Effect of Rail Performance on Vessel Time-in-Port

QUORUM CORPORATION
NOVEMBER 8, 2024

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Executive Summary

This report investigates the impact of railway performance on port activity across three Western Canadian ports: Vancouver, Prince Rupert, and Thunder Bay. The objective is to quantify how railway delays may affect port operations, measured by the time grain vessels spend in port.

The analysis shows some distinct operational differences between each location. Thunder Bay exhibits notably lower overall vessel wait times and less variation in time-in-port when compared to Vancouver and Prince Rupert.

This lower variation in wait times at Thunder Bay can be attributed to a number of factors, not the least of which is the relative scope of the port's throughput, which is much lower than what is handled through the West Coast ports. Moreover, grain storage at Thunder Bay allows for the maintenance of comparatively larger safety stocks. In addition, railway capacity constraints through to Thunder Bay figure far less than they do on movements to the West Coast. Lastly, marine vessels serving the port are largely focused on repositioning grain through the St. Lawrence Seaway rather than direct export as on the West Coast. This allows for shorter trips with a consistent fleet of vessels.

To assess railway performance, this analysis focuses on two primary metrics: out-of-car time (OOCT) and car velocity. Out-of-car time reflects the time that terminals expect railcars but do not receive them due to railway related issues. Car velocity, measured in miles per day, expresses how quickly shippers receive their cars for unloading at port. Velocity normalizes for different lengths-of-haul (or railway distances) across the grain-gathering network, which are not reflected in typical car cycle metrics that measure only in days.

Of the two rail measures, out-of-car time and car velocity, velocity is the better predictor of port performance on the West Coast. The observed relationship between car velocity and the average number of days vessels spend in port is significantly stronger than the relationship with out-of-car time. At Vancouver, changes in car velocity can account for 46% of the observed time-in-port variance, and 30% at Prince Rupert. While out-of-car time also has a significant relationship with time-in-port, it accounts for only 9% of the variability at Vancouver and 8% at Prince Rupert. Car velocity also normalizes the data for differences in trip distance which can lead to greater reliability when comparing multiple origin and destination pairs.

This report emphasizes the critical role of railway performance, particularly car velocity, in influencing port operations. Addressing railway delays, or improving the predictability of rail service, could increase the efficiency of grain vessel operations at Vancouver and Prince Rupert. Thunder Bay operations remain stable, showing minimal variation in vessel wait times and car velocity over time.

Background

This analysis aims to quantify the effect that railway performance has on the port activity of grain vessels. Quorum Corporation is interested in determining the extent to which railway delays influence port operations. This report separates three Western Canadian ports; Vancouver, Prince Rupert and Thunder Bay, to look at their individual operations.

The two measures used in this analysis to evaluate railway performance are out-of-car time and car velocity.

Out-of-car time (OOCT) measures the fraction of time where a terminal is expecting railcars, and they do not arrive. As out-of-car time increases, it is expected that vessel time-in-port will also increase as there may not be sufficient grain to finish loading. In this report, the average monthly out-of-car time for each port is used.

Car velocity is a measure of how quickly railcars move between the country origin and port destination in a given period. It is calculated for each trip by dividing the miles travelled by the total days spent in three stages of the car cycle[1]: origin dwell, loaded transit and destination dwell. Recorded in miles per day, this metric normalizes for the varying distances between origin stations within the country's elevator network. Additionally, it accounts for all disruptions, including weather delays, providing an accurate performance measure throughout the year. Generally, as the monthly average velocity decreases, the time vessels spend in port is expected to increase.

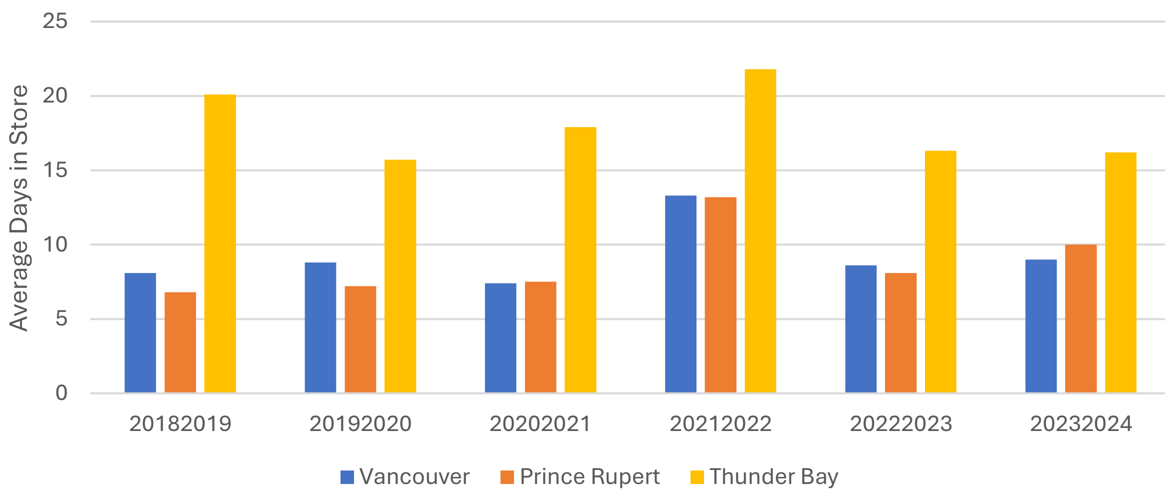
Differences at Thunder Bay

The Port of Thunder Bay operates differently from the two West Coast ports for several reasons, resulting in significantly lower vessel wait time variability compared to Vancouver and Prince Rupert.

With an annual throughput averaging about a quarter of what the West Coast ports manage, Thunder Bay's lower volume reduces the potential for fluctuation in wait times. Furthermore, its grain storage capabilities allow for larger safety stocks, which means that railway delays have less immediate impact than they do on the West Coast, where such delays can lead to insufficient stock for vessel loading. This is evident in Figure 1, which highlights the yearly average number of days that grain stocks spend in storage at each of the three ports. On average, stocks at Thunder Bay are held in storage 8.8 days longer than at Vancouver and 9.2 days longer than at Prince Rupert. Railway capacity constraints when considering all sectors on routes to the West Coast are also much more significant than those to Thunder Bay, providing fewer opportunities for variation in transit time or velocity.

Lastly, marine vessels that are serving the port are primarily focused on repositioning grain through the St. Lawrence Seaway rather than direct export as on the West Coast, and to do so, they rotate a consistent fleet of vessels that travel shorter distances.

Figure 1 Average Time Stocks Spend in Storage in Vancouver, Prince Rupert and Thunder Bay



[1] GMP Table 5B-1 M

Figures 2 and 3 reflect some additional differences between the three ports and demonstrate why they are analyzed separately within this report. Figure 2 emphasizes the variation in days vessels spend in each of the three ports. The average time-in-port is significantly lower at Thunder Bay than the other two, with an overall average wait time of 2.3 days compared to 15.3 days at Vancouver and 14.6 days at Prince Rupert.

Figure 3 illustrates the relationship between vessel time-in-port and velocity. The variation in the two West Coast ports is much larger than at Thunder Bay where the trendline is essentially flat as the values cluster much closer around the average. Specifically, the coefficients of variation for velocity are 15.9% at Vancouver and 23.2% at Prince Rupert, compared to just 11.5% at Thunder Bay. When paired with Figure 2, it is evident that operations at the Port of Thunder Bay remain relatively stable.

Figure 2 Average Vessel Days at Vancouver, Prince Rupert and Thunder Bay

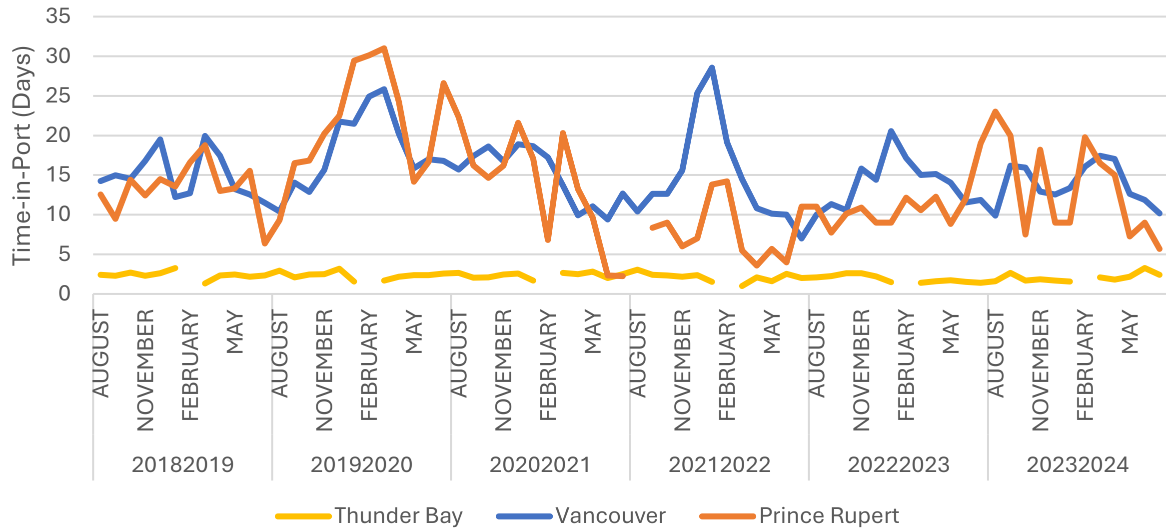
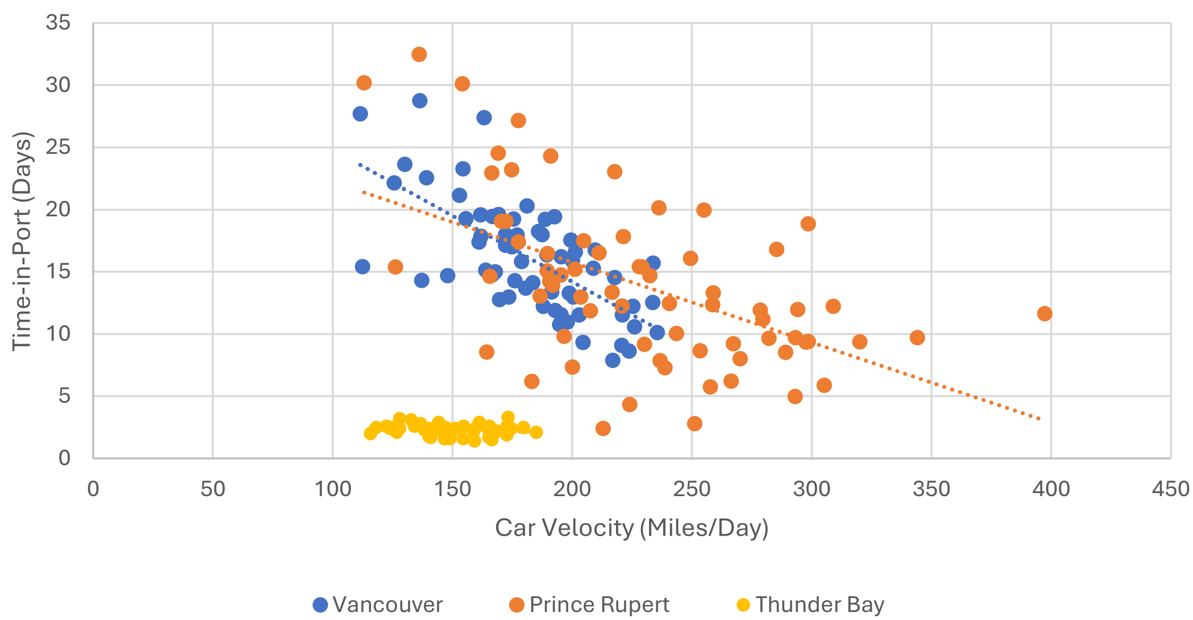


Figure 3 Average Time Vessels Spend in Port Versus Car Velocity, August 2018-July 2024



Vancouver

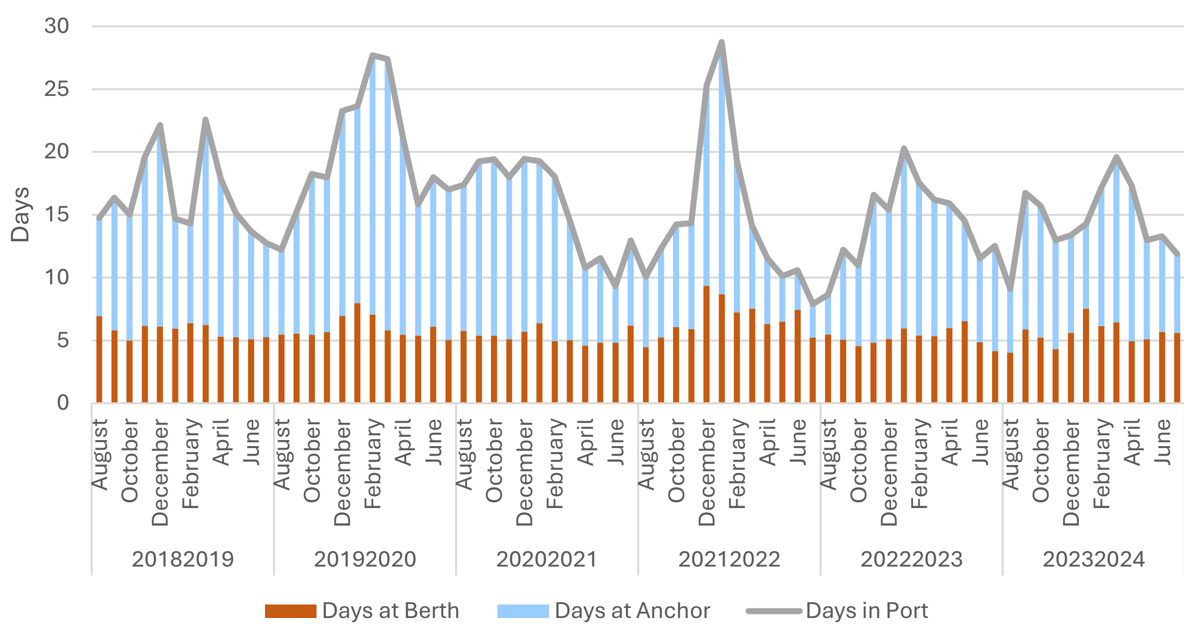
The Port of Vancouver consists of seven grain terminals[2] that handle between 40-60 vessels each month.

Between July 2021 and December 2021, Vancouver was affected by two natural disasters that severely impacted their operations: wildfires near Lytton, BC from June 29-July 09 and an atmospheric river, from November 15-December 06. This section of time has been removed from analysis where scatterplots are used as the data is not representative of typical operations, however, all time series charts have the period left in for continuity.

Vessels in Vancouver spend on average 62.5% of their time-in-port waiting at anchor (Figure 4) and while the time at anchor varies, the time spent at berth remains mostly stable. This analysis will examine how railway performance impacts total time-in-port, and the time spent at anchor, since it constitutes such a significant portion of the total.

When calculating average monthly time-in-port, each vessel's departure date was used to classify which month it belonged in; if a vessel arrived in port in August, but departed in September, it's count of days in port contributes to the September average.

Figure 4 Average Time Vessels Spend in Port at Vancouver



Out-of-Car Time

Figure 5 illustrates the positive relationship between the monthly average time vessels spend in port and out-of-car time at Vancouver. As out-of-car time increases, days in port increase accordingly.

[2] Fibreco and Pacific Marine terminals have been excluded from this analysis as they are not primarily grain terminals.

Figure 5 Average Time Vessels Spend in Port Versus Out-of-Car Time

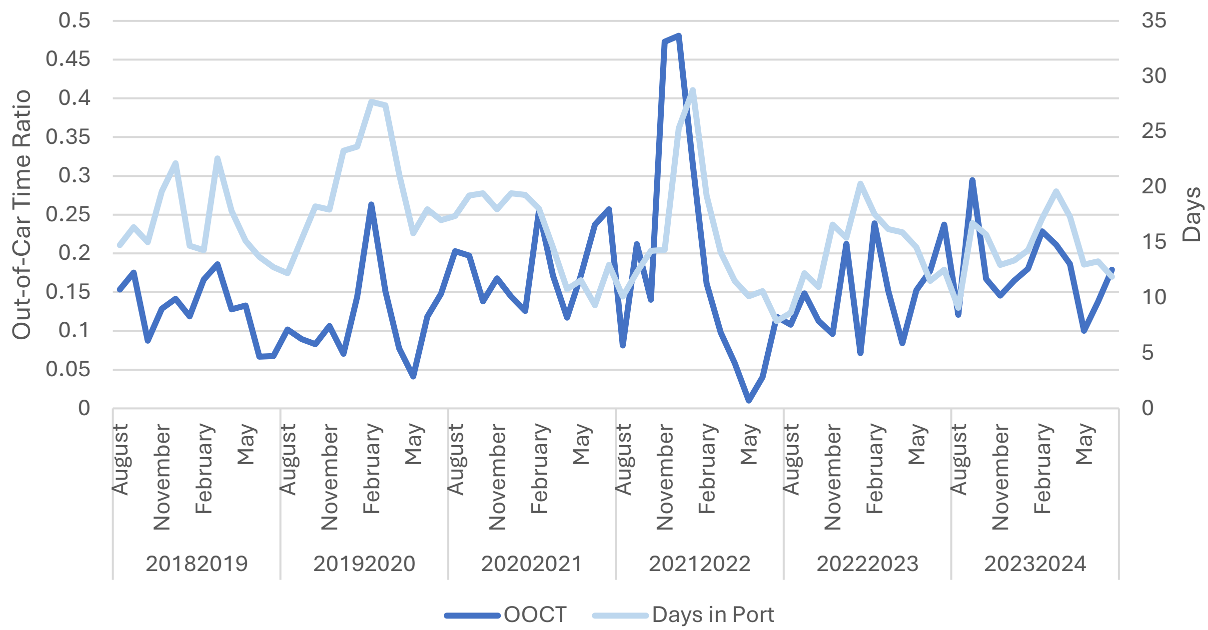
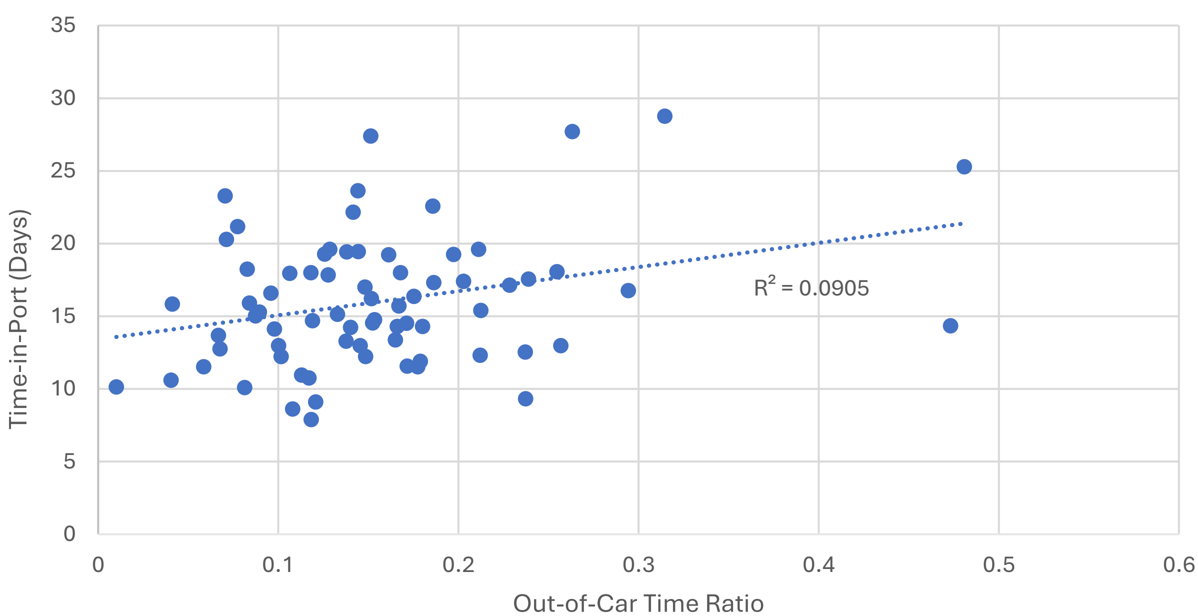


Figure 6 further demonstrates the positive relationship expected: months with higher out-of-car time had longer average vessel times in port. While this relationship is significant, it is relatively minor compared to the relationship between velocity and time-in-port. Out-of-car time explains only 9% of the variance whereas velocity accounts for 46%.

Figure 6 Average Days in Port versus Out-of-Car Time, August 2018-July 2024

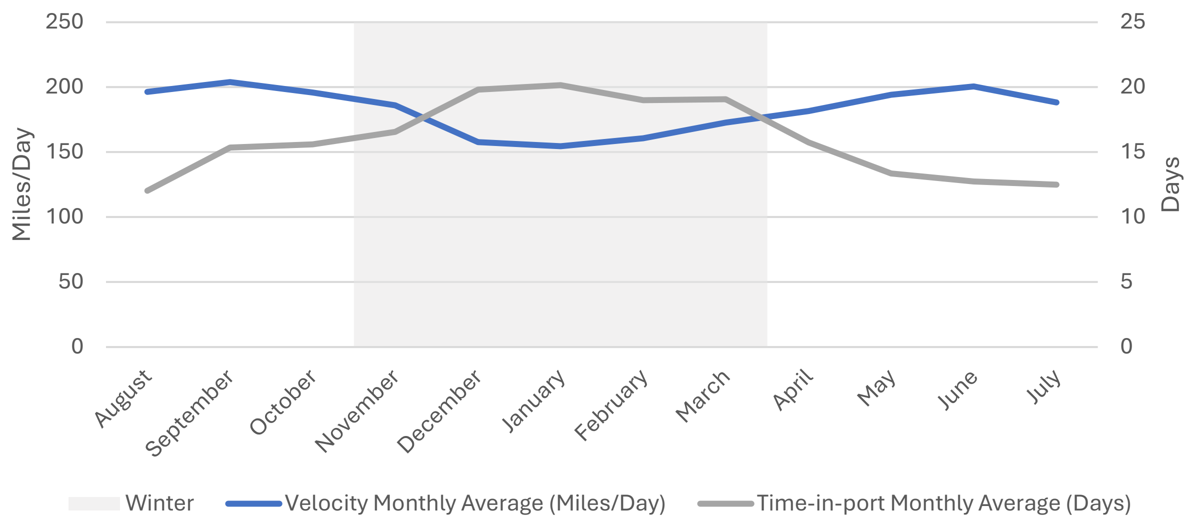


*The R-Squared value of 0.09 indicates that 9% of the variance in time-in-port can be explained by out-of-car time.

Car Velocity

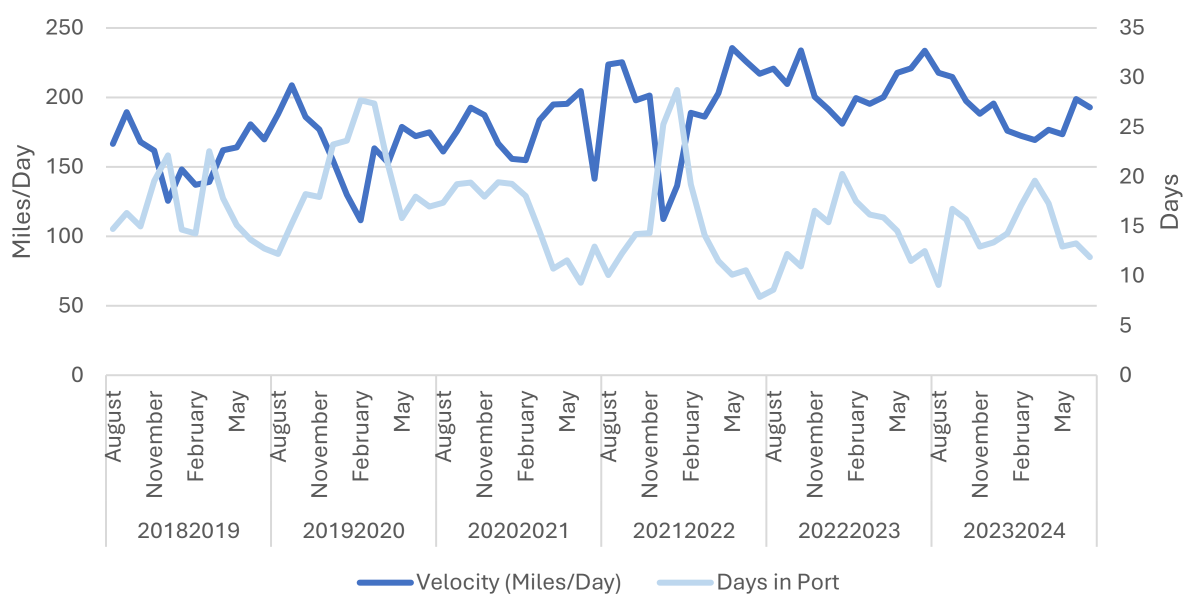
It is important to recognize that car velocity in the Vancouver corridor displays seasonality during the winter months. Specifically, there is a notable slowdown in velocity alongside an increase in vessel time-in-port during this period. This trend is shown in Figure 7, which presents the monthly averages of both car velocity and vessel time-in-port at Vancouver from August 2018 to July 2024, demonstrating the changes occurring between November to March.

Figure 7 Vancouver Monthly Average Velocity and Time-in-Port, August 2018-July 2024



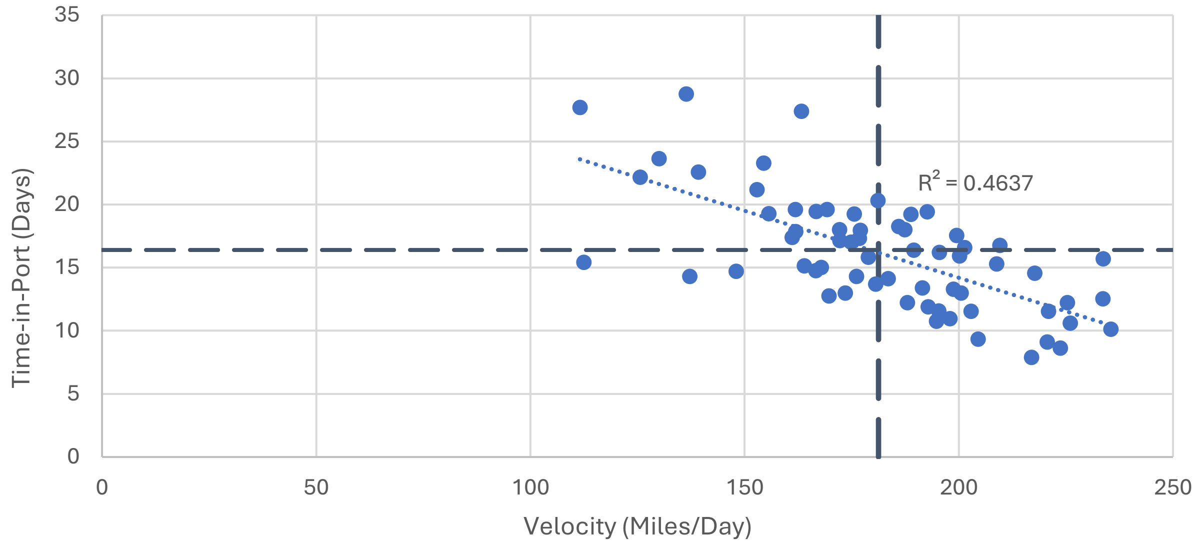
The significant negative relationship between car velocity and the time vessels spend in port is evident in Figure 8. As car velocity increases, there is a corresponding decrease in the number of days vessels spend in port. This pattern becomes especially prominent in November 2021, with a large increase in the average days-in-port due to the atmospheric river, though it continues through subsequent years, even following recovery.

Figure 8 Average Time Vessels Spend in Port Versus Car Velocity



The negative relationship between the two variables continues to be apparent in Figure 9. As car velocity increases, average monthly vessel time-in-port decreases. The Vancouver long-term average time-in-port is 16.4 days, and the velocity average is 181.3 miles per day, shown by the dashed lines on the chart. Once velocity exceeds 181 miles per day, 82% of months turned vessels quicker than the average.

Figure 9 Average Time Vessels Spend in Port Versus Car Velocity, August 2018-July 2024



*The R-Squared value of 0.46 indicates that 46% of the variance in time-in-port can be explained by car velocity.

Prince Rupert

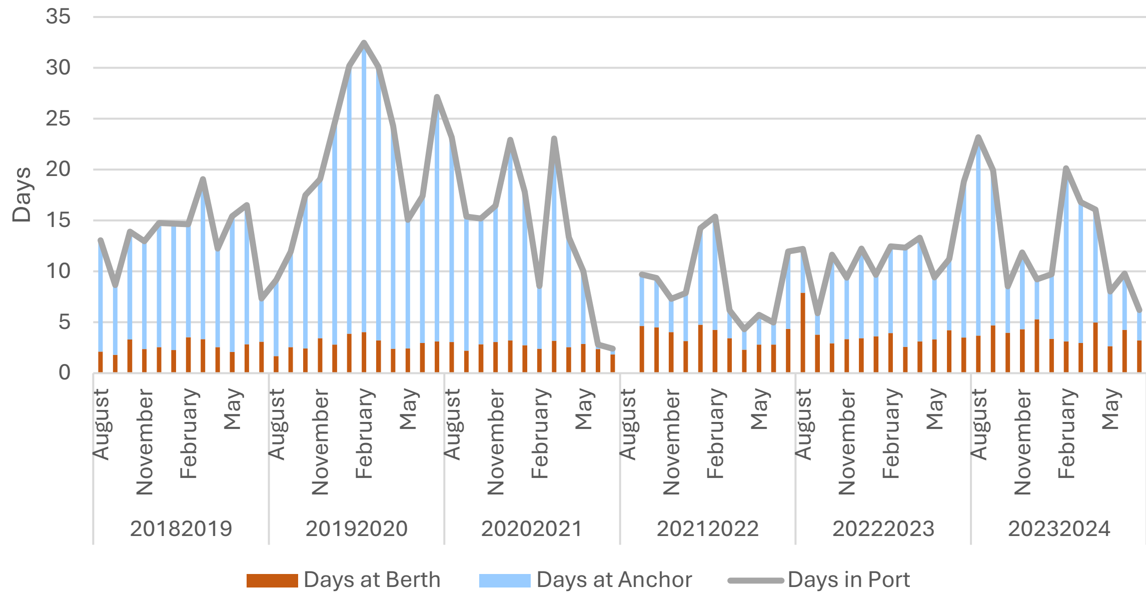
The Port of Prince Rupert sees fewer vessels each month than Vancouver, with only one grain terminal handling approximately 5-7 vessels. This can cause impacts on performance to present differently between the two ports; one outlier vessel at Prince Rupert may alter an entire month's performance metrics whereas an issue at Vancouver would need to be more widespread to be recognized in analysis.

All regression analysis done for Prince Rupert removes data from August 2021 as the grain terminal was closed for maintenance for the entirety of the month. The time-series charts in this section display a gap as this period has been included for continuity.

This section will also analyze the total time vessels spend in port, similar to the Port of Vancouver. Notably, vessels spend an average of 71.6% of their time at anchor (Figure 10), therefore, the conclusions drawn on time-in-port also apply to the vessels' time-at-anchor.

As with Vancouver, vessels' departure dates were used to classify their average monthly time-in-port.

Figure 10 Average Time Vessels Spend in Port at Prince Rupert



Out-of-Car Time

Figure 11 reveals the positive relationship between the average number of days vessels spend in port at Prince Rupert and the average monthly out-of-car time. As the average out-of-car time increases, the time vessels spend in port generally increases accordingly, and vice versa.

Prince Rupert regularly records 0.0 weekly out-of-car time as shown in Figures 11 and 12, as idle time is typically a result of lower demand for inbound cars rather than railway related issues.

Figure 11 Average Time Vessels Spend in Port Versus Out-of-Car Time

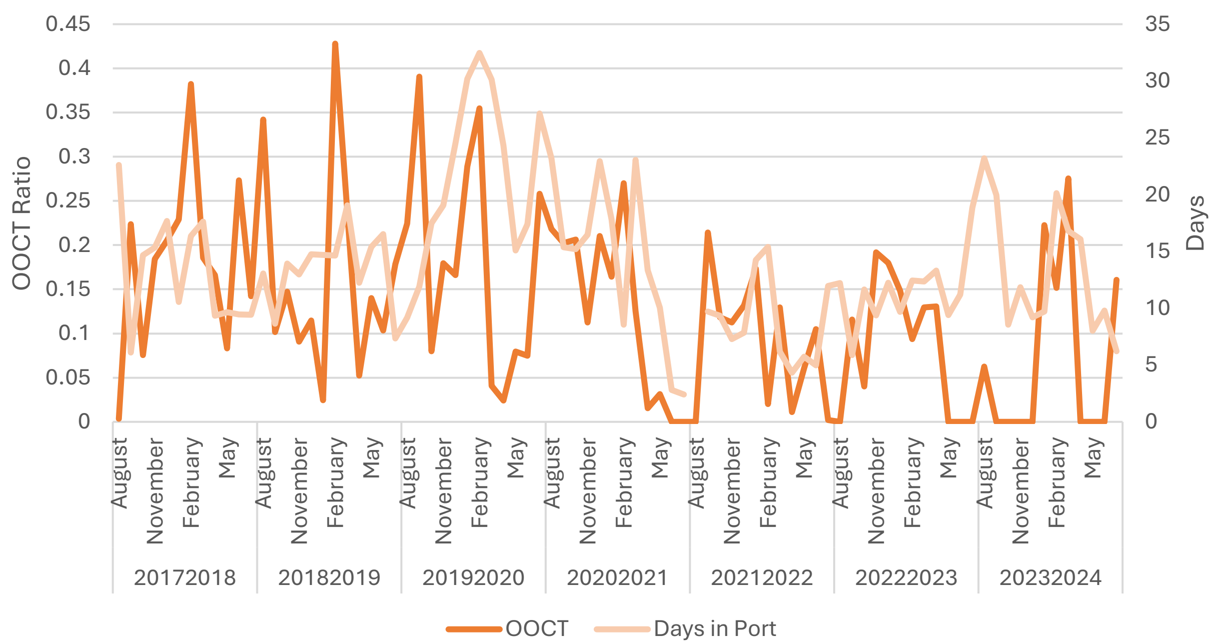
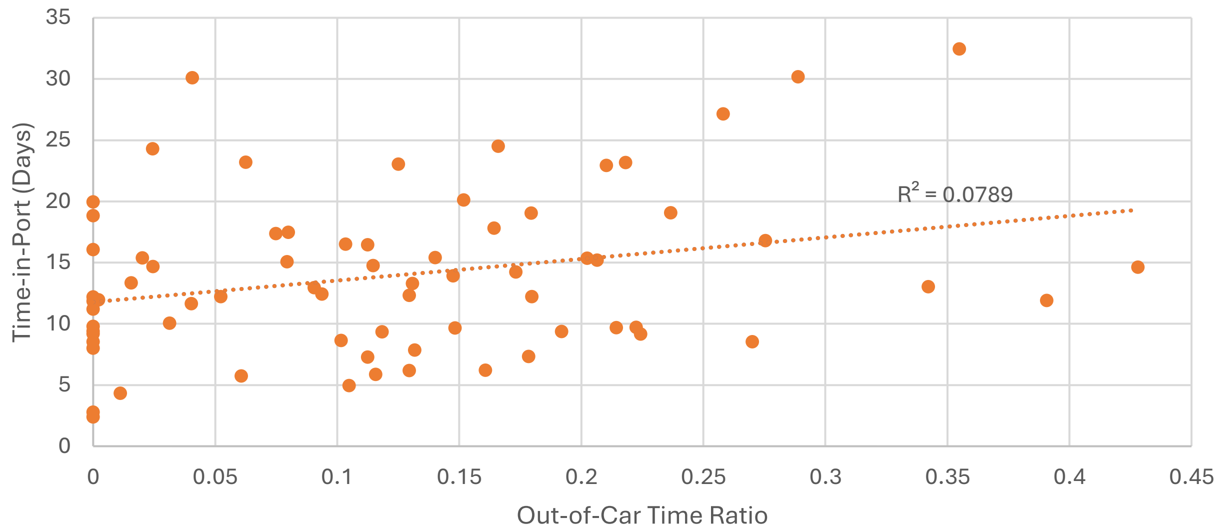


Figure 12 also depicts the significant positive relationship between average time-in-port and monthly average out-of-car time, like Vancouver when the same date range is analyzed. As out-of-car time increases, the time vessels spend in port does as well.

Figure 12 Average Days in Port Versus Out-of-Car Time, August 2018-July 2024



*The R-Squared value of 0.08 indicates that 8% of the variance in time-in-port can be explained by out-of-car time.

Car Velocity

Velocity in the Prince Rupert corridor follows a similar seasonal pattern to what was observed for Vancouver by Figure 7. Figure 13 highlights the changes occurring during the winter months of November to March by taking a monthly average of both velocity and vessel time-in-port.

Figure 13 Prince Rupert Monthly Average Velocity and Time-in-Port, August 2018-July 2024

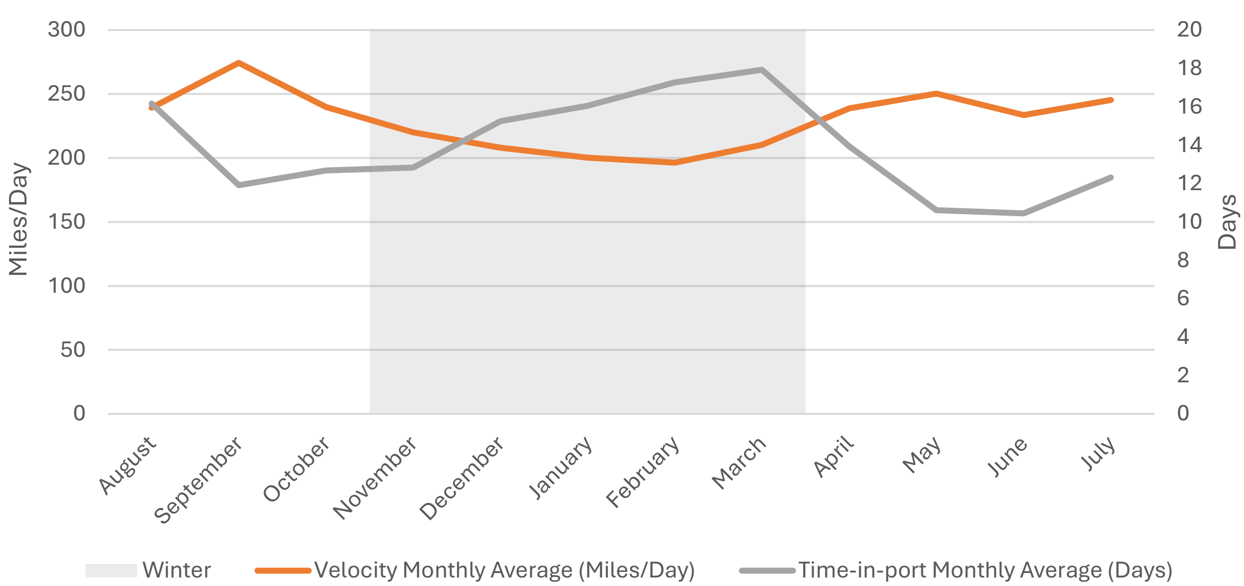


Figure 14 exhibits the negative relationship between the time vessels spend in port and the average monthly car velocity at Prince Rupert. As car velocity increases, the average days in port decreases and vice versa.

Figure 14 Average Time Vessels Spend in Port Versus Car Velocity

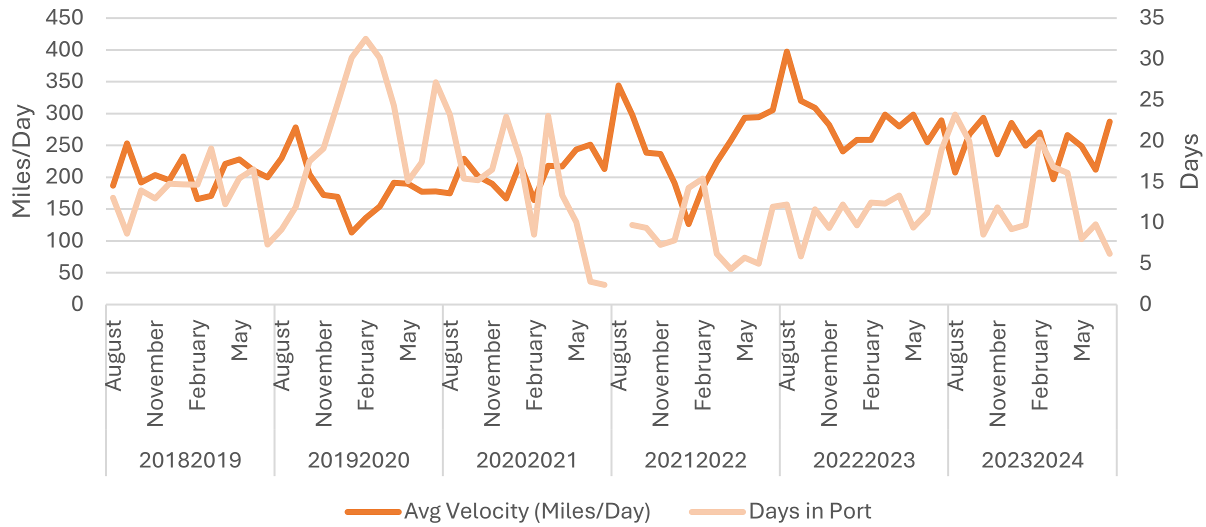
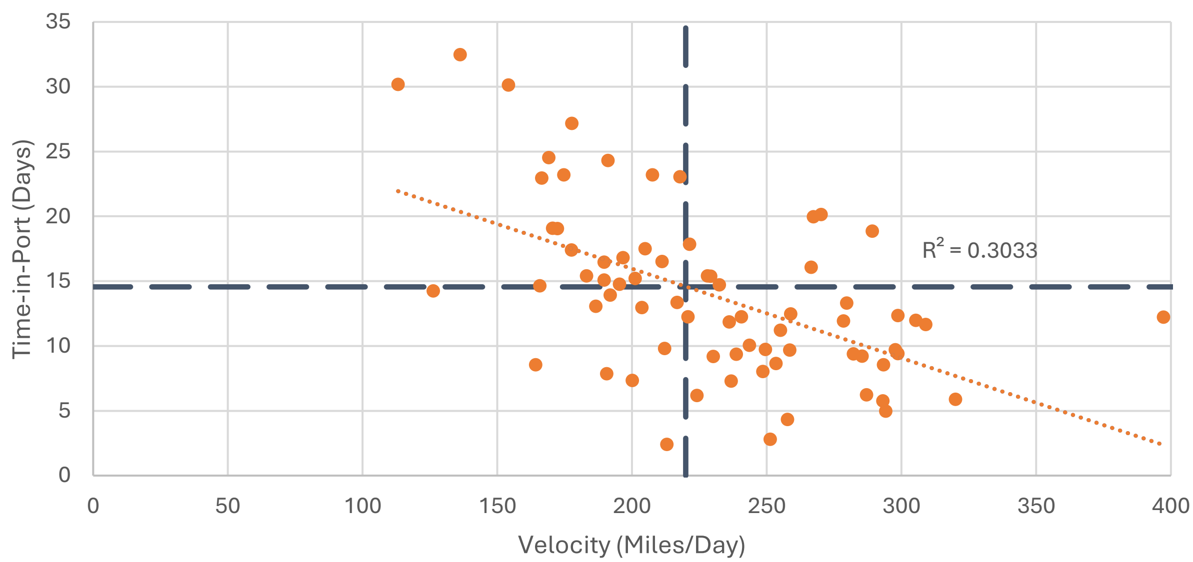


Figure 15 reinforces the negative relationship seen in Figure 14: as car velocity increases, average vessel time-in-port decreases. While the relationship is significant, it is not as strong as at the Port of Vancouver, which is possibly due to outliers in the data having a higher effect on the results.

The Prince Rupert long-term average time-in-port is 14.6 days, and the velocity average is 219.9 miles per day, shown by the dashed lines on the chart. Once velocity exceeds 220 miles per day, 78% of months turned vessels faster than the average.

Figure 15 Average Time Vessels Spend in Port Versus Car Velocity, August 2018-July 2024



*The R-Squared value of 0.30 indicates that 30% of the variance in time-in-port can be explained by car velocity.

Thunder Bay

As previously mentioned, the Port of Thunder Bay operates differently than the West Coast ports, and this is apparent in the following sections. The methodology used to measure time-in-port at Thunder Bay is the same as the West Coast, categorizing each vessel into a month based on its departure date from the port.

Note that all analysis done for Thunder Bay excludes data from January, February and March as the port closes through the winter each year. These months have also been removed from the time-series charts.

Analysis of the Thunder Bay port data reveals no statistically significant relationship with the railway data. This lack of correlation can likely be attributed primarily to the absence of variance in both vessel time-in-port and car velocity. As a result, the conclusions formed for the West Coast in this analysis may not be applicable to Thunder Bay.

Out-of-Car Time

Figure 16 illustrates the consistency of average days in port even through fluctuations in out-of-car time. Notably, in 2022-2023 there is a large increase in the out-of-car time ratio but there is no corresponding change in the average time vessels spend in port, therefore, no significant relationship can be drawn from these variables.

Figure 16 Average Time Vessels Spend in Port Versus Out-of-Car Time

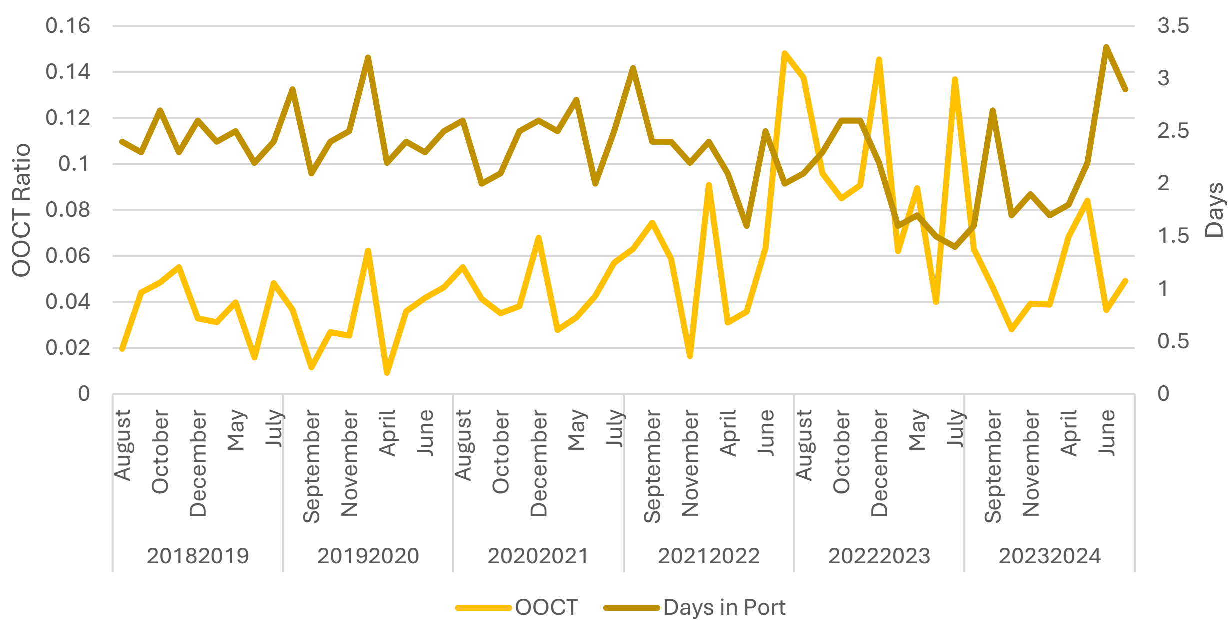
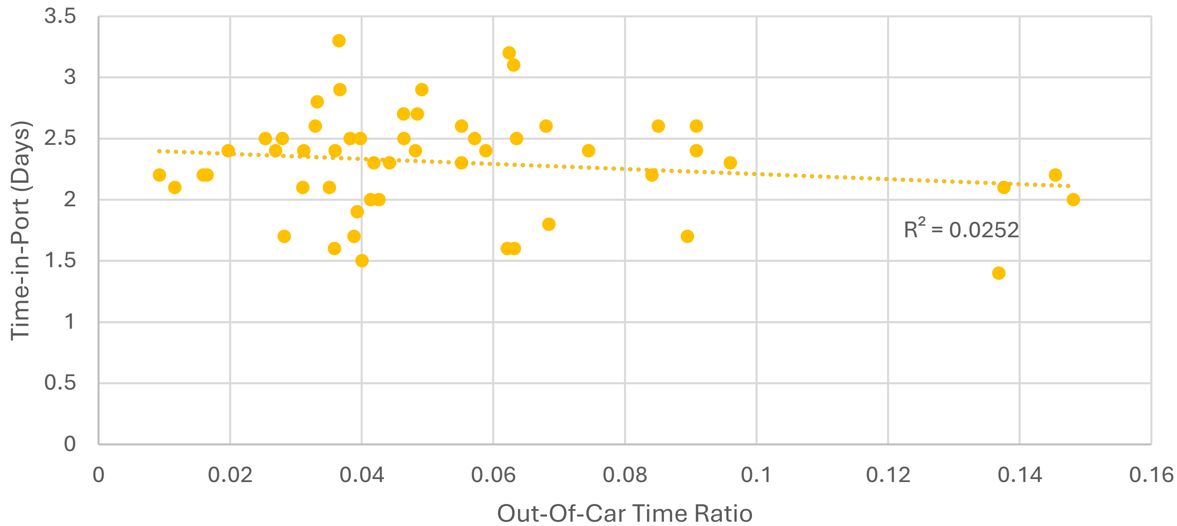


Figure 17 further displays the lack of correlation between out-of-car time and the average time vessels spend in port. As car velocity changes, there is little corresponding change to the average number of days that vessels are in port; only 3% of the variance in time-in-port can be explained by changes in out-of-car time.

Figure 17 Average Days in Port Versus Out-of-Car Time, August 2018-July 2024



*The R-Squared value of 0.03 indicates that 3% of the variance in time-in-port can be explained by out-of-car time.

Car Velocity

Since the Port of Thunder Bay is closed annually from January to March, the seasonal patterns in car velocity seen on the West Coast do not occur at Thunder Bay.

Figure 18 shows the lack of variance in both velocity and the average days in port at Thunder Bay. Both variables remain quite stable over time especially in comparison to the West Coast (Figures 8 & 14).

Figure 18 Average Time Vessels Spend in Port Versus Car Velocity

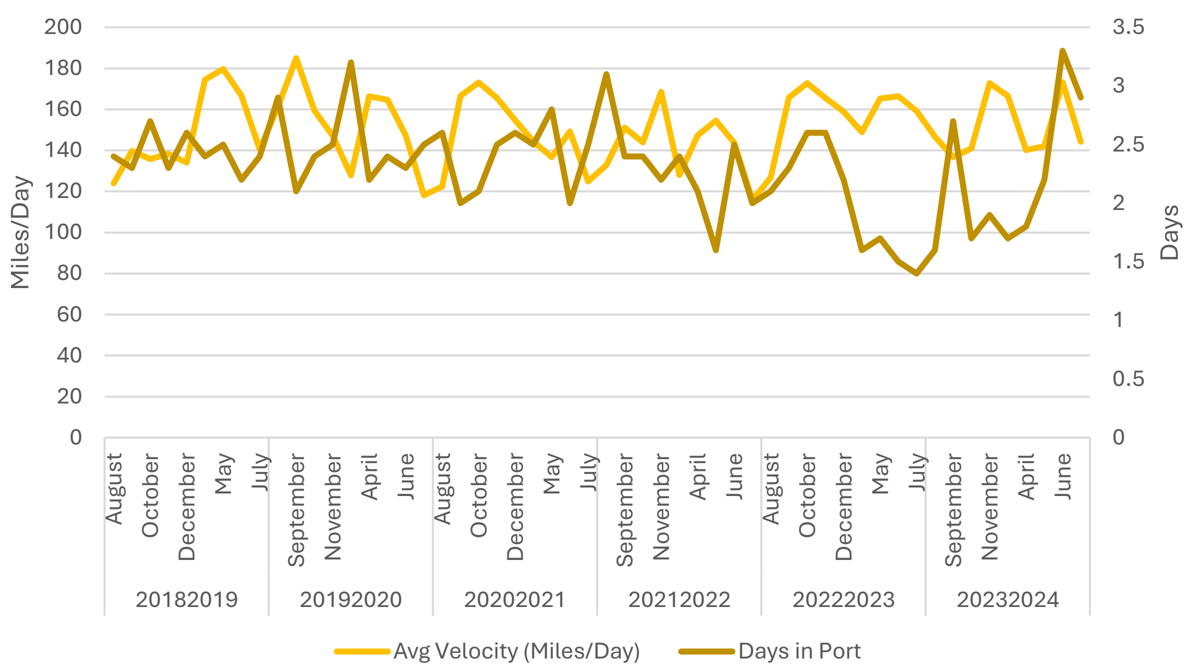
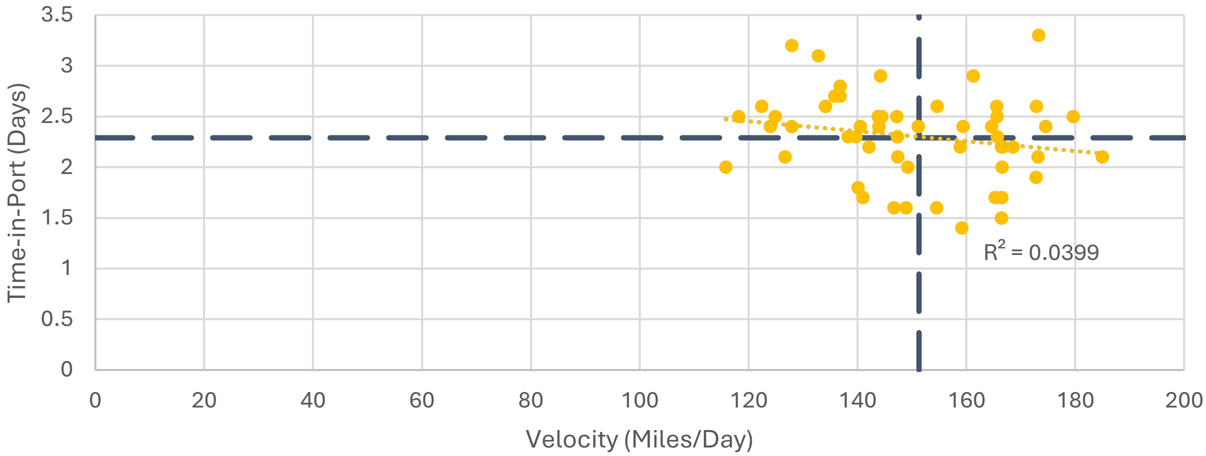


Figure 19 presents the lack of correlation between car velocity and the total time that vessels spend in port. Only 4% of the variance in average vessel time-in-port can be explained by changes in average car velocity, which is not sufficient to conclude a significant relationship between the two.

Additionally, the long-term average velocity at Thunder Bay is 151.3 miles per day and the time-in-port average is 2.3 days, shown by the dashed lines on the chart. Once velocity increases to 151 miles per day, only 54% of months turned vessels quicker than average, suggesting the lack of effect that an increase in velocity has on time-in-port.

Figure 19 Average Time Vessels Spend in Port Versus Car Velocity, August 2018-July 2024



*The R-Squared value of 0.04 indicates that 4% of the variance in time-in-port can be explained by car velocity.

Overall, Thunder Bay operations stay consistent; port performance sees little fluctuation throughout the year compared to the West Coast in the years analyzed. The data, therefore, does not reflect the inverse relationship between car velocity and total time-in-port seen on the West Coast, nor does it capture the direct relationship between out-of-car time and total time-in-port. Rather, it suggests that railway performance is less of a critical factor at Thunder Bay.

Conclusion

On the West Coast, among the two railway metrics, out-of-car time and car velocity, velocity serves as a more effective predictor of port performance. The correlation between car velocity and the average number of days vessels spend in port is significantly stronger than that of out-of-car time. At Vancouver, variations in car velocity account for 46% of the observed variance in time-in-port, while at Prince Rupert, 30%. Although out-of-car time also has a notable relationship with time-in-port, it explains much less variability. Additionally, car velocity helps standardize the data for differences in trip distance, enhancing reliability when comparing various origin and destination pairs.

In contrast, at Thunder Bay, the vessel data shows less variability compared to the West Coast, resulting in an inability to conclude the same relationships. Railway performance is less critical at Thunder Bay due to several factors: the port's lower throughput and higher storage capacity, fewer railway capacity constraints, and a consistent fleet of marine vessels making shorter trips through the seaway system.