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AN INVESTIGATION OF THE RELATIONSHIP BETWEEN CLASS I RAILROAD
EMPLOYMENT AND TEU TRAFFIC AT THE PORTS OF LONG BEACH
AND LOS ANGELES, CALIFORNIA: 1997-2006

By

James Augustus Burt, IV

A Thesis
Submitted to the Faculty of
Mississippi State University
in Partial Fulfillment of the Requirements
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in Geosciences
in the Department of Geosciences

Mississippi State, Mississippi

May 2008

AN INVESTIGATION OF THE RELATIONSHIP BETWEEN CLASS I RAILROAD
EMPLOYMENT AND TEU TRAFFIC AT THE PORTS OF LONG BEACH
AND LOS ANGELES, CALIFORNIA: 1997-2006

By

James Augustus Burt, IV

Approved:

Shrinidhi Ambinakudige
Assistant Professor of Geography
and GIS
(Director of Thesis)

Kathleen Sherman-Morris
Assistant Professor of Meteorology
(Committee Member)

Charles Wax
Professor of Geography
(Committee Member)

Christopher Dewey
Associate Professor of Geology
Graduate Coordinator of the
Department of Geosciences

Gary Myers
Interim Dean of the College of
Arts and Sciences

Name: James Augustus Burt, IV

Date of Degree: 3 May 2008

Institution: Mississippi State University

Major Field: Department of Geosciences

Major Professor: Dr. Shrinidhi Ambinakudige

Title of Study: AN INVESTIGATION OF THE RELATIONSHIP BETWEEN CLASS I RAILROAD EMPLOYMENT AND TEU TRAFFIC AT THE PORTS OF LONG BEACH AND LOS ANGELES, CALIFORNIA: 1997-2006

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Candidate for Degree of Master of Science

The twin ports of Long Beach and Los Angeles, California have become the focal point of the influx of containers from East Asia and China. The purpose of this study is to determine the relationship between monthly Class I Transportation (T&E) employment and combined monthly TEU traffic at the Ports of Long Beach and Los Angeles, California for the years 1997 through 2006. The Spearman Rank-order Correlation Coefficient was administered to analyze the relationships. Results indicated that proximity is not the sole factor in a relationship between monthly Class I Transportation (T&E) employment and combined monthly TEU traffic at the Ports of Long Beach and Los Angeles. This study also contains a historical analysis of the development of railroad intermodal transportation.

DEDICATION

I dedicate this work to Railway Ages' Railroader of Century: the Railroad Worker.

A railroad consists of two steel rails which are held a fixed distance apart upon a roadbed. Vehicles, guided and supported by flanged steel wheels, and connected into trains, are propelled as a means of transportation.

John H. Armstrong, *The Railroad, What It Is, What It Does*

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LIST OF ACRONYMS

ACRONYM

AAR	Association of American Railroads
BN	Burlington Northern
BNSF	Burlington Northern Santa Fe
CN/IC	Canadian National/Illinois Central
COFC	Container on flatcar
Conrail	Consolidated Rail Corporation
CP	Canadian Pacific
CR	Consolidated Rail Corporation (see also Conrail)
CSX	CSX Transportation
CTC	Centralize Traffic Control
CTEU	Combined Twenty-foot Equivalent Unit
DTC	Direct Traffic Control
FEC	Florida East Coast
FEU	Forty-foot Equivalent Unit
GTW	Grand Trunk Western
IC	Illinois Central
KCS	Kansas City Southern

KCSM	Kansas City Southern de Mexico
MP	Missouri Pacific
NS	Norfolk Southern
N&W	Norfolk & Western
Santa Fe	Atchison, Topeka & Santa Fe
SOO	SOO Line
SP	Southern Pacific
STB	Surface Transportation Board
TEU	Twenty-foot Equivalent Unit
2TEU	Two Twenty-foot Equivalent Unit
TOFC	Trailer on flatcar
TTX	TrailerTrain
UP	Union Pacific

CHAPTER I

INTRODUCTION

The expansion of trade with China and the transportation of containers filled with consumer goods was a major reason behind the revitalization of the American railroad industry in the late 1990's and early 2000's (Murray, 2006; Saunders, 2003). Rail is now utilized by steamship companies as a landbridge, linking the Pacific Ocean with the Atlantic Ocean and cutting transit times from East Asia to the United States east coast and Europe (Rodrigue et al., 2006; Armstrong, 1998; McKenzie et al., 1989).

The purpose of this study is to determine if there are any relationships between monthly TEU (Twenty-foot Equivalent Unit) traffic at the Ports of Long Beach and Los Angeles, California (CTEU) and monthly Transportation (train and engine) employment (T&E) among America's Class I railroads for the years 1997 through 2006. The study also investigates the temporal patterns of correlations between monthly T&E employment and monthly CTEU among the Class I railroads from 1997 through 2006.

Intermodal (in-ter-mod-al, *adj.*) is the transfer of products involving multiple modes of transportation; truck, railroad, or ocean carrier (North American Intermodal Association, 2008a). The Ports of Long Beach and Los Angeles, California have become the epicenter of the rail-ocean carrier interface, where containers are transferred between

different modes of transportation (Rodrigue et al., 2006) and serves as the western anchor of the American landbridge (Smith-Peterson, 2006; Murray, 2006).

In 2006, international container traffic represented roughly 59.7 percent of the total railroad intermodal moves in North America (Intermodal Association of North America, 2008b) and since 2003, intermodal has been the American railroad industry's largest source of revenue (Association of American Railroads, 2007c). The railroad that has positioned itself to benefit most from the landbridge traffic, BNSF, credits international intermodal traffic for 64 percent of its volume growth between 1995 and 2005 (BNSF Railway, 2006). BNSF also reportedly hauls two-thirds, and by process of elimination Union Pacific hauls one-third, of the containers that move via rail from the Ports of Long Beach and Los Angeles (Frailey, 2007b).

The boom in international intermodal traffic has aided in reversing a decades long trend of declining railroad employment in the United States (Railway Age, 2004). A service meltdown nearly occurred on America's largest railroad, Union Pacific, in 2003 as a result of an unexpected increased in international intermodal traffic and a shortage of operating crews (Blaszak, 2004). It is this event that is the prime motivation behind this study.

Objectives and Hypotheses

The two objectives of this study are:

- 1 To investigate the history of development of railroad intermodal transportation in the United States.
- 2 To analyze the relationship between TEU traffic and railroad employment in the United States.

Assuming that BNSF reportedly hauls two-thirds, and by process of elimination Union Pacific hauls one-third, of the containers that move via rail from the Ports of Long Beach and Los Angeles (Frailey, 2007b), these two railroad's monthly T&E employment should have higher correlations with monthly CTEU traffic. Working under this assumption, the four hypotheses that will be addressed in this study are:

- 1 That BNSF will have the most positive significant correlations between its monthly T&E employment and monthly CTEU.
- 2 That BNSF will have the fewest inverse significant correlations between its monthly T&E employment and monthly CTEU.
- 3 That Union Pacific will have the second most positive significant correlations between its monthly T&E employment and monthly CTEU.
- 4 That Union Pacific will have the second fewest inverse significant correlations between its monthly T&E employment and monthly CTEU.

Organization of Study

This study is organized into seven chapters. The first chapter is an introduction to the study and summarizes the objective and hypotheses. Chapter two presents a review of several studies regarding railroad employment and chapter three is a background for

this study. Chapter four describes the data and methodology used in the study. Chapter five covers the historical analysis and chapter six outlines the results and discusses the statistical analysis. Chapter seven presents the conclusions and has suggestions for future research.

CHAPTER II

LITERATURE REVIEW

This chapter covers a series of previous investigations into railroad employment. The chapter ends with a summary of these investigations.

Previous Investigations

One of the earliest studies on the effects of railroad employment on a local community is Cottrell's "Death by Dieselization" (1951). A sociological work, it documents the demise of Caliente, Nevada after the Union Pacific Railroad converted from steam to diesel-electric locomotives. Caliente, Nevada is located in an isolated part of the state and its population's main source of employment was to service steam locomotives. Diesel-electrics had a longer endurance and no longer needed the intermediate stops and the railroad wanted to close the shops. Local unions and community leaders had tried to have laws passed that would force the railroad to perform some functions, change crews or inspect cars. These efforts came to nothing and employees with seniority moved elsewhere and younger ones had to find a new trade.

Yochum and Rhiel (1990) identified some causes of the dramatic decline in railroad employment from 1952 to 1984 by testing an industry employment function. It was found that the decline in passenger travel in the late 1940's was made up for in

increased freight traffic, until the conversion from steam to diesel-electrics locomotives in the 1950's. This along with rising wages and deregulation, were found to be the primary factors behind the fall Class I railroad employment. The intensive merger activity in the 1960's and early 1970's had little effect on the decline in railroad employment (Yochum and Rhiel, 1990).

MacDonald and Cavalluzzo (1996) found that Class I railroads used their efficiency to move bulk traffic and lowered rates to compete with other forms of freight carriers after the passage of the Staggers Act. Mergers and abandonment hearings and decisions were streamlined and the railroads were able to mold themselves into more efficient trunk systems. The effect on the wages and employment for the railroad workers was far reaching. Consolidation into more heavily used lines reduced the demand for labor and weaken the employees' union's bargaining position. Wages had climbed after the Staggers Act until 1985, but by the late 1980's wages were being eroded (MacDonald and Cavalluzzo, 1996).

Talley and Schwarz-Miller (1998) studied the impacts of deregulation on the weekly earnings of male locomotive engineers and conductors between 1973 and 1993. They found a significant negative impact from deregulation on the locomotive engineers and conductors of approximately 11 percent, compared to workers from other industries. The conclusion was that deregulation in 1980 had allowed railroads to press harder for work and pay-rule changes (Talley and Schwarz-Miller, 1998).

Davis and Wilson (1999) found that between 1978 and 1994, employment in the industry decreased by 58 percent as a direct result of deregulation and mergers accounted

for approximately 12.5 percent of the decline in Class I railroad employment. Twenty-five percent of the losses were determined to be as a result of changes in traffic patterns. Firm-level data was used to explain sources of employment decline, as opposed to MacDonald and Cavalluzzo's usage of industry wide aggregate data (Davis and Wilson, 1999).

Davis and Wilson (2003) found that between 1978 and 1994, Class I railroad employment decreased by about 60 percent and as Class I railroads merged the average firm size employment increased by 33 percent. It was also found that real wages (average compensation) increased by 43 percent during the study period. The authors, following on their previous work by Davis and Wilson (1999), used firm-level data but had focused developing and estimating wage compensation effects. Their conclusion was that mergers increased the wages for Class I railroad employees, mostly due to the technology that reduced labor, left individuals who were more skilled and could command a higher wage (Davis and Wilson, 2003).

Bitzin and Keeler (2003) developed a model to determine the affects of the elimination of the caboose and reduction in crew sizes after deregulation on productivity. They used financial and operational data to determine if Class I railroads were operating in 1997 under the same conditions that were in place in 1983, would there be substantial difference in their performance. The findings were that if cabooses and the five man crew sizes were still in use, costs to operate the railroads would have been between 5.3-11.2 percent higher, affecting different railroads differently (Bitzin and Keeler, 2003). It was also found that if the railroads had not had any of the technological innovations over

the same period the costs would have been between 14-60 percent higher (Bitzin and Keeler, 2003). The combined effect of no reduction in labor and any technological innovations, costs would have been between 20-77 percent higher (Bitzin and Keeler, 2003). These findings would indicate that for most railroads, technological improvements increased productivity more than reducing labor (Bitzin and Keeler, 2003).

Summary

Literature on the effects of deregulation appears to be inconclusive. MacDonald and Cavalluzzo's (1996) study using aggregate data draws the conclusion that there was a decline in Class I railroad employment and an eventual decline in their wages. Talley and Schwarz-Miller (1998) also found a decline in weekly earnings of male locomotive engineers and conductors specifically between 1973 and 1993. Davis and Wilson's (1999) over a similar study period using firm-level data also determined there was a drastic decline in Class I railroad employment as well. The follow-up study by Davis and Wilson's (2003), again using firm-level data over a similar study period, found that Class I railroad employees wages had increased over a similar study period.

Yochum and Rhiel's (1990) study seems to validate Cottrell's study that the conversion from steam to diesel-electric locomotives would reduce employment. They also determine that rising wages and deregulation were also found to be the primary factors behind the decline in Class I railroad employment. The intensive merger activity was found to have had little effect on the decline in railroad employment. Bitzin and Keeler's (2003) function's differently, tries to determine the effect of employees and

work rules as apposed to the technological advancements on the Class I railroads. They determined it was the technological changes that lead to greater Class I railroad productivity.

These studies do well to try to determine the effects of changes in Class I railroad employment. It is well determined that there was a decline in Class I railroad employment since the passage of the Staggers Act but most terminate their study period in the 1990's; MacDonald and Cavalluzzo (1996) in 1990, Talley and Schwarz-Miller (1998) in 1993, Davis and Wilson (1999; 2003) both in 1994, and Bitzin and Keeler (2003) in 1997. This was on the verge of the hiring surge by the Class I railroad's in the late 1990's (Fischer, 1999).

These studies have one glaring omission; they do not cover employees of railroads that are below the Class I level. This is largely because Regional and Local railroads are not required to file the data with the government that are required of the Class I railroads. The smaller railroads also can cease to operate and others start in their place in a short amount of time. There also are hundreds of Regional and Local railroads and the ever changing nature of the industry would make it difficult to accurately study all in a single study. Finally, Regional and Local railroads did not really begin to expand until the 1980's, taking over the branch lines being discarded by the Class I railroads.

CHAPTER III

BACKGROUND

This chapter provides a background into the major topics necessary to completing this study. These topics include; the structure of the American railroad network, the Staggers Railroad Act, the decline in railroad employment between 1950 and 2006, train & engine employment, and the American landbridge.

Structure of the American Railroad Network

In the United States, railroad traffic flows with more loaded cars traveling west to east and south to north. More unloaded cars travel in reverse order, east to west and north to south. Railroads that serve the northeastern United States have to deal with the added expense of making final delivery and returning non-revenue generating un-loaded cars. This is exacerbated by the fact that industrialization in this area occurred before the development of railroads in the 1800's; in other parts of the United States settlement and industrialization followed the construction of the railroads (Saunders, 2001).

Chicago, Illinois, Kansas City and St. Louis, Missouri are the eastern gateways that handle most of the traffic from the West into the Northeast. Memphis, Tennessee, and New Orleans, Louisiana are the gateways that handle most of the traffic from the West into the Southeast. Cincinnati, Ohio, and Alexandria, Virginia use to be the

gateways between North and South (Saunders, 2001) but have lost their status as the railroads of the Eastern United States merged during the 1960's to 1990's.

Railroads in the United States are grouped in two similar but different ways. The governmental agency the Surface Transportation Board (STB) groups railroads based solely on operating revenue generated by a given railroad. The Association of American Railroads (AAR) groups railroads on a mixed criterion of operating revenue and size of network (Table 3.1).

Both the AAR and STB classify a Class I railroad as having operating revenues in excess of \$319.3 million in 2005 and this threshold is adjusted each year for inflation (Table 3.1). Below the Class I level the groupings are different, but a Class II railroad is equivalent to a Regional railroad and a Class III is equivalent to a Local railroad (Table 3.1). There are over 553 Regional and Local railroads, almost all are considered Local or Class III, that operate in localized areas, usually on lines discarded by the Class I railroads (Association of American Railroads, 2007a).

Table 3.1 Classifications of American Railroads (Association of American Railroads, 2006).

STB	AAR
<i>Class I</i>	<i>Class I</i>
Annual operating revenues of \$319.3 million or more as of 2005 (amount is adjusted annually for inflation and must be reached or exceeded for three consecutive years for a firm to be considered Class I)	Same as STB
<i>Class II</i>	<i>Regional</i>
Operating revenues of \$25.5 million to \$319.2 million (2005)	Line-haul railroads operating at least 350 miles of network and/or earning revenue between \$40 million and the (STB) Class I revenue threshold
<i>Class III</i>	<i>Local</i>
Operating revenues of less than \$25.5 million (2005)	Line-haul railroads below the Regional criteria, plus switching & terminal railroads

The seven Class I railroads dominate the American railroad network, operating 95,664 miles (153,956 km) of the 140,810 mile (226,612km) trackage and employing 162,438 of the 181,807 railroaders within the United States (Association of American Railroads, 2007a).

Class I railroads operating in the United States are divided into Eastern or Western railroads. A dividing line from the gateway of Chicago, Illinois to St. Louis, Missouri and along the Mississippi River to Memphis, Tennessee and New Orleans, Louisiana, is used to separate between east and west (Saunders, 2001). There are exceptions and mergers having lead to routes that can cross this line but the bulk of a given railroad's trackage is located in the region of classification.

The bulk of three out of the seven current Class I railroads trackage are predominately in the eastern United States; CSX Transportation (CSX) (Map A.4),

Norfolk Southern Combined Railroad Subsidiaries (NS) (Map A.8), and Grand Trunk Western Railroad (GTW) (Map A.5). CSX and NS are the two giant railroads that dominate the eastern United States, extending from the western gateways to the Atlantic Ocean. GTW is the American subsidiary of the Canadian National Railway (CN) and its lines radiate from Chicago, Illinois northwestward and northeastward to the Canadian border and south towards the New Orleans, Louisiana (Association of American Railroads, 2007f) on the former Illinois Central Railroad. GTW in this study is referred to as Canadian National/Illinois Central (CNIC) to differentiate from the pre-2002 GTW.

The other four Class I railroads trackage that are predominately in the western United States; Union Pacific Railroad (UP) (Map A.10), BNSF Railway (BNSF) (Figure A.1), Kansas City Southern Railway (KCS) (Map A.7), and SOO Line Railroad (SOO) (Map A.9). UP and BNSF are the two giants that cover the western United States, UP being the larger of the two. The two smaller Class Is are KCS and SOO; KCS is the smallest of the of the Class Is and operates as a bridge carrier between east and west as well as a link from Kansas City, Missouri to the Gulf of Mexico. SOO operates mostly in the upper Midwest from Chicago, Illinois northwestward to the Canadian border and in the Mid-Atlantic.

In the post-NAFTA (North American Free Trade Agreement) world, both CN and CP have American subsidiaries, for tax and regulatory purposes, which connect with their own lines within Canada (Association of American Railroads, 2007f; 2007i). KCS has its own Mexican subsidiary Kansas City Southern de Mexico (KCSM) and half ownership the Panama Canal Railway (Association of American Railroads, 2007g).

Two railroads were included in this study that were at some point during the study period. First is Consolidated Rail Corporation (Conrail) (Map A.3), the former federally run after the consolidation of several bankrupt Northeastern railroads in 1976 and sold to the public in 1987 (Burns, 1996). Conrail was an 11,400 mile (18,346km) system by the late 1990's, serving the Northeast and Midwest. Conrail as Class I railroad would be split and merged in 1999, 58 percent going to Norfolk Southern and 42 percent going to CSX (Railway Age, 1999).

Conrail today functions a switching and terminal railroad serving the Detroit, Northern New Jersey, and Philadelphia/South Jersey Shared Assets Areas. These were areas that CSX and Norfolk Southern could not agree to satisfactory ownership. Conrail handles the switching and terminal operations in Detroit, Michigan and most of New Jersey for both CSX and Norfolk Southern (Blanchard, 2005).

The other former railroad included in this study is Illinois Central Railroad (IC) (Map A.6), which had a unique position in American railroading being a north-south railroad in a predominantly east-west system. IC was a 3,450 mile (5552km) system that started in Chicago, Illinois and traveled south to Memphis, Tennessee and the Gulf ports of New Orleans, Louisiana and Mobile, Alabama (Welty, 1998). IC was bought by Canadian Nation in June of 1999 (Luczak, 1999) and consolidated with CN's other American subsidiary Grand Trunk Western (Map A.5) in June 2002 (Surface Transportation Board, 2007).

The Stagers Act

The Stagers Railroad Act of 1980 was a watershed event in the history of America's railroads. Before October 14, 1980, America's railroads were the most regulated industry in the United States. The Interstate Commerce Commission (ICC), formed in 1887, was given power over almost every aspect of railroad management including rates, mergers, and abandonment. The ICC was created to keep the "monopolistic" railroads in check, which by 1980 this function was no-longer valid. Reducing rates to meet the competition were almost uniformly rejected (Phillips, 2000).

The 1970's started with the bankruptcy of the Penn Central and 25 percent of the industry, mostly Northeastern railroads. Conrail (CR), a 1976 consolidation of the bankrupt Northeastern railroads and run by the government, was losing 1 million dollars a day. The decade ended with the liquidation of the Chicago Rock Island & Pacific (Rock Island) in early 1980. Some in Congress thought nationalization was the only option since they believed America's railroads might never generate enough income to finance their own capital spending (Kaufman, 2000).

What the Stagers Act did was largely deregulate the industry and allow railroads to price their services to what the market would bear. The railroads had a steep learning curve to over come as they had to market themselves in ways they never had to before. Instead of open rates, secret and unregulated contracts were permitted and eventually most shipments by rail were done with contracts (Phillips, 2000).

Staggers Act Controversy

The Staggers Act and deregulation is not without controversy. During the debate in Congress, it was widely expected that railroads would raise their rates (Phillips, 2000). Captive shippers, industries that are dependent on rail service, have argued that they have been gouged by the railroads since deregulation and pay rates higher than average. Their lobbying organization, Consumers United for Rail Equity (CURE), have pushed Congress to introduce re-regulation in recent years (Kaufman, 2004).

One of the major issues for captive shippers is a Surface Transport Board (STB), the ICC's regulatory replacement, decision in 1996 to allow railroads to quote rates only from origin to destination. Shippers have tried to convince Congress to reverse this decision and require quoting of rates from any junction (Gallinger, 2006). They contend this will relive bottlenecks and improve service. Railroads argue that maintaining of track is expensive and if volume is suddenly cut off and redirected, the on-line customers would have to cover the cost and if there is not enough revenue generated, abandonment would occur (Gallinger, 2006).

Captive shippers are also pushing to make it easier to challenge rates before the STB. The STB considers a rate to be reasonable if it equals 180 percent or less of the railroad's cost of providing a service. Captive shippers make the claim they pay up to 450 percent and to challenge a rate can costs thousands of dollars and can take several years to get a resolution. They claim they have to bear the costs and the burdens of proof that a rate is unreasonable. Railroads counter that shippers are the ones that bring the

charge and must bear the burden of proof, like any other court case in the United States (Gallinger, 2006).

Staggers Act's Impact on Rates

Burton (1993) found that shippers have generally benefited from deregulation. He also concluded that the competitive high-value shippers have benefited more than bulk shippers in the decade after the Staggers Act. Hecker (2006) found that rates, when adjusted for inflation, had declined from 1985 to 2004. There was a sharp decline of rates of 10 percent from 1985 to 1987, steady decline to 2000, and increase of 3 percent from 2001 to 2004. Despite the slight increase at the end of the study period, rates were 20 percent lower in 2004 than in 1985 (Hecker, 2006).

The increase in rates was largely a result of increased traffic that occurred in the late 1990's until the end of Hecker's (2006) study period. After the Staggers Act, railroads cut rates for long term contracts and a guarantee of a source of revenue. The contracts began to expire at the time of the increase in traffic, allowing railroads to increase rates in the face of greater demand for their service. Surcharges also have been utilized to make up for the increase in the cost of fuel in the past two years (Blaszak, 2007).

Decline in National Railroad Employment from 1950 to 2006

Railroad employment in the United States has seen a dramatic decline since 1950. The following table (Figure 3.1) displays the pattern of change that has occurred with in

the railroad industry. The total number of railroad employees in the United States in the year of 1950 was 1,404,555. This number declined rapidly to 671,759 in 1970, a reduction of 52 percent. There was a less pronounced decline during the 1970's to 519,000 in 1980. There was a decline to 260,451 in 1990, another reduction of 50 percent. The trend began to level off and in 2006 there were 198,100 railroad employees, 76 percent of the 1990 total and 14 percent of the 1950 total (Bureau of Economic Analysis, 2007; Ashby and Cartwright, 1975).

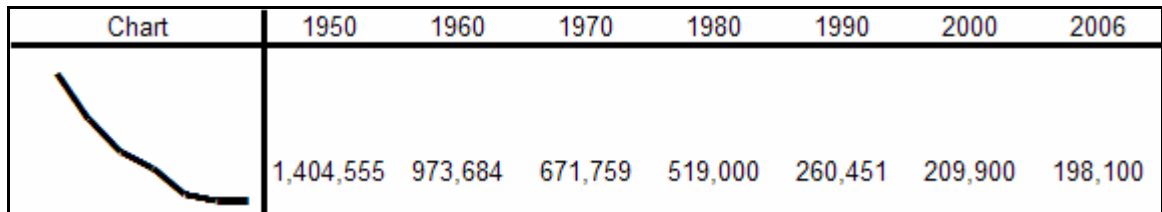


Figure 3.1 United States Railroad Employment: 1950 to 2006 (US Bureau of Economic Analysis, 2007; Ashby and Cartwright, 1975).

The decline in the 1950's was largely the result of the conversion from labor intensive steam locomotives to diesel-electric locomotives that could be maintained with fewer employees (Burns, 1996). The decline in the 1960's was largely the result of the development of continuous welded rail (CWR), centralized traffic control (CTC), radio and microwave communication that reduced the number of employees that were needed to maintain right of ways and direct traffic (Burns, 1996).

This era also saw the decline of the passenger train on the American railroad network and there was an associated reduction in employment. The number of

employees associated freight operations did not decline during the era (Yochum and Rhiel, 1990).

The post 1980 decline was largely the result of the reduction of operating crews. Trains still operated into the 1980's with what was called "full crews" of four or five. A series of concessions was gained by American railroads over crews sizes, including the elimination of the caboose, two man crews on through trains, and pay based on a working day instead of based on mileage (Bitzin and Keeler, 2003, Saunders, 2003; Schwarz-Miller and Talley, 2002).

As the 1990's ended, a new trend began to develop, railroads began to hire in mass and reversed the steady trend of declining employment since 1980. It was about this time that railroads were being swamped with increased traffic and started a new hiring trend (Fischer, 1999). In 2004, the Association of American Railroads expected the railroad industry to hire more than 13,000 workers annually for the next six years, about 80,000 in total and the Railroad Retirement Board was expecting 140,000 new hires through 2014 (Railway Age, 2004).

There are two main reasons for the increase in hiring; the sharply increasing railroad traffic and a worker shortage due to retirements. In 2000, a law was enacted that reduced the full benefits retirement age by two years. As a result, nearly 40 percent of the current railroad workforce will be eligible to retire within the next decade (Railway Age, 2004).

It was during this time that UP went through its 2003-2004 slow down. Decades of non-hiring, reduced employment, military reservist call-ups for Iraq and Afghanistan,

and a greater than expected increase in traffic, largely fed by Asian trade, almost crippled the United States' largest railroad (Blaszak, 2004).

Train & Engine Employment

T&E operating crews can face some of the most difficult working conditions in the United States. Working nights, weekends, and holidays in adverse weather conditions is expected in order to operate trains that run 24 hours a day, 7 days a week. The nature of railroading, with divisions being spread over hundreds miles, means most work is performed without direct supervision (Bureau of Labor Statistics, 2008). Many can work more than a 40-hour workweek with shifts that lasted up to 12 hours, followed by a federally mandated 8 hour rest period (Murray, 2007b). Operating between points hundreds of miles apart, T&E employees may spend consecutive nights away from home (Bureau of Labor Statistics, 2008).

T&E employees are divided into three categories; locomotive engineers, conductors, and brakemen. Locomotive engineers are responsible for the operating the locomotives and must have thorough knowledge of their route and the condition of their train. Locomotive engineers are required to complete a formal engineer training program to obtain a federal license and must periodically pass an operational rules efficiency test to maintain their licensure (Bureau of Labor Statistics, 2008).

A conductor is responsible for coordinating all activities of the freight train and its crew. Conductors assigned to freight trains review schedules, switching orders, waybills, and shipping records to obtain loading and unloading information regarding their cargo

(Bureau of Labor Statistics, 2008). A brakeman assists the conductor with the coupling and uncoupling of cars and operates some switches. Railroads have begun to phase out the brakeman position, and many trains use only an engineer and a conductor (Bureau of Labor Statistics, 2008).

The pay for T&E employees is better than the average pay normally available with minimal education and experience requirements, with an industry average of about \$67,000 in 2005 (Association of American Railroads, 2007b). Locomotive engineers earned an average of \$27.88 per hour, \$26.70 for conductors, and \$23.49 for brakeman, in May 2006 (Bureau of Labor Statistics, 2008). Employees working for a Regional, Local, or Switching & Terminal railroads generally earn less than Class I employees, but usually more than the local average income. They also are less likely to have to spend time away from home for extended periods of time (Saunders, 2003).

T&E employees on all Class I railroads are required to join a union after the initial training period and the establishment of a seniority date. The two main unions for T&E employees are the United Transportation Union (UTU) and the Brotherhood of Locomotive Engineers and Trainmen (BLET) (Bureau of Labor Statistics, 2008).

Work assignments are based on two “if and or” conditions. The first is a T&E employee is either working or furloughed. If the T&E employee is working, then they are either assigned to an extra board or the pool. Seniority determines if the employee is assigned to the pool that has more desirable work assignments or the extra board which is used to fill in crews during periods of increased traffic (Johnson and Harmon, 1994) or an illness or vacation of a pool employee (Bureau of Labor Statistics, 2008).

A more recent development in T&E crew assignment is turnaround service. An outbound crew leaves their home terminal, meets an inbound train at a half way point, exchanges trains, and operates the inbound train back to their home terminal. Turnaround service requires the crew assignment coordination that only schedule train operations can provide (Johnson, 1997).

T&E employees working turnaround service choose a spread, a specific time period, and train they wish to work. The spread is one hour before and two hours after the given time based on when the train arrives. Seniority also determines spread assignments and working consistently at 1:00 AM is more desirable than working at random start times (Johnson, 1997). The need for strict adherence to scheduled operations has limited turnaround service adoption to Canadian National's subsidiaries (National Transportation Safety Board, 2007) and Regional railroad Florida East Coast (Frailey, 2007c).

Remotely Controlled Locomotives

As mentioned before in this section, America's railroads have increased hiring to make up for some of the losses as older employees retire. Another solution may be in the use of remotely controlled locomotives (RCL), mostly older units converted to operate as a RCL. RCLs theoretically allow a single employee with an operator control unit (OCU) to control the locomotive remotely and perform the tasks of both conductor and engineer (Kube and Hemphill, 2003). So far operations have been limited to yards and not allowed for mainline operators (Kube and Hemphill, 2003).

There still remain the issues over the use of RCL's in terms of safety and productivity, with conflicting views between management and the unions. Managers say RCL's increases productivity per employee and are as safe as or safer than having an engineer in the locomotive. Engineers and dispatchers contend the productivity per employee costs efficiency for the whole railroad. They believe at best, a RCL does 60 percent of the work of a traditional two man crew and is only a ploy to reduce employment (Kube and Hemphill, 2003).

RCL's do have the benefit for smaller railroads. Remotely operated locomotives have operated on industrial railroads, such as steel mills, since the 1950's. It is possible for shippers on low density branch lines to continue to receive service via rail (Kube and Hemphill, 2003). RCL still requires employees to operate, but there are plans for unmanned trains. Unmanned trains would require tracks that had no grade crossings and the expense would make high density lines economical for unmanned trains (Kube and Hemphill, 2003).

While unmanned trains may be years away, more imminent is positive train control (PTC). PTC automatically enforces speed restrictions and prevents trains from exceeding authorized limits, using GPS and satellite technology (Hansen, 2001).

Despite the potential showdown with labor, BNSF has been testing a version of PTC called Electronic Train Management System (ETMS) since January 2004 on 134 miles (216 km) of track between Beardstown and Centralia, Illinois. This single-track secondary main line hosts 12 to 15 daily trains, mostly unit coal trains. There is a mix of

signaled and dark territory (no signals), and a simulated helper district to cover all aspects of main line operations (Mitchell IV, 2006).

BNSF's ETMS has been in place since 2004 and other PTC systems include CSX's Communications Based Train Management, in place since 1998 and what ETMS is based on. Norfolk Southern started testing Optimized Train Control in 2005 and regional railroad Alaska Railroad is installing Collision Avoidance System for operation in 2007 (Mitchell IV, 2006). PTC is a potentially a powerful tool to improve safety and is on the National Transportation Safety Board's list of Most Wanted Transportation Safety Improvements (National Transportation Safety Board, 2008).

The American Landbridge

The North American landmass poses a formidable obstacle to ocean transit of containers from East Asia to the eastern United States and Europe. The Panama Canal provides a shorten route than sailing around the tip of South America but is limited by the size of the canal locks. An alternative to the Panama Canal is the American landbridge (Rodrigue et al, 2006; Armstrong, 1998; McKenzie et al, 1989).

The railroad's main contribution to the American landbridge is the reduction in shipping times. Six days to two weeks are saved on container shipments between East Asia and the East Coast of the United States. An all ocean transit between Tokyo, Japan and Rotterdam, Netherlands averages five to six weeks. Utilizing an eighty hour journey via rail reduces transit times to about three weeks (Rodrigue et al, 2006).

Railroads carry the containers across the American landbridge in solid unit trains under contract. Trains move from port to destination with little or no switching of the railcars. The shipping companies pay the railroads for the fronthaul and backhaul of the containers, regardless if they are loaded or empty (Armstrong, 1998; McKenzie et al, 1989).

Landbridge

A landbridge involves a journey via rail across land in between two ocean legs. Rail is used over truck because it is more efficient in the transcontinental journey over land (Rodrigue et al, 2006; Armstrong, 1998; McKenzie et al, 1989). An example of landbridge transit is an ocean transit of containers across the Pacific Ocean from East Asia and unloading them onto a train at the Port of Los Angeles, California. The train crosses the continental United States and the containers are loaded onto a ship at the port of New York/New Jersey to be shipped across the Atlantic Ocean to terminate in Europe (Map 3.1) (Rodrigue et al, 2006; Armstrong, 1998; McKenzie et al, 1989).

Minilandbridge

A minilandbridge involves a journey via rail across land after a single ocean leg and terminates at a port (Rodrigue et al, 2006; Armstrong, 1998; McKenzie et al, 1989). An example of landbridge transit is an ocean transit of containers across the Pacific Ocean from East Asia and unloading them onto a train at the Port of Los Angeles, California. The train crosses the continental United States and the containers terminate at

the Port of New York/New Jersey. Shippers still save time and money by sending the containers by rail to an east coast port instead of an all water transit via the Panama Canal (Map 3.2) (Rodrigue et al, 2006; Armstrong, 1998; McKenzie et al, 1989).

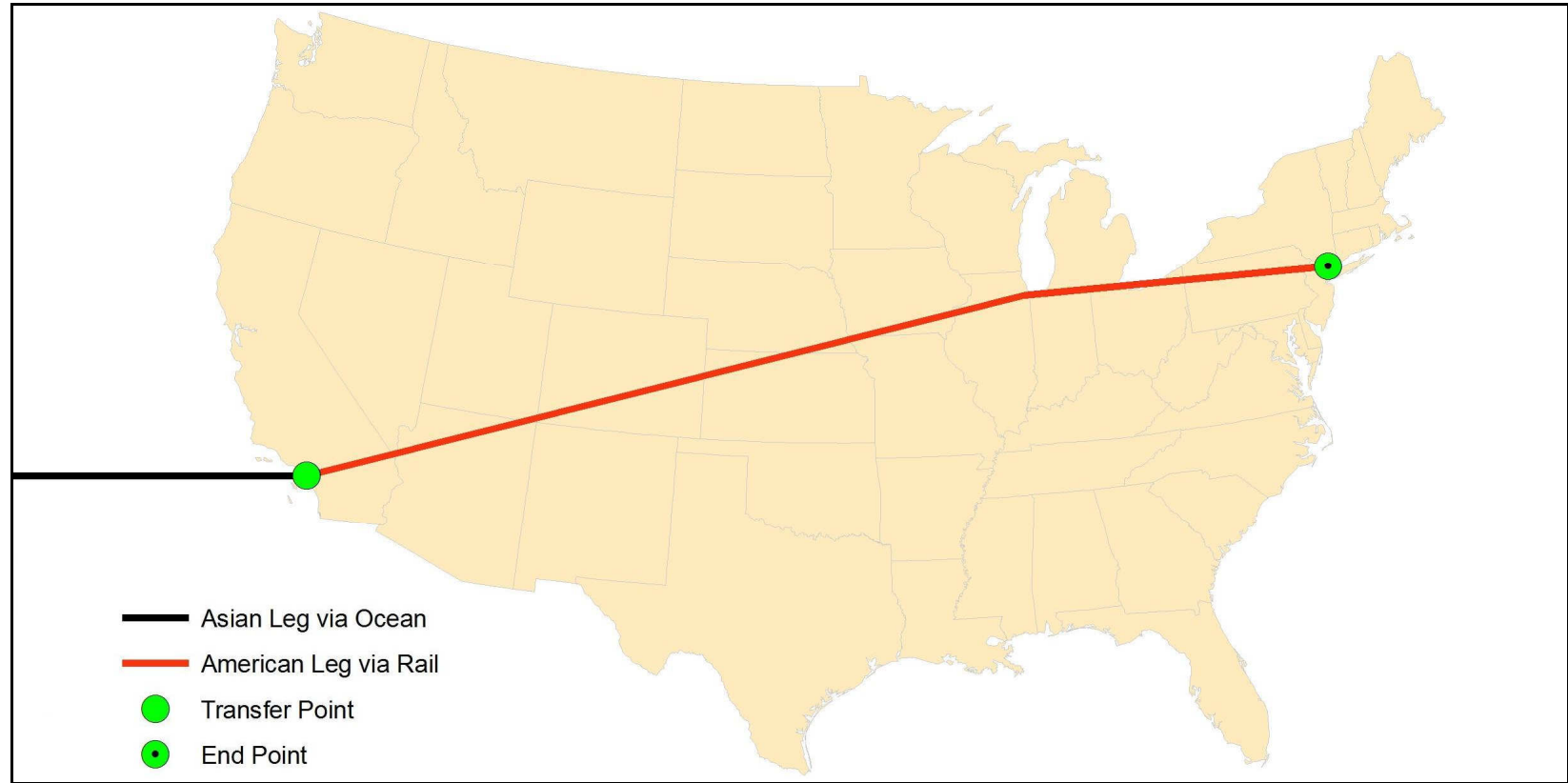
Microlandbridge

A microlandbridge involves a journey via rail across land after a single ocean leg to an inland termination point (Rodrigue et al, 2006, Armstrong, 1998; McKenzie et al, 1989). An example of landbridge transit is an ocean transit of containers across the Pacific Ocean from East Asia and unloading them onto a train at the Port of Los Angeles, California. The train travels inland and the containers terminate at an inland point such as Chicago, Illinois (Map 3.3) (Rodrigue et al, 2006; Armstrong, 1998; McKenzie et al, 1989).

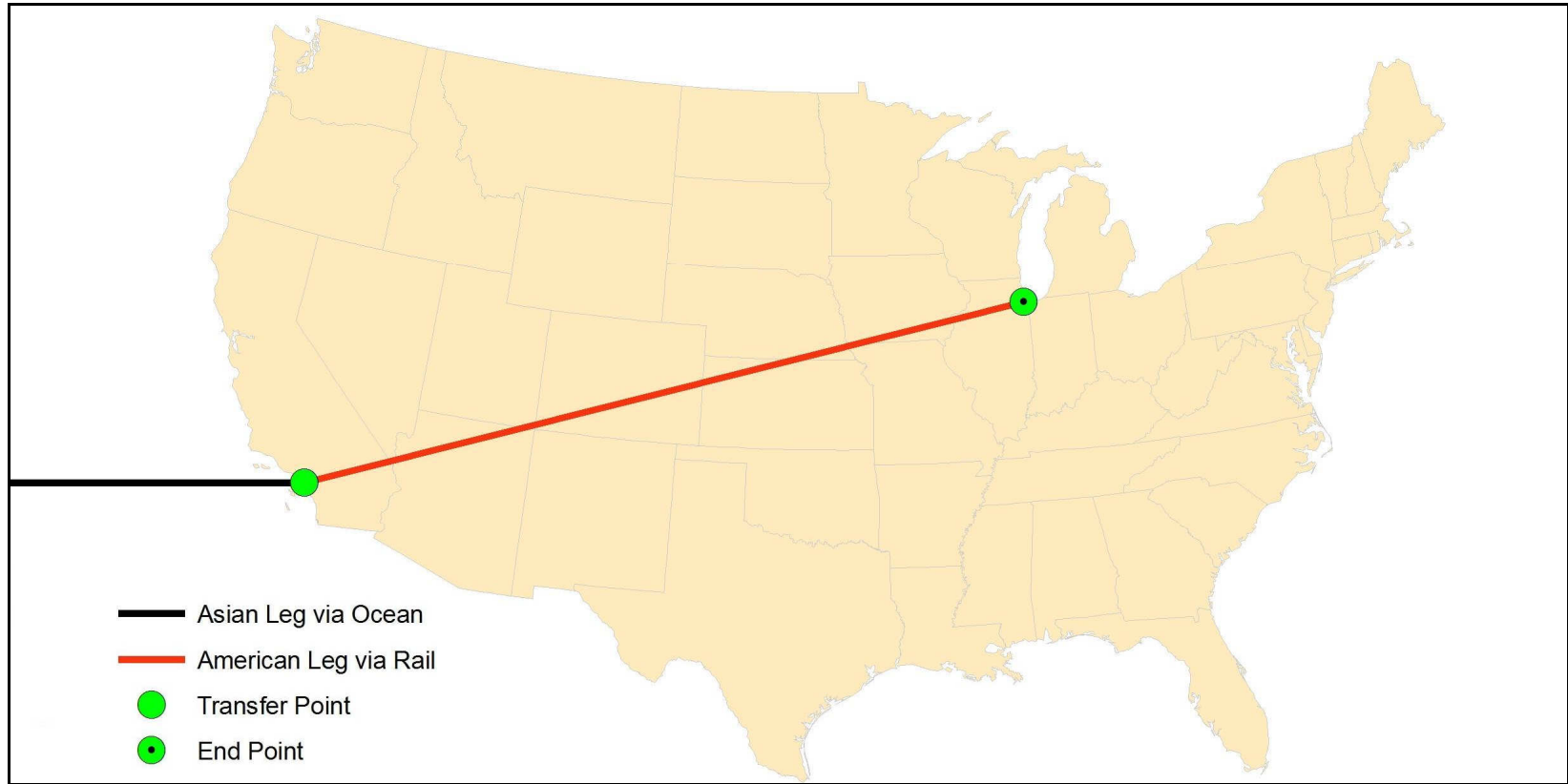
The mini- and microlandbridges were not fully exploited until a deregulation of collaboration between steamship and railroad companies (Rodrigue et al, 2006). In March of 1981, the ICC removed all economic regulations on intermodal transportation with its *Ex Parte* 230 (Strawbridge, 1994; Mahoney, 1985). The Shipping Act of 1984 deregulated pricing between different modes of transportation, allowing for a single rate for all legs of transportation and simplifying operations for shippers (Mahoney, 1985).



Map 3.1 Asia to Europe Landbridge (McKenzie et al, 1989).



Map 3.2 Asia to East Coast Minilandbridge (McKenzie et al, 1989).



Map 3.3 Asia to a Non-port Terminal Microlandbridge (McKenzie et al, 1989).

The Twin Ports of Long Beach and Los Angeles, California

The twin Ports of Los Angeles and Long Beach, California have become the main source of containers flowing into the United States (Smith-Peterson, 2006). These two ports have benefited from the influx of container traffic from East Asia and in turn benefited the American railroads that lie on the routes that extend across country the continent (Smith-Peterson, 2006).

The Port of Los Angeles is the busiest port in the United States and is the tenth busiest container cargo port in the world. The Port of Long Beach is the second busiest port in the United States and is the twelfth busiest container cargo port in the world. Combined, the Ports of Long Beach and Los Angeles would be the fifth busiest container port in the world behind the ports of Singapore and Hong Kong, Shanghai, and Shenzhen, China (Port of Los Angeles, 2007a; Port of Long Beach, 2007a).

Both ports gained their status from the wave of Asian imports, especially as the container ships that were too large to fit through the Panama Canal, referred to as post-panamax ships. This necessitated the use of America's railroads as a land-bridge (Armstrong, 1998; McKenzie et al, 1989).

Cramer (2007) identified three key geographic features that further enhance the twin Ports of Los Angeles and Long Beach. First, both ports are well sheltered and have a moderate year-round climate. Second, there already is a large contiguous metropolitan market for some of the imports. Finally, BNSF and Union Pacific do not face the topographic barriers east of Los Angeles as compared with the Sierra Nevada of Northern

California and Cascade Mountains of the Pacific Northwest. Passes through the latter two can experience heavy winter snowfalls (Cramer, 2007).

Another factor for the ports success identified by Smith-Peterson (2006) is both the ports of Long Beach and Los Angeles compete with each other and other ports on the west coast for the container business. Facilities are continuously upgraded or new terminals are built to better attract steamship companies. Rail access is giving special attention in the ports ongoing competition to facilitate smoother transfer operations (Smith-Peterson, 2006).

The growth of trade with Asia, especially China, was one of the biggest pushes for the growth of intermodal traffic in the United States. In 1985, the United States imported \$3.8 billion worth of goods from China and by 2005 that figure had increased to \$243 billion. Between 2000 and 2005, the number of containers arriving in the United States from China grew by 101 percent (Smith-Peterson, 2006). China is now ranked third, behind Canada and Mexico, as the United States' largest trading partners (Smith-Peterson, 2006). The ports on the Pacific Coast dominate container traffic from Asia, with the combined twin ports of Los Angeles and Long Beach being the largest in terms of TEU traffic and outnumbering the next six American ports (Association of American Port Authorities, 2007). About half of containers handled by the ports of Long Beach and Los Angeles are transported via rail (Smith-Peterson, 2006).

In 1997 the Ports of Long Beach, Los Angeles, and CTEU were 14.2, 12.1, and 26.3 percent of the national TEU total respectively. By 2006, Ports of Long Beach, Los Angeles, and CTEU were 16.4, 19.1, and 35.5 percent of the national TEU total

respectively (Association of American Port Authorities, 2007). During this period the Port of Los Angeles also surpassed the Port of Long Beach in terms of TEU traffic (Association of American Port Authorities, 2007).

Intermodal Container Transfer Facility

The Intermodal Container Transfer Facility (ICTF) (Map 3.4) was an early infrastructural boost to international intermodal traffic. The ICTF was constructed in 1986 about 5 miles (8km) from the ports of Los Angeles and Long Beach, California. Santa Fe, now apart of BNSF, and UP declined to participate in the construction of the ICTF, leaving Southern Pacific as the sole operator (Fraily, 1993). This was a costly move for BNSF as UP inherited the ICTF after merging with SP in 1996.

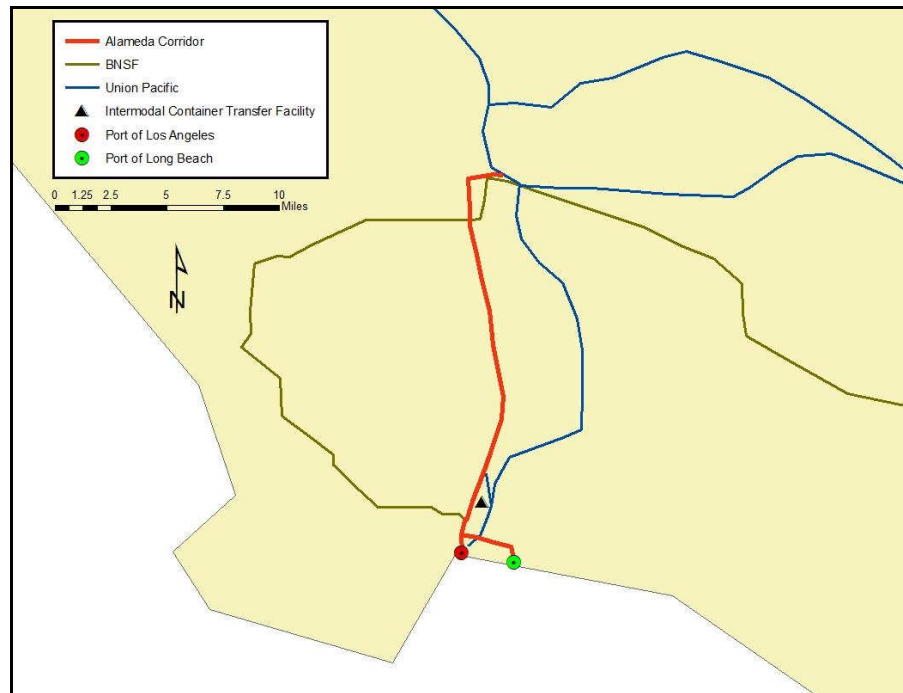
The advantage of ICTF is that it is only about a ten minute drive from the ports to the facility instead of the 20 miles (32km) on the Interstate 710 to UP's East Los Angeles Yard or BNSF's Hobart Yard. A truck driver can deliver six containers in an eight hour shift to the ICTF as compared to only two to the more distant yards. By 1993, SP was averaging 36 double-stack trains a week out of Los Angeles, California to Santa Fe's 17 and UP's 10 (Fraily, 1993). The ICTF help SP increase both intermodal carloadings and intermodal revenues in the years following its opening (Fraily, 1993) and continues to be a critical part of UP's intermodal network.

In 2005, it was the UP's busiest intermodal yard, handling up to 70 inbound and 70 outbound trains a week (Smith-Peterson, 2006). The ports account for 95 percent of ICTF's volume, mostly from port locations that lack direct rail access (Smith-Peterson,

2006). Union Pacific plans to expand capacity by 2010; by stacking containers higher, adding loadout tracks, and new electric cranes replacing older diesel-powered ones (Fraily, 2007d).

The Alameda Corridor

One of the most important events in the growth of intermodal traffic is the completion of the Alameda Corridor (Map 3.4). In April of 1993, the ports of Long Beach and Los Angeles, California agreed to buy 20 miles (32 km) of SP's right-of-way. The \$275 million purchase was for the construction of an improved rail line to run through Los Angeles and would be needed for the completion of the corridor project. SP, Santa Fe, and UP all had their own lines to the ports and once construction was completed, all were to be given equal access to the Alameda Corridor (Railway Age, 1993).



Map 3.4 The Alameda Corridor, Los Angeles, California (Union Pacific Corporation, 2006).

The main purpose of the Alameda Corridor is to expedite container traffic from the Ports of Long Beach and Los Angeles without increasing congestion on the highway system and city streets. The various rail lines were consolidated onto a single line and once complete, transit times for trains declined from two hours to 45 minutes. The project also separated the right-of-way from the road network by eliminating 209 grade crossings (Lustig, 2002).

The Alameda Corridor opened in April of 2002 at a cost of \$2.4 billion, one of the most expensive public works projects in American history (Lustig, 2002). The Mid-Corridor Trench portion is a 10 mile (16km) long triple-track, 40 mph (64 kph) right-of-way, 33 feet (10m) below the busy streets above which greatly increased the flow of

trains from the ports. By 2006, there was an average of 51 trains, 7,791 containers, passing through the Alameda Corridor daily (Murray, 2006). This corridor has become the main outlet of BNSF and UP's container traffic from Southern California to the Midwest, Northeast, and Southeast (Murray, 2006).

The success of the Alameda Corridor and an expected increase in container traffic has led to the development of the Alameda Corridor East Project. The increasing number of trains is expected to cause congestion problems in the communities that lie outside the Alameda Corridor. In all, \$910 million, \$125 million in federal funding, will be used to extend the Alameda Corridor 35 miles (56km) east through the San Gabriel Valley from East Los Angeles to Pomona, California. The project will build twenty grade separations, closing 2 grade crossings, and improving safety at 42 others (Giblin, 2005).

CHAPTER IV

DATA AND METHODOLOGY

This chapter provides a description of the data and methods used to conduct this study. This study is divided into two parts, a historical analysis and a statistical analysis. The historical analysis investigates the development of railroad intermodal transportation by studying the available literature. The statistical analysis uses the Spearman Rank-order Correlation Coefficient to measure the available non-parametric data on an ordinal scale to address the second objective of this study; to analyze the relationship between TEU traffic and railroad employment in the United States. The statistical analysis will also be used to answer the four hypotheses of this study:

- 1 That BNSF will have the most positive significant correlations between its monthly T&E and monthly CTEU.
- 2 That BNSF will have the fewest inverse significant correlations between its monthly T&E and monthly CTEU.
- 3 That Union Pacific will have the second most positive significant correlations between its monthly T&E and monthly CTEU.
- 4 That Union Pacific will have the second fewest inverse significant correlations between its monthly T&E and monthly CTEU.

Historical Analysis

Data for the addressing of the historical analysis of this study came largely from the periodicals *Railway Age* and *Trains*. *Railway Age* is the main trade magazine for the North American rail industry and *Trains* is a rail enthusiast magazine that focuses on the North American rail industry. Both have editorial staff and reporters with long histories of rail industry experience and produce articles, interviews, opinion, and editorial pieces that can be considered well informed and accurate. These sources were supplemented with various other books, periodical articles, and company annual reports that were relevant to this study.

The historical analysis is divided into two parts. The first part studies the development of railroad intermodal transportation and the second part investigates several selected examples of modern intermodal routes; Santa Fe/BNSF's Transcon, Union Pacific's Sunset Corridor and Texas & Pacific Route, Kansas City Southern's Meridian Speedway, and the Florida East Coast.

Examples of Current Intermodal Routes

Four examples of current intermodal routes were investigated to give a geographical context to the historical analysis. First is BNSF's Transcon which is the main route of containers from the Ports of Long Beach and Los Angeles, California and Chicago, Illinois and the northeastern United States (Frailey, 2007b). Union Pacific's Sunset Corridor and Texas & Pacific Route was selected since both combined are a vital link between Ports of Long Beach and Los Angeles, California and the Southeast

(Frailey, 2007d). Kansas City Southern's Meridian Speedway is an example of a major transformation of a route to increase intermodal traffic (Frailey, 2007d). Finally, Florida East Coast was selected because it is an example of a Regional (Class II) railroad that is highly dependent on intermodal traffic (Frailey, 2007c).

Statistical Analysis

According to Thorne and Giesen (2000), the definition of correlation is the degree of a relationship between two or more variables. One method of determining correlation is the Spearman Rank-order Correlation Coefficient, r_s , which applies to variables on an ordinal scale. The data can be ranked from the onset of the study or values reduced to ranks by a researcher.

The formula for obtaining r_s is as follows;

$$r_s = 1 - \frac{6(\sum d^2)}{N(N^2 - 1)}$$

where d is the difference between the ranks of the two variables and N is the number of pairs of observations.

After r_s is determined, it is tested for significance based on the sample size (N), if the absolute value is greater than the critical value, then the null hypothesis is rejected and it can be determined that there is a relationship between the variables being studied. The level of significance was determined by comparing the observed r_s with a published table of various levels of significance (Thorne and Giesen, 2000).

For example, for a sample size 12 the critical value of r_s at 0.05 percent level of significance is 0.591. If the absolute value of observed r_s is above 0.591, then there is of 95 percent confidence that the correlation has not occurred by chance. If the absolute value of observed r_s is below 0.591, then it is possible the correlation is a product of chance and the hypothesis is rejected (Thorne and Giesen, 2000) (See Appendix C for null hypotheses test results).

There are three types of correlation, positive, negative, and zero. Positive correlation (direct) indicates as values of independent variables increase or decrease, the values of the dependent variables follow suit. Negative correlation (inverse) indicates as values of independent variables increase or decrease, the values of the dependent variables does the opposite. Zero correlation indicates there is no correlation between the independent and dependent variables. The direction of correlation is based on a scale of +1 to -1, the further away from 0, the stronger the correlation (Thorne and Giesen, 2000).

It should be noted that correlation does not mean causation, only that there is an apparent relationship (Thorne and Giesen, 2000). All calculations were done by hand with the aid of a Texas Instruments TI81 calculator.

Results of the null hypothesis were used to create two tables, one indicating positive and inverse significant correlations by year. This table was used to address the second objective; to investigate temporally any significant correlations between monthly T&E and monthly CTEU among the Class I railroads 1997 through 2006. The other table indicates positive and inverse significant correlations by railroad to address the four hypotheses of this study.

Data and Variables

Data for the employment variables were obtained from the Surface Transportation Board's monthly *Report of Railroad Employment – Class I Line-Haul Railroads* available from the Surface Transportation Board's website, www.stb.gov. Data from line L600 Transportation (train and engine (T&E)) was entered into a Microsoft Excel Spreadsheet, separated by the given month and railroad. Each month was then ranked, highest number of T&E employees was ranked first and then preceded downward. T&E employment was chosen since the researcher reasons that the people who operate the trains would be most affected by any changes in TEU traffic.

There are ten dependent variables separated by each of the American Class I railroads being studied, BNSF (BNSF), Canadian National/Illinois Central (CNIC), Conrail (CR), CSX (CSX), Grand Trunk Western (GTW), Illinois Central (IC), Kansas City Southern (KCS), Norfolk Southern (NS), SOO Line (SOO), and Union Pacific (UP).

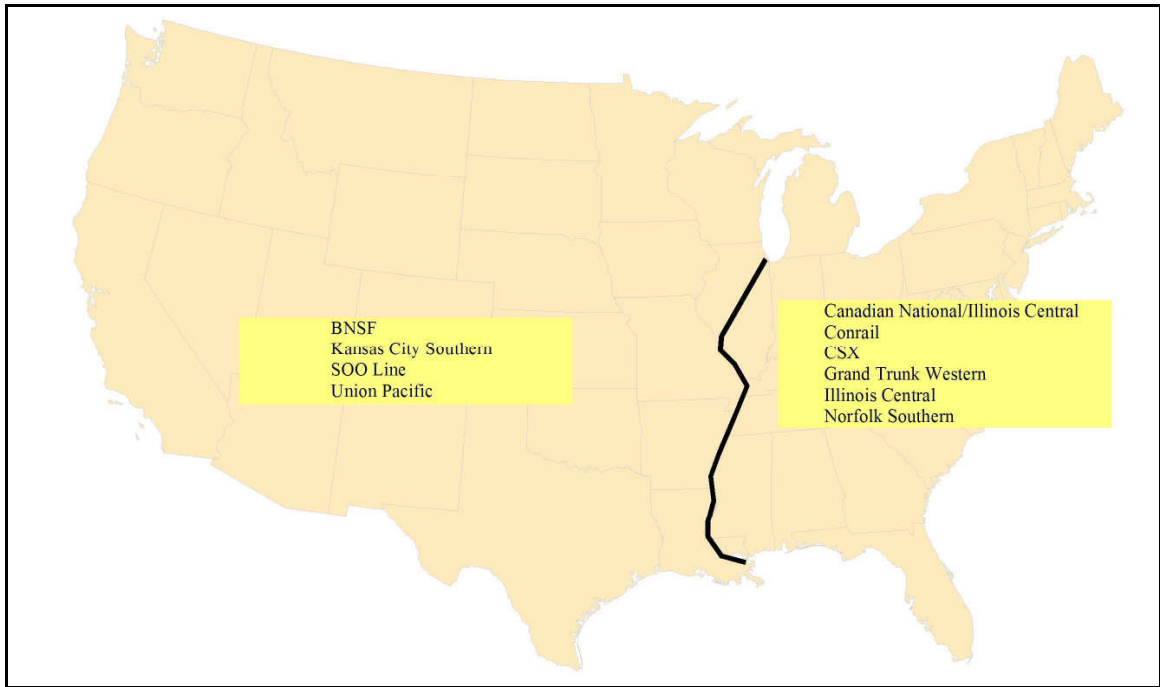
Data for the TEU variables were obtained from the Port of Long Beach's *TEUs Year to Date* and *TEUs Archive Since 1995*, available from the Port of Long Beach's website www.polb.com, and the Port of Los Angeles' *Annual Statistics*, available from the Port of Los Angeles' website www.portoflosangeles.org. The monthly TEU totals were entered into a Microsoft Excel Spreadsheet, and totals from the two ports were combined. Each month was then ranked, highest number of combined TEU (CTEU) data was ranked first and then preceded downward.

The lone independent variable made up of the combined TEU totals from the Ports of Long Beach and Los Angeles (CTEU)

Study Area

The study area (Map 4.1) is based on the regional nature of America's railroads. Six out of the ten Class I railroads being studied had the bulk of their trackage predominately in the eastern United States; Canadian National/Illinois Central, Conrail, CSX, Grand Trunk Western, Illinois Central, and Norfolk Southern. CSX and NS are the two giant railroads that dominate the eastern United States (Map A.4; A.8), Conrail was located in the Midwest to the Northeast (Map A.3), Grand Trunk Western was located in the Midwest (Map A.5), and Canadian National/Illinois Central and Illinois Central straddles the east-west dividing line (Map A.2; A.6).

Four out of the ten Class I railroads being studied had the bulk of their trackage predominately in the western United States; BNSF, Kansas City Southern, SOO Line, and Union Pacific. BNSF and Union Pacific are the two giant railroads that dominate the western United States (Map A.1; A.10), Kansas City Southern is located mostly in the Southwest to the Mid South (Map A.7), and SOO Line is located in the Upper Mississippi Valley (Map A.9). SOO Line does have trackage in the Northeast, but is considered a western railroad for this study.



Map 4.1 Study Area.

Study Period

The variables are divided into 10 yearly groups of 12, by month, from January 1997 to December 2006. Each variable is labeled _1997, _1998, etc. to differentiate by each yearly group. The beginning of the study period starts the first month that monthly employment data are available from the Surface Transportation Board in 1997 and ends with the most recent year with complete monthly employment data available, 2006.

BNSF, Kansas City Southern, SOO Line, and Union Pacific are presence for the full 10 years of this study (1997 to 2006). Conrail is included in this study for the first two years (1997 and 1998) and was split and merged into CSX and Norfolk Southern in June 1999 (Murray, 2005). Illinois Central and Grand Trunk Western are included in the

first five years of this study (1997 to 2001) before Illinois Central was merged into Grand Trunk Western after Canadian National consolidated its American subsidiaries in July 2002 (Association of American Railroads, 2007f). This railroad is referred to as Canadian National/Illinois Central in this study and is included for the remaining of the study period (2003 to 2006). CSX and Norfolk Southern are included in this study for the years 1997 to 1998 and again from 2000 to 2006. Variables that have been involved in a merger or consolidation in given year were passed over to avoid skewing of ranks.

The two key periods within the study period are the first increase of railroad employment in the late 1990's (Fischer, 1999) and again in late 2003 and early 2004 (Blaszak, 2004).

Preparation of Maps

All maps within this study have been prepared by the researcher using the ESRI ArcGIS software package version 9.2. Railroad shapefile datasets available from the US Bureau of Transportation Statistics' *National Transportation Atlas Databases 2006 Shapefile Format CDROMs* were used to create maps of current railroads. Data attributes for line ownership and trackage rights were selected to create the maps for; BNSF, Canadian National/Illinois Central, CSX, Kansas City Southern, Norfolk Southern, SOO Line, and Union Pacific. Data from published articles, books, and periodicals was used to digitize maps for Conrail, Grand Trunk Western, Illinois Central, the intermodal routes maps, and the landbridge maps. Annotation was applied sparingly to avoid detracting from the display of rail network attributes.

Limitations

One of the main limitations of the data used for this study is that the railroads have merged in the last five decades and change from being located within a region of the United States to massive systems that can cover large segments of the country. This resulted in the inclusion of employees that would not normally be affected by intermodal traffic from the Ports of Long Beach and Los Angeles, California in this study. Also, only Class I railroads can be investigated statistically since the governmental requirements for reporting employment data does not apply to railroads that fall below the Class I threshold.

CHAPTER V

HISTORICAL ANALYSIS

This chapter discusses the research into the first objective of this study; to analyze the development of railroad intermodal transportation in the United States. The second objective is discussed as statistical results in the next chapter.

The Development of Railroad Intermodal Transportation

This section covers the first objective of this study: to investigate the development of railroad intermodal transportation in the United States. The first topic defines intermodalism and containerization as well as a background into early developments for both.

Intermodalism and Containerization

Intermodal is defined as the transfer of products involving multiple modes of transportation; truck, railroad, or ocean carrier (Intermodal Association of North America, 2008a). In the context of railroad intermodal transportation it is carrying of highway trailers (trailer on flatcar, TOFC) or shipping containers (container on flatcar, COFC). Early intermodal operations relied heavily on TOFC, but greater efficiency and

flexibility has made COFC after the development of doublestacking of containers is currently more prominent (Giblin, 2007; Rodrigue et al, 2006).

Modern containerization can be traced back to Malcolm P. McLean who converted an ocean going tanker to carry trailers. He hoped to smooth the process of transloading of cargo from truck to ship by longshoremen. The *Ideal-X* made its maiden voyage on April 26, 1956 and would be the first ship in what would become Sea-Land Services. Matson Navigation Co. began its own service in the Pacific in 1958 and by 1966 Sea-Land started the first trans-Atlantic service to Germany, Britain, and the Netherlands (McKenzie et al, 1989).

Containerization's worldwide commercial revolution began as result of the Organisation Internationale de Normalisation (International Standards Organization, or ISO) establishing a standard classification system in 1973. The first containers were 20 feet (6 meters) long and referred to as Twenty-foot Equivalent Unit (TEU). 40 foot (12 meters) containers also began to appear at this time and are referred to as Two Twenty-foot Equivalent Unit (2TEU). 2TEUs (sometimes referred to as FEU, Forty-foot Equivalent Unit) are more popular because of their greater volume while a TEU are used to carry smaller but heavier cargos such as sheets of steel (McKenzie et al, 1989). Forty-five foot containers have also become more common (Armstrong, 1998).

Railroads generally divided intermodal up into two categories; international, domestic. International intermodal is feed by container import traffic from steamship companies. Domestic intermodal usually consists of a mix of highway trailers and

containers within the United States (BNSF, 2006). Domestic containers match the size of highway trailers to better compete with trucking companies (McKenzie et al, 1989).

Beginnings of Railroad Intermodal Transportation

The 1950's saw the steady erosion of the railroad's less than carload traffic by the trucking industry. The main reason was the greater speed trucks had over the railroads. Speed of service from door to door is the most important reason for the selection of a carrier. Speed of service had three parts; (i) transit time between terminals, (ii) time spent in terminals, and (iii) pick-up and delivery time (Taff, 1986). Railroads had the greater advantage in the transit time between terminals aspect, referred to as line-haul, but the trucking industry excelled at the other two (Giblin, 2007).

Another disadvantage the railroads faced was their own drive for productivity. The recent dieselization of the industry allowed the running of longer trains with the same amount or less labor. The downside was railcars spent more time in the yards, time in terminals, waiting to be assembled into longer trains. This resulted in fewer and fewer trains operating between terminals and negating the railroad's line-haul advantage over the trucking industry (Giblin, 2007).

The Doublestack Revolution

While experiments with containers and trailers go back to the earliest days of the railroad, it was not until the mid 1950's that highway trailers and containers started to be carried on railroad flatcars in sizable amounts. A major problem with placing a single

trailer on a single flatcar was the tare weight per car, the weight of a container without a load, made the operation inefficient. In the late 1950's a 85 foot (25m) flat car was developed to carry two 40 foot (12m) trailers on a single car, thus reducing the tare weight (Saunders, 2001).

These new cars would be expensive and railroads did not, or just did not want to, have the money to purchase the individual cars. To meet this challenge, the Pennsylvania Railroad and Norfolk & Western Railway (N&W) joined together to form TrailerTrain (TTX) to pool resources in 1955 and by 1960 twenty other railroads had joined in as well (Saunders, 2001). As highway trains grew in length to 45 feet (13m) and then 48 feet (14m), an 89 foot (27m) flatcar was introduced (Armstrong, 1998).

Despite these improvements, trailers could never be a replacement for the boxcar and the pursuit of intermodal as loose-loads, a single rail car not part of any unit train movement, was counter productive. Railroad intermodal traffic grew by 40 percent between 1969 and 1977, but never climbed above 1 percent of the national intercity tonnage (Mahoney, 1985). Mahoney (1985) identified the three main causes for this: (i) the federal regulatory structure would not allow for the flexibility of intermodal transportation; (ii) the railroads did not aggressively market intermodal because they did not want to work with truckers and the service was seen as marginally profitable; (iii) shippers thought the service complicated by lack of coordination between railroads and truckers.

A major change occurred in the early 1980's with the introduction of doublestack wellcars that carried two containers each (Figure 5.1). Southern Pacific (SP) was the first

to operate such cars in 1981, however they had not fully realize it's potential. It was not until American Presidents Lines (APL) in 1984 contracted the Union Pacific and Chicago & Northwestern to haul unit container trains from the Port of Los Angeles to Chicago, Illinois was the value of doublestacking containers was realized (McKenzie et al, 1989).



Figure 5.1 Doublestack container wellcar at Myrtle, Mississippi. Photo Credit: James A. Burt.

There are three important features of the newer rail cars that would make doublestacking a viable means of intermodal transportation. First was the stacking of two containers on a single car and thus allowing for greater loads to be carried per train, up to 250 containers. Second, the removal of bulkheads located at the end of the intermodal rail cars permitted the use of larger containers. This action allowed for domestic containers to become larger and match the sizes of conventional highway trailers. Both

reduced the tare weight and made rail movements of containers more economical (Strawbridge, 1994; McKenzie et al, 1989; Overbey, 1986). Finally, the introduction of articulated cars where multiple cars are linked together with either a drawbar or share wheel sets (Figure 5.2), reducing slack action associated with couplers which could damage cargo (Strawbridge, 1994; McKenzie et al, 1989; Overbey, 1986).



Figure 5.2 Shared wheel sets of a multi-unit wellcars in Tupelo, Mississippi. Photo credit: James A. Burt.

During the mid 1980's there was a shift from trailers being the primary source of intermodal traffic to containers, international and domestic (Figure 5.3), after it was determined double-stacking containers was more economical than trailers (Strawbridge, 1994; McKenzie et al, 1989; Overbey, 1986).

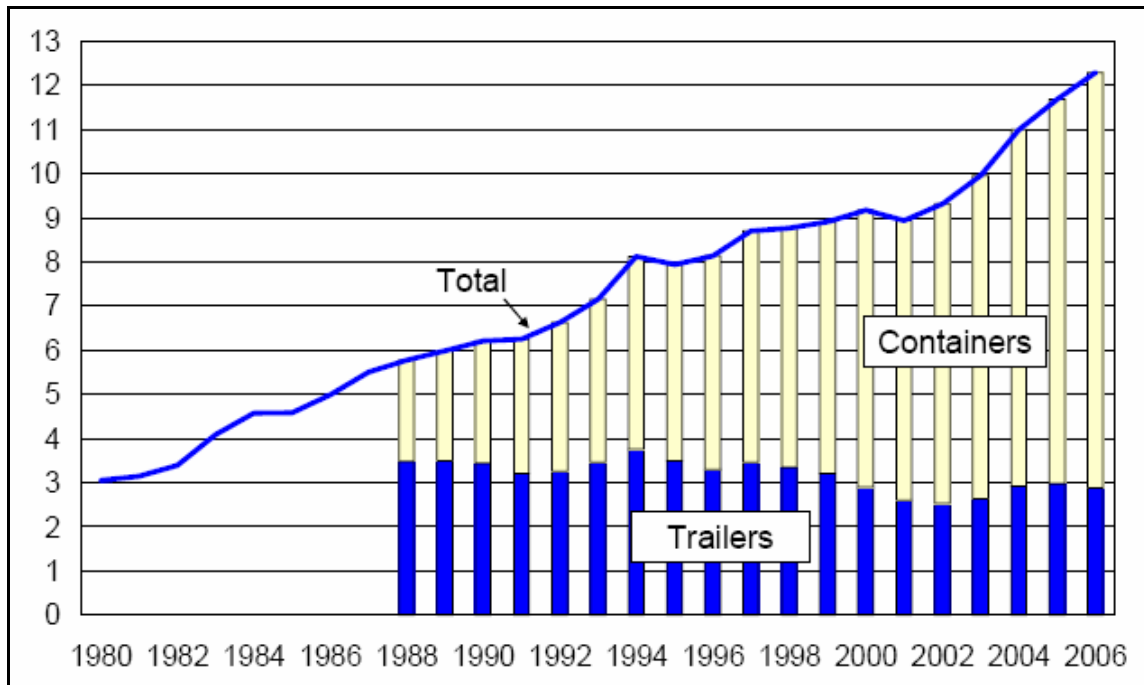


Figure 5.3 United States Rail Intermodal Traffic: 1980-2006 (Millions of Units) (Association of American Railroads, 2007b).

The new wellcars became the industry standard in the late 1980's and into the 1990's was doublestacking boomed. The older 89 foot (27m) flatcars were further made redundant with the expansion of highway trailers to 53 feet (16m). The flatcars have not reached the end of their useful life spans and were converted to autoracks (Armstrong, 1998).

Doublestacking along with the deregulation of intermodal operations between different modes of transportation has led to the rationalization of the intermodal facilities and networks in Canada and the United States. Railroads began to develop hub and spoke networks for intermodal operations, allowing trucking companies bring trailers and containers to the terminal (Mahoney, 1985).

Slack (1990) revealed that Canadian National had reduced its intermodal terminals from 80 to 6, Santa Fe 100 to 28, and Burlington Northern 140 to 22 during the 1980's. At the beginning of the 1970's there were about 2,500 intermodal terminals in the United States, down to 1,176 in 1978 and further reduced to 176 in 1986. The terminals themselves began to be spaced further apart from each other, usually at least 1,000 km (Slake, 1990). The rule of thumb is there has to be at least a 500 mile (804km) haul via rail in order for it profitable (Armstrong, 1998) and between 700 (1,126km) and 2,000 (3,218km) miles being ideal (Frailey, 2007c).

The older ramps were time consuming and cost railroads in their advantage of moving bulk loads over greater distances. The lifting of trailers and containers via a gantry crane greatly decreased loading times; however, the expense of the equipment required the concentration of intermodal terminals (Strawbridge, 1994; McKenzie et al, 1989; Overbey, 1986).

Santa Fe's Intermodal Marketing Revolution

The first major railroad to really attempt to compete and truly make intermodal traffic profitable was the Santa Fe. In 1989 Santa Fe established a dedicated Intermodal Business Unit that consolidated marketing, pricing, train operations, terminal, and equipment of intermodal services (Giblen, 1998). This allowed managers to obtain a clearer view of intermodal operations as functions once assigned to many departments were now assigned into single department. Santa Fe also began to place an emphasis on yield over volume (Giblen, 1998).

Santa Fe divided intermodal up into three categories; international, premium, and intermodal marketing companies (IMC). Premium generated more revenue than IMC, but IMC produced far more volume. When it was determined that 20 percent of IMC's produced 80 percent of intermodal traffic, contracts were renewed only after volume and revenue requirements were increased, reducing the number of shippers from 260 to 55 (Giblen, 1998).

Capacity was increased by discontinuing intermodal service to areas Santa Fe was not competitive and focus on it's Chicago, Illinois to Los Angeles, California Transcon route (short for Transcontinental) and revenues were increased when it was determined that shippers would pay premium price for premium service (Giblen, 1998). Shippers were encouraged to use more efficient containers over trailers and Santa Fe furthered increased capacity by forming an alliance America's largest trucking company J.B. Hunt in 1989. Santa Fe would provide the long haul for J.B. Hunt in dedicated trains and J.B. Hunt would make the deliveries and pickups (Giblen, 1998).

A review of the current Class I railroad's annual reports indicate that they have adopted some variation of Santa Fe's intermodal methods; dedicated intermodal units, doublestacking, and alliances with trucking companies and even other railroads (BNSF Railway, 2006; Canadian National Railways, 2006; Canadian Pacific Railway, 2006; CSX Corporation, 2006; Kansas City Southern Industries, 2006; Norfolk Southern Corporation, 2006; Union Pacific Corporation, 2006a).

Summary

Railroad intermodal transportation had its beginnings in the 1950's as a means to compete with the emerging trucking industry by simply placing highway trailers on railroad flatcars, referred to as TOFC (Giblin, 2007; Rodrigue et al, 2006).

Containerization soon followed, referred to as COFC, and had similar limitations as the highway trailers, a high tare weight (McKenzie et al, 1989). This changed as doublestacking of containers and other technological improvements took hold in the 1980's (Strawbridge, 1994; McKenzie et al, 1989; Overbey, 1986).

Deregulation of intermodal transportation and the added expense for the equipment needed for intermodal transportation had the affect of reducing the need for a large number of intermodal terminals (Strawbridge, 1994; McKenzie et al, 1989; Overbey, 1986). Trucking companies began to form partnerships with the railroads running the long haul on dedicated trains (Giblen, 1998). These trailers are currently being replaced with containers to take greater advantage of doublestacking's efficiency (Railway Age, 2007).

Containerization has also led to introduction of the American landbridge as means of saving transit time by bypassing the Panama Canal (Rodrigue et al, 2006; Armstrong, 1998; McKenzie et al, 1989), with the twin Ports of Los Angeles and Long Beach serving as the western anchor of the American landbridge (Smith-Peterson, 2006). The ports gained their position as the top in terms of TEU traffic because a mix of geographic location (Cramer, 2007), improved port facilities (Smith-Peterson, 2006), and

improvements to the rail lines from the Ports of Long Beach and Los Angeles, most prominent being the Alameda Corridor (Murray, 2006).

Santa Fe's intermodal marketing revolution which emphasized yield over volume, partnering with trucking companies, and doublestacking help make intermodal a profitable venture (Giblen, 1998) Most of the methods developed by Santa Fe have been adopted by the other Class I railroads (BNSF Railway, 2007; Canadian National Railways, 2007; Canadian Pacific Railway, 2007; CSX Corporation, 2007; Kansas City Southern Industries, 2007; Norfolk Southern Corporation, 2007; Union Pacific Corporation, 2007).

Examples of Current Intermodal Routes

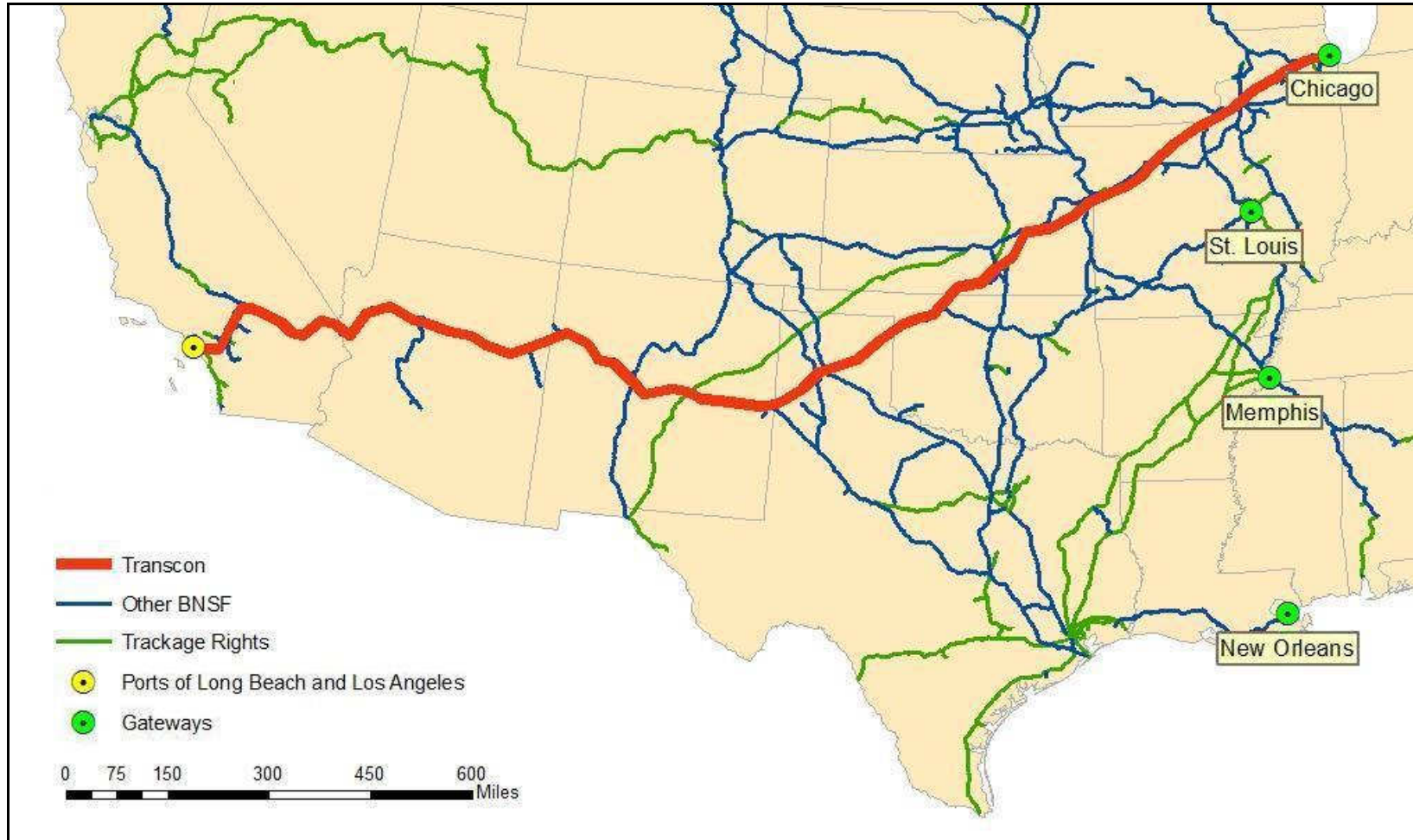
The following section contains several examples of intermodal routes. First is an analysis BNSF's Transcon, followed by an investigation of Union Pacific's Sunset Corridor and Texas & Pacific Route. The final two examples presented are Kansas City Southern's Meridian Speedway and Regional (Class II) railroad Florida East Coast.

BNSF's Transcon

BNSF's Transcon (Map 5.1) is a result of Santa Fe's intermodal marketing revolution in the early 1990's, (Santa Fe and Burlington Northern merged in 1995 to form BNSF) and has undergone a major expansion project. Almost \$1 billion invested since 1994, to meet the capacity demands on the 2,200 mile (3,540km) route (Frailey, 2007b). Double-tracking, adding more crossovers and installing centralized traffic control

(CTC) allows for the transit of up to 85 trains on peak days (Judge, 2003) and occasionally 100 plus (Frailey, 2007b).

The increased capacity on the Trascon has been mostly completed and nearing BNSF's goal of 100 percent double-track, 100 percent CTC coverage, and double-crossovers every 12-14 miles between Los Angeles, California and Chicago, Illinois (Vantuono, 2005). Only several portions in rural Oklahoma-Kansas border region and segments in New Mexico located in mountainous terrain of Abo Canyon remain single-track and awaiting double-tracking (Frailey, 2007b). The increased capacity and a more direct route into the Midwest and the Transcon has allowed BNSF haul two-thirds of the containers that originate from Southern California (Frailey, 2007b).



Map 5.1 BNSF's Transcon (Frailey, 2007b; Surface Transportation Board, 2006).

Union Pacific

The growth of intermodal and container traffic has made it necessary for Union Pacific to rehabilitate two major routes. First is its Sunset Corridor and the second is the Texas & Pacific Route. Combined, these two routes provide a faster link from the Ports of Long Beach and Los Angeles, California and the Southeast.

The Sunset Corridor

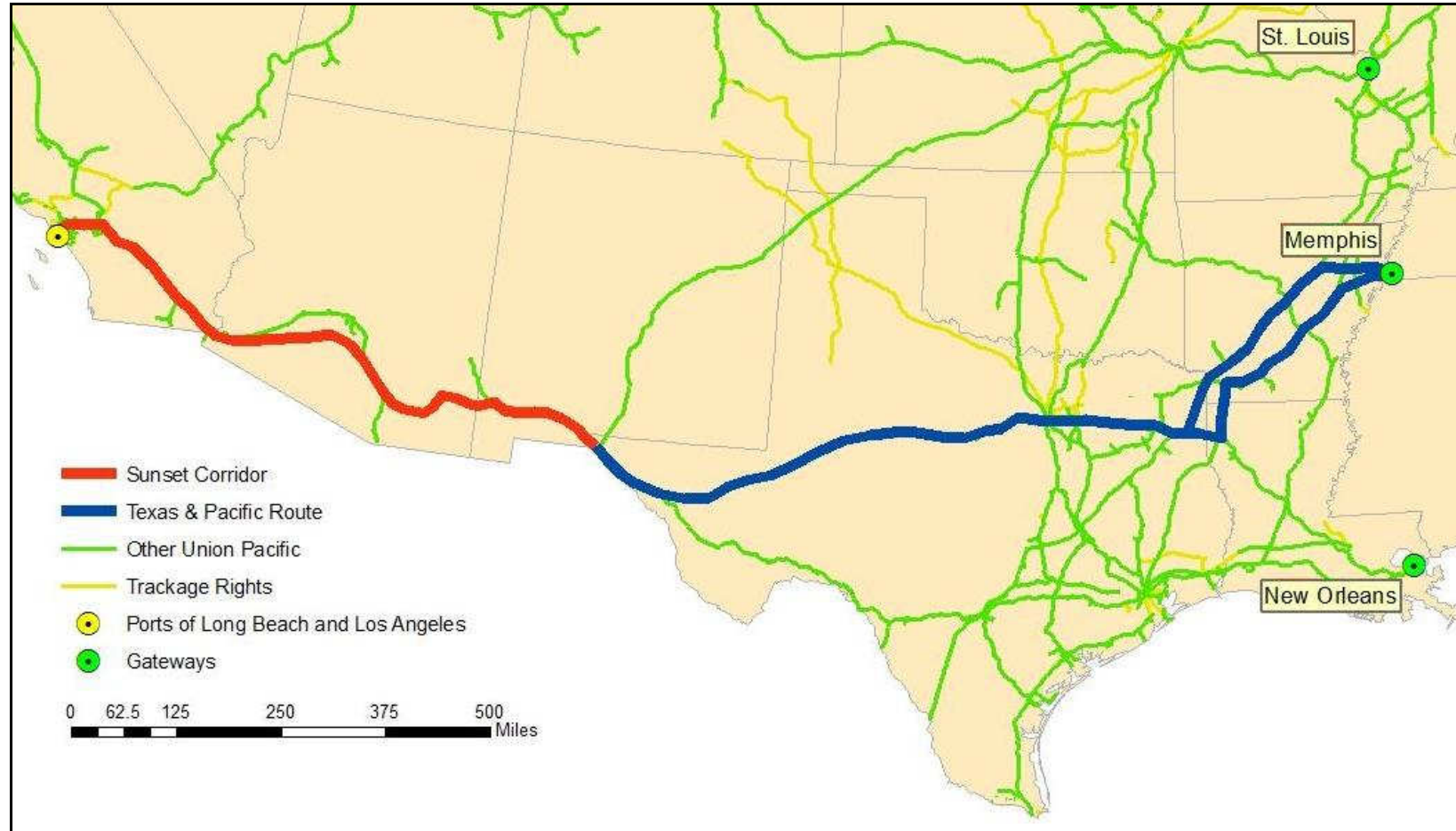
Despite an early 1990's double-tracking project started by Southern Pacific (SP) on the Sunset Corridor (Map 5.2) in southeastern Arizona, UP inherited a rail line with capacity limitations. UP has continued the double tracking effort, with a capital investment plan calling for the construction of about 50 miles (80 km) of track per year (Murray, 2007b). The project will be 50 percent complete by the end of 2007 and finished by 2013. UP's 2007 budget for capital spending projects was expanded by \$400 million, most going to the Sunset Corridor, to a total of \$3.2 billion for 2007 (Murray, 2007b).

Once the project is completed, the Sunset Corridor should allow Union Pacific to better handle the expected increase in intermodal traffic in the coming years. In 1999, 30 to 35 trains per day traveled over the Sunset Corridor, increased to about 50 per day in 2006 (Murray, 2007b). Intermodal traffic between Southern California and the Sunset Corridor's outlets in Texas and the Southeast grew by 35 between 2002 and 2005. By 2010, Union Pacific expects 70 to 80 trains per day on the Sunset Corridor west of El Paso, Texas (Murray, 2007b).

The Texas & Pacific Route

The merger between UP and SP would provide a more direct route between the Southwest/Texas/Southeast, all areas of growth. Following the melt-down of 1997-1998, UP began a massive program to upgrade the former Texas & Pacific's Ft. Worth and El Paso, Texas route (Frailey, 2005) (Map 5.2). Inherited from Missouri Pacific (MP), merged in 1982, it had long been under utilized since SP had its own route to East Texas and interchanged little traffic to the MP at El Paso, Texas. Hundreds of millions of dollars have been spent to upgrade the jointed rail, ties, sidings, and installing CTC, increasing daily train density west of Odessa, Texas from 2 in 1996 to 19 in 2004 (Frailey, 2005).

The Sunset Route east of El Paso, Texas has seen a decline in traffic as a result of the Texas & Pacific rehabilitation as traffic has been routed to the more direct Dallas, Texas and Memphis, Tennessee lines, but it still remains an important route to Houston, Texas and New Orleans, Louisiana (Frailey, 2005).



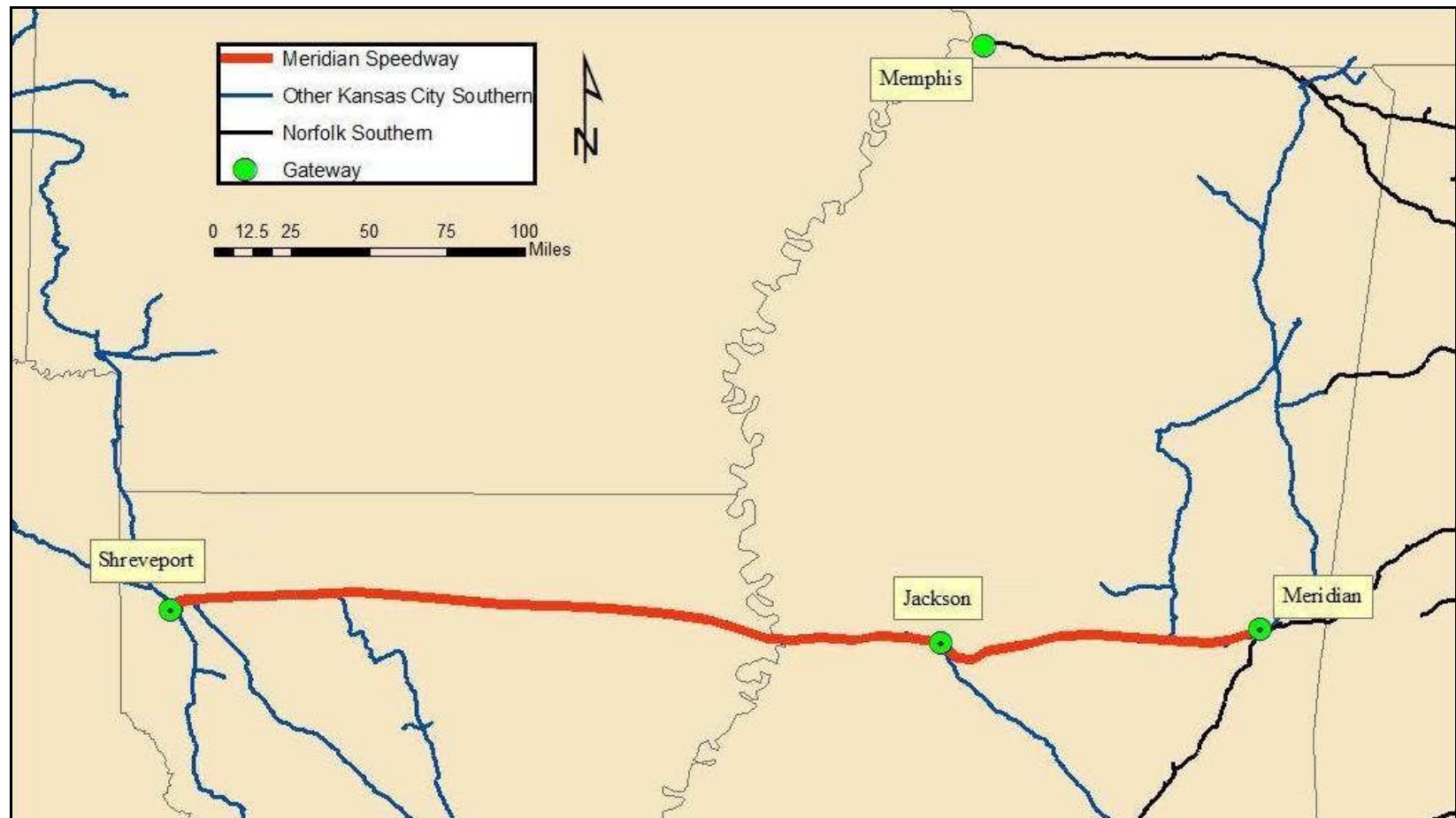
Map 5.2 Union Pacific's Sunset Corridor and Texas & Pacific Route (Frailey, 2007d; Surface Transportation Board, 2006).

Kansas City Southern's Meridian Speedway

KCS and NS have formed a unique partnership to increase their intermodal traffic and to expand an already existing relationship since KCS's purchase of MidSouth. This involved expanding capacity on the Meridian Speedway (Map 5.3), its line from Meridian, Mississippi to Shreveport, Louisiana, via Jackson Mississippi (Wallace, 1997).

While the route bypasses the congested terminals of New Orleans, Louisiana and Memphis, Tennessee, it is not without its problems; it is KCS's most congested stretch of track. Passing through the heart of the broiler belt, it is filled with pulpwood yards, feed mills, paper mills, and numerous other industries. The local trains that serve these customers can also tie up the track's limited capacity and cause congestion (Frailey, 2003).

KCS had to find remedies to alleviate the congestion problems on the Meridian Speedway. One was increasing intermodal speeds from 49 mph (78kph) to 59 mph (95kph) combined with the use of direct traffic control (DTC) to isolate trains into blocks of track with authorities by dispatchers via radio (Frailey, 2003). Another was the installation of power switches that operates via radio by the train's crew and exiting the siding through a spring switch at the other end of the siding (Frailey, 2003). A major improvement was the building of a new modern ten track rail yard in Jackson, Mississippi, named High Oak Yard (Frailey, 2003). CTC would greatly decrease the congestion on the Meridian Speedway, but these types of traffic control systems are very expensive and are installed only in areas of high train density.



Map 5.3 Kansas City Southern's Meridian Speedway (Frailey, 2006; Surface Transportation Board, 2006).

A relationship between the two railroads, KCS and NS, has existed since November 1994 when a single daily Atlanta, Georgia to Dallas, Texas train began running on thirty-one hour schedules (Frailey, 2003). Meridian, Mississippi served as the transfer point, with United Parcel Service (UPS) being the lead shipper. Intermodal traffic start to pick up until May of 2000 on the Meridian Speedway after KCS became a bridge carrier between BNSF, Dallas, Texas and NS, Meridian, Mississippi (Frailey, 2003). By March 2003, there were on average 33 westbound and 51 eastbound intermodal trains per month using Meridian Speedway (Frailey, 2003).

Since the 1993 purchase of MidSouth, KCS has spent a proximally \$300 million on improvements to the Meridian Speedway. To reach the potential full of the line, numerous other improvements are needed and could cost another \$300 million (Frailey, 2006). To help raise the capital, KCS decided in late 2005 to franchise the Meridian Speedway to NS. Paying \$260 million for track improvements over the next four years directly too the Meridian Speedway and \$40 million for KCS to use at its discretion, NS will get a 20 percent stake in the Meridian Speedway (Frailey, 2006). KCS remains the operator while NS has the exclusive right to route transcontinental intermodal between Shreveport, Louisiana and Meridian, Mississippi (Frailey, 2006).

As a response to NS's joint venture with KCS, BNSF and CSX introduced their own Southern California to Southeast intermodal service (Frailey, 2007a). BNSF carries the containers to an interchange at Birmingham, Alabama, via Avard, Oklahoma, Springfield, Missouri, and Memphis, Tennessee. From Birmingham, Alabama to Atlanta, Georgia, CSX provides a fee-based haulage for the BNSF intermodal trains (Frailey,

2007a). Both roads are currently improving their respected lines to handle the increase in traffic and UP have replaced BNSF as KCS and NS's western connection (Frailey, 2007a).

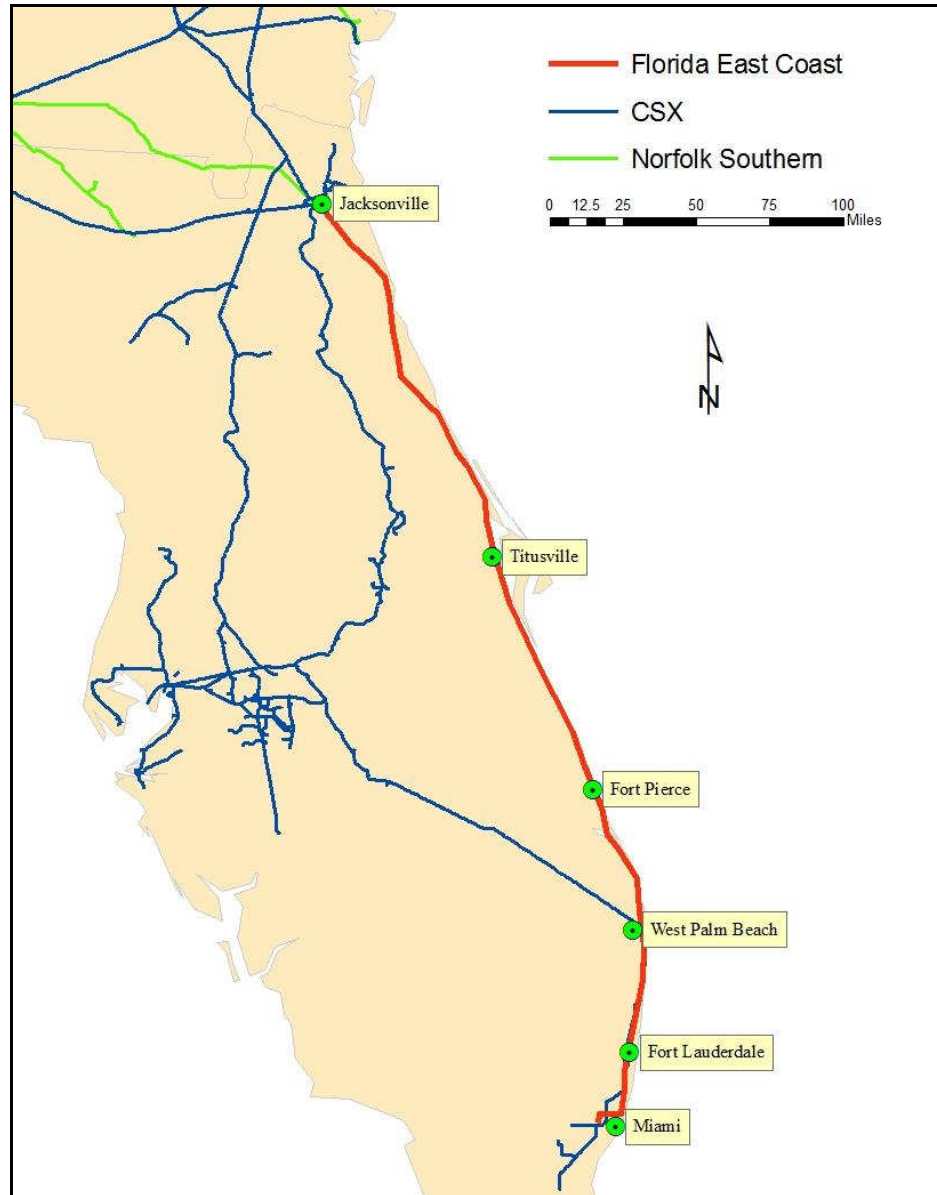
Florida East Coast

A prime example of a Regional railroad (Class II) that utilizes high customer service intermodal along with doublestacking is Florida East Coast Railway (FEC) (Map 5.4). Located within the state of Florida and does not have any "recession proof" coal revenues and is depended on intermodal, aggregate, and automotive traffic (Railway Age, 2007). FEC focused on performance and its intermodal service had a 98.6 percent on time performance in 2006. FEC markets a truck-like, door-to-door service for its retail and motor carrier customers, thus providing seamless transport (Railway Age, 2007).

FEC's capacity was expanded in three ways; improved terminals, double tracking, and doublestacking. Growth of Wal-Mart intermodal traffic at its Ft. Pierce, Florida distribution center necessitated an expanded terminal in that city (Railway Age, 2007). To alleviate a bottleneck in its system, FEC double tracked 12 miles (19 km) of its line. Finally, FEC intermodal service had relied heavily on trailers began to expand train capacity by doublestacking (Railway Age, 2007).

What is practically unique about FEC is that its longest possible haul is 350 miles (563km) long (Frailey, 2007c), well below the industry consensus of 500 mile (804km) haul via rail to reach profitability (Armstrong, 1998). Revenues generated per trailer or container carried in 2006 was an average of \$368 as compared to Union Pacific's, \$813

CSX's \$648, and Norfolk Southern's \$605 (Table 5.1). FEC makes up for this disadvantage in revenue per unit by its sheer volume of intermodal shipments (Frailey, 2007c).



Map 5.4 Florida East Coast (Frailey, 2007c; Surface Transportation Board, 2006).

Table 5.1 Intermodal Revenue per Unit, Percentage of Volume, and Percentage of Revenue for selected railroads in 2006 (Frailey, 2007c; CSX Corporation, 2007; Florida East Coast Railway, 2007; Norfolk Southern Corporation, 2007; Union Pacific Corporation, 2007).

Railroad	Revenue per Unit	Percentage of Volume	Percentage of Revenue
FEC	\$368	60.2	45.9
CSX	\$648	29.6	14.7
NS	\$605	41.2	20.9
UP	\$813	30.0	18.8

FEC competes with the trucking companies by having a superiorly engineered right of way when compared to congested Interstate 95 and the geography of Florida (Frailey, 2007c). South Florida (West Palm Beach, Fort Lauderdale, and Miami) is an area of mass consumption with little production for a backhaul and trucking companies have found it less expensive to use rail from Jacksonville, Florida southward and back (Frailey, 2007c). With high volumes, FEC can run frequent intermodal departures and its well built right of way has the capacity to handle the demand (Frailey, 2007c).

Summary

America's railroads have used their geographic advantages to increase their intermodal traffic. A major first step was taken by Santa Fe which emphasized yield over volume and partnering with trucking companies (Giblen, 1998). Santa Fe's, now BNSF, Los Angeles, California to Chicago, Illinois Transcon has become the leading intermodal route in the United States. The improved Transcon allows BNSF to haul two-thirds of the containers from Southern California (Frailey, 2007b).

Union Pacific's Sunset Corridor and Texas & Pacific Route takes advantage of a shorter route from the Ports of Long Beach and Los Angeles, California into Texas and the Southeast. The Sunset Corridor is an ongoing project that is expected to be completed in 2013 (Murray, 2007b). Kansas City Southern's Meridian Speedway is a natural extension to the Sunset Corridor and Texas & Pacific Route and provides a vital link into the Southeast (Frailey, 2007a).

Florida East Coast further emphasizes that providing better service can make intermodal a profitable venture (Frailey, 2007c; Railway Age, 2007). This is accomplished by maintaining a superior right of way and Florida's geography that favors FEC (Frailey, 2007c).

CHAPTER VI

STATISTICAL ANALYSIS AND DISCUSSION

This chapter presents the results of the null hypotheses tests conducted for this study and summarized into tables by year. The results of any significant correlations are discussed by railroad and then explored the significant correlations temporally.

Statistical Analysis

In 1997, BNSF (BNSF_1997), CSX (CSX_1997), Kansas City Southern (KCS_1997), and Norfolk Southern (NS_1997) each had a positive significant correlation between its monthly T&E and monthly CTEU. Illinois Central (IC_1997), SOO Line (SOO_1997), and Union Pacific (UP_1997) each had an inverse significant correlation between their monthly T&E and monthly CTEU. Conrail (CR_1997) and Grand Trunk Western (GTW_1997) had no significant correlations in 1997 (Table 6.1).

In 1998, Conrail (CR_1998), Norfolk Southern (NS_1998), SOO Line (SOO_1998), and Union Pacific (UP_1998) each had a positive significance correlation between its monthly T&E and monthly CTEU. Grand Trunk Western (GTW_1998) and Kansas City Southern (KCS_1998) each had an inverse significant correlation between its total monthly T&E and monthly CTEU. BNSF (BNSF_1998), CSX (CSX_1998), and Illinois Central (IC_1998) had no significant correlations in 1998 (Table 6.1).

In 1999 there were no positive significant correlations between monthly T&E and monthly CTEU. BNSF (BNSF_1999) and Union Pacific (UP_1999) each had an inverse significant correlation between its monthly T&E and monthly CTEU. Grand Trunk Western (GTW_1999), Kansas City Southern (KCS_1999), Illinois Central (IC_1999), and SOO Line (SOO_1999) had no significant correlations in 1999 (Table 6.1).

In 2000, only CSX (CSX_2000) had a positive significant correlation between its monthly T&E and monthly CTEU. Kansas City Southern (KCS_2000), Norfolk Southern (NS_2000), and Union Pacific (UP_2000) each had an inverse significant correlation between its monthly T&E and monthly CTEU. BNSF (BNSF_2000), Grand Trunk Western (GTW_2000), Illinois Central (IC_2000), and SOO Line (SOO_2000) had no significant correlations in 2000 (Table 6.1).

In 2001, only Kansas City Southern (KCS_2001) had a positive significant correlation between its monthly T&E and monthly CTEU. Norfolk Southern (NS_2001) and Union Pacific (UP_2001) each had an inverse significant correlation between its monthly T&E and monthly CTEU. BNSF (BNSF_2001), CSX (CSX_2001) Grand Trunk Western (GTW_2001), Illinois Central (IC_2001), and SOO Line (SOO_2001) had no significant correlations in 2001 (Table 6.1).

In 2002, only BNSF (BNSF_2002) had a positive significant correlation between its monthly T&E and monthly CTEU. CSX (CSX_2002), Kansas City Southern (KCS_2002), Norfolk Southern (NS_2002), SOO Line (SOO_2002), and Union Pacific (UP_2002) had no significant correlations in 2002 (Table 6.1).

In 2003, BNSF (BNSF_2003), CSX (CSX_2003), and Norfolk Southern (NS_2003) had a positive significant correlation between its monthly T&E and monthly CTEU. Kansas City Southern (KCS_2003), Canadian National/Illinois Central (CNIC_2003), SOO Line (SOO_2003), and Union Pacific (UP_2003) had no significant correlations in 2003 (Table 6.1).

In 2004, CSX (CSX_2004), Kansas City Southern (KCS_2004), and Union Pacific (UP_2004) had a positive significant correlation between its monthly T&E and monthly CTEU. BNSF (BNSF_2004), Canadian National/Illinois Central (CNIC_2004), Norfolk Southern (NS_2004), and SOO Line (SOO_2004) had no significant correlations in 2004 (Table 6.1).

In 2005, only Norfolk Southern (NS_2005) had a positive significant correlation between its monthly T&E and monthly CTEU. BNSF (BNSF_2005), Canadian National/Illinois Central (CNIC_2005), CSX (CSX_2005), Kansas City Southern (KCS_2005), SOO Line (SOO_2005), and Union Pacific (UP_2005) had no significant correlations in 2005 (Table 6.1).

In 2006, only Canadian National/Illinois Central (CNIC_2006) had a positive significant correlation between its monthly T&E and monthly CTEU. BNSF (BNSF_2006), CSX (CSX_2006), Kansas City Southern (KCS_2006), Norfolk Southern (NS_2006), SOO Line (SOO_2006), and Union Pacific (UP_2006) had no significant correlations in 2006 (Table 6.1).

Table 6.1 Spearman Rank-order Correlation Coefficient Results between Class I Monthly T&E Employment and Monthly CTEU.

Railroad	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
BNSF	*+		*-			*+	*+			
CNIC										*+
CR		*+								
CSX	*+			*+			*+	*+		
GTW		*-								
IC	*-									
KCS	*+	*-		*-	*+			*+		
NS	*+	*+		*-	*-		*+		*+	
SOO		*+								
UP	*-	*+	*-	*-	*-			*+		

*+ = significant positively at 0.05 level

*- = significant inversely at 0.05 level

Discussion

This section discusses the results of the significant correlations by railroad and then explores these results temporally.

Summary of Correlations

One objective of this study was to determine if there are any significant correlations between monthly T&E employment and monthly CTEU among the Class I railroads for the years of 1997 thru 2006. Of the 74 Spearman's Rank-order Correlation Coefficients performed; there were a total of 30 significant correlations, 19 were found to be positively significantly correlated and 11 were found to be inversely significantly correlated (Table 6.2). Once it was determined that there were significant correlations, data were grouped to answer the four hypotheses for this study (addressed in Chapter VII).

During the study period, eight out of the ten railroads being studied had at least one positive significant correlation between monthly T&E employment and monthly CTEU. The three variables with the most positive significant correlations were CSX (CSX) and Norfolk Southern (NS) with four each. For the rest of the railroads, BNSF (BNSF) and Kansas City Southern (KCS) each had three positive significant correlations; Union Pacific (UP) had two; Canadian National/Illinois Central (CNIC), Conrail (CR) and SOO Line (SOO) each had one. Grand Trunk Western (GTW) and Illinois Central (IC) had no positively significant correlations (Table 6.2).

Six out of the ten railroads being studied had at least one inverse significant correlation between T&E and CTEU. The variable that had the most inverse significant correlations was Union Pacific (UP) with four. For the rest of the railroads, Kansas City Southern (KCS) and Norfolk Southern (NS) each had two inverse significant correlations; BNSF (BNSF), Grand Trunk Western (GTW), and Illinois Central (IC) each had one. Canadian National/Illinois Central (CNIC), Conrail (CR), CSX (CSX), and SOO Line (SOO) had no inverse significant correlations (Table 6.2).

Table 6.2 Spearman Rank-order Correlation Coefficient Results by Railroad.

Railroad	Positive	Inverse
BNSF	3	1
CNIC	1	0
CR	1	0
CSX	4	0
GTW	0	1
IC	0	1
KCS	3	2
NS	4	2
SOO	1	0
UP	2	4
Total	19	11

For the entire study period, BNSF, CSX, Kansas City Southern, and Norfolk Southern was found to be significantly positively correlated between their monthly T&E and monthly CTEU. The Class I aggregate monthly T&E was also found to have been

significantly positively correlated with monthly CTEU. The other railroads in this study; Canadian National/Illinois Central, Conrail, Grand Trunk Western, Illinois Central, and Union Pacific, were not significantly correlated between their monthly T&E and monthly CTEU for the entire study period. No railroad was significantly inversely correlated between their monthly T&E and monthly CTEU between 1997 and 2006 (Table 6.3).

Table 6.3 Correlations between Class I Monthly T&E Employment and Monthly CTEU: 1997 to 2006.

Year	Correlation
BNSF	*+
CNIC	*+
CR	
CSX	*+
GTW	
IC	
KCS	*+
NS	*+
SOO	
UP	
Class I	*+

*+ = significant positively at 0.05 level

*- = significant inversely at 0.05 level

The follow series of charts graph the monthly patterns of monthly T&E employment and monthly CTEU. BNSF, CSX, Kansas City Southern, Norfolk Southern, and the Class I T&E all show and early increase early in the study period, a decline until the middle of the study period and then increasing to the end of the study period (Figure

6.1, 6.2, 6.3, 6.4, and 6.5). It should be noted that the spike in 1999 for CSX and Norfolk Southern was a result of absorption of their share of Conrail T&E employees after the merger (Figure 6.2 and 6.4). CTEU during the study period had a general increase.

Union Pacific had an early decrease, an increase, another decline, and final increase towards the end of the study period (Figure 6.6). Conrail had a relative level T&E employment numbers the two years of its inclusion in the study period (Figure 6.7). Illinois Central and Grand Trunk Western, also had a relative level T&E employment numbers during their inclusion in the study period (Figure 6.8 and 6.9). Canadian National/Illinois Central had a decline during its inclusion in the study period (Figure 6.10).

Percentage-wise, CTEU had an increase of 168.3 percent; BNSF 20.3 percent, CSX 28.5 percent, Kansas City Southern 25.3 percent, Norfolk Southern 71.8 percent, Union Pacific 21.2 percent, and the Class I T&E aggregate 14.5 percent during the study period. Conrail T&E employment had an increase of 1 percent during its two years in the study period while Canadian National/Illinois Central had a decline of 14.7 percent, Grand Trunk Western a decline of 5.6 percent, and Illinois Central a decline of 4.7 decline during their presence in this study.

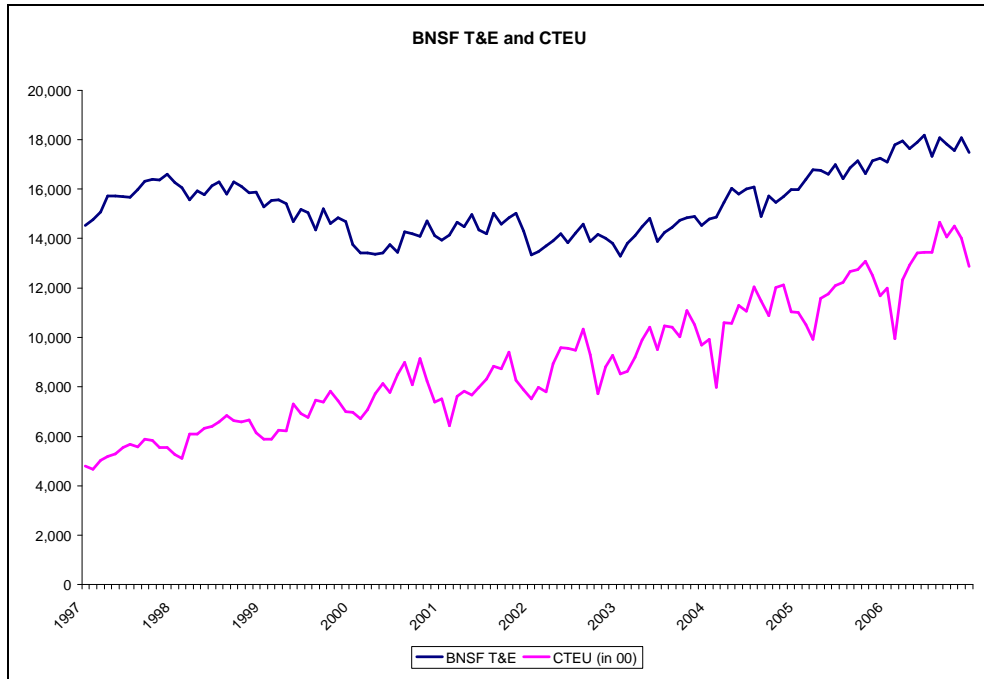


Figure 6.1 BNSF T&E and CTEU: 1997 to 2006.

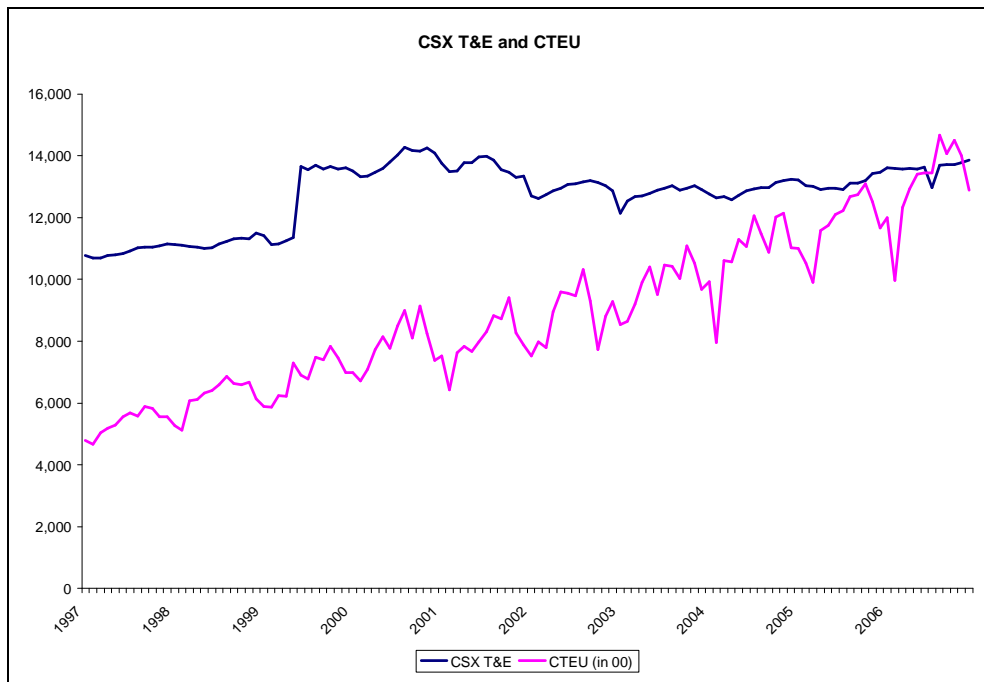


Figure 6.2 CSX T&E and CTEU: 1997 to 2006.

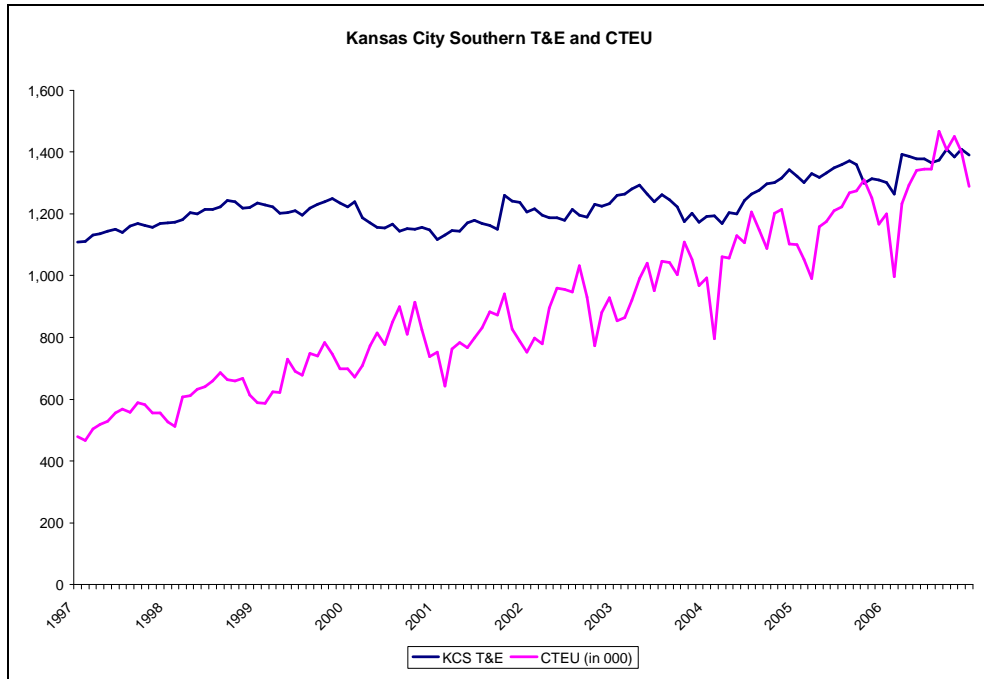


Figure 6.3 Kansas City Southern T&E and CTEU: 1997 to 2006.

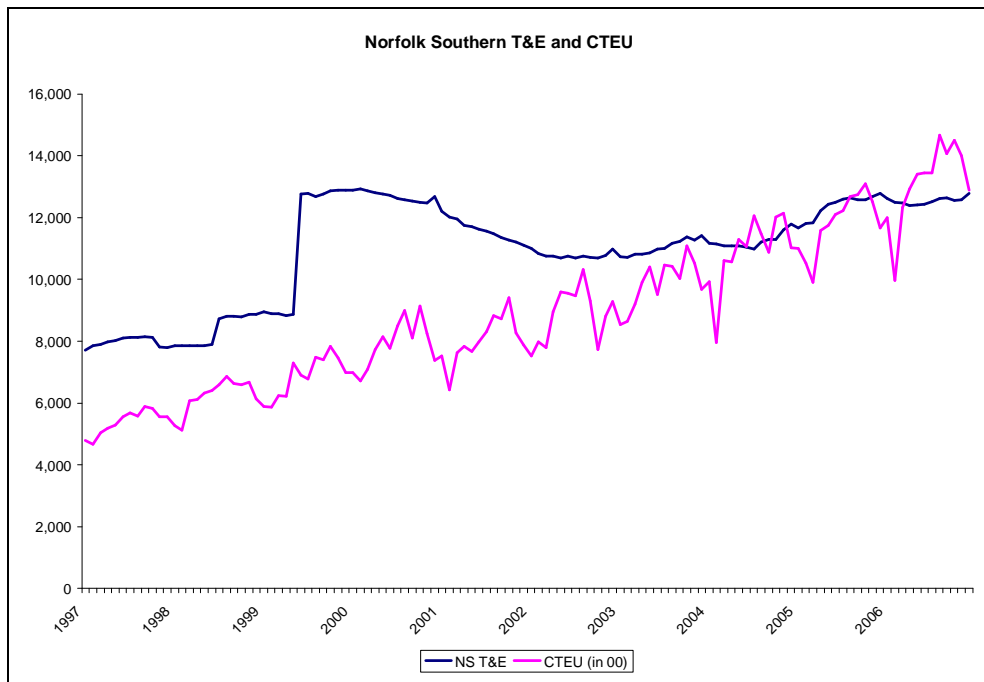


Figure 6.4 Norfolk Southern T&E and CTEU: 1997 to 2006.

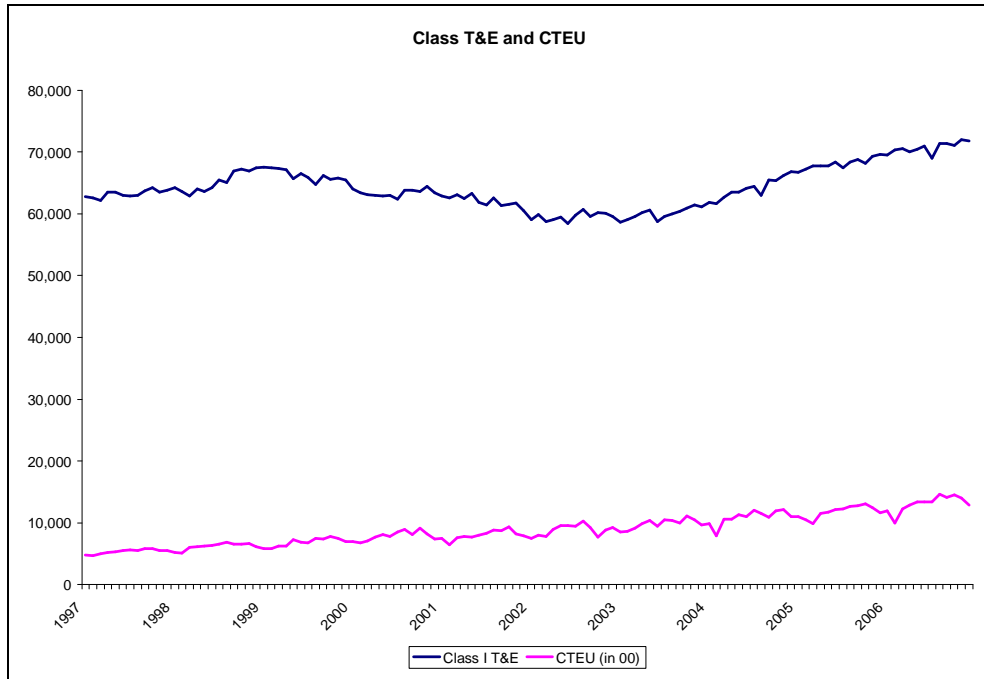


Figure 6.5 Class I T&E and CTEU: 1997 to 2006.

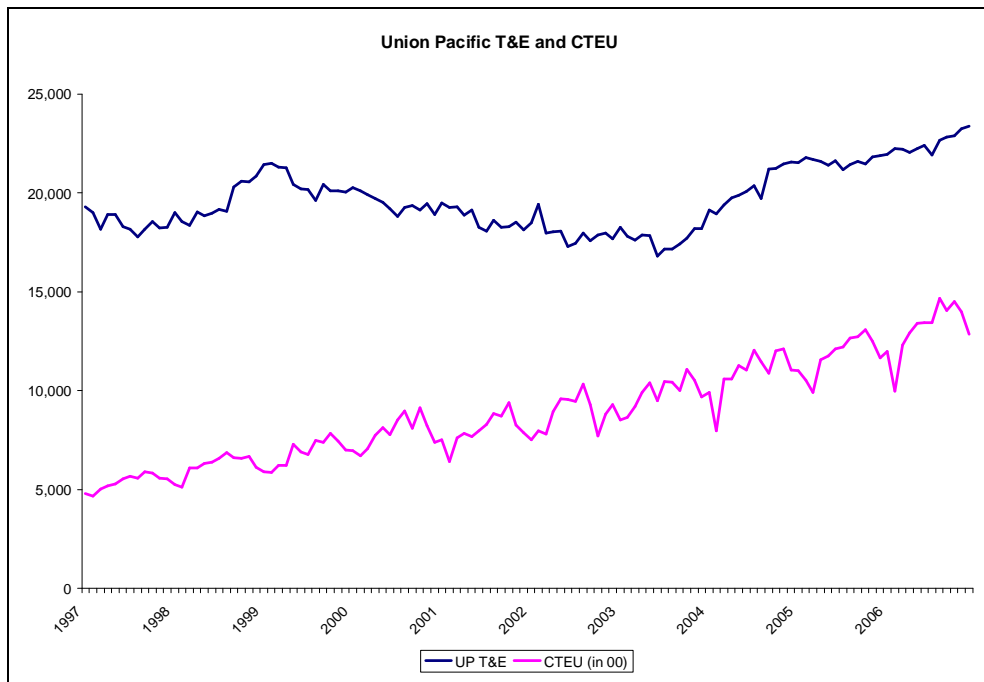


Figure 6.6 Union Pacific T&E and CTEU: 1997 to 2006.

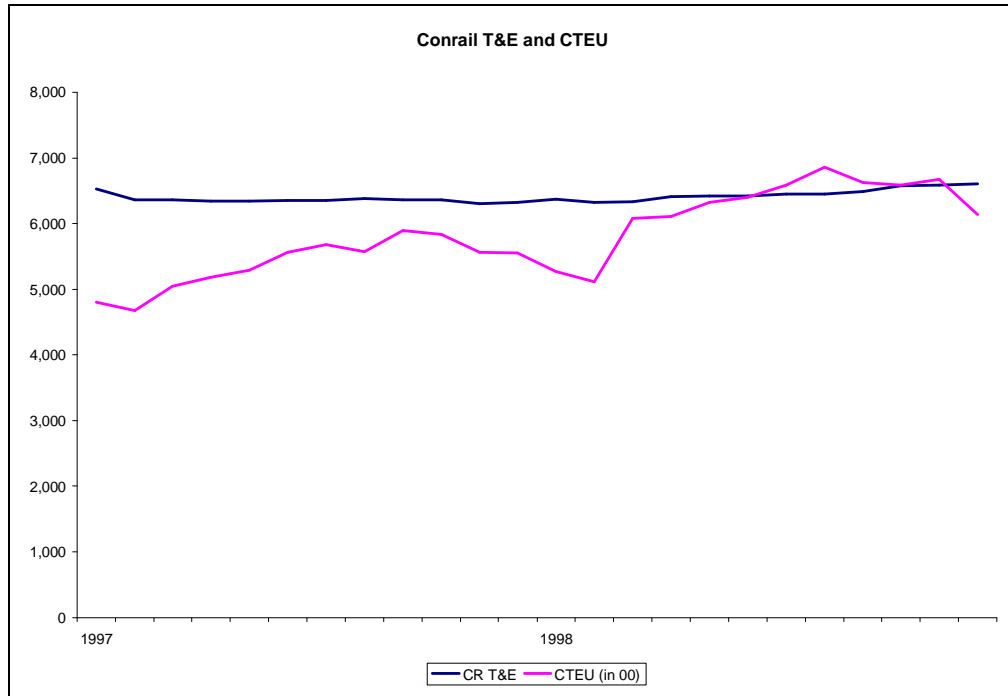


Figure 6.7 Conrail T&E and CTEU: 1997 to 1998.

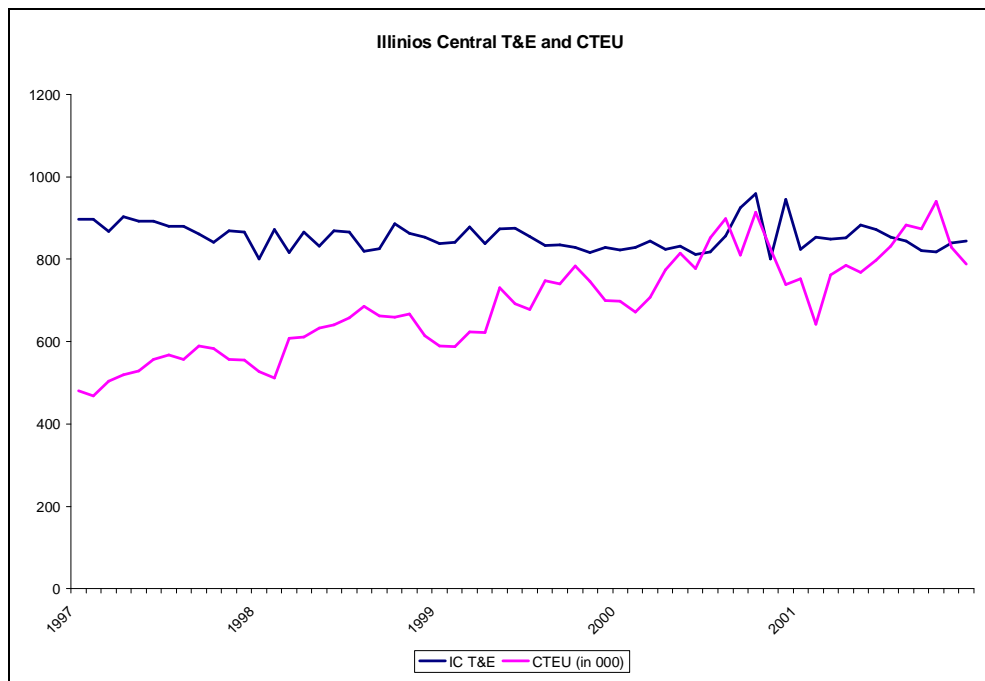


Figure 6.8 Illinois Central T&E and CTEU: 1997 to 2001.

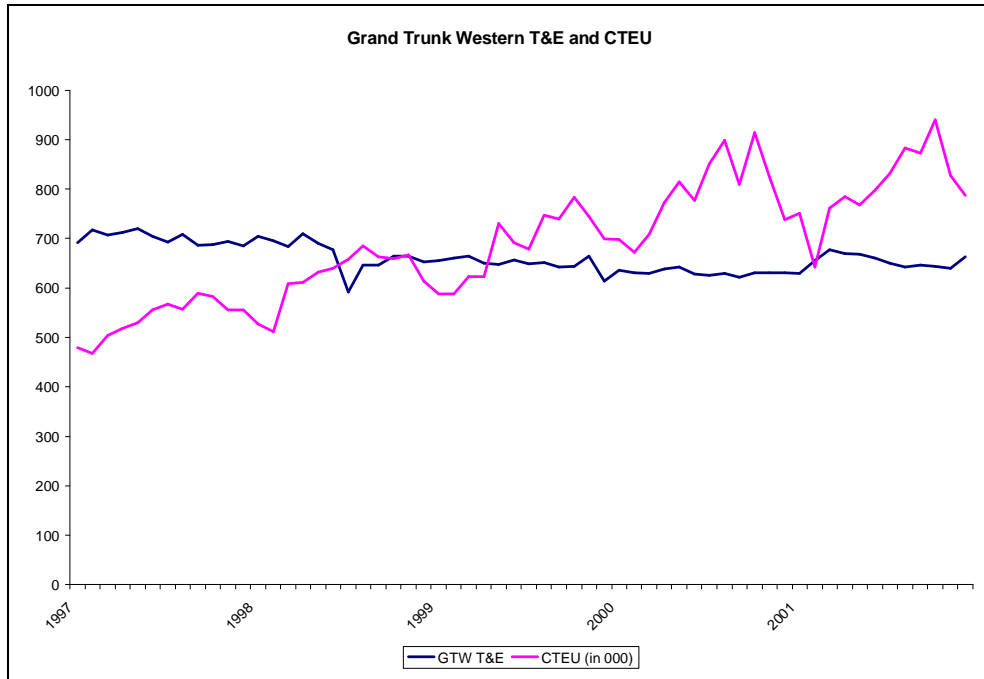


Figure 6.9 Grand Trunk Western T&E and CTEU: 1997 to 2001.

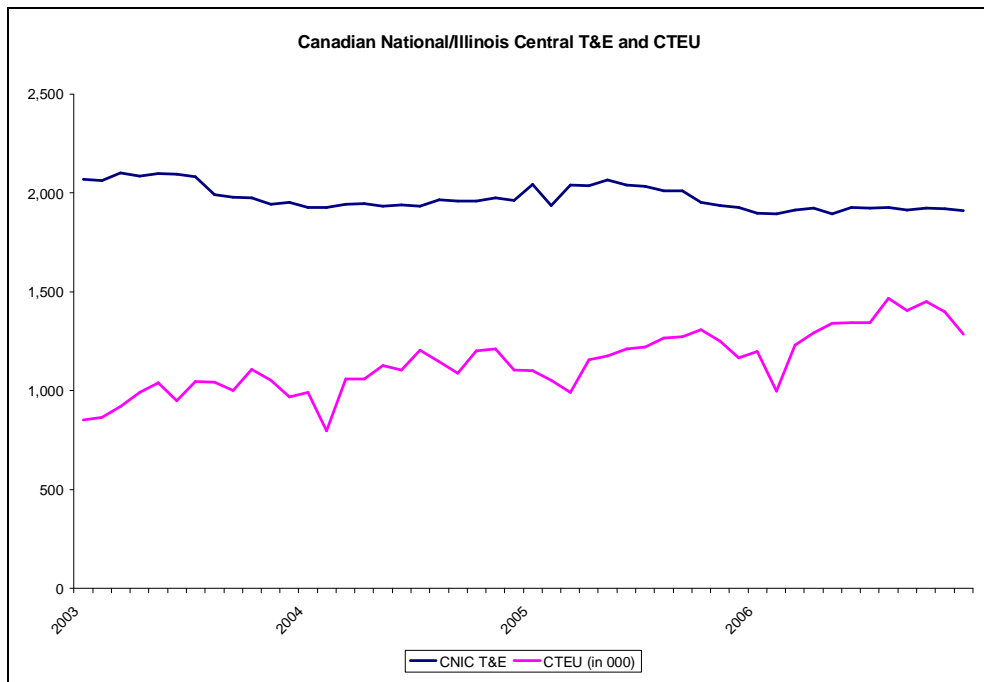


Figure 6.10 Canadian National/Illinois Central T&E and CTEU: 2003 to 2006.

BNSF did not have the most positive significant correlations between its monthly T&E employment and monthly CTEU for the years of 1997 through 2006. This ran contrary to what the researcher had expected since BNSF reportedly hauled two-thirds of the containers that move via rail from Southern California of the containers that move via rail from Southern California (Frailey, 2007b) and landbridge traffic accounted for 64 percent of BNSF's volume growth between 1995 and 2005 (BNSF Railway, 2006). BNSF's massive capital investment on the Southern California to Chicago, Illinois Transcon seemed to have improved operations (Frailey, 2007b) and lessened the need for more operating crews (T&E).

Since the Transcon is almost completely double tracked, trains can be longer and maximize the containers carrier per train. Evidence of this is BNSF tested a 10,009 foot (3km) doublestack container train in May of 2007. BNSF is trying to determine if it can run even longer trains and carry an increasing number of containers with fewer trains (Trains, 2007) and fewer crews.

Union Pacific's not having more positive significant correlations is not as surprising to the researcher, but does seem low for a railroad that directly serves the Ports of Long Beach and Los Angeles. Two major reasons are likely Union Pacific's two major service interruptions, first in 1997 (Saunders, 2003) just as TEU traffic was increasing in at the ports. Union Pacific other service interruption occurred in 2003, again as TEU traffic was increasing in at the ports (Blaszak, 2004), Union Pacific's positive significant correlations occurred in 1998 and 2004.

Union Pacific also inherited a less than optimal Sunset Route from Southern California after its 1996 merger with Southern Pacific and was slower to upgrade than BNSF. The route is also less competitive with BNSF's Transcon from Southern California to the Midwest (Frailey, 2007d). Union Pacific is currently working to double track the Sunset Route from Southern California to El Paso, Texas and appears to be focusing on landbridge traffic into the Southeast (Frailey, 2007d).

The railroads that had the most positive significant correlations between T&E employment and CTEU were CSX and Norfolk Southern. This result is interesting since both CSX and Norfolk Southern are located in the eastern United States and are the eastern ends of the American landbridge (Smith-Peterson, 2006; Murray, 2006). The nature of the American railroad network may have played a part with their significant positive correlations, since making the final delivery in the eastern United States can be more labor intensive than a western transcontinental transit (Saunders, 2001). BNSF and Union Pacific also have the advantage of fewer routes that carry a higher concentration of their traffic (Cramer, 2007).

Kansas City Southern's three positive correlations were likely the result of improvements made on its Shreveport, Louisiana to Meridian, Mississippi Meridian Speedway. The Meridian Speedway fills in a gap between the Southwest and Southeast and bypasses the congested gateways of New Orleans, Louisiana and Memphis, Tennessee (Frailey, 2006).

Conrail was merged into CSX and Norfolk Southern in 1999 and spent only two years in the study. Despite this it also had a single correlation, likely because it was the

main leg of the eastern end of the American Landbridge before its merger. CSX inherited most of Conrail's former landbridge traffic (Murray, 2005).

The author has no explanation for the single positive significant correlations for Canadian National/Illinois Central and SOO Line or the lack of a positive significant correlation for Grand Trunk Western. The author has not found any literature that would indicate they play any major role in American Landbridge and since all three are the American arms of Canadian railroads (Association of American Railroads, 2007f; 2007i), their orientation lies elsewhere. The lack of a positive significant correlation for Illinois Central is likely because of its north-south orientation from Chicago, Illinois to New Orleans, Louisiana before its merger into Grand Trunk Western (referred to as Canadian National/Illinois Central in this study) (Association of American Railroads, 2007f; Luczak, 1999).

Temporal Patterns

The second objective was to study any significant correlations between monthly T&E and monthly CTEU among the Class I railroads 1997 thru 2006 temporally. The search for temporal patterns was accomplished by grouping the significant correlations by year.

The years with the most positive significant correlations between monthly T&E and monthly CTEU were 1997 and 1998, 4 correlations each, and 2003 and 2004, 3 correlations each (Table 6.4). The positive significant correlations in 1997 and 1998 appear to be the result of an early hiring increase in the American railroad industry

undergone in the late 1990's as a result of increased traffic (Fischer, 1999). The Ports of Long Beach and Los Angeles both experienced a growth in TEU traffic during 1997 and 1998 (Port of Long Beach 2007b; Port of Los Angeles, 2007b).

Table 6.4 Spearman Rank-order Correlation Coefficient Results by Year.

Year	Positive	Inverse
1997	4	2
1998	4	2
1999	0	2
2000	1	3
2001	1	2
2002	1	0
2003	3	0
2004	3	0
2005	1	0
2006	1	0

The Class I aggregate monthly T&E employment for the years 1997, 1998, 2003, and 2004 was found to be significantly positively correlated with monthly CTEU. These years had the most individual railroads with significant positive correlation between their monthly T&E employment and monthly CTEU; 4 in 1997 and 1998, and 3 in 2003 and 2004. In 2000, the Class I aggregate monthly T&E employment was found to be significantly inversely correlated with monthly CTEU with three railroads with

significant inverse correlation. The remaining years the Class I aggregate monthly T&E employment had no significant correlation with monthly CTEU (Table 6.5).

Table 6.5 Correlation of Class I Aggregate Monthly T&E Employment and Monthly CTEU: 1997 to 2006.

Year	Correlation
1997	*+
1998	*+
1999	
2000	*-
2001	
2002	
2003	*+
2004	*+
2005	
2006	

*+ = significant positively at 0.05 level

*- = significant inversely at 0.05 level

The positive significant correlations in 2003 and 2004 appear to have occurred after a greater than expected increase in intermodal traffic, especially from the Ports of Long Beach and Los Angeles (Blaszak, 2004). The port of Long Beach also showed signs of leveling off of TEU traffic growth in late 1999 and then renewed growth in the early 2003 (Port of Long Beach, 2007b; 2007c). The port of Los Angeles had almost continuous TEU traffic growth during the study period (Port of Los Angeles, 2007b) and it appears the CTEU traffic growth was the cause of the unexpected increase in intermodal traffic in 2003. It also should be noted that 2003 was the first full year in which the Alameda Corridor was in operation (Lustig, 2002).

Of notable interest, no inverse significant correlations occur after 2001. This appears to be result of increased hiring that has occurred in the industry as the workforce is aging and retiring (Railway Age, 2004). 2000 had the most inverse significant correlations 3 correlations (Table 6.4). This was a result of a downward trend in railroad employment that peaked in the late 1999 and bottomed out in 2004 when the retirement age was lowered (Railway Age, 2004) (Figure 6.11).

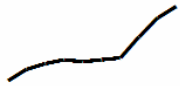
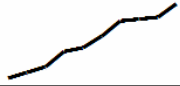

	Chart	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Port of Long Beach		3,504	4,097	4,408	4,600	4,462	4,526	4,658	5,779	6,709	7,290
Port of Los Angeles		2,959	3,378	3,828	4,879	5,183	6,105	7,178	7,321	7,484	8,469
Total Railroad Employment		216,553	220,597	220,701	209,900	201,900	194,900	190,200	190,100	193,100	198,100

Figure 6.11 Annual TEU Traffic at the Ports of Long Beach (in 000) and Los Angeles, California (in 000), and Total Railroad Employment: 1997 to 2006 (Bureau of Economic Analysis, 2007; Port of Long Beach, 2007b; Port of Los Angeles, 2007b).

CHAPTER VII

CONCLUSIONS

This chapter summarizes the results of the hypotheses of this study. The chapter ends with suggestions for possible future research.

Hypotheses

One of objectives of this study was to determine if there are any significant correlations between T&E employment among the Class I railroads and CTEU for the years of 1997 thru 2006. This objective was achieved by reviling that of the 74 T&E variables tested; 19 were found to be positively significant correlation with CTEU and 11 were found to be inversely significant correlation with CTEU. Achieving this objective was required for addressing the four hypotheses of this study:

- 1 That BNSF will have the most positive significant correlations between its monthly T&E and monthly CTEU.
- 2 That BNSF will have the fewest inverse significant correlations between its monthly T&E and monthly CTEU.
- 3 That Union Pacific will have the second most positive significant correlations between its monthly T&E and monthly CTEU.
- 4 That Union Pacific will have the second fewest inverse significant correlations between its monthly T&E and monthly CTEU.

Hypothesis 1: That BNSF will have the most positive significant correlations between its monthly T&E employment and monthly CTEU.

BNSF did not have the most positive significant correlations between its monthly T&E employment and monthly CTEU. CSX and Norfolk Southern had the most positive significant correlations between their monthly T&E employment and monthly CTEU with four apiece. BNSF only had three positive significant correlations between its monthly T&E employment and monthly CTEU (Table 6.2).

Hypothesis 2: That BNSF will have the fewest inverse significant correlations between its monthly T&E employment and monthly CTEU.

That BNSF did not have the fewest inverse significant correlations between its monthly T&E employment and monthly CTEU. Canadian National/Illinois Central, Conrail, CSX, and SOO Line had the fewest positive significant correlations between their monthly T&E employment and monthly CTEU, each with none. BNSF had one inverse significant correlation between its monthly T&E employment and monthly CTEU (Table 6.2).

Hypothesis 3: That Union Pacific will have the second most positive significant correlations between its monthly T&E employment and monthly CTEU.

Union Pacific did not have the second most positive significant correlations between its monthly T&E employment and monthly CTEU. BNSF and Kansas City Southern had the second most positive significant correlations between their monthly T&E and monthly CTEU with three apiece. Union Pacific only had two positive

significant correlations between its monthly T&E employment and monthly CTEU (Table 6.2).

Hypothesis 4: That Union Pacific will have the second fewest inverse significant correlations between its monthly T&E employment and monthly CTEU.

That Union Pacific did not have the second fewest inverse significant correlations between its monthly T&E employment and monthly CTEU. BNSF, Grand Trunk Western, and Illinois Central had the second fewest positive significant correlations between their monthly T&E employment and monthly CTEU, each with one apiece. Union Pacific had four inverse significant correlations between its monthly T&E and monthly CTEU, the most of any railroad in this study (Table 6.2).

All four hypotheses were rejected. This ran contrary to what the researcher had expect since BNSF reportedly hauled two-thirds of the containers that move via rail from Southern California (Frailey, 2007c) and by process of elimination Union Pacific hauled one-third of the containers that move via rail from Southern California. BNSF and Union Pacific's proximity to the ports of Long Beach and Los Angeles, being the only Class I's to directly serve them, did not appear too influence the correlations.

It appears increased hiring that has occurred in the railroad industry as the workforce was aging and retiring (Railway Age, 2004) also was a factor as well. The year 2000 had the most inverse significant correlations 3 correlations (Table 6.4). This was a result of a downward trend in T&E employment in the late 1990's and early 2000's after the retirement age was lowered (Railway Age, 2004). Both BNSF and Union

Pacific's positive significant correlations occurred in 1997 to 1998 and 2003 to 2004 time frames, both periods of unexpected increase in CTEU (Blaszak, 2004; Fischer, 1999).

For the entire study period, BNSF, CSX, Kansas City Southern, and Norfolk Southern was found to be significantly positively correlated between their monthly T&E and monthly CTEU (Table 6.3). The Class I aggregate monthly T&E was also found to have been significantly positively correlated with monthly CTEU. The other railroads in this study; Canadian National/Illinois Central, Conrail, Grand Trunk Western, Illinois Central, and Union Pacific, were not significantly correlated between their monthly T&E and monthly CTEU for the entire study period. No railroad was significantly inversely correlated between their monthly T&E and monthly CTEU between 1997 and 2006.

Suggestions for Future Research

A recommendation for future research is to collect data from other ports correlation to changes in Class I T&E employment or other career fields. One of the main limitations of this study is that there was prolific merger activity in the five decades proceeding the study period. America's railroads went from being mostly localized regional railroads to massive systems that can cover larger segments of the country (Saunders, 2003; 2001). This resulted in the inclusion of employees that would not normally be affected by TEU traffic from the Ports of Long Beach and Los Angeles in this study. Future studies could work with a specific Class I railroad and its employee's union to obtain T&E employment data in areas that lie predominately on specific routes.

Research can also be dedicated to any of the over five hundred Regional and Local in the United States. This would definitely require the cooperation of the railroads being studied since government regulations requiring the reporting of employment figures only applies to Class I railroads.

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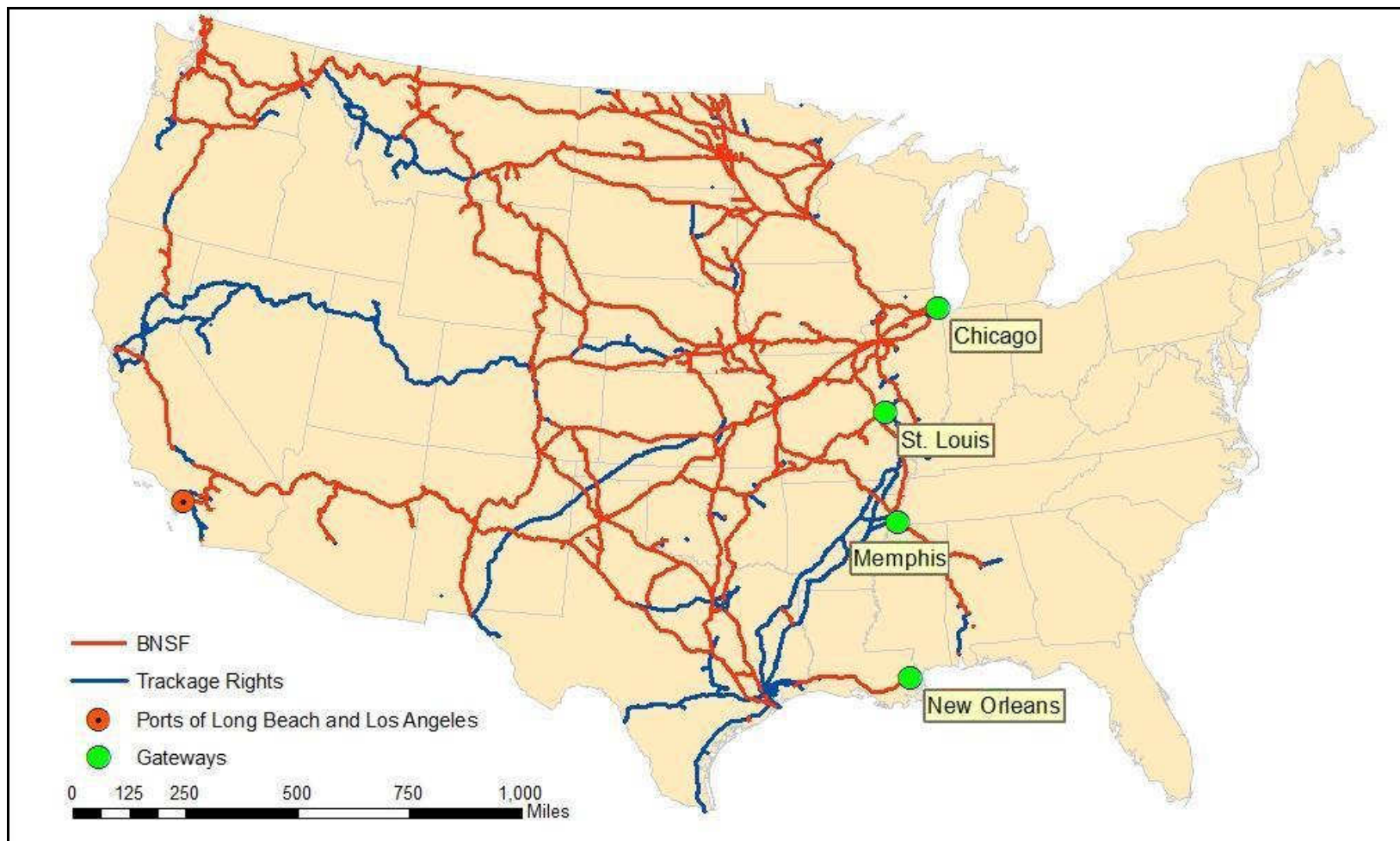
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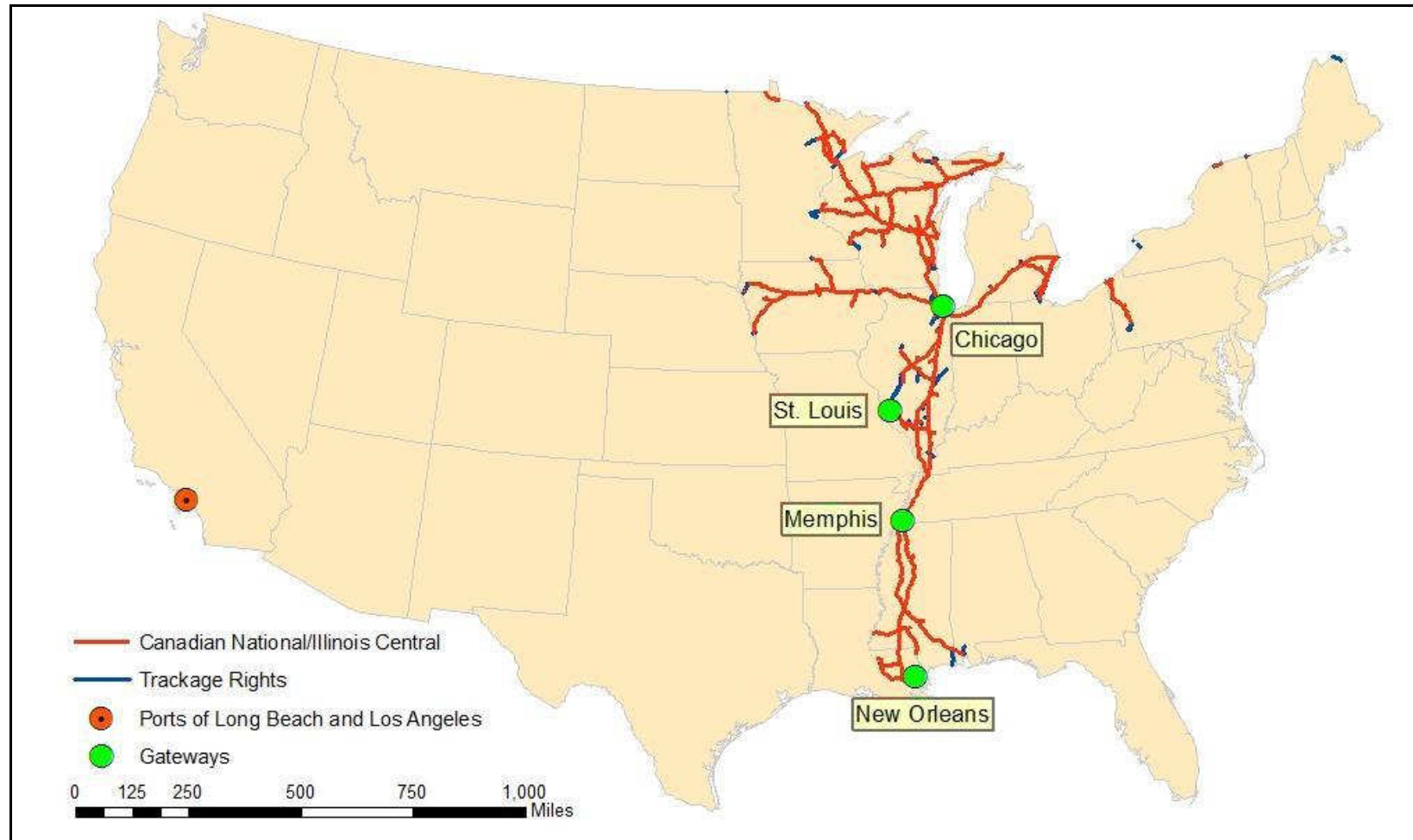
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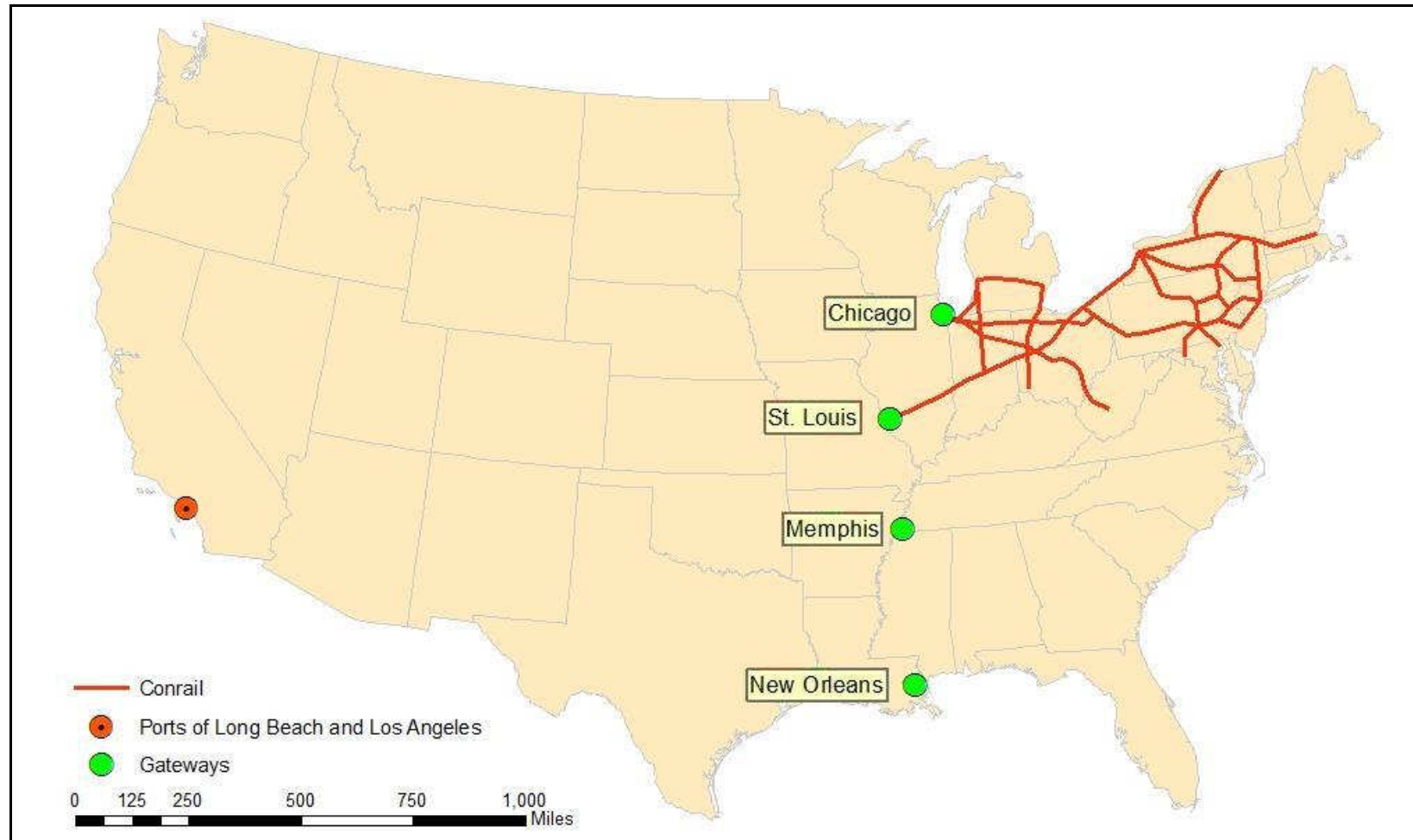
APPENDIX A
MAPS OF CLASS I RAILROADS



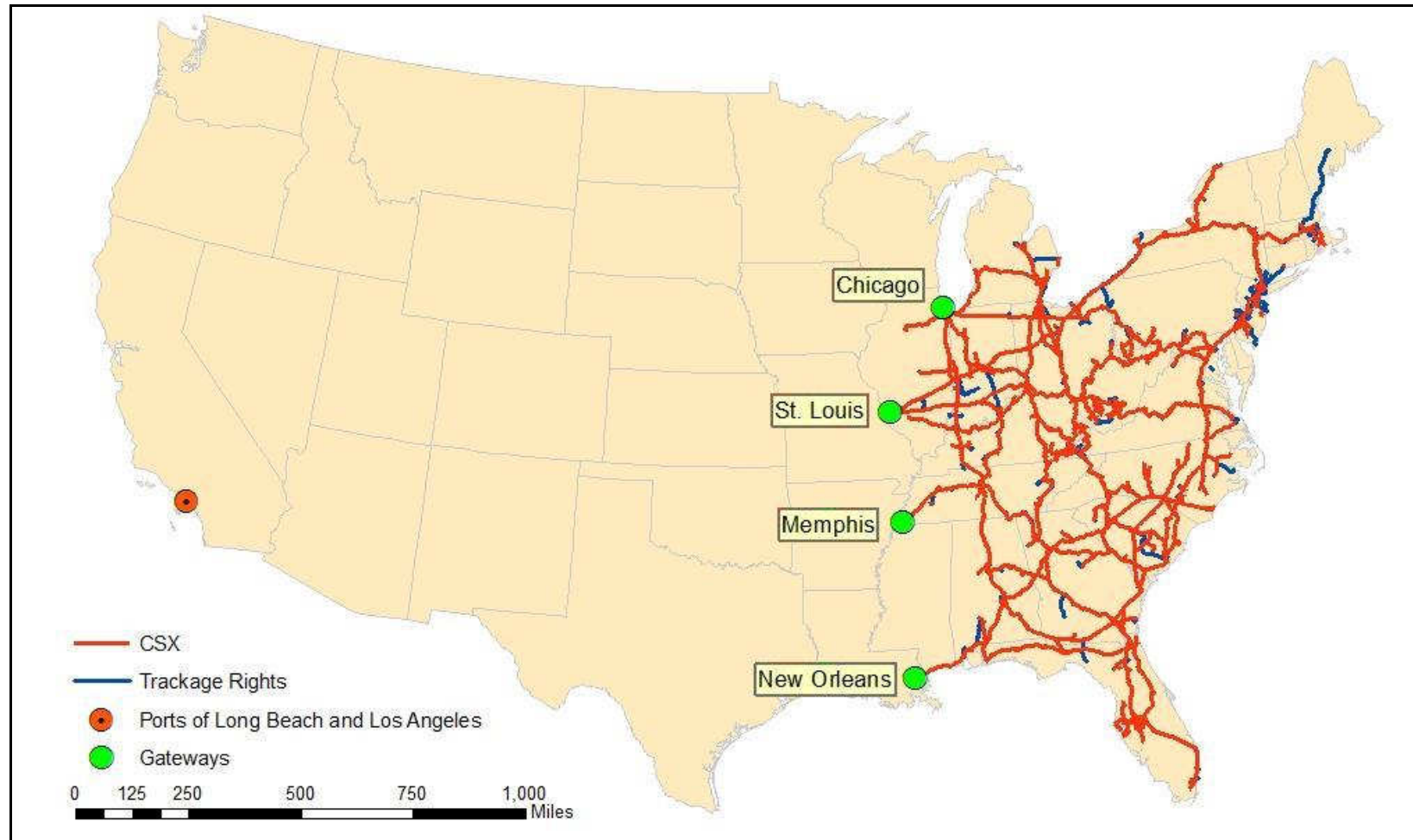
Map A.1 BNSF in 2005 (US Bureau of Transportation Statistics, 2006).



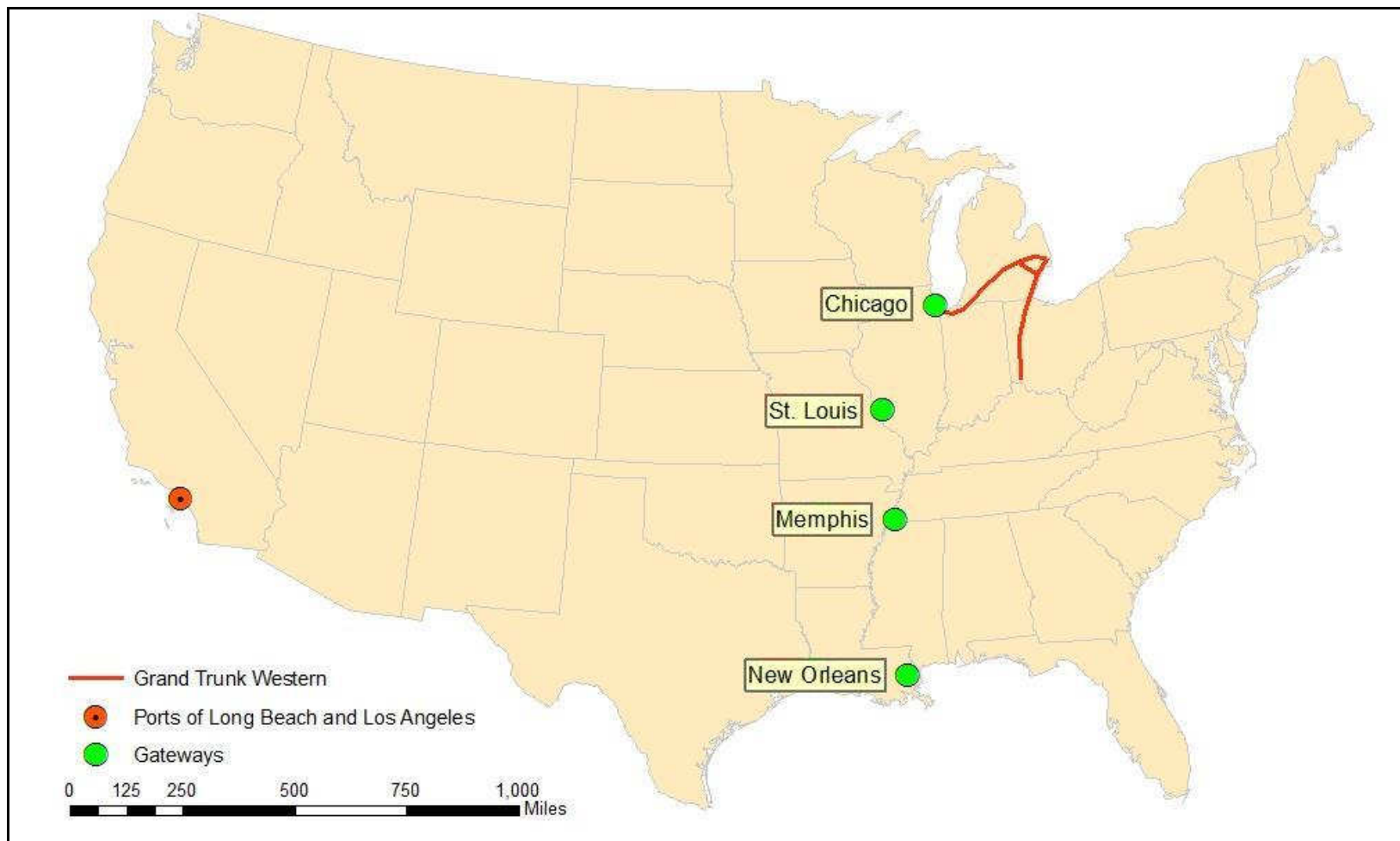
Map A.2 Canadian National/Illinois Central in 2005 (US Bureau of Transportation Statistics, 2006).



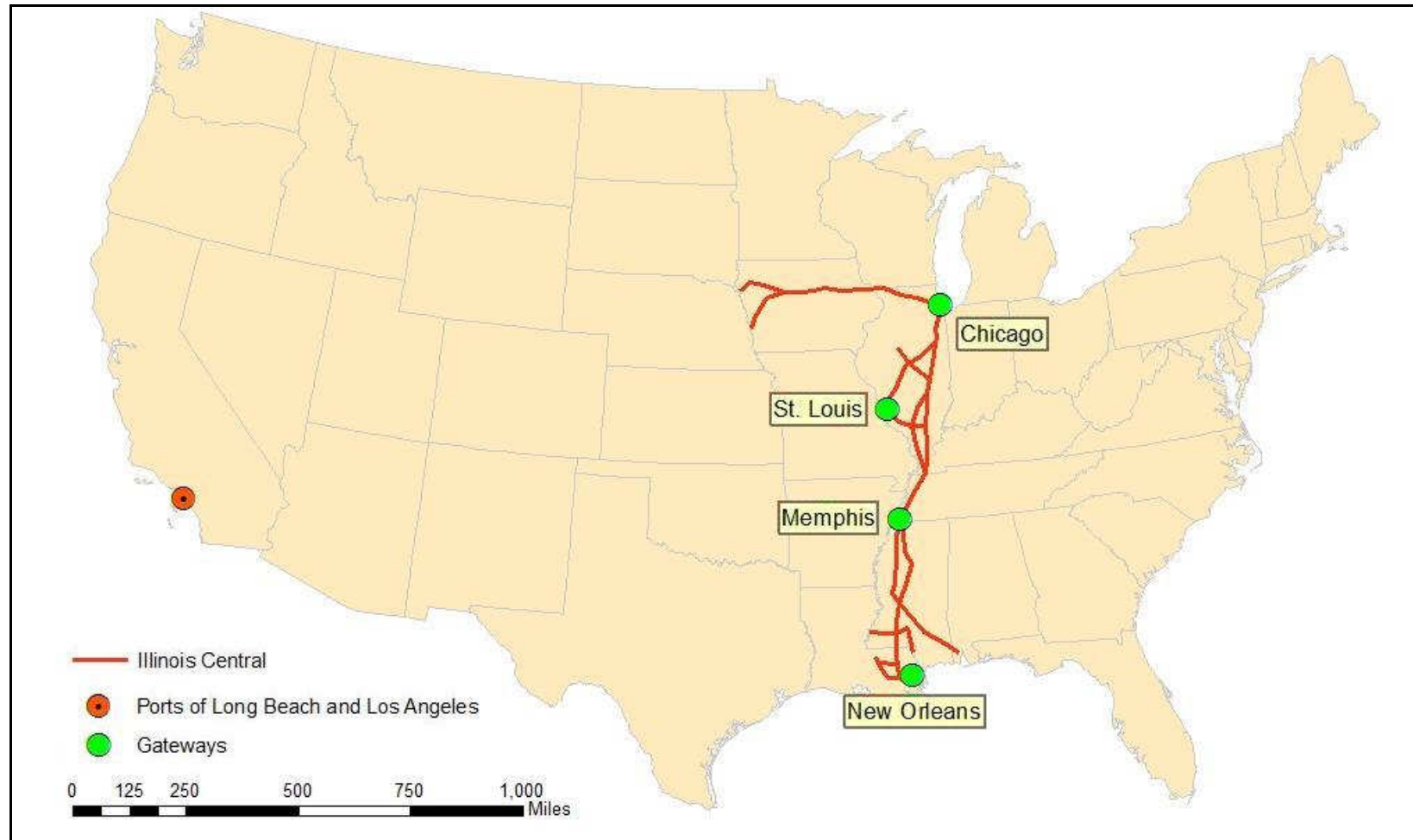
Map A.3 Conrail in 1997 (Trains, 1997).



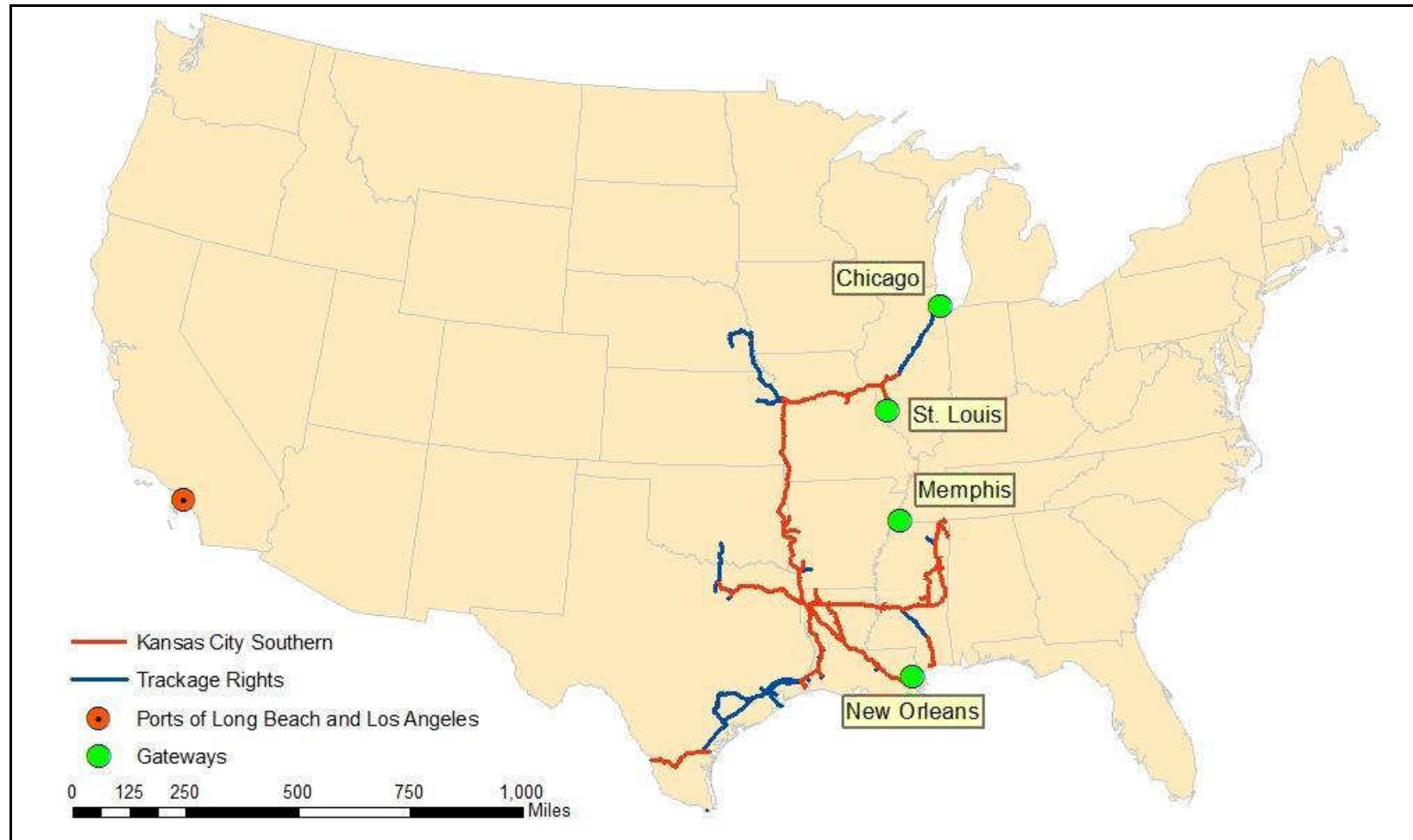
Map A.4 CSX in 2005 (US Bureau of Transportation Statistics, 2006).



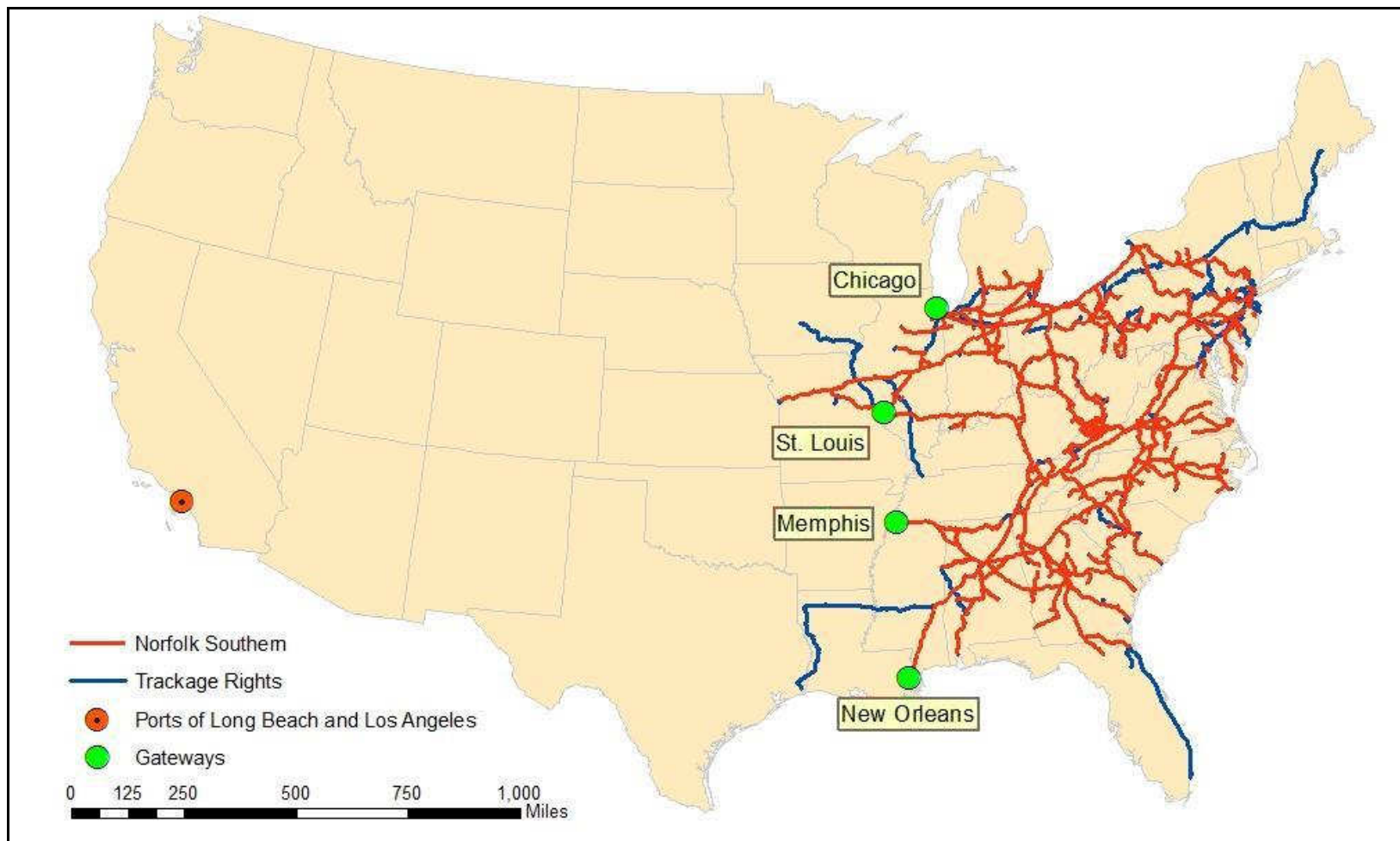
Map A.5 Grand Trunk Western in 1998 (Welty, 1998).



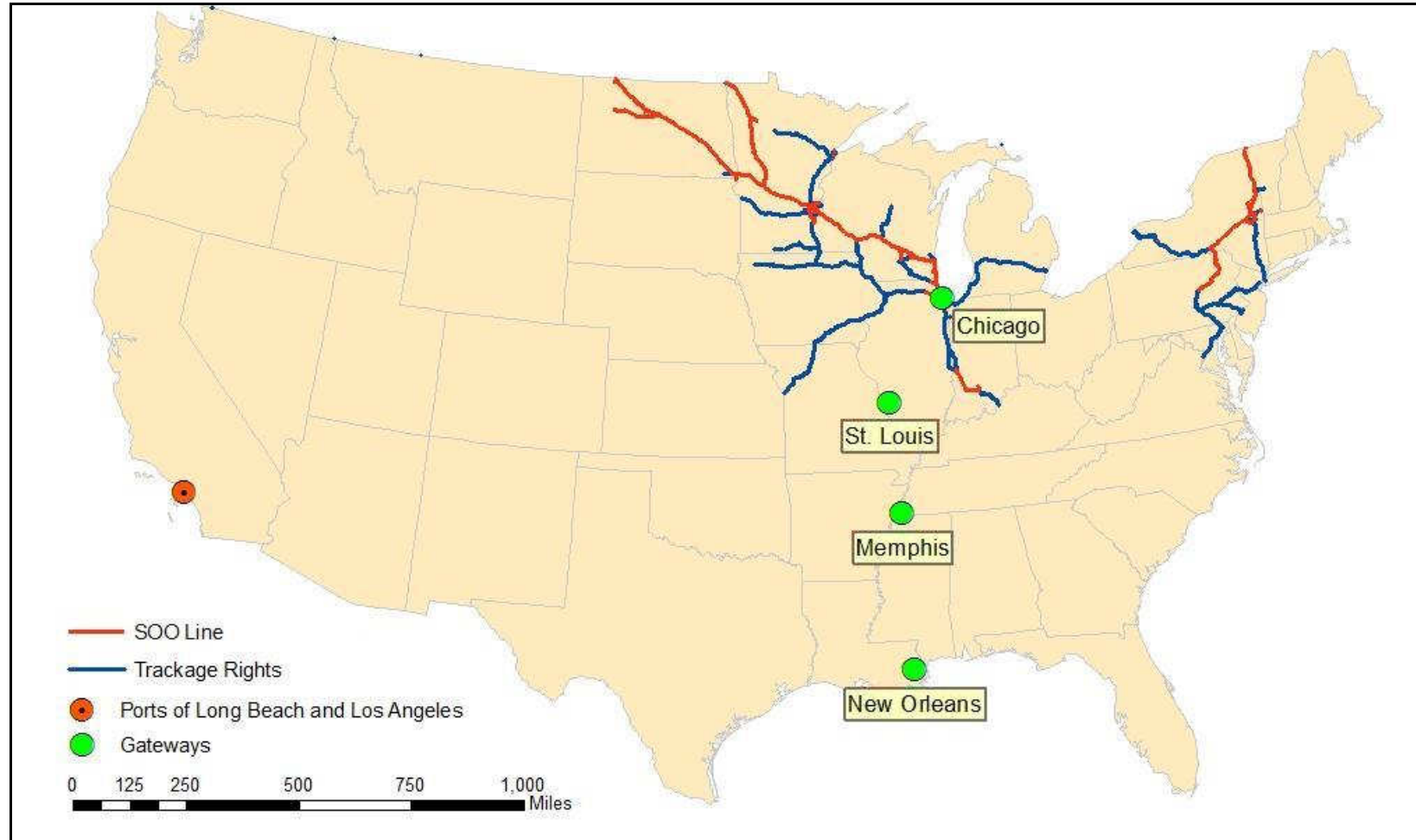
Map A.6 Illinois Central in 1998 (Welty, 1998).



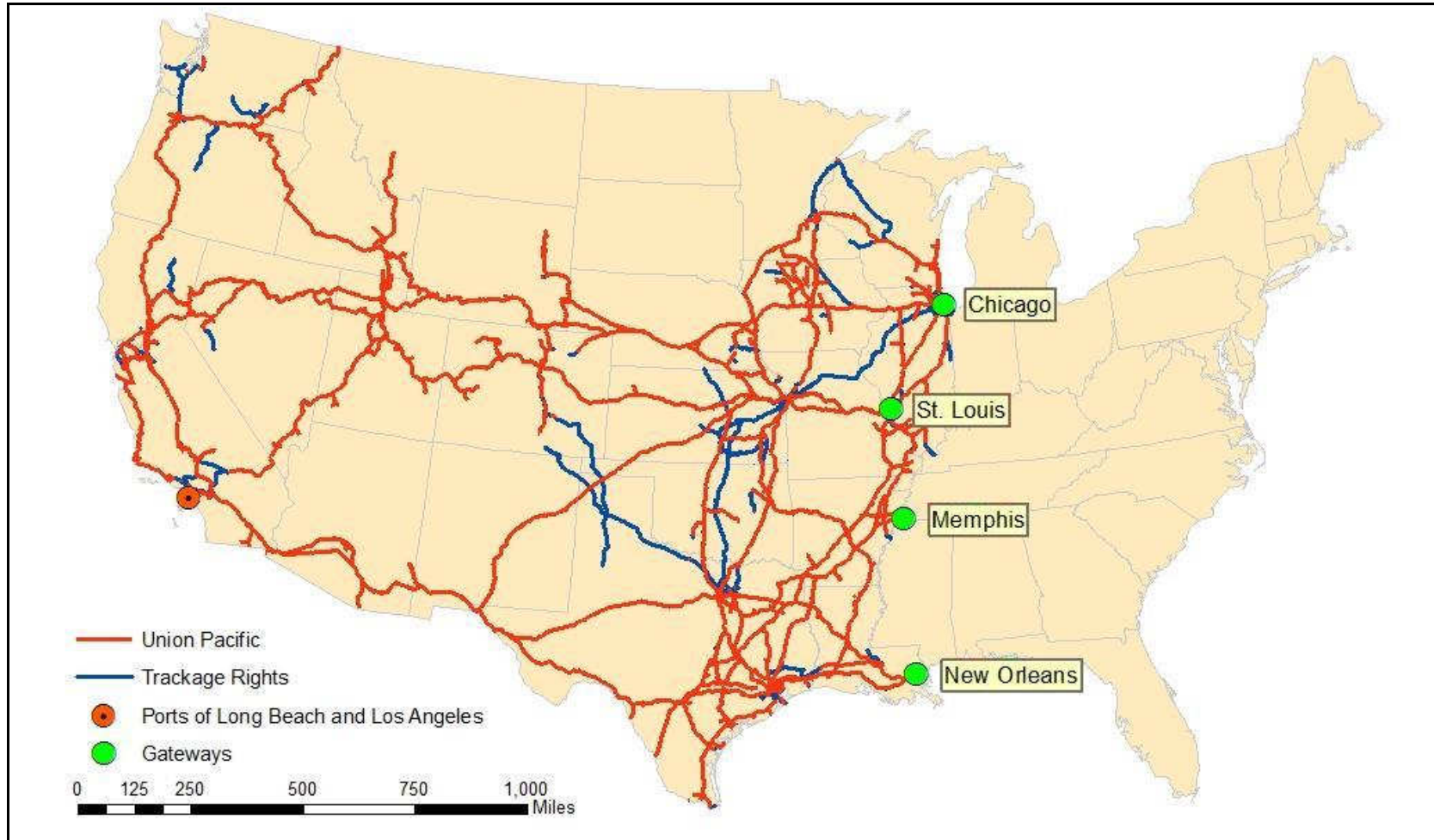
Map A.7 Kansas City Southern in 2005 (US Bureau of Transportation Statistics, 2006).



Map A.8 Norfolk Southern in 2005 (US Bureau of Transportation Statistics, 2006).



Map A.9 SOO Line in 2005 (US Bureau of Transportation Statistics, 2006).



Map A.10 Union Pacific in 2005 (US Bureau of Transportation Statistics, 2006).