

A Container Terminal at the Port of Prince Rupert: Considerations from a Transportation Perspective

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Abstract

This paper discusses the transport of containers between the Port of Prince Rupert and the hinterland. The result of several data collection and analysis efforts, we present a set of findings regarding the role Prince Rupert might play in North American transportation, and the particular strengths or weaknesses of this facility. In the short term, there will be no facilities for container rehandling in Prince Rupert. This activity may take place in Prince George, or more likely these importers may continue to use the facilities surrounding Vancouver. Given the current rail network, Prince George will be required to handle as much cargo as Prince Rupert. This will have negative impacts on air quality in Prince George, yet potentially positive impacts on employment and economic activity through rehandling and transloading opportunities. Due to sizeable resources in Western Canada, this Port may offer a better ratio of exports to imports than other West Coast terminals which will attract steamship lines looking for west-bound fares. We conclude that, because of its unique features, this Port has strong potential to impact logistics practices in a continental transportation system.

Introduction

In September 2007 the Port of Prince Rupert opened a marine container terminal. The plans are for this terminal to ultimately have a capacity of at least two million TEUs, approximately the 2007 volumes of the Ports of Vancouver, Seattle, and Tacoma. There also exist plans to increase this to four million TEUs. At this capacity Prince Rupert would be the largest container port in Canada (by container volume). In this paper we consider some of the issues surrounding the transport of these containers between the port and the hinterland. These include evaluating the capacity of existing transportation infrastructure, considering the dynamics of the market for freight transportation, and the impact of Canadian and US container law.

The Port of Prince Rupert is free from ice year round, is a naturally deep harbor, is closer to Asia than other ports on the west coast of North America, and is a node on an extensive rail network. In addition, the Port of Prince Rupert is not located in a large urban region, therefore reducing

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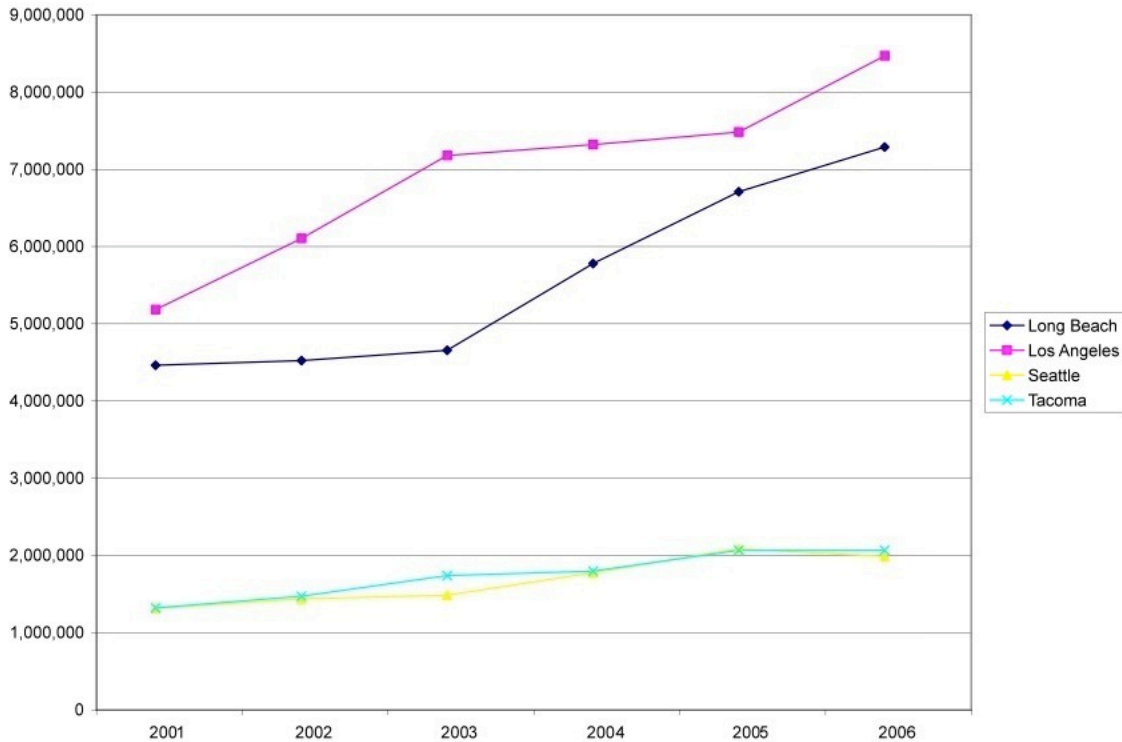
the effects of air quality, congestion, and the threat of security breaches. Prince Rupert's small population, and distance from a major urban center, makes it a distinctive port. All other North American West Coast marine terminals serving at least one million TEUs annually are in large urban centers such as Vancouver, Seattle, Tacoma, Oakland, Los Angeles, and Long Beach. This presents a new model of the North American marine terminal. Prince Rupert does not have significant local services nor is there a significant local demand for goods. Unlike other west coast ports Prince Rupert will not have resources for rehandling goods or transloading containers nor well developed and resilient communication, energy, and transportation infrastructure. The interplay of these unique features, and current market dynamics in container transportation, are discussed below.

Reliable Transportation

There is a sense that disruptions to the transportation system are becoming more common, and more costly.¹ These disruptions are caused by a diverse set of events such as labour unrest (for example the 2002 West Coast port lockout; 2005 truck strike at the Port of Vancouver), extreme weather (Hurricane Katrina; 2007 Skeena river flood), natural disasters (Loma Prieta Earthquake), terrorist events (destruction of the World Trade Center), failing infrastructure (collapse of the I-95 bridge in Minnesota), and security vulnerabilities (police chase closes Canadian/US border, 2006). At the same time, companies have been streamlining their supply chains by consolidating flow into a small number of channels, and reducing inventory cost. Although these supply chains can operate under normal conditions at lower cost, there are greater economic costs to disruption. A literature has developed to consider the "resilient enterprise"², one that can operate efficiently, but is also tolerant to disruption. As a result, more recently, large importers such as WalMart, who had previously used a one port strategy; importing all of their United States destined Asian goods through the Ports of Los Angeles and Long Beach, have moved to a distributed strategy, using five geographically distributed ports around the United States for their Asian imports (Los Angeles, Tacoma, New York, Savannah, and Houston). An example of this can be seen by considering the volumes of containers handled at West Coast ports in recent years (see figure 1 below). In 2004 the Ports of Los Angeles and Long Beach suffered from heavy congestion due in large part to a lack of available longshoremen, and vessels were delayed by up to a week.³ In 2005, the Port of Seattle had the largest percentage growth of all US ports, in part because many carriers decided to divert volume north in search of more reliable travel times.

An efficient supply chain has become a requirement for success in the retail market.⁴ Contemporary business leaders such as WalMart and Dell have established their success on their ability to keep logistics costs down. This can be done in a reliable transportation system, but uncertainty is the enemy of logistics; increasing the difficulty of managing inventory.

Figure 1. Volumes (in TEUs) handled at selected West Coast Ports (source: AAPA).



Estimating Landside Transportation Capacity

The goal of this and the subsequent section is not to very accurately predict port traffic or rail line capacity, but to estimate, and compare broadly, the two values.

Consistent with the Port of Prince Rupert’s expectations, it is assumed all containers will leave the port on trains. The Port aims to reach an annual capacity of two million TEUs. The track between Prince George and Prince Rupert is a single track with one kilometer sidings approximately every 30 kilometers, the track is approximately 600 kilometers in length with centralized traffic control. During 2007 the tunnels between Smithers and Terrace, BC will be undercut to permit double-stack clearances along the line. With current sidings, the line can handle trains of about 90 cars in length. At typical speeds, it would take trains approximately eight hours to travel the distance between Prince Rupert and Prince George. If trains traveling in each direction are spaced about every hour, there would be only minor delay caused by the need for passing. At this spacing, the track can handle about 24 trains in each direction per day when the source and destination terminals and yards operate 24 hours per day. If the origin and destination terminals operate for 16 hours a day, then the capacity of the track is 16 trains in each direction.



Figure 2. Canadian National Railway Company Network (source: CN).

Alternatively, for a given time period, the track could be used for travel in one direction. Given the eight hour travel time between Prince George and Prince Rupert, the periods of travel in one direction must be at least this long in order to avoid the limitation of passing sidings and allow clumping of trains more tightly. With 5 minute headways the capacity of the line is 48 trains in each direction each day. This would be extremely difficult to manage at the terminals with a train arriving or departing every five minutes for four hours. With 10 minute headways, the capacity drops to 24 trains per day in each direction. Table 1 summarizes these estimations of the Prince Rupert to Prince George line capacity.

Table 1. Estimated Prince Rupert to Prince George line capacity.

Hours Per Day	Comments	Capacity
24	Two directions simultaneously	24 trains per day each direction
16	Two directions simultaneously but terminals operate just 16 hours per day	16 trains per day each direction
24	Segregate traffic with 5 minute headways.	48 trains per day in each direction
24	Segregate traffic with 10 minute headways.	24 trains per day in each direction

Port Traffic Generation

Very few, if any, containers will be destined for the local market in Prince Rupert, and it is anticipated that many goods that are consumed in Prince Rupert will still be transported initially to Prince George, handled, and trucked back to Prince Rupert. Containers are typically shipped from factories in Asia full of goods from that factory, and it is unlikely that an entire container of goods will be bound for Prince Rupert, rather, these goods may be transported to a consolidation center where containers are unpacked, packed with the goods destined for a single location (and perhaps from several factories) and shipped out. A double stacked train can hold approximately 350 TEUs (assuming each rail car carries two 40 foot containers or 4 TEUs). Table 2 shows the number of trains required to service the intermodal traffic if operating 52 weeks a year.

Table 2. Trains required given port volume.

TEUs annually	Days of port operations per week	Trains per day each direction
1,000,000	7	4
1,000,000	5	6
2,000,000	7	8
2,000,000	5	11
4,000,000	7	16
4,000,000	5	22

In addition to intermodal trains carrying containers, the Port of Prince Rupert plans to service coal trains from Eastern British Columbia and grain trains from the prairies to Prince Rupert. Ridley terminal in Prince Rupert handles both the coal and grain exports. Currently the Port can load up to 4,000 tons of wheat or barley per hour.⁵ Assuming this rate is constant for the duration of a nine hour day, and each train has approximately 147 cars, each with about 45,000 kilograms, about six trains will be traveling to Prince Rupert each day. These cars would need to

return empty to the source. The coal facility can handle 24 million tones per year which means that when operating at capacity this would generate about 13 trains in each direction each day.

Three days a week a passenger train travels from Prince Rupert to Prince George and three days a week the train will be going the opposite direction. Presumably there may be demand for more service if significant economic growth goes along with the port expansion.

We do not expect significant changes in the volumes of bulk grain and coal handled as a function of the growth of the container terminal. The volumes of grain and coal handled at Prince Rupert during the second quarter of 2007 were almost equivalent, 2.5 million tons of each. This would generate approximately six trains each day in each direction for each commodity.

Given these assumptions, we conclude the Port has sufficient existing rail capacity to handle all anticipated container volume with the existing infrastructure available.

Transportation Infrastructure Reliability

The Skeena River experiences heavy flows from snow fall, snow melt and rainfall in the winter and spring. This has historically caused frequent roadway and rail-line closures due to flooding and landslides. To understand the impact of these failures on service reliability, the historical record of rainstorm and flood damage in the area⁶ provided details of all rainstorms and consequent damages. From this we extracted events that caused rail line damage or interrupted service between Prince Rupert and Prince George. For events that indicate interruption, but lack data on length, the average of all interruption lengths is assumed. If the direction of the disruption is omitted, it is assumed the disruption occurred in both directions.

If we assume this weather data represents future weather patterns it is possible to estimate the impact of weather disruptions to containers traveling in and out of the Port of Prince Rupert. For example, on 03 March, 1911 there was service interruption at Swanson Bay due to a landslide. All service on the line was ceased for three days. In the example above, it is assumed the Port would like to be moving four trains per day, but cannot move any for three days. It then has the capacity to move 24 trains a day until the congestion has been cleared. On day three the trains are able to depart, but the queue is not cleared until about half way through the day. The queuing delay is shown in figure 3 as the total gray shaded area minus the shaded area under the blue curve. The intercept point between the two curves is the point where the queue has dissipated. In this example, total train delay is 43.2 train-days. With 350 containers per train, this is 15,120 container-days. The table below shows the results of container delay based on different annual Port TEU volumes.

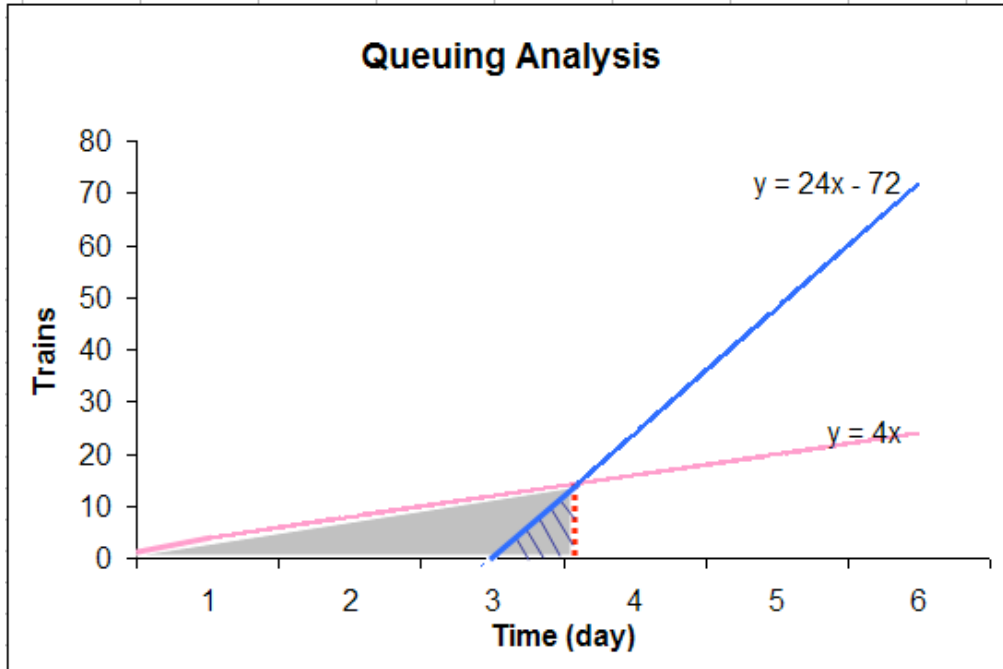


Figure 3. Queuing analysis example.

Table 3. Summary of results (total delay for both directions).

TEUs Annually	Days of port operations per week	Trains per day each direction	Capacity (trains/day)	Average Delay (Container-days/Year)	Average Annual Delay (Container-Hours)	Average Annual Delay (container-hours per container throughput)
1,000,000	7 day a week operation	4	24	95222	2285335	2.29
1,000,000	5 day a week operation	6	24	158704	3808892	3.81
2,000,000	7	8	24	238056	5713339	2.86
2,000,000	5	11	24	402864	9668727	4.83
4,000,000	7	16	24	952223	22853355	5.71
4,000,000	5	22	24	5237227	125693450	31.42

As shown in the figure 4 below, the average annual delay drastically increases when the Port increases volume to four million TEUs (22 trains per day each direction, close to the capacity of 24 trains per day). This is typical of a queuing system. With four million TEUs per year and five days a week operation, the delay would be significantly larger than operating at seven days per week. This is also because the railroad system operates at a rate that is very close to capacity with five days a week operation.

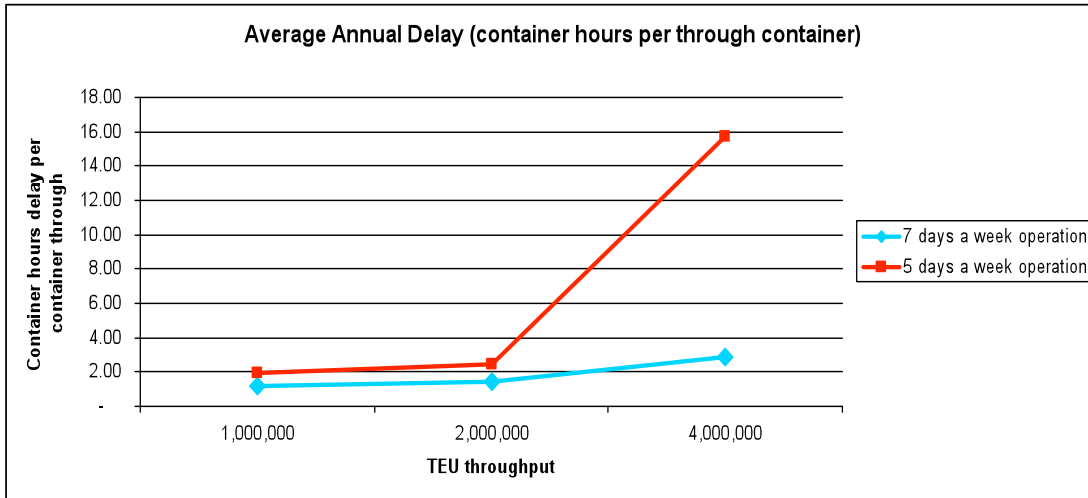


Figure 4. Average delay with various train services.

Figure 5 is the graphic representation of average interruption duration between 1891 and 1991. Most disruptions occurred in the winter months, October through January, while summer months have low disruption rates. This is due to weather patterns in the area, with most flooding and rainfall occurring in the winter and spring.

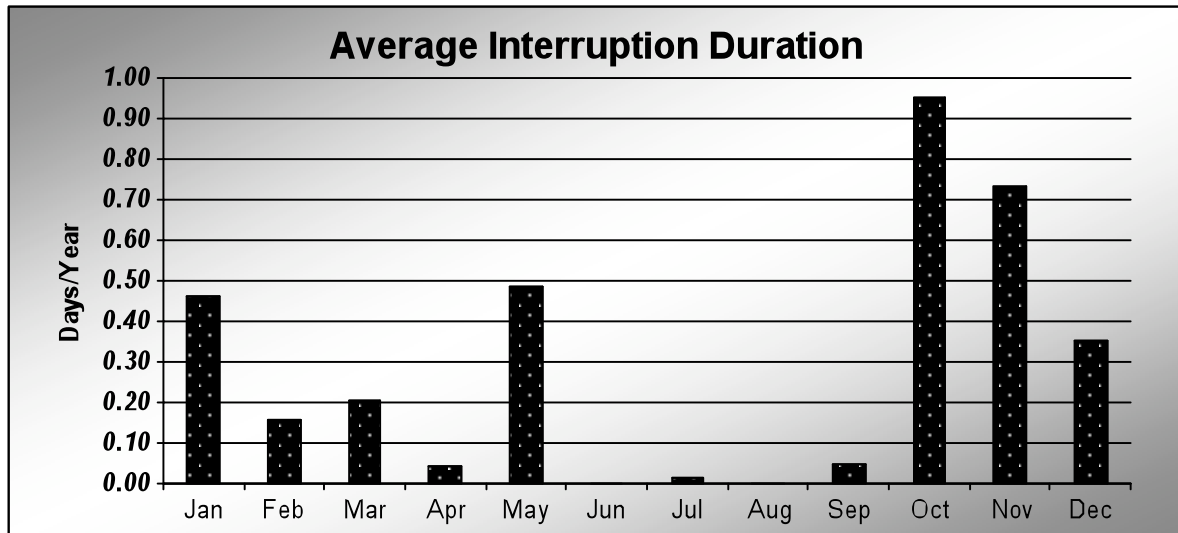


Figure 5. Average service interruption duration by month.

Table 4 shows the average service interruption duration and delay by month for various levels of Port activity. The average disruption duration is almost 1 day in October (no service in each direction), whereas it is 0 in June. The expected total delay is shown for each month in train-

days of delay, for various volumes. In October, we expect almost 160 train-days of delay with the port generating eight trains per day (two million TEU), whereas in June we expect no delay.

Table 4. Train delays by month.

Month	Average Duration	Delay (train-days)					
		4 trains/day	6 trains/day	8 trains/day	11 trains/day	16 trains/day	22 trains/day
Jan	0.46	13.2	21.9	32.9	55.7	131.6	723.7
Feb	0.16	2.5	5.3	8.0	13.5	31.9	175.2
Mar	0.20	10.2	7.0	10.5	17.8	42.0	231.2
Apr	0.04	0.1	0.7	1.0	1.7	4.0	22.1
May	0.49	57.5	90.3	135.5	229.3	541.9	2980.6
Jun	0.00	0.0	0.0	0.0	0.0	0.0	0.0
Jul	0.02	0.0	0.1	0.1	0.2	0.4	2.2
Aug	0.00	0.0	0.0	0.0	0.0	0.0	0.0
Sep	0.05	0.1	1.0	1.5	2.5	6.0	32.9
Oct	0.95	1.6	158.4	237.7	402.2	950.6	5228.5
Nov	0.73	67.7	61.4	92.2	156.0	368.7	2027.7
Dec	0.35	14.2	21.1	31.7	53.6	126.6	696.4

Figure 6 shows the total service interruption duration and delay by year. The duration and delay have a similar pattern in the years of high disruptions. This shows it is the long duration disruptions that cause significant delay.

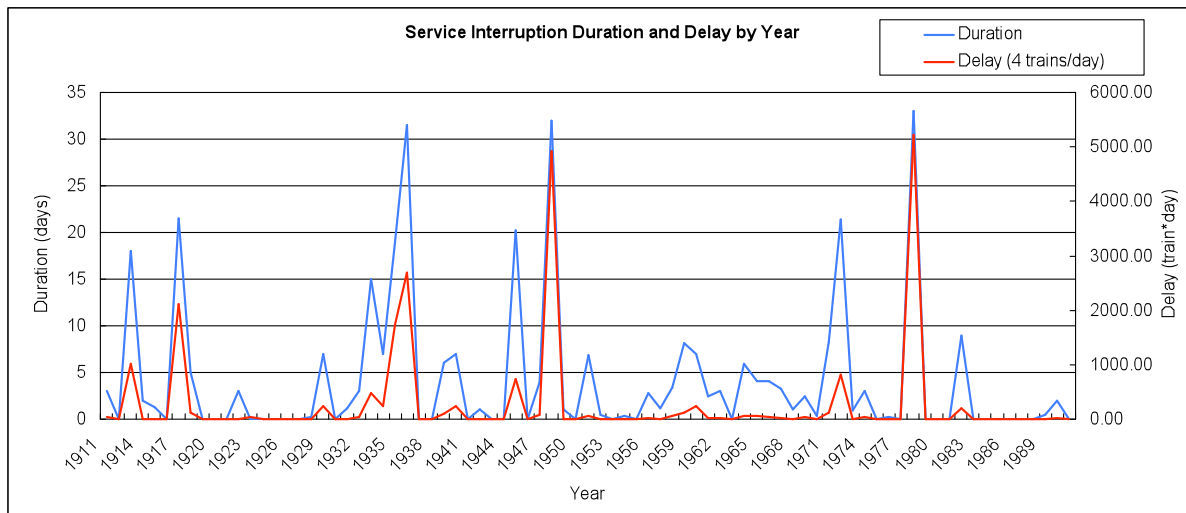


Figure 6. Service interruption duration and delay by year.

Line closures in and out of Prince Rupert are not uncommon, and would cause significant disruption to the transportation system. A recent study suggests the cost of the Los Angeles and Long Beach port complex closure at \$1 billion per day.⁷ While this port complex handles an

order of magnitude more containers than plans for Prince Rupert, should disruptions occur at Prince Rupert, such costs of disruption would still be very significant.

Rehandling

Most ports on the west coast act as both nodes and terminals on the transportation system. A pass-through facility for goods traveling through the location but destined for outside the region, and a terminal for goods destined for the region itself. Historically ports were designed as terminals, and are still referred to as marine terminals, serving the area around them. With the development of low cost overland transportation, the West Coast ports have become the import locations of choice, and containers are moved via double stacked trains to locations inland via what is referred to as the landbridge.

In the short term the Port of Prince Rupert will not have any regional handling facilities (facilities in Prince George are not considered regional). Vancouver will therefore probably continue to do all of the consolidation/deconsolidation.⁸ Importers use regional handling facilities to take advantage of inventory management opportunities and pricing structures for long-haul containers. This is typically advantageous for importers of low cost goods for whom time is less valuable, and importers of large quantities who can take advantage of the economies of scale in transportation cost. Deconsolidation also allows importers to delay destination decisions until demand estimates are more certain, reducing inventory and missed sales opportunities, and to carry out necessary re-stuffing to convert from factory based packing to store based packing. Prince Rupert will therefore be a useful channel for small importers and for large importers of low-value goods distributing in Canada and the US mid-west.

Prince George

There is a spur line from Prince George to Prince Rupert (see figure 2). This means that to reach any destination, all containers leaving Prince Rupert must travel through Prince George, and vice-versa. The growth in container traffic of container vessels and intermodal trains will have a significant effect on regional air quality. Air quality is not currently a major concern in Prince Rupert given the small size of the community and the ability of the air basin to absorb these toxins. Even at a micro scale we do not expect air quality to be a problem due to the reliance on rail transport. Trains traveling up the Skeena River valley fully loaded will certainly introduce toxins and contribute to air pollution in Prince George, where federal air quality standards are often exceeded. Adding 100 trains a day to the rail traffic in Prince George will have a significant, negative impact on the air basin which is already of concern.⁹

Much of the economic activity generated by ports is in peripheral activities, not directly through handling at the port itself. In a recent report by Martin Associates it is estimated that of the 8,397,301 Americans working for ports and port-related industries in 2006, nearly seven million were employed by firms involved in handling imports and exports, such as retailers, wholesalers, manufacturers, distributors and logistics companies. Given the existing base of infrastructure it is anticipated that most of these businesses will actually locate in Prince George. It is not necessary for them to be located in Prince Rupert itself. Martin estimates that 507,448

Americans held jobs at the ports themselves as terminal operators, longshoremen, freight forwarders, steamship agents, ship pilots, tug and towboat operators, chandlers, warehousemen, as well as jobs in the dredging, marine construction, ship repair, trucking and railroad industries. This is six percent of the estimated number of jobs working for ports and port related industries. The study estimates another 630,913 induced jobs supported by these port jobs due to purchases of food, housing, transportation, apparel, medical and entertainment services. Also included as induced jobs were those with local, state and federal agencies providing support functions such as education and municipal services. The report also finds that port-sector jobs tend to pay above-average wages. Port-sector workers today earn, on average, about \$50,000 a year, which is \$13,000 more per year than the National Average Wage Index, as computed by the Social Security Administration.¹⁰

US Market

Prince Rupert plans to rely in large part on carrying traffic for US destinations. Container throughput in North America in 2004 was 41.1 million TEU, and 78 percent of Asia-US traffic was handled by the West Coast Ports. In 2006 and 2007, about five percent of the volume carried by the Port of Vancouver was US traffic.¹¹ Approximately 30 percent of inbound containers at Halifax in 2007 were bound for the US¹², a significantly larger percentage than at Vancouver. Costs associated with entry into the US market are the extra cost of border security in the post 9-11 era and documentation. Interruptions or slowdowns to clear customs carry a cost as it is a loss of time in transporting and delivering goods. A recent study examined this issue and determined the costs of increased security also has the potential to impact the level of investment between the two countries, and that this cost will primarily be borne by Canada as its exports will be more adversely affected by security-exacerbated border crossing delays, and thus impact the whole network of supply chain systems on both sides of the border.¹³

Canadian taxes are not levied on goods destined for the US that are imported through Canada; however if the final destination is not known at the time of import, then duties must be paid and reimbursement sought for those goods. The transaction costs for the importer discourages importers from using Canadian ports as their North American port of entry.

Exports

The Port of Prince Rupert is close to the resource rich areas of British Columbia and Alberta, and has the potential to capture the related exports. From 2005 to the present North American West Coast Ports have imported more loaded containers than they have exported, creating more demand for eastbound service from Asia than westbound service to Asia, and a much higher cost for eastbound service. In Southern California the export/import ratio is about 0.35, in Northern California 0.95, in Oregon 0.98 and in Washington 0.72. At the port of Vancouver the ratio was also 0.72.¹⁴ Ports that can offer export traffic allow shipping lines to generate more revenue and are therefore appealing as destinations. This balance of trade also allows efficiencies landside as intermodal trains do not need to return to the port empty, but can carry export loads which are revenue generating loads. This makes serving the destination more appealing to the railroad as well, as revenue can be generated on trips to and from the port.

Most shipping lines choose to visit terminals with significant exports last in a multi-stop route, and destinations with “hot” imports first on a multi-stop route. Typical multi-stop routes leave Asia for Southern California, and then travel up the coast to Northern California or the Pacific Northwest before returning to Asia. This allows them to service the “hot” imports in Southern California quickly and as much as possible load the vessel with loaded containers before traveling across the Pacific, better utilizing the ship’s capacity. Most exported containers are empty, so there is significantly more time pressure when handling imports. There are, however, a smaller number of services that do visit the Pacific Northwest first. To date Prince Rupert is the first port of call for services that call at the port, allowing the port to take advantage of its position as the closest North American terminal to Asia. In addition, export volumes at Prince Rupert have been minimal.

Container Law

The container industry is worldwide, with 90 percent of global cargo (by weight) carried in marine containers. Marine containers used in international trade upon entering Canada are granted duty relief, subject to several limitations: 1) The container must be exported within 30 days of the date of importation, and 2) may be used in one domestic move, provided the move is between the point of discharge of imported cargo and the point of loading for export, or if it is empty, provided the move is to the point of exit. This is different from US cabotage laws, which allow for 365 days and do not legislate domestic repositioning (or, DRP). Consequently, US cabotage is considered more liberal than Canadian laws. NAFTA classifies marine containers as “steel packaging” as they do not alter the form or value of a product and therefore, are exempt from tariffs.

The movement of empty containers on North America’s rail networks is an inefficient use of intermodal capacity. The imbalance of full and empty containers is partly a factor of geographic size and also because many exporters are located outside main consuming regions. In response, to container law, and existing pricing structures, transload facilities have been established¹⁵ so that importers can send their marine containers to a transload facility, discharging 40 foot containers into trailers or domestic containers for haulage either directly to a store or a regional distribution center.¹⁶

However, under the Canadian post audit system, ocean carriers have the status as a “pool operator.”¹⁷ Under this status, which allows for an inventory of equipment, containers can remain in Canada duty free for up to 180 days; as a result, the time restrictions are not the primary limiting concern of Canadian cabotage, but rather, the type and direction of movement allowed. For large ocean carriers such as Maersk, the differences in US and Canadian cabotage laws does not affect the way Maersk does business in Canada. For Maersk, the time requirement is not a concern; rather, greater freedom of movement in addition to ports of exit is preferred.¹⁸ For other companies, the time restriction and DPR requirement act “as a hindrance to developing synergistic partnership.”¹⁹

While it may be beneficial for Canadian cabotage regulations to be harmonized with more liberal US cabotage, it is not clear Canadian cabotage adversely impacts large international

ocean carriers. It seems shipping lines may have a preference for managing containers in the US, over Canada, due to the reduced restrictions.

North American Port Capacity

Container traffic continues to grow worldwide and is expected to double in the next decade. Containerization is a dynamic trade for ports, involving significant capital, is highly competitive, and is risky by nature. Increasing containerization growth has had an impact on Vancouver and other major US west coast ports. Much of the container trade growth comes from the rise of China as a major manufacturer, and has led to a booming trans-Pacific pendulum trade from Asia to the west coast of North America. The Port of Vancouver experienced congestion as imports from Asia led to double-digit growth in 2004, leading the Port Authority to plan to develop a second container terminal. At the Port of Prince Rupert, capacity will be added as needed in a more isolated environment to handle the growing trans-Pacific container trade.²⁰

Demand for services at North American Ports has been growing dramatically over the last 15 years (see figure 7 below). The vast majority of this growth, however, has occurred at the ports of Los Angeles/Long Beach, and New York/New Jersey. While other ports on the West Coast have experienced strong growth, the growth at LA/LB and NY/NJ has been exponential. Although there has been much discussion about the need for additional capacity, there are still ports operating below their capacity.

It is difficult to identify the capacity of a marine terminal. Port capacity is a function of its physical infrastructure as well as its methods of operation and information infrastructure. This can be observed by the distinctly lower TEU throughput/hectare ratios when comparing ports around the globe (see figure 8 below).

The historic ports of Hong Kong and Singapore have experienced constraints on their physical land area for some time and so have optimized their operations to minimize land utilization, while relying more heavily on more available resources such as labor. The argument, therefore, that West Coast Ports will soon run out of capacity is dependent on their being a maximum capacity for these ports to move containers. It is clear that with changes currently being implemented such as technology deployments and reductions in free storage time, that the existing terminals may be able to handle additional goods. Prince Rupert cannot rely solely on the necessity of the terminal, but will also have to offer a reliable, efficient service to compete.

Figure 7. TEUs handled at North American ports over the last 25 years (source: AAPA).

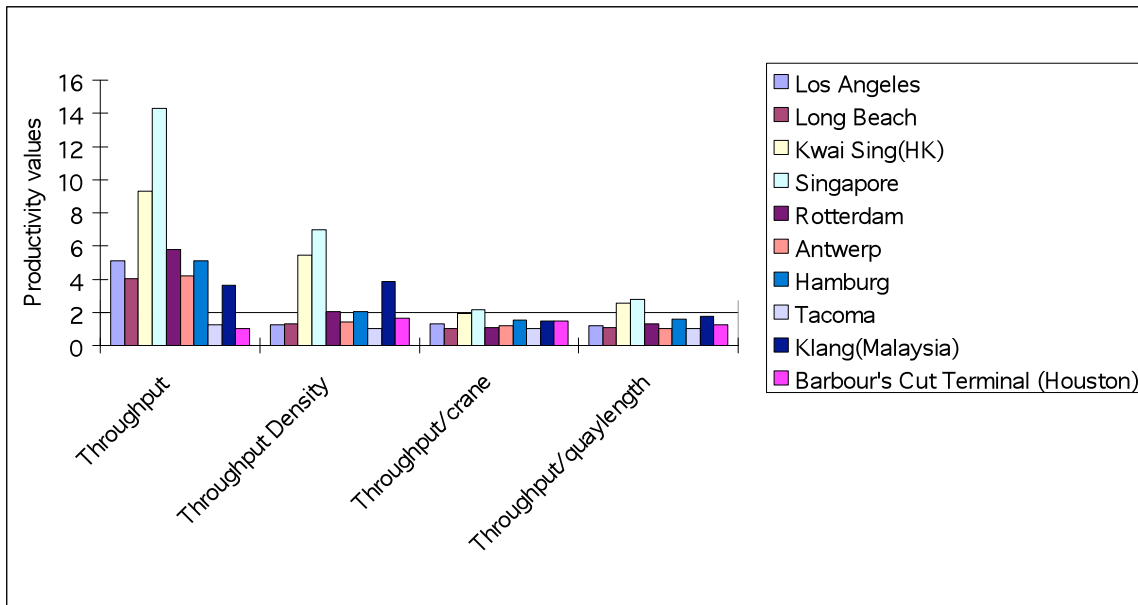
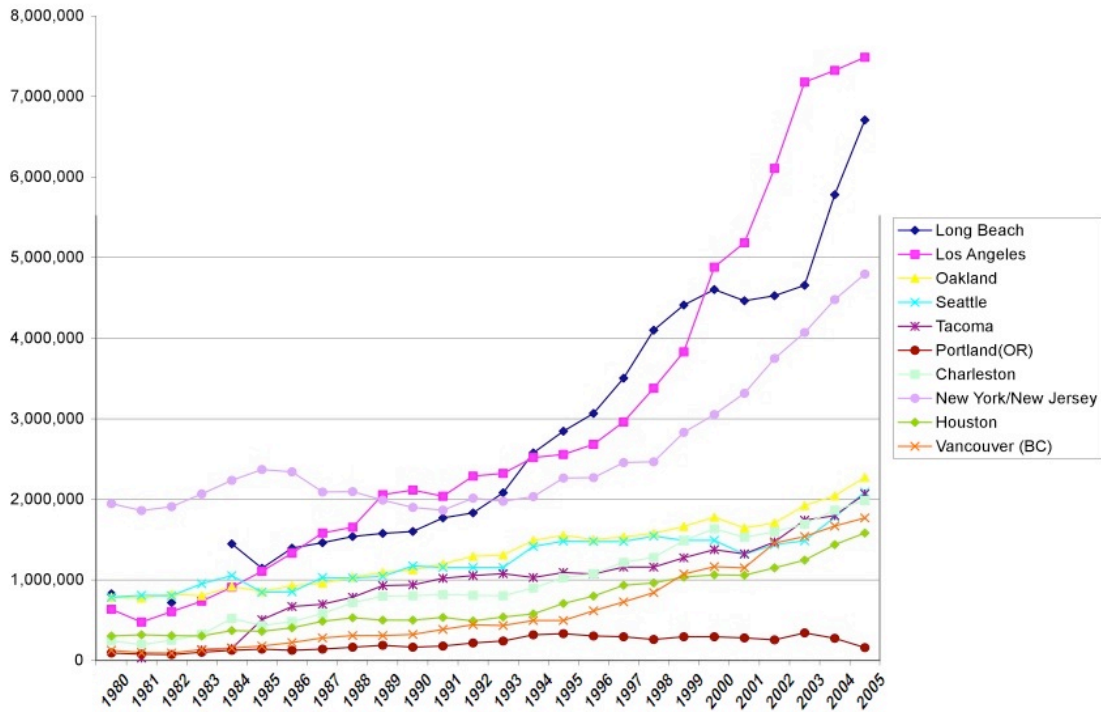


Figure 8. Productivity metrics for selected world ports (source: National Urban Freight Conference 2006 21).

Conclusions

Being closer to Asia is a significant asset if the vessel calls at Prince Rupert first, but this works in contrast to developing export markets. Shipping lines want to visit ports with exports last, to load the vessel prior to returning to Asia. Basic port services such as terminal operations must occur in Prince Rupert but much peripheral activity could occur in Prince George, such as re-handling and rail switching operations. This could mean significant economic activity for Prince George as well as the associated environmental cost. It is assumed that much of the two million TEUs handled at Prince Rupert will be destined to the US. Currently only five percent of Vancouver's imports are destined to the US. There are barriers to cross-border trade that need to be understood and addressed if Prince Rupert is to capture more of the US market. As a sign of things to come, Prince Rupert has had a very successful first year, and is delivering on its promise to provide reliable transportation for imported goods from Asia to the American heartland.

Endnotes

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