ECONOMY

A summary report of California's rail system and its economic impact on the state

Produced by the Institute of Transportation Studies at the University of California, Berkeley, in cooperation with:

California State Transportation Agency  
California Department of Transportation  
University of California Center on Economic Competitiveness in Transportation  
University of California Transportation Center

