



Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Pacific Northwest Research Station | Research Paper PNW-RP-619 | November 2024

The Trade Flow of Primary Wood Products in the Pacific Coast Region

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Cover photo: Lumber mill machinery and Longview Bridge (currently known as Lewis and Clark Bridge) in Rainier, Oregon. Photo credit: David Gn/Adobe Stock.

Abstract

Evans, Samuel G.; Potts, Matthew D. 2024. The trade flow of primary wood products in the Pacific coast region. Res. Pap. PNW-RP-619. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 33 p. <https://doi.org/10.2737/pnw-rp-619>.

The forests and associated wood products of the Pacific coast region (PCR)—British Columbia, Washington, Oregon, and California—play an important role in mitigating climate change by storing carbon long term in durable wood products and providing a significant share of non-fossil fuel-based building materials and other renewable products. Understanding the supply chains and flows of these wood products into and out of the PCR is essential for supporting this goal. The objective of this research paper is to quantify the trade flows in the four PCR jurisdictions. This analysis focuses on the flow of primary wood products, such as lumber, veneer, structural panels (plywood and oriented strand board), nonstructural panels (fiberboard and particle board), pulp and pulp products (e.g., paper, paperboard, tissue), and woodchips and pellets. We identified publicly available datasets that can be used to describe each of the primary wood product flows, including flows between PCR jurisdictions, flows between PCR jurisdictions and non-PCR U.S. states, and international trade flows. We reported detailed results across all these dimensions. Results highlight the significant intra-PCR trade flows for many wood product categories, highlighting the interconnectedness of the region's wood products economy. Results also support research on tracking the embodied carbon in wood products entering and leaving the PCR. Finally, this research highlights important information gaps on wood product trade flows and suggests areas of future improvement.

KEYWORDS:

Economics

Pacific coast region

Primary wood products

Trade

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Introduction

Forests and associated wood products play important roles in mitigating climate change by storing carbon long term in durable wood products and providing a significant share of non-fossil fuel-based building materials and other renewable products (Cabiyo et al. 2021, Sathre and O'Connor 2010). Wood product markets are often interconnected both within and across national and subnational jurisdictions. To understand how forest management in working forests can contribute to the goal of greenhouse gas mitigation, it is important to understand how regional wood product markets are linked through regional supply chains and product markets.

The objective of our research was to identify several publicly available datasets that can be used to describe primary wood product flows into and out of the Pacific coast region (PCR), which is composed of four jurisdictions: British Columbia, California, Oregon, and Washington. In addition to providing a comprehensive overview of primary wood product flows, this exercise was also meant to highlight existing data gaps and suggest areas for future improvement.

Our research fills an important gap in the literature by increasing understanding of wood product trade in the PCR. Documenting these regional trade flows can have important economic and environmental policy applications, including understanding the economic contributions of wood products in the various PCR jurisdictions and the market-mediated flow of embodied carbon stored in wood products. Tracking domestic and international trade flows is also a required foundation for assessing the impacts of changing macroeconomic and policy conditions on forest product markets. This includes changes in market demand fueled by shifting consumption patterns in traditional markets, such as pulp and paper (Latta et al. 2016), and new markets, such as wood for bioenergy (Favero et al. 2023).

National trade authorities maintain detailed records, which allow for accurate tracking of international wood product trade flows. Models based on these underlying international trade data have been used to study several important trade economics and policy questions, such as the determinants of wood product import and export volumes (Buongiorno et al. 1980, Larson et al. 2018, Zhang and Li 2009), consequences of bilateral and multilateral trade agreements (Buongiorno 2016, Parajuli and Zhang 2016), and trade effects of forest product certification (Chen et al. 2020). There is a more limited body of research on intraregional trade flows within the United States, focusing primarily on sawlog and pulpwood markets in the Southeastern (Lamica and Parajuli 2022, Polyakov and Teeter 2007) and Western United States (Dillon and Morgan 2023, Rossi et al. 2021). These studies generally rely on timber product data tracked as part of the U.S. Department of Agriculture, Forest Service's Forest Inventory and Analysis program. To our knowledge, there are no studies of intraregional trade flows of primary wood products in the United States. We illustrate the methodology that we developed for estimating intraregional trade flows by applying it to the PCR, but it could be applied more broadly to characterize state-to-state trade flows throughout the United States. The underlying trade flow data presented in this study could also form the foundation for calibrating economic models of intraregional trade in North America, allowing future research to analyze several interesting economic topics.

This research paper is organized as follows: first, we describe the datasets that we used in the analysis and the conversion assumptions that we used to uniformly track wood product flows across disparate reporting conventions. Then we present results for several major

primary wood product categories that represent the primary volume of physical flows into and out of the PCR. Finally, we conclude with key insights on trade patterns and areas where continued research is necessary.

Data and Methods

Wood Product Definitions

This analysis focuses on the flow of primary wood products, such as lumber, veneer, structural panels (plywood and oriented strand board), nonstructural panels (fiberboard and particle board), and pulp and pulp products (e.g., paper, paperboard, tissue). Figure 1 shows a stylized diagram of the wood product production process, beginning with timber products such as sawlogs, veneer logs, and pulplogs, and ending with various mill outputs. In this analysis, we did not include final consumer wood products, such as final printed products (books, magazines, newspapers), furniture, or manufactured homes. These form a particularly challenging group of products to classify because they are often composed of substantial nonwood materials and are classified in categories that also include nonwood product variants. Estimating the wood content in these final consumer products is an important area of future research. We also did not cover timber product flows in this research paper, but these have been analyzed elsewhere (Dillon and Morgan 2023).

Data Sources

We combined three data sources to provide a picture of commodity flows into and out of the four PCR jurisdictions. For international trade flows, we relied on detailed data collected by national trade authorities. For domestic trade flow data in the United States, we combined a U.S. Census Bureau industry survey with industry production estimates. While the international trade flow data is available as a complete and current timeseries, the most recent information on domestic trade flows is only available for 2017. Our approach therefore provides a detailed cross-sectional analysis of 2017 trade flows.

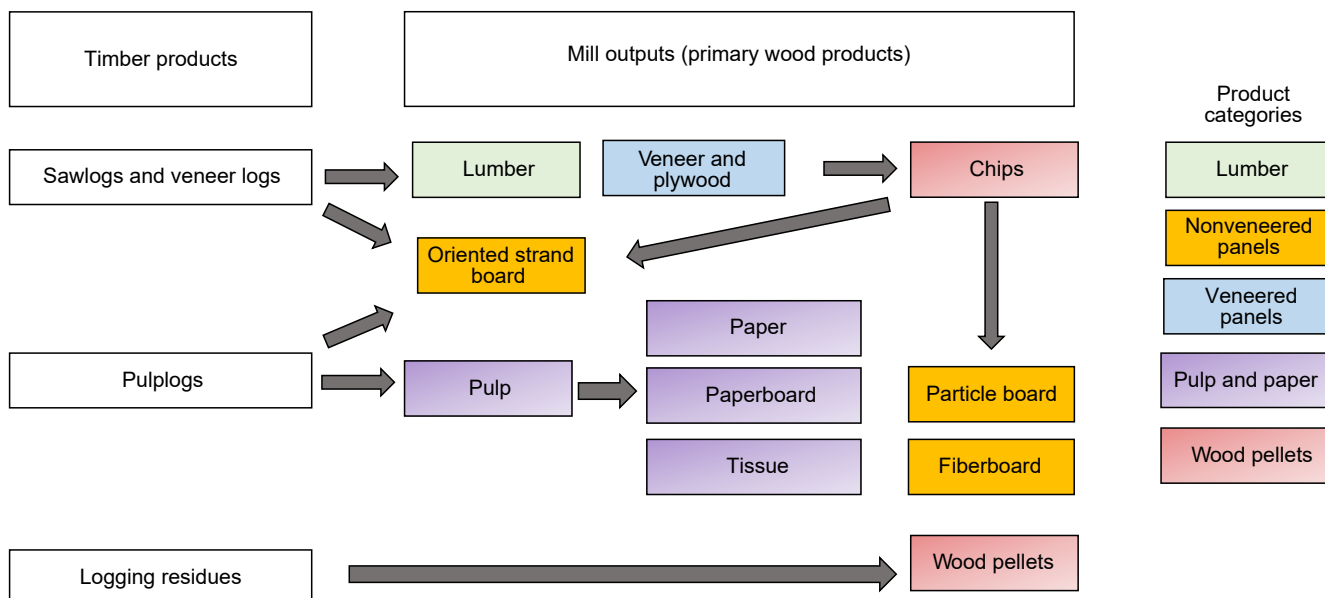


Figure 1—Stylized visual of timber products and wood products.

We used international trade flow data for the three U.S. PCR states from the U.S. International Trade Commission (USITC) DataWeb (USITC 2020a, 2020b), which collects comprehensive data on all products entering and exiting the United States. For the three U.S. PCR states, data were collected for products entering and exiting ports in the San Francisco, Los Angeles, and San Diego customs districts in California; the Columbia-Snake customs district in Oregon; and the Seattle customs district in Washington. Product classifications in the USITC database follow the harmonized tariff schedule (HTS) codes (USITC 2020c). For this analysis, 4-digit HTS classifications were sufficient for reporting aggregate flow data consistent with the other data sources that we used. More detailed product classification, up to 10-digit HTS codes, are available through the USITC DataWeb. In cases where reported units differed by product category within a 4-digit HTS classification, we first converted the products to a common metric and then aggregated them.

We used Canadian International Merchandise Trade (CIMT) database wood product import and export data (StatCan 2020) for British Columbia. CIMT classifies products at the 6-digit HTS level, which we aggregated to the 4-digit HTS level after making necessary unit conversions. For product flows between Canadian provinces and the United States, CIMT notes the U.S. state of origination or final destination. We did not identify any data source that tracked trade flows between Canadian provinces, which is a data gap that should be addressed in future research.

The USITC and CIMT databases provided two different estimates of wood product flows between the United States and Canada. However, there were considerable differences in estimates between the two sources. For example, the amounts of wood products imported to California from British Columbia according to the USITC database were substantially lower than the amounts of wood products exported from British Columbia to California using the CIMT database. We believe this is because Canadian imports, as recorded using USITC, are based on the point of entry, rather than the final destination. Because much of the wood products enter the United States through a customs district in Washington State, these will be recorded as Washington imports even if the goods are bound for another state. CIMT exports, however, are reported based on the U.S. state of final destination. For this reason, we reported United States-Canadian trade flows using the CIMT data.

We estimated domestic state-to-state trade flows for the three U.S. PCR states using the U.S. Commodity Flow Survey (CFS) (U.S. Census Bureau 2017) and, when available, state-level production information. The U.S. Census Bureau conducts the CFS every five years as part of the Economic Census and provides a comprehensive picture of freight flows within the United States. The CFS covers industries in the mining, manufacturing, wholesale, and certain retail and service sectors. The survey captures trade flows in both wood product manufacturing industries (NAICS code 321) and lumber and other construction materials merchant wholesalers (NAICS codes 423310 and 423390) (NAICS 2023). Results are reported using Standard Classification of Transported Goods (SCTG) commodity codes (US DOT and US DOC 2016), rather than the NAICS code of the surveyed firms. The dataset does not capture most retail trade flows crossing state lines. Although this is unlikely to be a consequential omission for certain wood products, such as lumber and structural panels, it could result in a substantial undercount of other material products, such as paperboard and packaging, particle or fiberboard in furniture, and other products purchased directly through retail channels. The CFS reports several variables, such as shipment value by transportation mode, but we used shipment weight as the variable of interest. All shipment weights in the

CFS are reported in U.S. short tons. While the U.S. Census Bureau conducts the CFS every 5 years, we only used 2017 data for this analysis. We made a special data request to census staff with the Commodity Flow Survey program for more detailed wood product commodity disaggregation. Future research should use additional CFS data to better understand time trends in the flow of traded wood product commodities.

One important limitation of the CFS is that total state import and export volumes differ significantly from industry production sources. For example, total exports from a state for a given wood product, based on the CFS, may exceed industry estimates for total state production of that product. For this reason, in cases where state-level production information was available, we created state-to-state trade shares using the CFS shipment information to allocate these flows. Comprehensive state-level production data was available for plywood (APA—The Engineered Wood Association 2020) and composite boards (CPA 2020). Lumber production information was available for U.S. PCR states through the Western Wood Products Association (WWPA 2020) but not for other states outside of the West. We used the lumber production estimates from WWPA to allocate state-to-state flows from lumber originating in California, Oregon, and Washington.¹ For flows where direct conversion of the CFS shipment weights was necessary, the individual wood product sections below discuss the unit conversion assumptions that we made to transform the data into standard wood product unit measures. This would apply to lumber imports from non-PCR U.S. states, pulp and paper products, and woodchips and pellets. For these specific flows, the volumes should be interpreted with caution, and future research should validate these estimates with industry production data if it becomes available. We obtained production volumes for products produced in British Columbia from annual Major Timber Processing Facility surveys (BC Ministry of Forests 2019).

The wood product categories that we used for this analysis and concordance with the SCTG codes and HTS codes are shown in table 1.

Conversion Assumptions

Primary wood products are usually reported in different units depending on the product type and reporting standards. Reported units differed across the datasets that we used in our analysis, and thus, we had to use conversion assumptions to standardize results. We reported results in board feet, lumber tally, for lumber; square feet, $\frac{3}{4}$ -inch basis, for plywood and veneer and nonveneered panels and boards; and metric tonnes (shipping weight) for pulp, paper, woodchips and pellets. This section details the unit conversion assumptions that we used in this analysis. A summary of the conversion assumptions is shown in table 2. Density to volume conversion assumptions are required for conversion of the CFS data, which for all trade flows were in U.S. short tons. Reported units for international trade flows for both the United States and Canada differed by product. For example, sawnwood lumber and panel products were reported in cubic or square meters, while pulp and paper products were generally reported in weights.²

¹ See appendix 2 for a comparison between Commodity Flow Survey data (U.S. Census Bureau 2017) and industry trade flow estimates for lumber using Western Wood Products Association data (WWPA 2020).

² Although not specified in the Commodity Flow Survey documentation, we assumed that pulp and paper weights were shipping weights, not air-dry weights.

Table 1—Wood product classifications

Wood product category	Standard classification of transported goods code	Harmonized tariff schedule code
Lumber	26211—Lumber, treated 26212—Lumber, untreated	4407—Wood sawn or chipped lengthwise
Plywood and veneer	26310—Veneer sheets and sheets for plywood 26330—Plywood, veneered panels, and similar laminated wood	4408—Sheets for veneering 4412—Plywood, veneered panels, and similarly laminated wood
Nonveneered panels and boards	26320—Particle board, fiberboard, and similar board of wood or other ligneous materials	4410—Particleboard, oriented strand board, and similar board 4411—Fiberboard
Pulp and paper	27110—Mechanical wood pulp 27120—Non-dissolving grades of soda or sulfate chemical wood pulp 27191—Dissolving grades of chemical wood pulp 27199—Other pulp of fibrous cellulosic materials, not elsewhere classified (includes recycled pulp) 27200—Newsprint in large rolls or sheets 27311—Uncoated paper for writing, printing, or other graphic purposes, in large rolls or sheets 27312—Toilet or facial tissue stock, towel or napkin stock, and similar paper stock used for household or sanitary purposes, in large rolls or sheets 27319—Other uncoated paper in large rolls or sheets 27320—Uncoated paperboard in large rolls or sheets 27410—Paper, coated, impregnated, treated, or worked, in large rolls or sheets 27420—Paperboard, coated, impregnated, treated, or worked, in large rolls or sheets	All chapter 47 products—Pulp of wood or of other fibrous cellulosic material; recovered paper or paperboard All chapter 48 products—Paper and paperboard; articles of paper pulp, of paper or of paperboard
Woodchips and pellets	26100—Woodchips or particles	4401—Fuel wood; wood in chips or particles; sawdust and wood waste and scrap

Table 2—Unit conversion assumptions

Primary wood product	Density conversion	Volume conversion
Softwood lumber	0.974 short tons per thousand board feet, lumber tally	588.5 board feet per cubic meter
Hardwood lumber	—	423.7 board feet per cubic meter
Plywood and veneer, OSB, and composite board	—	1130.08 square feet per cubic meter

Note: Density conversions for panel and board products were not needed because U.S. Census Bureau's Commodity Flow Survey data were only used to calculate trade flow shares. Trade flow volumes were based on Western Wood Products Association data (WWPA 2020), which were available in the units reported in the report.

OSB = oriented strand board.

— = not applicable.

Lumber

We used board feet, lumber tally, as the unit of measurement in this analysis for lumber products. We used two conversion assumptions to convert results into this common unit. For the CFS data, which is reported using a weight metric (U.S. short tons), we assumed 0.974 short tons per thousand board feet (Briggs 1994). This is a weighted average of softwood lumber of the United States. We are unable to distinguish softwood versus hardwood products in the CFS dataset, and for simplicity we assumed all flows were of softwood lumber products. While softwood species dominate the lumber market, this assumption will introduce some error and should be investigated further in future research. This unit conversion assumption is only necessary for products exported to U.S. PCR states from states not surveyed by the WWPA. For WWPA states, state production values for softwood and hardwood lumber are used in conjunction with CFS trade shares to estimate flows in metric tonnes.

To convert the international trade flow data from the reported units of cubic meters into board feet, lumber tally, we used separate assumptions for hardwood and softwood products because we could distinguish them in the dataset. For softwood lumber, we assumed 588.5 board feet per cubic meter. This was derived from Briggs's assumption of 60 cubic feet of lumber per thousand board feet, which is a U.S. composite average for softwood lumber. For hardwood species, we followed Briggs's assumption of 83.33 cubic feet of lumber per thousand board feet, which converts to 423.7 board feet per cubic meter. While we are able to apply separate hardwood and softwood conversion factors to international trade flow data, it is important to note that nearly all PCR lumber exports (97.7 percent) and imports (97.5 percent) are softwoods.

Pulp and Paper Products, and Woodchips and Pellets

Weights are the standard reporting unit for tracking shipments of pulp and paper, and woodchips and pellets. These were generally the reported units for these products in the datasets that we used in the analysis, so only some standard metric conversions were necessary. We assumed that all weights were in shipping weight units, which was reasonable because these products were likely at their final shipping stage. For conversion to carbon estimates, assumptions regarding water content of the products should be applied to convert from shipping weight to dry weight. Finally, for several paper products, units were either not specified or specified in a raw product number. We removed these product categories from the analysis. They appeared to account for small volumes of products.

Results

Wood product trade flow results are presented below by wood product category. For each product category, information is shown for aggregate trade flows, intra-PCR trade flows, interstate (between PCR jurisdictions and non-PCR U.S. states) trade flows, and international trade flows.

Lumber Trade Flows

In 2019, the lumber production volume in the PCR was about 21.8 billion board feet, lumber tally. British Columbia produced the most lumber in the PCR, accounting for 46.8 percent of the total regional lumber production (fig. 2). Oregon, Washington, and California produced 24.7, 18.9, and 9.6 percent of the total regional lumber output in 2019, respectively. While lumber production volumes have either remained stable or increased slightly in the Western

U.S. states since the Great Recession (2007 to 2009), they have dropped considerably in British Columbia since 2016.

Table 3 shows the lumber trade flows into and out of PCR jurisdictions for 2017, the latest year with complete trade flow data. In 2017, about 21 billion board feet, lumber tally, was exported from PCR jurisdictions. A substantial percentage (23 percent) of these exports were to other PCR jurisdictions. Lumber exports to non-PCR U.S. states accounted for about 47 percent of the total PCR lumber export volume. British Columbia was the main exporter to these non-PCR U.S. markets, accounting for nearly 79 percent of the PCR lumber export volume to non-PCR U.S. states. PCR exports to international partners (excluding U.S.-Canadian PCR trade) accounted for the remaining 30 percent of the PCR lumber export volume. Most of these other international exports (88 percent) originated in British Columbia.

In 2017, the total lumber import volume into the PCR was about 5.7 billion board feet, lumber tally. About 48 percent of these imports were into the California market, and 85 percent of the imported lumber into PCR jurisdictions originated in other PCR jurisdictions. Again, California was the primary destination for this intra-PCR trade. Oregon's lumber

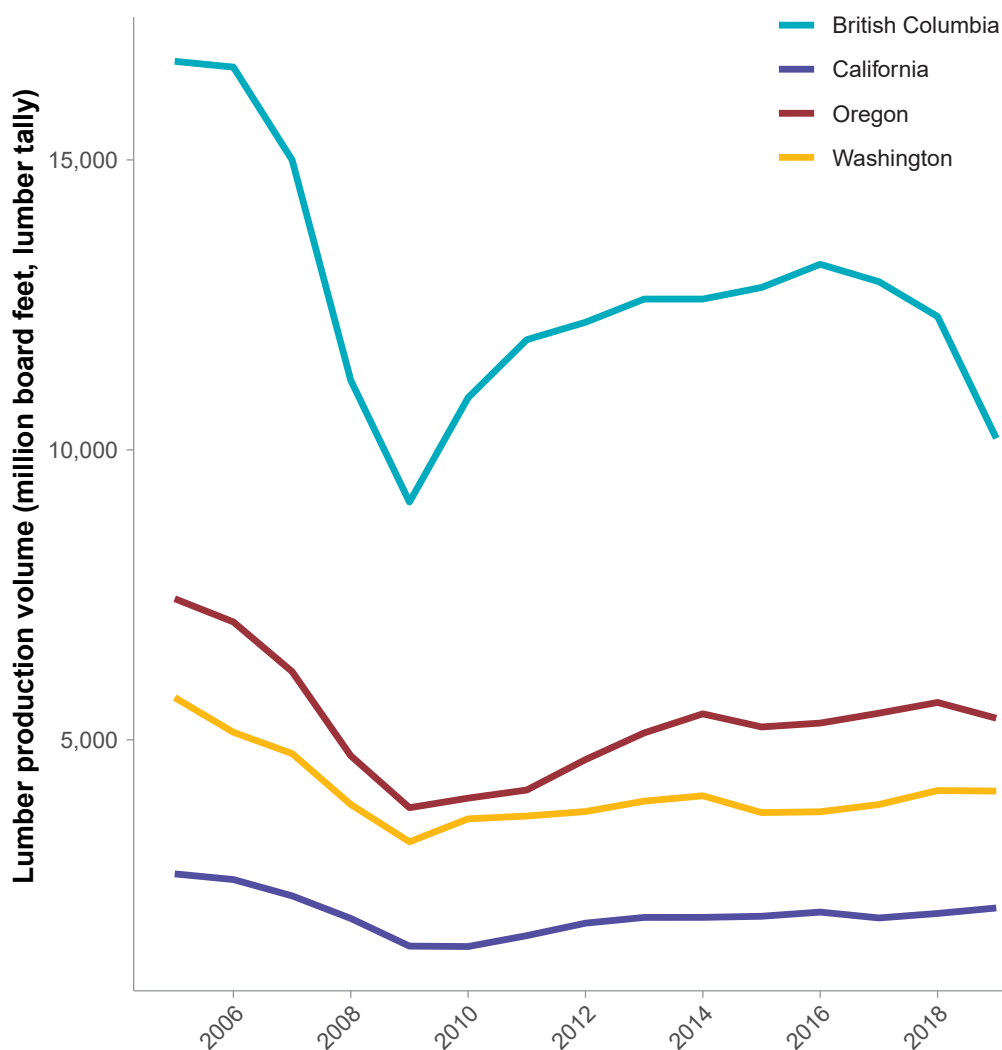


Figure 2—Total lumber production by Pacific coast region jurisdiction, 2005 through 2019. Source: WWPA (2020).

export volume to California was the highest, except for British Columbia's export volume to non-PCR U.S. states and other international partners. Lumber imports from non-PCR U.S. states accounted for 11 percent of the total PCR lumber import volume, and the remaining 3 percent of imports originated from international partners. Interestingly, Oregon and Washington were the primary recipients of lumber imports from non-PCR U.S. states.

Table 4 shows the lumber trade flows between PCR jurisdictions and other U.S. regions (see appendix 1 for regional definitions) for 2017. In 2017, 646 million board feet, lumber tally, were imported into PCR jurisdictions (mostly Washington and Oregon) from non-PCR U.S. states. Relatively low volumes of lumber products were imported into the PCR from non-PCR U.S. states outside of the West.

In 2017, PCR jurisdictions exported about 9.9 billion board feet, lumber tally, to other U.S. regions. British Columbia accounted for 79 percent of these lumber exports. Oregon, Washington, and California accounted for 11, 8, and 1 percent of these lumber exports, respectively. Regional trade patterns differed between lumber exports from U.S. PCR

Table 3—Lumber trade flows between Pacific coast region jurisdictions and other sources and destinations, 2017

Export region	Import region						Total exports
	California	Oregon	Washington	British Columbia	Non-PCR U.S. states	Other international	
	MILLION BOARD FEET, LUMBER TALLY						
California	—	24	10	13	104	400	551
Oregon	1,876	—	223	46	1,114	2	3,261
Washington	380	412	—	205	830	362	2,189
British Columbia	270	221	1,155	—	7,831	5,402	14,879
Non-PCR U.S. states	87	274	259	26	—	—	—
Other international	103	1	88	5	—	—	—
Total imports	2,716	932	1,735	294	—	—	—
Net exports	−2,165	2,329	454	14,585	—	—	—

Note: Sums of columns and rows may not add up to totals because of rounding.

— = no data.

Table 4—Lumber trade flows between Pacific coast region (PCR) jurisdictions and other U.S. regions, 2017

PCR jurisdiction	Imports from				Total imports	Exports to				Total exports
	Midwest	West	North	South		Midwest	West	North	South	
	MILLION BOARD FEET, LUMBER TALLY									
California	62	8	5	12	87	14	73	9	7	104
Oregon	2	163	67	42	274	108	735	8	263	1,114
Washington	5	220	0	34	259	215	335	126	154	830
British Columbia	7	13	4	2	26	2,224	1,360	1,008	3,239	7,831
PCR total	76	404	76	90	646	2,561	2,503	1,151	3,663	9,878

Note: Sums of columns and rows may not add up to totals because of rounding.

states and British Columbia to non-PCR U.S. states. For example, most (56 percent) lumber exports from U.S. PCR states to non-PCR U.S. states went to other Western states, while British Columbia's non-PCR U.S. trading partners were primarily Southern states, accounting for 41 percent of exports from British Columbia to non-PCR U.S. states. While not the primary destination for lumber exports from U.S. PCR states, the Midwestern and Southern U.S. states were important markets, accounting for a combined 37 percent of California, Washington, and Oregon exports to non-PCR U.S. states.

Table 5 shows the lumber trade flows between British Columbia and the U.S. PCR states over time. U.S. PCR states were an important market for British Columbia lumber products. In 2018, British Columbia exported about 1.5 billion board feet, lumber tally, to the U.S. PCR states. This was down considerably from export volumes prior to the Great Recession, which exceeded 2 billion board feet, lumber tally, in 2000 and 2006. In 2018, Washington was the primary U.S. PCR market for British Columbia lumber exports. British Columbia lumber imports from the three U.S. PCR states have been relatively small from 2000 through 2018, averaging just several hundred million board feet, lumber tally, per year. Again, Washington was the predominant U.S. PCR partner for British Columbia's lumber imports.

The British Columbia export market dominated the international trade flows of lumber in the PCR. As shown in figure 3, British Columbia export volumes, ranging from about 9 to 17 billion board feet, lumber tally, per year, accounted for nearly all internationally traded lumber volumes from 2001 through 2019. As shown in figure 4, the United States (excluding PCR states) was the primary market for these British Columbia lumber exports. However, since the Great Recession, China has become an increasingly important trading partner. Japan was the next primary lumber export partner, followed by small export volumes to many other countries, including New Zealand. Lumber import volumes typically only ranged in the tens of millions of board feet, lumber tally, per year.

Table 5—Lumber trade flows between British Columbia and U.S. Pacific coast region states, selected years

Trade flow	2000	2006	2012	2018
MILLION BOARD FEET, LUMBER TALLY				
British Columbia to California	441	534	143	243
British Columbia to Oregon	629	671	209	162
British Columbia to Washington	1,099	1,385	555	1,064
Total exports	2,169	2,590	907	1,469
California to British Columbia	7	4	9	11
Oregon to British Columbia	34	44	130	49
Washington to British Columbia	73	74	44	197
Total imports	114	121	581	256

Note: Sums of columns and rows may not add up to totals because of rounding.

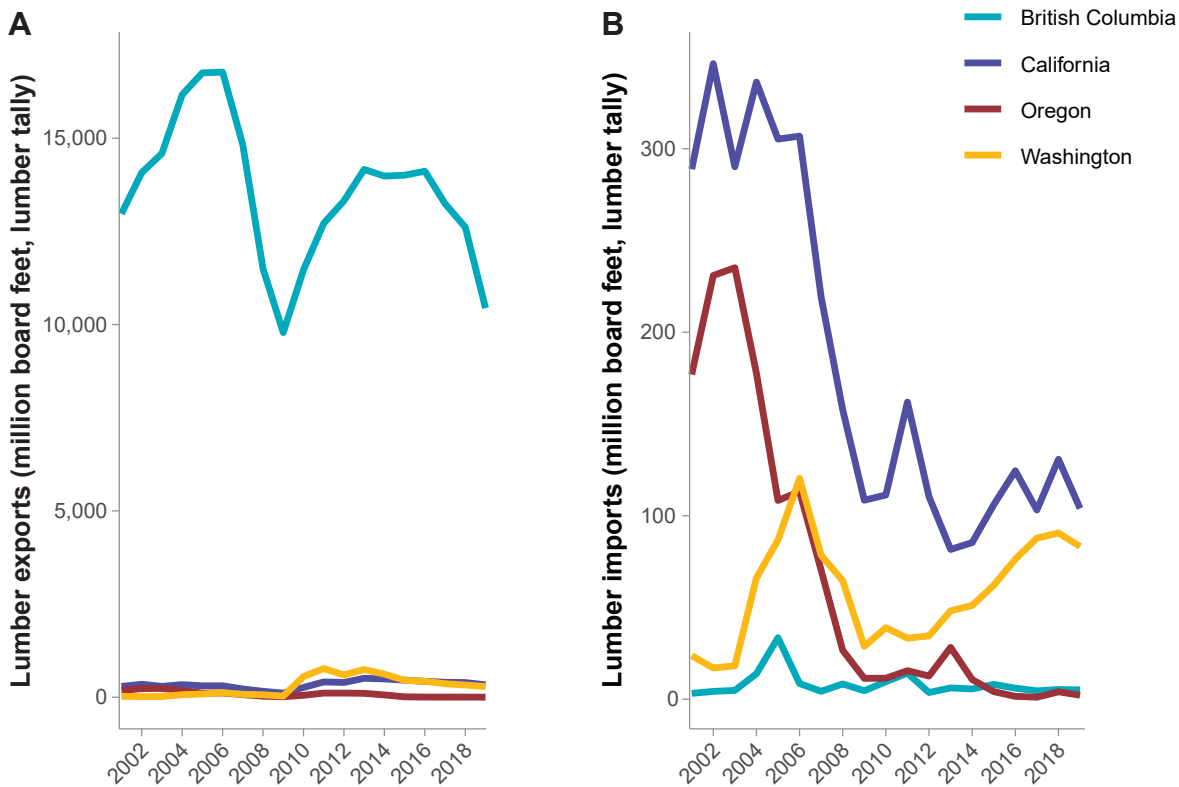


Figure 3—International lumber (A) exports and (B) imports by Pacific coast region (PCR) jurisdiction, 2001 through 2019. Data excludes intra-PCR trade between British Columbia and the three U.S. PCR states. Sources: StatCan (2020), USITC (2020a, 2020b).

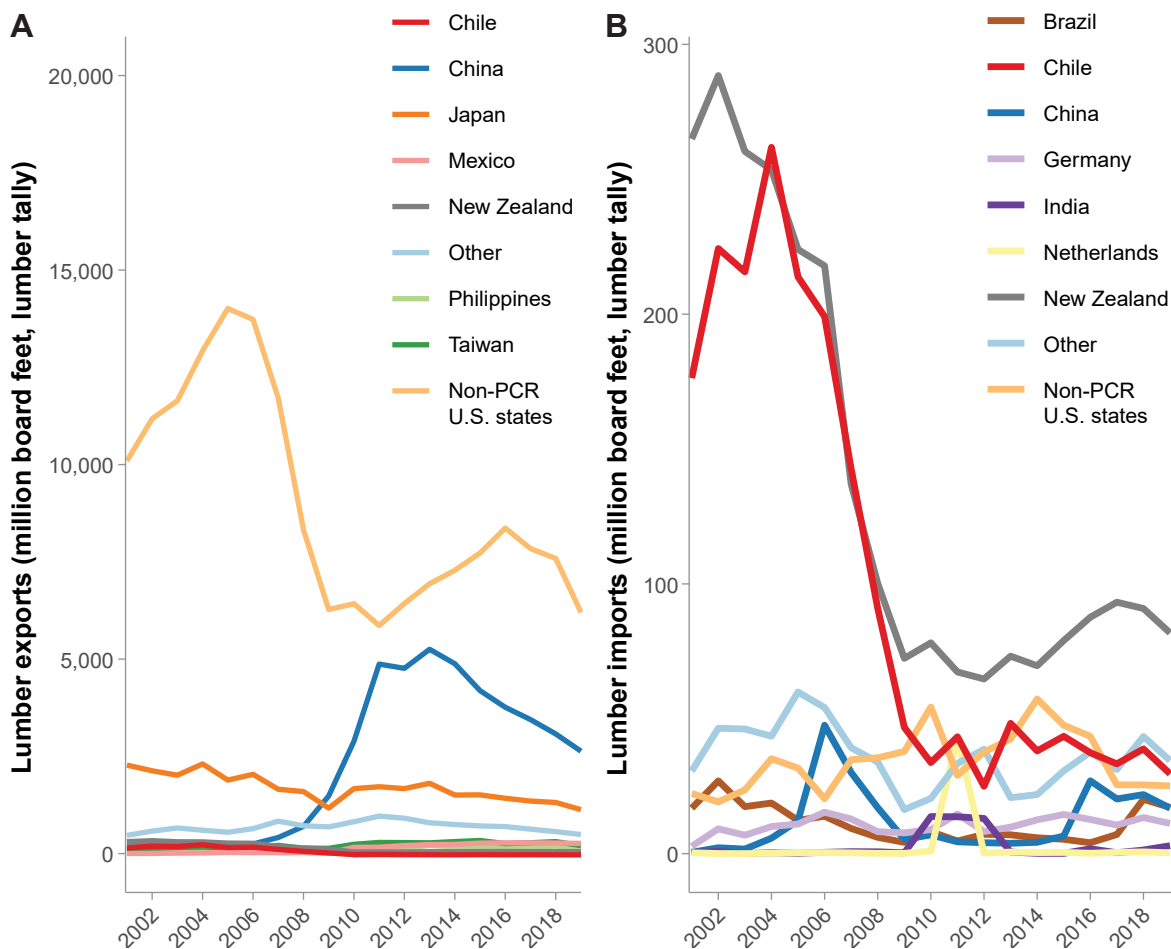


Figure 4—International Pacific coast region (PCR) lumber (A) exports and (B) imports by top trading partners, 2001 through 2019. Data excludes intra-PCR trade between British Columbia and the three U.S. PCR states. Sources: StatCan (2020), USITC (2020a, 2020b).

Plywood and Veneer Trade Flows

The PCR was a major producer of structural plywood and veneer sheets used to manufacture plywood. In 2019, PCR jurisdictions produced about 5.8 billion square feet, $\frac{3}{8}$ -inch basis, of plywood and veneer. Figure 5 shows the breakdown of plywood and veneer production from 2015 through 2019 for British Columbia and from 2015 through 2020 for Oregon, and Washington. California produced a small quantity of veneer sheets but no structural panel products. These veneer products did not appear in the APA—The Engineered Wood Association’s (formerly the American Plywood Association) production numbers, and we therefore excluded them from our trade flow analysis. British Columbia and Oregon accounted for most of the plywood and veneer production in the PCR in 2019, producing 48.5 and 41.5 percent of the regional output, respectively. Washington accounted for the remaining 10 percent of regional plywood and veneer production. According to data from mill surveys and trade groups, U.S. PCR states were not significant manufacturers of other structural panel products, such as oriented strand board (OSB).

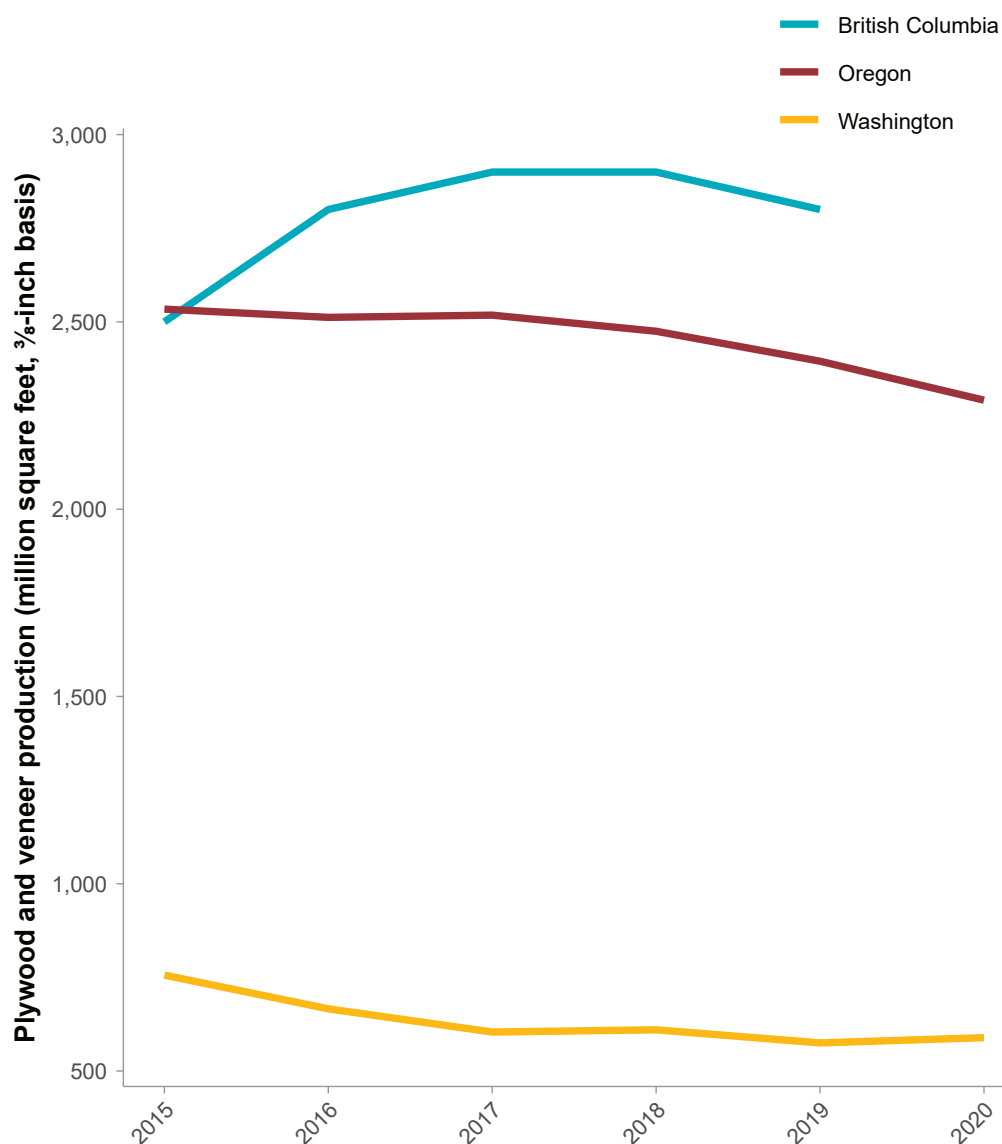


Figure 5—Total plywood and veneer production by Pacific coast region jurisdiction, 2015 through 2020. Sources: APA—The Engineered Wood Association (2020), BC Ministry of Forests (2019).

Table 6 shows the plywood and veneer trade flows into and out of the PCR for 2017. In 2017, about 2.7 billion square feet, $\frac{3}{8}$ -inch basis, were exported from PCR jurisdictions. This accounted for about 48 percent of the total regional plywood and veneer production. In 2017, Oregon was the largest regional plywood and veneer exporter, accounting for 54 percent of the total PCR plywood and veneer export volume, followed by British Columbia (23 percent), Washington (18 percent), and California (4 percent). The fact that British Columbia was the largest producer of plywood and veneer of the PCR jurisdictions but the second largest exporter suggests that much of British Columbia's plywood and veneer production remains in the Canadian market. Intra-PCR trade accounted for 60 percent of the total export volume. Similar to lumber, Oregon's plywood and veneer export volume to California was one of the highest trade flows of these products in 2017, accounting for 21 percent of the total PCR plywood and veneer export volume. In 2017, 27 percent of the total plywood and veneer export volume went to non-PCR U.S. states. The remaining 13 percent of plywood and veneer exports went to other international markets.

In 2017, the PCR imported slightly more volume than it exported, at about 3.1 billion square feet, $\frac{3}{8}$ -inch basis, of plywood and veneer. About 53 percent of this plywood and veneer import volume was from intra-PCR trade. California accounted for 47 percent of the total plywood and veneer imported volume, followed by British Columbia (28 percent), Washington (17 percent), and Oregon (8 percent). The PCR imported 1.47 billion square feet, $\frac{3}{8}$ -inch basis, from outside of the PCR. In 2017, 92 percent of this non-PCR import volume originated from international sources, while the remaining 8 percent originated from non-PCR U.S. states.

Table 7 shows the plywood and veneer trade flows between the PCR jurisdictions and other U.S. regions for 2017. In 2017, the four PCR jurisdictions imported 122 million square feet, $\frac{3}{8}$ -inch basis, of plywood and veneer from non-PCR U.S. states. California was the largest importing state in the PCR, accounting for 59 percent of PCR plywood and veneer imports from non-PCR U.S. states. All of these imported plywood and veneer products originated from Southern U.S. states.

Table 6—Plywood and veneer trade flows between Pacific coast region jurisdictions and other sources and destinations, 2017

Export region	Import region						Total exports
	California	Oregon	Washington	British Columbia	Non-PCR U.S. states	Other international	
MILLION SQUARE FEET, $\frac{3}{8}$ -INCH BASIS							
California	—	0	0	5	29	86	121
Oregon	576	—	159	349	408	0	1,492
Washington	9	63	—	102	98	222	494
British Columbia	75	122	177	—	213	48	636
Non-PCR U.S. states	72	20	0	30	—	—	—
Other international	738	41	192	372	—	—	—
Total imports	1,471	246	528	858	—	—	—
Net exports	-1,350	1,247	-34	-223	—	—	—

Note: Sums of columns and rows may not add up to totals because of rounding.

— = no data.

The PCR jurisdictions exported about 748 million square feet, $\frac{3}{8}$ -inch basis, of plywood and veneer to non-PCR U.S. states. This represents about 13 percent of the plywood and veneer produced in the PCR in 2017. Oregon was the largest exporter of plywood and veneer, accounting for about 55 percent of the volume exported to non-PCR U.S. states. The Midwest was the main destination of PCR exports, accounting for about 37 percent of the traded plywood and veneer originating in the PCR. Northern, Southern, and Western states accounted for 24, 21, and 18 percent of the exported plywood and veneer volumes, respectively.

Table 8 shows plywood and veneer trade flows between the three U.S. PCR states and British Columbia over time. Relative to the regional production capacity in the PCR, British Columbia-U.S. trade in these products was small. From 2000 through 2018, total plywood and veneer exports from British Columbia to U.S. PCR states ranged between 243 and 413 million square feet, $\frac{3}{8}$ -inch basis, per year. Oregon and Washington were the primary destinations for British Columbia's plywood and veneer exports to U.S. PCR states. British Columbia imported a small volume of plywood and veneer products from U.S. PCR states (65 to 283 million square feet, $\frac{3}{8}$ -inch basis, per year). Oregon was the primary source of these products, although small volumes also originated in Washington.

Table 7—Plywood and veneer trade flows between Pacific coast region (PCR) jurisdictions and other U.S. regions, 2017

PCR jurisdiction	Imports from				Total imports	Exports to				Total exports
	Midwest	West	North	South		Midwest	West	North	South	
MILLION SQUARE FEET, 3⁄8-INCH BASIS										
California	0	0	0	72	72	0	29	0	0	29
Oregon	0	0	0	20	20	169	44	109	86	408
Washington	0	0	0	0	0	37	28	26	7	98
British Columbia	4	18	2	6	30	74	36	41	61	213
PCR total	4	18	2	97	122	280	138	176	154	748

Note: Sums of columns and rows may not add up to totals because of rounding.

Table 8—Plywood and veneer trade flows between British Columbia and U.S. Pacific coast region states, selected years

Trade flow	2000	2006	2012	2018
MILLION SQUARE FEET, $\frac{3}{8}$ -INCH BASIS				
British Columbia to California	23	60	30	61
British Columbia to Oregon	155	220	93	138
British Columbia to Washington	65	133	128	178
Total exports	243	413	251	377
California to British Columbia	2	2	3	4
Oregon to British Columbia	42	94	180	156
Washington to British Columbia	22	56	100	49
Total imports	65	152	283	208

Note: Sums of columns and rows may not add up to totals because of rounding.

Figure 6 shows the international import and export volumes of plywood and veneer by PCR jurisdiction. In the last few years of the study period, British Columbia and Washington were the main exporters of these products. Prior to the Great Recession, California was also a significant exporter of plywood and veneer. However, because there is no plywood manufacturing capacity in the state, the exports must originate in other states and leave through California ports. Unfortunately, the trade data does not track the original source of the product. International imports of plywood and veneer products trended upward since 2009 in all PCR jurisdictions except Oregon. California was the largest importer of international plywood and veneer products, followed by British Columbia. As with export data, one challenge with import data is that products may be entering a PCR customs district but ending in a different state or jurisdiction.

Figure 7 shows the top plywood and veneer export and import partners for all the PCR. For exports, aside from British Columbia exports to non-PCR U.S. states, small volumes of plywood and veneer were exported to many countries. China and Mexico were the largest non-U.S. export partners, although plywood and veneer export volumes have been at or below 100 million square feet, $\frac{3}{8}$ -inch basis, per year over the last few years of the study period. In terms of imports, China was by far the largest trading partner of plywood and veneer for the PCR, with imports from China ranging from 500 million to 1.5 billion square feet, $\frac{3}{8}$ -inch basis, per year from 2004 through 2019.

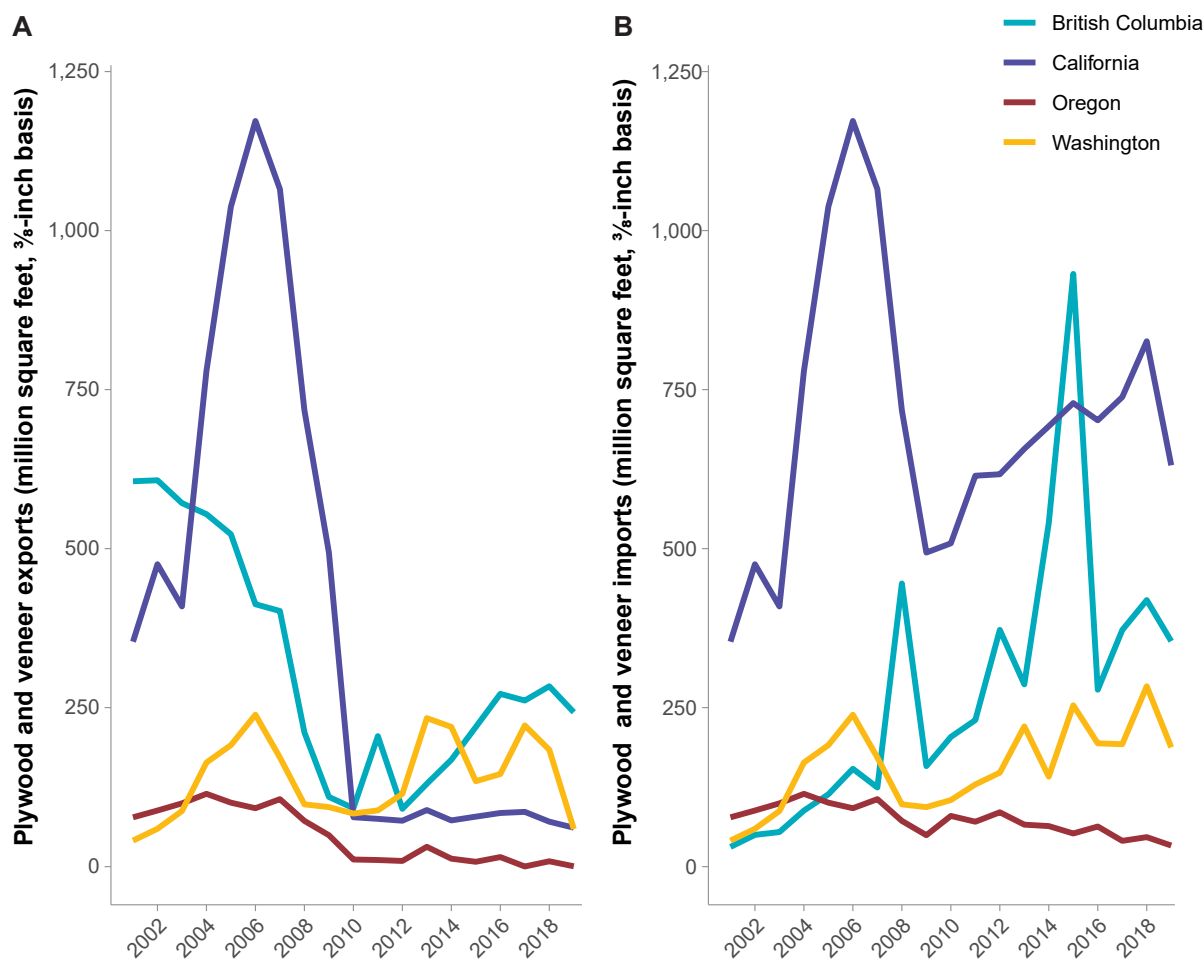


Figure 6—International plywood and veneer (A) exports and (B) imports by Pacific coast region (PCR) jurisdiction, 2001 through 2019. Data excludes intra-PCR trade between British Columbia and the three U.S. PCR states. Sources: StatCan (2020), USITC (2020a, 2020b).

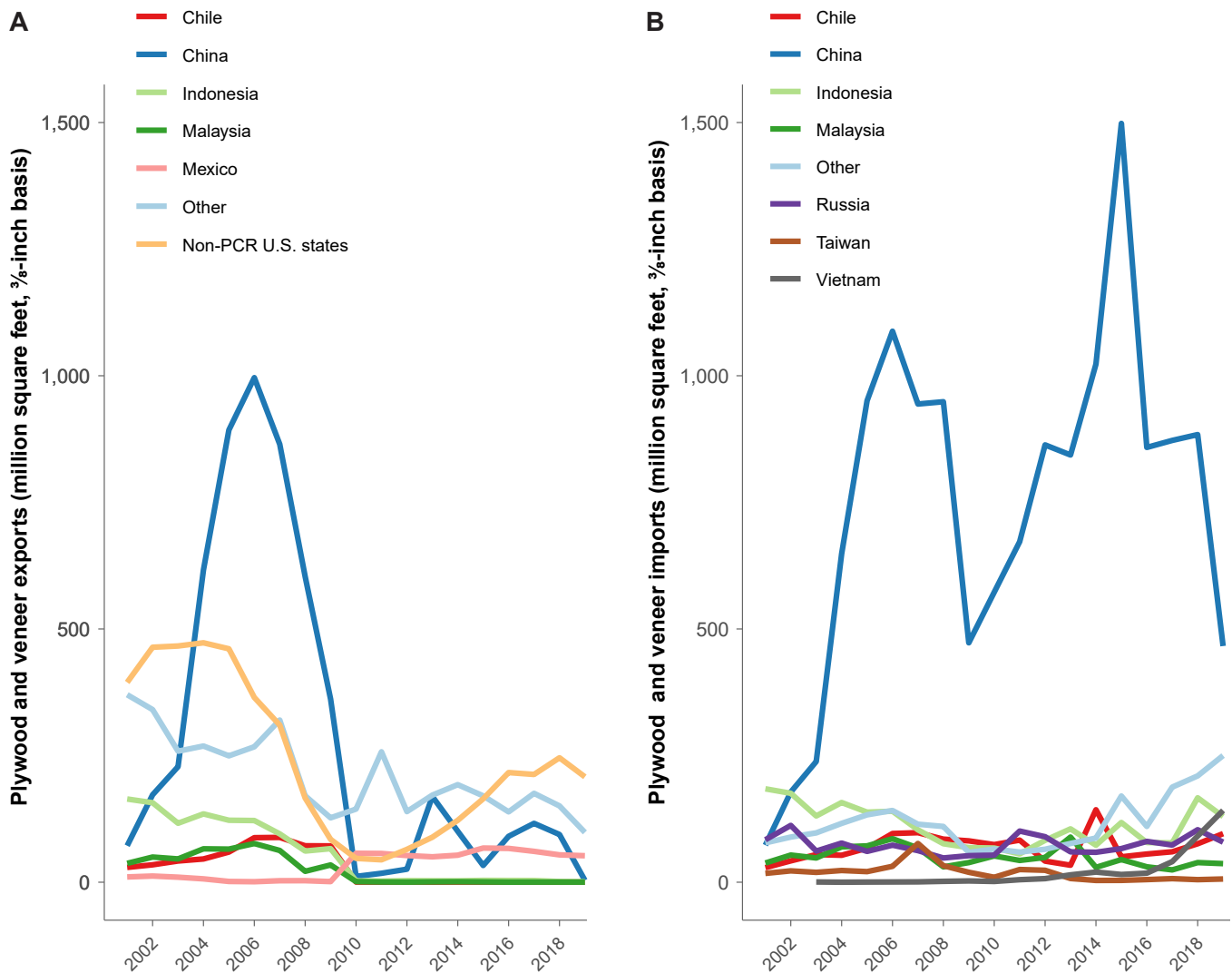


Figure 7—International Pacific coast region (PCR) plywood and veneer (A) exports and (B) imports by top trading partners, 2001 through 2019. Data excludes intra-PCR trade between British Columbia and the three U.S. PCR states. Sources: StatCan (2020), USITC (2020a, 2020b).

Nonveneered Panel and Board Trade Flows

Nonveneered panels and boards include products such as fiberboard, particle board, and OSB. Some of these products, such as OSB, are used for structural applications, while others, such as particle board, are for nonstructural applications. Figure 8 shows recent production data on nonveneered panels and boards in the PCR. Table 9 shows nonveneered panel and board trade flows into and out of the PCR for 2017. In 2017, the PCR exported about 4.8 billion square feet, $\frac{3}{8}$ -inch basis, and imported about 3.1 billion square feet, $\frac{3}{8}$ -inch basis, of nonveneered panels and boards. California and Washington were both net importers of nonveneered panels and boards, with the largest import demand coming from California. British Columbia was a net exporter, exporting 1.97 billion square feet, $\frac{3}{8}$ -inch basis, more than it imported. The U.S. PCR states received 60 percent of British Columbia's exports. The remainder was split between other U.S. and international markets. Other U.S. and international markets were important sources of imports for California, Oregon, and Washington.

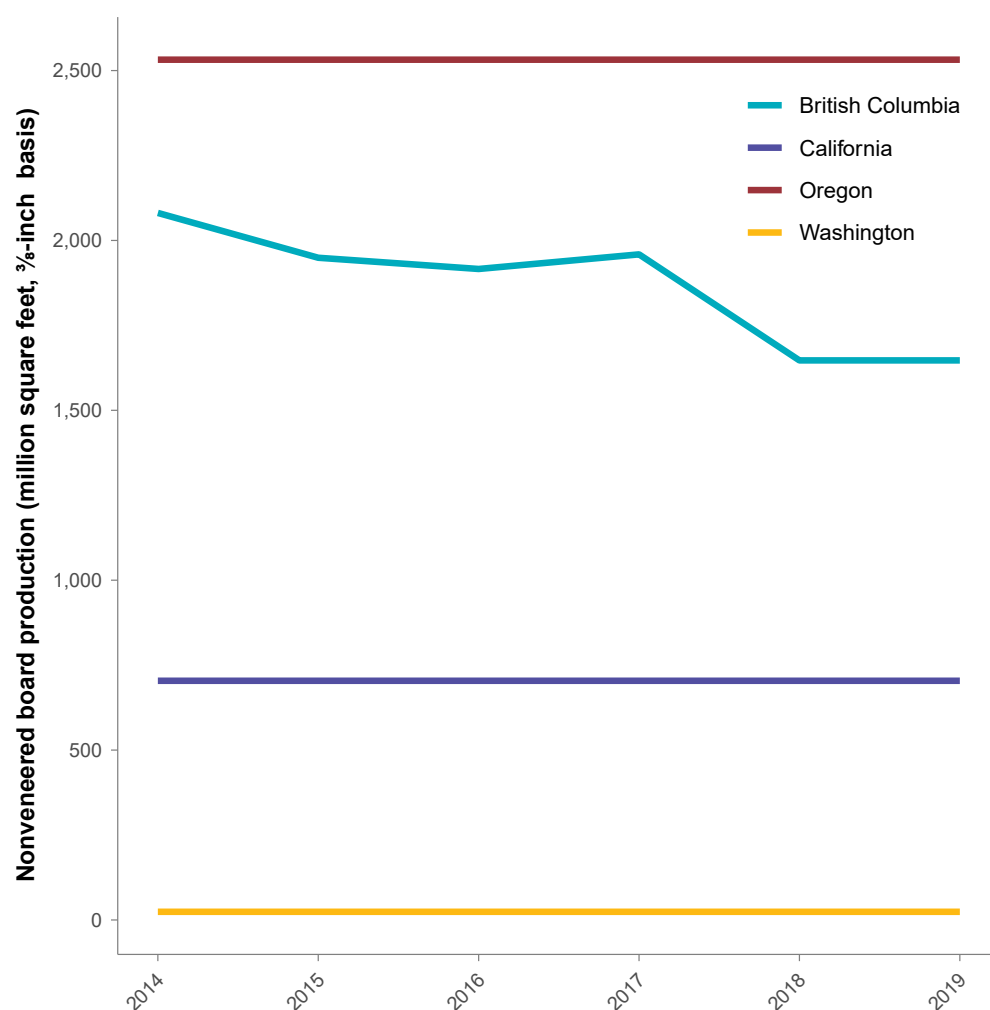


Figure 8—Total nonveneered panel and board production by Pacific coast region jurisdiction, 2014 through 2019. Sources: CPA (2020), APA—The Engineered Wood Association (2020), British Columbia data was compiled from annual mill surveys.

Table 9—Nonveneered panel and board trade flows between Pacific coast region jurisdictions and other sources and destinations, 2017

Export region	Import region						Total exports
	California	Oregon	Washington	British Columbia	Non-PCR U.S. states	Other international	
	MILLION SQUARE FEET, 3/8-INCH BASIS						
California	—	0	3	1	5	114	123
Oregon	0	—	0	79	2,454	0	2,533
Washington	0	1	—	0	2	7	10
British Columbia	519	266	486	—	417	424	2,111
Non-PCR U.S. states	348	191	123	45	—	—	—
Other international	841	8	158	14	—	—	—
Total imports	1,708	466	770	138	—	—	—
Net exports	–1,585	2,068	–760	1,973	—	—	—

Note: Sums of columns and rows may not add up to totals because of rounding.

— = no data.

Table 10 shows nonveneered panel and board trade flows between PCR jurisdictions and other U.S. regions for 2017. In 2017, the four PCR jurisdictions received 706 million square feet, $\frac{3}{8}$ -inch basis, of nonveneered panels and boards from non-PCR states. Much of these products (47 percent) came from non-PCR Western U.S. states. Montana products accounted for nearly all of these imports. While the Southern and Midwestern regions accounted for much of the remaining imports, a large fraction of nonveneered panels and boards came from two states—Louisiana and Michigan. Louisiana exported about 157 million square feet, $\frac{3}{8}$ -inch basis (22 percent of total interstate imports) and Michigan exported about 97 million square feet, $\frac{3}{8}$ -inch basis (14 percent of total interstate imports) of nonveneered panels and boards. California received the most nonveneered panel and board imports, accounting for nearly half of the volume.

In 2017, the four PCR jurisdictions exported almost 2.9 billion square feet, $\frac{3}{8}$ -inch basis, of nonveneered panels and boards to non-PCR U.S. states. Oregon and British Columbia accounted for 85 and 14 percent, respectively, of the total export volume. Most of this export volume was sent to just four states—Texas, Idaho, Utah, and Michigan.

The U.S. PCR is an important market for British Columbia's nonveneered panels and boards. Table 11 shows that from 2000 through 2018, British Columbia exported volumes of about 1 to 1.5 billion square feet, $\frac{3}{8}$ -inch basis, of nonveneered panels and boards per year to the three U.S. PCR states. British Columbia's nonveneered panel and board import volumes from the U.S. PCR states were negligible.

Table 10—Nonveneered panel and board trade flows between Pacific coast region (PCR) jurisdictions and other U.S. regions, 2017

PCR jurisdiction	Imports from				Total imports	Exports to				Total exports
	Midwest	West	North	South		Midwest	West	North	South	
	MILLION SQUARE FEET, 3/8-INCH BASIS									
California	14	92	60	183	348	2	0	0	3	5
Oregon	24	167	0	0	191	470	1,079	0	905	2,454
Washington	80	43	0	0	123	0	2	0	0	2
British Columbia	9	32	0	3	45	87	211	21	97	417
PCR total	127	334	60	186	706	559	1,292	21	1005	2,877

Note: Sums of columns and rows may not add up to totals because of rounding.

Table 11—Nonveneer panel and board trade flows between British Columbia and U.S. Pacific coast region states, selected years

Trade flow	2000	2006	2012	2018
MILLION SQUARE FEET, $\frac{3}{8}$ -INCH BASIS				
British Columbia to California	632	613	455	539
British Columbia to Oregon	223	228	161	274
British Columbia to Washington	317	599	336	491
Total exports	1,172	1,440	952	1,304
California to British Columbia	8	10	3	1
Oregon to British Columbia	70	73	94	96
Washington to British Columbia	9	63	45	97
Total imports	87	145	142	194

Note: Sums of columns and rows may not add up to totals because of rounding.

The international export market for nonveneered panels and boards was particularly important for British Columbia and less so for the U.S. PCR states (fig. 9). While nonveneered panel and board export volumes dropped in British Columbia after the Great Recession, international exports still generally exceeded 500 million square feet, $\frac{3}{8}$ -inch basis, per year from 2011 through 2019. From 2010 through 2019, California also exported about 100 to 200 million square feet, $\frac{3}{8}$ -inch basis, of nonveneered panels and boards per year. It is likely that these products originated in non-PCR U.S. states because California did not have significant production capacity, aside from a single particleboard facility. Aside from non-PCR U.S. states, Mexico and China were the largest international markets for nonveneered panel and board exports since the Great Recession (fig. 10).

International nonveneered panel and board imports are an important and growing market for California but less so for the other PCR jurisdictions. California nonveneered panels and board imports have fluctuated between about 200 and 800 million square feet, $\frac{3}{8}$ -inch basis from 2002 through 2019, with a significant drop and gradual recovery following the Great Recession (fig. 9). China, Chile, and Germany were the primary import trading partners for PCR nonveneered panel and board imports from 2016 through 2019 (fig. 10).

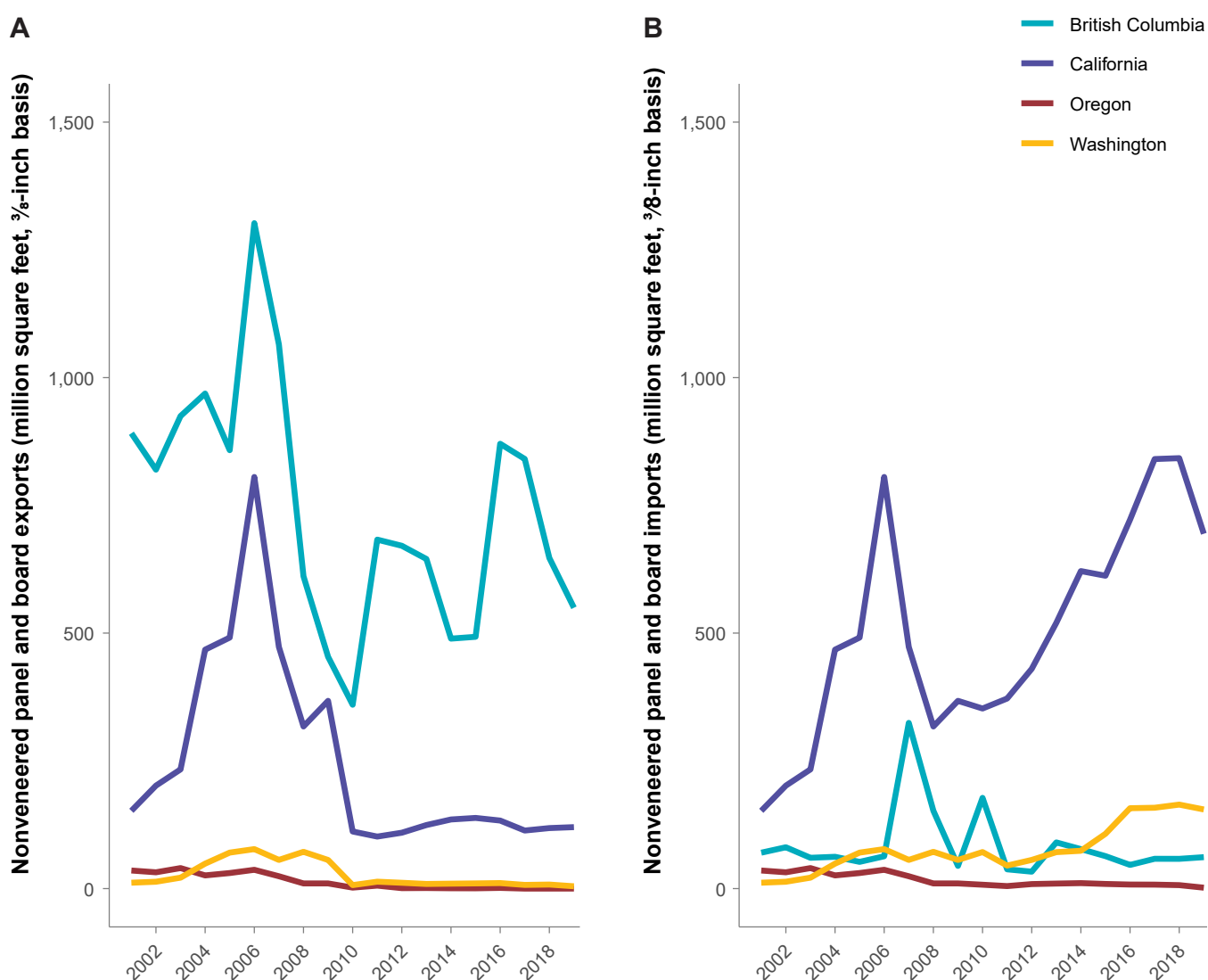


Figure 9—International nonveneered panel and board (A) exports and (B) imports by Pacific coast region (PCR) jurisdiction, 2001 through 2019. Data excludes intra-PCR trade between British Columbia and the three U.S. PCR states. Sources: StatCan (2020), USITC (2020a, 2020b).

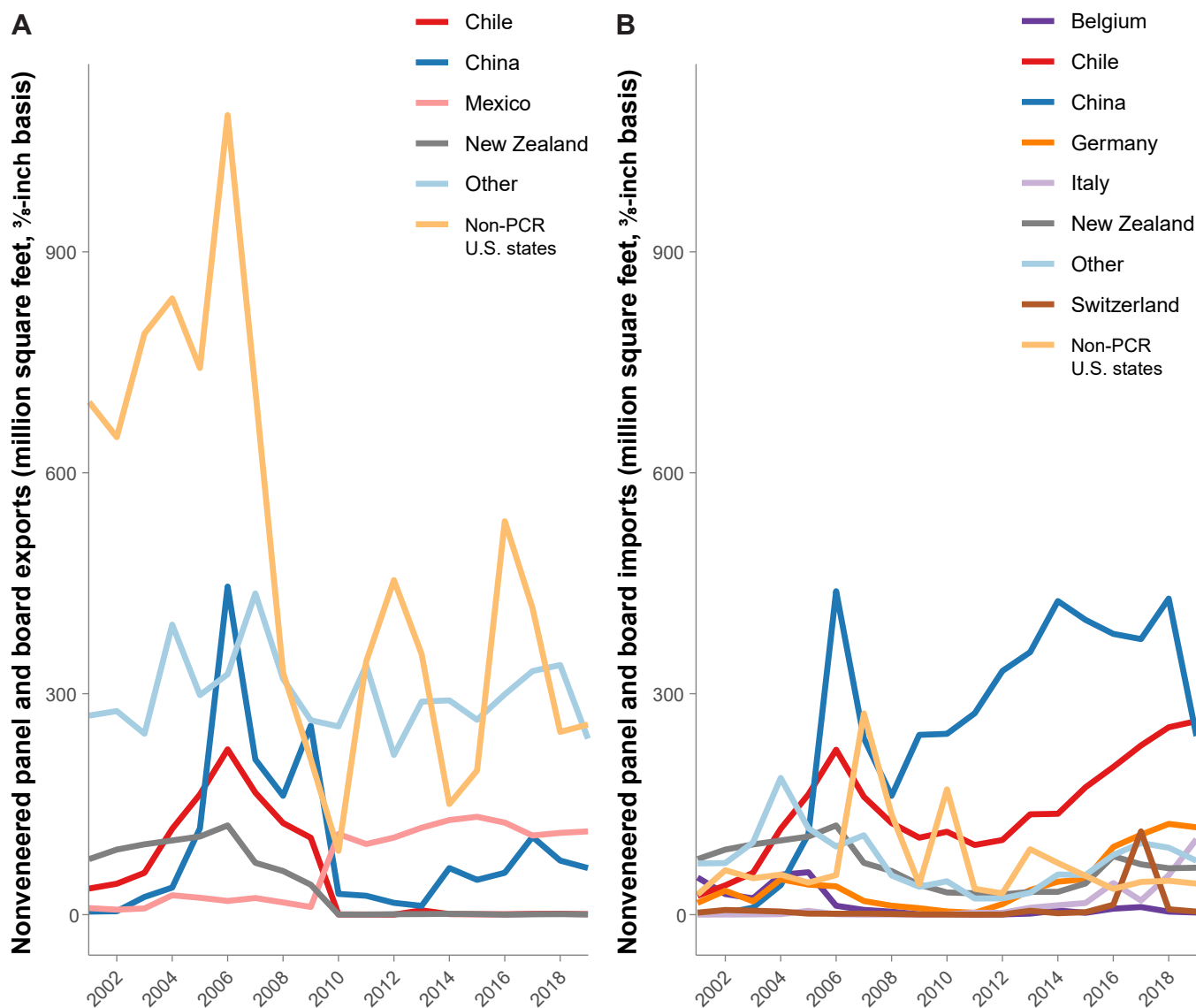


Figure 10—International Pacific coast region (PCR) nonveneered panel and board (A) exports and (B) imports by top trading partners, 2001 through 2019. Data excludes intra-PCR trade between British Columbia and the three U.S. PCR states. Sources: StatCan (2020), USITC (2020a, 2020b).

Pulp and Paper Product Trade Flows

The PCR was a net importer of pulp and paper products; however, trade patterns varied considerably among PCR jurisdictions. For example, Washington, Oregon, and British Columbia were net exporters of pulp and paper products, while California was a net importer. Table 12 breaks down aggregate pulp and paper product trade flows for the four PCR jurisdictions. Intra-PCR trade consisted largely of Washington and Oregon exporting to California, although there was also considerable trade between Washington and Oregon. California imported more than 3.5 million metric tonnes of pulp and paper products from non-PCR U.S. states and more than 1.1 million metric tonnes from non-Canadian international trading partners. Aside from California, the non-PCR U.S. and international markets were important export destinations for PCR pulp and paper product exports.

Table 13 shows the pulp and paper product trade flows between PCR jurisdictions and other U.S. regions for 2017. In 2017, more than 4 million metric tonnes of pulp and paper products were imported into the PCR from non-PCR U.S. states, and more than 2 million metric tonnes were exported from the PCR to non-PCR states. For imports, the Southern United States was a main source of pulp and paper products. This region supplied 67, 60, 49, and 35 percent of the non-PCR U.S. imports to California, Washington, Oregon, and British Columbia, respectively. Most (60 percent) pulp and paper product exports from the PCR jurisdictions went to other Western states.

Table 14 shows pulp and paper product trade flows between the U.S. PCR states and British Columbia over time. While British Columbia was a large exporter to U.S. PCR states prior to the Great Recession, export volumes dropped considerably from 2006 through 2018. In 2018, only 200,000 metric tonnes of pulp and paper products were exported from British Columbia to the U.S. PCR. Most of these exports were to the California market. British Columbia imported a similar volume from the U.S. PCR states, primarily from Washington, and these levels were relatively stable from 2000 through 2018.

Table 12—Pulp and paper product trade flows between Pacific coast region jurisdictions and other sources and destinations, 2017

Export region	Import region						Total exports
	California	Oregon	Washington	British Columbia	Non-PCR U.S. states	Other international	
	THOUSAND METRIC TONNES						
California	—	18	57	8	496	1,146	1,726
Oregon	1,201	—	694	42	286	131	2,354
Washington	993	252	—	223	943	995	3,406
British Columbia	146	16	105	—	314	362	943
Non-PCR U.S. states	3,535	178	231	91	—	—	—
Other international	1,166	9	148	52	—	—	—
Total imports	7,041	474	1,235	416	—	—	—
Net exports	−5,316	1,880	2,171	528	—	—	—

Note: Sums of columns and rows may not add up to totals because of rounding.

— = no data.

Table 13—Pulp and paper product trade flows between Pacific coast region (PCR) jurisdictions and other U.S. regions, 2017

PCR jurisdiction	Imports from				Total imports	Exports to				Total exports
	Midwest	West	North	South		Midwest	West	North	South	
	THOUSAND METRIC TONNES									
California	523	380	250	2,371	3,524	4	427	13	53	496
Oregon	35	46	10	87	178	43	161	0	82	285
Washington	31	62	1	138	231	204	588	32	119	943
British Columbia	47	5	6	31	90	134	40	70	70	314
PCR total	636	493	267	2,628	4,023	384	1,216	115	323	2,038

Note: Sums of columns and rows may not add up to totals because of rounding.

Table 14—Pulp and paper product trade flows between British Columbia and U.S. Pacific coast region states, selected years

Trade flow	2000	2006	2012	2018
THOUSAND METRIC TONNES				
From British Columbia to California	744	492	221	152
From British Columbia to Oregon	87	112	35	19
From British Columbia to Washington	140	283	60	30
Total exports	971	887	315	201
To British Columbia from California	16	22	10	10
To British Columbia from Oregon	69	84	89	33
To British Columbia from Washington	165	191	223	213
Total imports	250	297	322	256

Note: Sums of columns and rows may not add up to totals because of rounding.

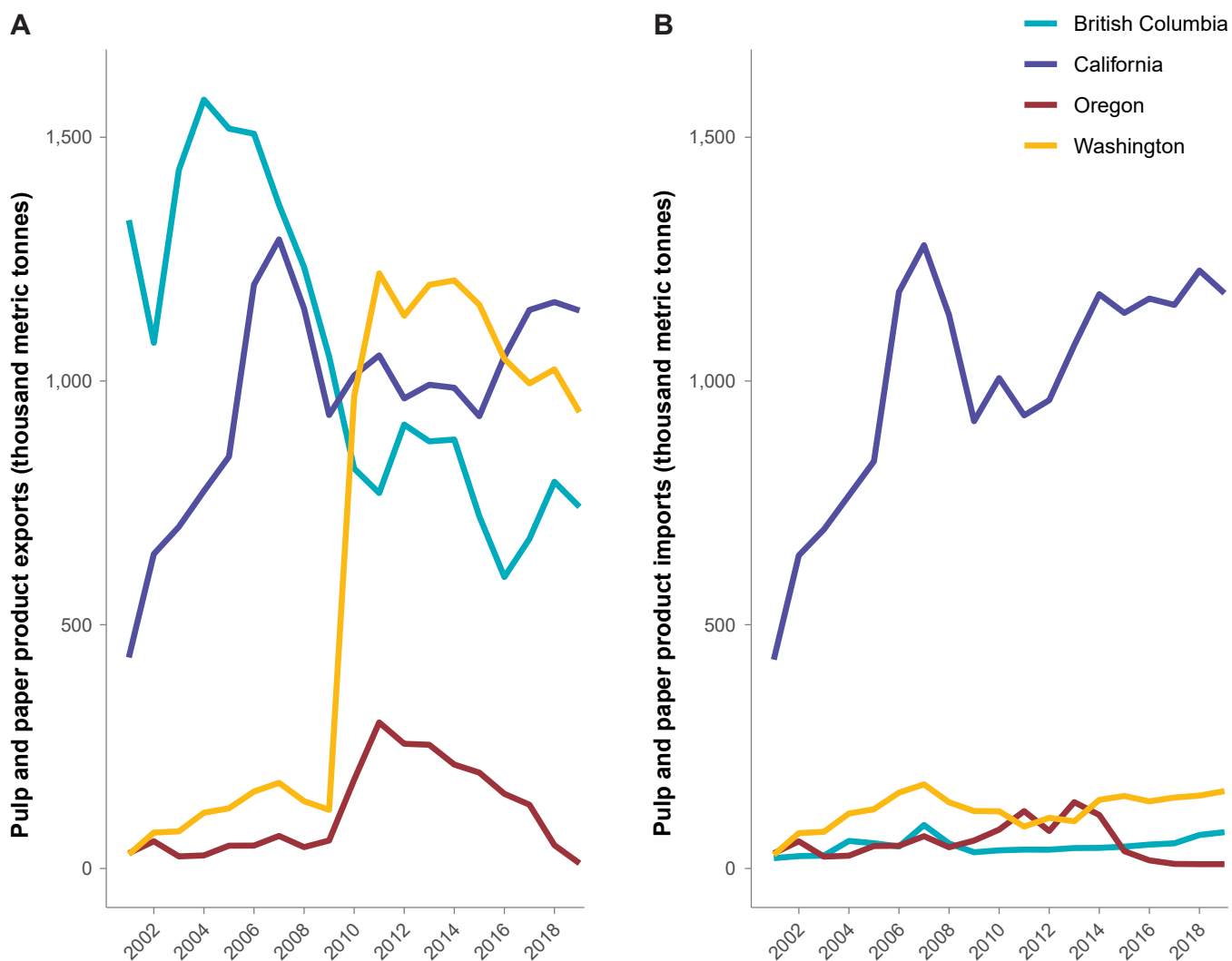


Figure 11—International pulp and paper (A) exports and (B) imports by Pacific coast region (PCR) jurisdiction, 2001 through 2019. Data excludes intra-PCR trade between British Columbia and U.S. PCR states. Sources: StatCan (2020), USITC (2020a, 2020b).

International markets are a relatively small, but significant, source of imports and exports of pulp and paper products for PCR jurisdictions (fig. 11). For example, starting in 2006 through 2019, California exported and imported more than 1 million metric tonnes of pulp and paper products annually in most years. California's international pulp and paper product imports grew substantially from 2001 through 2019. Because California did not have a strong pulp and paper industry, except for a single paperboard facility, the exports likely originated in other states. International pulp and paper product exports were also high for British Columbia and Washington, although for British Columbia, the international pulp and paper product export market declined substantially from 2001 through 2019. Oregon pulp and paper product exports also declined from 2011 through 2019 and were much lower than the other PCR jurisdictions. International pulp and paper product imports to British Columbia, Oregon, and Washington were relatively low, at less than 200,000 metric tonnes per year. These import volumes remained relatively stable from 2001 through 2019.

China was the primary trading partner for the PCR in terms of pulp and paper products. China was both the largest source of imports and one of the top five largest export destinations from 2005 through 2019 for PCR pulp and paper products (fig. 12). There were several other important bilateral trading partnerships for PCR exports. Mexico, for example, was the primary export destination for PCR pulp and paper products from 2016 through 2019. Japan, South Korea, Taiwan, Indonesia, and India were also important export markets. Export partners also tended to be the primary import partners for pulp and paper products. The exceptions were India, which imported relatively little to the PCR, and Australia, which imported considerable volumes but was not an important PCR export partner.

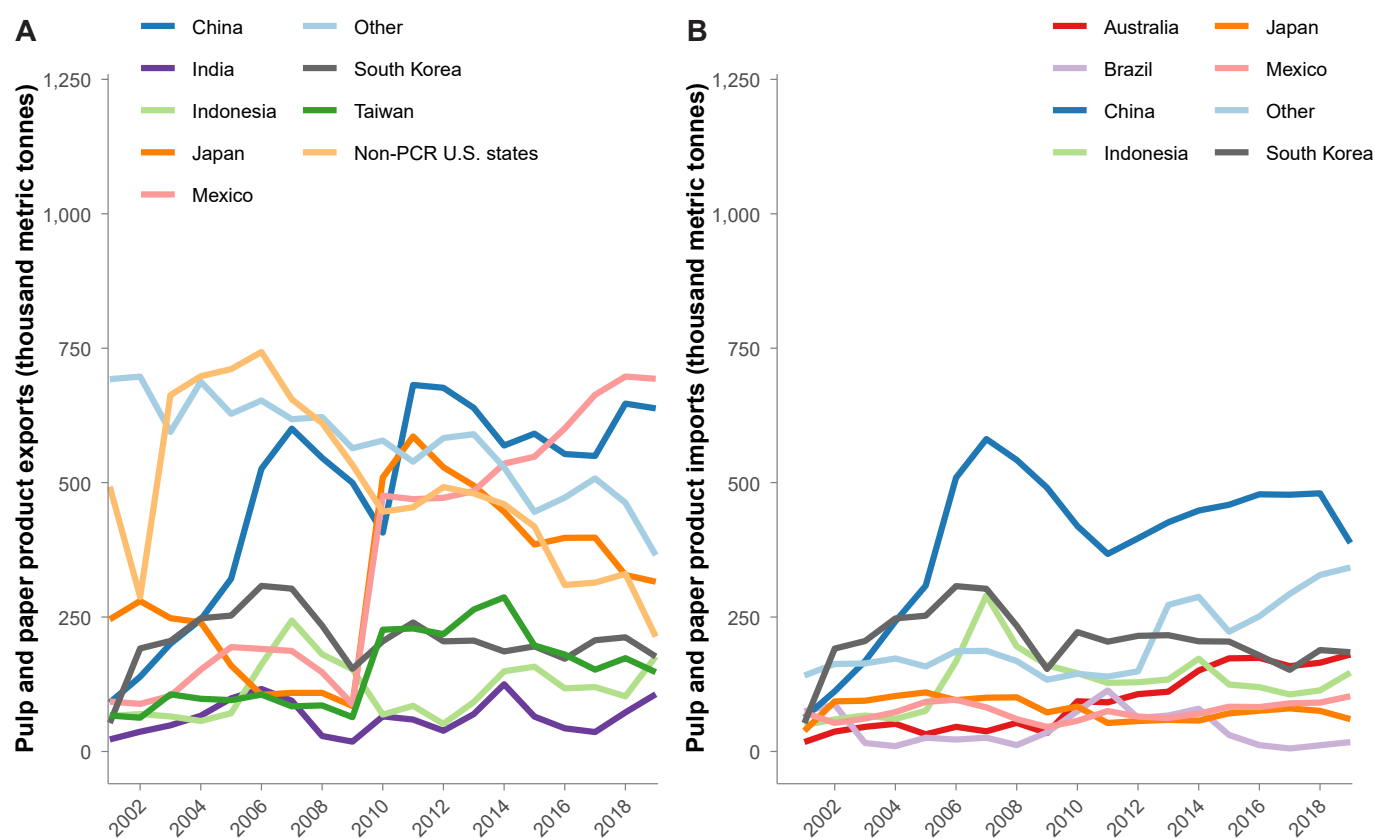


Figure 12—International Pacific coast region (PCR) pulp and paper (A) exports and (B) imports by top trading partners, 2001 through 2019. Data excludes intra-PCR trade between British Columbia and the three U.S. PCR states. Sources: StatCan (2020), USITC (2020a, 2020b).

Woodchips and Pellets Trade Flows

Woodchips and pellets represented a small volume of traded wood products relative to the other products that we considered in this research paper. Table 15 shows the woodchip and pellet trade flows into and out of the PCR jurisdictions for 2017. Total exports in 2017 were about 3.4 million metric tonnes. About 55 percent of these exports were from British Columbia, and most served non-U.S. international markets. Washington was also a large exporter of woodchips and pellets, representing about 30 percent of PCR exports. Most of these products from Washington went to other PCR jurisdictions. The PCR imported about 1.7 million metric tonnes of woodchips and pellets in 2017. Again, British Columbia and Washington were the primary destinations of these products.

Woodchip and pellet trade flows between PCR jurisdictions and other U.S. regions are shown in table 16. Woodchip and pellet imports from non-PCR states were almost entirely from other states in the Western United States. In fact, Washington woodchip and pellet imports from Idaho comprised almost the entire import volume into Washington, and Idaho and Montana accounted for nearly the entire trade flow into British Columbia from non-PCR

Table 15—Woodchip and pellet trade flows between Pacific coast region jurisdictions and other sources and destinations, 2017

Export region	Import region						Total exports
	California	Oregon	Washington	British Columbia	Non-PCR U.S. states	Other international	
THOUSAND METRIC TONNES							
California	—	7	0	1	0	111	119
Oregon	0	—	0	132	281	0	413
Washington	166	156	—	623	65	1	1,011
British Columbia	15	11	17	—	23	1,809	1,875
Non-PCR U.S. states	3	0	440	155	—	—	—
Other international	1	0	0	0	—	—	—
Total imports	184	174	457	911	—	—	—
Net exports	-65	239	554	964	—	—	—

Note: Sums of columns and rows may not add up to totals because of rounding.

— = no data.

Table 16—Woodchip and pellet trade flows between Pacific coast region (PCR) jurisdictions and other U.S. regions, 2017

PCR jurisdiction	Imports from				Total imports	Exports to				Total exports
	Midwest	West	North	South		Midwest	West	North	South	
THOUSAND METRIC TONNES										
California	0	0	0	3	3	0	0	0	0	0
Oregon	0	0	0	0	0	281	0	0	0	281
Washington	10	430	0	0	440	53	0	0	13	65
British Columbia	1	153	0	1	155	10	4	2	7	23
PCR total	11	583	0	3	598	344	4	2	20	370

Note: Sums of columns and rows may not add up to totals because of rounding.

U.S. states. Woodchip and pellet exports from the PCR went primarily to the Midwestern states of Minnesota and Kansas.

Woodchip and pellet trade flows between U.S. PCR states and British Columbia over time are shown in table 17. Prior to the Great Recession, woodchip and pellet exports from British Columbia were substantially higher than they had been in recent years. In 2018, there was very little (<40,000 metric tonnes) export volume from British Columbia to the U.S. PCR states. However, Washington, and more recently Oregon, were relatively large exporters of woodchips and pellets to British Columbia.

International woodchip and pellet exports from PCR jurisdictions increased substantially from 2002 through 2019. As shown in figure 13, the woodchip and pellet export market for

Table 17—Woodchip and pellet trade flows between British Columbia and U.S. Pacific coast region states, select years

Trade flow	2000	2006	2012	2018
THOUSAND METRIC TONNES				
From British Columbia to California	7	17	10	12
From British Columbia to Oregon	40	28	4	9
From British Columbia to Washington	282	144	21	18
Total exports	329	188	35	39
To British Columbia from California	3	4	2	1
To British Columbia from Oregon	2	1	17	285
To British Columbia from Washington	334	541	588	653
Total imports	339	546	607	939

Note: Sums of columns and rows may not add up to totals because of rounding.

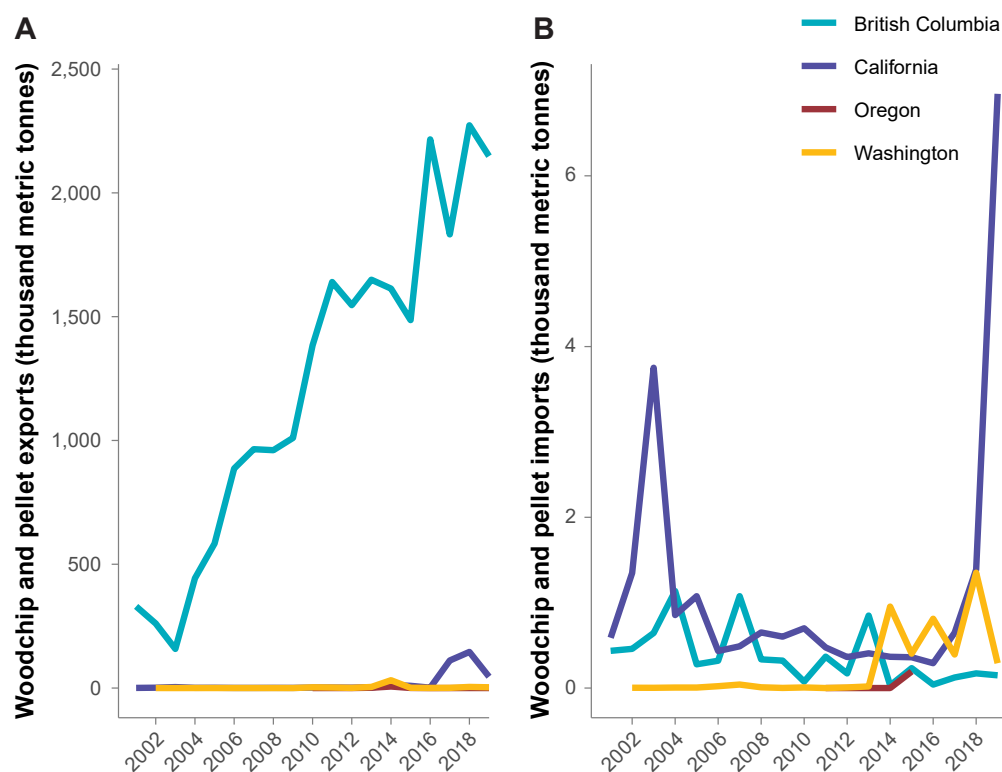


Figure 13—International woodchip and pellet (A) exports and (B) imports by Pacific coast region (PCR) jurisdiction, 2001 through 2019. Data excludes intra-PCR trade between British Columbia and the three U.S. PCR states. Sources: StatCan (2020), USITC (2020a, 2020b).

British Columbia averaged more than 2 million metric tonnes per year from 2016 through 2019. This was because of a rapid increase in pellet demand from the United Kingdom as part of its domestic biomass energy program. The United Kingdom and Japan were the primary destinations for woodchips and pellets from British Columbia (fig. 14). Imports of woodchips and pellets from international markets were negligible. As shown in figure 14, only several thousand metric tonnes of woodchips and pellets per year were imported into the PCR from international markets.

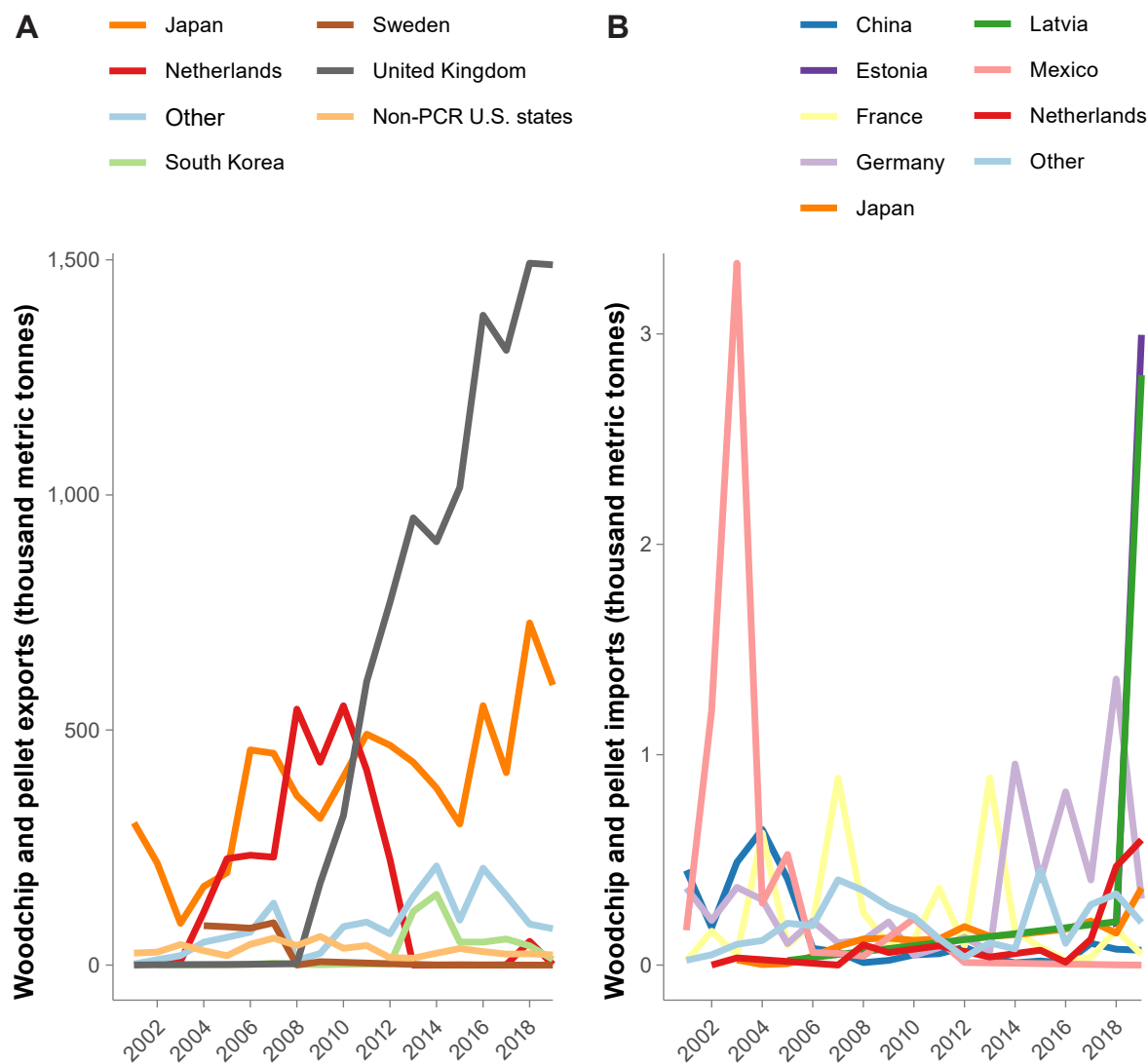


Figure 14—International Pacific coast region (PCR) woodchip and pellet (A) exports and (B) imports by top trading partners, 2001 through 2019. Excludes intra-PCR trade between British Columbia and the three U.S. PCR states. Sources: StatCan (2020), USITC (2020a, 2020b).

Discussion and Conclusions

The objectives of this research paper were (1) to identify useful datasets for tracking the trade flows of primary wood products into and out of the PCR and (2) to characterize these trade flows to the extent possible. This section highlights several broad conclusions around each of these objectives.

In terms of data availability, we identified three data sources for tracking the trade of lumber, veneer and nonveneered panels and boards, pulp and paper products, and wood-chips and pellets. The tracking mechanisms that are in place for internationally-traded wood products in the United States and Canada are of high quality and are generally sufficient for providing high confidence in the physical volumes or weights (for pulp and paper products) entering and exiting the PCR jurisdictions. The one main shortcoming of these international data, and for the U.S. data in particular, is that the initial state of origin, where the product enters the United States, and the final state of destination, where the product is consumed, may not be the same because imports are recorded at the port of entry. This is likely to be a particular problem for California, the largest consumer of wood products in the PCR, in two cases. First, products that enter from non-California ports of entry (e.g., Washington or Oregon) with California as a final destination are misclassified. California's imports, on a consumption basis, are underestimated. Second, imports coming into California ports of entry but ultimately destined for non-California states are misclassified. These imported products are counted as consumed in California, which is incorrect, resulting in an over-estimation of California imports. For Canada-U.S. trade, this issue can be resolved by using Canadian export data, which identifies the final U.S. state of destination for any Canadian exports.

We identified a novel use of the U.S. Census Bureau's CFS data for tracking the volumes of primary wood products. This dataset, to our knowledge, is the only dataset that systematically tracks historical state-to-state trade flows of primary wood products over time and at a reasonably disaggregated commodity level. However, this dataset has several shortcomings. First, wood product classifications are still fairly aggregated and do not allow for important disaggregation at the level that forest researchers may desire. In particular, the trade flow of nonveneered panel and board products is tracked at a highly aggregate level. This is a challenge for carbon accounting, one important potential future application of this work, because board densities vary considerably by product category. The second challenge with the CFS dataset is that data are only tracked every 5 years, and the data take several years after collection to compile and release. As opposed to the international trade data, which the U.S. Census Bureau releases monthly, the state-to-state trade flow data provide a considerably delayed snapshot of wood product trade flows. Furthermore, historical trade flows may not accurately represent future trade flows, and wood product markets can change rapidly because of regional and national economic conditions. Third, the total state-to-state traded volumes or weights implied in the CFS are not necessarily consistent with industry trade flow estimates. We therefore suggest that CFS data be used to understand trade flow shares, rather than total trade flow volumes. This means that trade flow volumes require additional state-level data on production to share out wood product production volumes. While some industries make this production data easily accessible, others do not. One solution to these shortcomings would be to add questions to state-level mill surveys that ask respondents to identify the final state-level destinations of their products on a more updated time interval and with more commodity details.

The findings of this report also highlight some important characteristics of the PCR as a producer and consumer of primary wood products. For lumber, perhaps the most important wood product in the region, the PCR is a net exporter. While British Columbia is the largest exporter in the region, Oregon and Washington are also net exporters of lumber. California is a net importer, and a large fraction of these import trade flows are from other PCR jurisdictions. For veneer and plywood panels, the PCR is both a large exporter and importer of these products. California, British Columbia, and Washington are all net importers, while Oregon is a net exporter. For nonveneered panels and boards, the U.S. PCR is a net importer, driven largely by California's demand. Oregon's net exports are roughly similar to Washington's net imports. British Columbia is a net exporter of these products. For pulp and paper products, the results follow a similar pattern where high demand from California results in the state importing large volumes of product, while the other PCR jurisdictions are net exporters. Woodchip and pellet markets are relatively small except for some bilateral trade between Western states and the PCR, intra-PCR trade, and the British Columbia export market to Europe and Japan.

In general, at the time of our analysis, domestic markets (and intra-PCR trade) were the main markets for PCR wood products. International trade was important for some subcategories of primary wood products but was relatively minor compared to domestic markets. The geographic scope of primary wood product trade in the United States and British Columbia depends on the product type. Lumber and plywood trade is focused largely on regional markets, but lower value products are imported and exported at much greater geographic distances. However, there is considerable nuance in these broad conclusions that we examined in the individual sections of this research paper.

Future work could focus on expanding this analysis in several ways. First, using more than the latest 2017 CFS survey data would give a broader picture of changing state-to-state trade flow patterns in the United States. This could be especially interesting once the U.S. Census Bureau releases the 2022 CFS results, as market conditions may have changed substantially over this period. Second, these data could be used to develop economic models that could answer interesting intrastate policy questions, similar to what other researchers have done using international trade data. One potential application would be to analyze the consequences of state-specific carbon mitigation policies and how that can potentially affect interstate wood product trade flow patterns.

Acknowledgments

This work is in support of the Pacific Coast Temperate Forests Memorandum of Understanding as signed by the California Natural Resources Agency; British Columbia Ministry of Forests, Lands, Natural Resource Operations, and Rural Development; Oregon Department of Forestry; and Washington State Department of Natural Resources. We gratefully acknowledge financial support from the California Department of Forestry and Fire Protection and the California Board of Forestry and Fire Protection through agreements with the USDA Forest Service, Pacific Northwest Research Station, Forest Inventory and Analysis program (Agreement 20-JV-11261979-091).

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Appendix 1

Table A1.1—U.S. region definitions

Pacific coast region (PCR)	West (non-PCR)	Midwest	North	South
California	Alaska	Illinois	Connecticut	Alabama
Oregon	Arizona	Indiana	Delaware	Arkansas
Washington	Colorado	Iowa	Maine	Florida
	Hawaii	Kansas	Maryland	Georgia
	Idaho	Michigan	Massachusetts	Kentucky
	Montana	Minnesota	New Hampshire	Louisiana
	Nevada	Nebraska	New Jersey	Mississippi
	New Mexico	North Dakota	New York	Missouri
	Utah	Ohio	Pennsylvania	North Carolina
	Wyoming	South Dakota	Rhode Island	Oklahoma
		Wisconsin	Vermont	South Carolina
			Washington, D.C.	Tennessee
			West Virginia	Texas
				Virginia

Appendix 2

The U.S. Census Bureau's Commodity Flow Survey (CFS) was not specifically designed to measure state-to-state trade **traded quantities** for the wood products industry. It is therefore important to compare, whenever possible, the estimates of traded volumes to other sources of data. Unfortunately, little information is available on state-to-state primary wood product trade flows. One source of trade information is the Western Wood Products Association (WWPA), which tracks the principal markets for lumber produced in all Western states (WWPA 2020). We compared the WWPA lumber trade flow data to the traded volumes estimated in the CFS data (U.S. Census Bureau 2017). Because the CFS was based on 2017 data, we also used the 2017 WWPA trade flow data, rather than the most current data, for this comparison.

WWPA data are reported in board feet, lumber tally. To compare to the CFS data, which is reported in U.S. short tons, we converted CFS data to board feet, lumber tally, using the density conversion factor in table 2. Figure A2.1 shows the total lumber export volumes (to other U.S. states) for the main lumber-producing states in the West—California, Idaho, Montana, Oregon, and Washington. For Oregon and Washington, the top producing states, estimates for the two datasets were reasonably close. For the lower production states, the percentage of differences in the two datasets are quite large. For example, the CFS export estimates were 73 and 31 percent higher than the WWPA estimates in California and Idaho, respectively, whereas in Oregon and Washington, CFS estimates were 2 and 11 percent lower, respectively.

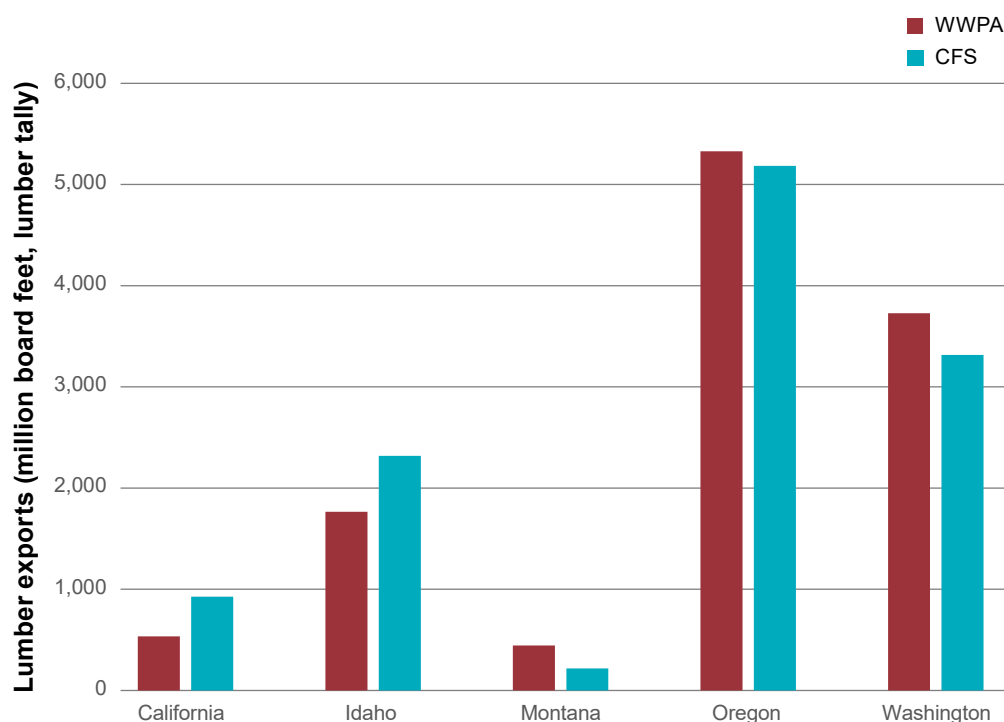


Figure A2.1—Comparison of Western Wood Products Association lumber exports (WWPA 2020) and U.S. Census Bureau's Commodity Flow Survey (CFS) lumber exports (U.S. Census Bureau 2017) to other U.S. states, 2017.

The discrepancy between the two datasets was particularly apparent when we compared the state-to-state trade flow volumes. Table A2.1 shows these volume estimates for the WWPA data (table A2.1A), CFS data (table A2.1B), and the percentage differences (table A2.1C). While in both datasets California was the principal market for Oregon lumber exports, WWPA estimated 1.6 billion board feet, lumber tally, exported to California, while CFS estimated more than 3 billion board feet, lumber tally. The CFS considerably underestimated Oregon exports to other Western states compared to WWPA data.

Because of these large state-to-state trade discrepancies between the WWPA and CFS data, the approach that we used in the study was to use the trade flow shares from CFS, rather than the total trade flow volumes. Table A2.2 shows the comparative trade flow shares for the WWPA and CFS datasets. While there were still significant differences, the shares were much more closely aligned than the total traded volumes.

Table A2.1—State-to-state comparison of (A) Western Wood Products Association (WWPA) trade flow volumes (WWPA 2020), (B) U.S. Census Bureau's Commodity Flow Survey (CFS) trade flow volumes (U.S. Census Bureau 2017), and (C) percentage change between the two datasets (i.e., [(WWPA-CFS)/CFS] × 100), 2017

(A) Western Wood Products Association							
Export state	Principal market						Total exports
	California	Midwest	Northeast	Other West	South central	Southeast	
	MILLION BOARD FEET, LUMBER TALLY						
California	0	120	39	264	71	40	534
Idaho	41	299	136	943	191	156	1766
Montana	3	92	14	242	71	20	443
Oregon	1649	399	246	2598	333	104	5328
Washington	466	454	396	1888	334	190	3729

(B) U.S. Census Bureau's Commodity Flow Survey							
Export state	Principal market						Total exports
	California	Midwest	Northeast	Other West	South central	Southeast	
	MILLION BOARD FEET, LUMBER TALLY						
California	0	93	34	722	17	60	926
Idaho	3	390	186	1055	403	279	2317
Montana	0	21	5	131	61	0	218
Oregon	3018	242	12	1552	323	36	5185
Washington	754	536	246	1522	125	133	3316

(C) Percentage change							
Export state	Principal market						Total exports
	California	Midwest	Northeast	Other West	South central	Southeast	
	PERCENT						
California	—	-22	-12	173	-76	47	73
Idaho	1236	-23	-27	-11	-53	-44	-24
Montana	—	349	177	84	18	—	104
Oregon	-45	64	1894	67	3	189	3
Washington	-38	-15	61	24	167	43	12

— = undefined.

Table A2.2—State-to-state comparison of (A) Western Wood Products Association lumber trade flow shares (WWPA 2020) and (B) U.S. Census Bureau's Commodity Flow Survey lumber trade flow shares (U.S. Census Bureau 2017), 2017

(A) Western Wood Products Association						
Export state	Principal market					
	California	Midwest	Northeast	Other west	South central	Southeast
	PERCENT OF STATE EXPORT					
California	0	22	7	49	13	8
Idaho	2	17	8	53	11	9
Montana	1	21	3	55	16	5
Oregon	31	7	5	49	6	2
Washington	13	12	11	51	9	5

(B) U.S. Census Bureau's Commodity Flow Survey						
Export state	Principal market					
	California	Midwest	Northeast	Other west	South central	Southeast
	PERCENT OF STATE EXPORT					
California	0	10	4	78	2	6
Idaho	0	17	8	46	17	12
Montana	0	9	2	60	28	0
Oregon	58	5	0	30	6	1
Washington	23	16	7	46	4	4

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