Title
Synthesis of California Port Competitiveness Issues and Policy Recommendations

Author
Chu, Priscilla Eng Kyet

Publication Date
2020

Peer reviewed|Thesis/dissertation

UNIVERSITY OF CALIFORNIA,
IRVINE

Synthesis of California Port Competitiveness Issues and Policy Recommendations

THESIS

submitted in partial satisfaction of the requirements
for the degree of

MASTER OF SCIENCE

in Civil Engineering

by

Priscilla Chu

Thesis Committee:
Professor Stephen G. Ritchie, Chair
Professor Jean-Daniel Saphores
Associate Professor Wenlong Jin

2020

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

ACKNOWLEDGEMENTS

First, I want to thank my research advisors: Professor Ritchie and Craig Rindt from the Institute of Transportation Studies at UC Irvine. Your feedback and counsel during this endeavor was invaluable to me, and I am very grateful.

Thank you to my thesis committee, which included Professor Jin and Professor Saphores. The support you provided by offering me detailed feedback will always be remembered.

I also want to express my gratitude to Eric Shen. Thank you for taking the time to chat with my research team, sharing your knowledge, and providing guidance on how to make my research more relevant. Without you, my thesis would have taken a completely different direction.

Many thanks to my family for supporting me and cheering me on throughout my entire educational career. Thank you, Sam, for keeping me company during my writing sessions and offering useful insights along the way.

Lastly, thank you to Molly for proofreading my thesis, providing moral support, and being an all-around great friend.

ABSTRACT OF THE THESIS

Synthesis of California Port Competitiveness Issues and Policy Recommendation

by

Priscilla Chu

Master of Science in Civil Engineering

University of California, Irvine, 2020

Professor Stephen G. Ritchie, Chair

Over the past two decades, California's major ports have lost a significant percentage of market share to ports on the East Coast and Gulf Coast, and even to ports in Canada. The objective of this research is to review the most critical issues that are preventing California's ports from being more competitive and propose a plan of action to state lawmakers to help address these issues. California's declining grasp on the market can be attributed to a variety of reasons ranging from high costs due to stringent state environmental policies, to Californian ports' reputation of being unreliable based off of past labor disruptions. Another contributing factor to California's eroding market share is a lack of coordination between California's extensive network of maritime groups. The ports are an essential component of the maritime industry, a complex web that involves countless stakeholders and organizations. Accordingly, a review of the California Freight Mobility Plan was performed to evaluate the direction currently being provided to ports and the maritime sector, to identify shortcomings of these freight plans, and how to best address these shortcomings. California lacks a specialized maritime strategy,

which makes it difficult for stakeholders to work in tandem and bolster California's maritime competitiveness. It is concluded that such a maritime policy could address challenges the ports are experiencing, focus stakeholders' efforts and resources into a shared vision for the future of California's maritime sector, and benefit California's ports as a whole.

Chapter 1: Introduction

1.1 Background

California's ports are on track to being surpassed by competing ports. Although California's powerhouse container ports are still ranked among the United States' top ports, ports along the Gulf Coast and East Coast are growing at a faster rate than California's ports [1]. Some factors behind this shift were out of the control of California stakeholders, such as the widening of the Panama Canal, while other contributing factors could have been more proactively addressed or minimized, such as California's deteriorating infrastructure.

This thesis evaluates the status of California's ports, surveys how the ports are being supported, and suggests a potential solution that can be implemented by state legislators.

1.2 Research Objective

The focus of this research is investigating how to best promote port efficiency and throughput—two factors behind port competitiveness—through legislation. This thesis reviews the issues that are restricting California's ports from growing as quickly as their competitors and will provide a recommendation which combats these issues.

1.3 Thesis Outline

The remainder of this thesis is organized as follows:

Chapter 2, Challenges for California Ports

This chapter looks at the various issues that Californian ports are up against and provides context to explain why Californian ports have been losing market share. One of the issues addressed is that California is part of an extensive network of stakeholders—an overview of these stakeholders and their roles in the maritime sector is presented. Another issue the ports are dealing with is COVID-19, which has introduced unique challenges.

Chapter 3, California Ports

This chapter has individual overviews of the California ports. After each port is introduced, the ports are grouped by size, and comparisons are drawn between the groups. Then, a comparison is done between Californian ports and its competitors along the Gulf and Atlantic Coast.

Chapter 4, Existing California Legislation

To better understand the supporting role state legislators can play, Chapter 4 contains a review of legislation affecting the ports. This chapter inventories policies that have been proposed and implemented and analyzes the 2020 California Freight Mobility Plan.

Chapter 5, Recommendation

This chapter considers the information presented in Chapters 1 through 4 and makes a recommendation on how to support the ports most effectively through legislation.

Chapter 6, Conclusions

The final chapter condenses the findings of this thesis and suggests future areas of study.

Chapter 2: Challenges for California Ports

2.1 Current Situation

California's major ports have been losing market share over the past twenty years. A report prepared by the Pacific Merchant Shipping Association (PMSA) found that the largest West Coast ports—including the ports of Oakland, Long Beach, and Los Angeles—controlled 46.8% of all containerized trade at mainland U.S. ports in 2006, but by 2019, this percentage had dropped to 37.7% [1]. During this same time frame, East Coast ports' and Gulf Coast ports' share of the market increased from 41.7% to 46.5% and from 11.9% to 16.1%, respectively [1]. Focusing only on the Ports of Los Angeles and Long Beach, which make up the San Pedro Bay port complex and lead North America in containerized trade, reveals declining trends—out of North America's total containerized trade, the San Pedro Bay port complex garnered a combined market share of 26.5% in 2015, which fell to 22.9% in 2019 [2].

2.2 General Issues

There are multiple factors contributing to Californian ports' market share erosion. One factor is California's port infrastructure—Californian ports have not adequately modernized and improved their infrastructure for proper facilitation of international trade [1]. In contrast, over the last twenty years, port authorities along the East and Gulf Coast have invested billions of dollars into dredging and bridge-raising projects to ensure that their ports would be able to accommodate the mega-ships that arose in response to the widening of the Panama Canal [3]. Another reason behind Californian ports' market share erosion are the emissions regulations California has

implemented, such as the Clean Air Action Plan, and the costs—which are on the scale of billions of dollars—associated with compliance [4]. Gulf Coast and East Coast competitors do not observe such environmental regulations, thus putting Californian ports at a cost disadvantage [5]. More recently, the West Coast ports' loss of market share has been accelerated by the trade war between the United States and China—affected importers and exporters are expanding their business to alternative markets to maintain or increase sales. For instance, U.S. importers are shifting their sourcing from China to countries in Southeast Asia, while U.S. exporters are expanding their reach to new markets [2]. The San Pedro Bay port complex is hurt by these market shifts since China is a major trade partner for both ports, accounting for 46% and 50% of all trade at the Port of Los Angeles and the Port of Long Beach, respectively, in 2019 [6], [7]. In addition, the countries that U.S. importers and exporters are shifting their markets to are countries "where ports on the [East] and Gulf Coast [can] more effectively compete [2]," which further contributes to the decline of Californian ports' control over the market.

Another issue that is detracting from the competitiveness of Californian ports is rail-related cost disadvantages. Mercator, a consulting firm, was contracted by the Pacific Maritime Association to investigate rail rates and potential cost disadvantages for Californian ports [8]. This study specifically focused on Asian exports that are destined for inland markets—the Chicago, Memphis, Minneapolis, and Detroit hubs were highlighted—and concluded that Gulf Coast and East Coast ports can offer a cost advantage over West Coast ports ranging anywhere from $300 to $1000 per container. The Mercator report broke down freight transportation costs into three sub-costs: the cost of ocean shipping, freight transfer from ship-to-train, and inland transportation by rail. West Coast ports have the cost advantage over Gulf and East Coast ports when it comes to ocean shipping costs, as these costs are based on distance. As seen in Table 1,

Mercator's estimated ship-to-train handling and rail transport costs are estimated to be more expensive for West Coast ports than they are for ports along the East and Gulf Coast [8]. Mercator states that the higher rates charged by West Coast railroads, and the fact that East Coast ports are simply closer to inland markets explain why West Coast ports charge higher rail transportation costs than their competitors.

Table 1 – Transport cost comparison per container [8].

	Cost per FEU* container at the West Coast ports	Cost per FEU* container at East and Gulf Coast ports
Ship-to-train handling	$600-$660	$450-$545
Inland transportation by rail**	77 cents per mile	67-70 cents per mile

**Note: Forty-foot equivalent unit*
***Note: These are estimated costs, as the exact rates negotiated between ocean carriers and railroad companies are kept confidential.*

California's Freight Mobility Plan delineates additional issues that are harming California's ability to compete, several of which are outlined below.

Issues identified by Caltrans, plus several proposed courses of action are as follows [9]:

- California has been prioritizing an improved quality of living by passing more stringent environmental regulations. While this is important, the impacts these regulations are having on California's economic growth should not be overlooked. There needs to be a balance between environmental protection laws and investment in the ports' economic development, as well as greater efforts made to maintain employment, job security, and earnings security at the ports.
- Californian maritime stakeholders have stated that California's regulations are "frequent and unpredictable." These stakeholders are referring to how several investments that were

made to comply with prior regulations have been rendered obsolete as CARB continues to roll out increasingly stringent clean air action plans.

- Infrastructure and facility investments are often stalled at the local and regional levels. Local communities in California are known for their opposition to projects due to anticipated impacts, including noise, traffic, and emissions. In other words, California is not viewed as receptive to new developments like other states are. The Appendix of the Caltrans Freight Mobility Plan references one California-based industrial development company's report that "other states encourage projects…, in contrast to a perceived indifference or hostility to projects within California." Caltrans suggests that the State should focus on streamlining regulations (including environmental regulations) and the overseeing of commercial and industrial development, as this would provide more direction for agencies at the local level.
- Another issue Caltrans brings to the forefront is that when it comes to attracting and keeping business, California has a reputation for being "aloof." Such perceptions of California detract from California's competitiveness, but efforts to rebrand California's image could prove fruitful.
- Each of California's ports are local entities, rather than state entities. Several of California's competitors, such as ports in Georgia, Houston, South Carolina, are state agencies—these ports can draw upon state resources to help with new developments. Caltrans proposes the integration of "port and state economic development efforts and fund[ing] them" at a competitive level. More resources and funds are required if California wants to catch up to the economic development efforts that other states and Canada are pursuing.

- The alleviation of California highway congestion would increase California's capacity, and thus, competitiveness. Some of California's ports have been actively working to increase their capacity through infrastructure development projects, and these efforts could be further amplified through government support.

2.3 Complex Maritime Network

Californian ports play a key role in the maritime industry, a complex web made up of many organizations—these groups are of varying sizes, hold different purposes and roles, and harbor different interests. Collaborating optimally with all these groups is a challenge for the Californian ports since each maritime group has different priorities and motivations. For example, the ports' interests regularly clash with the interests of regulatory bodies such as CARB, which is highlighted when CARB releases new emissions regulations. The maritime industry has stakeholders at the federal level and the state level, ranging from state regulatory agencies, to ports (which will be covered in Chapter 4), to advocates representing various maritime groups. An overview of the maritime industry is provided in the remainder of Section 3.2.

2.3.1. Key Players in California's Maritime Network

2.3.1.1 Federal-Level

To understand the intricacies of California's maritime industry it is important to understand who is involved in the national maritime sphere.

2.3.1.1.1 Federal Agencies

- SECURITY AND NATIONAL DEFENSE
    - The **Department of Homeland Security (DHS)** [10] plays an important role in the maritime sector through their Port of Entry Security Program, which investigates the integrity of international freight. Homeland Security screens all freight being imported and exported to protect against terrorist threats and smugglers using specially developed technologies. Homeland Security works in partnership with the **U.S. Coast Guard**, border officials, and immigration officials to secure the United States' land, air, and sea borders. Another agency associated with DHS is the **U.S. Bureau of Customs and Border Protection**, which handles landside security [11].
    - Another relevant federal entity is the **United States Coast Guard**, which is a branch within the **Department of Homeland Security** and one of the five U.S. armed forces. The U.S. Coast Guard is a national maritime first responder, defending "marine resources and maritime commerce" and guarding against maritime terrorism through counterterrorism and anti-terrorism measures [12]. Like Homeland Security, the Coast Guard helps secure America's maritime borders, performing operations such as Search and Rescue, Aids to Navigation, and Marine Safety [13]. The Coast Guard works with other branches within Homeland Security and various other federal, state, and local agencies [14]. In addition, the Coast Guard acts as an interface between Homeland Security and the **Department of Defense**.
    - The **U.S. Army Corps of Engineers** supports California's ports by completing dredging projects. This responsibility fits into the Army Corps' mission of "strengthen[ing]... [national] security by building and maintaining America's

infrastructure [15].” In addition to dredging California’s ports, the Army Corps of Engineers contributes to the maritime sector by dredging other national waterways, developing infrastructure to minimize storm and hurricane damage, and cleaning up toxic waste.

- **United States of America Department of Transportation** oversees the following operating administrations and bureaus:
  - Federal Aviation Administration (FAA)
  - Federal Highway Administration (FHWA)
  - Federal Motor Carrier Safety Administration (FMCSA)
  - Federal Railroad Administration (FRA)
  - Federal Transit Administration (FTA)
  - Maritime Administration (MARAD)
  - National Highway Traffic Safety Administration (NHTSA)
  - Office of Inspector General (OIG)
  - Office of the Secretary (OST)
  - Pipeline and Hazardous Materials Safety Administration (PHMSA)
  - Saint Lawrence Seaway Development Corporation (SLSDC)
- **MARAD, U.S. DOT (Maritime Administration)** belongs to the U.S. Department of Transportation, and specifically handles waterborne transportation. Congress has set MARAD up with the tasks of “foster[ing], promot[ing], and develop[ing] the maritime industry” so that the maritime industry can fulfill America’s “economic and security needs [16].” MARAD also aims to connect America’s oceangoing transportation with the rest of the pieces making up its transportation network [17].

MARAD has a fleet of ships, called the National Defense Reserve Fleet, that are crewed by merchant mariners and are at the ready in times of disasters and war [18]. MARAD also protects the **U.S. Merchant Marine**, a maritime group composed of U.S.-flagged ships and U.S. mariners protected under the Jones Act.

- The motto of the **Federal Maritime Commission (FMC)** is "competition and integrity for America's ocean supply chain [19]." It is an independent agency whose responsibility is to advocate on behalf of United States consumers, exporters, and importers by regulating the U.S. international marine transportation system. The FMC is charged with tasks such as reviewing agreements between ocean carriers and terminal operators to ensure that transportation services and transportation costs are maintained, overseeing the rates of government-owned carriers to keep them reasonable, and addressing harmful conditions which arise concerning shipping between the U.S. and foreign countries. The main goals of the FMC are to "ensure competitive and efficient ocean transportation services for the shipping public" and to "[protect] the public from financial harm and [contribute] to the integrity and security of the U.S. supply chain and transportation system [19]."
- The **National Oceanic and Atmospheric Administration (NOAA)** is an administration under the U.S. Department of Commerce which tracks, forecasts, and monitors weather among other efforts. In addition, NOAA is involved in "coastal restoration and supporting marine commerce, …affect[ing] more than one-third of America's gross domestic product [20]."
- The **U.S. Navy's Military Sealift Command** provides ocean transportation capabilities for the **Department of Defense** and operates ships that are crewed by

non-military civilians [21]. These ships provide the U.S. Navy with critical supplies such as food and fuel.

- The **U.S. Transportation Command** works with the U.S. Navy's Military Sealift Command, the Army's Military Traffic Management Command, and the Air Force's Air Mobility Command and provides the **Department of Defense** with "land, sea, and air transportation assets required to respond to any event worldwide [22]."
- **National Maritime Intelligence Integration Office (NMIO)** [23]—The purpose of this office is to protect the United States, allies of the United States, global interests, and partners against all global maritime threats. This office has several roles, such as acting as the foremost maritime advisor to the Director of National Intelligence, representing the U.S. Intelligence Community on maritime issues, and helping unite connections between government, academia, and industry against maritime terrorists. NMIO also supports the maritime community by streamlining maritime information and intelligence that will help "stakeholders to proactively identify, locate, track, and defeat threats."

- DEPARTMENTS/REGULATORY BODIES – POLICY/REGULATION/ENFORCEMENT
  - Regulations for food imports and exports are created by the **United States Department of Agriculture** [24].
  - The **Department of Commerce** helps "negotiate bilateral trade agreements" to protect American businesses from disadvantageous deals and promote fair trade [25].
  - The **Department of Energy** has a stake in the maritime industry because it is invested in expanding maritime usage of renewable energy [26].

- The **Department of Labor** is home to the **Occupational Safety and Health Administration (OSHA)**, which has an office for maritime regulations**,** the **Office of Maritime and Agriculture**. The Office of Maritime and Agriculture creates safety standards and guidelines which impact the maritime and agriculture industries [27].
- The **Marine Mammal Commission** is a government agency which has influence in the maritime sector because they seek to protect marine mammals and their habitat by investigating how "science, policy, and management actions [affect] marine mammals [28]."
- All transportation accidents, including those that are maritime related, are investigated by the **National Transportation Safety Board (NTSB)** [29]. The NTSB also conducts transportation safety studies.
- The **U.S. Committee on the Marine Transportation System (CMTS)** [30] belongs to the U.S. Department of Transportation and is presided over by the Secretary of Transportation. It is responsible for improving the U.S. maritime transportation system through the following methods:
    - Evaluate the United States' marine transportation system—this includes ports, waterways, channels, and intermodal connections
    - Work to better integrate the nation's maritime transportation system with other transportation modes
    - Coordinate and make recommendations on federal policies which will impact America's marine transportation system

  The CMTS accomplishes its duties by coordinating between various federal and sub-level agencies.

2.3.1.2 State-Level

2.3.1.2.1 Ports

Ports play a critical role in California's maritime and logistics industries. California's twelve ports are heterogeneous and diverse in terms of specialty, location, and size. Benicia is the only port out of these twelve that is privately owned. To make comparisons more straightforward, the ports were categorized by size and specialty.

Table 2 is adapted from Bearth and the 2019 Pacific Maritime Association's Annual Report.

Brief port profiles exploring California's ports on an individual basis can be found in Chapter 4.

Table 2 – California ports, listed from highest to lowest revenue tonnage (2019 data).

Port Name	2019 Revenue Tonnage [31]	Freight Types [32], [33]	Classification
Los Angeles	115,597,740	Containers, automotive, break bulk, dry bulk, liquid bulk, heavy lift, project cargo, refrigerated, passenger	Major
Long Beach	102,360,079	Containers, automotive, break bulk, dry bulk, liquid bulk, heavy lift, project cargo, refrigerated, passenger	Major
Oakland	32,439,750	Containers, break bulk, dry bulk, liquid bulk	Major
Port Hueneme	6,369,662	Containers, dry bulk, liquid bulk, automobile, passenger	Minor, Regional
San Diego	5,333,253	Automobile, containers, passenger	Minor, Regional
Stockton	3,458,744	Container, break bulk, dry bulk, liquid bulk	Minor, Specialty
Benicia	2,575,029	Automobile	Minor, Specialty
San Francisco	2,105,748	Break bulk, dry bulk, liquid bulk, passenger	Minor, Specialty
Redwood City	1,983,903	Container, dry bulk, liquid bulk	Minor, Specialty
Richmond	1,671,722	Container, break bulk, dry bulk, liquid bulk	Minor, Specialty
West Sacramento	724,985	Break bulk, dry bulk, liquid bulk	Minor, Specialty
Eureka	277,097	Forest products	Minor, Specialty

2.3.1.2.2 Advocates

A large portion of stakeholders are advocates for parties involved in the maritime sector such as the ports, workers, and shipping companies.

1. All of California's publicly owned ports (11 in total) are members of the **California Association of Port Authorities (CAPA)**. CAPA advocates on a state level, national level and globally—educating policymakers about port operations while also advocating for the ports' best interests concerning any issues impacting port operations (i.e. "Issues relating to transportation, trade, the environment, land use, energy… [etc.]") [34]. CAPA also interfaces with federal groups such as the **Federal Maritime Commission** on behalf of the ports it represents. CAPA's overarching mission is to bolster the competitiveness of California's ports.

   CAPA's structure involves a president and vice president, along with a Board of Directors comprised of representatives from each of California's public ports. The current president, Gene Seroka, is from the Port of LA [35]. In February 2020 on California Ports Day, CAPA met with state government officials to remind them of California ports' contributions to the state economy, and struggles the ports are experiencing to remain competitive [36]. This meeting was organized to ensure state lawmakers and maritime interest groups were all on the same page, so that future legislation can address relevant challenges the ports are facing.
2. The **International Longshore and Warehouse Union (ILWU)** [37]**:** This organization represents approximately 40,000 workers from West Coast, Alaskan, and Hawaiian ports. ILWU has more than 50 local unions, each of which have their own Executive Board, Board of Trustees, and relevant committees. At the top of the hierarchy is the Union's International

Convention, a group which meets once every three years—the Convention holds the power to "adopt resolutions and statements of policy on political, economic, and other issues and to amend the International Constitution," an important ILWU document. In addition to the Convention, there is an International Executive Board which enforces the International Constitution; this board meets three times a year at minimum. An important group within the ILWU is the Coast Longshore Division, which is formed by about 30 local unions—this group shares a set of agreements which establish a baseline for benefits, vacations, salaries, and so on. Some of the Coast Longshore Division's core documents are agreements negotiated between the ILWU and the **Pacific Maritime Association** (more on PMA later). The Coast Longshore Division also has a committee whose purpose is to decide on a common set of demands that will be made during any upcoming contract negotiations. On the other hand, when it comes to settling local issues and agreements, each local union within the Coast Longshore Division is expected to operate autonomously.

3. The **Pacific Merchant Shipping Association (PMSA)** [38] is a non-profit organization whose members are owners and operators of marine terminals on the West Coast, and general maritime stakeholders who conduct business at the West Coast ports. In addition, PMSA represents owners and operators of domestic and foreign vessels. PMSA's members trade in Asia primarily, but also have ties to Europe, South America, and the Mediterranean. Members of PMSA include: Blue Water Shipping, BNSF Railway, Long Beach Container Terminal, Maersk, Pasha Stevedoring and Terminals, Pilot Thomas Logistics, SSA Marine, TraPac, and Yang Ming [39]—this is not an extensive list of PMSA's members, but gives an idea of PMSA's membership portfolio. PMSA advocates for its members concerning international trade issues, proposed legislation, and regulations. PMSA further supports its

members by providing them with information on relevant developments within the shipping industry and environmental regulatory sphere.

PMSA released a briefing paper in June 2020 to highlight how West Coast ports have been losing their market share to other ports in North America through figures and statistics [40]. Then in July 2020, PMSA sent Governor Newsom and California's state legislators a call to action backed by more than 50 stakeholders [41]. This call to action delineates causes behind California's loosening grasp on the market and proposes actions which state lawmakers can take to help the ports regain their competitiveness. PMSA's suggestions encourage lawmakers to heighten promotions of California ports, revisit existing legislation that may be negatively impacting the ports, and "recapture lost market share."

PMSA has offices in Oakland, Long Beach, and Seattle and has a 9-member Board Staff.

4. The **Pacific Maritime Association (PMA)** is an organization which represents domestic and international ocean carriers, stevedores, and terminal operators. PMA consists of a 15-member executive team, as well as a Board of Directors that is composed of representatives from several of the PMA's clients.
5. The **California Marine Affairs and Navigation Conference (CMANC)** is a "consortium of California harbors, ports, and marine interest groups." On their website CMANC categorizes its members into two groups: public and corporate. All the California ports, as well as various cities and harbor districts fall under the public category. The corporate side consists of a plethora of engineering consulting firms.
6. The **California Marine and Intermodal Transportation Advisory Council (CALMITSAC)** organizes the California Maritime Leadership Symposium, an event that brings together the ports and various maritime and "intermodal transportation" organizations.

This symposium provides an opportunity for legislators to discuss with representatives from the maritime sector, educate themselves, and become aware of the challenges that California's maritime industry faces.

7. Like its name suggests, the **Seafarers International Union of North America, AFL-CIO (American Federation of Labor and Congress of Industrial Organizations)** represents 80,000 North American merchant mariners and aims to secure mariner jobs. The Seafarers International Union has 12 sub-unions, each of which operate autonomously [42], and a 10-member executive board which oversees the Union.
8. **The Maritime Alliance** was recently renamed "TMA BlueTech" and is a non-profit organization based in San Diego. This organization pulls key maritime groups together to cultivate innovations in technology that will address maritime technology needs.

2.3.1.2.3 Regulatory & Government Agencies

The stakeholders within this section are primarily government establishments. Some of the roles they play within the maritime industry include providing funding and establishing policies for the maritime sector to abide by.

1. The **California Department of Transportation (Caltrans)** is known for maintaining, improving, and supporting California's transportation system. This extensive transportation system includes California's highways, freeways, airports, and seaports. Caltrans regularly produces a statewide Freight Mobility Plan which details California's long-term "planning activities and capital investments" relating to freight movement [43]—California's 12 seaports are major modes in California's freight transportation network, and are thus covered

in the Freight Mobility Plan. The 2020 California Freight Mobility Plan provides a brief overview of California's ports on an individual basis, while also acknowledging that other states' ports are proving to be fierce competition.

2. The **California Air Resources Board (CARB)** is in partnership with the **U.S. Environmental Protection Agency (EPA)**, as well as 35 local air pollution control districts. The objective of each of these parties is to control and reduce air pollution. At the top of the hierarchy is the EPA, which sets nationwide emissions standards and manages state endeavors, including CARB's. CARB sets air quality standards for the state of California, aiming to reduce air pollution through regulations. This role also includes overseeing local air pollution control districts. The ports are under CARB's jurisdiction and so must comply with all relevant regulations and programs. There are programs for regulating emissions from any port-related sources, such as drayage trucks and ships calling at the ports [44].
3. The **California Energy Commission (CEC)** develops energy policies and pursues innovations in energy and renewable energy. The reason the CEC is relevant when discussing the maritime industry is because the CEC works with organizations such as the seaports to invest in clean energy projects. The CEC grants $100 million on an annual basis to fund such endeavors—qualifying projects include the California ports' purchases of zero or near-zero emission medium and heavy-duty trucks.
4. The **Southern California Association of Governments (SCAG)** is the largest Metropolitan Planning Organization in the United States, serving 191 cities and six counties—Los Angeles, Orange, San Bernardino, Riverside, Ventura, and Imperial. The governing structure of SCAG is complex, with a General Assembly composed of representatives from all

member cities and counties, a Regional Council that is smaller because it consists of one representative from each county, various committees, and subcommittees.

5. The **California State Lands Commission** oversees land use and development within California, issuing leases such that California's environment can be protected while still allowing interested parties to partake in California.
6. The **U.S. Maritime Service** self-declares itself as the "forgotten service." It is unclear whether they are still an active entity, but they were participants in a roundtable discussion held at CSU's Maritime Academy in 2016. The purpose of this entity is "serve as a naval or military auxiliary in time of war or national emergency."

2.4 Impacts of COVID-19

The COVID-19 pandemic has taken a major toll on the California ports, and in different ways over the course of 2020. Cruise ship line visits have been suspended at ports with a cruise ship service, such as Los Angeles and San Diego. Volumes have been in decline at all Californian ports due to cancelled sailings. For example, an article by the San Mateo Daily Journal found that the Port of Redwood City's tonnage figures in September 2020 were down 21% when compared to one year prior—these declines were attributed to "decreased consumer demand, government mandates and canceled sailings [45]." The San Mateo Daily Journal also reported that the Port's largest tonnage reductions occurred in the fourth quarter of the 2019-2020 fiscal year. During this quarter, government mandates restricting the construction industry had a ripple effect, impacting the Port of Redwood City as well. Since the Port of Redwood City specializes as a feeder port for construction projects in the Bay Area, construction industry developments dictate the health of the Port. As of September 2020, the Port has not had to

modify operational levels and cargo volumes are recovering [45]. Another small Californian port, the Port of Hueneme, has grown over the past decade because of its expanding automobile trade. Due to stagnant car sales and lessened automobile production, Hueneme has projected a loss of $2.7 million for 2020 [46].

Early in the pandemic, Los Angeles and Long Beach were also experiencing decreases in volumes—more than 25% of sailings were cancelled at the Port of Los Angeles that were scheduled to happen between February-April 2020 [47]. China is a major trade partner at the San-Pedro Bay complex, so the production levels of Chinese companies plummeting in the early months of the pandemic had an especially consequential impact on the Ports of Los Angeles and Long Beach. However, Bill Mongelluzzo, from the Journal of Commerce, reports that in the more recent months of the COVID pandemic, the Los Angeles-Long Beach port complex have been overwhelmed with imports [48]. Ports along the West Coast generally have time-to-market advantages due to their closer proximity to inland destinations. However, the Port of Los Angeles and the Port of Long Beach in particular have received the "largest proportion of Asian imports" because of their infrastructure capacity and the extensive services they can offer. Mongelluzzo reports that in September 2020 alone, total Asian imports headed for the United States increased by 13.1% year over year, with Asian imports arriving at the Los Angeles-Long Beach port complex increasing 22.1% year over year. In comparison, Asian imports increased 10.1% at New York-New Jersey and 9.2% at Oakland but decreased 7.1% at Seattle and Tacoma. The high import volumes traversing through the Los Angeles-Long Beach port complex have rendered the complex at nearly full capacity—resulting consequences include longer dwell times for containers, longer truck turn times, and chassis shortages. Ocean carriers predict that the Southern Californian ports will continue to receive large shipments of "PPE, e-commerce

products, and holiday-season merchandise" going into November and possibly all the way through January 2021.

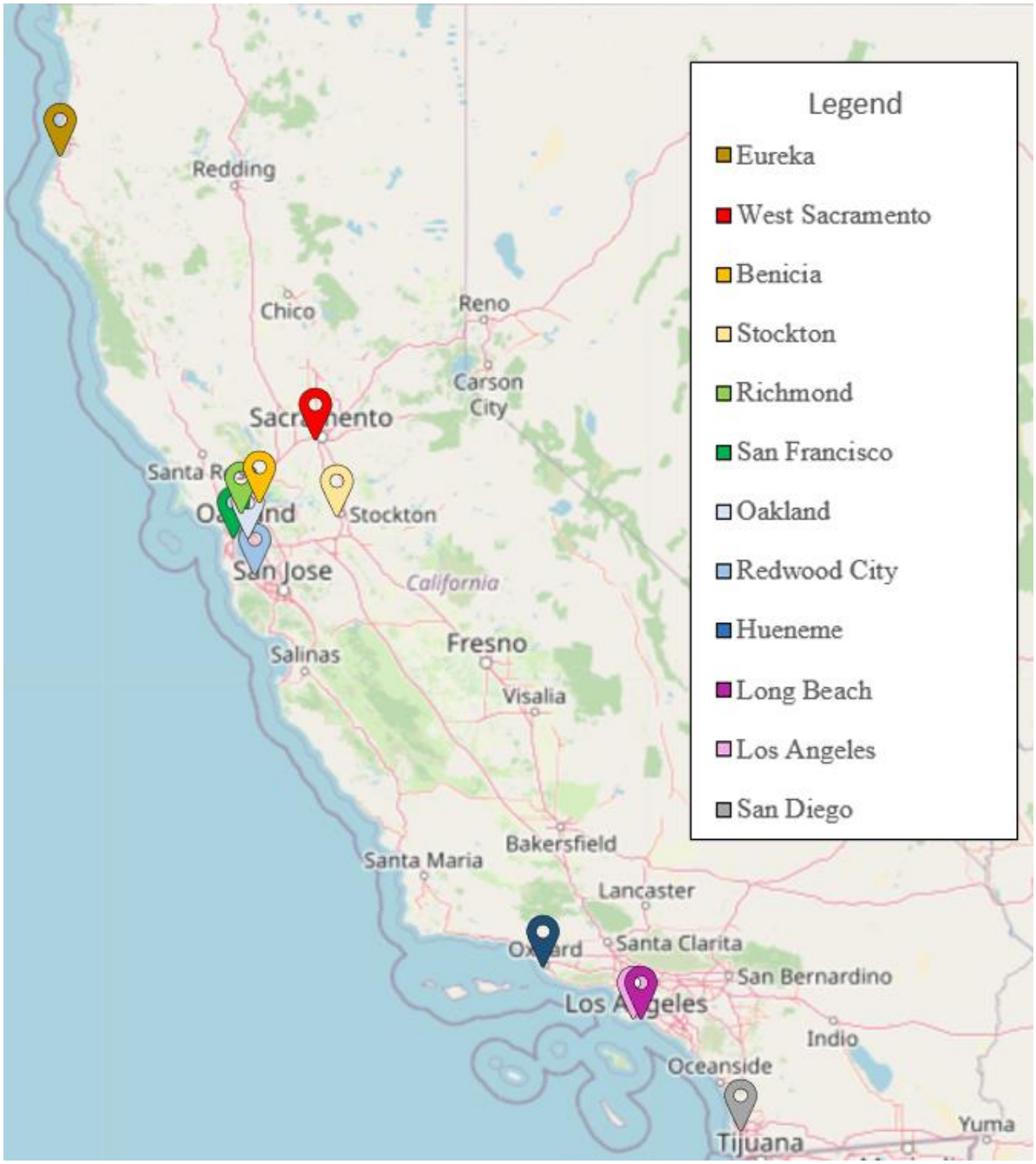
Chapter 3: California Ports

3.1 Individual Port Spotlights

All information within this section is pre-COVID and is meant to provide context on how each port was performing prior to the pandemic. California's twelve ports are as follows, in order of most to least yearly throughput (based on 2019 revenue tonnage data) [31]:

- Port of Los Angeles
- Port of Long Beach
- Port of Oakland
- Port of Hueneme
- Port of San Diego
- Port of Stockton
- Port of Benicia
- Port of San Francisco
- Port of Redwood City
- Port of Richmond
- Port of West Sacramento
- Port of Eureka

Figure 3 – Approximate map of California port locations.



**Note: The base map was pulled from OpenStreetMap.org.*

This chapter provides condensed writeups on each Port. Each port writeup contains figures that were generated using data obtained from the Pacific Maritime Association's annual reports

(2007-2018). Maps of the three largest Californian ports (Los Angeles, Long Beach, Oakland) are included in Appendix A.

3.1.1 Port of Los Angeles

3.1.1.1 Background

Port of LA is ranked the highest valued port in the United States, specializing in bulk cargo, containers, and automobiles. In 2018, the Port's trade accounted for 15% of national port commerce. The majority of the Port's trade partners are Asian countries; trade with China alone accounted for 46% of the Port's overall annual trade ($127B) in 2019 [6]. 26% of all freight moving through the Port is handled by on-dock rail [49], a percentage that is projected to increase every year [49] as the Port relies more on on-dock rail and develops additional on-dock rail facilities. The Port is investing in greener infrastructure and technology for compliance with strict environmental regulations passed in the early 2000s.

3.1.1.2 Historical Performance

The Port of Los Angeles has seen increased cargo volumes over the last decade, which can be attributed to a booming global economy. Figure 4-Figure 6 reflect relatively stable positive growth in overall volume, revenue tonnage, and container TEUs. In 2015 the Port opened a new on-dock rail facility [50], which may explain the increase in container volume from 2015-2018, seen in Figure 6. The Port launched automated on-dock rail at its TraPac terminal in 2016, which may further explain Figure 6. Less stable sectors at the Port were automobiles, general cargo, forest products, and bulk cargo. 2017 was a peak year for the Port's automobile trade (Figure 7), but since the Port "has reached its maximum capacity," [51] there

will be no additional growth until the Port expands its automobile facilities. General cargo had its peak in 2014 (Figure 8), then plateaued from 2016-2018. Given that containerized cargo volumes increased during this same period, the Port may have repurposed general cargo resources to better handle containers. The Port's bulk cargo numbers, depicted in Figure 10, are riddled with spikes and drops, switching off about every other year. These trends may be explained by market fluctuations causing bulk cargo shipments to be turbulent.

Figure 4 – LA volumes.

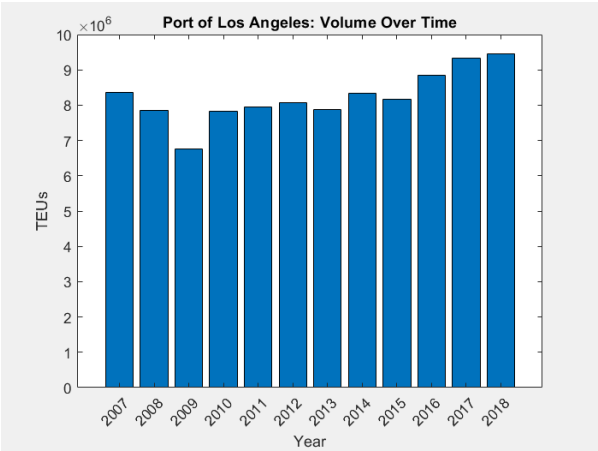


Figure 5 – LA revenue tonnage.

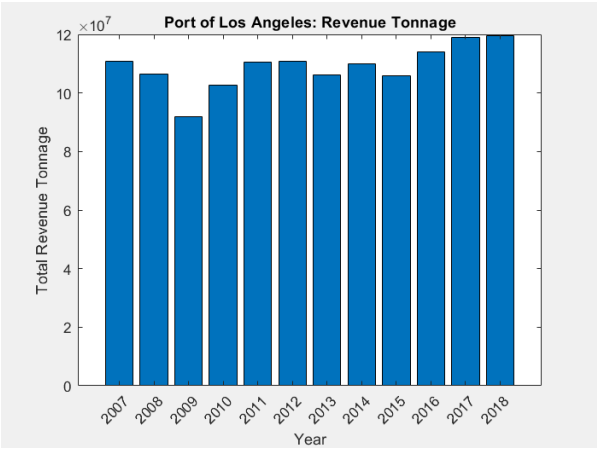


Figure 6 – LA containers (TEUs).

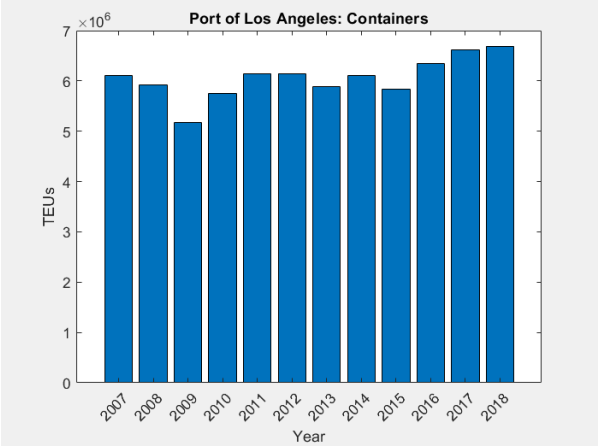


Figure 7 – LA automobiles.

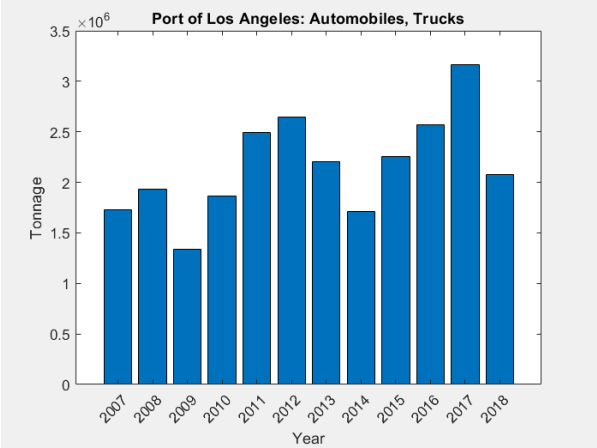


Figure 8 – LA general cargo.

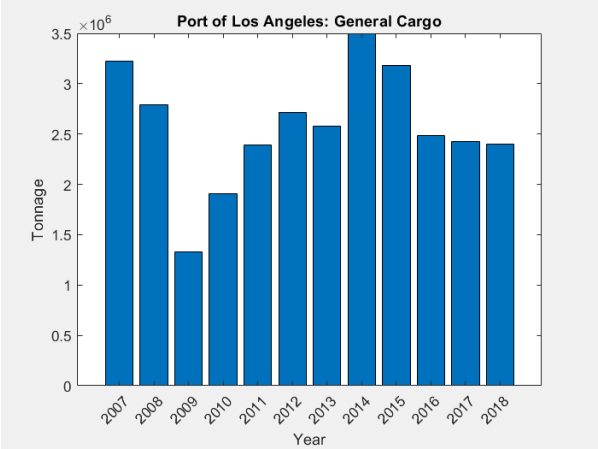


Figure 9 – LA lumber and logs.

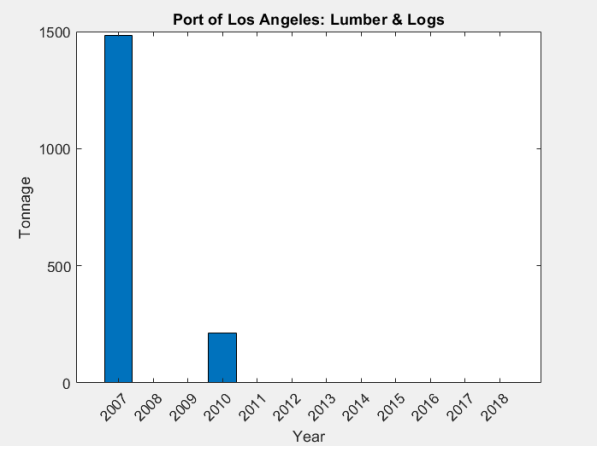
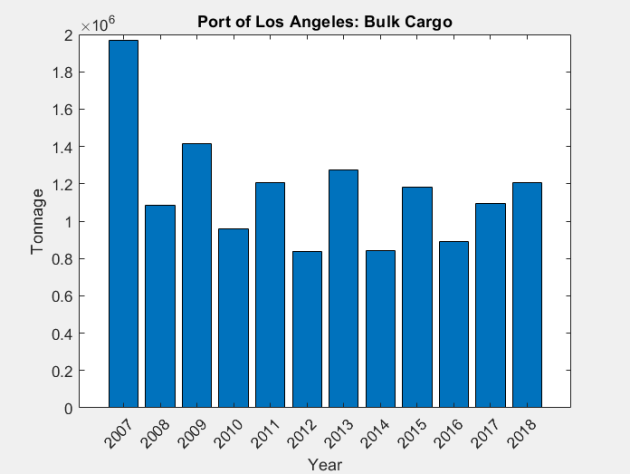


Figure 10 – LA bulk cargo.



3.1.1.3 Future

- The Port of Los Angeles has made several technology investments—since infrastructure developments take years to plan, pass, and complete, technological improvements can yield more immediate benefits.
    - The Port of Los Angeles has been relying on computerized systems to arrange trucker appointments. In October 2019, the Port achieved its fastest truck turn times since 2013, with turn times nearly 25% lower when compared to times posted earlier in the year. The Port is also investing in new data-sharing tools

to improve availability of information for truckers regarding container pickups and near-Port congestion [52].

- The Port of Los Angeles has also made physical infrastructure investments.
    - Expansion: Since the San Pedro Ports have already met Clean Air Action Plan (CAAP) requirements for 2023, the Ports set aside a combined $6B which will be used for expansion projects [52].
        - Everport Container Terminal Improvement: Multiple berths at this terminal will be deepened to accommodate more sizeable vessels [53].
        - Pier 400 Corridor Storage Tracks Project: This project will add additional storage tracks and extend an existing rail bridge [53].
        - Terminal Island Railyard Enhancement Project [54]: This project will expand an existing intermodal rail yard on Terminal Island, thus increasing its capacity to as much as 525,000 additional TEUs annually. These TEUs will be shifted from off-dock rail yards, which will mean the number of truck trips will be reduced. Most of the project will be funded by SB1's Trade Corridor Enhancement Program ($21.6M of the needed $34M).
        - Marine Oil Terminal & Engineering Maintenance Standards (MOTEMS) project: This project will upgrade one of the Port's existing wharves to have a concrete loading platform.

3.1.2 Port of Long Beach

3.1.2.1 Background

Port of Long Beach is the 2nd busiest container port in California and ranked 3rd in North America for throughput [2]. The Port deals in all types of cargo, ranging from bulk cargo to automobiles. Recent years have proved fruitful for the Port, with consecutive growth over the past three years in overall revenue tonnage. Congestion is a major problem at the Port of Long Beach and the Port must actively address these issues to continue growing. China dominates nearly 50% of all trade that the Port of Long Beach conducts, which in total is valued at $194B every year [7]. East Asia, as a whole, accounts for 90% of all trade at the Port [55].

3.1.2.2 Historical Performance

Figure 11 and Figure 12 offer insight into overall freight trends at Long Beach over the past decade. RoRo cargo (Figure 14), general cargo (Figure 15) and forest products (Figure 16) are all industries at the Port that have not fully recuperated to pre-recession performance levels. On the other hand, containerized cargo, overall volumes, revenue tonnage, and bulk cargo have made complete recoveries. 2015 marked the completion of the Green Port Gateway Rail project, which increased on-dock rail capabilities to the point that 1/3 of containers could be moved using on-dock rail [50]. The completion of this project coincides with the beginning of a rising trend in containerized cargo, demonstrated in Figure 13. Another explanation behind rising trends following 2015 might be the Port's efforts to optimize its supply chain in 2015. The goal of this supply chain optimization was to improve speed and efficiency while keeping costs low, as well as increasing dependability through better technology and more data [56].

Figure 11 – Long Beach volumes.

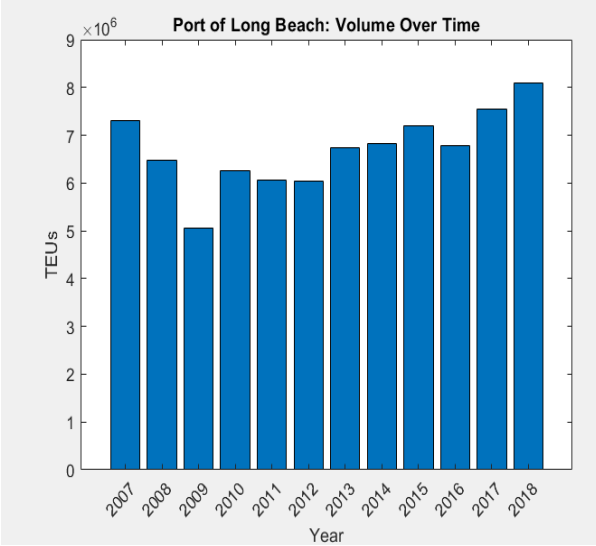


Figure 12 – Long Beach revenue tonnage.

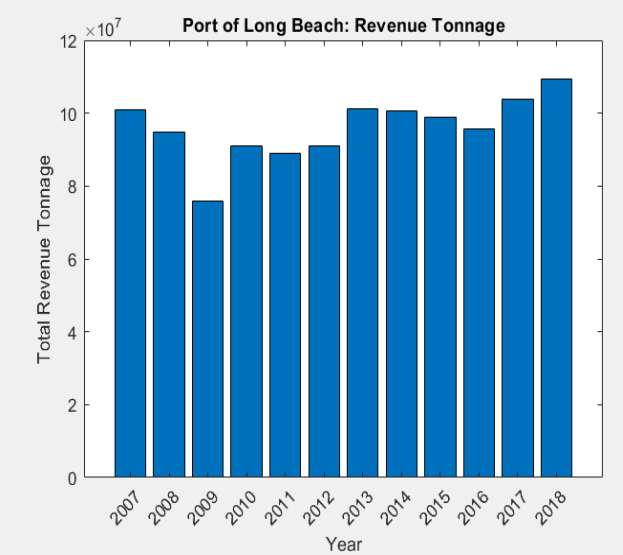


Figure 13 – Long Beach containers.

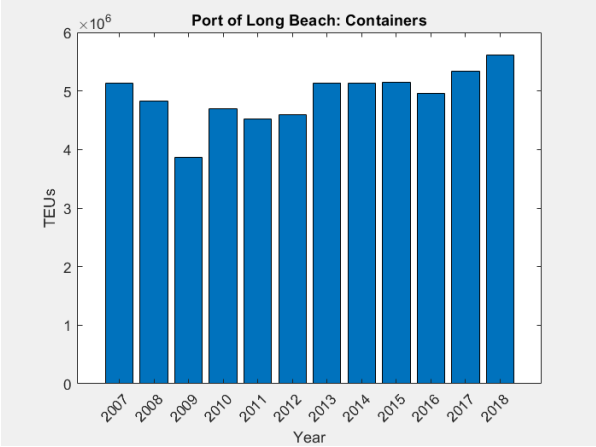


Figure 14 – Long Beach automobiles.

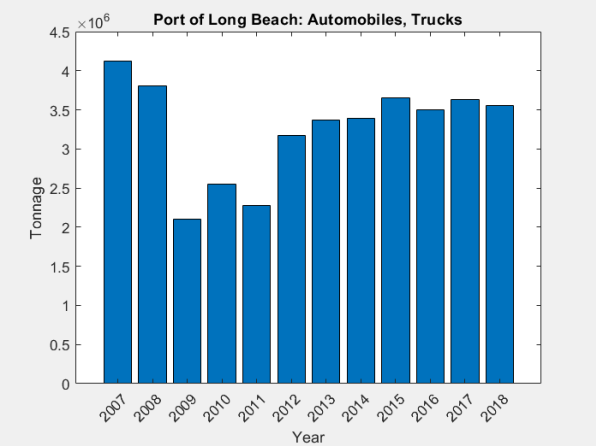


Figure 14 exhibits a stagnation in automobile tonnage over the past five years. The Port of Long Beach does not have sufficient space in its facilities to allow for expansion or optimal handling of automobiles. Currently the Port's automobile business partners, such as Mercedes-Benz, own vehicular distribution and storage facilities several miles away from the Port, but delay exporting vehicles out of the Port when sales slow [51]. These delivery postponements lead to further congestion at the Port, which already does not have adequate space for vehicle handling.

Figure 15 – Long Beach general cargo.

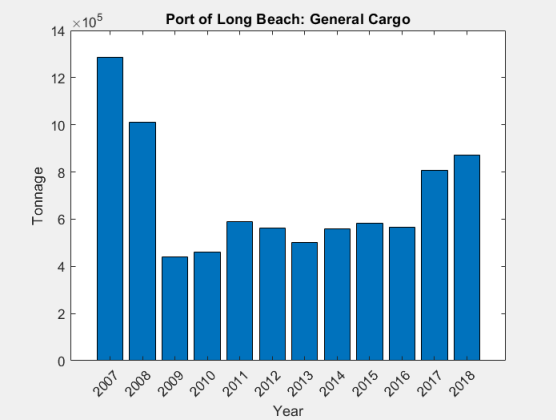


Figure 16 – Long Beach forest products.

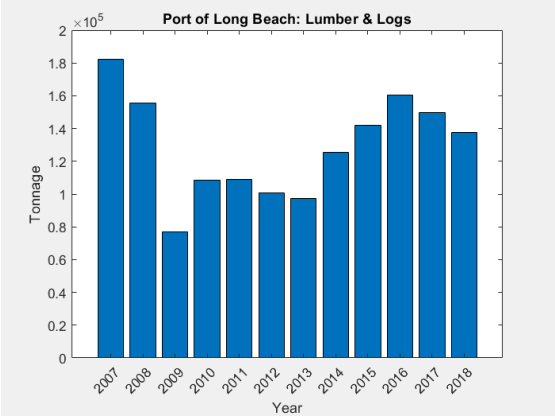
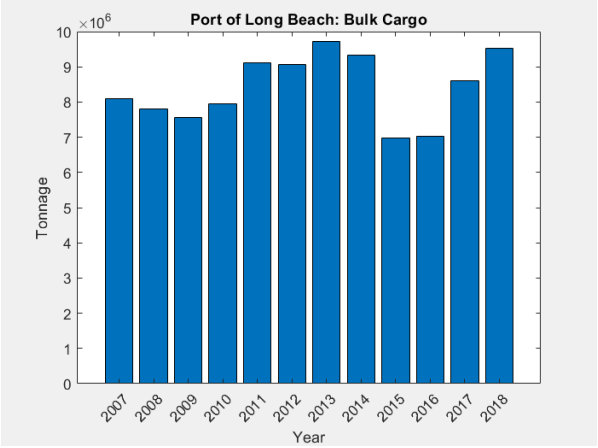


Figure 17 – Long Beach bulk cargo.



3.1.2.3 Constraints

The Port of Long Beach, like other large ports, is heavily impacted by the fluctuations of trade—for example towards the end of 2018 when the U.S. government threatened to impose 25% tariffs on goods from China, manufacturers front loaded shipments in an attempt to mitigate their losses [57]. Because of this development there was a buildup of cargo at the Port, as retailers deliberated on which locations in the Eastern portion of the U.S. they should ship their cargo to. The Port bore the brunt of this accumulation while other large U.S. ports were left unscathed by congestion due to delayed shipments [57]. Congestion is a critical issue that the

Port of Long Beach deals with regularly. Chassis shortages are one major reason behind congestion; when there is a backlog of cargo, terminal operators store cargo everywhere they can, including on chassis. When chassis are in short supply, suppliers cannot move their cargo around efficiently; "hundreds of chassis are sitting under loaded import containers that can't be unloaded at the warehouses, ...[while] hundreds more are stuck with empty containers that...terminals are refusing...because there is no space at the terminals" for empty containers [57]. Another contributor to congestion at the Port is miscellaneous rail problems, which cause delays to the trains departing and result in some containers being stuck for days to weeks [57].

3.1.2.4 Infrastructure Plans

The Port has several infrastructure projects in motion to improve traffic flow, upgrade its rail system, and reduce congestion. Ongoing projects at the Port include dredging, new wharfs, rail improvements, and redevelopment of port terminals [58]. See Appendix A for a map displaying all project locations.

1. Gerald Desmond Bridge Replacement [59]: The new replacement bridge will have a higher vertical clearance than the original bridge, which will allow larger vessels to be accommodated. The new bridge will also have additional lanes for improved traffic flow.
2. I-710 Corridor Project: The I-710, also called the Long Beach Freeway, is a heavily congested corridor that is crucial to the movement of cargo processed at the Port. Infrastructure updates are desperately needed, and the Port is conducting a study to gauge what the environmental impacts of such projects would be.
3. Middle Harbor Terminal Redevelopment Project: This project will consolidate two outdated terminals into one large terminal. The terminal consolidation is projected to cut

air pollution by 50% at the terminal, increase on-dock rail capabilities, and expand terminal capacity [58], [60]. After the redevelopment is complete, the terminal's upgraded capacity will be 3.3M TEUs annually.

4. Pier B On-Dock Rail Support Facility: Pier B currently serves as an important connection in the Port's rail network, acting as a storage and staging space for trains and cargo. This infrastructure project aims to increase on-dock rail capacity, through an array of methods. The current situation is that longer trains are being staged on main track lines, blocking the path for other trains that need to get through. Additions will be made to the facility so that it can handle these longer trains that need to be staged upon arrival, or while preparations are being made before departure [61]. The Pier B project will also connect the Pier to the Alameda Corridor and to on-dock rail facilities. An estimated 12,750 truck trips per day will be eliminated due to this project [61].

3.1.2.5 Future

The biggest deterrent to the Port of Long Beach's growth is the congestion issues prevalent in the Port's operations, such as in the rail system, in truck lines, or within the Port. If the Port can reduce congestion by working out chassis issues and random rail problems, these improvements, along with investments in infrastructure, will prove beneficial to the growth of the Port's operations.

3.1.3 Port of Oakland

3.1.3.1 Background

Port of Oakland, California's 3rd highest value port, specializes in containerized cargo and bulk cargo. Over the past decade the Port has experienced little growth in trade (a ~7% rise in revenue tons over the past decade); however, its trade numbers have remained stable throughout the years. The Port is reducing truck congestion by publishing current turn time data, which helps truckers better plan their schedules [62], and investing in infrastructure projects which expand the Port's access to rail [63]. Oakland is the fastest gateway for all containers bound for Asia, and has a competitive advantage when attracting refrigerated cargo [64].

3.1.3.2 Historical Performance

The Port's annual tonnage has slowly increased from just under 2.4 million TEUs in 2007 to 2.55 million TEUs in 2018, shown in Figure 18. The Port went from processing 29 million revenue tons (2007) to 31 million revenue tons (2018), for a growth of approximately 7%.

Figure 18 – Oakland volumes.

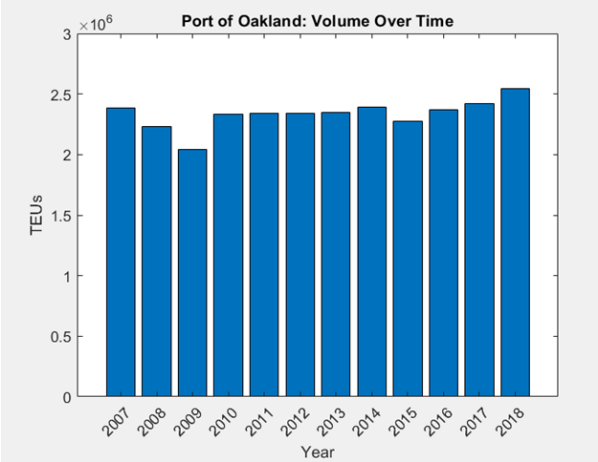


Figure 19 – Oakland revenue tonnage.

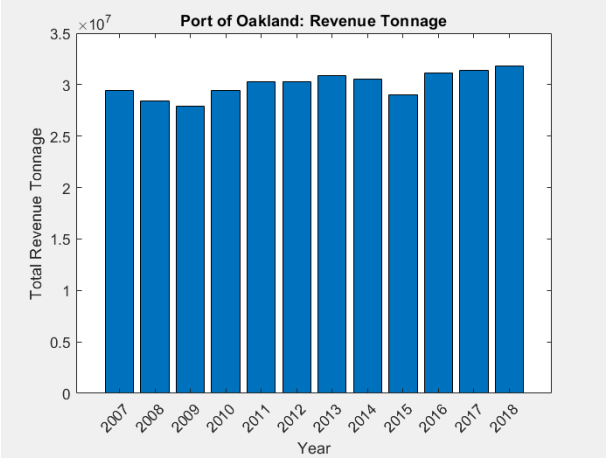


Figure 20 – Oakland containers (TEUs).

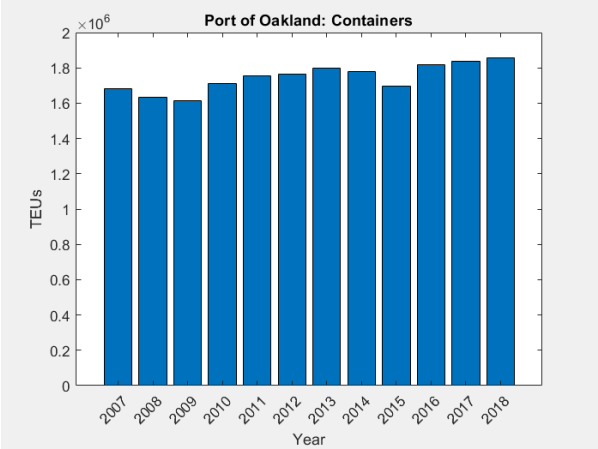


Figure 21 – Oakland automobiles.

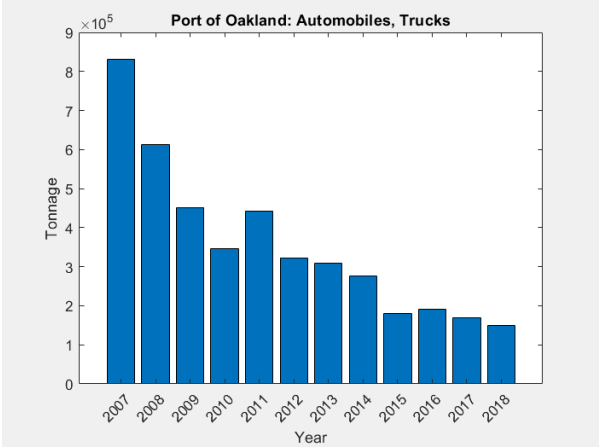
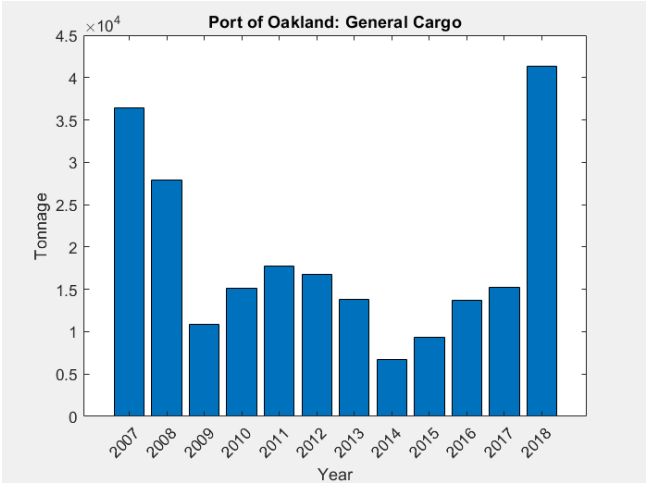


Figure 22 – Oakland general cargo.



Regardless of slight fluctuations in trade volume over the past decade, the Port's primary type of cargo—containers—has hovered above 1.6 million TEUs per year, with a net growth of 10% from 2007 to 2018 (Figure 20). As shown in Figure 21, automobile trade has sharply declined over the last decade. General cargo trends at Oakland are more difficult to decipher, with a sharp decrease in tonnage from 2007 to 2009, a slight uptick in performance moving into 2011, another decline over the following years, and then an upward trend through 2018 (Figure 22).

3.1.3.3 Constraints

Due to investments in infrastructure over the past decade, the port has sufficient capacity for projected cargo volumes—however, Oakland's paramount constraint to growth involves landside inefficiencies. One bottleneck is significant gate down time due to train crossings located at major intersections. This leads to heavy traffic congestion inside the port, especially along arterial roads such as Maritime Street, 7th Street, and Middle Harbor Road (see Appendix A) [65]. Truck queues have a wait time of up to 3 hours simply to enter the marine terminals [66]. These delays result in truckers missing their pickup or drop off appointment windows, along with increased air pollution and GHG emissions while idling.

Another drag on Oakland's growth is the limited multimodal access to relevant locations in the San Francisco Bay, including various commercial developments and recreational centers [67]. Oakland has historically faced limited rail issues because the Port of Oakland primarily serves Northern California--the Port's close proximity to the market it is serving means that containerized cargo is more efficiently transported by trucks rather than trains. However, over the past five years, Oakland has made strides in its rail access with the completion of a $100M, 35-acre railyard, and additional rail lines at its new refrigerated distribution site, Cool Port Oakland.

3.1.3.4 Future

The Port is focusing its efforts on infrastructure projects that will heighten the seaport's efficiency, relieve congestion, and shift the port towards clean energy. Substantial infrastructure investments include the Cool Port project and the Global Trade & Logistics Complex project. Cool Port recently opened in November 2018 and adds enough capacity to ship 1 million additional tons of cargo [68]. In addition, the Global Trade & Logistics Complex is slated to open mid-2020 and is forecasted to improve port efficiency by eliminating more than 100 thousand truck trips [63]. Due to frequent improvements to its infrastructure, the Port seems to be on track to perform consistently like it has in the past, with definite potential to grow more than it has in the past decade. Oakland is also upgrading its operations and increasing efficiency through technology in tandem with physical infrastructure improvements, rather than simply focusing on building additional physical infrastructure which can take many years to come to fruition. Technology projects such as the Oakland Portal, which will supply truckers with real-time information on turn times, traffic conditions, and cargo status [62], and the GoPort Freight Intelligence Transportation System [67] demonstrate the Port's efforts to constantly increase its competitiveness, while the new Cool Port facility and Seaport Logistics Complex reflect the Port's proactive efforts to continually further the Port. The Port is focusing its efforts on infrastructure projects that will heighten the seaport's efficiency, relieve congestion, and shift the port towards clean energy.

3.1.4 Port of Hueneme

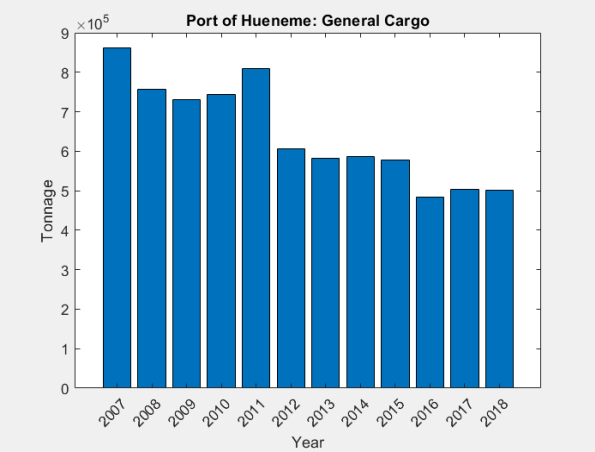
3.1.4.1 Background

The Port of Hueneme is thriving in part due to its prime position as the only deep-water seaport between Los Angeles and San Francisco [69] and proximity to Los Angeles. In 2019, the Port ranked 35th highest value seaport in the United States [70]. The Port is historically known for specializing in produce, but the Port has expanded its horizons to include a booming trade of automobiles as well—recently motor vehicles have been the Port's top export and import [69]. Hueneme does not have the same congestion issues that other ports struggle with, which is helping to accelerate its business growth. This is convenient for the Port especially since it is nearing full capacity in its operations. The Port has near-dock rail connections to the local Ventura County Railroad, which allows the Port to serve the surrounding region, and connections to the Union Pacific Railroad [71].

3.1.4.2 Historical Performance

The Port of Hueneme's revenue tonnage has increased by about half a million revenue tons since 2009, with growth levelling off around 2015. Starting in 2015, the Port has hovered at around 6M revenue tons—it appears that the Port has reached its full capacity given that trade has stopped increasing at the steady pace it had been from 2009 to 2015.

Figure 27 – Hueneme general cargo.



reveals how general cargo tonnage decreased from approximately 850,000 tons in 2007 to 500,000 tons in 2018. This loss was most likely due to the Port needing to reallocate resources to support expansion of trade in other sectors, such as containerized cargo, automobiles, and bulk cargo. Figure 24, Figure 25, and Figure 26 support this interpretation. Containerized freight in 2018 was 2.5 times the TEUs recorded in 2007 (Figure 24). Figure 25 illustrates how automobile trade has soared, doubling in tonnage from 2009 to 2018. Bulk cargo has been less stable over the past ten years, experiencing some fluctuations, but tonnage has remained comparable across the decade (Figure 26).

Figure 23 – Hueneme revenue tonnage.

Figure 24 – Hueneme containers (TEUs).

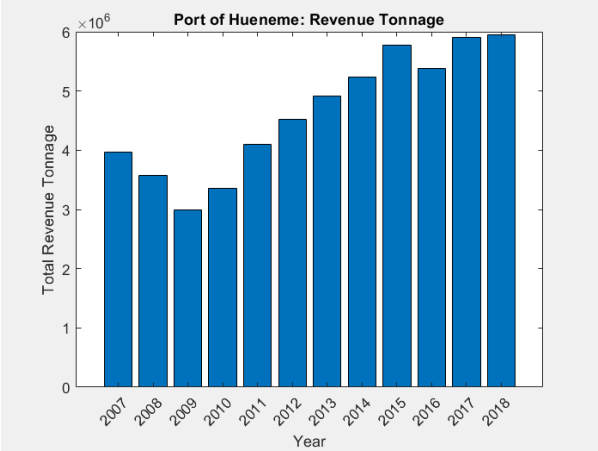


Figure 25 – Hueneme automobiles.

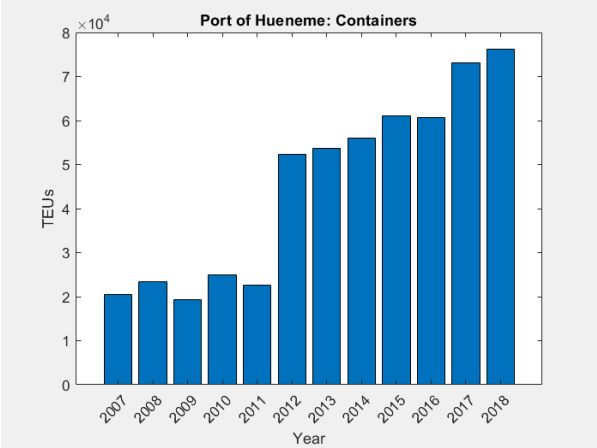
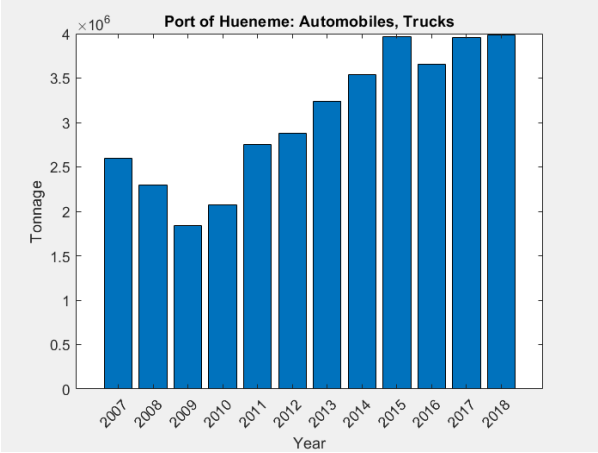


Figure 26 – Hueneme bulk cargo.



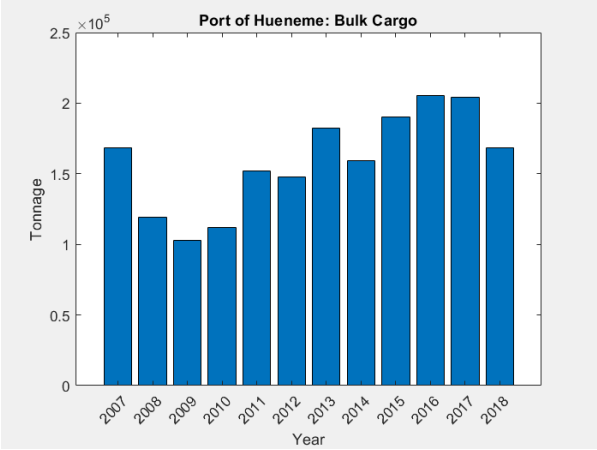
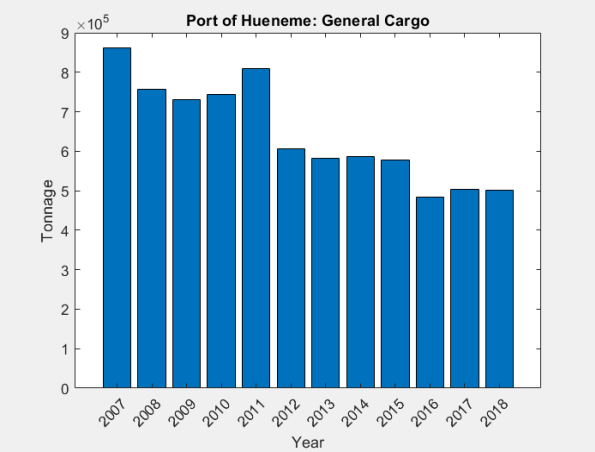


Figure 27 – Hueneme general cargo.



3.1.4.3 Future

Hueneme has not grown complacent with its success, especially since success has brought with it increased demand. The Port acquired a new crane in the middle of 2019 with the intent of improving efficiency and cargo unloading capacity [72]. There are ongoing dredging projects [73], as well as other various infrastructure projects. The Port's South Terminal is undergoing major renovations, including channel deepening and demolition of obsolete facilities [74]. This will allow the Port to accept ships laden with heavier loads and free up enough space to double the Terminal's current cargo handling area, respectively [74]. Remodeling the cargo handling area enables the Port to stay relevant amidst new shipping trends: shipping companies have switched from transporting fresh produce in containers instead of on pallets, so the Port's previous practice of using on-dock storage was rendered obsolete [75]. Also, as its facilities reach full capacity, the Port is striving to maximize infrastructure use by increasing rail usage, reducing ship dwell time, and exploring different methods of consolidating its automobile storage [51]. Upgrades in rail would allow the Port to increase cargo throughput while also expanding the Port's reach to areas of the country such as the Pacific Northwest, Midwest, and

Southeast area [76]. Currently the Port has nearly 200 acres of land dedicated to automobile storage, but is feeling space constraints [51]. There is also a new $135M "Multimodal Optimization and Vehicle Efficiency" project in the works, which aims to increase efficiency of cargo transportation at the rail, truck, and ship level. To support this goal, the Port is working to develop a Multimodal Logistics Park to increase capacity and reconfigure traffic flow within the port [77].

3.1.5 Port of San Diego

3.1.5.1 Background

The Port of San Diego, one of California's mid-sized ports, handles containers, automobiles, refrigerated cargo, break-bulk cargo, and dry-bulk cargo. The Port is ranked 43rd nationally in terms of cargo value and is California's 6th highest valued port [78]. There is much more going on at the Port than just cargo trading; the Port of San Diego is a bustling hub for a multitude of industries—the Port runs a cruise ship business, shipbuilding & ship-repair business (14,000 employees) [79], and commercial activities. Furthermore, the Port is home to the U.S. Navy's largest base in the Pacific [80]. Much of the infrastructure improvements happening at the Port are waterfront related [81].

3.1.5.2 Historical Performance

The Port's annual tonnage in 2018 was 1.27 million tons. The Port has experienced some net growth over the past decade in container shipments; however, in the areas of revenue tonnage, automobiles, lumber & logs, bulk cargo, and general cargo, the Port had negative net

growth from 2007 through 2018 (Figure 28-Figure 33). The sharp decline in tonnage across these various industries occurred around 2007-2009, during the Great Recession. Since 2009, the Port of San Diego has gradually recovered, but still has not made a full comeback to how much tonnage was being passed through the Port in 2007. Of note is the Port's lumber and logs numbers, demonstrated in Figure 31. Lumber and logs, a declining industry, stopped being traded at the Port in 2014—this partially explains lower overall revenue tonnage at the Port in more recent years, compared to 2007 numbers. Similarly, the bulk cargo industry at the Port experienced a 57% drop from 2007 to 2008, dropping even further in 2009 (Figure 32). Since 2009, bulk cargo tonnage has not returned to even half of 2007's tonnage.

Figure 28 – San Diego revenue tonnage.

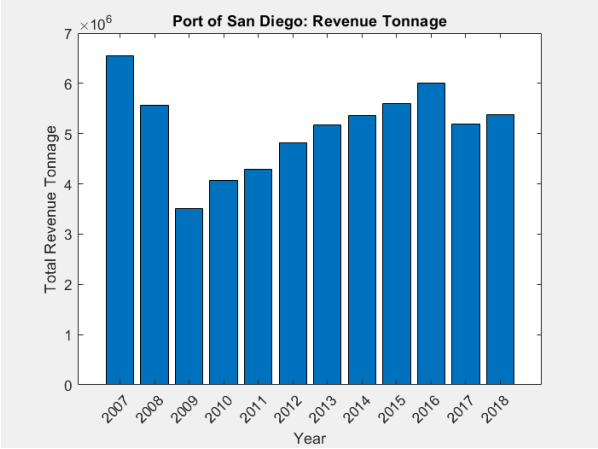


Figure 29 – San Diego containers (TEUs).

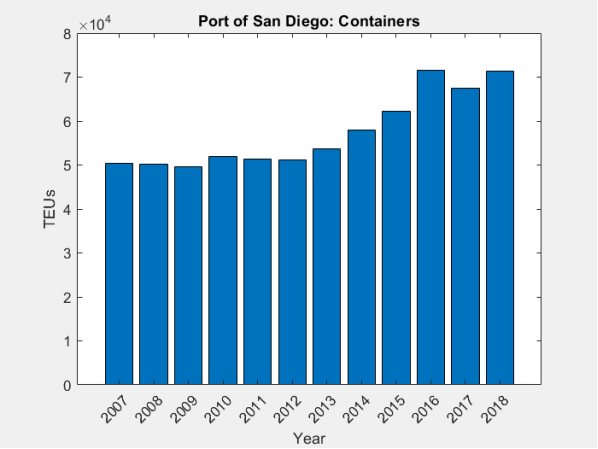


Figure 30 – San Diego automobiles.

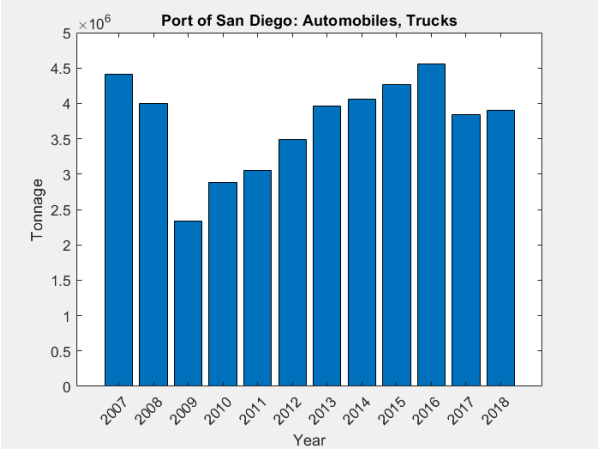


Figure 31 – San Diego forest products.

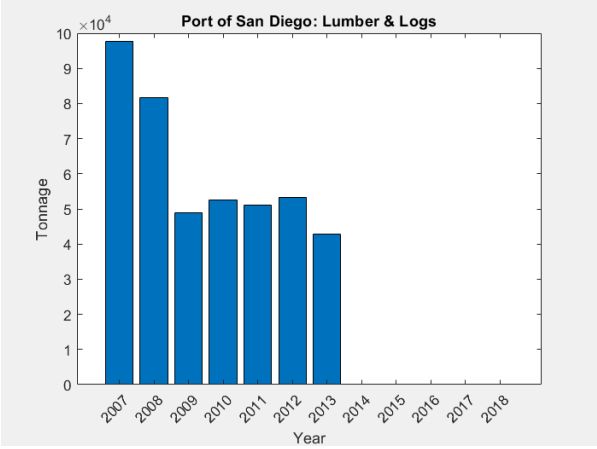


Figure 32 – San Diego bulk cargo.

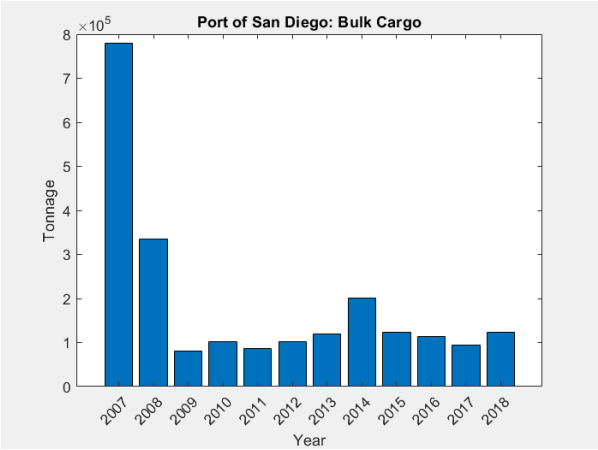
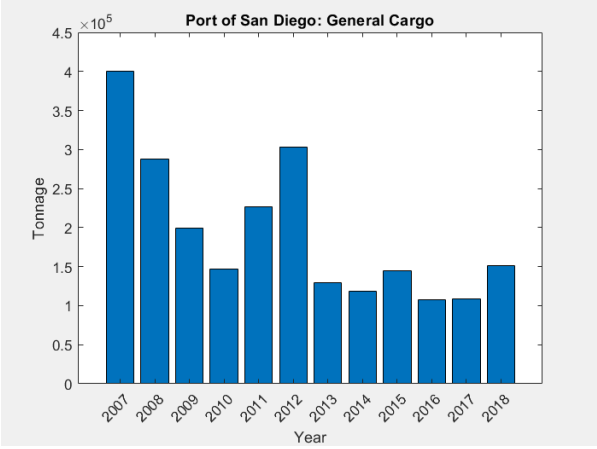


Figure 33 – San Diego general cargo.



3.1.5.3 Constraints

Over the past decade, car sales in the U.S. market have nearly doubled [51]. About 25% of all vehicles imported into the United States are handled by Southern California ports, and this boom in car sales has led ports, such as the Port of San Diego, to experience capacity constraints. Infrastructure developments are infrequent, and the ports must manage with the land that they already have. Another constraint that the Port is facing is due to long ground leases and land use restrictions [82]. Ground leases at the Port last anywhere between 40-66 years; although this primarily applies to businesses on the waterfront, potential expansion of the maritime sector is

limited due to less flexibility in available land. This also lessens ability to build infrastructure that would otherwise help the Port to streamline its operations.

3.1.5.4 Future

The Port of San Diego's automobile sector has room for growth. If the Port can keep up with increasing demand for car shipments, the Port will be able to expand its automobile trade. The Port has plans to build additional rail, remove unused equipment, and restructure roads—these adjustments are expected to increase the Port's capacity from 600,000 units to 800,000 units annually [51]. Additionally, the Port has accepted trial automobile shipments from Mexico, a rising force in the automobile industry. With Mexico as a promising automobile trading partner and Asian car sales providing a steady business, the Port should consider investing additional funds into its infrastructure to sustain its growth in the automobile sector.

3.1.6 Port of Stockton

3.1.6.1 Background

The Port of Stockton is an inland port specializing in dry bulk, breakbulk, liquid bulk, and project cargo. It ranked 73rd highest value seaport in the United States in 2018 [83]. Its strengths include extensive rail infrastructure, numerous warehouses, and an ability to be flexible in response to shifts in market demand. The Port is at a prime location for accessing nearby regional networks, as well as other parts of the country. 2018 was a record-breaking year for the Port, with 2.1M+ metric tons of exports and 4.7M+ million metric tons of imports over the course of the year. Going into the future, the Port has infrastructure plans that aim to improve the

efficiency of its arterial roads and increase both warehouse and terminal capacity [84]. The Port is also looking for new business partners to further diversify its trading portfolio [85], [86].

3.1.6.2 Historical Performance

Looking at Figure 34, Stockton's revenue tonnage experienced its most severe drop in 2008, lining up with the economic recession. Focusing only on this time period from the past decade, 2008-2018, there is a pattern of the Port's revenue tonnage growing by half a million to a million revenue tons, and then undergoing a gradual descent in revenue tons over the next few years (seen from 2011-2013, and 2014-2016 in particular). Figure 35-Figure 37 illustrate the Port's diversification in cargo: containerized cargo was traded sporadically throughout the 2007-2018 timeframe, automobiles were traded in 2014 alone, and lumber and logs were traded from 2007-2008.

Figure 34 – Stockton revenue tonnage.

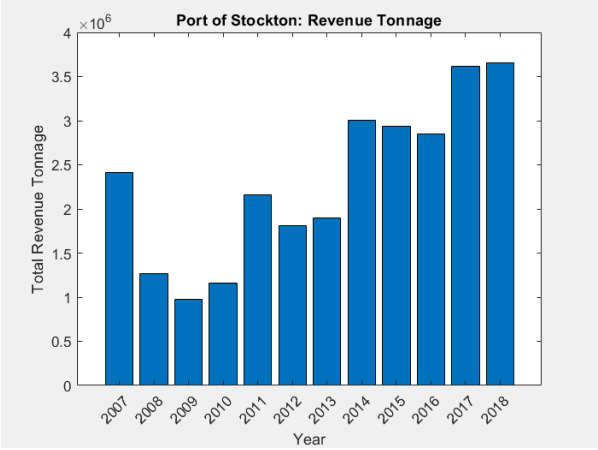


Figure 35 – Stockton containers (TEUs).

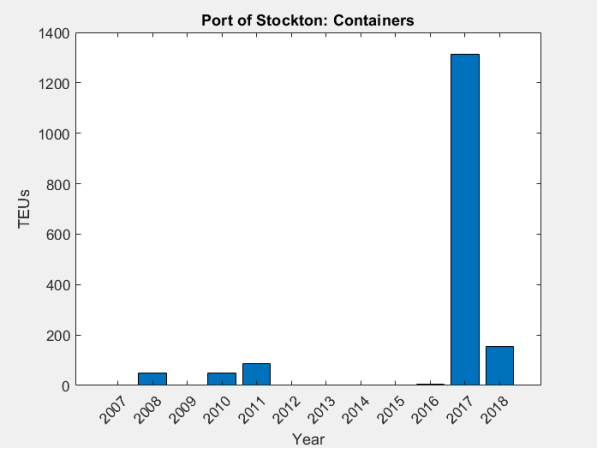


Figure 36 – Stockton automobiles.

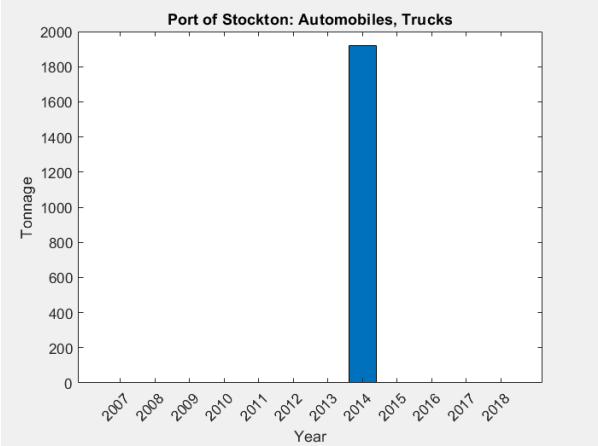
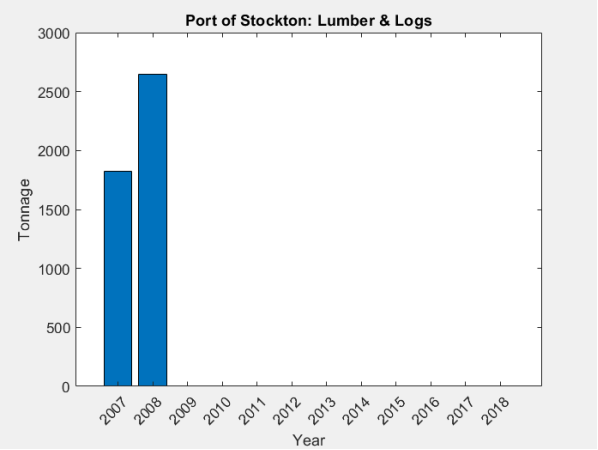


Figure 37 – Stockton lumber & logs.



Contrasting with Figure 34-Figure 37,

Figure 38 – Stockton bulk cargo.

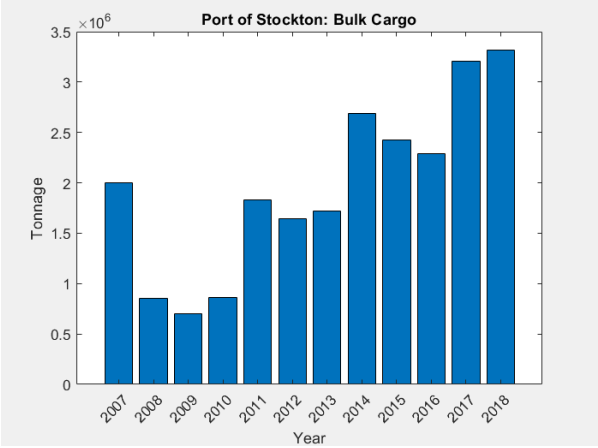
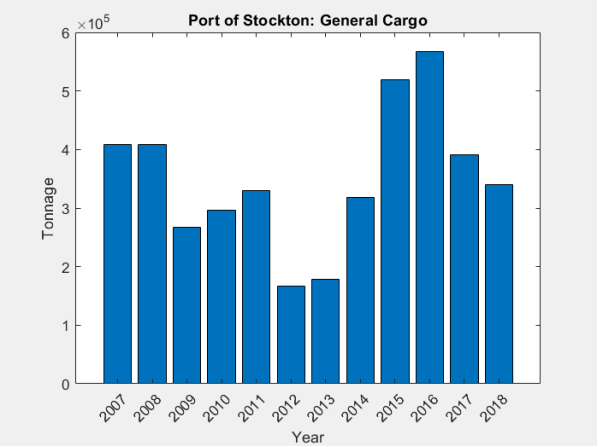


Figure 39 – Stockton general cargo.



and Figure 39 (which depict bulk cargo and general cargo, respectively) show consistent trade happening. While bulk cargo has shown growth over the past five years, the general cargo industry at Stockton seems to be in decline. Stockton's strategy is to be flexible in response to volatile market demands. One example is how the Port saw a 16% decline in cement tonnage and a 22% decline in steel in 2018, but was still able to obtain its best trade numbers in Port history (record high of 3.6M revenue tons) by expanding its “service offerings [84].” The Port can stay relevant by relying on its assets, which include extensive rail infrastructure, diverse cargo handling equipment, available land, skilled labor, and professional expertise in handling a range of cargo [84].

Figure 38 – Stockton bulk cargo.

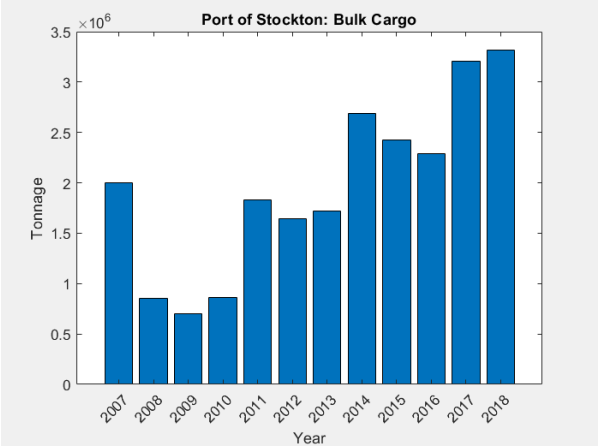
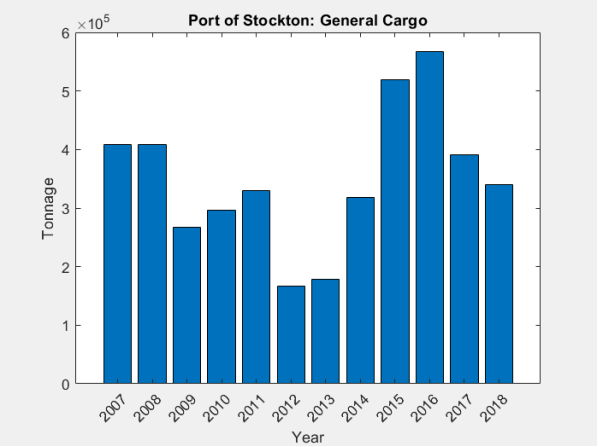


Figure 39 – Stockton general cargo.



3.1.6.3 Future

An upcoming infrastructure development is the Fyffe Grade Separation, which will target a rail crossing located at one of the Port's entrances. Over 3,000 vehicles use this entrance every day, so this grade separation project will have significant impacts in mitigating truck delays. Another ongoing project involves replacing a rail bridge and extensively renovating the Port's arterial network of streets [84]. Additionally, several of the Port's current tenants are developing their terminals and warehouses. Contanda—a dealer in liquid bulk products—is expanding, remodeling and adding tanks, pipeline, and rail. Another tenant, Yara, owns two separate facilities for fertilizer - one for dry bulk and the other for liquid bulk. Yara is working to add a truck terminal that will be located right across from their liquid bulk facility, which will increase cargo throughput capabilities. Other infrastructure developments at the Port of Stockton include the construction of a glass recycling facility and the West Coast's first sulphuric acid maritime facility.

3.1.7 Port of Benicia

3.1.7.1 Background

The Port of Benicia is privately owned and operated by AMPORTS, a company that specializes in automotive processing. AMPORTS owns 10 ports in total, with locations on the West Coast, East Coast, Gulf Coast, and in Mexico [87]. In addition to the AMPORTS terminal, Benicia also caters to the Valero Corporation, which exports bulk petroleum coke [80]. The Port is a deep-water port located less than 20 miles from the Golden Gate Bridge, at the northern tip of the San Francisco Bay. Cars arriving at Benicia are primarily destined for Northern California and the Pacific Northwest [88]. The Port has on-dock rail plus connections to the Union Pacific Railroad and is close to Highway 680. The Port handles automobiles and bulk petroleum coke and has the capacity to berth 3 vessels simultaneously [89].

3.1.7.2 Historical Performance

As displayed in Figure 40, the Port of Benicia's revenue tonnage (r.t.) has been on an unfaltering ascent since 2011, climbing from a low point of 860,000 r.t. (2011) to 2.6 million r.t. in 2018. There are only a handful of tenants (not all are involved in maritime operations) at the Port, which has a history of handling bulk petroleum coke (Figure 43), but primary business occurs at AMPORTS' automobile terminal. The Port has seen increasing automobile tonnage from 2011 through the present day; Figure 42 reflects how the Port has grown from handling less than 1 million tons of automobiles coming out of the Recession, to upwards of 2.6 million tons in 2018. In February 2018, Volkswagen Group opened a new facility where imported cars will receive final touches before they are distributed to dealerships. Volkswagen is projected to

process 40,000 cars annually through the Port of Benicia [88], so tonnage can be expected to increase even further in coming years.

Figure 40 – Benicia revenue tonnage.

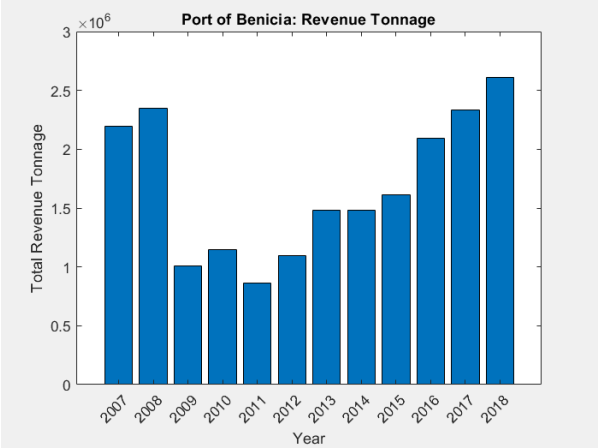


Figure 41 – Benicia general cargo.

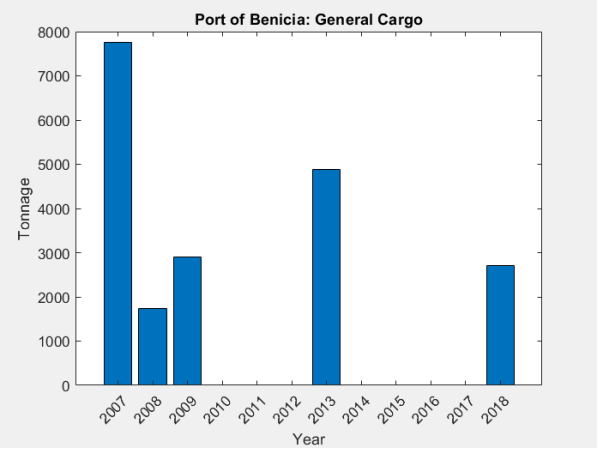


Figure 42 – Benicia automobiles.

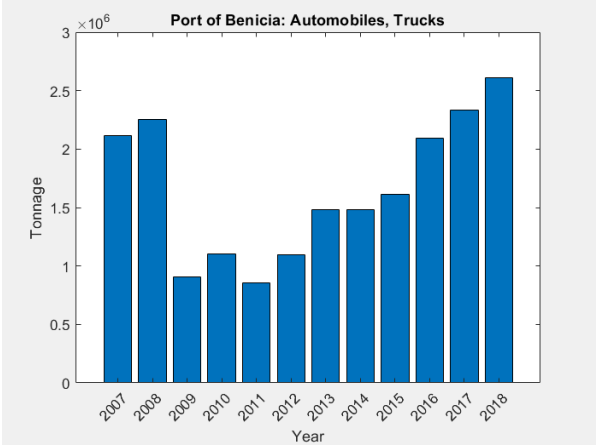
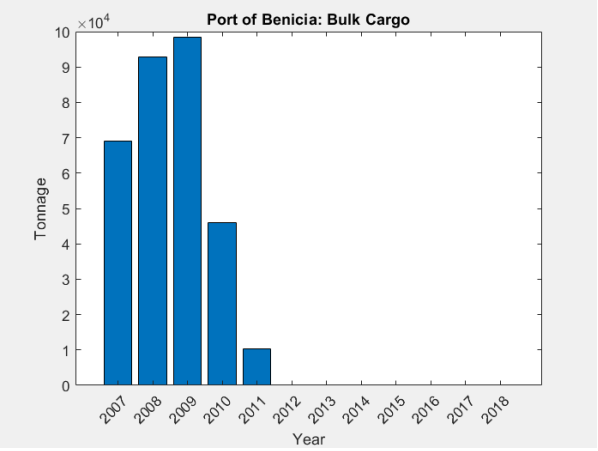


Figure 43 – Benicia bulk cargo.



3.1.8 Port of San Francisco

3.1.8.1 Background

The Port of San Francisco specializes in trading automobiles and bulk cargo. In 2019, the Port was ranked 41st highest value U.S. port [90]. All port terminals have on-dock rail connections to the San Francisco Bay Railroad and the Union Pacific Railroad [91]. The Port of San Francisco's potential has not yet been fully realized. Although trade has improved for the Port over the past four years, the Port still has room to expand its maritime operations. The next few years will mark a crucial time during which the Port must find which market niches it can fit into.

3.1.8.2 Historical Performance

Revenue tonnage at the Port was lowest in 2010, and reached another low point in 2016 (Figure 44). Since 2016, the Port has been recovering but is still currently about 300k tons short of its 2007 volumes. Cargo trends at the Port have been sporadic, as revealed in Figure 45-Figure 49. Automobiles only began to be traded in 2016 when the Pasha Group signed a long-term lease, thus marking the beginning of significant automobile trade at the Port [92]. Compared with other automobile ports, the Port of San Francisco had been vastly underutilized [73]. Pasha has been incrementally increasing the number of cars they send through the Port; although 2017 and 2018 car statistics were relatively comparable, in 2019 Pasha sent 115k+ additional units through the Port (Figure 50). This large jump explains the Port's recovery in revenue tonnage from 2016 to 2018, even with general cargo trade ceasing (Figure 48) in 2015. The Port's Pier 80 Terminal was originally a break-bulk terminal [93] specializing in building materials including steel

imports [94], so the repurposing of this terminal to handle automobiles explains the decrease in bulk cargo being traded from 2016-2018 (Figure 47).

Two of the Port's other terminals, Pier 92 and Pier 94 still handle dry bulk concrete materials such as sand and aggregates [93]. Aggregate is self-unloaded by the ships that bring them to the Port, onto a conveyor belt that shifts the aggregate onto trucks. The trucks move the aggregate to nearby concrete batching plants where they are used to prepare concrete, before finally being trucked to construction sites around the Bay Area [95]. As these aggregate imports are used towards Bay Area construction projects, oscillations in the construction industry might explain the fluctuations in tonnage that can be seen over the past decade. The Port also has a terminal called Pier 90 which is currently inactive and was formerly a grain processing terminal [94]. Another terminal the Port owns is Pier 96, which is being used as a recycling center; however, the Port envisions transitioning this terminal into a hub for maritime operations.

Figure 44 – SF revenue tonnage.

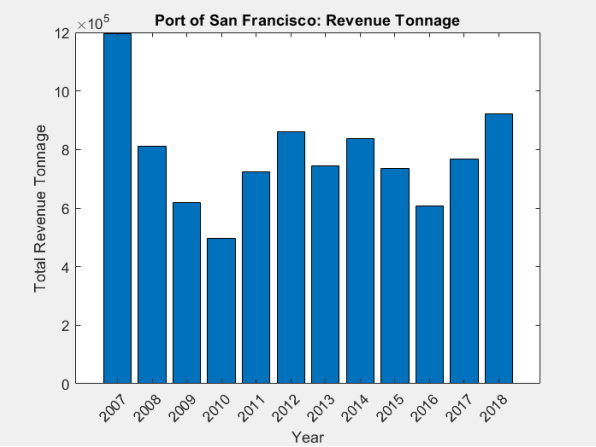


Figure 45 – SF containers (TEUs).

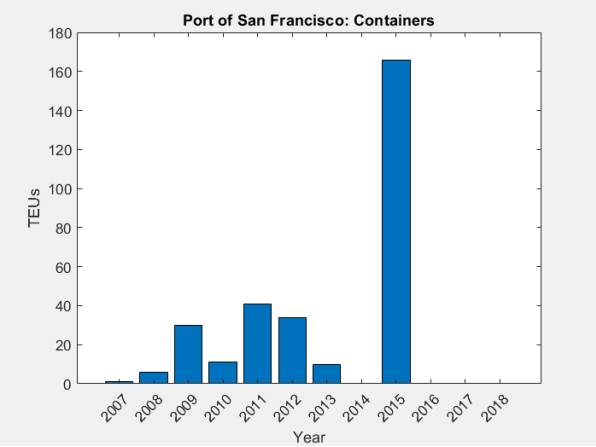


Figure 46 – SF forest products.

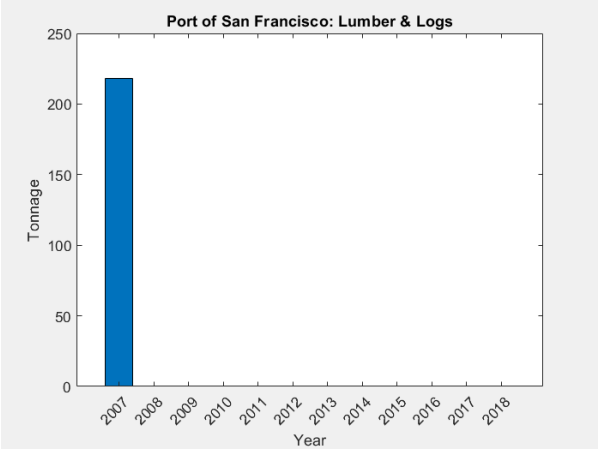


Figure 47 – SF bulk cargo.

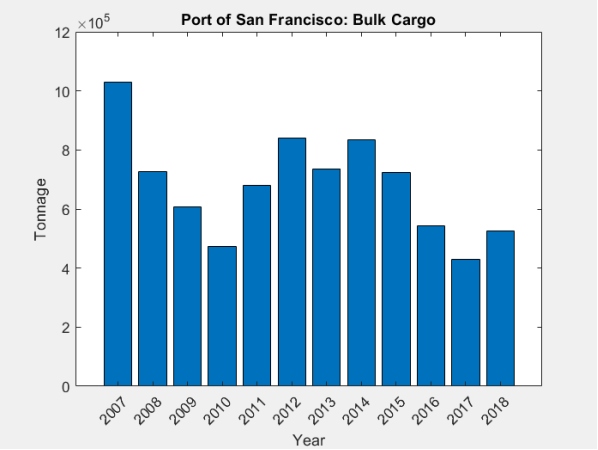


Figure 48 – SF general cargo.

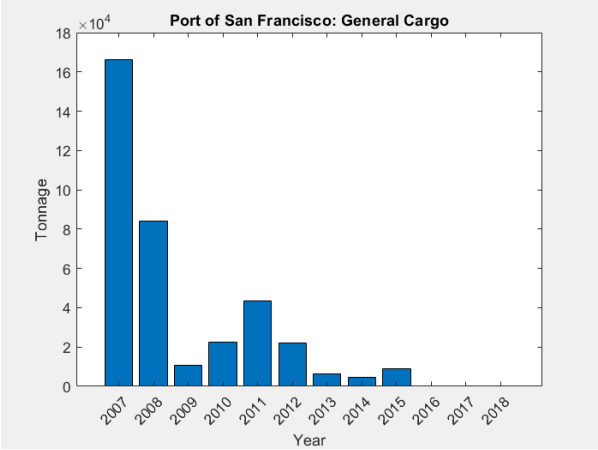


Figure 49 – SF automobiles.

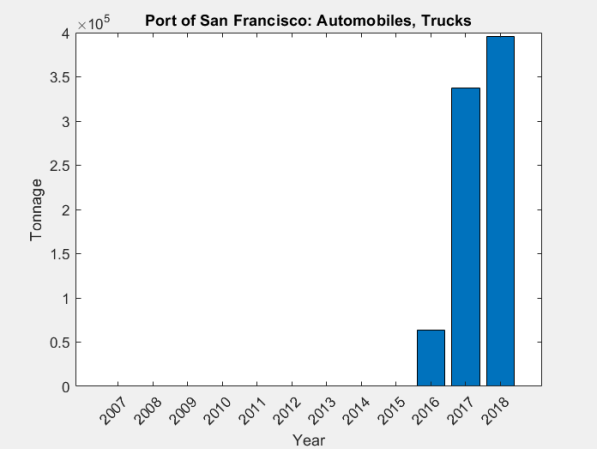
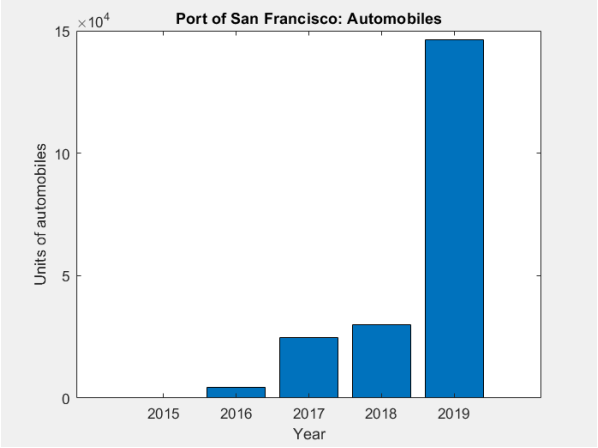


Figure 50 – SF automobiles [96].



3.1.8.3 Constraints

The Port is working to maximize utilization of its facilities. One of the Port's terminals is currently a center for commercial recycling, but the Port plans to repurpose it as a bulk cargo terminal [97]. In order to prepare the Pier for cargo goods, the rail yard storage area must be expanded, as well as miscellaneous improvements need to be made to enclosures and berths at the Pier. Another hurdle the Port is grappling with is the labor costs and inefficiencies that come along with lower cargo volumes [94].

3.1.9 Port of Redwood City

3.1.9.1 Background

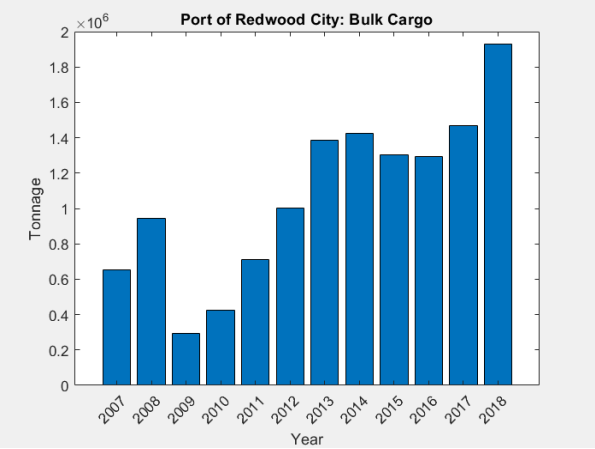
The Port of Redwood City is a mid-sized California port located 18 nautical miles away from San Francisco [98]. It specializes in bulk cargo, namely scrap metal exports and construction material imports [99]. Redwood City is performing at record volumes, boasting a 104% increase in cargo tonnage from 2008 to 2018, and is ranked 110th nationally in cargo value [99]. However, this growth is predominantly due to the success of the construction industry and the Port's role as a feeder port for construction projects across the Bay Area [100]. Diversification is needed for the Port to maintain its current performance levels and is an issue that the Port is working to address [101].

3.1.9.2 Historical Performance

The Port specializes in trading bulk cargo (Figure 51). Trade at the Port plummeted in 2009 due to the toll of the economic recession on the construction industry, but in the years following the Port made a steady recovery. By 2012, trade numbers were even better than they

had been in 2008. During the years 2013-2017, Redwood City experienced little growth, maintaining a constant performance of around 1.4 million revenue tons annually. In 2018, revenue tonnage increased by a noteworthy margin, resulting in a 104% increase in trade from 2008. Compared with larger California ports, Redwood City was able to make a full recovery after the recession, even outperforming its previous tonnage statistics. However, it is difficult to make a definitive statement about the relation of port size to ability to recuperate from an economic downturn using this example alone.

Figure 51 – Redwood City bulk cargo.



3.1.9.3 Constraints

Redwood City's current strength is also one of its biggest weaknesses. The Port is performing the best it ever has because the construction industry in the South Bay is flourishing, and 99% of the Port's cargo is construction materials [99]. Conversely, Port activity would crash if the construction industry experienced a slump. The Port has already begun to diversify its trade partnerships and can further stabilize its position in the market if it diversifies its trade portfolio as well. An interview with the Port's executive director, Kristine Zortman [101], revealed that

the Port's scrap metal export business began "diversifying away from China... [and] increas[ing] its exports to countries such as Indonesia and Vietnam" in 2016 so that "new markets and new sources of revenue" could be generated for the Port. Zortman also explained that infrequent dredging is limiting the Port's potential—the Port has been dredging its ship channel every two years, but dredging needs to occur annually in order to "provide a reliable depth for ships" to reach the Port's terminals.

3.1.9.4 Future

A major project that is undergoing consideration is a potential ferry terminal that will be built at the Port—currently, feasibility studies are being conducted. A ferry service with San Francisco would help relieve congestion on the Highway 101 corridor connecting Silicon Valley to San Francisco [102]. This waterborne route would link Silicon Valley, San Francisco, and the Ports of Oakland and Redwood City to each other, thus relieving congestion on the nearby highways.

The Port's outlook is bright—Commission chair, Lorianna Kastrop, commented in a press release that "construction industry trends indicate continued growth over the next five years [103]," for the Port. While the Port is doing well, it must prepare for the future so that it is not totally dependent on the construction industry to thrive. Growing its maritime business through more frequent dredging is another option under consideration—the Port is exploring a collaboration with environmental groups who desire that the dredge materials be used to support wetlands augmentation. This collaboration would also lower dredging costs for the Port [101].

3.1.10 Port of Richmond

3.1.10.1 Background

The Port of Richmond is the 52nd highest value port in the United States and is mainly an automobile and bulk cargo port [104]. Richmond processes the highest amount of automobiles and liquid bulk cargo—top imports being oil and gasoline—out of all Bay Area ports [105]. Richmond has historically been stricken with debt and systemic operational issues, as well as funding projects that did not have a high enough return on investment—examples include plans for container operations and the expansion of automobile facilities [106]. All of the Port's terminals have connections to either the BNSF, Union Pacific, or both railroads.

3.1.10.2 Historical Performance

Revenue tonnage has generally increased over the past decade, with several slumps along the way such as in 2009 and 2013. The Port's staple cargo is in bulk trades and automobiles; these have been traded consistently over the last ten years. Containerized cargo was only traded from 2014 to 2016 (Figure 53) and general cargo was traded even more sparingly, with several tons traded in 2008 and negligible tonnage in 2014. The increase in automobile tonnage beginning around 2009-2010 can be explained by the Port signing a contract with Honda in 2010, agreeing to import 150k vehicles annually. Prior to this, Honda had been primarily importing vehicles through the Port of San Diego, and then trucking at least 35k vehicles to be distributed in the Bay Area each year [107].

Figure 55 displays the Port's growth in its bulk cargo trades, with tonnage more than doubling from 2008 to 2018. This progress can be attributed to the Port's targeted expansion of bulk handling capabilities, where initially the Port only specialized in liquid bulk cargo [105].

The three years, 2014-2016, of the past decade during which containers were traded at the Port may help in explaining why bulk cargo tonnage plateaued for about three years, during this same three-year timeframe.

Figure 52 – Richmond revenue tonnage.

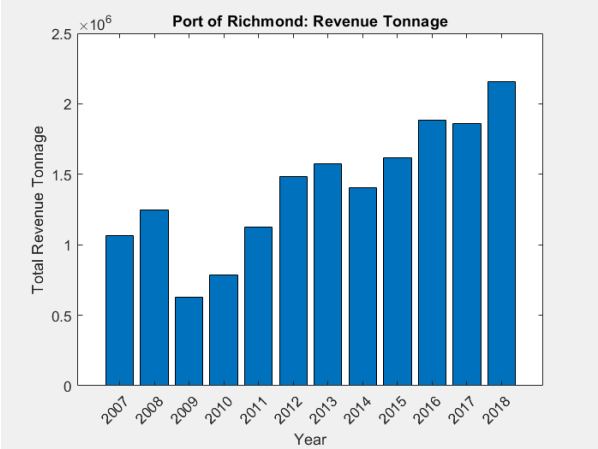


Figure 53 – Richmond containers (TEUs).

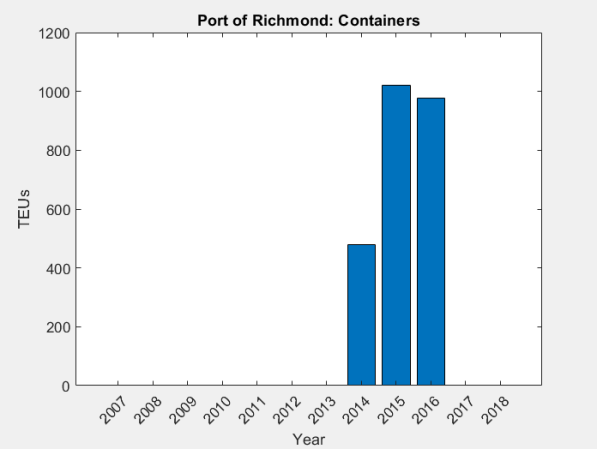


Figure 54 – Richmond automobiles.

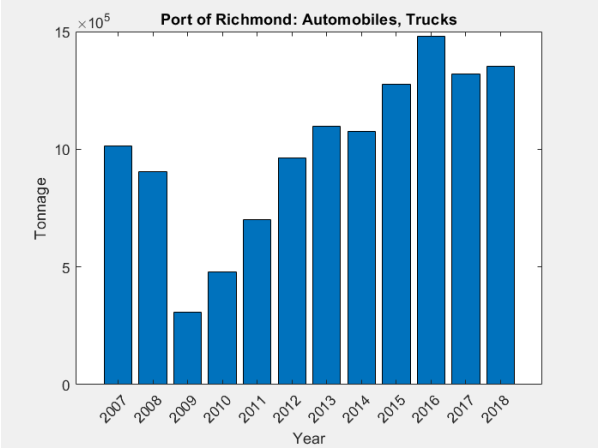


Figure 55 – Richmond bulk cargo.

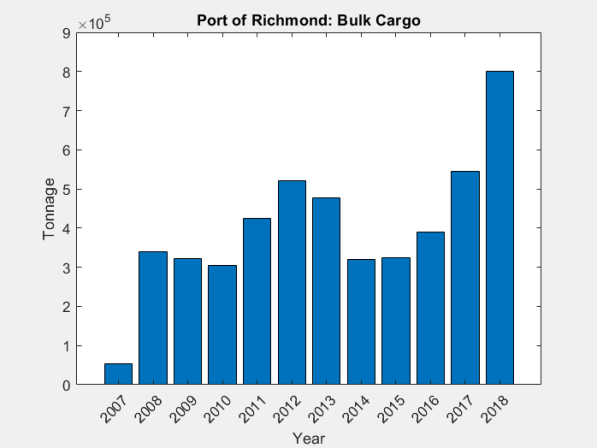
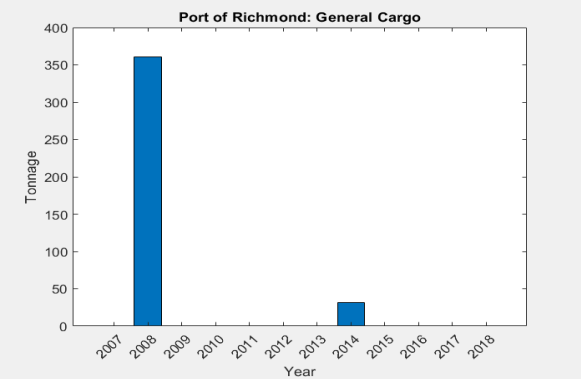


Figure 56 – Richmond general cargo.



3.1.10.3 Constraints

The Port faces several constraints having to do with infrastructure and establishing trade partners. For one, Richmond is not well-equipped to accommodate larger vessels. The Port is also not suited for containerized trade—it lacks the depth and acreage required to be able to compete with existing container ports. The Port also seems to be struggling to find tenants for its facilities. Terminal 4 is currently vacant, and several cranes are sitting idle [106].

3.1.10.4 Future

The largest Port infrastructure project from the past two decades is the Honda Port of Entry project at Pt. Potrero Marine Terminal. This project involved various improvements to streamline the terminal's automobile handling operations and was completed in 2009. Perhaps due to the economic recession Richmond was unable to capitalize on this new infrastructure, and in 2015 accumulated a debt of $47M [106]. However, automobile trends at Richmond (Figure 54), as well as hopes that Chinese car manufacturers begin to import cars through the Port of Richmond [106], provides some optimism that the Honda infrastructure project will eventually help the Port to break even.

Currently, the Port still has room to expand maritime operations with Terminal 4 lacking tenants. The terminal does not have any equipment, but it does have railroad connections to UP and BNSF. At Terminal 3, a group called RJJ International is working with the Port to develop a log exporting facility forecasted to ship as much as 6 shiploads of forest products to China per year [108]. Only minor repairs and installations are needed to accomplish this development and running this log exporting business out of Terminal 3 will add further diversity to the Port's cargo portfolio.

3.1.11 Port of West Sacramento

3.1.11.1 Background

The Port of West Sacramento is an inland port that specializes in bulk cargo. In 2006, the City of West Sacramento took over management of the port and in 2013, the Port became a landlord port, which means that the Port leases its infrastructure out to private entities [109]. Before this major change the Port was in the red [110], but new tenants like the SSA Marine helped stabilize business at the Port [80], relieving the Port of operations and maintenance expenses. The Port of West Sacramento has been struggling financially [110], which has implications for development, maintenance, and upgrades that would otherwise increase the Port's competitiveness. For instance, the Port owns a significant amount of developable land (260 free acres) [33] that is not being put to use.

3.1.11.2 Historical Performance

The Port was initially designed to serve as a bulk cargo port primarily dealing in agricultural and natural resources stemming from Northern California. Since it first opened in

1963, the Port consistently processed approximately 1 million tons of cargo—however, volumes began to decline starting in 1999 [33] and levelled off at 320k tons annually from 2010-2012 (Figure 57). Cement, the Port's top import, was not introduced until 2007.

Revenue tonnage decreased sharply during the Recession, and also in 2014. The drop in 2014 may be due to the Port undergoing a major change of becoming a landlord port in 2013, and having to adapt to having new tenants, along with managing new types of freight that might have been uncommon at the Port prior to 2013. General cargo volumes (

Figure 59 – West Sacramento general cargo.

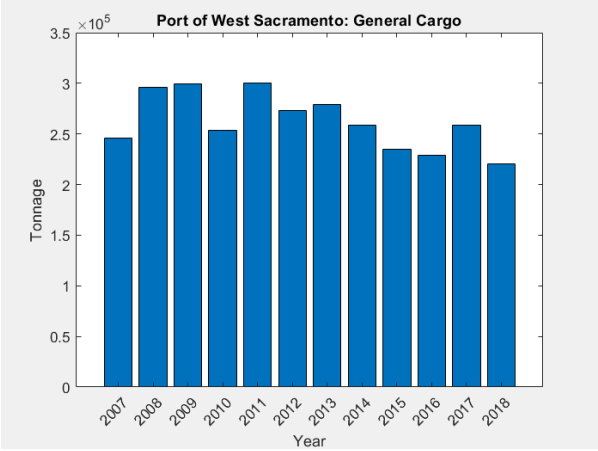
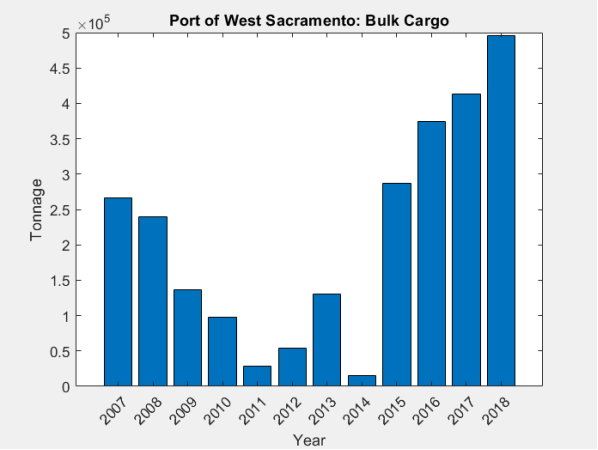


Figure 60 – West Sacramento bulk cargo.



) have steadily decreased from 2007 to 2018. Figure 60 reveals a more promising growth, with tonnage increasing by roughly 75% over the last four years of data recorded. Again, this tonnage growth is most likely explained by new tenants signing leases with the Port starting from 2013, which helped guarantee that the Port would experience more stable volumes than in the past.

Figure 57 – West Sacramento r.t.

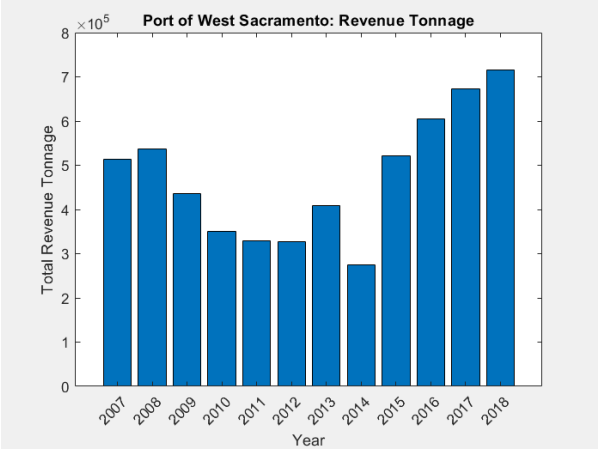


Figure 58 – West Sacramento containers (TEUs).

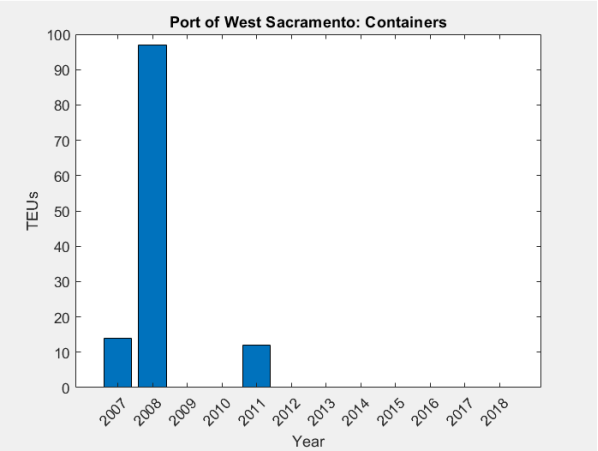


Figure 59 – West Sacramento general cargo.

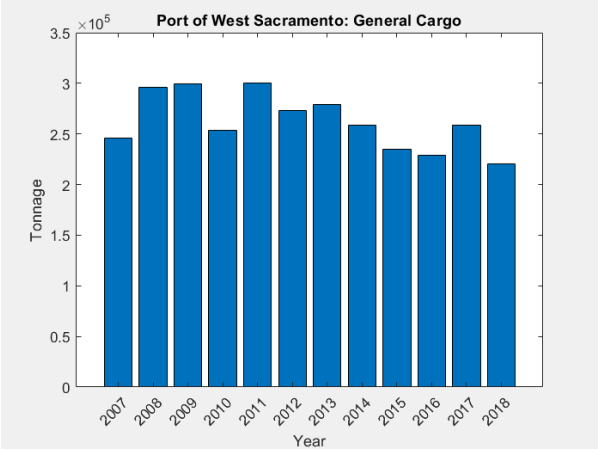
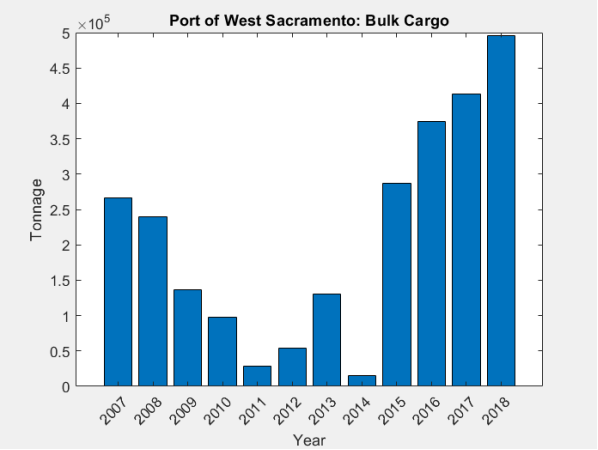


Figure 60 – West Sacramento bulk cargo.



In 2010, bulk cement imports were temporarily discontinued due to the Recession and the corresponding crash of the construction industry. Cement imports did not return to the Port until April 2015 [110], which explains the spikes in bulk cargo depicted in Figure 60. The Port built extensive infrastructure prior to the Recession, for handling cement and other construction materials: enough to accommodate 4 million tons of cement every year [110]. Other Californian ports specializing in bulk cargo include the Ports of Richmond, Redwood City, Stockton, and San Francisco. The Port of Redwood City is similar to the Port of Stockton, as it also specializes in bulk construction materials, although its annual tonnage is much larger than West Sacramento's. Generally comparing the performance of California's bulk ports, West Sacramento's tonnage has not been as consistent as other bulk ports. Tonnage took a plunge from 130k tons in 2013 to 15k tons the following year. Also looking at older data, over the span of five years (2007-2011) tonnage began at 260k tons and finished off at 30k tons.

3.1.11.3 Constraints

The Port's financial situation is preventing it from maintaining and upgrading its facilities. The Port's 2013 Business Plan outlines the main constraints limiting the Port [33]. Only a portion of the North Terminal's facilities is maintained—those that are critical to rice handling operations—which is problematic since the Port cannot secure new types of cargo or expand current operations. Another area that needs attention is the outdated conveyor systems. The Port's bulk cargo competitors, Stockton and Richmond, already have an advantage over West Sacramento since their facilities and equipment are more modern. The Port is also limited by its 30-foot channel depth, whereas its competitors are 35 ft for the Port of Stockton and 38 ft for the Port of Richmond. Deepening the channel has been a top priority for the Port, but it has been hampered by a lack of funding. In addition, the Port has higher labor costs than other Ports that are not a part of the International Longshore and Warehouse Union (ILWU).

3.1.12 Port of Eureka (Humboldt Bay Harbor)

3.1.12.1 Background

Port of Eureka, also known as Humboldt Bay Harbor, is a small port in northern California. In 2019, the Port ranked 113th highest valued and 88th highest tonnage seaport in the U.S. [111]. The Port mainly trades with Asian countries, including Japan, China, and Taiwan. The Port's singular export is forest products, while the top import is fork-lifts [111]. There are no rail lines linking the Port to the rest of the United States—more than twenty years ago, the Port's rail connection to the inland markets was irreparably damaged by flooding [112]. As a result, freight is primarily moved by truck. The Port must also deal with truck length restrictions which are in place because of the rugged terrain of the Port's surrounding environment [113].

3.1.12.2 Historical Performance

Between 1990 and 2010, Port of Eureka's volumes dropped by almost 75%, from 1.479 million metric tons in 1990 to 377,000 metric tons in 2010 [112]. More recently, the Port of Eureka was hurt by the Recession (Figure 61

Figure 61 – Eureka revenue tonnage.

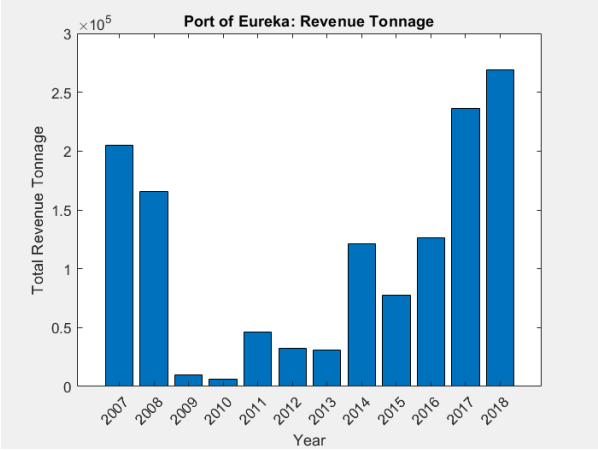
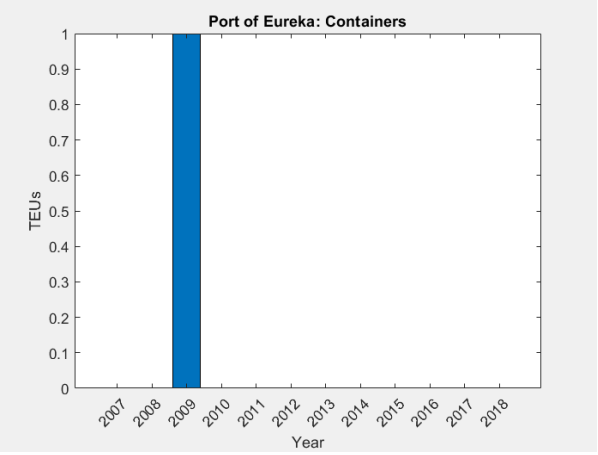


Figure 62 – Eureka containers (TEUs).



) with revenue tonnage dropping to a low of 6000 revenue tons but it has since recovered. In 2018, the Port traded more than 260,000 revenue tons worth of cargo. The forest products industry has been a staple at the Port, but tonnage has fluctuated over the past decade, with five consecutive years of decline between 2012 and 2016 (

Figure 63 – Eureka forest products.

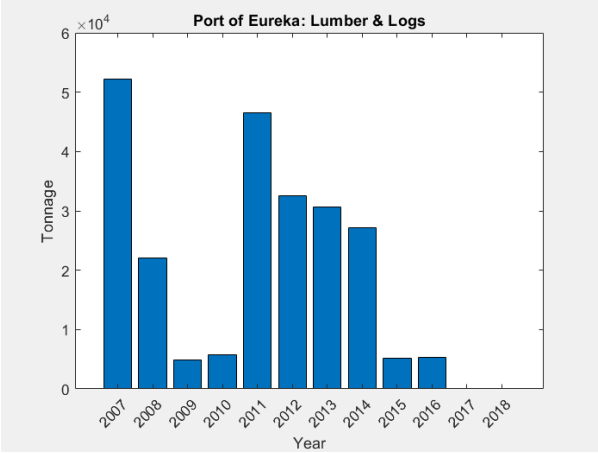
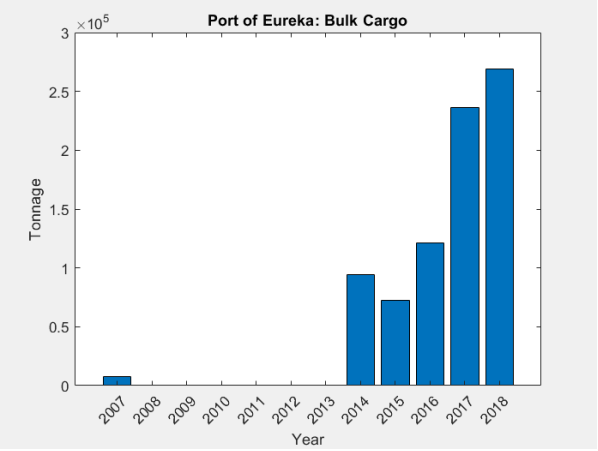


Figure 64 – Eureka bulk cargo.



), and no trade in 2017 and 2018. To compensate for this instability, the Port has also dabbled in bulk cargo since 2014. Figure 62 and*Figure 65* Figure 65 display the years that the Port traded containerized cargo and general cargo; as can be seen in the graphs, these types of cargo are not normally handled by the Port.

Figure 61 – Eureka revenue tonnage.

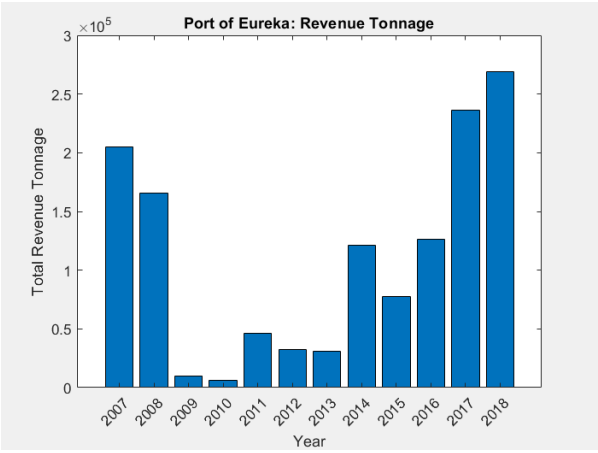


Figure 62 – Eureka containers (TEUs).

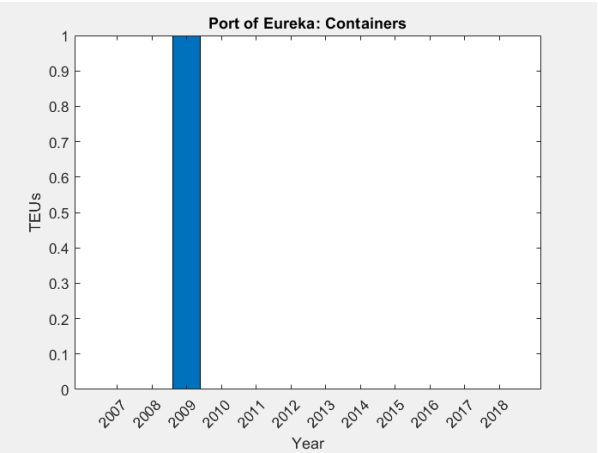


Figure 63 – Eureka forest products.

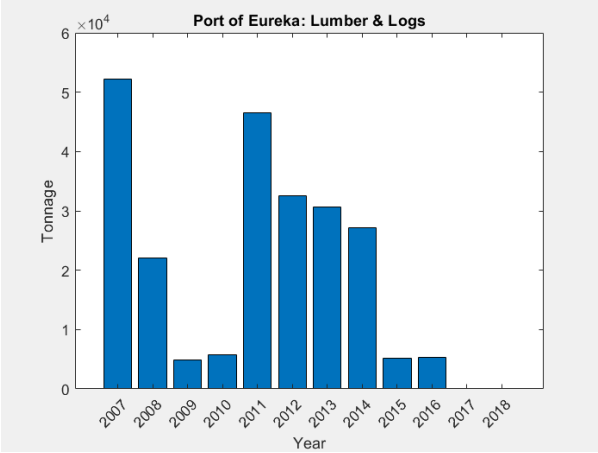


Figure 64 – Eureka bulk cargo.

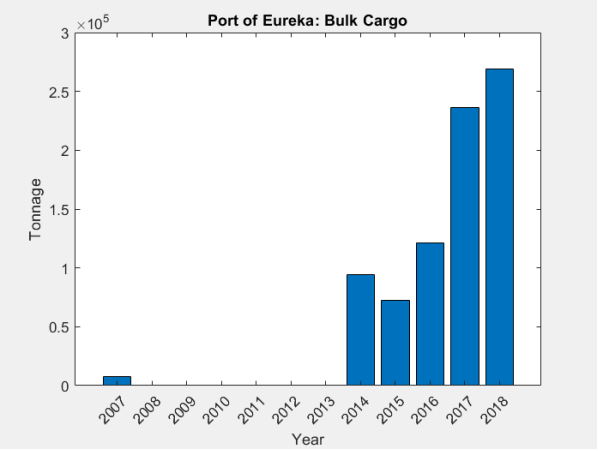
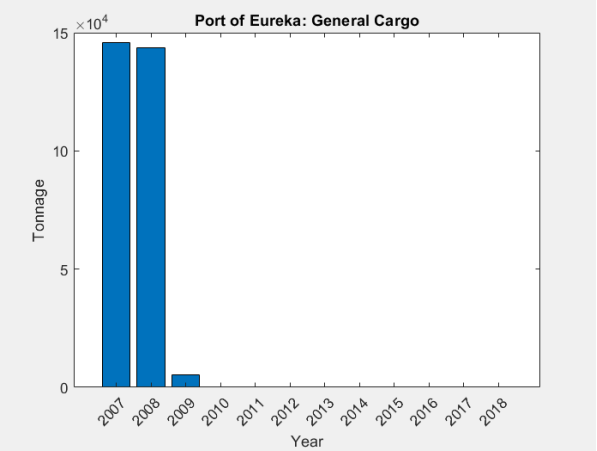


Figure 65 – Eureka general cargo.



3.1.12.3 Constraints

Lumber and logs, which is a significant component of the Port's trade, is a declining industry—in 2017, lumber and logs volumes were 70 percent lower than in 1982 [114]. Additionally, adding rail capabilities at the Port is not a viable option. A feasibility study from 2013 titled "Humboldt Bay Alternative Rail Corridor Concept Level Construction Cost and Revenue Analysis" [114] determined that the Port would face too many barriers if attempting to launch a rail line. The Port's annual cargo volumes are not high enough to make a new rail route economically feasible, and even if the cargo volumes did increase to the level needed to cover

the new rail route's capital costs, the Port's terminals would need to be rehabilitated in order to handle such volumes. In addition, the Port of Eureka does not have an advantage over other Californian ports in terms of distance, and the fact that most California ports already have rail infrastructure would put the Port of Eureka at an even further disadvantage since capital costs would soar over 1 billion dollars.

3.1.12.4 Future

The Port is currently working to expand its capacity, as about "15 percent of [the Port's] 33 miles of shoreline" is available for infrastructure development [115]. One project the Port is actively pursuing is the re-development of land formerly used by a pulp mill [116]. The site is being cleaned of environmental hazards and transformed into a new terminal, the Redwood Marine Terminal 2 [116], which is intended to become the headquarters of a new marine research facility.

3.2 Comparison Between Californian Ports

3.2.1 Major Ports

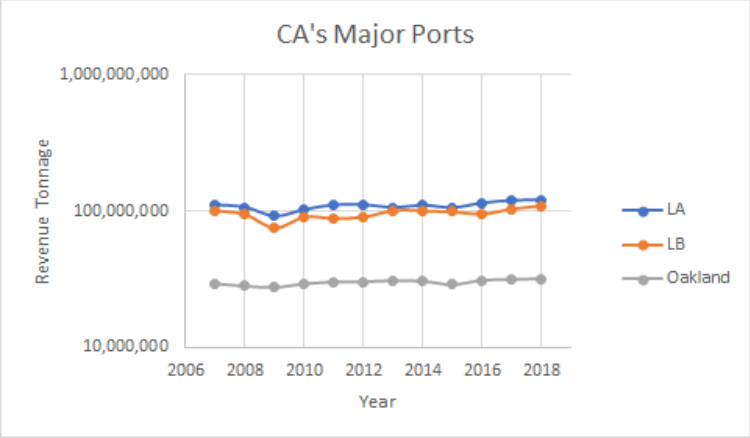
California's major ports are the Ports of Los Angeles, Long Beach, and Oakland. All three ports rank in the top 10 in the nation in terms of value, and all three are top container ports: in 2019, Los Angeles and Long Beach were the top two container ports in North America, and Oakland was 11th [117]. All three ports have higher import throughput than export throughput, and trade primarily with Asian countries. Nut exports are the leading commodity for both Long Beach and Oakland [7], [118], and automobiles are a major industry at all three ports (LA = automobile exports and imports, LB = exports, Oakland = imports).

Table 66 - California's major ports: seaport rankings [6], [7], [118], [119].

	Los Angeles	Long Beach	Oakland
National value ranking, 2019	1st	6th	10th
National tonnage ranking, 2019	4th	7th	23rd
Revenue tonnage, 2018	119,456,349	109,495,954	31,773,287

In terms of growth, revenue tonnage has increased by about a net 8.8% at both Long Beach and Los Angeles whereas Oakland's revenue tonnage has grown by 4% over the past five years (2015-2018). When analyzing the ports' growth over a longer span of time (2007-2018), Long Beach's revenue tonnage increased 8.4%; this is a bit higher than Los Angeles and Oakland's growth rates, both of which had revenue tonnage increasing by about 7.9% [120], [119].

Figure 67 – Revenue tonnage comparison from 2007-2018 for major ports.



Comparing the performance of each cargo type across 2007-2018 sheds more light on the trends at each port (see Table 68). Oakland does not handle bulk cargo, but comparing Los Angeles and

Long Beach, Long Beach increased by 17.49% while Los Angeles's bulk cargo tonnage fell by 38.69%. For automobiles, Los Angeles's automobile tonnage grew (20.27%) while Oakland and Long Beach decreased (81.96% and 13.91%, respectively). General cargo was another area with mixed performance; Los Angeles and Long Beach's general cargo tonnage fell by 25.69% and 32.18%, while Oakland's tonnage grew 13.61%. All three ports had similar levels of growth in container TEUs and revenue tonnage from 2007-2018, which is emblematic of each port's strategy to stay competitive. Oakland sharply decreased its automobile throughput in order to grow its containers and general cargo industries. As a result, Oakland tied Long Beach in terms of revenue tonnage growth. Long Beach had a different approach—resources shifted from general cargo, forest products, and automobiles to support growth in containers and bulk cargo. Los Angeles on the other hand had the highest spike in revenue tonnage, which can be attributed to an increase in automobile throughput, and less decrease in other sectors compared to Long Beach and Oakland. All three ports focused on containerized cargo growth, as each had an approximately 10% increase in container traffic.

Table 68 – Percent change at the major California ports over the period 2007-2018.

	Los Angeles	Long Beach	Oakland
Revenue tonnage	+8.44%	+7.89%	+7.89%
Containers	+9.61%	+9.32%	+10.49%
General cargo	-25.69%	-32.18%	+13.61%
Forest products	-	-24.47%	-
Automobiles	+20.27%	-13.91%	-81.96%
Bulk cargo	-38.69%	+17.49%	-

All three of the major California ports suffer from congestion, although major causes differ among the ports. At the Ports of Los Angeles and Long Beach, congestion is mainly due to the sheer volume of cargo and insufficient capacity to meet this demand properly. At Oakland, the root cause of congestion is landside inefficiencies—such as railroad grade crossings. Within the port, arterial roads are clogged, and trucks simply trying to enter the port can experience a wait time of up to three hours. Each port has its own unique problems in addition: Los Angeles and Long Beach struggle with chassis shortages and a plethora of rail-related issues causing delays [57], while Oakland has to rely on trucks as its primary mode of cargo transport, since there is limited rail infrastructure [63].

3.2.2 Minor ports

3.2.2.1 Specialty

Seven of California's ports can be classified as specialty ports: Benicia, Eureka, Redwood City, Richmond, San Francisco, Stockton, and West Sacramento. All of the aforementioned ports, excluding Benicia and Eureka, specialize in bulk cargoes. Redwood City, Stockton, and West Sacramento are focused on bulk construction materials—a type of cargo that is dependent on the fluctuations of the construction industry. Over the course of the past decade, these three ports experienced some of the highest levels of growth in revenue tonnage among the specialty ports, but the performance of these ports is unstable due to the construction industry's tendency to slow to a halt during economic downturns. The more stable specialty ports are Richmond, Eureka, and Benicia, for different reasons. Richmond has a more diverse cargo portfolio, as it does not rely on construction material imports, but also ships bulk goods such as oil and gasoline. Although the Port of Eureka does not have much room for economic growth, it

can still deliver relatively stable import numbers that are not as affected by recessions. Similarly Benicia, which had the slowest growth over the past decade (Table 71), is still more stable than the specialty ports focused on construction materials since its specialty is in automobiles.

Table 69 gives an overview of the specialty ports and how they relate to each other. There are several trends that can be observed at all specialty ports. For instance, a shared trait among the specialty ports is that none of them have significant container throughput. In addition, the specialty ports have collectively been trading higher tonnages of bulk cargo (Table 71) compared to a decade prior, with the most drastic change being at the Port of Richmond, where bulk cargo tonnage increased by 1369% (increasing from 54,540 to 801,490 tons) from 2007-2018 [120], [119]. The only port that diverged from this trend is the Port of San Francisco, where general cargo tonnage fell from 166k tons to 0 by 2017 (Figure 48). Table 71 reflects changes in overall revenue tonnage over the past decade, as well as percentage shifts in each type of freight. Again, San Francisco is the only port to have decreased bulk cargo tonnage and is also the only specialty port to have a negative percent change in revenue tonnage from 2007-2018. The Port of San Francisco began receiving automobile shipments in 2016, but this uptick in automobile freight was not enough to compensate for its decreased general cargo (and bulk cargo tonnage as well), so the Port still saw a decrease in revenue tonnage.

Table 69 – California's major ports: 2019 seaport rankings.

	Stockton	Redwood City	Richmond	San Francisco	West Sacramento	Benicia
National value ranking	74th	109th	42nd	41st	N/a	N/a

National tonnage ranking	51st	63rd	22nd	40th	N/a	N/a
Revenue tonnage, 2018	3,657,338	1,930,688	2,154,843	921,221	716,010	2,612,323

Figure 70 – Revenue tonnage comparison for specialty ports.

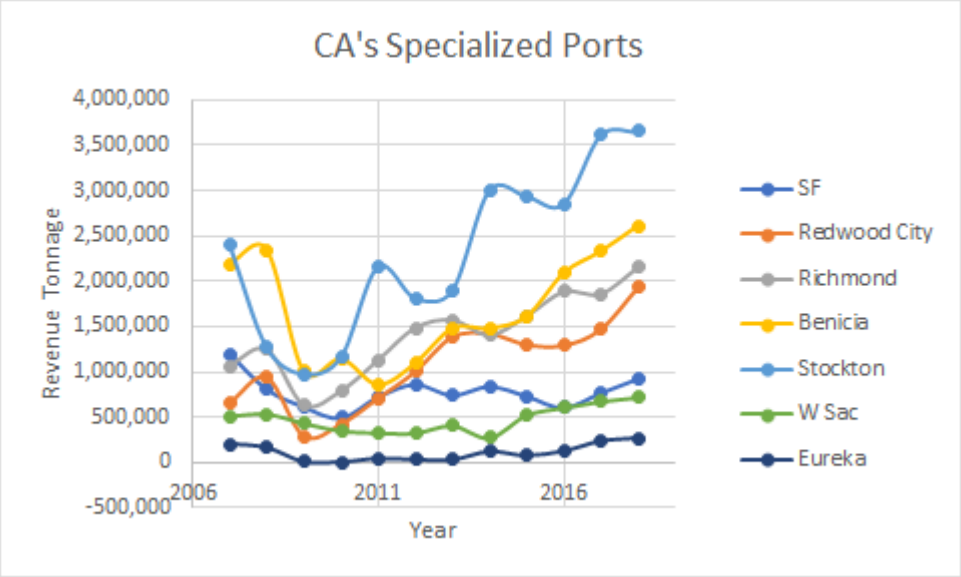


Figure 70 shows growth trends at the different specialty ports Eureka, San Francisco, and West Sacramento experienced little to no growth between 2007 and 2018. Stockton, Benicia, Richmond, and Redwood City all had significant drops around the 2008 economic recession, but all recovered and grew until 2019. This graph also helps with contrasting ports that were performing comparably a decade ago. For example, Stockton and Benicia both logged around 2M-2.5M revenue tons in 2007. Stockton, which is a much more diversified port than Benicia, now far surpasses Benicia in terms of revenue tonnage.

*Table 71 – Percent change at the specialized California ports over 2007-2018.**

	Stockton	Redwood City	Richmond	San Francisco	West Sacramento	Benicia	Eureka
Revenue tonnage	+51.65%	+194.87%	+101.82%	-22.95%	+39.59%	+19.08%	+31.02%
Containers	-	-	-	-	-	-	-
General cargo	-16.69%	-	-	-	-10.26%	-	-
Forest products	-	-	-	-	-	-	-
Automobiles	-	-	+33.58%	-	-	+23.28%	-
Bulk cargo	+65.61%	+194.87%	+1369.5%	-48.99%	+85.59%	-	-

*Note: Percentages were only calculated if that type of cargo was consistently seen at the port from 2007-2018.

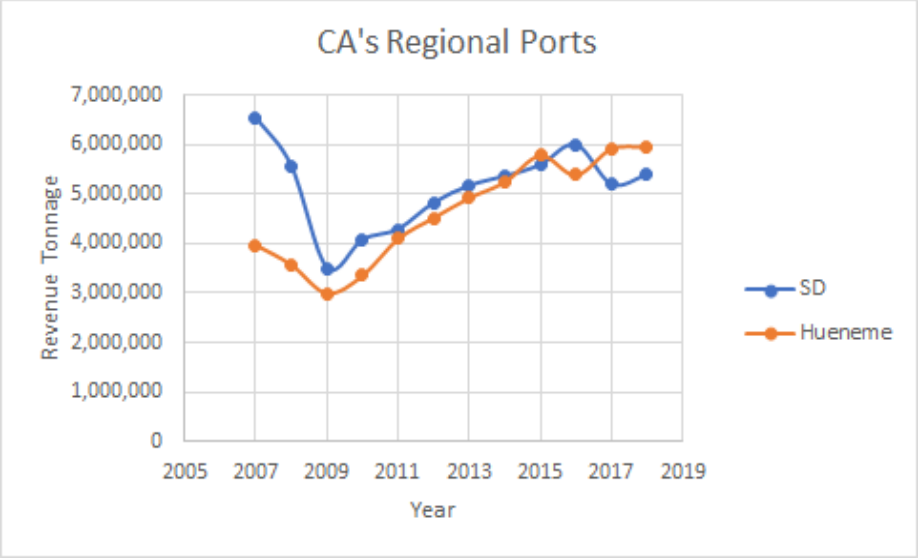
3.2.2.2 Regional

Port of San Diego and Port of Hueneme are the two regional ports in California. These ports are not as specialized as the other minor ports, with Hueneme trading general cargo, bulk cargo, containers and automobiles, and San Diego dealing in containers, automobiles, and forest products. In years past, San Diego overshadowed Hueneme in throughput. For example in 2007, San Diego processed 6.54M revenue tons compared to 3.97M for Hueneme. Contrasting this dynamic, in 2018 San Diego's revenue tonnage (5.38M r.t.) was outperformed by Hueneme's revenue tonnage (5.94M r.t.). Figure 72 depicts how the economic recession of 2008-2009 left the Port of San Diego in a similar position to Hueneme, with San Diego only 0.5M r.t. above Hueneme's revenue tonnage. Hueneme had already been accepting automobile shipments in 2007, but it was not until after the Recession that automobile tonnage at Hueneme nearly

doubled. Hueneme's success can also be attributed to its ability to keep up with market trends: over the past decade not only automobiles, but also containerized freight and bulk cargo tonnage increased at the port. Drawing upon Table 71, which compared specialty ports' growth over the past decade, ports which had growth in bulk cargo shipments also saw overall economic growth. San Diego's containerized freight increased by about 40% from 2007 to 2018, but automobile numbers fell, and bulk cargo performance deteriorated over the past decade.

In terms of potential, San Diego does not have as much room to grow as Hueneme does. Hueneme's facilities can handle a wider variety of cargo, and the Port has ample rail access. Hueneme is also continuously constructing and implementing new projects in order to make effective use of space and increase its cargo handling and storage efficiency. In comparison, San Diego only has one major infrastructure project currently, which involves modernizing an existing terminal so it can handle more diverse cargo. San Diego is not as flexible or prepared as Hueneme is for expansion; its automobile trade is capped at the moment due to space constraints, which could severely limit San Diego's growth.

Figure 72 – Revenue tonnage comparison from 2007-2019 for regional ports.



3.3 Comparison Between CA Ports and North American Ports

This section will discuss California's top three ports—the San Pedro Bay ports and the Port of Oakland—as they compare to other top North American ports. The results of a study done by Martin Associates are shown below, comparing freight charges at different locations in the U.S. and Canada: Environmental mitigation efforts certainly factor into the Port of Los Angeles's and Long Beach's inflated costs and are only expected to contribute further to the increasing cost in the future. Shippers who once favored Los Angeles and Long Beach as their primary route to reach the East Coast are now either diversifying their shipping routes or shifting their routes so that they bypass the Ports of Los Angeles and Long Beach.

Figure 73 – Terminal charges by container [5].

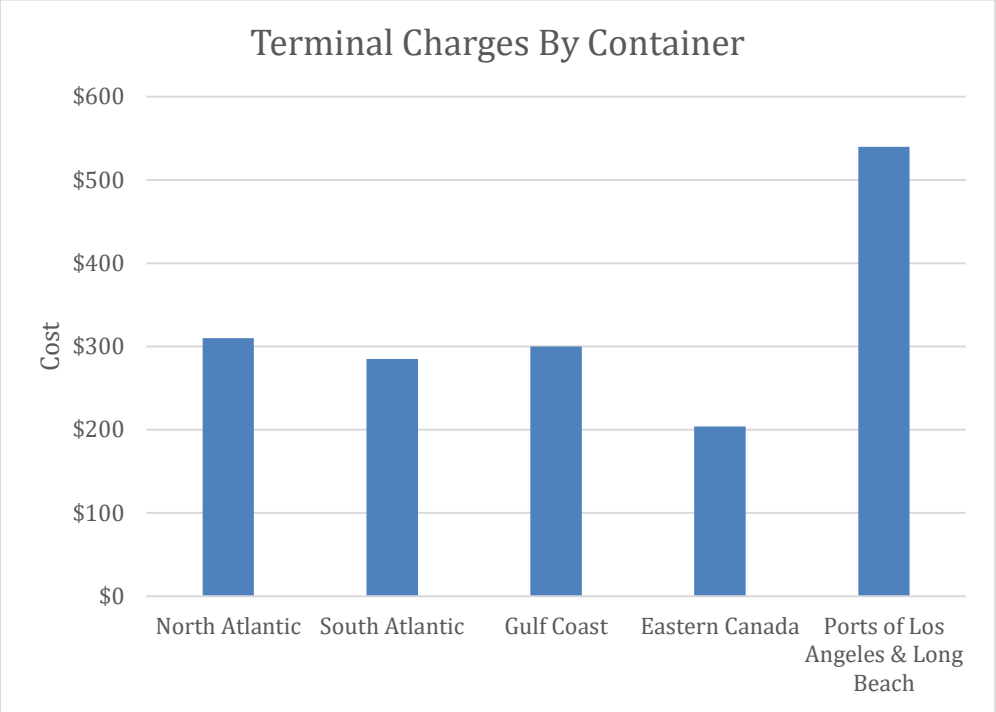


Figure 73 reveals how the San Pedro ports are charging terminal rates that are 90% to 165% higher than their competitors. Unlike East Coast and Canadian ports—who work with state and provincial governments to their advantage—California ports lack collaboration with their state government to "aggressively market…[their] gateways [121]." In Canada, these government-maritime port collaborations result in "hundreds of millions of dollars in government funding" [121] to help build new corridors.

John McLaurin, president of the PMSA, cited some statistics that are useful for comparisons between the Ports of Los Angeles and Long Beach and their competitors across the continent. From roughly 2002 to 2019, the San Pedro Bay complex's container volume increased 11%. Over the course of this same timeframe, container volumes increased by "41 percent in New York-New Jersey, 40 percent in Norfolk, 68 percent in Houston, 94 percent in Vancouver and Prince Rupert, and 101 percent in Savannah [121]." The Port of LA is losing business to other ports on the East Coast, Gulf Coast, and Canada. Asian trade partners account for more than 90% of LA's trade [6], but the Port has been steadily losing its hold on discretionary cargo from Asia. LA's share of the Asian market, which was 56% in 2003, is projected to drop to 42% by 2030; in comparison, East Coast and Gulf Coast ports' share of the Asian market was 27% in 2003 and is expected to increase to 46% in 2030 [5].

Oakland ranks as the 11th busiest container port in the United States. Its overall performance has remained consistent over the past decade, albeit growth is stagnant in comparison with other U.S. ports. For example, the Port of Savannah had comparable volumes to Oakland in 2007 (2.6 million TEUs) but grew by 67% from 2007 to 2018. Additionally, the Port of New York/New Jersey handled 3 million TEUs in 2007, and increased volumes by 131%, entering 2018. In comparison, the Port's volumes have increased by only 6% over the past

decade [120], [119]. Figure 19 exhibits port performance in terms of revenue tonnage, a weight and volume-based measurement unit; the Port went from processing 29 million (2007) to 31 million revenue tons (2018).

Chapter 4: Existing California Legislation

This chapter reviews proposed and existing legislation to understand how legislation has been employed to support California's ports.

4.1 Policy Brief

4.1.1 Key Research Findings

Existing pieces of state legislation that impact California's ports are listed in Table 74 and have ranged from funding grants, to investigations into what can be done to improve the ports' business prospects. However, there are three common themes in most of the existing legislation—lessening environmental impacts, improving efficiency, and investing in infrastructure.

Table 74 – List of legislation relevant to ports.

Legislation	**Title**
SB-1	Transportation funding.
SB-32	California Global Warming Solutions Act of 2006: emissions limit.
SB-103	Transportation.
SB-498	Vehicle fleets: zero-emission vehicles.
SB-595	Metropolitan Transportation Commission: toll bridge revenues: BART Inspector General: Santa Clara Valley Transportation Authority: high-occupancy toll lanes.
SB-739	Ports: congestion relief: air pollution mitigation.
SB-743	Environmental quality: transit oriented infill projects, judicial review streamlining for environmental leadership development projects, and entertainment and sports center in the City of Sacramento.
SB-1204	California Clean Truck, Bus, and Off-Road Vehicle and Equipment Technology Program.
SB-1228	Trade Corridors Improvement Fund.

SB-1403	California Clean Truck, Bus, and Off-Road Vehicle and Equipment Technology Program.
AB-14	State Freight Plan.
AB-32	Global Warming Solutions Act.
AB-285	California Transportation Plan.
AB-371	Transportation: freight: statewide economic growth, prosperity, and resiliency assessment.
AB-821	Transportation: Trade Corridor Enhancement Account: project nomination: California Port Efficiency Program.
AB-1073	California Clean Truck, Bus, and Off-Road Vehicle and Equipment Technology Program.
AB-1262	California Sustainable Freight Action Plan.
AB-1411	Integrated action plan for sustainable freight.
AB-1561	Economic development: infrastructure: logistic hubs.
AB-2043	Maritime Port Strategic Master Plan Task Force.
AB-2145	Vehicular air pollution.
XO-B-15-30	Executive Order B-15-30.
XO-B-16-12	Executive Order B-16-12.
XO B-32-15	Executive Order B-32-15.
XO B-48-18	Executive Order B-48-18.
XO B-55-15	Executive Order B-55-15.
XO S-3-05	Executive Order S-3-05.
Prop 1B	Highway and Port Safety and Air Quality Bond Act.

There is a plethora of bills whose purpose is to mitigate emissions. AB-1262 and AB-285 are two examples of bills which simply mandate that certain transportation plans (i.e. the CA Transportation Plan) must include strategies for meeting emissions reduction goals in the transportation sector. Some bills which specifically target the ports as sources of emissions, such as SB-739—SB-739 require relevant parties to perform an assessment of "air quality improvement needs" in the form of projects that "improve the efficiency of [cargo movement and] reduce congestion impacts associated with the movement of cargo [122]." Other bills focusing on emissions mitigation provide funding towards emissions reductions, as well as financing for zero or near-zero emissions equipment at ports.

The California Air Resources Board (CARB) has been empowered through a string of laws and executive orders to oversee emissions reductions efforts. The ports will be impacted as

CARB strives to meet each one of these GHG emissions goals. AB-32, the California Global Warming Solutions Act of 2006, mandates CARB to lead California towards 1990 emissions levels by 2020 [123]. B-32 also requires CARB to "maintain and continue reductions in emissions of greenhouse gases beyond 2020 [123]." SB-32, titled 'California Global Warming Solutions Act of 2006: emissions limit builds upon AB-32. SB-32 requires CARB to lower California's GHG emissions to 40 percent below 1990 emissions levels by 2030 [124]. AB-32 and SB-32 have been expanded with the passing of supplemental executive orders. Executive Orders S-3-05, B-16-12, and B-15-30 set expectations for GHG levels as follows [125]:

- By 2010, reduce GHG emissions to 2000 emissions levels.
- By 2020, reduce GHG emissions to 1990 emissions levels.
- By 2030, reduce GHG emissions to 40 percent below 1990 levels.
- By 2050, reduce GHG emissions to 80 percent below 1990 levels.

Other expectations set by Executive Orders are defined below:

- By 2030, have at least 5 million zero-emission vehicles on California roads [126].
- By 2045, achieve carbon net neutrality. In following years, achieve and maintain net negative emissions [127].

Another bill that has implications for the ports is SB-743. Fehr and Peers, a consulting firm that is helping organizations understand SB-743, summarizes the bill by saying that it "shift[s] the focus from measuring impacts to drivers to measuring the impact of driving [128]." The bill requires that for state highway projects, transportation impacts collected for the California Environmental Quality Act (CEQA) be measured in vehicle-miles travelled (VMT) [129], rather than the previously used metric of congestion and level of service [130]. Fehr and Peers also asserts that SB-743 will "better align transportation impact analysis and mitigation

outcomes with… California's goals to reduce GHG emissions [128]." Intermodal freight transport will most likely be impacted since SB-743 shifts the focus from reducing congestion in the transportation system to minimizing overall VMT. The full impacts of SB-743 are unknown, but the bill will certainly change how freight travels to its destination.

Other bills aim to reduce congestion and boost efficiency in the California transportation system. Congestion minimization within the transportation system streamlines the movement of goods stemming from ports. One example is SB-595, which provides funding to reduce congestion in the County of Alameda, where the Port of Oakland is located. SB-595 defines qualifying projects as those enabling "improvements… [that will] enable more goods to be shipped by rail, access improvements on [various Interstates], and improved access to the Port of Oakland [131]." Bills such as SB-595 aim to eliminate congestion to increase efficiency when transporting freight. Another variation of bills impacting the ports are those that are intended to improve efficiency more broadly, not necessarily by decreasing congestion. These bills encourage higher efficiency in the freight and goods movement system (i.e. AB-371 [132], AB-1262) [133], increased efficiency within ports and competitiveness of California's freight system (i.e. XO B-32-15) [134], or both (i.e. AB-821) [135].

Another major focus of recent legislation is to bolster infrastructure. There are bills which grant funding towards internal infrastructure improvements within ports (i.e. SB-103) [136], but most California bills that have been proposed provide funding for a more general scope of infrastructure improvements. The majority of state bills grant money for the purpose of improving, repairing, maintaining, and adding to the freight transport system (i.e. SB-1228)

[137]. This entails funding for highways, rail, local streets, and major transportation corridors (i.e. Prop. 1B) [138].

4.2 Review of State Freight Plan

As there is no dedicated maritime authority for California, Caltrans is essentially California's de facto voice on maritime issues. In March 2020, Caltrans released its California Freight Mobility Plan (CFMP) to provide governance for California's more "immediate and long-range freight planning activities and capital investments [43]." The CFMP was drawn up in response to AB-371, California Government Code Section 13978.8, which mandated that a state freight plan be prepared to comply with the federal Fixing America's Surface Transportation Act (FAST Act) [43]. Since the maritime sector and the ports play an important role in freight transport, the CFMP does incorporate maritime related information and recommendations. The CFMP's self-declared motive is to "balance the need for mobility, reliability, and speed, the capacity for growth and innovation, economic competitiveness goals, and the importance of clean air and healthy communities."

A list of topics that would be beneficial to address in a future state maritime policy was constructed from the issues, covered in Chapters 2 and 3, which California ports are contending with. These topics are compiled in the bulleted list below. The approach to reviewing the CFMP was to first ascertain what was written about each topic in the list, and then discuss the weaknesses and strengths of the CFMP's coverage.

- Labor
- Automation

- Infrastructure
- Digital infrastructure
- Competitiveness
- Business costs
- Reliability

4.2.1 Labor

CFMP:

The CFMP includes an overview of the labor force of Californian ports. ILWU, which advocates for the workforce, and PMA, which represents ocean carriers (both domestic and international) and stevedores operating on the West Coast, are the main organizations of interest. Employment terms and conditions are negotiated between the PMA and ILWU—once an agreement has been reached, all ports on the West Coast adopt the terms agreed upon by the PMA and ILWU. Following this overview, the CFMP touches on a myriad of labor-related topics.

- Labor disputes: The CFMP mentions labor disputes, and the 2002 labor dispute specifically, as such disputes are costly and can have long-term impacts if shippers decide to permanently redirect their freight to other ports in the United States. Labor disputes and lockouts take place when the PMA and ILWU cannot reach an agreement when negotiating.
- Automation's impact on labor: Another facet the CFMP touches on are the inevitable plans to incorporate automation, thus replacing cargo handling operators.

- Workforce/training: The CFMP mentions maritime academies across the country, all of which are partially funded by the Maritime Administration—one maritime academy is located in Vallejo, California and is the only one on the West Coast. Maritime academies prepare their students for careers in American merchant mariner positions, in the U.S. Armed Forces, and in various roles within the intermodal transportation system. In addition, in its "Strategies and Objectives" discussion on how to increase California's freight competitiveness, the CFMP identifies "economic prosperity" as one goal. To achieve this, the CFMP expresses the need for California to heighten workforce accessibility and training. The CFMP highlights how effective a collaboration between the freight industry and educational institutions would be in ensuring students are prepared to work in the industry. Another suggestion made by CFMP is for a wider selection of training programs to be made available in areas such as logistics and supply chain management.

Comments:

The CFMP neglects to delineate plans for workforce development in detail, an element that would add to port competitiveness. For instance, focusing on specific training guidelines for California's maritime workforce and providing the best education possible to people undergoing training would increase the overall caliber of the workforce, thus supplying ports with strong employees. The only labor-related topics that the CFMP mentions are: the PMA and ILWU (who negotiate the workforce's employment terms and conditions), the future of automation in the freight industry, and the maritime academy located in California. While these facets are all important, crucial maritime groups—such as the U.S. Coast Guard, the U.S. Army Corps of

Engineers, and MARAD's Ready Reserve Force—and workforce development strategies should have been mentioned.

All of the aforementioned groups hold a presence in California. For instance, the Eleventh Coast Guard District oversees California, amongst other states, and major Californian ports, such as the Ports of San Diego, Los Angeles, Richmond, Long Beach, San Francisco, and Oakland, are all protected by the Coast Guard [13]. The U.S. Army Corps of Engineers' South Pacific Division has 3 locations in California, in the Los Angeles, Sacramento, and San Francisco Districts [139]. As for MARAD's Ready Reserve Force, there is one fleet site situated at Suisun Bay—the only Ready Reserve Force fleet on the West Coast [140]. The CFMP is lacking acknowledgement of all these groups, and also would have benefitted from the inclusion of a workforce development strategy.

The CFMP does bring up the need to improve workforce accessibility and training, but only makes broad statements about how doing so would make California's freight system more competitive. Rather than making generalized statements, strategies for workforce training and development in the context of each major maritime group should be addressed more specifically since the employees that each group is composed of—merchant mariners, dockworkers, port workers, and the like—are crucial to the success of the ports. Future maritime policy should clearly address major maritime organizations, along with training guidelines specific to each group. Ensuring that proper and relevant training is being made available is essential since the employees receiving training form the backbone of the maritime industry.

4.2.2 Automation

CFMP:

As mentioned in the section on Labor, the ports are moving towards automation. The CFMP discusses automation plans and concerns in the context of marine terminals, rail yards, and vehicles.

- Marine terminals: The CFMP reports that none of California's ports are planning to have fully automated marine terminals. However, the ports are considering partially automated terminals, which entails automated trucks and automated rail mounted gantry cranes that can stack containers without any human operators. The benefits of partial automation are greater efficiency and lower emissions due to the employment of electric technology (EVs), decreased truck idling, and less time taken when processing containers. If marine terminals are partially automated in the future, one potential consequence that the CFMP foresees is that since trucks will be fulfilled more quickly, there will also be more of them traversing the transportation network simultaneously—this will put more strain on transportation infrastructure beyond port boundaries. The CFMP notes that "when and if automated marine terminal technology is adopted, close coordination will be necessary between the ports, Caltrans, and local jurisdictions [43]."
- Rail yards: Automated rail yards are another area of automation covered by the CFMP. The CFMP says that fully automated freight rail yards "may be deployed in the future." Automated rail yards would increase safety, throughput, and efficiency so they are being pursued by the ports. Implementation of automation at rail yards is slow-going though since the process is complex and costly to develop—the ports have to develop a system that will connect port equipment and technology to "provide real-time communication and information-sharing throughout the facility for operations."

- Trucks: The CFMP focuses on connected and autonomous trucks, talking about expected benefits such as increased safety and efficiency, and referencing a study [141] that estimates a timeline for the deployment of autonomous trucks. The study forecasts that until 2025, there will be constrained truck platooning. 2025-2027 will see greater levels of autonomy, and by 2027, autonomous trucks can be fully deployed. The CFMP recognizes that one of the repercussions of driverless technologies coming to the forefront is that truck drivers will be displace and "will require workforce development."

The CFMP also goes deeper and discusses concerns about the impacts that automation will have. Currently there is a national shortage of truck drivers, which is only expected to worsen going into 2026—the shortage of truck drivers is expected to grow from 63,000 drivers in 2018 to 174,000 drivers by 2026 [141]. The CFMP cites that in California alone, nearly 140,000 jobs could be lost if California transitions to automated trucks. Thus, the truck driver displacement is an issue that needs to be resolved. The widespread deployment of autonomous and connected vehicles for freight transport is also expected to have impacts on labor, but the CFMP highlights liability being the main issue to be wary of—since there will be no drivers manning the autonomous vehicles, the CFMP calls for liability standards and practices to evolve along with the evolving technology.

Comments:

The CFMP only briefly mentions automation at the terminals. The CFMP briefly states that "when and if automated marine terminal technology is adopted, close coordination will be necessary between the ports, Caltrans, and local jurisdictions." Ports are provided with no further information on coordination and support offered by Caltrans. Providing more guidance could

assist the ports in ensuring their implementation of automation is successful. Furthermore, in the subsection written about connected and autonomous vehicles, the CFMP acknowledges the displacement of truck drivers which will occur once autonomous vehicle technology is deployed. Beyond just mentioning this issue, a maritime policy should provide further details on how exactly displaced workers—not just truck drivers, but terminal operators as well—should be reassigned, retrained, or considered.

4.2.3 Infrastructure

CFMP:

The CFMP discusses several components of California's freight system infrastructure. First, the CFMP delves into a performance assessment of the major elements making up the freight system: these elements are highway, rail, and the seaports. When evaluating the seaports, the CFMP underlines the important role dredging has in preserving maritime transportation infrastructure. Without frequent dredging, ports are unable to accommodate the ship sizes they were originally designed to accommodate. The CFMP also recognizes the benefits of investing in infrastructure improvements at seaports, amongst other fixtures which make up California's transportation system. Some of the benefits of infrastructure investments, as cited by the CFMP, include reductions to congestion and improvements to public health and safety through reduced emissions. Additionally, the CFMP investigates potential and ongoing freight infrastructure developments in California. Some maritime-centered developments mentioned are the feasibility of inland ports and marine highways. The CFMP also advises against complacency: continual investment in California's transportation infrastructure is critical to keeping up with California's competitors who are improving their own transportation infrastructure. In the CFMP's Appendix [9], Caltrans also brings attention to how infrastructure projects are getting stalled at the local

and regional levels—local stakeholders often oppose projects because of their inevitable impacts, which lengthens the planning and approval phase. Caltrans advises that deeper State involvement, in the form of regulation streamlining and overseeing of developments, would help local agencies execute infrastructure projects more rapidly.

Comments:

One strength of the CFMP is its mention of several key infrastructure topics which are relevant to the ports—these include the importance of regular dredging, maintenance, and upgrades to uphold port competitiveness, as well as the acknowledgement of California's lagging infrastructure upgrades when compared to California's competition. However, although infrastructure is discussed to an adequate degree for the purposes of the entire freight transportation system, the CFMP is not specific enough when discussing the maritime system or the ports. Californian ports would get more use out of a plan that is more targeted; for instance, a performance assessment of infrastructure at each port would be helpful instead of just stopping at a general performance assessment of seaports. The CFMP also tends to focus on infrastructure plans that are already in progress at the ports. Although this focus may be because local agencies, not Caltrans, hold jurisdiction over California's ports, moving beyond summaries of the current infrastructure projects to instead discuss the future would be more helpful. Even if future recommendations are kept general, Caltrans might be able to organize the ports in making united efforts that will benefit all parties involved. Another way the CFMP could be improved is by discussing how the state can provide financial support to ports for infrastructure projects, and additional funding opportunities that are available. Since federal funding for maritime infrastructure is limited [142], it would be helpful for the CFMP to provide support to the ports to increase the likelihood of the ports getting chosen for federal funding. In addition,

infrastructure projects take years, or even decades to come to fruition. The CFMP would be more complete if it explored how to streamline the process of getting infrastructure projects approved.

4.2.4 Digital Infrastructure

CFMP:

Digital infrastructure is a rising subject as it is a means of improvement that can be more immediately achieved than physical infrastructure. The CFMP suggests blockchain as a tool that may be useful moving forward. Blockchain has applications in supply chain management since it can supply real-time information about the status and location of freight as it moves along the supply chain. Caltrans makes the case that blockchain can help soothe common problems like congestion on the roads, streamline truck drivers' schedules, and minimize truck turn times at ports.

Comments:

The Port of Oakland is one port that has already started to invest in its digital infrastructure in the form of a web portal that truck drivers can access for real-time information on cargo and wait times. Bringing up the topic of digital infrastructure draws attention to how streamlining data flow along the supply chain can help increase competitiveness. The CFMP would be further strengthened by exploring the topic of digital infrastructure security, since shipping companies will be attracted by ports which have solid security in place to protect freight-related data.

4.2.5 Competitiveness

CFMP:

The CFMP includes a chapter dedicated to Strategies and Objectives which is intended to increase the competitiveness of California freight. Two main goals laid out in this chapter are focused on multimodal mobility and economic prosperity. First, the section identifies the need to "maintain, enhance, and modernize the multimodal freight transportation system" for the purpose of achieving the following goals—optimized efficiency, improved reliability, and decreased congestion. Another goal highlighted in this Strategies and Objectives chapter is economic prosperity, which will be achieved by fostering the "economic competitiveness of California's freight sector through increased system efficiency, productivity, and workforce preparation." Both goals, once achieved, would help increase California's competitiveness on the global scale. Caltrans provides a more detailed breakdown of Caltrans's vision of how economic prosperity will be achieved. For example, Caltrans points out that investments in infrastructure and operational improvements will help California's economic development along. Improvements like the elimination of bottlenecks through infrastructure projects and clearing traffic incidents more quickly by way of operational modifications would reduce transportation cost, and inversely impact competitiveness. The CFMP expresses Caltrans's willingness to work with the freight industry to identify and financially support major infrastructure projects which will greatly benefit California's freight. Caltrans also declares that it will advocate for new freight infrastructure funding by engaging with affiliates in both the public sector and the private sector. Another sub-objective listed under Caltrans's goal of economic prosperity is to "promote freight projects that enhance economic activity, freight mobility, … and global competitiveness." This sub-objective entails committees at the regional level, whose responsibility will be to tackle their region's specific freight issues. The CFMP also proposes the need to develop a set of metrics which will measure the competitiveness of California's freight system. Having a defined method

for tracking competitiveness is a necessary first step to strengthen California's position both nationally and globally, since tracking California's performance will give CalTrans and other freight stakeholders an idea of how California is faring and when further action needs to be taken to galvanize California's freight industry. Another component of Caltrans's plan to bolster California's economic prosperity is to improve the freight industry's workforce by investing in workforce training and education—expanding course offerings at post-secondary schools to include topics that will prepare students for careers in freight management and logistics.

The CFMP also includes some findings from focus groups that were run to collect stakeholder input. Stakeholders believed that setting performance goals would help increase Californian port competitiveness. Another finding from the focus group sessions was the need to "collaboratively design strategies between State regulations and privately-held interests" to improve port competitiveness. One example supplied by the CFMP was streamlining the permitting process and offering financial assistance to companies investing in the ports, to make industrial buildings near Californian ports more attractive.

Comments:

The CFMP touches on many different plans for how Caltrans intends to improve the Californian freight industry's competitiveness—improvements to efficiency, reliability, congestion, workforce preparation, infrastructure, and operations are all mentioned in the CFMP. However, few maritime-specific plans are mentioned. The CFMP expresses Caltrans's intention to form freight advisory committees at existing transportation agencies, which will address regional freight issues. A future maritime policy may want to initiate something similar, but specific to maritime—for instance, California could have maritime advisory committees based on region. These committees could play a supporting role, such as through coordination between

ports within a region, or devising plans on how to tackle each port's individual issues. This would be especially helpful since each port is unique, is facing different challenges (as described in Chapter 3) and would respond best to tailored solutions.

4.2.6 Business Costs

CFMP:

Under the CFMP's California Freight Competitiveness chapter, there is a subsection titled "California's Cost Difference." Within this section, three major costs incurred while transporting freight are discussed—trucking costs, rail costs, and ocean shipping costs. A cost comparison is provided for how California's trucking costs have varied over the years. No hard numbers are specified when comparing California with its competitors.

Comments:

During its "cost comparison," the CFMP makes vague statements such as "the ports'… charges tend to be highly competitive" and "railroad operating costs may be slightly higher in California than in other states." Although the CFMP explains that it cannot provide more specific cost information because such pricing data is kept confidential by service providers, stronger conclusions on California's business costs in comparison to its competitors can be made. For example, the 2020 Mercator study cited in Chapter 2 provided several cost statistics to illustrate the higher costs associated with doing business at Californian ports. One such statistic examined the cost differentials between California's largest ports and their competitors. Table 75 tabulates these cost differentials, which vary based on destination. Quantifying these kinds of cost data would greatly strengthen the CFMP's coverage of how California stacks up against its competitors.

Table 75 – Rail transport cost comparison per container based on destination [8].*

Destination	Cost differential per FEU** between the San Pedro Bay Ports and the Ports of Savannah and Charleston	Cost differential per FEU** between the San Pedro Bay Ports and Gulf Coast Ports
Chicago	$195	$350
Kansas City	$275	$410
Atlanta	$785	$410

**Note: The differences in transport time were not provided, but should be considered before making definite conclusions.*
***Note: Forty-foot equivalent unit*

The CFMP would be stronger if more weight were given to the issue of Californian business costs. There are other costs contributing to California's higher business costs such as terminal rents and implementation of environmental policies that should be mentioned. Additionally, it would be valuable for the CFMP to discuss ways in which California's business costs can be lowered or offset to ensure that California's competitiveness is not compromised. For instance, the Pacific Maritime Association argues that Californian ports can close the gap in freight transportation costs by partnering with "terminal operators, labor, western railroads, … and state environmental regulators to improve the efficiency of the marine terminal-to-rail transfer [8]."

4.2.7 Reliability

CFMP:

Reliability is another issue covered in the CFMP and is a primary focus throughout the Freight Plan. The CFMP delineates several components of reliability—travel time reliability, rail system reliability, and highway reliability. Strategies for improving California's reliability in each of these areas are included in the Freight Plan. For instance, the consistent maintenance of highway infrastructure is mentioned as a necessity for increasing reliability. Investments that would increase reliability are also proposed: several highway freight corridors such as the I-5 and

SR 99 are presented as examples of important links in the freight system that would benefit the most from infrastructure investments—expected improvements include congestion reduction and heightened travel time reliability.

Additionally, the CFMP contains a Strategies and Objectives section which partially focuses on reliability. Caltrans intends to invest in multimodal mobility to "improve travel time reliability." Caltrans also plans to collaborate with "other states and regions to improve multi-jurisdictional freight corridors to… improve reliability," reduce delay, and improve safety. Additionally, the Strategies and Objectives section reveals Caltrans's plans to "promote freight projects that enhance [characteristics of the freight system such as]… reliability."

Another issue brought up by the CFMP is the need to improve port access reliability. The CFMP states that especially because California has one of the highest concentrations of warehouses and distribution centers in the United States, California must focus on improving the reliability of its freight transportation system—otherwise, congestion will limit California's potential to be more competitive. The CFMP also prescribes a call to action, stating that California's competitiveness relies heavily on both the public and private sectors. Both sectors must collaborate and combine forces when transporting freight for California to have a chance at staying competitive.

Comments:

The CFMP recognizes that boosts to the reliability of California's freight industry is essential to attract more business. For all its mentions of reliability, the CFMP does not delve deeply into labor issues, where reliability is critical. The Freight Plan briefly mentions that shippers are wary of the stability of West Coast labor after the 2014-2015 strike, and cites this as a potential reason behind why West Coast ports are lagging behind their Gulf Coast and East

Coast counterparts (which are also unionized) in terms of growth. However, the Freight Plan does not expand on the topic—labor reliability is not directly addressed as an issue, nor are potential strategies to improve labor reliability explored. In addition, the CFMP does not address the potential that SB 743 has to penalize highway freight corridor improvement projects—congestion along these highway corridors will be decreased for all vehicles, not just freight trucks, and will likely add induced demand.

Chapter 5: Recommendation

5.1 Statewide Maritime Policy

From considering the different challenges the ports are facing generally and individually, as well as California's current lack of a specialized maritime plan, this thesis proposes that a statewide maritime policy be drawn up to address the diverse challenges which the ports are experiencing. Chapter 2 discussed different issues Californian ports are up against that are reducing their competitiveness, such as outdated infrastructure, inadequate measures to balance emissions regulations, and high business costs. A state maritime strategy could address all of the major issues which are present and provide the ports with a sense of how to handle or resolve these issues. Additionally, Chapter 3 provided a magnified look into the issues each port is experiencing on an individual level. The major finding of Chapter 3 was that each port has its own challenges, and a plan as general as the California Freight Mobility Plan is not able to sufficiently address each port's needs. A state maritime policy, however, can allot proper attention to each port and understand what the most pressing needs of each port are. Chapter 4 followed up by covering what sorts of legislation the ports are impacted by and reviewing the current freight policy, the California Freight Mobility Plan. Taking inventory of the contents of the CFMP helped to give an idea of what is lacking that the ports would benefit from, and thus should be included in a state maritime plan. The policy might follow a similar format to the CFMP in that the CFMP is geared towards providing a plan on how to increase competitiveness of California's freight industry. A state maritime policy would specifically target the maritime industry and focus on supporting and meeting the needs of Californian ports. The following

recommendations (extracted from Chapters 2 and 4 of this thesis) for how to improve the ports' situations [9], [43] can be implemented into a state maritime strategy.

1. There needs to be a balance between environmental protection laws and investment in the ports' economic development, as well as greater efforts made to maintain employment, job security, and earnings security at the ports.
2. The State should focus on streamlining regulations (including environmental regulations) and the overseeing of commercial and industrial development, as this would provide more direction for agencies at the local level.
3. Rebrand California's image to combat existing perceptions of California being "aloof" in business matters.
4. Invest in greater port workforce accessibility and training.
5. Streamline regulations and oversee developments to help local agencies get their infrastructure projects in motion.
6. Develop a set of metrics to assess the competitiveness of California's freight system. Doing so will allow freight stakeholders to track California's performance and adjust accordingly.

In addition to addressing challenges which the ports are struggling against, a state maritime policy could help coordinate maritime stakeholders' efforts. An example of coordination that would bolster Californian port competitiveness is a marine highway network. The M-580 Marine Highway, alternatively known as the California Green Trade Corridor, is a network that opened for business in June 2013. As of 2014, the marine highway is operating at

an irregular frequency due insufficient demand and support [143]. The highway, which was a $30 million project, was funded through grants from the U.S. Maritime Administration and the 2009 American Recovery and Reinvestment Act. The M-580 is a waterborne barge service that transports freight between the Port of Stockton and the Port of Oakland, serving both the Central Valley and Bay Area. This service was started to alleviate congestion along Interstate 580, which is recognized as one of the most congested routes in the country, and to mitigate truck emissions. Drayage trucks travelling between the Ports of Stockton and Oakland contribute to the I-580 blockage, with an estimated 1,600 containers in 2013 alone [144]. The barge service going between Stockton and Oakland was Phase 1 of the Marine Highway project—Phase 2 planned to create a new route connecting the service to the Port of West Sacramento as well.

Fourteen months after the Marine Highway launched, in 2014, the M-580 Project transitioned from being a "weekly service to [becoming] an 'as-needed' service [143]." The M-580 was not financially feasible due to insufficient demand for its services. One reason behind the lack of demand was that the M-580 had an unknown lifespan—even shippers who tried out the M-580 were unwilling to shift even more of their freight to be transported by the marine highway, since it seemed to be more of a trial experiment rather than a stable service [145]. The Port of Stockton's Port Director, Richard Aschieris, stated that a lesson learned while operating the Marine Highway full-time was that "build[ing] sustainable volumes… [took] longer than anticipated [143]." In the M-580's first 14 months, 25,000 truck trips were eliminated due to the service [143]. A maritime policy can harness the resources of maritime stakeholders to support collaborations, such as the M-580, that can have positive benefits on California's maritime system.

Chapter 6: Conclusions

6.1 Summary

This thesis explored each Californian port individually to understand each port's characteristics and unique challenges. A comparison was made between the Californian ports, as well as between California ports and national competitors, but the lack of data on freight transport costs (particularly rail shipping costs) made it difficult to make conclusive comparisons between California ports and their rivals. The ports' weaknesses and issues were also studied to compile a more complete context that would help when forming the recommendation. Another component of this thesis delved into existing and proposed legislation which have impacts on the ports—the purpose of this legislation review was to understand what sort of support has already been provided to the ports through legislation. Following this, an overview of the 2020 Caltrans Freight Mobility Plan was conducted. Similar to the intention of the legislation review, the perusal of the Freight Mobility Plan helped with understanding what types of recommendations and guidance have been set forth by maritime authorities. Reviewing previously mandated legislation and the Freight Mobility Plan helped to uncover gaps in California's current support of the ports—these gaps then formed the basis of the recommendation of this thesis. The main finding of this research is that there is no authority organizing in the interest of maritime groups, including the ports. Given the current position of Californian ports, the review of existing legislation and guidance, and the complex nature of the maritime sector, a maritime policy would be of great benefit to Californian ports since the policy would focus on strategies for keeping the ports competitive and collaboration within the network of maritime stakeholders.

6.2 Future Areas of Study

As California thinks of solutions and works to implement a state maritime policy, some states such as Texas have state maritime policies already in place. Future research might probe for any case studies that have been done to determine how impactful these maritime policies have been. A comparison of the performance of ports influenced by maritime policy, prior and post-maritime policy introduction, could be done to measure the impacts of maritime policy on ports and the magnitude of any potential improvements.

Another potential avenue for future research would be to conduct interviews with each Californian port and associated stakeholders regarding challenges, upcoming developments, and recommendations on how to best provide support. Interviews would provide a more direct source of information about each port's primary concerns. Additionally, the ports would be able to voice their opinions on what legislation and government intervention is having the most impacts, either positive or negative. Opening a discussion with the ports and soliciting feedback would be invaluable while forming a maritime policy. Incorporating suggestions from the ports during the policy-drafting process would ensure the maritime policy can adequately aid the ports in their quest to increase competitiveness and regain market share.

References

[1] J. O'Connell, "Briefing Paper: Loss of Market Share at U.S. West Coast Ports," Pacific Merchant Shipping Association, 2020.

[2] E. Johnson, "JOC Rankings: US–China trade war accelerates market share losses for West Coast ports," 4 May 2020. [Online]. Available: https://www.joc.com/port-news/us-ports/joc-rankings-us%E2%80%93china-trade-war-accelerates-market-share-losses-west-coast-ports_20200504.html. [Accessed 2020].

[3] B. Mongelluzzo, "Southern California Ports Losing Market Share," 2013. [Online]. Available: www.joc.com/port-news/us-ports/port-los-angeles/southern-california-ports-losing-market-share_20131031.html. [Accessed 2020].

[4] The Maritime Executive, "California Expands Emissions Regulations for Ships in Port," 27 August 2020. [Online]. Available: www.maritime-executive.com/article/california-expands-emissions-regulations-for-ships-in-port. [Accessed 2020].

[5] M. Nacht, L. Henry and J. Martin, "Sustaining the San Pedro Bay Community Ports of Los Angeles & Long Beach," [Online]. Available: www.pmanet.org/wp-content/uploads/2019/05/SoCal-Port-Sustainability-Report-2019-4.10.19.pdf. [Accessed 2020].

[6] USTradeNumbers, "Port of Los Angeles," [Online]. Available: www.ustradenumbers.com/port/Port-of-Los-Angeles/. [Accessed 2020].

[7] USTradeNumbers, "Port of Long Beach," [Online]. Available: https://www.ustradenumbers.com/port/port-of-long-beach/. [Accessed 2020].

[8] B. Mongelluzzo, "Rail-related costs harm West Coast competitiveness: study," 2020. [Online]. Available: https://www.joc.com/port-news/us-ports/rail-related-costs-harm-west-coast-competitiveness-study_20200929.html. [Accessed 2020].

[9] Caltrans, "California Freight Mobility Plan 2020 Appendices," 2020.

[10] "Borders and Maritime Security and Port of Entry Screening," [Online]. Available: www.dhs.gov/science-and-technology/borders-and-maritime-security-and-port-entry-screening. [Accessed 2020].

[11] "Port Security," [Online]. Available: www.pmsaship.com/affairs/port-security/. [Accessed 2020].

[12] "Ports & Waterway Security," [Online]. Available: www.gocoastguard.com/about-the-coast-guard/discover-our-roles-missions/ports-waterway-security. [Accessed 2020].

[13] "Eleventh Coast Guard District," [Online]. Available: www.pacificarea.uscg.mil/Our-Organization/District-11/. [Accessed 2020].

[14] "America's 21st Century Coast Guard: Resourcing for Safety, Security and Stewardship," 2013. [Online]. Available: https://www.hsdl.org/?abstract&did=739902. [Accessed 2020].

[15] [Online]. Available: www.usace.army.mil/about/. [Accessed 2020].

[16] *U.S. Maritime and Shipbuilding Industries: Strategies to Improve Regulation, Economic Opportunities and Competitiveness,* 2019.

[17] "America's Marine Highway," [Online]. Available: www.maritime.dot.gov/grants/marine-highways/marine-highway. [Accessed 2020].

[18] "The Ready Reserve Force (RRF)," [Online]. Available: www.maritime.dot.gov/national-defense-reserve-fleet/ndrf/maritime-administration's-ready-reserve-force. [Accessed 2020].

[19] "About the Federal Maritime Commission," [Online]. Available: www.fmc.gov/about-the-fmc/. [Accessed 2020].

[20] "About our agency," [Online]. Available: https://www.noaa.gov/about-our-agency. [Accessed 2020].

[21] "About MSC," [Online]. Available: https://sealiftcommand.com/about-msc. [Accessed 2020].

[22] "About USTRANSCOM," [Online]. Available: https://www.ustranscom.mil/cmd/aboutustc.cfm. [Accessed 2020].

[23] "National Maritime Intelligence-Integration Office (NMIO)," [Online]. Available: https://nmio.ise.gov/. [Accessed 2020].

[24] "United States Department of Agriculture Foreign Agricultural Service," [Online]. Available: https://www.fas.usda.gov/. [Accessed 2020].

[25] "About Commerce," [Online]. Available: https://www.commerce.gov/about. [Accessed 2020].

[26] "Powering the Blue Economy: Exploring Opportunities for Marine Renewable Energy in Maritime Markets," [Online]. Available: https://www.energy.gov/eere/water/powering-blue-economy-exploring-opportunities-marine-renewable-energy-maritime-markets. [Accessed 2020].

[27] "Maritime Industry," [Online]. Available: https://www.osha.gov/maritime. [Accessed 2020].

[28] "About the Commission," [Online]. Available: https://www.mmc.gov/about-the-commission/. [Accessed 2020].

[29] "About the National Transportation Safety Board," [Online]. Available: https://www.ntsb.gov/about/Pages/default.aspx. [Accessed 2020].

[30] [Online]. Available: www.cmts.gov. [Accessed 2020].

[31] Pacific Maritime Association, "2019 Annual Report," 2019.

[32] D. Bearth, "2017 Transport Topics Top 50 Global Freight Carriers," [Online]. Available: https://www.ttnews.com/sites/default/files/pdfs/gfc_2017_online.pdf. [Accessed 2020].

[33] "Port of West Sacramento Business Plan," 2013.

[34] "CAPA California Ports," [Online]. Available: https://californiaports.org/. [Accessed 2020].

[35] "Officers," [Online]. Available: https://californiaports.org/officers-2/. [Accessed 2020].

[36] "Ports Leaders Focus on Improving Competitiveness to Mark California Ports Day," 19 February 2020. [Online]. Available: californiaports.org/featured/port_leaders_focus_on_improving_competitiveness_to_mark_california_ports_day_2020/. [Accessed 2020].

[37] "How The Union Works," [Online]. Available: www.ilwu.org/wp-content/uploads/2010/12/how-the-union-works.pdf. [Accessed 2020].

[38] "Pacific Merchant Shipping Association," [Online]. Available: www.pmsaship.com/about/overview/. [Accessed 2020].

[39] "Member List," [Online]. Available: https://www.pmsaship.com/about/members/. [Accessed 2020].

[40] "Competitive Threats," [Online]. Available: www.pmsaship.com/affairs/competitive-threats/. [Accessed 2020].

[41] "PMSA Stakeholder Letter," 2020. [Online]. Available: www.pmsaship.com/wp-content/uploads/2019/12/PMSA-Stakeholder-Letter.pdf. [Accessed 2020].

[42] "Executive Board," [Online]. Available: https://www.seafarers.org/about/siu-information/executive-board/. [Accessed 2020].

[43] Caltrans, "California Freight Mobility Plan 2020," 2020.

[44] "Port Activities," [Online]. Available: https://ww3.arb.ca.gov/ports/ports.htm . [Accessed 2020].

[45] "Port of Redwood City reports decline in tonnage," 2 September 2020. [Online]. Available: www.smdailyjournal.com/news/local/port-of-redwood-city-reports-decline-in-tonnage/article_b0f54536-ecc3-11ea-94b5-8b791ae1cbcf.html. [Accessed 2020].

[46] M. Nall, "COVID-19 takes a toll on the Port of Hueneme," 15 May 2020. [Online]. Available: www.pacbiztimes.com/2020/05/15/covid-19-takes-toll-on-port-of-hueneme/. [Accessed 2020].

[47] J. Smith, "Port of Los Angeles Sees Coronavirus Impact Sharply Reducing Imports," *The Wall Street Journal*, 2020.

[48] B. Mongelluzzo, "Chinese retail imports flood LA-LB in September," 2020. [Online]. Available: www.joc.com/maritime-news/container-lines/chinese-retail-imports-flood-la-lb-september_20201014.html. [Accessed 2020].

[49] "On-Dock Rail Service, the Alameda Corridor and Intermodal Yards," [Online]. Available: www.portoflosangeles.org/business/supply-chain/rail. [Accessed 2020].

[50] Pacific Maritime Association, "2015 Annual Report," 2015.

[51] J. Bonney, "Southern California auto ports face capacity constraints," [Online]. Available: https://www.joc.com/port-news/us-ports/southern-california-auto-ports-face-capacity-constraints_20170811.html. [Accessed 2020].

[52] B. Mongelluzzo, "ARO 2020: US West Coast ports competing through infrastructure, technology," 2019. [Online]. Available: www.joc.com/port-news/port-productivity/aro-2020-us-west-coast-ports-competing-through-infrastructure-technology_20191230.html. [Accessed 2020].

[53] "Projects," [Online]. Available: www.portoflabonds.org/port-of-los-angeles-bonds-ca/about/projects/i1683. [Accessed 2020].

[54] "Port of Los Angeles Advances $34 Million On-Dock Rail Yard Expansion," 24 October 2018. [Online]. Available: www.portoflosangeles.org/references/news_102418_railyard_expansion. [Accessed 2020].

[55] "Port Facts & FAQs," [Online]. Available: https://www.polb.com/port-info/port-facts-faqs#facts-at-a-glance. [Accessed 2020].

[56] "Stakeholders Offer Views as the Ports of Long Beach and Los Angeles Host Forum to Gather Input on Supply Chain Optimization," [Online]. Available: californiaports.org/pier-news/stakeholders-offer-views-as-the-ports-of-long-beach-and-los-angeles-host-forum-to-gather-input-on-supply-chain-optimization/. [Accessed 2020].

[57] B. Mongelluzzo, "Worsening LA-LB port congestion stalls recovery," 8 February 2019. [Online]. Available: www.joc.com/port-news/us-ports/port-los-angeles/worsening-la-lb-port-congestion-stalls-recovery-further_20190208.html. [Accessed 2020].

[58] "Projects," [Online]. Available: www.polb.com/port-info/projects. [Accessed 2020].

[59] "About the Bridge," [Online]. Available: https://newgdbridge.com/about-the-bridge/. [Accessed 2020].

[60] "Middle Harbor Redevelopment Project Final EIR/EIS," 2009. [Online]. Available: http://polb.granicus.com/MetaViewer.php?view_id=18&clip_id=3143&meta_id=248665. [Accessed https://www.pmsaship.com/about/members/].

[61] C. Dupin, "Long Beach OKs $870 million for on-dock rail work," 26 September 2018. [Online]. Available: www.freightwaves.com/news/long-beach-oks-870-million-for-on-dock-rail-work. [Accessed 2020].

[62] B. Mongelluzzo, "Oakland portal to post current truck turn times," 29 January 2019. [Online]. Available: www.joc.com/port-news/us-ports/port-oakland/oakland-portal-post-current-truck-turn-times_20190129.html. [Accessed 2020].

[63] "Development," [Online]. Available: http://oaklandglobal.com/development/. [Accessed 2020].

[64] "Port of Oakland refrigerated exports jump 20 percent in past year," 16 September 2019. [Online]. Available: www.portofoakland.com/seaport/port-of-oakland-refrigerated-exports-jump-20-percent-in-past-year/. [Accessed 2020].

[65] "Major Port of Oakland project could have $1 billion upside," 27 August 2018. [Online]. Available: www.portofoakland.com/seaport/major-port-oakland-project-1-billion-upside/. [Accessed 2020].

[66] E. Baldassari, "Port of Oakland to Keep Extended Night Hours for Trucks," 14 June 2016. [Online]. Available: www.ttnews.com/articles/port-oakland-keep-extended-night-hours-trucks. [Accessed 2020].

[67] Alameda County Transportation Commission, "Global Opportunities at the Port of Oakland (GoPort)," September 2018. [Online]. Available: https://www.alamedactc.org/wp-content/uploads/2018/12/goport.pdf. [Accessed 2020].

[68] S. Kunthara, "For Port of Oakland, meat is a cool growth opportunity," 23 November 2018. [Online]. Available: https://www.sfchronicle.com/business/article/For-Port-of-Oakland-meat-is-a-cool-growth-13414887.php.. [Accessed 2020].

[69] K. R. Meeks, "West Coast Bulk and Breakbulk Ports," 1 October 2017. [Online]. Available: https://www.pacmar.com/story/2019/10/01/features/bulk-and-breakbulk/731.html. [Accessed 2020].

[70] USTradeNumbers, "Port Hueneme, Calif.," [Online]. Available: https://www.ustradenumbers.com/port/port-hueneme-calif/. [Accessed 2020].

[71] "World Class Rail Service," [Online]. Available: https://www.portofhueneme.org/business/transportation/train-routes/. [Accessed 2020].

[72] "Port Welcomes First Zero-Emission Crane," 9 July 2019. [Online]. Available: https://www.portofhueneme.org/zero-emission-crane/. [Accessed 2020].

[73] G. Lauriat, "Rise of California niche ports," *American Journal of Transportation*, no. 647, 2017.

[74] M. Harris, "Demolition project underway to double cargo capacity at Port of Hueneme's South Terminal," 2019. [Online]. Available: https://www.vcstar.com/story/news/local/communities/port-hueneme/2019/10/20/project-will-double-cargo-capacity-port-of-hueneme-south-terminal/3985720002/. [Accessed 2020].

[75] "First PLA Project in Port History Breaks Ground," [Online]. Available: https://www.portofhueneme.org/port-modernization-groundbreaking-july-2019/. [Accessed 2020].

[76] N. Kaplan, "The Port of Hueneme: Leading the Way," 9 January 2018. [Online]. Available: https://gorail.org/ports/the-port-of-hueneme-leading-the-way. [Accessed 2020].

[77] "Multimodal Optimization & Vehicle Efficiency Project," [Online]. Available: www.portofhueneme.org/wp-content/uploads/2019/03/New-INFRA-FY19-Grant-Project-Description-1-pager.pdf. [Accessed https://www.pmsaship.com/about/members/].

[78] USTradeNumbers, "Port of San Diego, Calif.," [Online]. Available: www.ustradenumbers.com/port/port-of-san-diego-calif/. [Accessed 2020].

[79] "Shipyards," [Online]. Available: www.portofsandiego.org/maritime/shipyards. [Accessed 2020].

[80] J. Shaw, "California's Smaller Ports Handling Bulk and Breakbulk," 1 October 2014. [Online]. Available: http://www.pmmonlinenews.com/2014/10/by-mark-edward-nero-californias-large.html. [Accessed 2020].

[81] "Projects," [Online]. Available: www.portofsandiego.org/projects. [Accessed 2020].

[82] C. Rossenfeld, "Port Prepared to Create a Diverse Waterfront," 13 May 2016. [Online]. Available: https://www.globest.com/sites/carrierossenfeld/2016/05/13/port-prepared-to-create-a-diverse-waterfront/. [Accessed 2020].

[83] USTradeNumbers, "Port of Stockton, Calif.," [Online]. Available: www.ustradenumbers.com/port/port-of-stockton-calif/. [Accessed 2020].

[84] "2019 Port of Stockton Annual Report," Stockton, 2019.

[85] C. Barnett, "Stockton leveraging niches to build on record 2017 volume," 2018. [Online]. Available: https://www.joc.com/port-news/us-ports/stockton-leveraging-niches-build-record-2017-volume_20180423.html. [Accessed 2020].

[86] "Port of Stockton Reports First Wood Pellet Shipment," [Online]. Available: www.portofstockton.com/port-of-stockton-reports-first-wood-pellet-shipment/. [Accessed 2020].

[87] "Locations," [Online]. Available: https://www.amports.com/locations. [Accessed 2020].

[88] K. S. Clair, "Volkswagen Group debuts new processing center at the Port of Benicia," 21 February 2018. [Online]. Available:

https://www.timesheraldonline.com/2018/02/21/volkswagen-group-debuts-new-processing-center-at-the-port-of-benicia/. [Accessed 2020].

[89] "Port of Benicia," [Online]. Available: www.worldportsource.com/ports/commerce/USA_CA_Port_of_Benicia_765.php. [Accessed 2020].

[90] USTradeNumbers, "Port of San Francscio, Calif.," [Online]. Available: www.ustradenumbers.com/port/port-of-san-francisco-calif/. [Accessed 2020].

[91] "Cargo Services," [Online]. Available: https://sfport.com/cargo-services. [Accessed 2020].

[92] "Port of San Francisco and Pasha Automotive Services Sign Agreement for Pier 80 Operations," 11 May 2016. [Online]. Available: https://www.fbjna.com/port-of-san-francisco-and-pasha-automotive-services-sign-agreement-for-pier-80-operations/. [Accessed 2020].

[93] "Port of San Francisco," May 2017. [Online]. Available: https://sfport.com/sites/default/files/Maritime/Docs/Cargo%20Fact%20Sheet.pdf. [Accessed 2020].

[94] "Port of San Francisco Piers 80-96 Maritime Eco-Industrial Center Strategy," March 2016. [Online]. Available: https://sfport.com/sites/default/files/032216_Piers%2080-96%20Strategy.pdf. [Accessed 2020].

[95] S. Margaronis, "Port of San Francisco still does freight," *American Journal of Transportation*, 19 May 2015.

[96] "Port of San Francisco Tonnage Report for General, Bulk Cargo and Autos 2015-2019," [Online]. Available: https://sfport.com/sites/default/files/Maritime/Docs/Cargo%20Statistics%202020.pdf. [Accessed 2020].

[97] "Pier 96 Bulk Cargo Marine Terminal, Request for Interest," 3 March 2011. [Online]. Available: https://sfport.com/pier-96-bulk-cargo-marine-terminal-request-interest. [Accessed 2020].

[98] Port of Redwood City, "Port of Redwood City," [Online]. Available: https://782212a8-b0fc-46e8-958b-591493c263bd.filesusr.com/ugd/c0af35_d679f97c6d4545e9b38ea913172439ad.pdf. [Accessed 2020].

[99] USTradeNumbers, "Port of Redwood City, Calif.," [Online]. Available: www.ustradenumbers.com/port/port-of-redwood-city-calif/. [Accessed 2020].

[100] "Growth at the Port of Redwood City," [Online]. Available: https://californiaports.org/pier-news/growth-port-redwood-city/. [Accessed 2020].

[101] S. Margaronis, "Port of Redwood City's Zortman plans for new business & more dredging," *American Journal of Transportation*, 13 June 2019.

[102] "Potential Redwood City Ferry," [Online]. Available: www.redwoodcity.org/departments/community-development-department/planning-housing/planning-services/potential-redwood-city-ferry. [Accessed 2020].

[103] Z. Clark, "Record-breaking year for Port of Redwood City," 2019. [Online]. Available: www.smdailyjournal.com/news/local/record-breaking-year-for-port-of-redwood-city/article_8619e6f6-1a19-11e9-aa8a-975c95097a39.html. [Accessed 2020].

[104] USTradeNumbers, "Port of Richmond, Calif.," [Online]. Available: https://www.ustradenumbers.com/port/port-of-richmond-calif/. [Accessed 2020].

[105] "Port Operations," [Online]. Available: https://www.ci.richmond.ca.us/102/Port-Operations. [Accessed 2020].

[106] Bay Area News Group, "After years of shortfalls, is Port of Richmond entering new era?," 2015. [Online]. Available: www.eastbaytimes.com/2015/11/13/after-years-of-shortfalls-is-port-of-richmond-entering-new-era/. [Accessed 2020].

[107] "Richmond Upgrades Rail Infrastructure to Serve Honda," [Online]. Available: www.transdevelopment.com/?p=249. [Accessed 2020].

[108] "RJJ Log Export Facility," [Online]. Available: www.ci.richmond.ca.us/3270/29976/RJJ-Log-Export-Facility?activeLiveTab=widgets. [Accessed 2020].

[109] "Port of West Sacramento," [Online]. Available: https://www.cityofwestsacramento.org/government/departments/city-manager-s-office/port-of-west-sacramento. [Accessed 4 December 2020].

[110] D. Smith, "West Sacramento port leaders optimistic after docking first cement ship since 2010," 2015. [Online]. Available: https://www.sacbee.com/news/local/article17251682.html. [Accessed 2020].

[111] USTradeNumbers, "Humboldt Bay Harbor, Calif.," [Online]. Available: https://www.ustradenumbers.com/port/humboldt-bay-harbor-calif/. [Accessed 2020].

[112] BST Associates, "Humboldt Bay Maritime Industrial Use Market Study," BST Associates, 2018.

[113] "Humboldt Bay Management Plan," 2007.

[114] BST Associates, Burgel Rail Group, "Humboldt Bay Alternative Rail Corridor Concept Level Construction Cost and Revenue Analysis," BST Associates, 2013.

[115] "What We Do," [Online]. Available: http://humboldtbay.org/what-we-do. [Accessed 2020].

[116] "Redwood Marine Terminal Berth 2," [Online]. Available: http://humboldtbay.org/redwood-marine-terminal-berth-2. [Accessed 2020].

[117] H. R. Morley, "North American port rankings: Mexican ports grow fastest," 2019. [Online]. Available: https://www.joc.com/port-news/north-america-port-rankings-mexican-ports-grow-fastest_20190506.html. [Accessed 2020].

[118] USTradeNumbers, "Port of Oakland, Calif.," 2020. [Online]. Available: https://www.ustradenumbers.com/port/Port-of-Oakland-Calif/.

[119] Pacific Maritime Association, "2018 Annual Report," 2018.

[120] Pacific Maritime Association, "2007 Annual Report," 2007.

[121] B. Mongelluzzo, "California ports suffer from higher costs, evolving supply chains: PMSA," [Online]. Available: https://www.joc.com/port-news/us-ports/california-ports-suffer-higher-costs-evolving-supply-chains-pmsa_20191017.html. [Accessed 2020].

[122] "SB-739 Ports: congestion relief: air pollution mitigation.," 2011-2012. [Online]. Available: http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201120120SB739. [Accessed 2020].

[123] "AB 32 Global Warming Solutions Act of 2006," 28 September 2018. [Online]. Available: https://ww2.arb.ca.gov/resources/fact-sheets/ab-32-global-warming-solutions-act-2006. [Accessed 2020].

[124] "SB-32 California Global Warming Solutions Act of 2006: emissions limit.," 2015-2016. [Online]. Available: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB32. [Accessed 2020].

[125] A. Schwarzenegger, "Executive Order S-3-05," 1 June 2005. [Online]. [Accessed 2020].

[126] "Governor Brown Takes Action to Increase Zero-Emission Vehicles, Fund New Climate Investments," 26 January 2018. [Online]. Available: www.ca.gov/archive/gov39/2018/01/26/governor-brown-takes-action-to-increase-zero-emission-vehicles-fund-new-climate-investments/index.html. [Accessed 2020].

[127] "Executive Order B-55-18 To Achieve Carbon Neutrality," [Online]. Available: https://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf. [Accessed 2020].

[128] "California Senate Bill 743," [Online]. Available: www.fehrandpeers.com/sb743/. [Accessed 2020].

[129] "Senate Bill (SB) 743 Implementation," [Online]. Available: https://dot.ca.gov/programs/transportation-planning/office-of-smart-mobility-climate-change/sb-743. [Accessed 2020].

[130] "SB 743: Changing How We Analyze Traffic Impacts," [Online]. Available: www.sandiegocounty.gov/content/sdc/pds/SB743.html. [Accessed 2020].

[131] "SB-595 Metropolitan Transportation Commission: toll bridge revenues: BART Inspector General: Santa Clara Valley Transportation Authority: high-occupancy toll lanes.," 2017-2018. [Online]. Available: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB595. [Accessed 2020].

[132] "AB-371 Transportation: freight: statewide economic growth, prosperity, and resiliency assessment.," 2019-2020. [Online]. Available: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200AB371. [Accessed 2020].

[133] "AB-1262 California Sustainable Freight Action Plan.," 2019-2020. [Online]. Available: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200AB1262. [Accessed 2020].

[134] "Executive Order B-32-15," 17 July 2015. [Online]. Available: https://www.ca.gov/archive/gov39/2015/07/17/news19046/index.html. [Accessed 2020].

[135] "AB-821 Transportation: Trade Corridor Enhancement Account: project nomination: California Port Efficiency Program.," 2019-2020. [Online]. Available:

https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201920200AB821. [Accessed 2020].

[136] "SB-103 Transportation.," 2017-2018. [Online]. Available: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB103. [Accessed 2020].

[137] "SB-1228 Trade Corridors Improvement Fund.," 2013-2014. [Online]. Available: http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB1228. [Accessed 2020].

[138] "California Proposition 1B, Highway and Port Safety and Air Quality Bond Act (2006)," [Online]. Available: https://ballotpedia.org/California_Proposition_1B,_Highway_and_Port_Safety_and_Air_Quality_Bond_Act_(2006). [Accessed 2020].

[139] "Locations," [Online]. Available: www.spd.usace.army.mil/Locations/. [Accessed 2020].

[140] "Suisun Bay Reserve Fleet," [Online]. Available: www.maritime.dot.gov/history/vessels-maritime-administration/suisun-bay-reserve-fleet. [Accessed 2020].

[141] A. Chottani, G. Hastings, J. Murnane and F. Neuhaus, "Distraction or disruption? Autonomous trucks gain ground in US logistics," 10 December 2018. [Online]. Available: https://www.mckinsey.com/industries/travel-logistics-and-transport-infrastructure/our-insights/distraction-or-disruption-autonomous-trucks-gain-ground-in-us-logistics.

[142] "Maritime Infrastructure: Opportunities Exist to Improve the Effectiveness of Federal Efforts to Support the Marine Transportation System," 13 November 2012. [Online]. Available: www.gao.gov/products/gao-13-80. [Accessed 2020].

[143] "Port of Stockton Transitions M-580 Marine Highway," [Online]. Available: https://maritime-executive.com/corporate/Port-of-Stockton-Transitions-M580-Marine-Highway-2014-08-11. [Accessed 2020].

[144] M. E. Nero, "M-580: California's Marine Highway," 1 June 2013. [Online]. Available: https://maritime-executive.com/corporate/Port-of-Stockton-Transitions-M580-Marine-Highway-2014-08-11. [Accessed 2020].

[145] M. Szakonyi, "Weekly Stockton-Oakland container barge service to end," [Online]. Available: https://www.joc.com/port-news/us-ports/port-stockton-calif/weekly-stockton-oakland-container-barge-service-end_20140808.html. [Accessed 2020].

[146] "Port of Los Angeles Cargo Terminals," [Online]. Available: https://www.portoflosangeles.org/latitude/content/Port_Cargo_Terminal_Map_072013.pdf. [Accessed 5 December 2020].

[147] "Port of Long Beach," [Online]. Available: https://www.polb.com/port-info/map/. [Accessed 5 December 2020].

[148] "Port of Oakland Maritime Facilities," [Online]. Available: https://www.portofoakland.com/files/pdf/about/maritimeBrochure.pdf. [Accessed 5 December 2020].

[149] "About Us," [Online]. Available: https://www.amports.com/about-us. [Accessed 2020].

[150] Pacific Maritime Association, "2008 Annual Report," 2008.

[151] Pacific Maritime Association, "2009 Annual Report," 2009.

[152] Pacific Maritime Association, "2010 Annual Report," 2010.
[153] Pacific Maritime Association, "2011 Annual Report," 2011.
[154] Pacific Maritime Association, "2012 Annual Report," 2012.
[155] Pacific Maritime Association, "2013 Annual Report," 2013.
[156] Pacific Maritime Association, "2014 Annual Report," 2014.
[157] Pacific Maritime Association, "2017 Annual Report," 2017.
[158] Pacific Maritime Association, "2016 Annual Report," 2016.
[159] "A history of fueling the local economy," [Online]. Available: www.redwoodcityport.com/history. [Accessed 2020].
[160] "2020-2021 Texas Port Mission Plan: Investment Strategy," [Online]. Available: https://ftp.txdot.gov/pub/txdot-info/tpp/giww/mission-plan-86.pdf. [Accessed 2020].
[161] "U.S. Department of Transportation," [Online]. Available: www.transportation.gov. [Accessed 2020].
[162] C. Arns, "California ranks No. 5 for shipbuilding," 24 June 2013. [Online]. Available: www.bizjournals.com/sacramento/news/2013/06/24/california-ranks-no-5-for-shipbuilding.html. [Accessed 2020].
[163] A. Klein, "Decline in U.S. Shipbuilding Industry: A Cautionary Tale of Foreign Subsidies Destroying U.S. Jobs," 2015. [Online]. Available: https://www.enotrans.org/article/decline-u-s-shipbuilding-industry-cautionary-tale-foreign-subsidies-destroying-u-s-jobs/. [Accessed 2020].

Appendix A

Port Maps

Figure 76 – Port of Los Angeles terminal map (taken from Port of LA's website) [146].

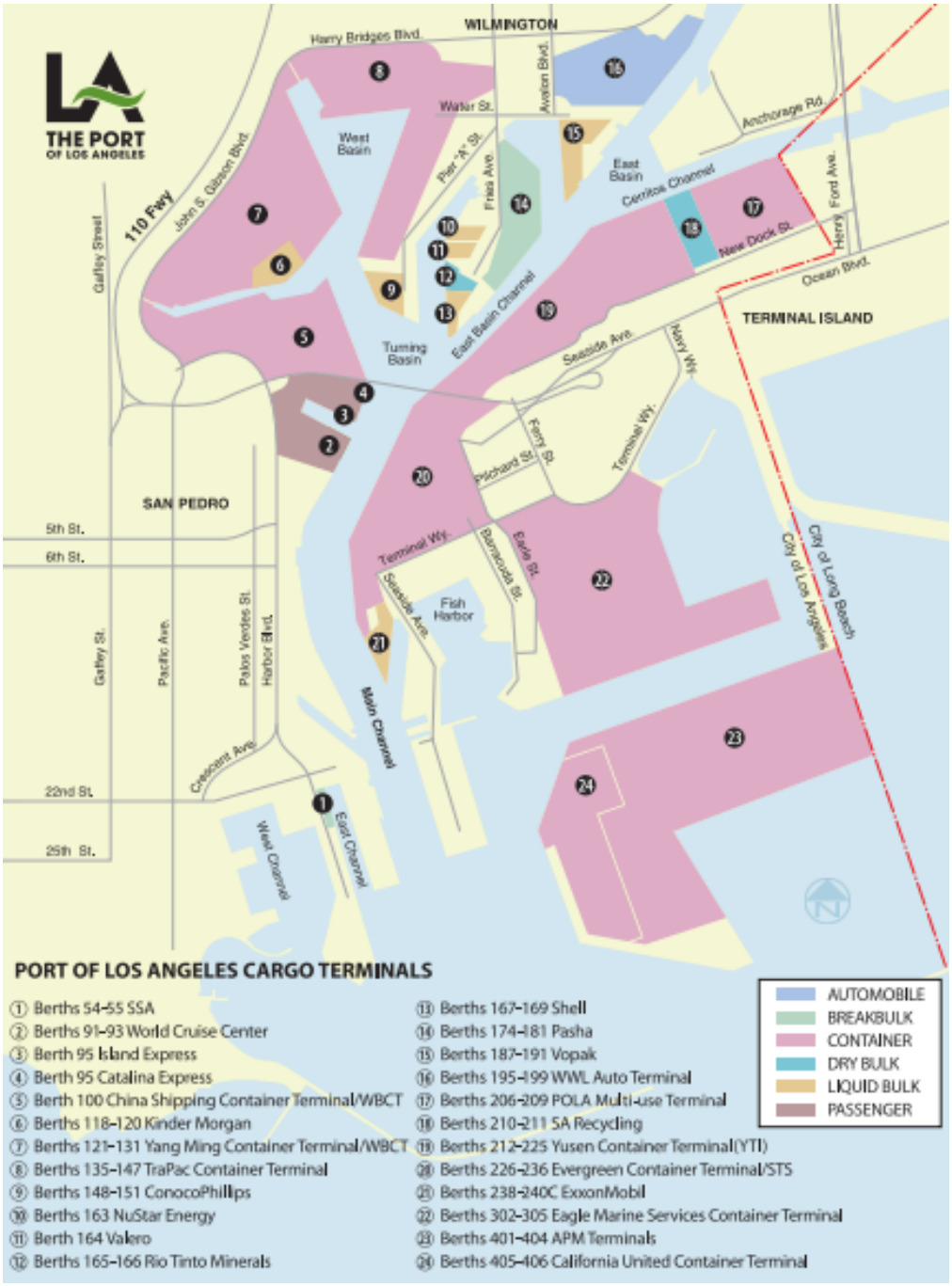
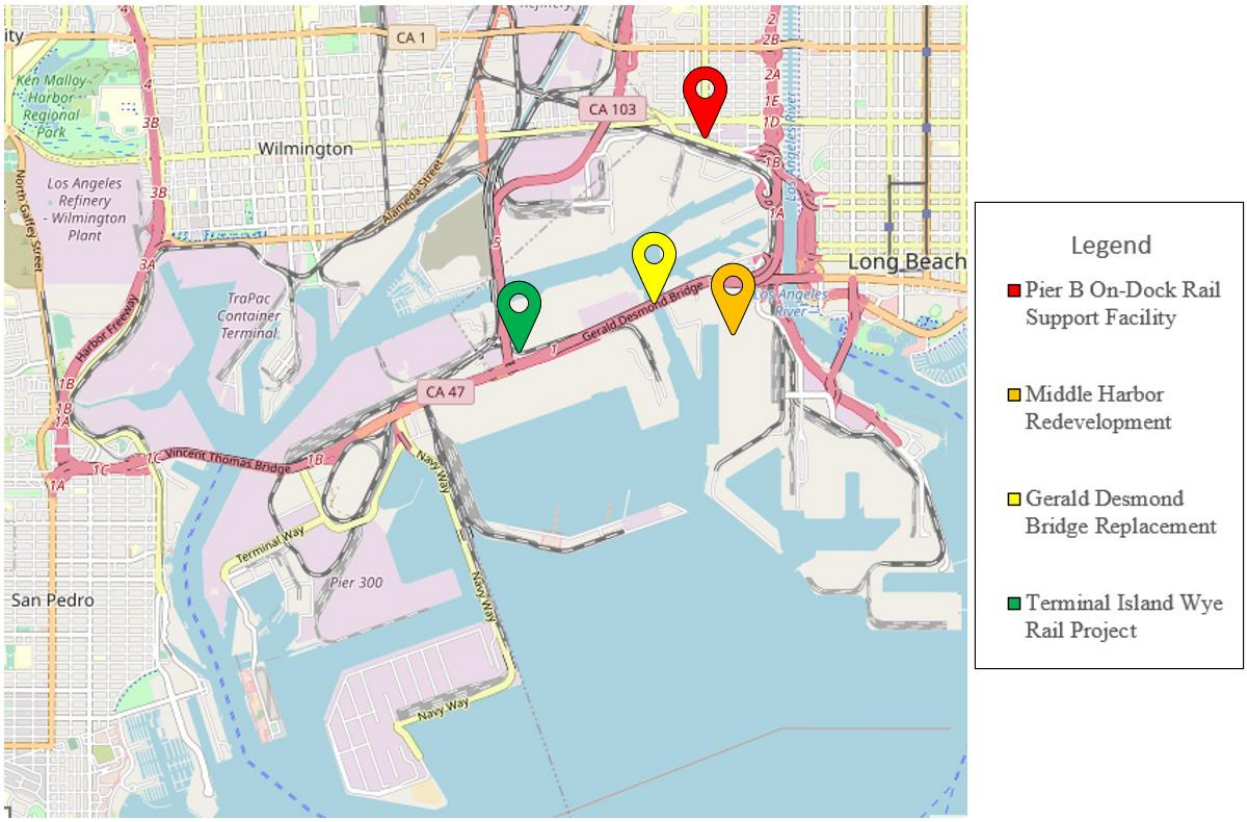


Figure 77 – Port of Long Beach Map [147].



**Note: The base map was pulled from OpenStreetMap.org.*

Figure 78 – Port of Oakland Map (see Port's website for more readable map) [148].