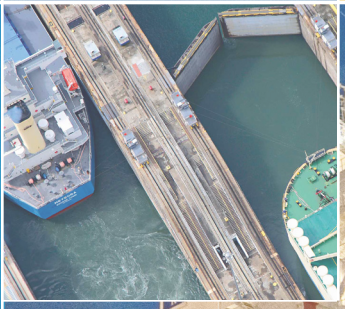
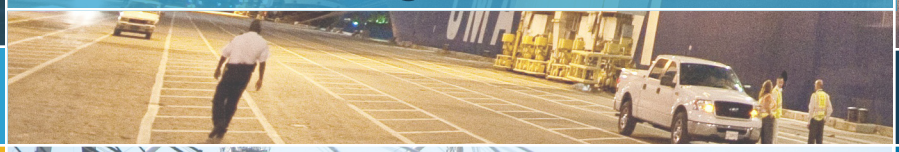
SEAPORT

2018

PANAMA CANAL EXPANSION AND FLORIDA SEAPORTS

A Preliminary Study of Post Panamax Vessel Calls and Pacific Region Container Volumes





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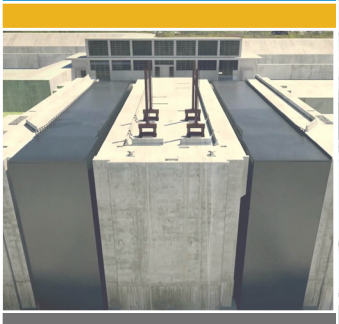

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Panama Canal Expansion and Florida Seaports:

A Preliminary Study of Post Panamax Vessel Calls and Pacific Rim Region Container Volumes

Florida Department of Transportation

Seaport Office

May 2018

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PANAMA CANAL EXPANSION AND FLORIDA SEAPORTS

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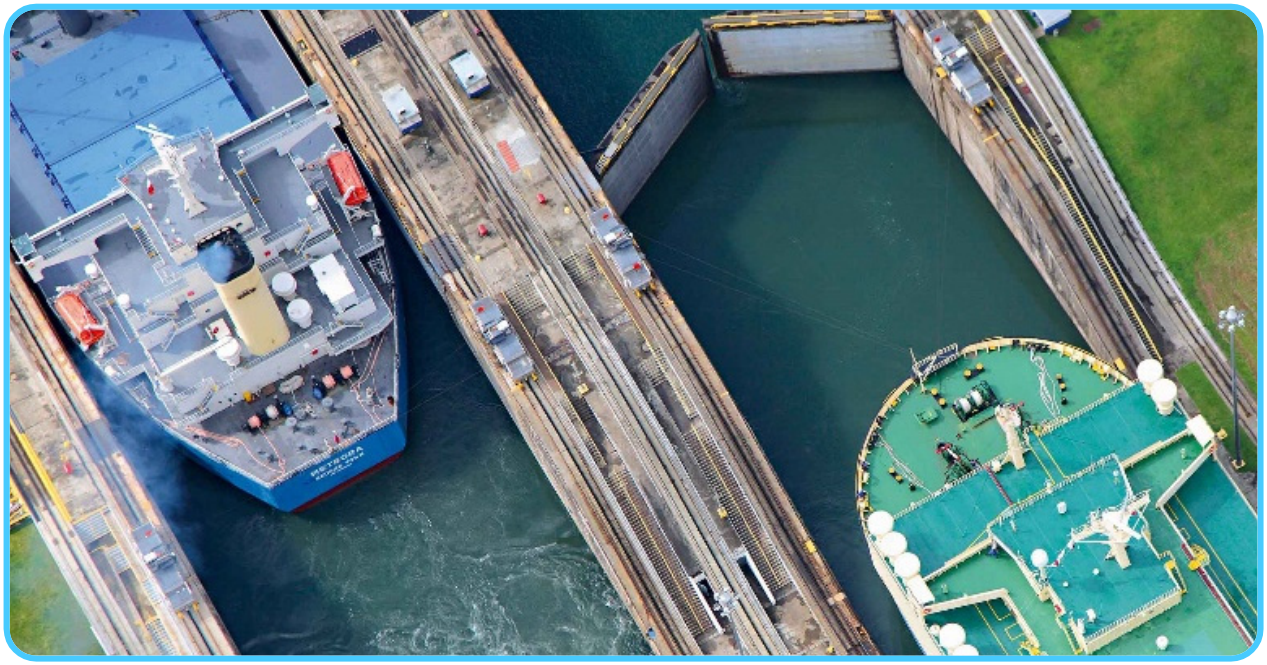
1. INTRODUCTION

The purpose of this preliminary study is to present and provide context for Post Panamax vessel calls at Florida's three largest container seaports and Pacific Rim Region international container cargo flow data, gathered relative to Florida's cargo seaports, following the first full-year's (July 1, 2016 – June 30, 2017) operation of the expanded Panama Canal.

This document presents a brief history of the Panama Canal, along with detailed specifications of both the original and expanded Canal. This document also provides a brief overview of potential impacts to United States (U.S.) East and Gulf Coast seaports along with a more detailed look at specific Florida seaports. The document then summarizes vessel call and trade data gleaned from industry research using national, state and local government resources, along with seaport specific and private data sources. Finally, this document identifies potential projects on the horizon related to the Panama Canal.

The Panama Canal is considered by some to be the eighth wonder of the world. The concept of an all water Canal through Central America was originally conceived in the late 1500's. The completion of this engineering marvel provides vessels a considerably shorter and safer voyage between the Pacific Ocean and the Atlantic Ocean via the Gulf of Mexico. The Canal reshaped global shipping lanes, as vessels no longer had to navigate the dangerous waters of Cape Horn at the southern tip of South America and effectively cut voyage time in half. The Canal continues to make waves today with the recently completed expansion. The Canal's expansion has been a primary catalyst for infrastructure development programs at many U.S. East Coast and Gulf of Mexico seaports. Florida's seaports have a natural geographic advantage, as many of Florida's seaports are closer to the Canal than other continental U.S. seaports. The relationship between Florida's seaport system and the Canal will be highlighted in this document.

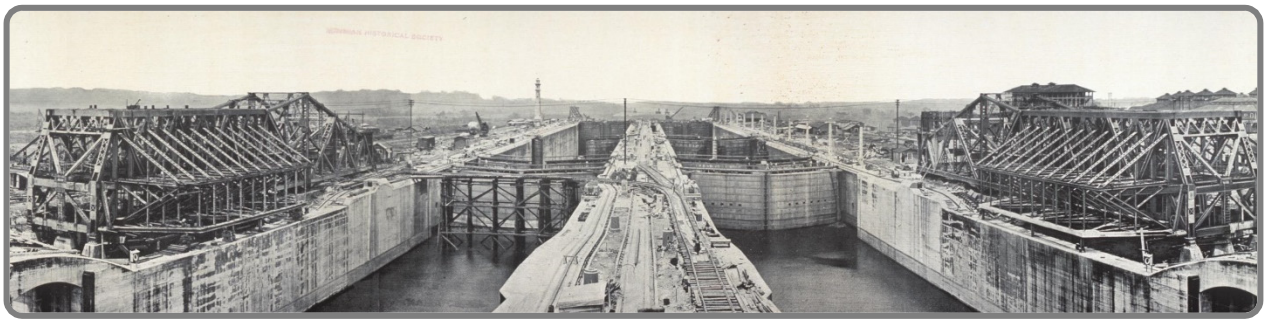


Source: Photo - Panama Canal Authority, 2017.

2. HISTORY OF THE PANAMA CANAL

The Panama Canal has an interesting history with origins dating back to the 1500's. The first modern construction activities began with the French, and the first shovel of dirt was moved by Ferdinand de Lesseps on January 1, 1880. The French spent nine years working on the Canal, excavating more than 70 million cubic yards of material along the selected Canal route prior to halting work on May 15, 1889. This effort came at a huge cost. Work completed along the Canal route cost over $260 million dollars. The French project also experienced a huge loss of life during construction, which exceeded 20,000 workers from accidents, mosquito borne illnesses and disease. These reasons, coupled with an economic downturn, were the major factors leading to the French abandoning work on the Canal in 1889 (Avery, 1913).

In 1902, the United States signed a treaty with the Colombian government, intending to purchase the rights to build the Canal, but could not come to terms on cost for the U.S. to take controlling development and administrative interest in the Canal. Shortly thereafter, President Teddy Roosevelt's administration supported a Panamanian revolution against Colombia, by sending in the U.S. Navy and allowing Panama to declare its independence on November 3, 1903. That same month, the Hay-Bunau-Varilla Treaty of 1903 was signed, allowing the United States to purchase rights to the Canal development for approximately $52 million dollars to the newly formed country of Panama. This included an initial $10 million payment, annual payments of $250,000 for the first nine-years, and $40 million for remaining French assets. The purchase included a coast-to-coast 10-mile wide strip of land, and the rights to complete the Canal, which the United States paid a total of $375 million to build. In total, over 25,000 workers died during the construction of the Canal, including 20,000 workers during the French project, and an additional 5,600 workers during the American project (United States Office of the Historian, 2017).



Source: Birds eye view of Gatun Locks construction, Panama Canal (U.S. Library of Congress, 1913)

The first vessel to transit the Canal from ocean-to-ocean was the SS Cristobal on August 3, 1914. The Canal officially opened for business on August 15, 1914. The Canal has had many other historic milestones since it opened. In the 1930's, additional water supply for the Canal was achieved through the creation of Gatún Lake by damning the Chagres River basin in central Panama. In the early 1930's the maximum cargo throughput capacity of the Canal was estimated at 80 million tons annually.

In 1977, the Torrijos-Carter Treaties provided for the transfer of control of the Panama Canal from the U.S. to the Panamanian government. The transfer was completed in December of 1999. The Autoridad del Canal de Panamá (ACP) or Panama Canal Authority, was established by the Panamanian government and is responsible for the operation and management of the Canal.

Ten years after Panama took control of the Canal, throughput was approaching 300 million tons a year. At nearly four times the original estimated maximum capacity of the waterway; improvements were essential to ensure safe transits, resiliency of trade, expansion of capacity, and accommodate larger vessels. The decision to expand the Panama Canal and add new locks was approved on October 22, 2006, by a national referendum with close to 80% of Panamanians voting in favor of the project. The Canal expansion program began in 2007 and was completed on June 26, 2016 (United States Office of the Historian, 2017).

According to ACP, in fiscal year 2016/2017 (see Appendix B) a total of 11,992 vessels transited the waterway. From that total, 1,828 vessels were characterized as Post Panamax vessels transiting the new expanded locks (see Section 4.2 of this document, which describes vessel size characteristics). The transits of the new locks were led by containerships with 954, followed by liquid petroleum vessels at 539, Liquid Natural Gas (LNG) with 159, dry bulk with 125, auto carriers with 22, and 1 cruise vessel (Panama Canal Authority, 2017).

3. PANAMA CANAL AUTHORITY (ACP) GOVERNANCE STRUCTURE

The Origins of the Panama Canal Authority (ACP) date back to its legal creation through the Organic Law of June 11, 1997. This Law established the legal framework for the ACP's structure and operation. The ACP reserves the right to administer its own finances, remaining autonomous from the government, and retaining its own land and estate to administer. The ACP remains a legal entity of the Republic of Panama, established under public law, Title XIV of the Panamanian Constitution. Its specific charge is to operate, administer, manage, preserve, provide maintenance, and plan and implement modernization of the Canal. The Canal must operate in a safe, continuous, efficient, and profitable manner under its charge, and to remain pursuant to international treaties. The legal framework of the Panama Canal Authority has the fundamental objective of preserving the conditions for the Canal to always remain an enterprise for the peaceful and uninterrupted service of the maritime community, international trade, and the Republic of Panama (Canal De Panamá, 2015).

The Canal authority is led by an Administrator and a Deputy Administrator who are supervised by an eleven (11) member Board of Directors. The ACP Administrator serves a seven-year (7) appointment, and can be re-elected for a second seven-year (7) term. Each Board Director serves a nine (9) year-term.

Board of Directors appointments are made as follows:

- Nine (9) directors appointed by the President of the Republic of Panama;
- One (1) director is designated by the Legislative Branch; and,
- The President of the Republic designates one (1) director, who shall chair the Board of Directors and have the rank of Minister of State for Canal Affairs.

The Panama Canal constitutes an inalienable patrimony of the Republic of Panama; therefore, it may not be sold, assigned, mortgaged, or otherwise encumbered or transferred (Canal De Panamá, 2015).

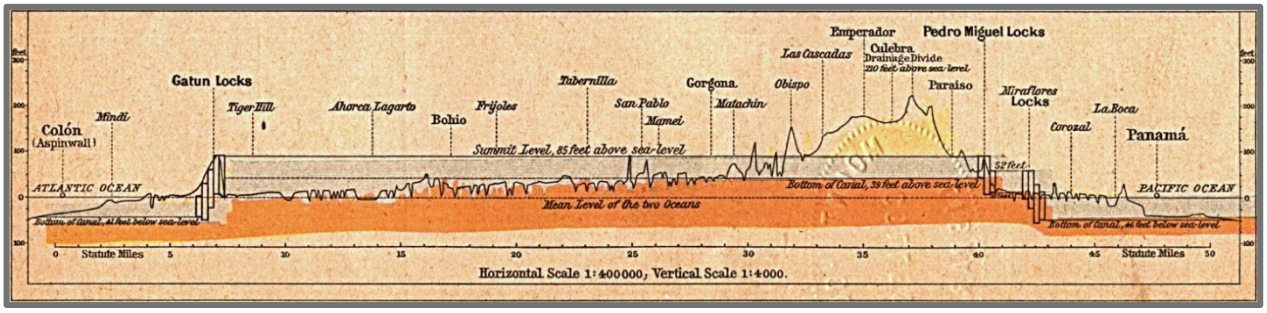
4. CANAL SPECIFICATIONS

The Panama Canal specifications and vessel size characteristics are found in the following sub-sections of this chapter: original canal specifications; rapid growth in container and cruise vessel sizes; new lock specifications; capacity implications for the new locks; and, new canal infrastructure to support the new locks.

4.1 ORIGINAL CANAL SPECIFICATIONS

The original Canal was designed with three lock locations, each configured with two adjacent and parallel sets of locks. The Gatun Locks on the Atlantic Ocean side of the Isthmus of Panama and the Pedro Miguel and Miraflores locks on the Pacific Ocean side. The summit of Lake Gatun is 85 feet above sea level and the water depth in the original Canal channel was 46 feet, illustrated in Figure 1 which is a historic rendering from a 1923 atlas of the Canal (see Shepherd, 1923).

Figure 1 - 1923 Elevation Map of the Panama Canal



Source: Shepherd, W. (1923). Panama Canal Shepherd Elevation.

General vessel and lock configurations are displayed in Figure 2 showing the maximum vessel size by length, width and depth. The maximum vessel size came to be known as Panamax or the maximum ship size that could transit the original Panama Canal locks. Also shown in this figure are the lock size dimensions and air draft restrictions.

Figure 2 - Original Lock and Vessel Specifications

PANAMAX				
(4,500 TEUs)	**Length**	**Width (beam)**	**Depth (draft)**	**Air Draft***
Lock Size	1,050 feet	110 feet	41.2 feet	Bridge of Americas - 201 feet
Vessel Size	965 feet	106 feet	39 feet	190 feet

Note: *Air Draft is clearance from waterway surface at Mean Highest High Water (MHHW), to lowest overhead structures.

Source: Panamax and New Panamax | Maritime-Connector.com

The Panama Canal map in Figure 6, includes illustrations of the original canal locks and the new canal locks' locations, and other features of the Panama Canal system.

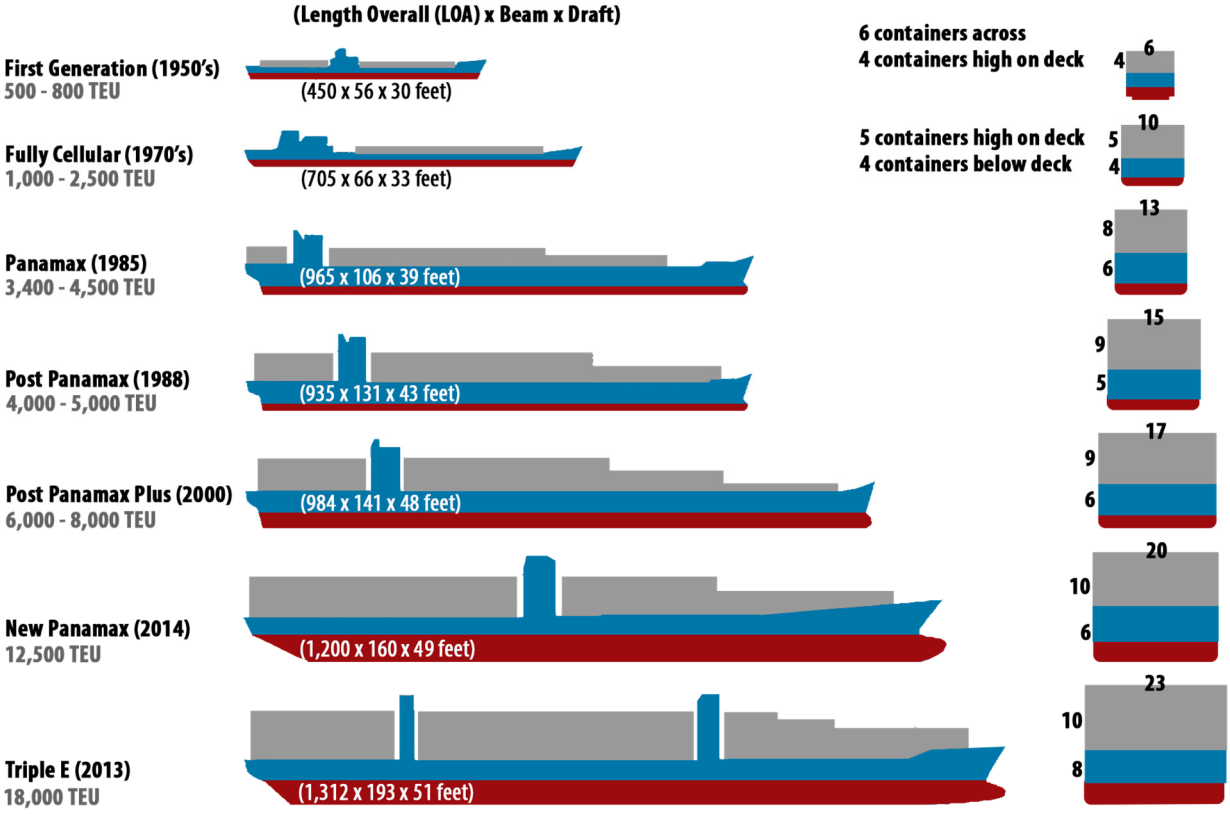
4.2 RAPID GROWTH IN CONTAINER AND CRUISE VESSELS SIZES

One of the primary motivations for the Panama Canal expansion project was that the original Canal had reached maximum operational capacity, and was heavily congested with vessels. Capacity constraints had two primary factors:

1) Only two passageways, limiting quantity of transits.
2) Existing locks limited vessel size, while industry vessel sizes were increasing well beyond the original lock and channel maximum limits.

Vessels have substantially increased in size and at a rapid pace during the past three decades. Figure 3 illustrates container vessel size comparison from the 1950's to around 2013. Between the 1980's and 2013 container ship capacities grew from a max of 4,500 TEUs to the "Triple E" class vessels with capacities of 18,000 TEUs. Since 2013, the latest generations of the Ultra Large Container Vessel (ULCV) class (not shown) have capacities of over 21,000 TEUs. Typically, vessels over 12,500 TEU capacity exceed the dimensions of the new expanded Canal locks.

Figure 3 - Containership Evolution from 1950 to 2013



Source: (Florida Department of Transportation, 2017).

As shown in Figure 3, the larger vessels are a substantial increase in length overall (LOA), beam (width) and draft (depth), over their predecessors from only two decades before. They provide economies of scale, carrying more than three times the cargo, with close to the same crew size and fuel cost. These new vessels stretch global supply chains, and place heavy demands on seaports. In response, seaports deepen and widen channels and harbors, improve berths, purchase new cranes, and expand or improve container

yards to provide more efficient container handling services, and prepare for cargo surges. In addition, tight vessel schedules add pressure to turn (i.e., dock, off-load, load and depart) vessels more efficiently, placing additional pressure on ports to purchase the most up-to-date cranes and yard handling equipment to remain competitive for accommodating global carrier trade routes. The Panama Canal's response to the growth in vessel size was to expand canal capacity with new locks that would increase the maximum ship dimensions that could be accommodated. The maximum ship dimension of the expanded Canal is represented on the chart in Figure 3 by the New Panamax, with a capacity of 12,500 TEUs. For a simple real-world capacity illustration of a TEU (Twenty-foot Equivalent Unit container or 20 -foot long truck trailer), the total furnishings of the average two-bedroom apartment could fit in one TEU. One "Triple E" container vessel is like 18,000 people moving their homes at the same time.

4.3 NEW LOCK SPECIFICATIONS

Source: Photo - Panama Canal Authority, 2017.

The Panama Canal expansion includes newly deepened channels with a third set of locks built parallel to, and operated in addition to, the original two sets of locks: one east of Gatun locks on the Atlantic side, and one southwest of the Miraflores locks on the Pacific side. Each set of new locks includes designated approach channels adjacent to original channels for queuing vessels in transit. The new locks on the Atlantic Ocean side are called the Agua Clara Locks which ascend from sea level directly to the level of Gatun Lake with three consecutive lock chambers and run adjacent to the original Gatun Locks. The new locks on the Pacific Ocean side are called the Cocoli Locks which ascend from sea level directly to the level of Gatun Lake with three consecutive lock chambers. The adjacent original locks; Miraflores and Pedro Miguel; are two separated lock systems divided by Miraflores Lake.

These new lock specifications are 1,400 feet (427 meters) long, 180 feet (55 meters) wide, and 60 feet (18.3 meters) deep. The new lock chambers allow transit of vessels 160 feet (49 meters) wide (beam), 1,200 feet (366 meter) in length overall (LOA), and 49 feet (15 meter) in draft (depth), equivalent to a container ship carrying approximately 12,500 TEUs. A general description of the new lock specifications and the new maximum vessel sizes known as New Panamax, or Panamax II are described in Figure 4.

Figure 4 - New Lock and Vessel Specifications

NEW PANAMAX or PANAMAX II				
(12,500 TEUs)	**Length**	**Width (beam)**	**Depth (draft)**	**Air Draft***
Lock Size	1,400 feet	180 feet	60 feet	Bridge of Americas - 201 feet
Vessel Size	1,200 feet	160 feet	49 feet	190 feet

Note: *Air Draft is clearance from water surface at Mean Highest High Water (MHHW), to lowest overhead structures

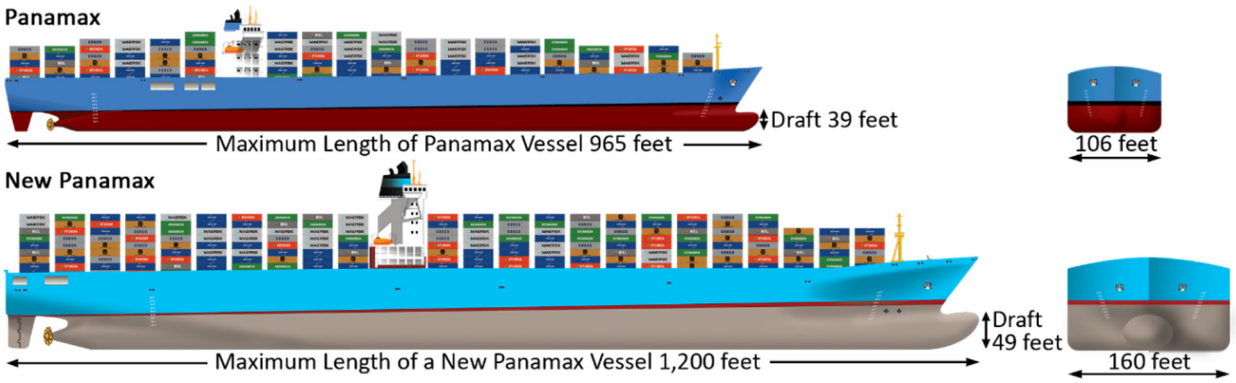
Source: Panamax and New Panamax | Maritime-Connector.com

4.4 CAPACITY IMPLICATIONS FOR THE NEW LOCKS

The major throughput expansion that occurs with the expanded Canal is per-vessel capacity, which increases the economy of scale for a shipping route. Container vessels provide a prime example, going from a Panamax vessel that can carry approximately 4,500 TEUs to a New Panamax vessel that can carry 12,500 TEUs, a shipper can provide nearly three (3x) times the capacity. Carrying nearly three times the cargo, with close to the same crew size and fuel cost. Figure 5 illustrates vessel specifications and general size comparison for both Panamax and New Panamax sized vessels.

Source: Photo - Panama Canal Authority, 2017.

Figure 5 - Panamax Vessel vs. New Panamax Vessels



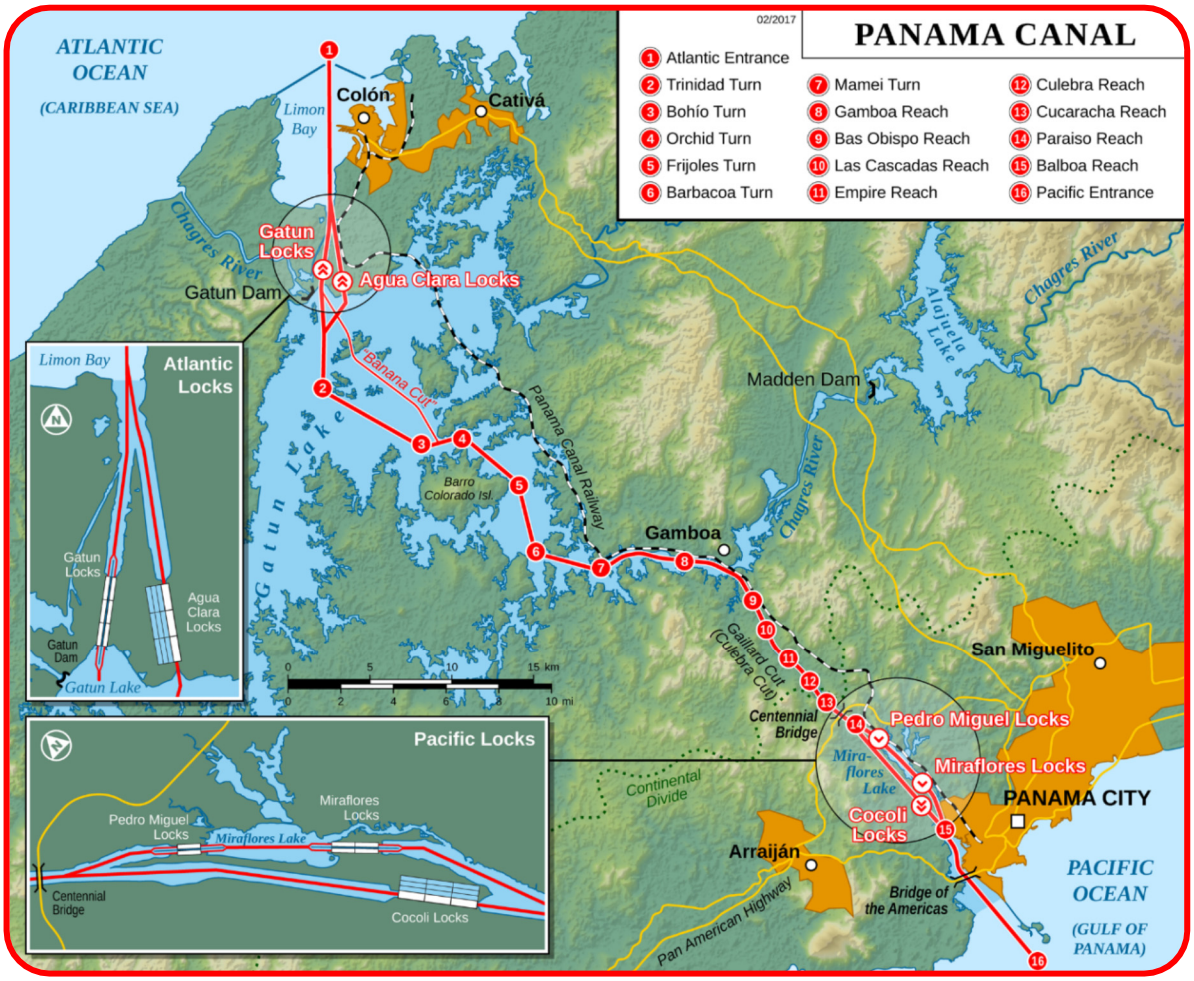
Source: Panamax and New Panamax Container Vessels Comparison (FDOT Seaport Office, 2018).

4.5 NEW CANAL INFRASTRUCTURE TO SUPPORT NEW LOCKS

The expansion of the Panama Canal locks was not the only infrastructure necessary to provide capacity for larger vessels. The new Cocoli lock system is supported by new approach channels including a 3.9-mile (6.2 kilometer) channel parallel to Miraflores lake from the new locks to the Centennial bridge or

Cucaracha reach. This new channel is 720 feet (218 meters) wide. The Gaillard Cut channel through Gatun Lake required widening to 920 feet (280 meters) on the straight portions, and a minimum of 1,200 feet (366 meters) on the bends. The maximum level of Gatun Lake was raised from 88 feet (26.7 meters) to 89 feet (27.1 meters).

Figure 6 - New Locks Locations and Major Projects



Source: Panama Canal Authority, 2017.

In addition to a widened channel, each new lock utilizes nine huge water reutilization ponds (three per lock chamber). These ponds, shown in the photo on the previous page, are approximately 230 feet (70 meters) wide, 1,400 feet (430 meters) long, and 18 feet (5.50 meters) deep. The ponds are gravity-fed and allow for more than 60% of the water used in each transit to be recycled, allowing the new locks to use 7% less water per vessel transit, than the original sets locks. The dredging of Gatun Lake and raising the maximum water level provides additional water storage capacity. These engineering designs reduce overall environmental impacts, allowing the Canal to expand and operate without constructing new water retention reservoirs (U.S. Department of Transportation Maritime Administration, 2013).

The total estimated cost of the Panama Canal expansion project was $5.25 billion in U.S. dollars. The ACP designed the project, anticipating growth in annual average maximum tonnage of 300 million tons in 2009 to nearly 510 million tons by 2025. The expanded Canal design includes a maximum sustainable capacity of approximately 600 million tons annually.

5. IMPACTS FROM CANAL EXPANSION

With the expansion of the Panama Canal, the economics of the all-water route from Asia to the Central and Eastern U.S. via U.S. East Coast and Gulf of Mexico seaports become more competitive with the U.S. West Coast Intermodal (i.e., long-haul rail and truck) model.

5.1 U.S. EAST AND GULF COAST CARGO SHIFT

At the 2017 American Association of Port Authorities (AAPA) annual "Shifting International Trade Routes" conference, the following statement summarizes a series of discussions:

> ***What should East Coast seaports do to capture more international trade now that the Panama Canal expansion is complete? Especially when trade is destined for the East Coast, but may enter the U.S. through a West Coast port like Los Angeles, Oakland or Tacoma/Seattle.***

A 2015 East Coast cargo shift was triggered by the International Longshore and Warehouse Union (ILWU) work disruptions of 2014 and 2015, which impacted West Coast port productivity. Many liner service companies like COSCO, Maersk and OCCL prior to the 2014/2015 West Coast productivity issues had only a few vessel routes from most of Asia to East Coast seaports. When the labor slow down issues occurred, these liner services did not have the relationships or capacity in place with East Coast ports and terminals. Many of their vessels in service at the time were already switched to Post Panamax, too large to go through the original Canal locks. Many liners rerouted smaller vessels and even sailed around South America or through the Suez Canal to open additional routes to the U.S. East Coast. This situation, along with the impending opening of the expanded Panama Canal, caused the industry to look at diversifying their cargo routings to include more all-water services to U.S. East Coast and Gulf of Mexico seaports.

According to recent industry articles in the Journal of Commerce (e.g., Braden, 2017), East Coast and Gulf of Mexico container seaport markets are gaining market share of U.S. Asian imports. Total U.S. Asian cargo imports grew 5.8% in 2016, while during the same period, East Coast seaport Asian cargo grew at 7.9% (Braden, 2017). Average containership sizes through the Canal have increased 47% since the new locks opened June 26, 2016 (Braden, 2017). "Shippers like reliability", Mr. Bourdon, CEO of CMA-CGM said during an interview with the Journal of Commerce. He went on to say, "During the West Coast slowdown, we had ships at anchor for 20 to 25 days… there's a realization among shippers that you can't put all your eggs in one basket" (Whelan, 2015). The industry movements and market analysis are pointing to a sustained and lasting shift for containerized freight to U.S. East Coast and Gulf of Mexico seaports.

From these and similar narratives, it is apparent to industry professionals, that Post Panamax vessels and the New Panama Canal expansion project are having significant impacts on trade lanes, supply chains, and infrastructure development, and these trends are likely to continue into the foreseeable future.

6. IMPLICATIONS FOR FLORIDA SEAPORTS

The expansion of the Panama Canal coincides with dramatic growth in Florida's consumer populations of full-time residents, seasonal residents and short-term visitors. In addition, Florida's leisure cruise market is continuing to grow at a sustainable pace. Florida's public seaports as defined in Section 311.09, Florida Statutes (F.S.), and the state of Florida Department of Transportation are responding to these opportunities with large investments in seaport related infrastructure, both on the landside and waterside.

Seaports of various forms have been active in Florida for more than 150 years. Florida is home to the three (3) largest cruise seaports in the world. In total, Florida represents the world's largest cruise market by a sizable margin, with 16.1 million annual revenue passengers in fiscal year (FY) 2017. Florida also has seven (7) seaports ranked in AAPA's top 50 container ports in North America. Florida seaports moved a combined 3.7 million TEUs in FY2017. Florida hosts the country's top automobile Ro/Ro export port. The Florida seaports are also a primary gateway for U.S. trade with Caribbean and Latin American countries. Florida's geographic location places it at the crossroads of both East-West and North-South trade lanes, with several Florida ports closer to the Panama Canal than any other U.S. mainland ports.

Florida's geographic location places it at the crossroads of both East-West and North-South trade lanes, with several Florida ports closer to the Panama Canal than any other U.S. mainland ports.

Over the past seven years (FY2011-FY2017), Florida seaports have invested billions of dollars in infrastructure, including federal, state and local funding sources. Florida's Governor and Legislature have remained committed to investments in the state's seaport system, investing over $1.02 billion dollars through the Florida Department of Transportation's work program for FY2011 through FY2017. Major areas of focus include channel deepening and widening, harbor deepening, cargo terminal expansions, new berths, new cargo handling equipment, and berth rehabilitation and repairs. In addition, the state and local governments, and the private sector have also invested in substantial road, highway and rail infrastructure to support the flow of seaport commerce well beyond the waterfront.

The following sections of this document identify the primary factors shaping the relationship of Florida seaports to the flow of vessels and goods transiting the Panama Canal and highlight the efforts Florida seaports are making to accommodate the rapid growth in both cargo and cruise vessels and volumes. The sections below also include a summary of the number of Post Panamax cargo vessels that have transited the expanded Canal calling on a Florida seaport during the first-year of expanded Canal operations. In addition, a summary of data, that represents the increasing amount of cargoes from Pacific Rim countries as a percentage of Florida's total cargos is presented, to demonstrate that an increasing share of Florida cargoes are transiting the Canal.

These aspects are among the many factors that make Florida a prime example of how the expanded Panama Canal, coupled with increases in vessel sizes and the expanding flow of goods and passengers, are positively impacting the efficiency and resiliency of global supply chains, and the growth and diversity of seaport operations throughout the U.S. mainland.

6.1 FLORIDA'S PROXIMITY TO PANAMA CANAL

Florida is the closest U.S. state to the Panama Canal. As such, several Florida seaports are closer to the Canal than seaports in any other U.S. state. Much of the Pacific Rim cargo that comes to Florida seaports transits the Panama Canal during its journey. This section identifies transit times from Hong Kong, China to U.S. East Coast and Gulf of Mexico seaports as shown in Figure 7. Results show that ten Florida seaports enjoy the advantage of being closer to the Panama Canal than other continental U.S. seaports. In fact, the closest Florida seaports are 30.5 sailing days from Hong Kong and the next closest non-Florida port is Gulfport, Louisiana which takes 30.9 days, which is 10 hours of additional sailing time at 14.3 knots.

Figure 7 - Distance and Transit Time through the Panama Canal

Origin Hong Kong, China to Gulf and East Coast Ports		
Gulf and East Coast Destination	Distance (Miles)	Transit Time (Days)
Port Manatee, FL	10,426	30.5
Port*Miami*, FL	10,435	30.5
Port Tampa Bay, FL	10,447	30.5
Port Everglades, FL	10,452	30.5
Port of Palm Beach, FL	10,492	30.6
Port of Fort Pierce, FL	10,540	30.7
Port of Port St. Joe, FL	10,549	30.8
Port Panama City, FL	10,557	30.8
Port of Pensacola, FL	10,572	30.8
Port Canaveral, FL	10,590	30.9
Gulfport, LA	10,594	30.9
Mobile, AL	10,598	30.9
Port of New Orleans, LA	10,638	31.0
Galveston, TX	10,720	31.2
Freeport, TX	10,723	31.2
Port of Fernandina, FL	10,738	31.3
JAXPORT, FL	10,740	31.3
Houston, TX	10,763	31.4
Corpus Christi, TX	10,775	31.4
Charleston, SC	10,795	31.5
Savannah, GA	10,798	31.5
Norfolk, VA	11,016	32.1
Baltimore, MD	11,139	32.5
NY/NJ	11,207	32.7

Source: www.Sea-Distances.org, 2018.

Figure 7 shows distance and transit times for vessels transiting the Panama Canal traveling from Hong Kong, China to U.S. East Coast and Gulf of Mexico seaports. The table demonstrates that Florida seaports provide the fastest transit times to and from Pacific Rim countries using the Panama Canal.

Florida stands to benefit tremendously from its proximity to the Panama Canal, the strategic location of its seaports, and its large and growing residential and visitor populations and consuming markets. Florida's Gulf coast cargo seaports are closer than any other gulf coast state seaports, and any vessel transiting the

Canal destined for the U.S. East Coast, must sail past Florida's East Coast which includes seven Florida cargo seaports. If a vessel has Florida bound cargo, and a Florida seaport can handle the vessel, there is increased opportunity for that vessel to call a Florida seaport. Therefore, several Florida seaports have been enhancing infrastructure to serve larger vessels. Port*Miami* is one of a few U.S. East Coast seaports that can currently handle a fully-laden Post Panamax container vessel. Many other Florida seaports have and likely will continue to focus a significant portion of infrastructure investments to serve larger vessels, encouraging liner services to include a stop at Florida seaports on their U.S. East Coast and Gulf Coast routes.

Florida's seaports also have the great fortune of being central to North-South and East-West trade lanes. This provides opportunities to service major liner routes throughout the western hemisphere and continue to grow opportunities in Europe, Asia, Central America, the Caribbean, South America and Africa.

6.2 ACCESS, INFRASTRUCTURE AND EQUIPMENT DEVELOPMENT

The growing size of vessels in conjunction with the expansion of the Panama Canal has influenced many East Coast and Gulf Coast states, local communities and respective seaports to invest in seaport related infrastructure. The increases in vessel sizes creates two primary implications for seaport infrastructure:

1) Larger waterway and landside facilities, modern cargo handling equipment, and new or improved infrastructure are necessary to accommodate larger vessels; and,
2) Increased terminal throughput capacity is needed to handle larger cargo volumes generated when higher capacity cargo and container vessels arrive, off-load and re-load.

The major infrastructure elements impacted by these two factors include channel and harbor deepening and widening programs, berth and wharf expansion and repair, capacity at gates and terminal yards, and modern more efficient cargo handling equipment. The following sections provide a brief look at each of these major infrastructure elements.

Channel and Harbor Deepening Programs

The vessel diagrams shown in Figure 3 show that vessel draft (depth under water) has been increasing from 39 feet in 1985 to over 50 feet in 2013. This factor along with the increasing beam (width) of vessels are primary reasons for seaports to widen and deepen their waterways, navigation channels, and turning basins. Deepening and widening projects require detailed environmental permitting and mitigation programs to receive federal and state environmental approvals. To receive federal authorization and potential funding, necessary permits coupled with preliminary design must be coordinated with the U.S. Army Corps of Engineers (USACE). Many of these deepening programs cost hundreds of millions of dollars and take several years, even decades, from concept to completion.

The Florida seaports, FDOT, local governments and the USACE combined, are programed to spend over 1.1 billion dollars from FY 2014/2015 to FY 2020/2021 on channel deepening related projects at Florida's public seaport facilities (Florida Department of Transportation, 2016). Port*Miami* recently deepened its channel to -50 feet in anticipation of larger Post Panamax vessels. This deepening project cost more than $220 million dollars, with the FDOT contributing $112 million in state transportation dollars (Florida Department of Transportation, 2016). Jacksonville Port Authority (JAXPORT) started the construction

phase of a deepening and widening project in 2018 that will deepen the St. Johns River to -47 feet and will cost approximately $483 million dollars (Jacksonville Port Authority, 2017). Port Everglades has a major waterway expansion program underway, authorized to a new depth of -48 feet by the USACE. The port is also widening navigation channels and the turning notch, and expanding berth and upland capacity. Other Florida seaports like Port Canaveral, Port of Panama City, and Port Tampa Bay are currently planning deepening or waterway maintenance projects to improve vessel capacity.

Expansion and Repair of Berths, Docks and Wharfs

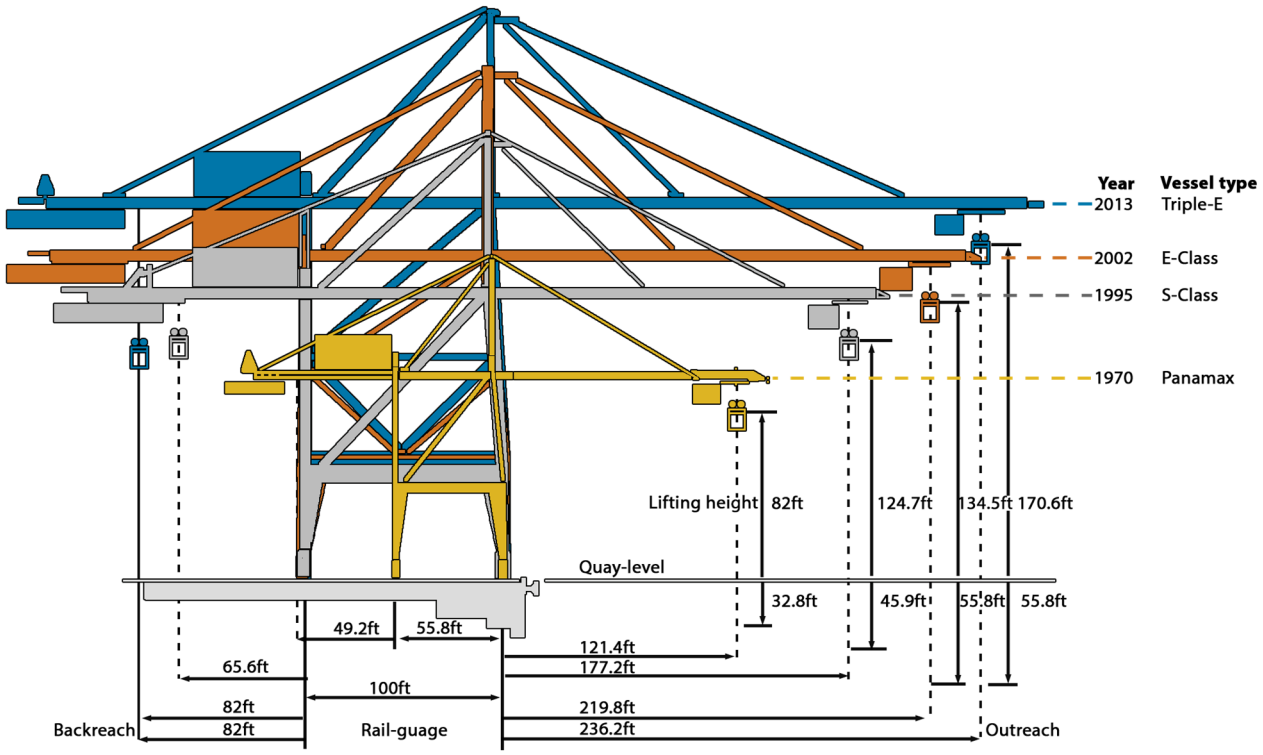
Florida seaport stakeholders interviewed during the 2015 Seaport System Plan, ranked bulkhead and berth infrastructure as the number one issue or need (Florida Department of Transportation, 2016). The demand by shipping lines and stevedores to serve larger vessels requires that aging berths be upgraded, expanded, or replaced. Larger, longer length vessels impact berth efficiency and occupancy rate, potentially reducing number of vessels that can be moored simultaneously. Length-over-all (LOA) also impacts dimensions of turning basins, which are used in turning ships for mooring or preparing for transit. As vessel length increases, beam width typically increases as well. This impacts safe vessel passage requirements, often hindering vessel mooring locations and berth utilization. Additionally, new engineering requirements, design standards, techniques, and improved construction materials are necessary to provide deeper berths and bulkheads, stronger bollards and mooring hardware, and structural support for Post Panamax cranes that weigh more, stand taller, and reach further than the last generation of cranes (see Figure 8). In addition, older berth areas are often crowded with dated infrastructure including warehouses, silos, tanks, older bulk transfer equipment and conveyance systems that must be relocated or removed.

Cargo Handling Equipment

Source: FDOT, Seaport Office Photo (August 24, 2016). Three new Post Panamax cranes delivered at Jacksonville Port Authority.

Florida seaports have been purchasing new, larger cranes to load and off-load cargo containers for many decades. The FDOT 2015 Seaport System Plan, lists cargo handling equipment as the second most common issue or need identified by Florida seaport stakeholders (Florida Department of Transportation, 2016). As described above, this is partially due to shipping lines placing larger vessels into service, which impacts seaport infrastructure needs. As vessels get longer, taller and wider, seaports require larger cranes with increased capabilities. Figure 8 entitled *Evolution of Wharf and Crane Dimensions*, shows the recent evolution in crane sizes and crane-rail gauge.

Figure 8 - Evolution of Wharf and Crane Dimensions



Source: FDOT, Seaport Office (2017). Updated and reconfigured illustration of Gantry Crane Evolution from APM Terminals Company Presentation.

Starting in the early 2000s, the purchase of larger cranes has been increasing rapidly throughout the Eastern United States, and Florida is no exception. FDOT evaluated Florida's seaport crane inventory in 2015, determining that the seaports plan to purchase approximately 13 new cranes over the next 5 years, at an estimated cost of $147 million dollars. Based on the same analysis, the Florida seaports have already spent over $93 million since 2010, on container cranes of various types and sizes. Some of these cranes are mobile harbor cranes and some are older gantry style cranes. However, the majority are newer generation cranes, which include Post Panamax and Super Post Panamax class gantry cranes that run on 100 feet gauge rails as shown in Figure 8. Most Post Panamax vessels require two or more cranes working side-by-side for efficient loading/off-loading operations.

Other Landside Infrastructure

While waterside improvements are critical, efficient operations are also dependent on interconnected upland development, including terminal yard, truck gate, and rail and roadway connector projects. These projects are necessary to handle container surges from the larger ships, and provide additional capacity on

and off the port. Some examples include sorting and stacking yards, storage yards, empties and chassis storage, truck queuing, truck gate upgrade and expansion, intermodal container transfer facilities, and yard equipment. These facilities and equipment may also include major enhancements to internal roadways, lighting systems, signage, security and fencing, drainage and water retention, and environmental impact mitigation.

The goal of many container terminal improvements is to increase the throughput per acre. Densification of container operations through stacking and efficient handling strategies enhances a terminal's ability to handle more containers within a given space and time. As more containers arrive at a terminal in a short period of time from both the landside and the waterside to accommodate the increased volumes from the larger ships, container throughput capacity needs to increase. Ports with limited access to land for expansion must find ways to densify, including stacking containers or quickly moving containers off-port to an Intermodal Logistics Center (ILC), Intermodal Container Transfer Facility (ICTF), or satellite yard.

Source: Photo - Jacksonville Port Authority, 2017. New Intermodal Container Transfer Facility at Dames Point Terminal.

7. FLORIDA POST PANAMAX CARGO VESSEL TRAFFIC AND PACIFIC RIM CARGO FLOWS

Source: Photo - Panama Canal Authority, 2017.

The previous sections of this document briefly describe the history of the Panama Canal, the Canal's governance structure, Canal specifications for both the original locks and the new expanded locks, impacts from the recent expansion project, and implications to Florida seaports. This section presents findings, and provides an overview of approach used to collect data and conduct analysis of vessel arrival information and Pacific Rim Region cargo volumes associated with Florida seaports. The three primary questions this preliminary research attempts to answer, include:

1) ***Have Florida seaports experienced vessel traffic from the expanded Panama Canal during the first full-year of operations?***
2) ***Would analysis of vessel transit and berthing data help measure Post Panamax Vessel utilization at Florida seaports?***
3) ***Are Florida seaports experiencing increased cargo volumes from countries in the Pacific Rim Region?***

7.1 POST PANAMAX VESSEL TRAFFIC AT FLORIDA SEAPORTS

The expanded Panama Canal has been open since June 26, 2016, allowing Post Panamax vessels up to the New Panamax dimension limits to pass from Pacific Rim Regions to the U.S. East Coast and Gulf of Mexico seaports and vice versa. On July 9, 2016, Port*Miami* hosted the first Florida seaport call from a Post Panamax vessel that transited the new expanded Canal. The anticipated opening of the expanded Canal was one of the major factors that triggered major seaport infrastructure investments, as discussed in previous sections. Growth in vessel size is one of the main reasons for Canal expansion and a premise that many Florida seaports used to implement infrastructure improvement programs during the past 5 to 10 years.

This preliminary study identified data sources that might be used to track Post Panamax vessels that make one or more stops at Florida seaports along their trade route, and attempted to identify if the vessel transited the Panama Canal on its voyage. The following sections discuss our data approach and methodology, data sources and results.

APPROACH AND METHODOLOGY

The original goal was to understand and analyze the number of vessels transiting the expanded Panama Canal by type of vessel (i.e., container, bulk, auto carrier, etc.) and subsequently identify the number of vessels calling at Florida seaports. Beginning in December 2016, the FDOT Seaport Office began to explore several avenues to access vessel information directly via web tracking software or identifying service providers that provide regular reports containing key elements of desired raw information.

Outline of Desired Raw Information Includes the Following Attributes:

1) Vessels using the expanded Panama Canal
2) Vessel specifications
3) Vessel name (vessel IMO number)
4) Vessel type (container, auto carrier or Ro/Ro, bulk, LNG, and cruise)
5) Routing (liner service routes, alliance routes)
6) Ports-of-call along routes
7) Florida seaport origins or destinations
8) Origin and destination of vessel route

Cost effective data collection proved challenging. Trial and error ultimately resulted in a workable, yet cumbersome methodology. The method that provided the greatest value was using vessel call data, available directly from the seaports. We were not able to find a cost-effective source for all of the eight attributes listed. Future research and data collection may be able to provide a more efficient and focused source for all data elements. Future research will also likely include more seaports for vessel call information, and more cargo types for cargo volume data. In addition, cruise ships can be added to the vessel call data.

Data Resources and/or Service providers

This section describes various potential data resources and research efforts used, while attempting to collect the desired information.

The Panama Canal Authority (ACP)

Initial thoughts were to contact the Panama Canal Authority and request detailed information directly, instead of asking multiple Florida seaports and potentially getting varied results. Correspondence with executive ACP offices was initiated, and the following information was requested:

1) Cross reference vessel names with additional resources for vessel specifications.

2) Provide vessel counts by type (Container, Auto Carrier, Bulk and LNG, Cruise).
3) The number of vessels transiting the Panama Canal by old and new locks.
4) Vessels headed for one or more Florida seaports within their route.
5) Track this information over time.

The ACP responded to our preliminary requests with very broad information. It did not appear that the ACP would be able to provide the level of detail necessary to attribute direct transits of vessels to various Florida seaports.

Third-Party Vessel/Liner Tracking and Data Services

We explored a few third-party services that provide vessel liner route information, AIS tracking data and other related services. Some of these providers offered subscription services that might provide a method to gather the information, or one-time or periodic reports. Ultimately, for this first-round of preliminary analysis, we decided to pursue the information with in-house resources using publicly available data.

Source: Photo - Jacksonville Port Authority, 2017. Dames Point Terminal.

Individual Florida Seaports Vessel Berthing Logs

As of May 2018, Florida has 11 active cargo seaports, each with unique daily vessel operations. For the first round of Post Panamax vessel analysis described in this preliminary study, Port*Miami*, Port Everglades and JAXPORT were selected. These three ports are Florida's largest volume container seaports, each handling more than 1 million TEUs annually. Each has completed or is in the process of implementing major channel deepening and widening programs to accommodate Post Panamax container vessels. Additionally, Port*Miami* and Port Everglades are two of the largest cruise ports in the world, consistently at number one and three in total passenger counts. JAXPORT is also a top automobile and RO/RO seaport, leading the U.S. in vehicle exports. This preliminary study focused on the Florida seaports most likely to see Post Panamax vessel calls immediately after the opening of the expanded Panama Canal. However, ongoing efforts will attempt to track and gather Post Panamax vessel activity at all Florida Seaports. Many Florida seaports are involved in significant cargo and cruise activities that could include Post Panamax vessel operations.

Data collection related to the selected seaports was accomplished by downloading vessel berthing logs. Each port made available detailed logs of all vessel calls during the prescribed time frame between July 1, 2016 and June 30, 2017. This time frame captured the first full year of vessel traffic since the opening of the expanded Panama Canal locks on June 26, 2016.

7.2 CARGO VESSEL CALL DATA FOR SELECTED FLORIDA SEAPORTS

The vessel call data collected from Port*Miami*, Port Everglades, and JAXPORT established the base raw data, and with subsequent analysis, provided the results and metrics summarized in Figure 9. The vessel routes using the expanded Panama Canal focused on the three-major container shipping alliances, which include: 2M Alliance; The Alliance; and, Ocean Alliance. These alliances have grouped major shipping lines and their vessels, to capture and share large container markets. According to iContainers which is an ocean freight web blog, "These three alliances represent 77.2% of global container capacity and a whopping 96% of all East-West trades" (iContainers, 2017).

Figure 9 - Florida Post Panamax Cargo Vessel Call Summary

Florida Post Panamax Cargo Vessel Calls - Combined Summary for Port*Miami*, Port Everglades, and JAXPORT

Arrival Statistics	**Start**	**Stop**	
Date Parameters of Analysis	July 1, 2016	June 30, 2017	
Total Cargo Vessel Arrivals		3,891	
Total Post Panamax Cargo Vessel Arrivals		612	16%
Post Panamax Cargo Vessel Arrivals Transiting the Panama Canal*		135	22%
Post Panamax Vessel Calls by Type of Cargo			
Total Post Panamax Cargo Vessel Arrivals by Type:	Containers	548	90%
	Automobiles	49	8%
	Mixed Cargo	15	2%
Vessel Statistics			
Total Number of Cargo Vessels		1,126	
Total Number of Post Panamax Cargo Vessels		210	19%
Largest Post Panamax Cargo Vessel by Length Overall (LOA) in feet		1,156	
Largest Post Panamax Cargo Vessel by Beam in feet		159	
Vessel Alliance Routes using the Expanded Panama Canal	**Routes**	**Post Panamax Vessel Arrivals**	
2M Alliance	TP16	16	
The Alliance	EC1	99	
Ocean Alliance	PEX3	20	
Total Post Panamax Vessel Arrivals via the Expanded Canal from the three Alliances		135	

Notes: *Post Panamax vessels designated to routes that transit the Panama Canal at least once before or after arriving in Florida. The assumption is that these vessels transit the Canal every time that they make their scheduled routing. This assumption is reasonable as vessel, liner and alliance routes show the Panama Canal within the route. Also, all these vessels are considered New or Post Panamax specifications of ≥ 966-foot length overall (LOA) and or ≥ 107-foot beam (width). The dates were chosen as first full month following new Panama Canal locks opening 7/01/2016 and 12 consecutive months following. We were not able to specifically confirm if the auto carriers or mixed cargo vessels transited the expanded Canal.

The three-port Post Panamax summary data in Figure 9 shows that 16% of all cargo vessel calls to the three ports during the period between of July 1, 2016 to June 30, 2017, were from Post Panamax vessels. Out of the 612 Post Panamax arrivals, at least 22%, or 135 Post Panamax vessel calls transited the expanded Panama Canal. Also, 90% of the 612 Post Panamax vessel calls were from container vessels. Significantly, 19% of all cargo vessels calling at the three ports are Post Panamax.

The next three sections provide a more detailed summary for each of the three Florida ports.

PortMiami

This study's first attempt to research vessel data was Port*Miami.* Port*Miami* recently completed a channel deepening project to -50 feet mean low water (MLW) in October of 2015. The Port has also improved access both by rail and highway, with the completion of on port ICTF served by Florida East Coast (FEC) railroad and completion of the Port*Miami* Tunnel, providing port users with a direct connection to I-395 and I-95. The port has also purchased three new super Post Panamax cranes. These improvements were completed prior to the opening of the new Panama Canal locks, making the port a viable stop for fully-laden (e.g., loaded to maximum capacity) New Panamax vessels.

CMA CGM Melisande arriving at Port*Miami* - Post Panamax 1,100 feet long by 141 feet wide

Source: Photo - Port*Miami*.

The original vessel berthing data was collected from the Port*Miami* online Daily Dock Report (PortMiami, 2017). This website allows users to enter date parameters and select vessel type by cruise or cargo. For the purposes of the initial analysis, we set the date parameters as previously described, between July 1, 2016 and June 30, 2017, and only downloaded cargo vessel data. This data was available to download in a raw format and required considerable manipulations to prepare for analysis. Identifying critical variables and key data necessary for analysis required additional data collection. Critical metrics were absent from the initial data, including vessel identification numbers (IMO), vessel beam (width), and vessel draft (depth). Additional vessel tracking and characteristic websites were utilized to fully develop this data set. A matrix of websites used and the type of information available at each site, is presented in Appendix A.

The resulting comprehensive data set loaded into a pivot table format, provides a detailed list of vessel arrivals and departures, with the capability to isolate Post Panamax vessels calls. The method used to determine Post Panamax segregation of data was based on two metrics: 1) length overall in feet; and, 2) beam or width of a vessel in feet. Most vessel specification websites provide these dimensions in meters,

so a conversion to feet was necessary for analysis and discussion purposes. As illustrated in Figure 2, the original Panama Canal locks have a maximum limiting vessel size of 965 feet in length (LOA), 106 feet beam (width), and 39 feet in draft (depth). Therefore, all vessel specifications exceeding these metrics must pass through the expanded Panama Canal locks or must utilize a different global shipping route. The exception is vessel draft, which can vary based on load weight or ballast at the time of transit or entry into a port harbor. For this reason, vessel draft was not used as limiting factor in determining Post Panamax vessels.

The spectrum of data collected for this analysis, provides a wealth of new metrics to analyze, including total cargo vessel arrivals, Post Panamax cargo vessel arrivals, number of Post Panamax cargo vessels, the longest or widest cargo vessel to use the port, and Post Panamax cargo vessel alliance arrivals based on routes that transit the Panama Canal and stop at Port*Miami*. According to the summary data shown in Figure 10, Port*Miami* had 1,040 total cargo vessel arrivals, of those, 264 were Post Panamax vessel arrivals, and at least 63 of those calls transited the Panama Canal. The port receives calls from Post Panamax vessels transiting the Panama Canal from three-major container vessel shipping alliances including The Alliance, 2M Alliance and Ocean Alliance.

Figure 10 - Port*Miami* Post Panamax Cargo Vessel Call Summary

Port*Miami* Post Panamax Cargo Vessel Call Summary

Arrival Statistics	**Start**	**Stop**	
Date Parameters of Analysis	July 1, 2016	June 30, 2017	
Total Cargo Vessel Arrivals		1,040	
Total Post Panamax Cargo Vessel Arrivals (all container)		264	25%
Post Panamax Cargo Vessel Arrivals Transiting the Panama Canal*		63	24%
Vessel Statistics			
Total Cargo Vessels		213	
Total Post Panamax Cargo Vessels		90	43%
Largest Post Panamax Cargo Vessel by LOA in feet		1,156	
Largest Post Panamax Cargo Vessel by Beam in feet		159	

Vessel Alliance Routes using the Expanded Panama Canal	**Routes**	**Post Panamax Vessel Arrivals**
2M Alliance	TP16	8
The Alliance	EC1	43
Ocean Alliance	PEX3	12
Total Post Panamax Vessel Arrivals via the Expanded Canal from the three Alliances	z	63

Notes: *Post Panamax vessels designated to routes that transit the Panama Canal at least once before or after arriving at Port*Miami*. The assumption is that these vessels transit the Canal every time they make their scheduled routing. This assumption is reasonable as vessel, liner and alliance routes show the Panama Canal within the route. Also, all these vessels are considered New or Post Panamax specifications of ≥ 966-foot length overall (LOA) and or ≥ 107-foot beam (width). The dates were chosen as first full month following new Panama Canal locks opening 7/01/2016 and the 12 consecutive months following.

During the one-year period of observation, Port*Miami* had the largest vessel in its history arrive with a length of 1,156 feet long. The port is also receiving many vessels that are characterized as Post Panamax based on width, with the largest vessels during the one-year study period measuring 159 feet wide.

The method for finding vessels that transited the Panama Canal was accomplished by cross referencing the list of Post Panamax vessels with the three-major liner service alliances and the routes that use the Panama Canal and stop at Port*Miami*. The results include the 2M Alliance's TP16 route had 8 vessel arrivals at Port*Miami*. The Alliance's EC1 route had 43 vessel arrivals, and the Ocean Alliance's PEX3 route had 12 arrivals.

Port Everglades

The same methods used for the Port*Miami* data analysis were also applied to vessel dockage data available from Port Everglades. The format that each port uses to tabulate vessel data and to report vessel arrivals and departures is slightly different. Because of variances, efforts were made to align the base data tables with identical column headings and data fields. This provided the capability to reproduce pivot table techniques that were identical in approach and could summarize results in a comparable manner.

Figure 11 - Port Everglades Post Panamax Cargo Vessel Call Summary

Port Everglades Post Panamax Cargo Vessel Call Summary			
Arrival Statistics	**Start**	**Stop**	
Date Parameters of Analysis	July 1, 2016	June 30, 2017	
Total Cargo Vessel Arrivals		1,254	
Total Post Panamax Cargo Vessel Arrivals		109	9%
Post Panamax Cargo Vessel Arrivals Transiting the Panama Canal*		0	0%
Vessel Statistics			
Total Cargo Vessels		391	
Total Post Panamax Cargo Vessels		39	10%
Largest Post Panamax Cargo Vessel by LOA in feet		1,066	
Largest Post Panamax Cargo Vessel by Beam in feet		159	
Vessel Alliance Routes using the Expanded Panama Canal	**Routes**	**Post Panamax Vessel Arrivals**	
2M Alliance	WCSA	0	
The Alliance	AL3, Altana	0	
Ocean Alliance	Americas Service	0	
Total Post Panamax Vessel Arrivals via the Expanded Canal from the three Alliances		0	

Notes: *Post Panamax vessels designated to routes that transit the Panama Canal at least once before or after arriving at Port Everglades. The assumption is that these vessels transit the Canal every time that they make their scheduled routing. This assumption is reasonable as vessel, liner and alliance routes show the Panama Canal within the route. Also, all these vessels are considered New or Post Panamax specifications of ≥ 966-foot length overall (LOA) and or ≥ 107-foot beam (width). The dates were chosen as first full month following new Panama Canal locks opening 7/01/2016 and 12 consecutive months following.

The summary of Post Panamax cargo vessel arrivals at Port Everglades provides total cargo vessel arrivals, Post Panamax cargo vessel arrivals, number of Post Panamax cargo vessels, the longest and widest cargo vessels to use the port, and Post Panamax cargo vessel alliance arrivals based on routes that transit the Panama Canal and stop at Port Everglades. According to the summary data shown in Figure 11, Port Everglades had 1,254 total cargo vessel arrivals, and 109 of those arrivals were Post Panamax. The port had Post Panamax cargo vessel calls in all three-major global container shipping alliances, but it appeared that none of the Post Panamax vessels visiting the port, during the one-year observation period, transited

the Panama Canal. The major routes serving Port Everglades were the 2M Alliance's West Coast South America Route (WCSA), which had many vessels transiting the Canal that were Panamax or fit within the original locks. The other major routes transiting the Panama Canal include The Alliance's AL3 and Altana routes, and the Ocean Alliance's Americas service. During the one-year observation period, these liner services were not employing Post Panamax vessels along Canal routes that stop at Port Everglades.

JAXPORT

JAXPORT cargo vessel data provided some unique challenges connected to auto carrier and Ro/Ro services. Setting that issue aside, the methods used to analyze Port*Miami* and Port Everglades data were also applied to analyze vessel dockage data gathered from JAXPORT. Once again, the format that each port uses to tabulate vessel data and to report vessel arrivals and departures is slightly different. These variances were accounted for by aligning the base data tables with identical column headings and data fields. This provided the capability to reproduce pivot table techniques that were identical in approach and could summarize results in a comparable manner.

Figure 12 - JAXPORT Post Panamax Cargo Vessel Call Summary

JAXPORT Post Panamax Cargo Vessel Call Summary

Arrival Statistics	**Start**	**Stop**	
Date Parameters of Analysis	July 1, 2016	June 30, 2017	
Total Cargo Vessel Arrivals		1,597	
Total Post Panamax Cargo Vessel Arrivals		239	15%
Post Panamax Cargo Vessels Arrivals Transiting the Panama Canal*		72	30%
Arrival Statistics by Vessel Type			
Total Post Panamax Cargo Vessel Arrivals by Type:	Containers	175	73%
	Automobiles	49	21%
	Mixed Cargo	15	6%
Vessel Statistics			
Total Number of Cargo Vessels		522	
Total Number of Post Panamax Cargo Vessels		81	16%
Largest Post Panamax Cargo Vessel by LOA in feet		1,115	
Largest Post Panamax Cargo Vessel by Beam in feet		159	
Vessel Alliance Routes using the Expanded Panama Canal	**Routes**	**Post Panamax Vessel Arrivals**	
2M Alliance	TP16	8	
The Alliance	EC1	56	
Ocean Alliance	PEX3	8	
Total Post Panamax Vessel Arrivals via the Expanded Canal from the three Alliances		72	

Notes: *Post Panamax vessels designated to routes that transit the Panama Canal at least once before or after arriving at JAXPORT. The assumption is that these vessels transit the Canal every time that they make their scheduled routing. This assumption is reasonable as vessel, liner and alliance routes show the Panama Canal within the route. Also, all these vessels are considered New or Post Panamax specifications of ≥ 966-foot length overall (LOA) and or ≥ 107-foot beam (width). The dates were chosen as first full month following new Panama Canal locks opening 7/01/2016 and 12 consecutive months following. We were not able to specifically confirm if the auto carriers or mixed cargo vessels transited the expanded Canal.

The summary of Post Panamax cargo vessel arrivals at JAXPORT as shown in Figure 12, provides total cargo vessel arrivals, total cargo vessel arrivals by type, Post Panamax cargo vessel arrivals, number of Post Panamax cargo vessels, the longest and widest cargo vessel to arrive at the port, and Post Panamax alliance arrivals based on routes transiting the Panama Canal before or after stopping at JAXPORT. According to the summary data shown in Figure 12, JAXPORT had 1,597 total cargo vessel arrivals, of those arrivals, 239 were Post Panamax cargo vessel arrivals from 81 Post Panamax vessels. JAXPORT had Post Panamax vessels in all three-major global vessel shipping alliances that transited the Panama Canal. Major liner routes include the 2M Alliance's TP16 route with 8 Canal transits, The Alliance's EC1 with 56 Canal transits, and Ocean Alliance's PEX3 service had 8 transits during the timeframe of this study. These alliance routes combined for a total of 72 Post Panamax cargo vessel calls at JAXPORT from a Panama Canal route.

One issue that arose, which was linked to Post Panamax Canal transits to/from JAXPORT, was related to major auto-carrier lines (e.g., HOEGH and Glovis). JAXPORT had 599 auto-carrier vessel arrivals or 38% of the 1,597 total arrivals during this study. Out of the total Post Panamax vessel arrivals, there were 49 Post Panamax auto-carrier arrivals or 21% of all Post Panamax vessel arrivals at JAXPORT. Most of the larger auto-carriers were characterized Post Panamax sized using beam criteria alone, with vessel widths greater than 106 feet. The issues concerning auto-carriers is that information on routes or route maps was not readily available. Some liners that provided maps like HOEGH, did not verify which vessels sailed on mapped routes. Other available resources and information provides documentation that many auto-liners transited the expanded Panama Canal Locks. At least 49 Post Panamax auto carrier arrivals came to JAXPORT, but it could not be easily confirmed which vessels where on a Panama Canal route. As a result, there is likely more Post Panamax traffic that transited the Canal and stopped at JAXPORT than shown on the chart (see Figure 12).

7.3 PACIFIC RIM CARGO FLOWS AT FLORIDA SEAPORTS

If the all-water route from the Pacific Rim is becoming more attractive and active, then Florida seaports should be seeing an increasing volume of cargo from Pacific Rim countries. To confirm this hypothesis, we used available data sources to answer the following questions.

> ***Are Florida seaports handling increasing volumes of Pacific Rim Region container cargo, and is this cargo representing a greater percentage of overall container cargo flows for Florida?***

IHS Markit and PIERS Data Resource

The IHS Global Markit toolkit includes a data resource called Port Import Export Reporting Service, better known by the acronym PIERS. This data resource provides specific international commodity and freight flow data.

The PIERS database provided specific data for this report related to the total counts of loaded container TEUs (twenty-foot equivalent unit), both import and export, from and to Pacific Rim countries, which includes Northeast Asia, Southeast Asia, Oceania and Southwest South America. Data was collected for

calendar years 2010 through 2017. The statewide total trade provided by this data is specific to international trade and does not include any domestic trade or empty container movements.

PIERS data was used to compare Pacific Rim regions with the Florida statewide totals. The analysis focused on containerized cargo. A multi-year comparison was used to develop a trend analysis.

A separate query was built for each annual import and export movement. The annual reports were developed for years 2010 through 2017. Data was pulled for loaded containers or TEUs only. Locations were set to include all Florida seaports that have container operations. To select foreign origins and destinations, geographic research was conducted to identify countries that would most likely use the Panama Canal to visit U.S. East Coast and Gulf Coast seaports. Therefore, the countries in Northeast Asia, Southeast Asia, Oceania and Western South America make up what will be referred to as the "Pacific Rim Region." The same data configuration was pulled for all international loaded container trade to and from Florida with all global regions. This allowed for a comparison of the Pacific Rim Region to the Florida statewide annual international trade total. The analysis results are illustrated in Figure 13 through Figure 15. The volumes represented in these Figures are "loaded" international TEUs, and do not include empty or domestic containers.

Figure 13 - Pacific Rim Region Containerized Imports and Exports with Florida Ports in (TEUs)[1,2]

Northeast Asian, Southeast Asian, Oceania and Western South American International Container Trade (TEUs) [1]				Florida International Container Trade (TEUs) [2]			
Year	Imports	Exports	Pacific Rim Total	Imports	Exports	Florida Total	% of Total
2010	230,345	168,645	398,991	811,775	1,372,914	2,184,689	18.3%
2011	273,422	204,355	477,777	888,443	1,435,305	2,323,748	20.6%
2012	284,423	218,618	503,042	920,192	1,429,626	2,349,819	21.4%
2013	309,062	208,203	517,265	976,449	1,412,537	2,388,986	21.7%
2014	336,537	205,070	541,608	1,033,181	1,408,544	2,441,726	22.2%
2015	362,804	200,882	563,686	1,088,564	1,432,664	2,521,228	22.4%
2016	399,465	208,316	607,781	1,136,041	1,412,537	2,548,577	23.8%
2017	430,121	198,854	628,975	1,205,257	1,328,247	2,533,503	24.8%
Difference between 2010 and 2017							
Total TEUS	199,775	30,209	229,984	393,482	(44,667)	348,814	
% Increase	87%	18%	58%	48%	-3%	16%	

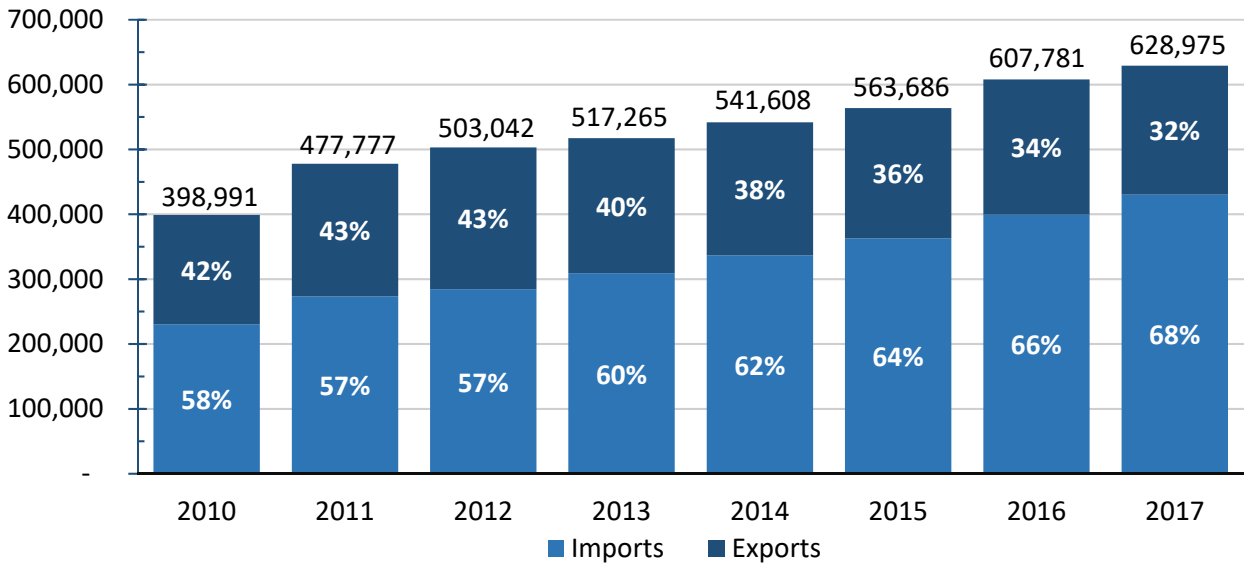
Source: PIERS (Port Import Export Reporting Service) data; 2017.

Notes: [1] Florida Pacific international trade is derived from IHS Global Markit subscription; PIERS international trade data resource. Data analysis includes raw data from 2010 through 2017; imports and exports totals; and total loaded TEUs; and covered the following regions NE Asia; SE Asia; Oceana; and Western South America. Summaries include total Florida international container trade with countries within these regions by import, export, and overall Pacific total. Domestic and empty container trade were not included.

[2] Total Florida international trade is derived from IHS Global Markit subscription; PIERS international trade data resource including all loaded container imports and exports in TEUs at all Florida seaports, with all regions globally; from 2010 through 2017. Domestic trade not included.

In Figure 13, trade with countries in the Pacific Rim Region and Florida seaports is shown in the blue columns by year, with segregated columns for loaded container (TEUs) imports, exports, and Pacific Rim total. The Florida statewide international trade total to and from all locations globally, are shown in the green columns by year, imports, exports and Florida totals. The last column displays the percent of Pacific Rim Region TEUs out of the total state annual international TEUs count. This is the quickest metric to analyze trends of Florida seaports Pacific Rim Region trade, which is characterized by upward growth, from 18.3% in 2010 to 24.8% in 2017. Almost a 7% increase of the statewide total container trade. Of particular importance is that imports from countries in the Pacific Rim Region have increased 87% from 2010 to 2017. Also, the State's total trade with the Pacific Rim Region grew 58% while statewide total trade over the same period had a 16% increase. Therefore, Florida's steadily increasing level of trade with the Pacific Rim Region makes up a majority of the state's total growth in international container trade. Pacific Rim Region annual container volume increased by almost 230,000 TEUs between 2010 and 2017.

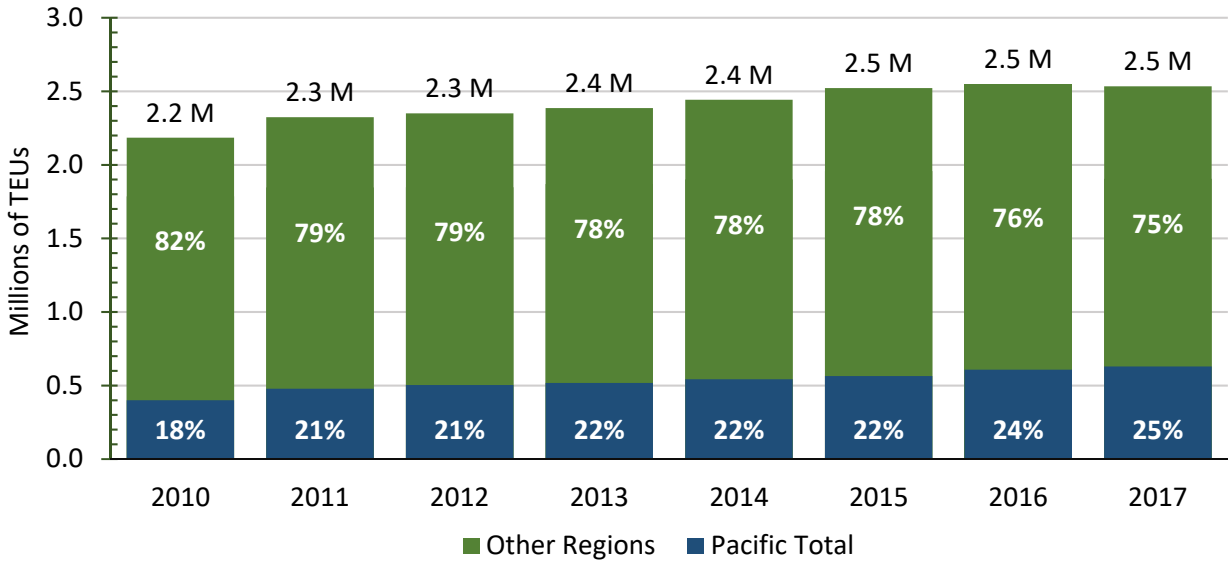
Figure 14 - Total Pacific Rim Region International Container Trade with Florida Seaports including Percent of Imports and Exports



Florida's steadily increasing level of trade with the Pacific Rim Region makes up a majority of the state's total growth in international container trade.

Specific to the Pacific Rim Region international trade, Figure 14 graphically illustrates the comparison of annual imports and exports of containers from these regions to Florida seaports. The light blue represents imports by year and the dark blue represents the exports to the Pacific Rim Region. The combination of the two blue boxes represents the total annual international trade to and from Pacific Rim countries shown at the top of each bar. This chart demonstrations continued growth over the past eight years.

Figure 15 - Total Florida International Container Trade with Florida Seaports including Percent of Total Pacific Rim Trade and Percent of Other Regions



Florida's total international loaded container trade has experienced about 16% growth since 2010, while the growth in Pacific Rim trade with Florida was 58%. Figure 15 confirms that countries in the Pacific Rim Region are seeing continued container trade growth with Florida. This data does not include domestic trade with other states, or territories like Puerto Rico and U.S. Virgin Islands, nor the flow of empty containers, either international or domestic.

Summary of Findings

These results provide evidence of significant growth in Florida's international loaded container trade related to the Pacific Rim Region. This cargo data combined with the Post Panamax and expanded Canal transit data, provides evidence to support the importance of Florida's continued investment in seaport infrastructure for handling Post Panamax vessels, and for the purpose of continuing to capture a greater share of the Pacific Rim cargos destined for Florida that arrive at other, non-Florida, U.S. seaports. When Florida destined cargos use a Florida seaport, rather than a non-Florida seaport, it reduces the burden on the U.S. rail and highway infrastructure, and creates a potentially more efficient supply chain for the entire country. Florida cargos arriving or departing at non-Florida seaports involve overland rail or truck movements to or from Florida, that burden the U.S. inland transportation infrastructure, and is less efficient than using a waterborne route to serve Florida.

8. CURRENT STATUS OF THE CANAL

The Panama Canal Authority provides a statistical summary (see Appendix B) describing the first complete fiscal year 2017 with the New Panamax locks open, in a table entitled "Traffic through the Panama Canal by lock Type and Market Segment" (Panama Canal Authority, 2017). The Canal had a total of 1,828 Post Panamax vessel transits in 2017. The majority were containerships with 954 Post Panamax transits, followed by Liquid Petroleum Gas (LPG) tankers with 539 vessel transits, Liquid Natural Gas (LNG) vessels had 159 transits, auto-carriers and Ro/Ro vessels had 22 transits, and dry bulk was up to 125 transits through the new locks (Panama Canal Authority, 2018).

Another interesting comparison provided by the Panama Canal data is that Panamax (e.g., old Canal locks) tonnage is down from a 2016 total of 198 million tons to 180 million in 2017. In 2016, 98% of transits were Panamax, while in 2017 that dropped to 85% of transits. Overall Panama Canal tonnage is growing with 241 million tons in 2017 compared to 205.3 million tons in 2016. The growth is unarguably, largely attributable to the expanded capacity of the Canal system (Panama Canal Authority, 2018).

Source: Photo - Panama Canal Authority, 2017.

9. WHATS ON THE HORIZON

Understanding global and regional trade trends helps to focus planning efforts, direct investments, and guide seaport market outreach. The expansion of the Panama Canal will impact the U.S. East Coast and Gulf Coast seaports, including Florida seaports, for many years to come. The magnitude of the impact is yet to be determined. Seaports with the appropriate services, infrastructure and access to markets stand to gain the most.

A 2015 article in Reuters Business News discusses the Panama Canal Authority initiating efforts to plan and design a fourth set of locks at a price tag of $17 billion. These locks would be built to accommodate vessels that can hold between 18,000 and 21,000 TEUs. Another potential project to watch related to trans Central American trade is the proposed $50 billion-dollar Nicaraguan Canal. Although this project is currently stalled.

The Panama Canal is a wonder of the world that will continue to impact international trade for many years to come. The expansion project completed June 26, 2016, has breathed new life into the waterway and has provided much needed capacity. The future appears to be bright for the Canal as it continues to make history. In March of 2018, the Canal Authority announced the transit of the 3,000th Post Panamax vessel. This milestone well exceeded projected volumes by this date, reaffirming the significant value and resource the Canal provides to the maritime community and the world's trade markets.

> "Today's milestone, achieved in less than two years of operation, serves as a proud reminder of the confidence that our customers and the broader maritime industry have placed in our route," said Canal Administrator, Jorge Luis Quijano.

The future of Florida seaports related to the Panama Canal, points to continued growth in Post Panamax container ship volumes, auto-carrier Ro/Ro vessels and Liquid bulk tankers, and continued growth with Florida's Pacific Rim trading partners. Global trade seeks the most efficient, cost-effective routes to markets.

Florida seaports' continued focus on world class service delivery and infrastructure investments, are providing the necessary platforms for meeting these market demands. Additional growth factors for Florida seaports related to trans-Canal traffic include: access to the manufacturing; increased trade with agricultural centers in Western South America; U.S. West Coast ports continued congestion of intermodal rail and truck connectivity; environmental regulations; low-cost energy; alternative fuels; and, new alliance routes that include Florida seaports. The Panama Canal expansion provides a cost and time effective all-water route to the U.S. East Coast and Gulf of Mexico seaports, alleviating a major operational bottleneck to Pacific Rim Region markets for imports, exports, and the repositioning of empty containers.

This preliminary study provides clear evidence that Florida is experiencing growing trade volumes with the Pacific Rim Region, and a significant number of Post Panamax vessel calls, including from vessels that are transiting the expanded Panama Canal. Ongoing tracking of vessel call data and various cargo flows will allow for more detailed and comprehensive assessments over time.

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APPENDICES

APPENDIX A: MARINE VESSEL INFORMATION AND SPECIFICATION WEBSITES

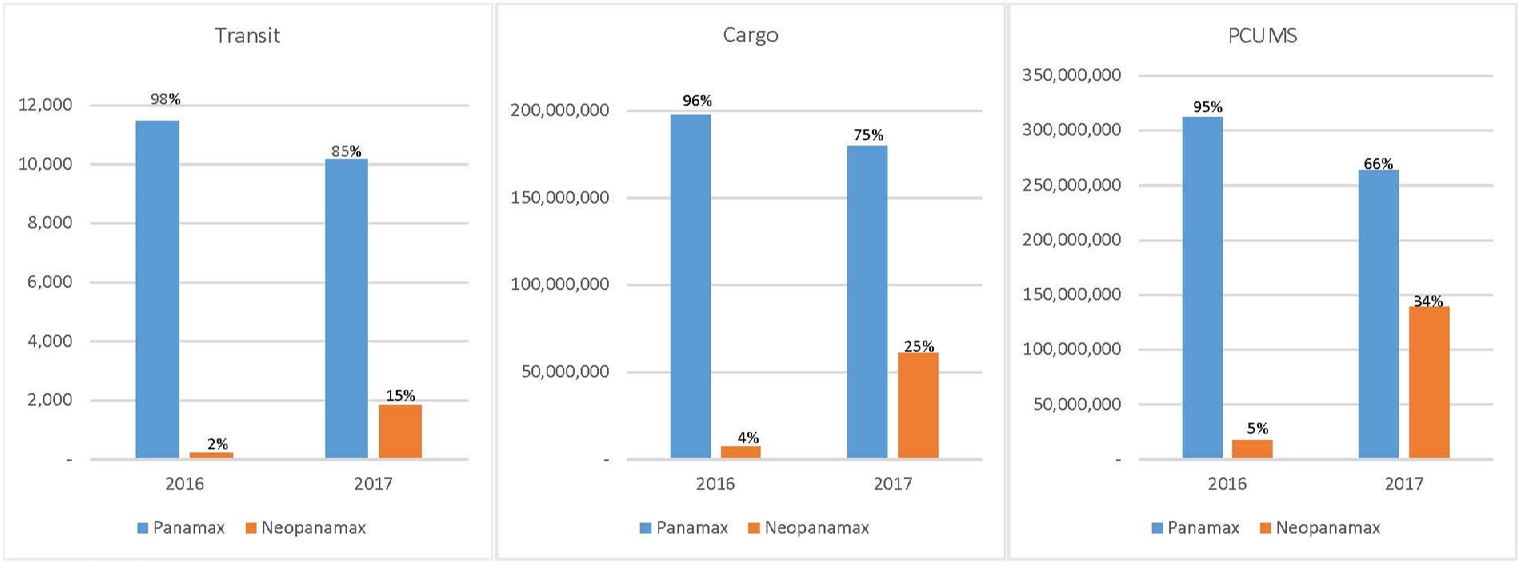
Vessel Information Website Matrix							
Website	LOA / Beam	Year Built	TEUs	Draft	Liner Route	Tons	Sources
Marine Traffic	●	○		○			https://www.marinetraffic.com/
Maersk Line	○	●	●				https://my.maerskline.com/schedules
Fleetmon	○			○			https://www.fleetmon.com
CMA CGM		○	●		●		https://www.cma-cgm.com/the-group/activities/shipping/vessel/
Vessel Finder				●		●	https://www.vesselfinder.com
Containership Info		○	●				http://www.containership-info.com
Ship Spotting			●				http://www.shipspotting.com

APPENDIX B: PANAMA CANAL 2017 STATISTICS

Traffic Through the Panama Canal by Lock Type and Market Segment[1]

Años Fiscales 2017-2016

Market Segment	Transits				Cargo				PCUMS[2]			
	Panamax		Neopanamax		Panamax		Neopanamax		Panamax		Neopanamax	
	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016
Container	1,539	2,833	954	144	19,196,769	34,426,794	34,459,114	5,224,379	53,473,710	106,612,818	89,139,804	13,187,408
Dry Bulk	2,790	2,633	125	1	88,565,552	89,451,106	7,675,437	73,815	70,353,604	65,714,490	8,781,606	85,293
Vehicle Carriers/RoRo	779	799	22	10	4,604,043	4,748,991	187,343	75,286	45,229,645	46,055,170	1,576,582	703,529
Chemical Tankers	1,955	1,899	4	-	39,301,754	38,318,565	162,343	-	42,374,190	39,618,769	98,748	-
Liquified Petroleum Gas	337	398	539	51	3,582,151	5,053,593	11,737,064	1,180,457	7,374,749	9,560,778	21,123,436	1,981,356
Crude Product Tankers	607	578	20	3	14,151,752	14,914,318	628,542	151,929	16,269,404	15,378,212	1,072,729	196,764
Liquified Natural Gas	4	2	159	15	-	-	6,359,634	549,806	76,360	38,180	17,015,521	1,468,488
Passengers	239	213	1	-	-	-	-	-	9,740,883	8,184,574	71,280	-
Refrigerated	868	948	-	-	3,274,474	3,340,147	-	-	8,450,045	9,040,294	-	-
General Cargo	654	710	-	-	5,038,298	4,845,678	-	-	7,808,221	8,419,346	-	-
Other	392	447	4	-	2,074,209	2,349,421	8,849	-	2,721,273	3,199,449	18,345	-
Grand Total	**10,164**	**11,460**	**1,828**	**224**	**179,789,002**	**197,448,614**	**61,218,325**	**7,255,672**	**263,872,084**	**311,822,080**	**138,898,051**	**17,622,838**



[1] Only includes oceangoing commercial traffic, those paying tolls greater than the minimum tariffs implemented on June 1, 1998. (Small commercial traffic not included)
The Neopanamax Lock was inaugurated on June 26, 2016

[2] The tonnage measurement system for the Panama Canal tolls assessment, the Panama Canal/Universal Measurement System (PC/UMS). This amount also includes the PC/UMS tonnage for full containership and passenger vessels.

Statistics and Models Administration Unit (MEMM) 1 TABLE NO. 11

Panama Canal Authority. (2017). *Traffic through the panama canal by lock type and market segment.* www.pancanal.com. Retrieved 13 March 2018, from https://www.pancanal.com/eng/op/transit-stats/2017/Table11.pdf.

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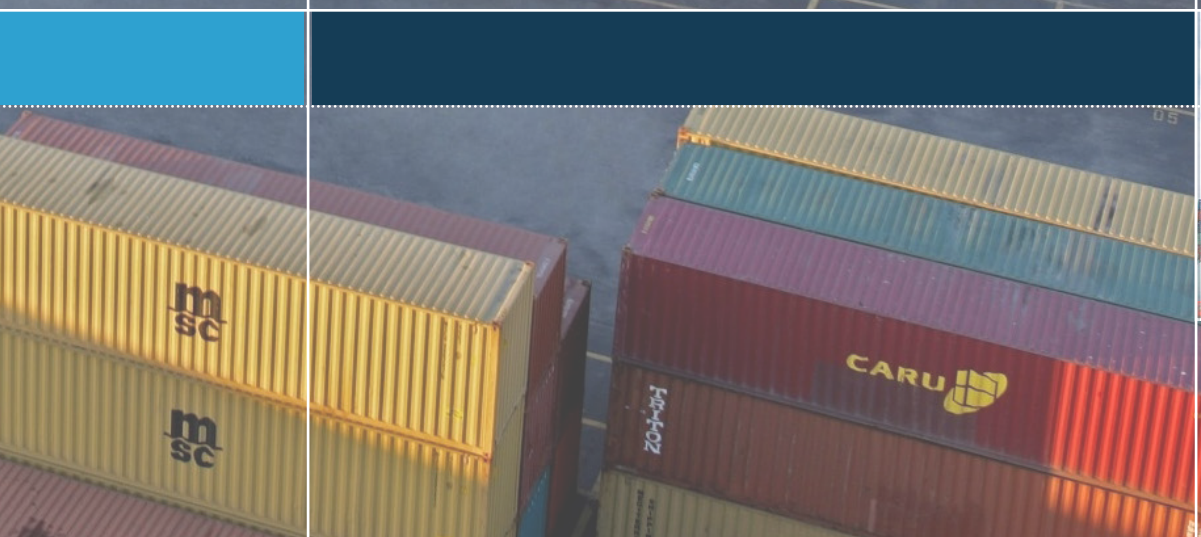

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