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Projections of Washington-British Columbia Trade and Traffic by Commodity, Route and Border Crossings

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ABSTRACT

Continuing adaptation to the changing transportation needs of the U.S. and Canada is critical in maintaining efficiency and reducing costs of raw and manufactured goods. As NAFTA moves into its twelfth year of existence, there is a growing need to continue adapting to the changing transportation environment. With bilateral trade in excess of $1.2 billion per day between the U.S. and Canada and over 200 million annual crossings (passenger vehicles and freight trucks), knowledge of the composition of commodities crossing the border allow for easier adjustment to and support for the changing needs of industries and transportation providers. Since Washington borders Canada and acts as an international trade hub for the state as well as industries throughout the United States, there is a specific need to evaluate the composition of commodities at its key border ports in order to project future traffic.

This project identifies key commodity groups in order to create a profile of major and minor Washington border ports in order to develop traffic projections. The central resource used to create the profile is the Strategic Freight Transportation Analysis (SFTA) database, a compilation of freight origin-destination survey results. The survey, not known to be duplicated by any other state, allows for the decomposition of freight flows by commodity, both northbound and southbound, thus allowing profiles to be created for seven major and minor border ports in Washington. The border ports analyzed are: Blaine/Pacific Highway, Lynden/Aldergrove, Sumas/Huntington, Oroville/Osoyoos, Danville/Carson, Laurier/Cascade, and Frontier/Patterson. Furthermore, SFTA allows for the decomposition of routes, which are used to estimate the flow of freight traffic on major Washington arterials, providing a profile of arterial highway usage by each border port.

Once the profile was created, projections of northbound and southbound crossings from 2006 to the year 2015 were estimated for each border port. Linear regression trend line analysis was used to determine the potential growth of crossings based on the growth of trade between the U.S. and Canada. After projected crossings were initially estimated, projections of future northbound and southbound trade by Harmonized System of Commodity Classification Codes (HS) at the 2-digit commodity level, as well as projections of U.S. and Canadian industries, were combined with SFTA to determine the future composition of commodities crossing through the various border ports. These projections of traffic based on trade were then compared with the initial border crossing projections. The process used to determine the projections is shown in Figure 1.

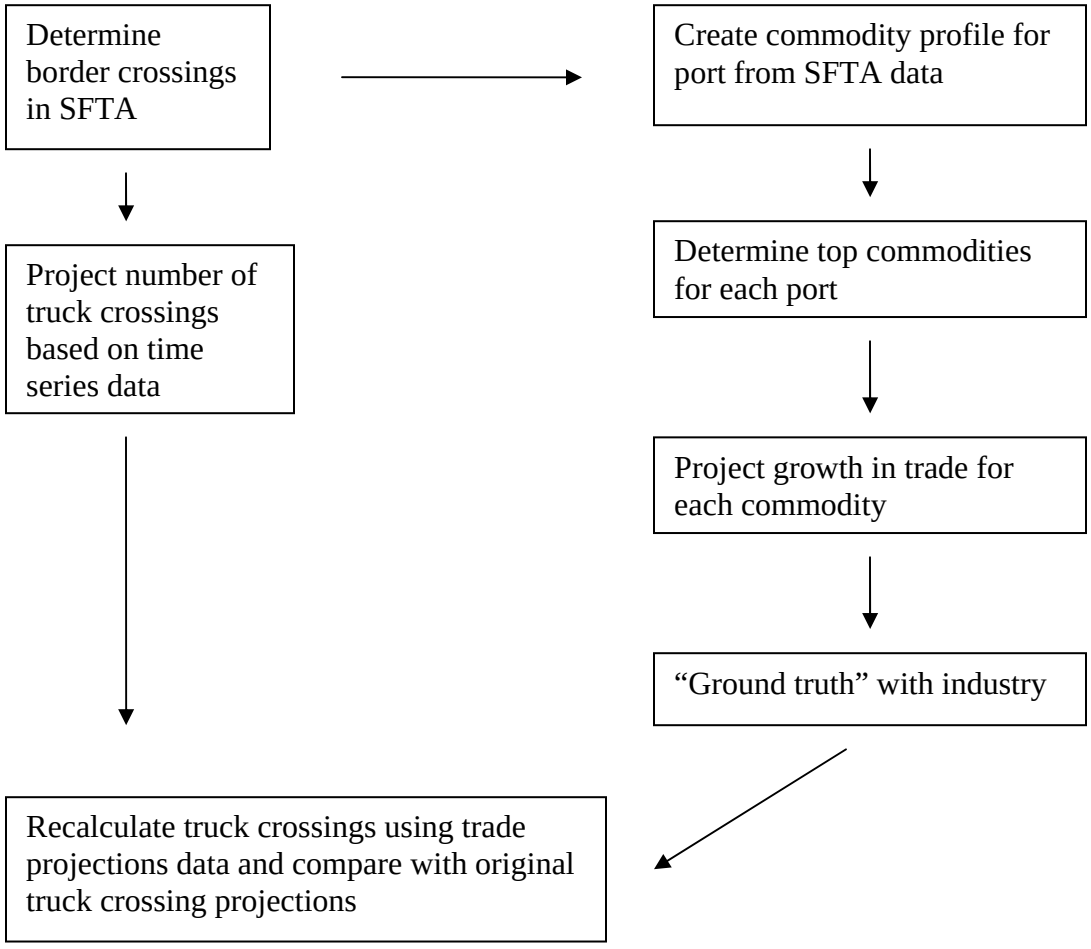
The top seven 3-digit NAICS commodity categories crossing the various Washington border ports are: food products, chemical products, plastic & rubber products, wood products, paper products, metallic products (fabricated and primary), and non-metallic mineral products. The NAICS categories were then translated into HS categories for

projections. The findings are in part corroborated with the Harmonized System trading commodities between British Columbia and Washington, as well as between Washington and Canada.

The truck crossing findings show that the percentage growth in the number of northbound and southbound crossings by border port, based on 10-year average annual percent changes, range from -6.1% to 3.82%. The 10-year average annual increases for bi-directional trade range from 0.81% to 4.7%. As trade growth averages change over time, so will the commodity profiles of the specific border ports. When truck crossings are incorporated with trade growth we see a difference of 0.62% and 15.46% between the original "naïve" truck crossing projections and the new trade adjusted truck crossing projections.

These projections on the future traffic volume and composition of commodities crossing between Washington and British Columbia serve as a guideline for future transportation of traded goods and the infrastructure investments necessary to support those flows.

Figure 1 – Methodology for Projecting Border Port Crossings and Profiles



PROBLEM STATEMENT

As the U.S. moves forward in the ever advancing international trade market, continuing adaptation to the changing transportation needs is critical in maintaining efficiency and reducing costs of raw and manufactured goods to ensure economic stability and growth. As NAFTA moves into its twelfth year of existence after its ratification in 1994, there is a growing need to continue to adapt to the changing transportation environment. With bilateral trade in excess of $1.2 billion per day between the U.S. and Canada and over 200 million annual crossings (passenger vehicles and freight trucks), knowledge of the composition of commodities crossing the border and the growth of those commodities allow for easier adjustment.[i] This project focuses on border flows by truck between Washington and British Columbia, through decomposition of the northbound and southbound flows by industry and commodity and projecting the trade growth in those industries. By knowing the potential growth and increases in commodity flows across border port locations, policy makers can better adapt border ports to allow for continuing efficiency in truck movements. This continuing or even increased efficiency would help maintain low costs and would help to maintain trade competitiveness in the international marketplace.

Furthermore, as trade continues to develop between Canada and the U.S., impacts on the route and road systems being used will inevitably occur. Therefore, an analysis of the routes utilized (North-South and East-West) will also help in determining the future development and maintenance of highway networks.

METHODOLOGY

The unique component in this research that enables the creation of border port commodity profiles is the Strategic Freight Transportation Analysis (SFTA) and the Eastern Washington Intermodal Transportation Study (EWITS). SFTA and EWITS are truck freight origin-destination surveys, conducted through the Washington State University Transportation Research Group and are not known to be duplicated anywhere else. EWITS was the first survey, conducted in the years 1992-1993 and SFTA was the second survey, conducted in the years 2002-2003. The unique aspect about the surveys is they collect information that is not provided by the census or government organization. The surveys gather information on origin of the tractor, destination, route used, main commodity type transferred, payload weight, operating company, number and location of LTL stops, number of axles, tractor/trailer type, and other characteristics. The surveys were conducted on four different days and have a combined sample observations of over 56,000 trucks. Each day corresponds to a different season in order to account for seasonal differences in truck flows.

In order to better estimate future cross-border freight flows between Washington and British Columbia, the SFTA and EWITS databases were used to:

a) determine cross-border truck freight flows
b) decompose total cross-border flows into individual highway crossings
c) separate crossings into northbound or southbound directional flows

d) further decompose highway crossings into specific commodity groups (3-digit NAICS)

For the purposes of this paper, only the SFTA database is used because SFTA is the most recent survey, offering the most current border port profile. In order to collect the specific information from SFTA, a query was conducted to isolate all British Columbia origin and destination locations.[ii] The location of origin and/or destination determined the directional flow of the truck movements at the border ports (i.e. if origin is BC then the direction of flow is "southbound"). After determining the direction of flow, the border ports used for the crossing could be determined through querying the route characteristics. Washington has approximately twelve British Columbia border crossing locations. In order from west to east, they are:

Point Roberts/Boundary Bay, Blaine/Douglas, Lynden/Alderwood, Sumas/Huntington, Nighthawk/Chopaka, Oroville/Osoyoos, Ferry/Midway, Danville/Carson, Laurier/Cascade, Frontier/Paterson, Boundary/Waneta, Metaline Falls/Nelway

Figure 2 – Washington State Border Crossing Locations

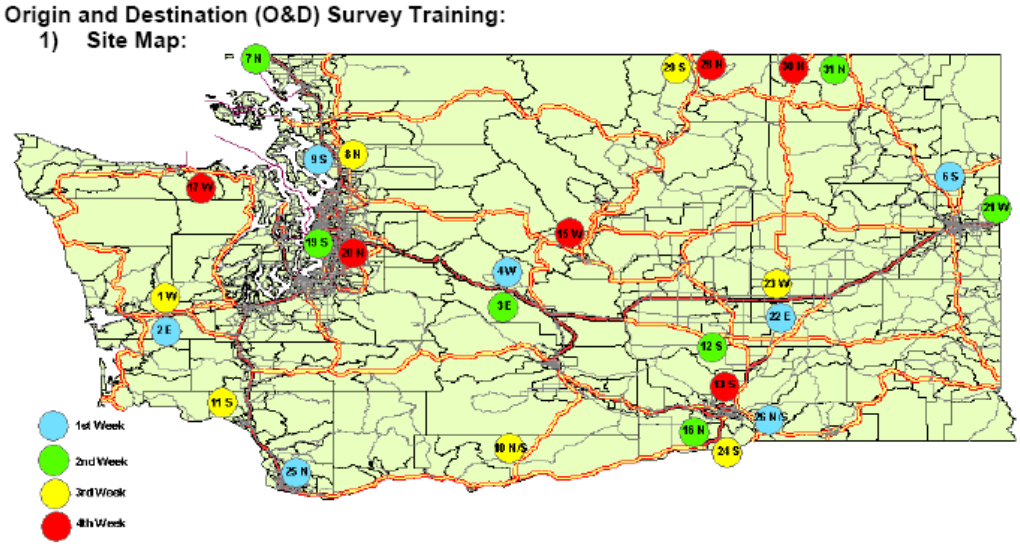
Source: Federal Highway Administration. Descriptive Report of Cross-Border Traffic and Transportation in the Western U.S.-Canada Region. Washington, D.C., September 1993

Of these listed border-crossing locations, Blaine (SR 543 Pacific Highway), Lynden (SR 539), Sumas (SR 9), Oroville (US 97), Laurier (US 395), Frontier (SR 25), and Danville (SR21 for SFTA only) are the only crossings that contained enough observations to decompose to a commodity level.

Only survey sites closest to the border or sites that would best identify trucks crossing the border were used in the data query. This total number of crossings was then divided by four (except on occasions where only three days of data were collected) to represent an average number of truck crossings in a day. However, some commodities at certain border ports, especially low truck volume ports in Eastern Washington, are not accounted

for because the SFTA survey site that completed the survey was not near the border. Figure 3 below indicates the survey locations.

Figure 3 – SFTA Survey Locations



From the query, the trucks were broken down into their respective 3-digit NAICS categories based on the description of the commodities contained in each truckload. The grouping of the commodities allows for the development of border port commodity profiles, through which projections and analysis were conducted. Furthermore, as stated above, the data provided in SFTA and EWITS allows for decomposition of routes. As a result, each evaluated border port is also broken down by major Washington State arterial routes used in transfer.

When border port profiles were created, analysis of the profile was conducted based on the top 5 commodities crossing. It is also prudent to mention that many border port profiles contain a large percentage of empty, unknown, or mixed trucks. These were included in the evaluation, in addition to the top five commodity categories.

After evaluation of border port profiles, projections of future truck crossings and future trade are made. Truck crossing time series data gathered from the Bureau of Transportation Statistics and Statistics Canada allowed for trend line regression forecasting of future truck crossings. This gave a basis for growth or decline in the number of trucks crossing at specific border ports. Secondly, trade data gathered from Stat-USA (part of the U.S. Department of Commerce), and Statistics Canada allow for trend line regression analysis and forecasting of trade between Washington State and Canada as well as British Columbia and Washington State. The reason for using British Columbia to Washington State instead of Canada to Washington State stems from an argument that a) most trade involving truck movements is regional and b) trucks traveling from eastern Canada will enter the U.S. through a border port in another state in order to utilize the U.S. interstate highway system.

Trend line regression for truck crossings gives a basis for comparison for the varying growth rates in trade. Theoretically, the weighted average growth rates of trade[iii], by commodity and frequency of crossing at each border port should be roughly equal to the growth rate of truck crossings at each border port. However, this would be a naïve approach because the collected time series trade data contains many modes of transportation. Additionally, different rates of changes in commodity trade growth may lead to a higher or lower level of truck crossings than those projected from the simple truck crossing data. Therefore, trade growth projections should allow for a more accurate depiction of projected truck crossings.

Trade projections are further "ground truthed" with an industry survey. The ground truthing survey was designed to determine if the regression results obtained from time series trade data coincide with industry expectations of trade.

The truck crossing frequency function can contain additional elements besides trade. In order to correct for this problem, we assume that the percentage growth in trade is indicative of and equal to the percentage growth in the number of truck crossings. Therefore, if trade in the food sector is growing at 3%, then the number of truck crossings that contain food products at border port (*i*) is growing at 3%.

After projections are completed, the observed growth rates in trade are then compounded with the current profile of commodities developed from SFTA. The frequency of truck crossings are compounded annually for ten years (from 2006 to 2015) based on the respective growth rates of the commodity categories. At 2015, a new border port profile is developed and analyzed to determine changes in profile structure.

RESULTS

Port Profiles

The following ports were analyzed for border port profiles: Blaine (SR 543 Pacific Highway), Lynden (SR 539), Sumas (SR 9), Oroville (US 97), Laurier (US 395), Frontier (SR 25), and Danville (SR21). These port crossings make up over 95% of both northbound and southbound crossings. The border ports and their respective profiles, based on their top five commodity categories, are presented in Table 1.

Of note is the diversity of commodities of the border ports across the state. Blaine, the state's largest border port, is by far the most diverse. However, it is very apparent that certain border ports have specific themes in terms of their profiles that make them unique. For instance, Danville and Laurier are predominately wood products, while Frontier has a large percentage flow of chemical products. Furthermore, many ports differ on their northbound and southbound commodity profiles. For example, Lynden's northbound crossing has 9.5% of it's crossings as machinery products, while it's southbound counterpart has 11.8% of it's crossings as beverage products. Additionally, there are certain products that consistently appear in the top categories, such as food products and wood products. Lastly, based on the profiles, the largest northbound movements are empty trucks. Empty trucks account for over 35% of total northbound movements and 25% of the total southbound movements in the evaluated ports.

Given the respective port profiles, nine industries were identified as "major" movers of freight trade across the ports. These industries according to NAICS codes at the 3-digit level are: Food Products (111, 311), Chemical Products (325), Plastics & Rubber (326), Wood Products (321), Paper Products (322), Metals (331,332), Non-Metallic Mineral (327), Transportation Equipment (336), and Machinery/Electrical (333,335).

Table 1

Border Port Commodity Profile				
	Northbound		Southbound	
Border Port	Commodity		Commodity	
Blaine	Empty	37.4%	Empty	24.5%
	Crop Production (111)	10.1%	Wood Products (321)	19.7%
	Other	7.4%	Paper Products (322)	8.5%
	Processed Food (311)	6.9%	Processed Food (311)	7.1%
	Unknown	6.1%	Non-Metallic Mineral (327)	6.2%
	Paper Products (322)	4.9%	Fabricated Metal (332)	5.8%
	Chemical Products (325)	3.7%		
	Plastics & Rubber (326)	3.3%		
Lynden	Empty	33.6%	Wood Products (321)	39.9%
	Crop Production (111)	19.0%	Unknown	25.7%
	Plastics & Rubber (326)	9.5%	Fabricated Metal (332)	11.8%
	Machinery (333)	9.5%	Beverage Products (312)	11.8%
	Other	9.5%	Transportation Equip (336)	10.7%
	Wood Products (321)	4.8%		
	Processed Food (311)	4.8%		
Sumas	Unknown	17.8%	Empty	38.1%
	Forestry & Logging (113)	11.2%	Wood Products (321)	23.6%
	Other	15.7%	Chemical Products (325)	17.4%
	Fabricated Metal (332)	10.3%	Plastics & Rubber (326)	8.7%
	Empty	11.5%	Processed Food (311)	6.0%
	Printed Material (323)	15.2%	Miscellaneous (339)	6.0%
	Chemical Products (325)	7.6%		
	Crop Production (111)	7.5%		
Oroville	Empty	57.6%	Wood Products (321)	36.4%
	Crop Production (111)	14.2%	Empty	11.8%
	Wood Products (321)	5.7%	Non-Metallic Mineral (327)	7.3%
	Beverage Manufacture (312)	4.1%	Plastics & Rubber (326)	6.7%
	Non-Metallic Mineral (327)	3.6%	Crop Production (111)	5.7%
	Transportation Equip (336)	3.5%	Transportation Equip (336)	5.3%
			Unknown	5.1%
Danville	Wood Products (321)	80.0%	Empty	57.1%
	Empty	20.0%	Wood Products (321)	35.7%
			Unknown	7.1%
Laurier	Empty	50.5%	Wood Products (321)	69.9%
	Wood products (321)	34.9%	Empty	16.7%
	Non-Metallic Mineral (327)	9.7%	Non-Metallic Mineral (327)	7.2%
	Unknown	2.7%	Forestry & Logging (113)	1.7%
			Chemical Products (325)	1.7%
			Unknown	1.7%

Table 1 continued

			Processed Food (311)	1.2%
Frontier	Empty	64.4%	Chemical Products (325)	73.4%
	Chemical (325)	22.6%	Empty	16.8%
	Wood Products (321)	13.0%	Wood Products (321)	4.9%
			Unknown	4.9%

Truck Crossing Projections

Once profiles are created, initial projections of the number of future truck crossings were made based on the current trend of growth or decline in truck crossings by border port. In this section, all ports except Point Roberts/Boundary Bay and Nighthawk/Chopaka were measured, in order to get a feel for the overall change in truck crossings as well as to investigate the level of year-to-year variability in the port-level crossings. As the results show, there is a wide spectrum of expected growth difference between border ports. Additionally, for some ports, there is a large level of variation in the number of truck crossings.[iv] This can be explained in part by the use of other modes of transportation, especially on the western side of the state.[v] Use of rail can help relieve the highway congestion resulting from high traffic volume at the ports. Furthermore, construction currently underway at ports such as Blaine may temporarily reduce the level of traffic flow as alternative routes or methods are used to transport goods. This is analyzed more thoroughly in the Implications and Exceptions section of the paper. Table 2 shows the predicted average annual percentage growth of truck crossings based on historical truck crossing data as well as the predicted number of yearly truck crossings.

Table 2

Growth Rate of Truck Border Crossings				
Average Annual Growth for 2006-2015				
Border Port	**Northbound**	**Average Increase**	**Southbound**	**Average Increase**
	Average Growth	**Trucks Per Year**	**Average Growth**	**Trucks Per Year**
Blaine	1.88%	10,052	1.90%	11,014
Lynden	3.82%	5,226	3.64%	3,014
Sumas	2.36%	2,281	3.21%	6,616
Oroville	3.34%	2,075	2.39%	1,321
Ferry	0.89%	51	-1.05%	(33)
Danville	-6.10%	(48)	-3.51%	(43)
Laurier	0.46%	71	2.07%	309
Frontier	1.68%	479	2.29%	662
Boundary	2.19%	4	5.16%	38
Metaline Falls	3.14%	411	3.14%	290
Total		20,602		23,188

Trade Growth Projections

Time series trend line analyses were conducted for each commodity to determine a 10-year average projected trade growth. Time series data was collected between the years 1985-2004 for Canada and 1987-2004 for the U.S. Trend line analyses for the respective industry outputs were conducted to insure relative industry stability and growth. The findings for industry growth in many cases differed significantly from the finding in trade

growth. This is expected because industry growth may not necessarily coincide with trade growth between the U.S. and Canada due to foreign exchange rate changes, and other market conditions. In other cases, such as southbound chemical trade and the chemical products industry, trade strongly coincided with industry growth. Given the exception of the Canadian non-metallic mineral industry (HS 25-27 & 68-71), all other industries show relative stability in terms of output growth.[vi] For trade, some commodities are relatively stable and consistent in growth (i.e.: plastics & rubber products, and paper products), while others show a high level of variability in trade, such as non-metallic mineral products, northbound food products, and northbound wood products.[vii] Based on the high variation, and other market conditions that can affect growth, true long term forecasting is very difficult for certain products. However, a general trend can be established that will allow for evaluations in profile changes, knowing that high trade volatility for certain products can change projected profile outcomes. Table 3 below summarizes the ten-year average annual growth in commodity trade and the growth in industry trade.

Table 3

Compounded Annual Growth Rates for Northbound and Southbound Trade and Industry

	Trade	Industry
Commodity Group	**North**	**United States**
Food	2.89%	1.72%
Chemicals	2.46%	2.45%
Plastics & Rubber	2.73%	2.64%
Wood	0.81%	2.59%
Paper	3.39%	1.54%
Metal	2.78%	1.86%
Non-Metallic Mineral	4.15%	2.35%
Transportation Equipment	0.62%	2.22%
Machinery	1.47%	1.95%
	South	**Canada**
Food	3.51%	1.34%
Chemicals	2.46%	2.03%
Plastics & Rubber	4.70%	3.05%
Wood	2.58%	2.10%
Paper	1.84%	1.07%
Metal	3.46%	2.56%
Non-Metallic Mineral	4.60%	3.44%
Transportation Equipment	4.15%	2.32%
Machinery	3.16%	1.99%

Due to a low response rate, the industry survey provided little insight for long-run trade projections for specific commodities. However, basic conclusions for two of the evaluated commodities were made. First, chemical products, which include fertilizers, pesticides, adhesives, resins, paints, soaps and detergents, and other miscellaneous chemicals appears to be on a steady trade growth path. Second, the wood products industry and southbound trade which include lumber, plywood, manufactured homes, trusses, wood containers, pallets and other miscellaneous wood products, may be slightly

overestimated based on historical data. Current market conditions are expected to decline in the short to medium run. However, no adjustments to trade growth have been made because of lack of information for long-run projections.

The Effect of Trade Growth on Border Crossings and Commodity Profiles

As stated above, in order to translate the trade growth into real truck movements, we assume that the percentage growth in trade has a direct correlation with percentage growth in truck movements. Therefore, a three percent growth in food trade translates into a three percent growth in the number of trucks transporting food products. With the knowledge of the commodity composition of the border ports and the trade growth of those commodities, estimates of future commodity profiles of those border ports can be made. Tables 4 and 5 below contain both the old and new percentage composition of the evaluated northbound and southbound commodities as well as the total change in the number of truck crossings by commodity between the years 2005 and 2015. Changes in specific commodity profiles can range anywhere from -4.25% to 6.05% depending on the growth of trade for the commodity and the percentage composition the commodity has for its respective border port.

Table 4

Northbound Changes in Commodity Profile and Number of Truck Crossings				
Port	**Commodity**	**Percent of Total (North) 2003**	**Percent of Total (North) 2015**	**Ten Year Change in Number of Trucks**
Blaine 2002	**Food Production**	**18.36%**	**18.51%**	**24,968**
	Wood Products	**1.60%**	**1.26%**	**505**
	Paper Products	**4.92%**	**5.60%**	**8,678**
	Chemical	**3.73%**	**3.71%**	**4,283**
	Plastics & Rubber	**3.26%**	**3.37%**	**4,288**
	Non-Metallic Mineral	**2.52%**	**3.22%**	**5,972**
	Metal	**4.51%**	**4.70%**	**6,105**
	Machinery	**1.95%**	**1.69%**	**1,207**
	Transportation Equip	**1.95%**	**1.50%**	**471**
Lynden 2005	**Non-Metallic Mineral**	**4.71%**	**5.49%**	**2,334**
	Crop Production	**19.01%**	**19.69%**	**6,261**
	Processed Food	**4.75%**	**4.74%**	**1,332**
	Fabricated Metal	**4.71%**	**4.81%**	**1,467**
	Plastics & Rubber	**9.50%**	**9.66%**	**2,902**
	Machinery	**9.46%**	**8.50%**	**1,468**
	Wood Products	**4.75%**	**4.00%**	**394**
Sumas 2004	**Crop Production**	**5.70%**	**5.77%**	**2,637**
	Fabricated Metal	**11.61%**	**11.72%**	**5,342**
	Chemical	**5.76%**	**5.59%**	**2,427**
Oroville 2004	**Non-Metallic Mineral**	**3.57%**	**4.27%**	**785**
	Paper Products	**1.19%**	**1.31%**	**204**
	Crop Production	**14.21%**	**14.91%**	**2,041**
	Metal	**1.53%**	**1.58%**	**208**

Table 4 continued

	Plastics & Rubber	**1.68%**	**1.73%**	**223**
	Beverage	**4.15%**	**4.18%**	**504**
	Processed Food	**2.10%**	**2.11%**	**255**
	Chemical	**1.07%**	**1.07%**	**126**
	Machinery	**0.85%**	**0.76%**	**56**
	Wood Products	**5.73%**	**4.79%**	**201**
	Transportation Equip	**3.45%**	**2.82%**	**92**
Laurier 2004	**Non-Metallic Mineral**	**9.70%**	**13.13%**	**647**
	Wood Products	**34.91%**	**31.99%**	**347**
Frontier 2002	**Chemical**	**22.64%**	**24.70%**	**1,420**
	Wood Products	**12.96%**	**11.30%**	**227**

The years associated with the data from the border ports are the years that had the least deviation from the fitted regression line and thus, are the years used to project the level of crossings based on trade growth.

Table 5

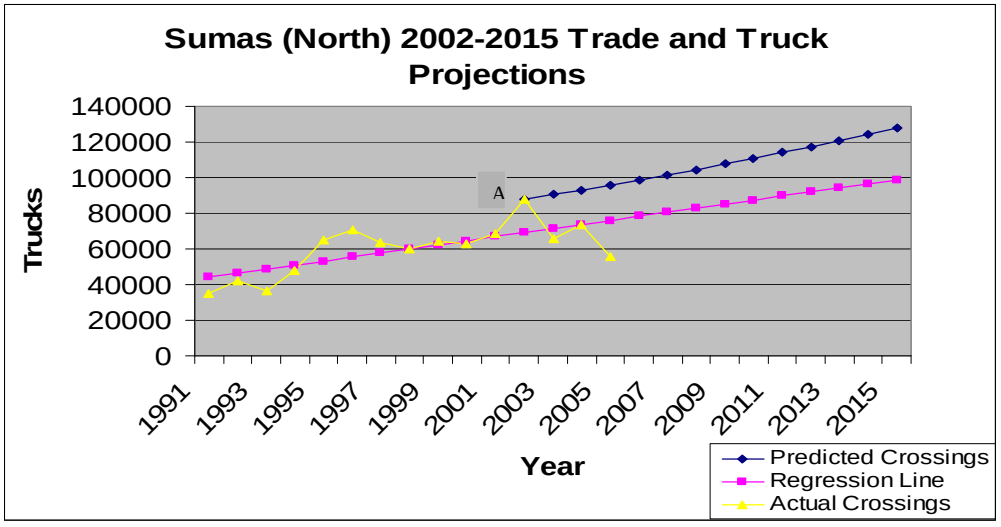
Southbound Changes in Commodity Profile and Number of Truck Crossings				
Port	**Commodity**	**Percent of Total (South) 2003**	**Percent of Total (South) 2015**	**Ten Year Change in Number of Trucks**
Blaine 2002	**Food Production**	**11.65%**	**13.14%**	**24,131**
	Wood Products	**20.18%**	**19.47%**	**26,308**
	Paper Products	**8.50%**	**7.35%**	**7,216**
	Non-Metallic Mineral	**6.21%**	**8.28%**	**19,017**
	Metal Products	**7.17%**	**7.92%**	**14,049**
	Machinery	**2.47%**	**2.60%**	**4,255**
	Chemical	**2.24%**	**2.13%**	**2,762**
	Plastics & Rubber	**2.09%**	**2.82%**	**6,605**
	Transportation Equip	**0.54%**	**0.67%**	**1,395**
Lynden 2004	**Transportation Equip**	**10.72%**	**10.44%**	**3,449**
	Beverage	**11.83%**	**10.68%**	**3,059**
	Fabricated Metal	**11.83%**	**10.67%**	**3,058**
	Wood Products	**39.89%**	**35.64%**	**10,210**
Sumas 2005	**Plastics & Rubber**	**8.72%**	**10.46%**	**7,780**
	Processed Food	**6.04%**	**6.41%**	**3,732**
	Wood Products	**23.59%**	**22.74%**	**10,110**
	Chemical	**17.45%**	**16.64%**	**7,127**
Oroville 2003	**Plastics & Rubber**	**6.71%**	**8.40%**	**2,090**
	Non-Metallic Mineral	**7.29%**	**9.00%**	**2,199**
	Processed Food	**4.95%**	**5.23%**	**1,014**
	Crop Production	**5.73%**	**6.63%**	**1,483**
	Transportation Equip	**5.33%**	**6.16%**	**1,381**
	Fabricated Metal	**1.57%**	**1.64%**	**315**
	Machinery	**1.82%**	**1.83%**	**324**
	Wood Products	**36.41%**	**33.94%**	**4,987**

Table 5 continued

	Chemical	**1.57%**	**1.44%**	**204**
	Paper Products	**1.41%**	**1.19%**	**129**
Laurier 2004	**Non-Metallic Mineral**	**7.17%**	**9.92%**	**530**
	Processed Food	**1.18%**	**1.43%**	**61**
	Wood Products	**69.91%**	**75.96%**	**2,467**
	Chemical	**1.67%**	**1.79%**	**56**
Frontier 2005	**Wood Products**	**4.90%**	**4.86%**	**326**
	Chemical	**73.39%**	**71.95%**	**4,627**

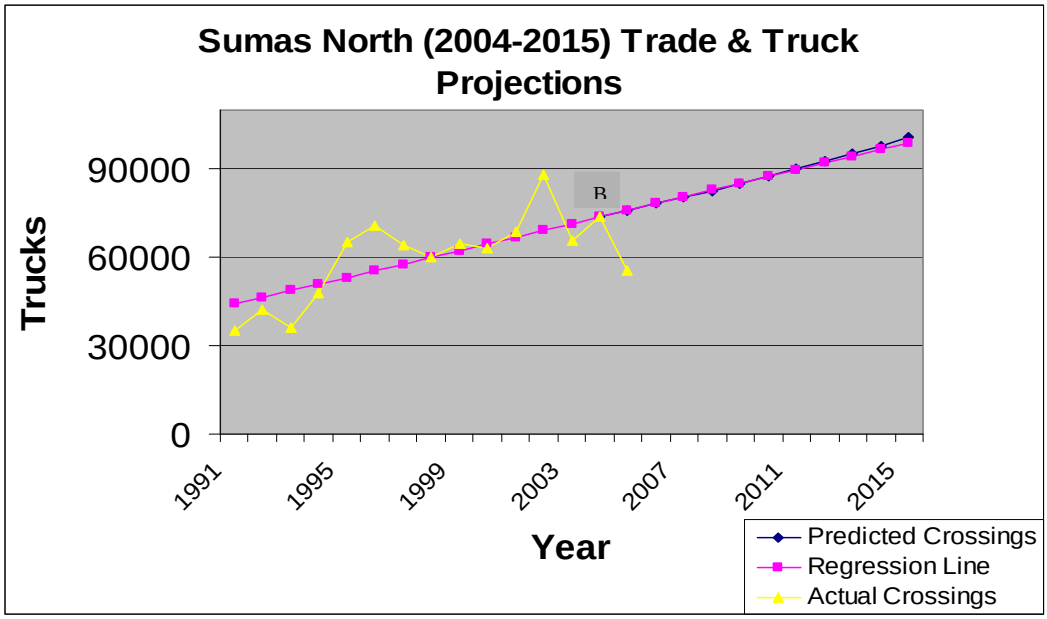
Due to deviation from the trend line in year-to-year crossings, starting dates for calculating growth and profile changes differ. The starting dates used are those closest to the trend line. This is based on the assumption that the growth in truck crossings is closely related to the growth in trade. If there is significant deviation from the trend line in the base year for calculating growth, then as trade growth is translated into growth in truck crossings, a new growth line is created that will not reflect the projected number of truck crossings. Figure 4 depicts this error. Point A reflects the year for which the SFTA survey was completed and the corresponding growth in truck crossings based on trade growth.

Figure 4



As a result, a year in which the number of actual truck crossings has a small deviation from the fitted regression line for the number of truck crossings is used. Additionally, the compounded annual growth rate is adjusted in order to reflect the year used for growth projections. When this is done, the two projections emulate each other with a smaller level of deviation. For the example above, the number of truck crossings in 2004 is closely related to the fitted regression line. When the trade growth projections begin in 2004, the projection line closely fits the regression line. Figure 5 depicts this relationship. Point B reflects the year closest to the regression line and the corresponding growth in truck crossings based on trade growth. Note that there is less than 2% difference between the projected truck crossings based on trade and the regression line.

Figure 5



The ten-year change in number of trucks reflects the difference between the 2006 and 2015 projected number of truck crossings (all are positive values). Though a specific commodity composition at a specific port may decline in terms of the port's overall profile, growth in trade for that commodity is still positive which results in increased truck crossings. For many of these border port commodity profiles, there is significant trade growth in one or more of the commodities relative to the other commodities in the profile. As a result, some significant drops in the percentage composition of commodities for smaller ports such as Oroville, Laurier, and Frontier are evident.

When comparing the fitted regression line of truck crossings to the projected level of truck crossings based on trade growth, there appears to be a small level of deviation for most ports. Table 6 shows the percentage of deviation from the fitted truck crossing regression line.

Table 6

Percent Difference of Trade Projections from Fitted Regression Line Projections		
Port	**Northbound**	**Southbound**
Blaine	7.52%	10.99%
Lynden	15.46%	6.14%
Sumas	1.91%	2.41%
Oroville	9.96%	12.65%
Laurier	8.46%	2.70%
Frontier	1.00%	0.62%

The three border ports that exceed 10% deviation from the fitted regression line projections are Blaine (southbound), Oroville (southbound), and Lynden (northbound).

Explanations for higher deviation at the Blaine and Oroville border ports most likely stem from construction. Blaine is still undergoing construction to expand the border port, resulting in congestion and average wait times in excess of 15 minutes in 2004.[viii] As for Lynden, there has been a recent slowing in the growth rate of truck crossings over the past 5 years. If a trend line were projected using only the more recent level of truck crossings, the projected level of truck crossings from trade projections would more closely reflect the slowdown.

Roadway Impacts

This section deals with the impacts of increased usage of arterial roads associated with the border ports and their respective flows. As trade continues to increase between the United States and Canada the level of highway road usage is expected to increase, resulting in an increased rate of road deterioration. It is very useful to understand the level of arterial usage by each border port in order to better prioritize infrastructure improvements.

As stated in the methodology section, SFTA collects information on origin and destination as well as route used. Using this information, a frequency table and corresponding map can be created that shows the level of usage for each border port.

This section focuses on the main arterial routes utilized by trucks at the various border ports. Based on the survey respondents identified as border crossings, another query was conducted in SFTA, to isolate nine arterial highways used, namely:

Interstate 5
Interstate 405
Interstate 82
Interstate 90
U.S. Highway 97
U.S. Highway 395
U.S. Highway 2
U.S. Highway 12
State Highway 14

These highways and interstates represent the bulk of north-south and east-west travel in Washington. The query for the frequency table does not focus on specific distances traveled on the arterial; the focus is on road network usage. Interstate 5 and Interstate 405 capture much of the north-south traffic flows between Washington, Oregon, and California. After reviewing much of the route data, I-405 is more heavily used by truck flows moving west or east across I-90. U.S. 97 and U.S. 395 capture the majority of the remainder of the north-south traffic flows, especially for goods that have origins and destinations in regions located east of the Cascade mountain range.

I-90 is the main arterial for east-west travel in Washington. In terms of border crossings I-90 is used in part or in full depending on the destination of the goods being transported. For example, goods crossing at Oroville, WA (U.S. 97) may only use a part of I-90, whereas goods crossing at Blaine, WA (SR543) may have an origin in Spokane and use

the entire Washington portion of I-90. U.S. Highway 2 captures east-west travel across northern Washington and is an important arterial for eastern Washington border ports. U.S. Highway 12 and State Highway 14, though not as heavily used as other arterials, represents the east-west travel across southern Washington and is an important entrance into the Washington road-network system from areas such as Idaho and Oregon.

One final key aspect to mention is since the query doesn't discriminate against distance and most border crossings are located on or near major north-south arterials, there tends to be 100% usage of the arterials located near the border crossing. The key is not to over-interpret the information; many of the routes only use a portion of the arterial that the located near the border crossing. An additional observation is added to indicate if only the arterial was used and no other highway/road networks, to help understand the road networks used. However, one further characteristic deals with the origin and destination on a single arterial. For example, a truck may have an origin in Omak, WA (north-central Washington on U.S. 97) and an Osoyoos, BC destination. As a result, U.S. 97 is used, but only a 45-mile section of the arterial.

Table 7 shows the arterial usage by border port in terms of the annual average daily truck (AADT) volume and percentage rate that the arterial is used for the specified border port.

Table 7

SFTA Average Annual Daily Truck (AADT)
Usage of Washington Arterial Roadways

Port	Northbound				Southbound		
Blaine	Highway	AADT	%AADT		Highway	AADT	%AADT
	I-5	896	97.87%		I-5	1678	100.00%
	I-5 (only)	713	77.83%		I-5 (only)	1196	71.29%
	I-90	111	12.09%		I-90	210	12.54%
	I-82	37	4.02%		I-405	167	9.96%
	SR543	20	2.13%		I-82	62	3.70%
	I-405	19	2.12%		US97	8	0.46%
	US2	9	0.99%		US2	8	0.46%
	US97	7	0.75%		US12	8	0.46%
	US12	5	0.51%				
	US395	1	0.16%				
Lynden	I-5	89	100.00%		I-5	65	100.00%
	I-5 (only)	51	57.02%		I-405	32	48.55%
	I-90	21	23.76%		I-90	22	34.39%
	I-82	17	19.01%		I-5 (only)	17	25.73%
	I-405	17	18.97%		I-82	15	23.67%
	US97	4	4.75%				
	US2	4	4.75%				
Sumas	I-5	56	100.00%		I-5	104	100.00%
	I-5 & SR542 (only)	47	84.91%		I-405	25	24.18%
	I-405	4	7.58%		I-90	16	15.45%
	US97	4	7.51%		US12	8	7.63%
	US2	4	7.51%		I-82	7	6.73%

Table 7 continued

Oroville	**US97**	**162**	**100.00%**		**US97**	**189**	**100.00%**
	US97 only	**84**	**51.58%**		**US97 only**	**67**	**35.54%**
	I-90	**35**	**21.70%**		**I-90**	**56**	**29.48%**
	US2	**19**	**11.96%**		**US395**	**44**	**23.40%**
	US395	**18**	**10.94%**		**US2**	**43**	**22.94%**
	I-5	**9**	**5.72%**		**I-5**	**10**	**5.35%**
	I-82	**4**	**2.38%**		**I-82**	**6**	**3.38%**
	US12	**2**	**1.42%**		**US12**	**3**	**1.69%**
	I-405	**1**	**0.85%**				
Laurier	**US395**	**22.92027**	**1**		**US395**	**94.23631**	**100.00%**
	US395 only	**19.58407**	**0.854443**		**US395 only**	**59.90475**	**63.57%**
					I-90	**18.51688**	**19.66%**
Frontier	**US395**	**5.203647**	**1**		**US395**	**19.57556**	**82.77%**
	I-90	**3.301194**	**0.634845**		**I-90**	**10.71321**	**45.30%**
	US97	**0.724696**	**0.139365**		**US395 only**	**8.792992**	**37.18%**
	US2	**0.724696**	**0.139365**		**US97**	**1.657012**	**7.01%**
	US395 only	**0.724696**	**0.139267**				
	I-5	**0.674044**	**0.129624**				

Through the use of geographic information systems technology (GIS), the SFTA survey data collected on the routes used to transfer goods both northbound and southbound was geocoded. Geocoding is a method of using characteristic data and translating that data to a real map. Route information is used to illustrate the frequency and flow of traffic throughout arterials in Washington State. Figure 6a shows inbound freight volume. I-5 is the most heavily used arterial since the majority of goods traveling to and from British Columbia come from either out of state, seaports, or airports and cross at either Blaine, Lynden, or Sumas. However, U.S. 97 at the Oroville border port, based on SFTA data, is also heavily used. Utilizing the map in Figure 6a, a better understanding of the flow and dissemination of incoming truck volumes can be made. Additionally, increased damage to roadway infrastructure can be better estimated in order to more efficiently maintain Washington's roadways.

Figure 6b shows the traffic volume density for freight traveling northbound to British Columbia. Much of the same level of density can be seen for the bi-directional flow of traffic, though in some cases, the density is lower. This is mainly due to the number of surveys captured at a given site. However, the density differences, especially those associated with the I-5 corridor, correspond to a higher level of southbound border crossings at Blaine, Lynden, and Sumas in the year the SFTA survey occurred.

Figure 6a[ix]

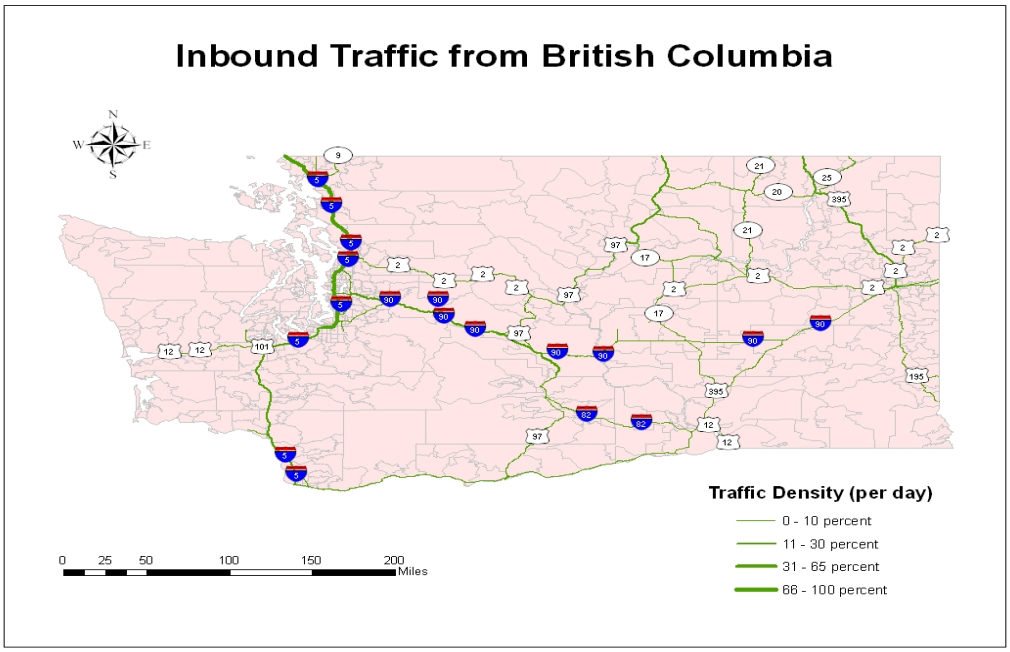
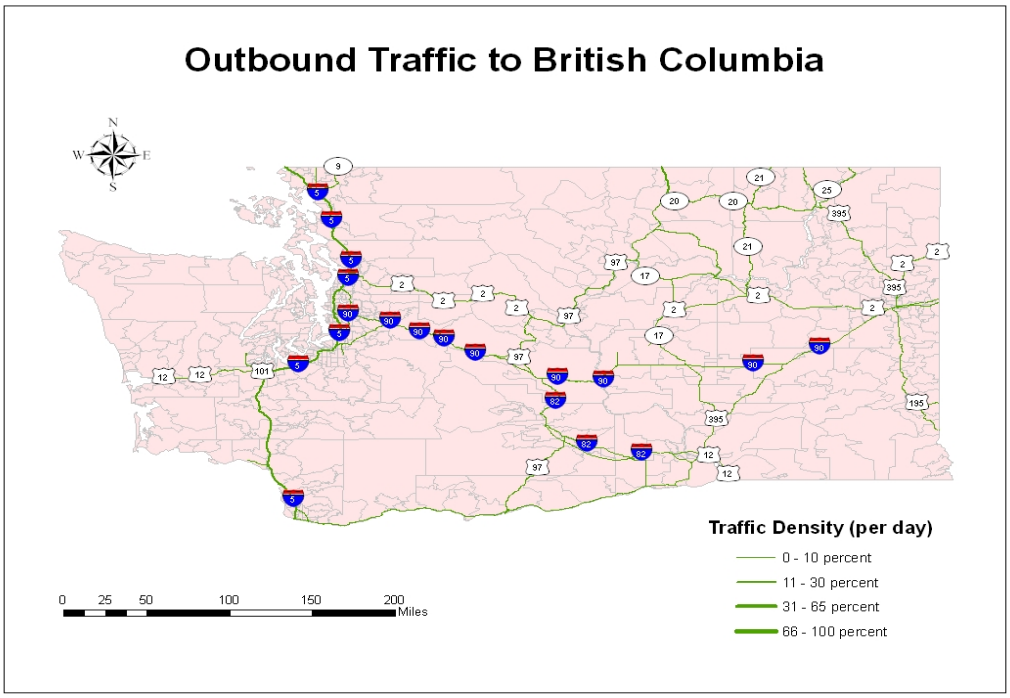


Figure 6b[x]



IMPLICATIONS AND EXPLANATIONS

Of note is the fact that recent time series data for the Blaine/Douglas border port has shown a decline in the number of truck crossings since 2001. This decline contradicts the projected growth in trade. Since Blaine is the largest Canadian border port in the

Western United States, further research and explanation was conducted. Figures 8 and 9 depict this decline over the last several years. Four possible explanations for this occurrence were determined.[xi] First, based on current trends, there appears to be a slight increase in cross border rail movements, especially for southbound flows. This small change from truck to rail helps to relieve congestion pressures at the border, especially for time insensitive, low value, and high volume goods. Secondly, wait times at the border, especially southbound, average between 20-30 minutes. The costs associated with these wait times may cause shifts to alternative transportation methods or alternative routes. This is especially practical under the assumption that the carriers have brokers at multiple border ports to facilitate crossings or the carriers are operating under Free and Secure Trade (FAST) program or a form of Electronic Data Interchange (EDI) system. Third, economic downturn in Canada and stagnation in the U.S. may have resulted in slower truck movements to a certain degree.

Figure 8

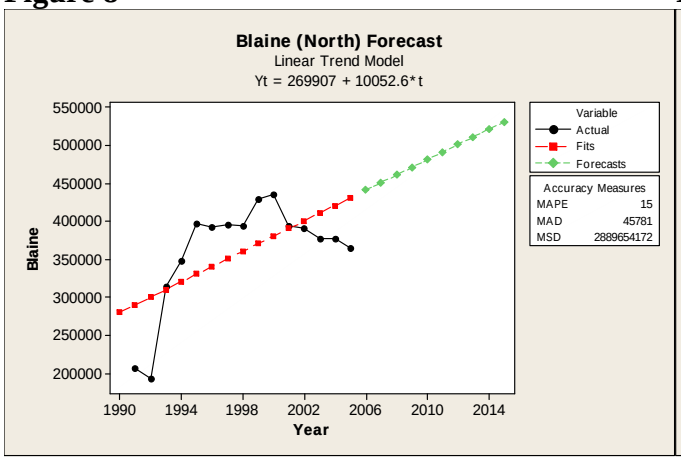
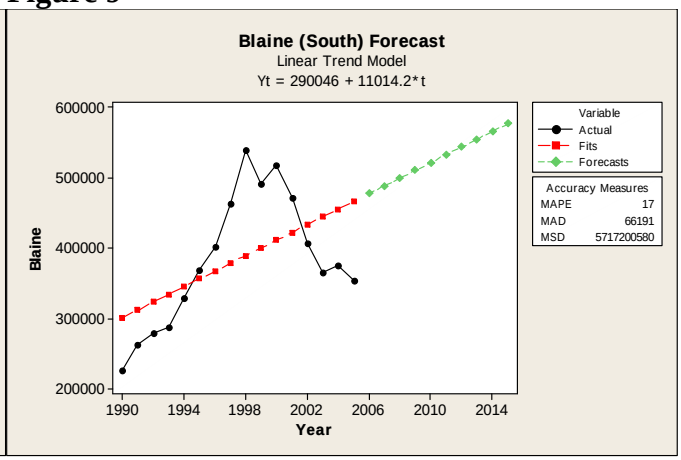


Figure 9



However, recent and projected trade growth contradicts this argument as being a major factor causing the decrease in truck crossings. The fourth and most plausible argument stems from the September 11, 2001 terrorist attacks. The resulting heightened security and full inspections at border ports would have created severe congestion and ultimately reduced the number of crossings.[xii] Given these arguments, there is still an expectation of increases in the number of bi-directional truck crossings. The reason for this is the continual development of programs to help facilitate the border crossing procedure while still maintaining security, and as the Canadian economy becomes more robust.

CONCLUSIONS

The successful completion of this project and methodology utilized is possible because of the unique and detailed information available through SFTA. The methodology chosen utilizes the available resources, data, and information, whereby projections of crossings and border port profiles can be modified based on expected trade growth changes. Furthermore, projections can be easily modified in the short run and long run to adjust for exogenous market changes or improved information because of the methodology used.

There is an expectation of increased flows for Washington's major border ports as evidenced in the data and subsequent analysis. Increases in bi-directional flows have implications ranging from crossing times, road deterioration, security, supply chain management, and border port processing capacity.

Future research naturally extends from these issues. A cost model that would estimate the various costs related to wait times could be developed. These costs include fuel consumption, wages, idle time, and other transportation costs. When an average of $2 billion a day in trade crosses between the United States and Canada, waiting several minutes can easily turn into wasting millions of dollars.

Road deterioration would be another extension from this research. Impacts of bi-directional trade flows on roadways can be described through a function of road type/thickness, axle loads, and deterioration rates. The end result is a prioritization of maintenance investments to insure safe road conditions and continued smooth transportation flows.

The purpose of this paper was to create information that will help in the policy decisions of border ports and infrastructure improvements. The information presented will better help prioritize investment projects that will enable Washington State to increase its trading efficiency and competitiveness on the world market.

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[i] Embassy of the United States of America, Ottawa. Canada-United States Relations: Background Notes. http://canada.usembassy.gov/content/textonly.asp?section=can_usa&document=canusarelations

[ii] It is important to note that some observations (mainly LTL freight movements) had BC as both origin and destination locations. These observations were treated as "Southbound" observations if the survey location is identified as a "south" location and "Northbound" observations if the survey location is identified as a "north" location.

[iii] In this case trade refers to the level of trade between Washington and Canada, and British Columbia and Washington.

[iv] Bureau of Transportation Statistics: Trans Stats. Border Crossing/Entry Data: Washington 1994-2005.

[v] Puget Sound Regional Council. FAST Corridor. http://www.psrc.org/fastcorridor/fastbrochure.pdf

[vi] Statistics Canada. Canadian Total Exports (British Columbia to Washington) Years 1990-2005.

[vii] STAT-USA. Cross-border Trade Data 1992-2005. AND Statistics Canada. Canadian Total Exports (British Columbia to Washington) Years 1990-2005.

[viii] United States Department of Transportation: Bureau of Transportation Statistics. TABLE 5-3/5-4 Average Daytime Wait Times for Commercial Vehicles at Selected U.S. Surface Border Gateways: 2003 and 2004.

[ix] Puenpatom, Tosmai, Jessup, Eric and Casvant, Ken. Applications of Geo-Coded Truck Route Data in Washington State: A GIS Approach. Transportation Research Group. Washington State University School of Economic Sciences. 2006 p. 17

[x] Puenpatom, Tosmai, Jessup, Eric and Casvant, Ken. Applications of Geo-Coded Truck Route Data in Washington State: A GIS Approach. Transportation Research Group. Washington State University School of Economic Sciences. 2006 p. 18

[xi] Explanations were gathered in part from a phone interview with Anne Goodchild, Assistant Professor at the University of Washington Department of Civil Engineering. AND "Talking Points" by Mitchell Optican. Canada Policy Advisor, Department of Homeland Security April 1, 2004. http://www.irpp.org/events/archive/apr04/optican.pdf

[xii] United States Department of Transportation: Federal Highway Administration. Freight Management Operations: Key Transportation Challenges. June 2006. http://www.ops.fhwa.dot.gov/freight/freight_analysis/freight_story/congest.htm

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15. United States Department of Transportation: Federal Highway Administration. Freight Management Operations: Key Transportation Challenges. June 2006. http://www.ops.fhwa.dot.gov/freight/freight_analysis/freight_story/congest.htm