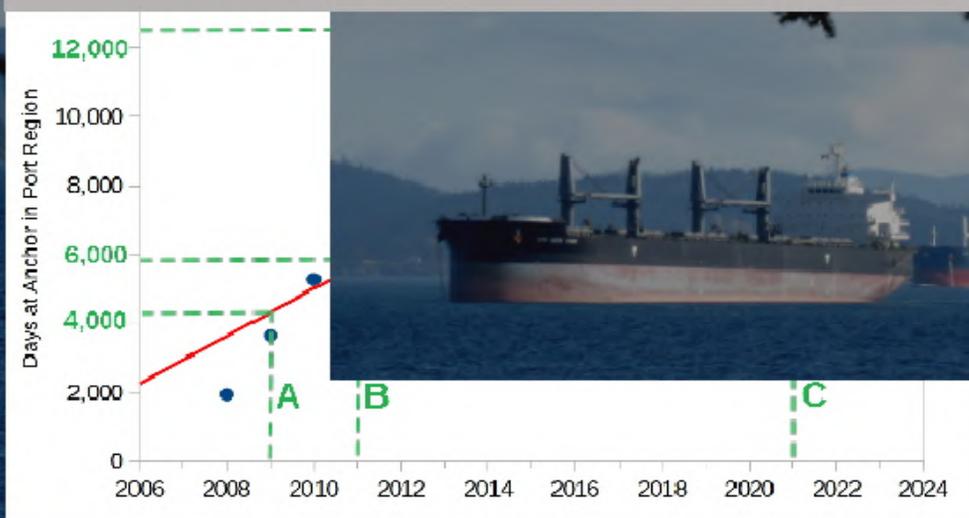


Ship Congestion at the Port of Vancouver and Southern Gulf Islands

Update March 2022



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**Update March 2022:
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at the Port of Vancouver
and Southern Gulf Islands**

***Green Solutions for Better Management of
Vessel Arrivals and Anchorage Demand***

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March, 2022*

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EXECUTIVE SUMMARY

This update is kept as short and concise as possible. It provides a focus on selected components and is not a complete revised version of the original report. Below are some results of this update.

(1) ***Anchorage use in the Southern Gulf Islands followed the exponential projections*** made in the original report (Figure 1). The Southern Gulf Islands have higher anchorage use than ever, and maximum capacity has been reached several times. This further confirms that these port practices are not sustainable.

(2) The Port of Vancouver (VFPA) is reporting an underestimate of 33% increase in the utilization of anchorages in the past decade. ***Our independent research reveals that anchorage use associated with the Port of Vancouver has at least doubled in ten years*** (Figure 2).

(3) ***Growth of anchorage demand is not proportional to growth in bulk exports but higher***, indicating that inefficiencies are getting worse (Figure 3). Even if anchorage use was proportional to export volume, this would still mean a bad report card for VFPA because of inaction that is allowing inefficiencies to remain the same.

(4) In the Southern Gulf Islands, the ***avoidable annual greenhouse gas emissions by stationary freighters exceeded 50,000 tonnes for the first time in 2020***. This is a very conservative estimate. Despite the public commitments by the Port of Vancouver to reduce greenhouse gas emissions and create a carbon-free port by 2050, this pollution problem has been ignored for over a decade and has now grown into extreme proportions.

(5) ***The increasing volume of coal ships using the Southern Gulf Islands is alarming*** (Figure 4), and this deserves further attention and more detailed study.

(6) ***Relatively short disruptions of supply lines are still causing massive congestion problems*** and long vessel lineups for unnecessarily extended periods of time. This was evident again in this time period when railway lines were cut in late November 2021 due to flooding and mudslides (Fig. 4).

The problem does not appear to be the actual disruption, but the continuous addition of ***new vessels that keep arriving as if nothing happened***. The ‘snowballing’ effect in ship waiting times comes from the cumulative number of ships in the lineup and not from the disruption itself.

The problem of large variance in vessel arrival remained the same during 2020-21 as had been observed in 2018-19 (Table 1, Figure 5). ***No substantial progress has been made towards increasing the efficiency in vessel arrivals, and towards avoiding port congestion and vessel lineups***.

There is still an apparent lack of feedback mechanisms to adjust the scheduling of deliveries for new contracts and contingency planning to avoid such overbooking of commodity supply channels.

Solutions to these problems had been described in the original report and are still valid. If these critical mechanisms are not addressed there is little hope for increased efficiency and better economic, environmental, and socio-cultural outcomes.

INTRODUCTION

The analysis, results, and conclusions of the original comprehensive report¹ are robust and not expected to change rapidly. Nevertheless, additional years of data provide an opportunity to test the robustness of results, further elaborate on new emerging angles, and revise conclusions where necessary.

The purpose of this update is not to replace the original report, but to add information on selected components and provide updated data for quick reference to the public and decision-makers.

This update is kept as short and concise as possible. It provides a focus on selected components and is not a complete revised version of the original report.

Our objective is to bring problems and solutions into sharper focus for raising public awareness and for assisting decision makers in industry, institutions, organizations, government, and First Nations with facts and constructive solutions with positive outcomes.

METHODS

Unless mentioned otherwise, the same methods were used as in the original report¹.

Data on anchorage use is based on the analysis of services to vessels reported by the Pacific Pilotage Authority^(PPA)². We assembled a database of approximately 175,000 individual records since 2008.

For overall anchorage use, vessels for all types of cargo were included but no passenger ships, navy vessels, or smaller vessels such as tugs. Where the name ‘bulk carrier’ is used, associated data refers to this vessel type only (excluding general cargo or heavy-lift).

Our estimates of anchorage durations are conservative due to the calculation method. Numbers for 2021 are underestimates because data from 2022 will be required to include anchorage durations that overlap calendar years.

The Port of Vancouver is also known as Vancouver Fraser Port Authority or VFPA, with a defined area of jurisdiction from Point Roberts at the Canada/U.S. border, the Fraser River, and Burrard Inlet to Indian Arm.³ Vessels destined for VFPA terminals also anchor outside VFPA jurisdiction. The use of our term ‘port region’ refers to all anchorage locations inside and outside VFPA jurisdiction (including Southern Gulf Islands and the Port of Nanaimo).

Additional data for Vancouver bulk exports was obtained from annual statistics reports by VFPA⁴ and include only cargo volumes that were reported as both “outbound” and “foreign”.

Weekly numbers of grain vessels anchoring in the Southern Gulf Islands were collected from reports published by Quorum Corporation⁵, while the overall numbers of vessels anchored in this area were obtained at the same time (Sunday noon) from the PatBayWebcam ship monitoring website.⁶

RESULTS AND DISCUSSION

ANCHORAGE USE IN THE SOUTHERN GULF ISLANDS (SGI)

Bulk carrier anchorage use of the Southern Gulf Islands outside the jurisdiction of the Port of Vancouver has exploded in less than a decade (Figure 1). The growth follows an exponential pattern and is not sustainable.

Port practices have not improved in the latest two years and anchorage use in the Southern Gulf Islands followed the projections made in the original report.

The Southern Gulf Islands have higher anchorage use than ever, and maximum capacity has been reached several times. This further confirms that these port practices are not sustainable.

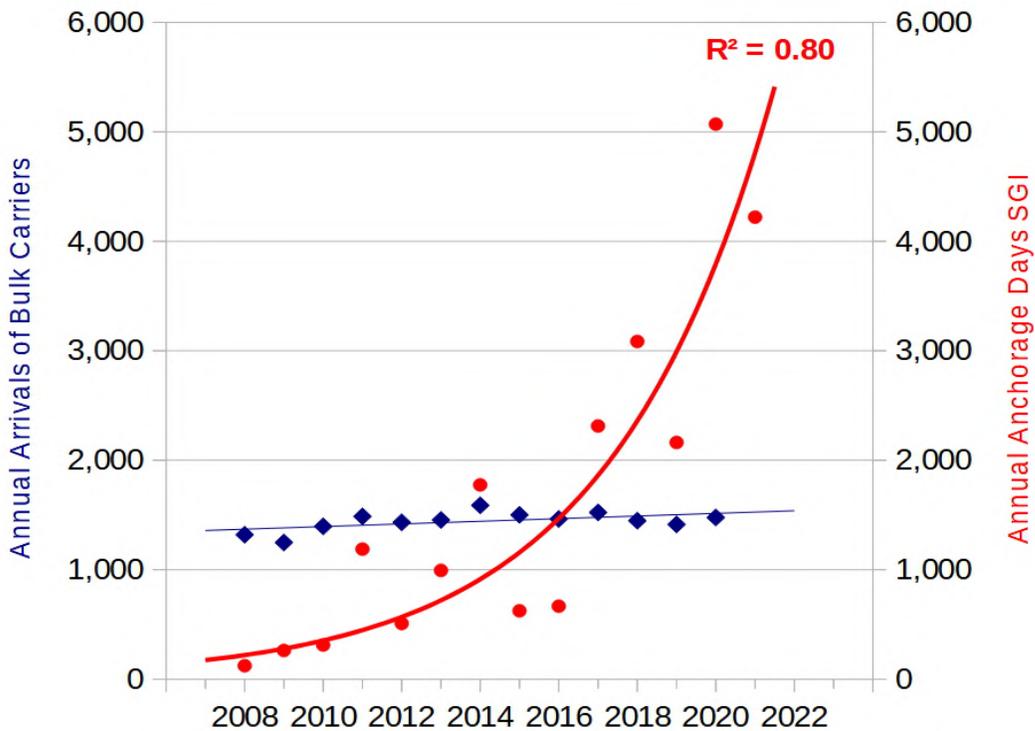


Fig. 1: Comparison of growth in annual arrivals of bulk carriers at the Port of Vancouver (blue) with the growth of the sum of annual days at anchor of freighters (all cargo types) at the Southern Gulf Islands (SGI, red). Vessel arrivals at port increased only moderately by about 10% from 2008 to 2021, but the increase in use of SGI anchorages was exponential (more than 10 fold). This indicates that the use of anchorages is not optimized and the growth in demand for anchorages is not sustainable.



Fig. 2: Growth in overall anchorage use for the Port of Vancouver, 2008-2021. Blue points are anchorage days per year by cargo ships of all types with destination Vancouver (entire port region). The red line shows a good linear fit of $R^2=0.84$. Since 2008-2009 anchorage use grew at least 3-fold (A), and since 2011 anchorage use grew about 2-fold (B) compared to 2021 (C).

GROWTH IN ANCHORAGE USE FOR THE PORT OF VANCOUVER

Overall anchorage use associated with the Port of Vancouver grew strongly in the past decade as shown in Figure 2. This includes daily operations by VFPA over the entire port region (as defined in Methods), not only the portion of anchorages close to VFPA terminals within VFPA jurisdiction.

The sum of anchorage days were plotted for each year and resulted in a good linear fit ($R^2=0.84$). This red line in Figure 2 illustrates how much anchorage use has grown, when a specific year is selected along with the corresponding value of total days at anchor of this year (green dashed lines).

Since 2008-2009 anchorage use grew at least 3-fold (A), and since 2011 anchorage use grew about 2-fold (B) compared to 2021 (C).

The Port of Vancouver (VFPA) is reporting an underestimate of 33% increase in the utilization of anchorages in the past decade^{7 8}. Our research that is not based on port statistics but using independent data from the Pacific Pilotage Authority reveals that anchorage use associated with the Port of Vancouver has at least doubled in ten years.

It is unclear why VFPA and Transport Canada continue to present numbers for growth in anchorage

numbers that are not representative and potentially misleading. Most likely they used data that were (a) incomplete over years, or (b) incomplete in the area covered⁹, or both.

Their data may be more accurate for port anchorages inside VFPA jurisdiction. Omitting all the marine traffic that was sent outside their jurisdiction to anchor in the Southern Gulf Islands, however, is a questionable approach. This may improve VFPA statistics and may make port practices look better than they are, but it does not change facts or the real dimensions of the problem.

GROWTH IN EXPORTS AND ANCHORAGE USE

It is often assumed that increased anchorage demand is simply an expression of growth in vessel traffic and exports at the Port of Vancouver.

This assumption, however, is not confirmed in Figure 3 when the number of overall anchorage use associated with the Port of Vancouver is compared to export numbers.

Growth of anchorage demand is not proportional to growth in bulk exports but higher, indicating inefficiencies are getting worse. Even if anchorage use was proportional to export volume, this still would mean a bad report card for VFPA because of inaction that is allowing inefficiencies to remain the same.

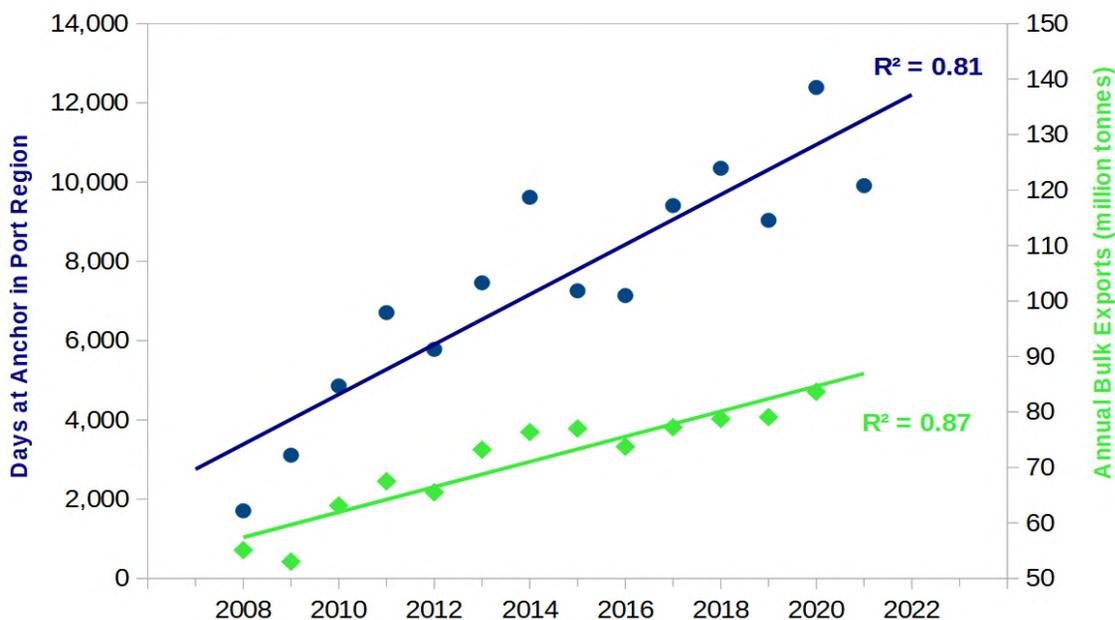


Fig. 3: Increase in anchorage use at the Port of Vancouver (entire port region) compared to annual export numbers. Growth of anchorage demand is not proportional to growth in bulk exports but higher, indicating inefficiencies are getting worse. Even if anchorage use was proportional to export volume, this would mean a bad report card for VFPA because of inaction that is allowing inefficiencies to remain the same.

Increasing efficiency in trade has many economic and environmental benefits. Other global ports have demonstrated that independent of export volume, anchorage demand can be reduced or even eliminated, thus substantially decarbonizing the footprint of marine shipping.^{9 10 11 12 13 14}

GREENHOUSE GASES PRODUCED BY ANCHORED FREIGHTERS IN SGI

Based on known data from bulk freighters at anchor¹⁵ and the annual days at anchor, it is possible to estimate annual greenhouse gas emissions produced by ships idling at anchor.

In the Southern Gulf Islands, the annual greenhouse gas emissions by stationary freighters *exceeded 50,000 tonnes for the first time in 2020*. This is a very conservative estimate. The actual number is much higher, for example because the 6-8 hour movements of these vessels between the Port of Vancouver and the islands are not included.

These emissions are avoidable. Despite the public commitments by the Port of Vancouver to reduce greenhouse gas emissions and create a carbon-free port by 2050¹⁶, this pollution problem has been ignored for over a decade and has now grown into extreme proportions.

VESSEL LINEUPS AND TRAFFIC CONGESTION PROBLEMS 2020-2021

The number of anchoring vessels remained high in the Southern Gulf Islands in the most recent two years. Except for a period of approximately 2 months in spring 2021, occupancy of SGI anchorages was almost continuously at least half full and reached capacity several times.

Several patterns are apparent in Figure 4.

First, coal ships and grain ships were similar in abundance during 2020 and early 2021, but coal ships started to dominate the island anchorages in the second half of this period. The export volume for grain was lower in 2021 due to a poorer harvest, but the gap between coal and grain bulkers is also due to an increase in absolute number of coal ships.

In Figure 4, grain ships are marked green, while most of the other ships (red) are waiting for loading coal, with some container ships added towards the end of the period. This increasing volume of ships using the Southern Gulf Islands independent of grain exports is alarming, and deserves further attention and more detailed study.

Second, as observed in our original report, a disruption of supply lines is still causing congestion and long vessel lineups for unnecessarily extended periods of time. This was evident again in this time period when railway lines were cut completely in late November 2021 due to flooding and mudslides.

While the effort of ground crews was heroic to restore railway service within less than 2 weeks⁵, and grain bulkers recovered sooner, but there was still the same pattern of prolonged traffic congestion and vessel lineups that filled up the Southern Gulf Islands for weeks into spring of 2022.

The problem does not appear to be the actual disruption, but the continuous addition of new vessels that keep arriving as if nothing happened. The ‘snowballing’ effect in ship waiting times comes from the cumulative number of ships in the lineup and not from the disruption itself. There is still an apparent lack of feedback mechanisms to adjust the scheduling of deliveries for new contracts and contingency planning to avoid such overbooking of commodity supply channels.

The same pattern has emerged from all previous disruptions through mud slides, labour disputes, blockades by protesters, fires, and other adverse conditions – but the lessons have still not been learned.

The mechanism involving this missing feedback link have been demonstrated in detail and with computer simulations in our original report¹⁷. If this mechanism is not addressed there is little hope for increased efficiency and positive change.

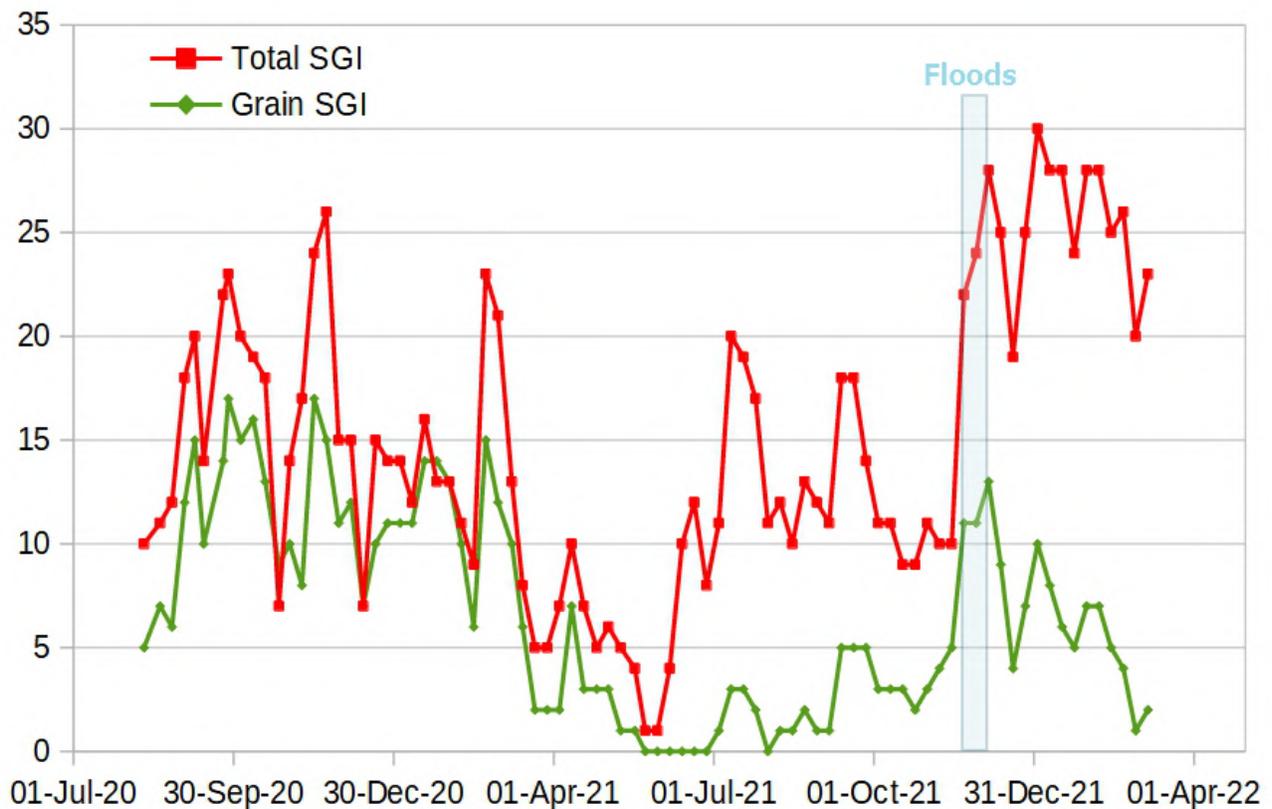


Fig. 4: Weekly numbers of anchored cargo ships in the Southern Gulf Islands (SGI). Total of all cargo ships in red, grain bulkers in green). Coal ships were the most common vessels and increasing in their use of SGI. Even relatively short disruptions of railway lines (floods) keep causing extended traffic congestion and vessel lineups, unless specific contingency plans are put in place to avoid overbooking of supply chains and too many vessels arriving.

Table 1: Descriptive statistics of the weekly number of vessels that arrived and were processed (loaded and cleared to depart) at Port Vancouver, during the grain years 2020-21 (Aug 2020 – March 2022, bulk carriers for grain only). * = Variances significantly different at $p=0.05$ ($F=0.69$, $df=82$).

	Processed	Arrived
Average	10.12	10.06
Variance*	13.42	19.30
N	83	83

MECHANICS OF PORT CONGESTION: THE IMPORTANCE OF VESSEL ARRIVAL

A more mechanistic approach to understanding ship congestion at port is to explore how vessel numbers build up over a smaller time scale.

Overall, arriving vessels must be in balance with vessels that have been loaded and are departing. At certain times, imbalances can occur. Arriving vessels will accumulate when processing at terminals is slower. A cumulative number of arrivals can be calculated and carried over to the next week after adjusting for ships that were loaded and are cleared to depart.

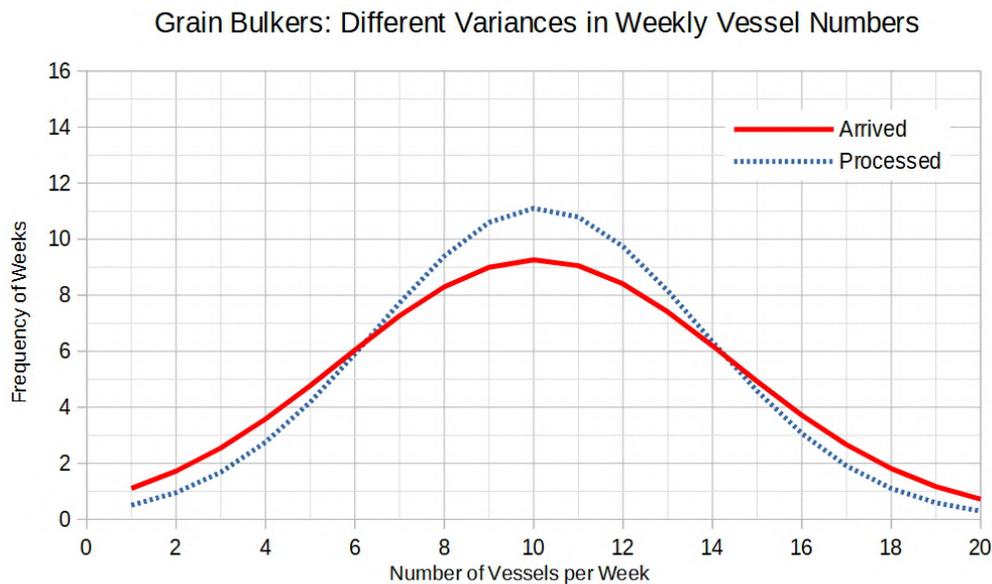


Fig. 5: Difference in variances of the distribution of weekly numbers of arrived and processed ships (grain bulk carriers during the grain years 2020-21, normal distributions using the descriptive statistics in Tab. 1). Arriving vessels have a wider variance in numbers and are not ideally tracking the weekly capacity of loading vessels at port.

Of particular interest is the question of how the numbers of ships being loaded at terminals compare with the numbers of vessels arriving per week. Descriptive statistics are summarized in Table 1. The means are very similar, with 10.12 vessels per week processed and 10.06 vessels arriving per week.

A larger difference is apparent in the variances of weekly vessel numbers (Table 1). The variance of 13.42 for the number of ships being loaded at terminals is relatively narrow. The variance of 19.30 in the number of arriving ships is over 144% larger than the variance in the number of ships being processed. The difference is statistically significant at $p=0.05$ ($F=0.69$, $df=82$).

Figure 5 visualizes the difference in variances of the distribution of weekly numbers of arrived and processed ships. Arriving vessels have a wider variance in numbers and are not ideally tracking the weekly capacity of loading vessels at port.

Variance in processing or loading ships is difficult to keep limited when delays in commodity supply chains occur. In comparison, it is much easier to control the variance of incoming ships. Integrated scheduling, logistics planning, and virtual arrival procedures can be used to minimize the variance of incoming vessels and synchronize them with current terminal capacities and vessel lineups.

Variances were larger than in 2018-19, but the pattern and relative difference remained the same. Variances of arriving ships were 144% larger in 2020-21 than the variance of ships being processed (150% in 2018-19).

This means that in the past 2 years no substantial progress has been made towards increasing the efficiency in vessel arrivals, and towards avoiding port congestion and vessel lineups.

The lessons and possible solutions described in detail in our original report¹⁸ and elsewhere^{9 10 14} are still valid but have not been taken into account.

- 1 Rohner, Christoph, and Ted Fullerton. 2020. Ship Congestion at the Port of Vancouver and Southern Gulf Islands: Green Solutions for Better Management of Vessel Arrivals and Anchorage Demand. Centre for Marine Affairs, Southern Gulf Islands. www.marineaffairs.ca/reports/anchorage-ship-congestion-rohner-fullerton-2020.pdf
- 2 Pacific Pilotage Authority. <https://ppa.gc.ca/>
- 3 Port of Vancouver. Port Information Guide, March 2022. <https://www.portvancouver.com/marineoperations/port-information-guide/>
- 4 Port of Vancouver (VFPA): Reporting, statistics and resources. <https://www.portvancouver.com/about-us/statistics/>
- 5 Quorum Corporation. <http://grainmonitor.ca/>
- 6 Pat Bay Webcam and Weather: A tracking project supporting the South Coast Ship Watch Alliance. <https://patbaywebcam.com/anchorage.php>
- 7 Petition e-2837 (Transportation), Response by the Minister of Transport, House of Commons. <https://petitions.ourcommons.ca/en/Petition/Details?Petition=e-2837>
- 8 Port of Vancouver (VFPA): Active Vessel Traffic Management. Project Summary & Information Package. January 18, 2022.
- 9 Heaver, Trevor (2021): Reducing Anchorage in Ports: Changing Technologies, Opportunities and Challenges. <https://www.frontiersin.org/articles/10.3389/ffutr.2021.709762/full>
- 10 Andersson, P. and P. Ivehammar. Green approaches at sea – The benefits of adjusting speed instead of anchoring. Transportation Research Part D, 51 (2017) 240-249. doi.org/10.1016/j.trd.2017.01.010
- 11 Best Port Practises: Port Authority of New South Wales shares insights into vessel arrival systems. Pacific Ports Magazine, August 2020: 48-49. <https://www.pacificports.org/pacific-ports-magazine-august-2020/>
- 12 Reduce port turnaround time, PortXchange Case Studies. <https://port-xchange.com/case-studies/reduce-port-turn-around-time/>
- 13 PortXchange and Greater Houston Port Bureau embark on five-year digitalization partnership. News, 16-09-2021. <https://port-xchange.com/portxchange-and-greater-houston-port-bureau-embark-on-five-year-digitalization-partnership/>
- 14 All those cargo ships sitting in the San Francisco Bay are going away, maybe forever. SF Gate, 12-Jan-2022. <https://www.sfgate.com/local/article/cargo-ships-San-Francisco-bay-Oakland-supply-chain-16770819.php>
- 15 Rohner, Christoph. 2020. Daily Fuel Consumption and Greenhouse Gas Emissions by Bulk Carriers Anchoring in the Southern Gulf Islands. <https://marineaffairs.ca/reports/daily-fuel-consumption-emissions-bulk-carriers.pdf>
- 16 Port of Vancouver (VFPA): Building a zero-emission port by 2050. <https://www.portvancouver.com/about-us/stories/building-a-zero-emission-port-by-2050/>
- 17 Rohner, Christoph, and Ted Fullerton. 2020, page 30ff, of: Ship Congestion at the Port of Vancouver and Southern Gulf Islands: Green Solutions for Better Management of Vessel Arrivals and Anchorage Demand. Centre for Marine Affairs, Southern Gulf Islands. www.marineaffairs.ca/reports/anchorage-ship-congestion-rohner-fullerton-2020.pdf
- 18 Rohner, Christoph, and Ted Fullerton. 2020, page 33ff, of: Ship Congestion at the Port of Vancouver and Southern Gulf Islands: Green Solutions for Better Management of Vessel Arrivals and Anchorage Demand. Centre for Marine Affairs, Southern Gulf Islands. www.marineaffairs.ca/reports/anchorage-ship-congestion-rohner-fullerton-2020.pdf