



Appendix C: Washington Supply Chains

(2022 Washington State Freight System Plan Update)

Appendix C: Washington Supply Chains documents the economic context for the Washington multimodal freight system, including population trends, economic trends, the role of freight-dependent industries, and Washington supply chains that depend on the freight system.

WASHINGTON STATE DEPARTMENT OF
TRANSPORTATION

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Acronyms & Abbreviations

Acronym	Text
ABB	Asea Brown Boveri
BEA	Bureau of Economic Analysis
BLS	U.S. Bureau of Labor Statistics
CLT	Cross-Laminated Timber
DtC	Direct-to-Consumer
FHWA	Federal Highway Administration
GDP	Gross Domestic Product
GEG	Spokane International Airport
MFC	Micro-Fulfillment Center
SEP	System Electrification Plan
USDA	U.S. Department of Agriculture
WSDOT	Washington State Department of Transportation
WSF	Washington State Ferries

1. Population and economic trends

Demand for freight transportation is created by activity in other parts of the economy, such as consumers buying products or companies manufacturing goods. This chapter's review of broad population and economic trends in Washington provides insight into some of the overarching forces driving demand for freight transportation services in Washington. Furthermore, understanding these broad factors provides context for the freight system trends, needs, and issues that will be explored in later stages of the Washington freight planning process.

Population

A growing population and increasing personal consumption of goods are likely to drive an increase in freight transportation activity.

The current demand and future needs for freight services and workforce availability are all influenced by population trends. As of 2020, approximately 7.7 million people call Washington home. Over the last decade, Washington experienced rapid population growth at 14.6%, almost double the rate of U.S. population growth at 7.4%. Yet, this growth was uneven across the state:

- **Migration is the primary driver behind metropolitan population growth**, primarily to the five largest counties of Clark, King, Pierce, Snohomish, and Spokane. The cities within these counties include Seattle, Vancouver, Spokane, Federal Way, Kent, Tacoma, Auburn, Redmond, and Everett.
- **Counties along the Interstate 5 corridor grew faster** than the rest of the state.
- **Counties bordering or within Puget Sound grew faster** than counties elsewhere.
- **Rural and/or economically distressed counties grew slower** than other counties.¹

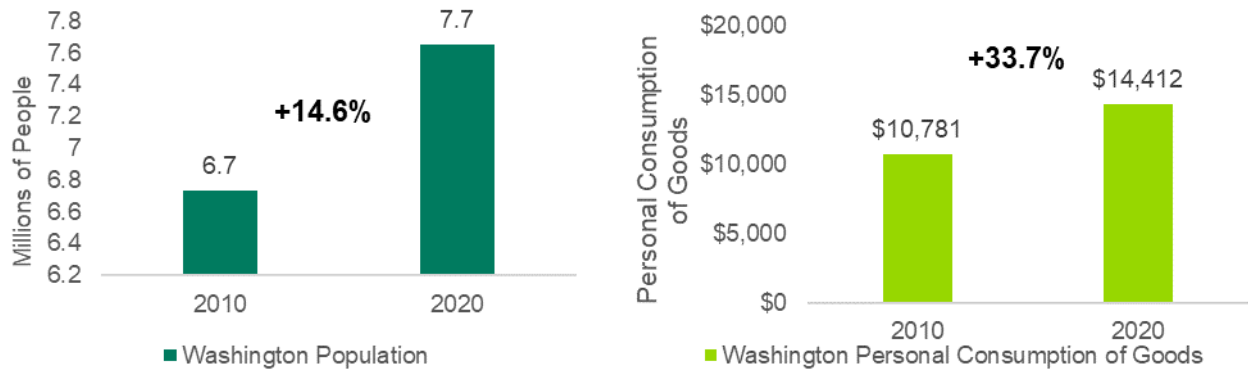
Washington residents are also consuming more goods: over the last decade, personal consumption of goods rose by 33.7%,² outpacing growth in median household incomes (21%).³ This increase in consumption is likely driving some of Washington's increased freight transportation volumes. The state is also rapidly recovering from the impacts of the COVID-19 pandemic, with unemployment falling below 5% in September 2021. Figure 1 illustrates the significant growth in Washington's population and personal goods consumption between 2010 and 2020.

¹ Revised Code of Washington Chapter 43.168.020, Washington State Legislature. <https://app.leg.wa.gov/RCW/default.aspx?cite=43.168.020>

² Consumer Spending by State: Personal Consumption Expenditures by State in current dollars, 2010-2020, US Bureau of Economic Analysis, 2021. <https://www.bea.gov/data/consumer-spending/state>

³ American Community Survey [S1501], US Census Bureau, 2010-2019. <https://www.census.gov/programs-surveys/acs>

Figure 1: Changes in population (left) and personal goods consumption (right)



Source: CPCS analysis of Washington OFM Population Estimates and BEA Consumer Spending by State, in current dollars, 2021.

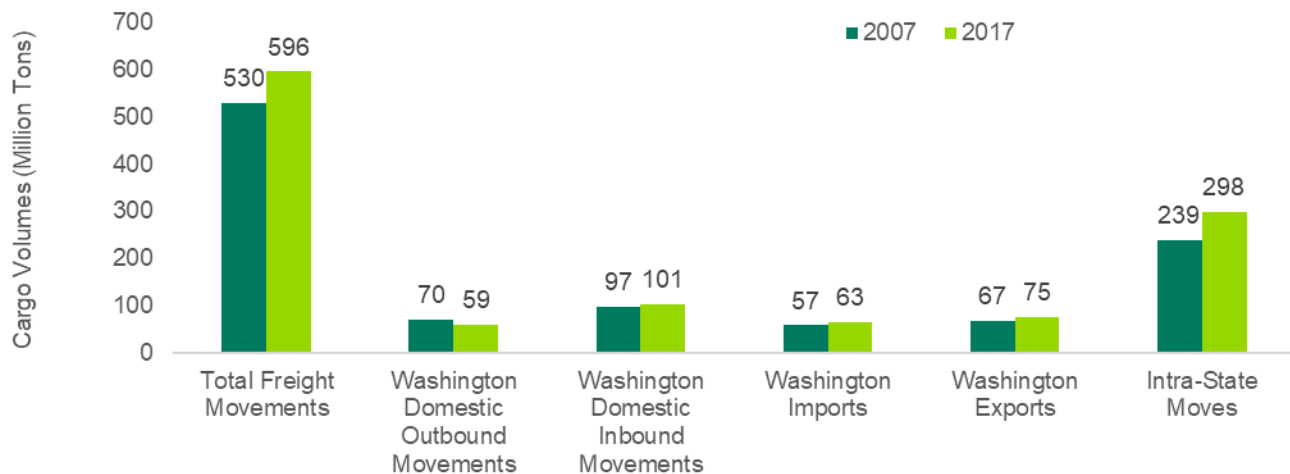
The trends of continued growth in population and increased demand for goods place pressure on existing freight infrastructure – particularly in urban regions and along I-5. Given these trends, Washington must maintain its ability to move freight efficiently and safely in order to ensure a high quality of life and strong economic competitiveness.

Trade

Washington’s multimodal freight system of truck, rail, maritime, aviation, and pipeline handles almost 600 million tons of cargo annually, worth \$677 billion.⁴

Washington’s freight transportation system links producers and consumers together through domestic and international supply chains. Between 2007 and 2017, Washington’s freight movements increased 12% as residential purchases and business orders increased (Figure 2). Domestic outbound shipments declined slightly while all other directions increased over this period – particularly intra-state moves as local residents demanded more goods.

Figure 2: Washington freight movements across all modes, 2007-2017



Source: CPCS analysis of FAF5.3 data, 2022.

⁴ US Freight Analysis Framework Version 5, Federal Highway Administration, 2021. <https://faf.ornl.gov/faf5/> | Represents 2017 base year flows for domestic movements destined for and/or originating from Washington, as well as international imports destined for and/or entering the U.S. through Washington, and international exports originating from and/or exiting the U.S. through Washington.

These trends illustrate how Washington’s multimodal freight system is handling higher volumes of freight movements on its roadways, rail, maritime, aviation, and pipeline systems.

Freight-Dependent industries

While Washington’s freight system supports all industries in the state, certain types of industries rely more-heavily on a safe, efficient, and reliable multimodal freight system to remain competitive. These are known as “freight-dependent industries” and include freight transportation, agriculture, seafood, forestry, energy, construction, manufacturing, retail, dining, disposal, and wholesale, warehousing, and storage. Together, these industries make up about 36% of Gross Domestic Product (GDP), 45% of jobs, and 39% of wages in Washington (Figure 3).

Figure 3: Washington freight-dependent industries’ share of the state’s economy, 2019



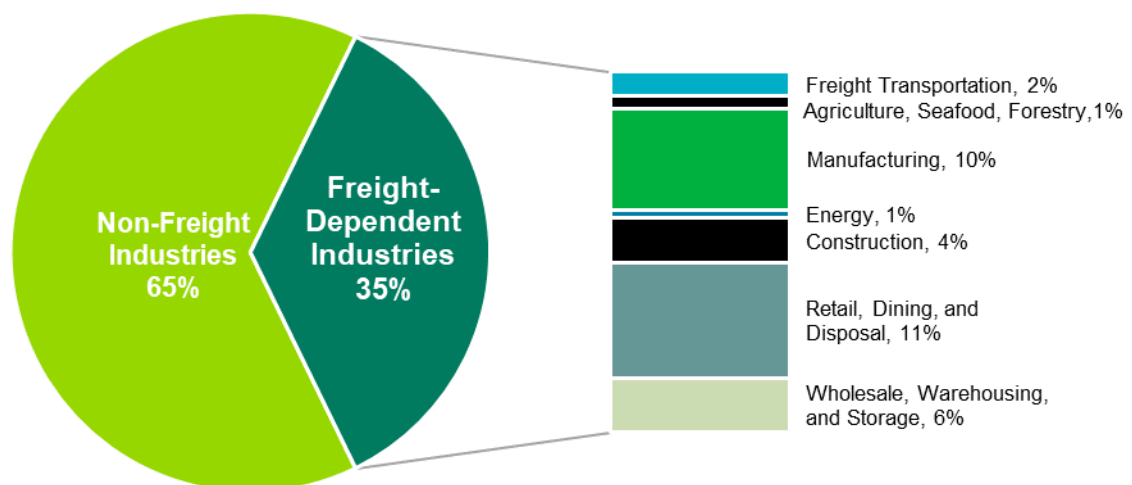
Source: CPCS analysis of U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics data, 2021.

Freight-Dependent industry GDP contributions

While freight transportation directly makes up only 2% of the state’s GDP, the freight system is foundational to 35.6% of GDP through its support of freight-dependent industries.

The top freight-dependent industries by GDP are (1) retail, dining, and disposal; (2) manufacturing; and (3) wholesale, warehousing, and storage (Figure 4).

Figure 4: Washington freight-dependent industry GDP contributions, 2019

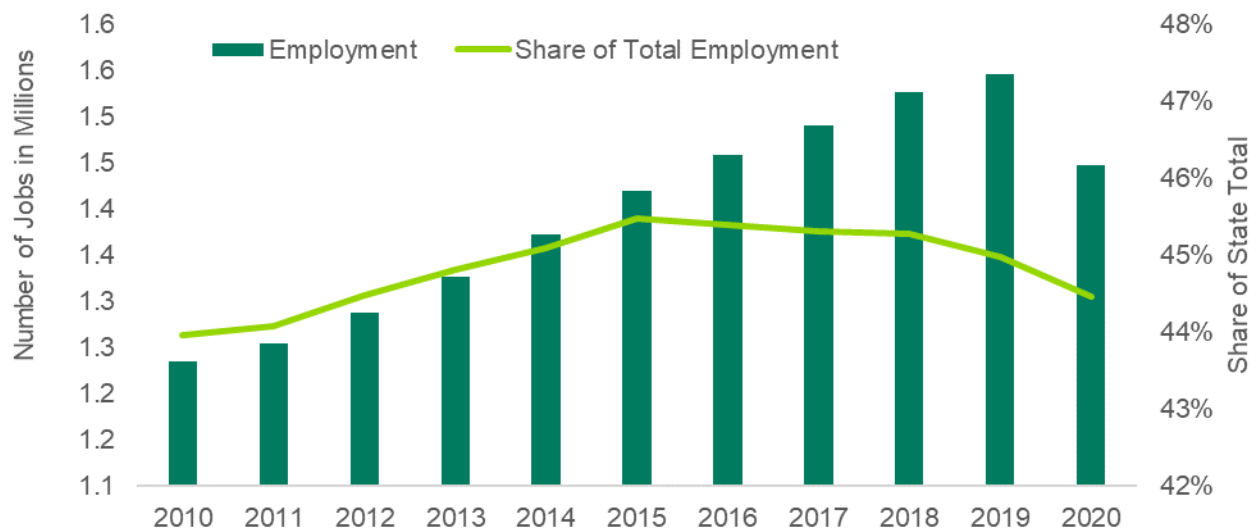


Source: CPCS analysis of U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics data, 2021.

Over the last ten years, freight-dependent employment remained steady between 44% to 45.5% of Washington jobs (Figure 5). While the state experienced relatively stable employment share in agriculture, seafood, warehousing, food manufacturing, and energy over the last ten years, other industries experienced changes. The data reflects:

- **Increased employment share in construction, retail, dining, and disposal, and freight transportation** – primarily to serve demand from continued population and economic growth in the state’s metropolitan cities.
- **Declining employment share in forestry products and manufacturing** (other than food manufacturing) – partially due to declining timber harvests and relocation of manufacturing plants to other locations.

Figure 5: Washington freight-dependent industry jobs and share, 2010-2020



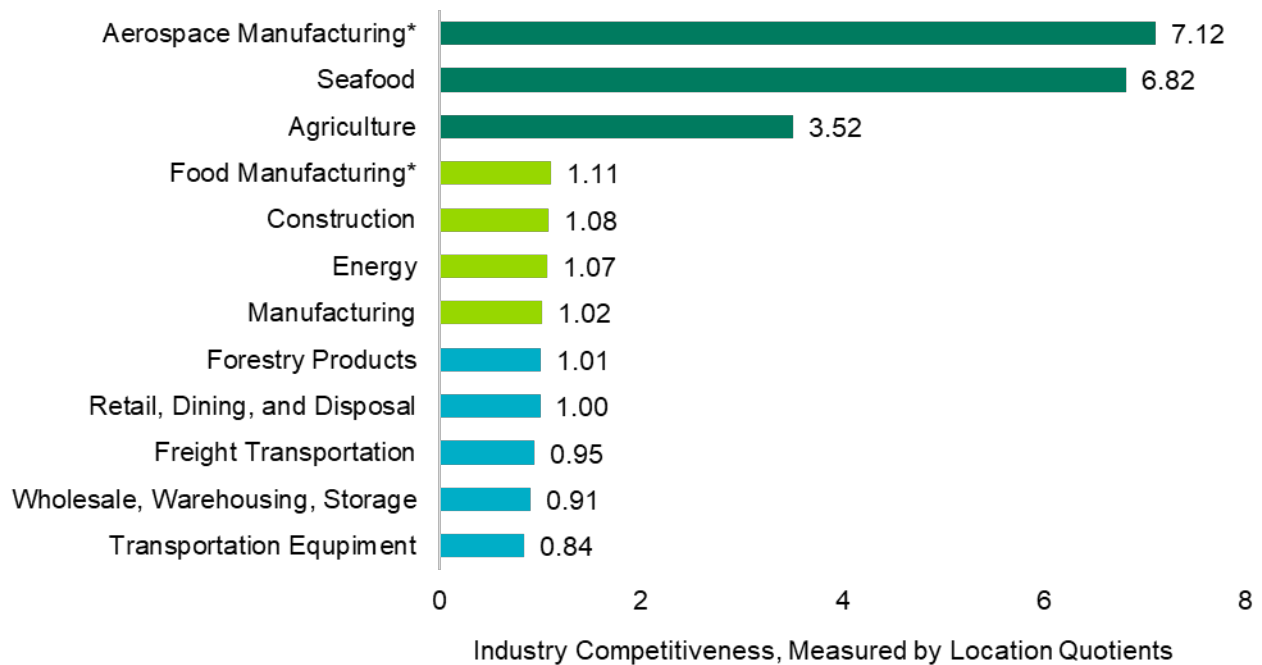
Source: CPCS analysis of U.S. Bureau of Labor Statistics data, 2021

Freight-Dependent industry competitiveness

Washington is home to several highly-competitive freight-dependent industries, such as aerospace manufacturing, seafood, and agriculture.

Figure 6 illustrates the state’s industry competitiveness compared to the rest of the nation. This is measured by “location quotients,” which use employment count to measure the level of industry specialization in a given area compared to the U.S. as a whole. A location quotient greater than 1.0 means the state is producing more of a good/service than the rest of the country, allowing “excess” goods to be exported outside the state. Higher values indicate a higher degree of specialization.

Figure 6: Washington freight-dependent industry competitiveness, 2019



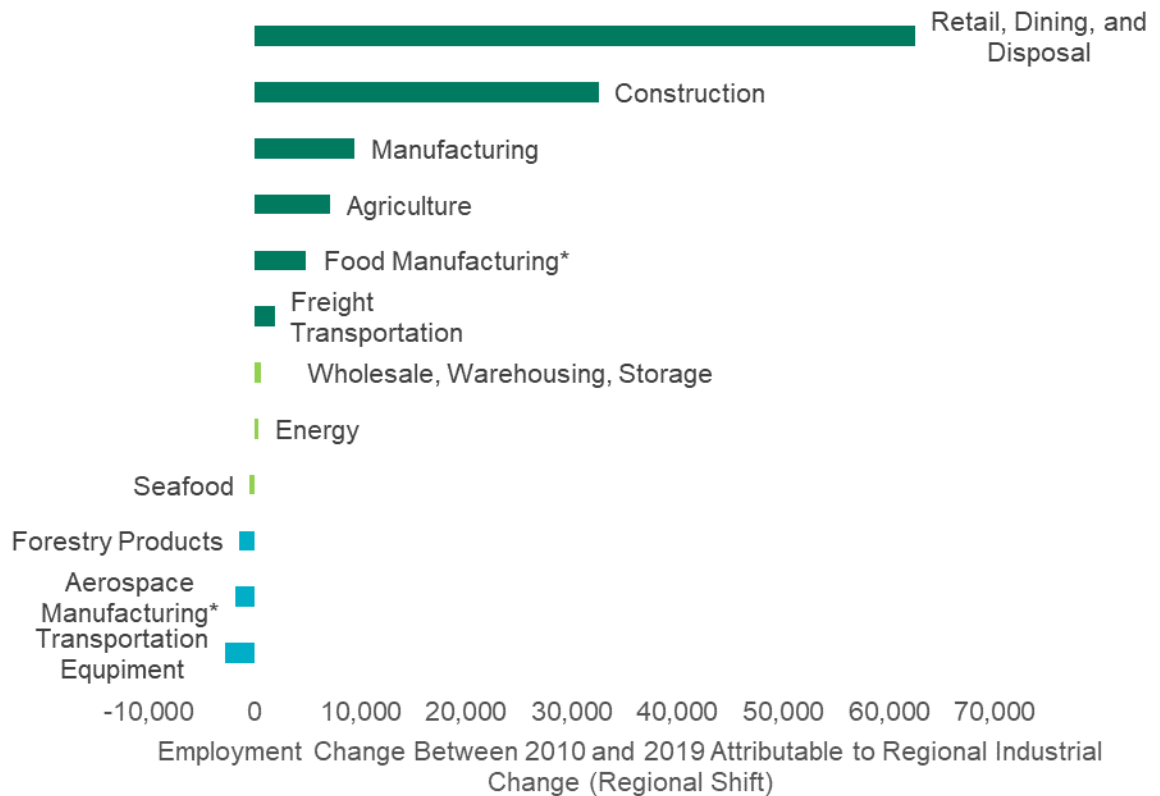
Source: CPCS analysis of BLS, Quarterly Census of Employment and Wages, Washington, and U.S., 2021.

*Asterisk industries fall within the manufacturing industry with an overall 1.02 location quotient.

Some of Washington’s freight-dependent industries increased their competitiveness over the past decade relative to the rest of the U.S., while others declined in competitiveness (Figure 7). A few of the key regional competitiveness trends include:

- **Increased competitiveness in retail, dining, and disposal, construction, and freight transportation** due to faster population growth than the rest of the country.
- **Increased competitiveness in manufacturing and agriculture.** While employment is not growing in these industries, the state still performed better than the rest of the U.S. in manufacturing and agriculture over the last decade.
- **Declining competitiveness in forestry products, aerospace manufacturing, and transportation equipment** compared to the rest of the country due to employment in these industries declining at faster rates than for the U.S. as a whole.

Figure 7: Change in Washington freight-dependent industry competitiveness, 2010-2019

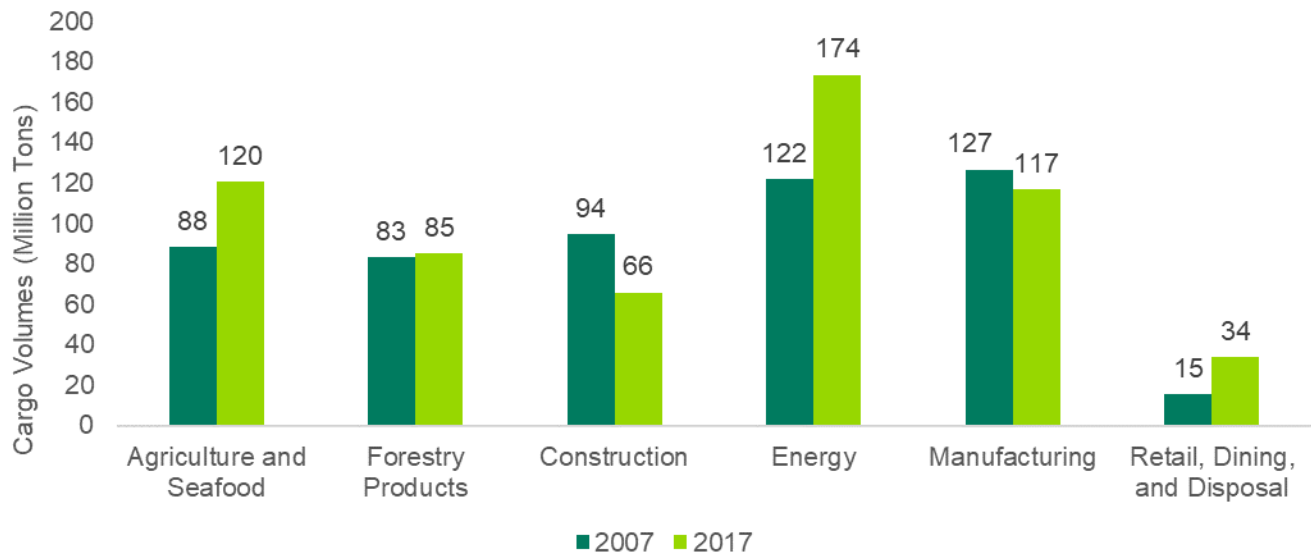


Source: CPCS analysis of BLS, Quarterly Census of Employment and Wages, Washington, and U.S., 2021.
 *Note: Aerospace, food, and high-tech manufacturing sub-sectors falls within the manufacturing industry.

Freight-Dependent industry freight movements

While energy, agriculture, seafood, forestry, and construction represent a small share of the state’s economy, they are the top generators of freight in the state (Figure 8).

Among freight-dependent industries, construction and manufacturing-related freight movements declined, while all others increased. This can be attributed to a slower level of construction activity in 2017 compared to pre-recessionary 2007, and the decline of manufacturing across the state over the last ten years. Note: commodities are attributed to only one industry, though overlaps may exist between certain industries. The industry-commodity table is located in **Reference Chapter A**.

Figure 8: Washington freight-dependent industry freight movements, 2007 and 2017

Source: CPCS analysis of FAF5.3 data, 2021.

Given the importance of freight-dependent industries to the state and their economic reliance on the multimodal freight system, the 2022 Washington State Freight Plan Update illustrates the importance of freight for the continued economic vitality of the state.

In the next section, each freight-dependent industry is profiled with the following information: economic importance and contributions to the state, geographic presence within the state, freight modes used, industry supply chain, key industry trends, and other relevant information. Some industries also include featured subsectors due to unique characteristics for the state:

- Chapter 2: Freight Transportation
- Chapter 3: Agriculture and Seafood – including apple, dairy, grain, potatoes, and seafood
- Chapter 4: Food Manufacturing – including wine production
- Chapter 5: Forestry
- Chapter 6: Energy
- Chapter 7: Construction
- Chapter 8: Manufacturing – including aerospace manufacturing
- Chapter 9: Transportation Equipment – including shipbuilding
- Chapter 10: Retail, Dining, Disposal
- Chapter 11: Wholesale, Warehousing, and Storage

2. Freight transportation

The freight transportation industry is made up of businesses that operate or serve Washington’s aviation, rail, maritime, and trucking sectors. This industry has a significant impact in terms of its overall employment and contribution to Washington’s economy, and Figure 9 provides a summary of some of the direct impacts generated by freight transportation companies in Washington.

Figure 9: Washington industry snapshot – freight transportation services

\$14.3 billion	97,000 jobs	\$6.6 billion
Contribution to state GDP	Employment	Paid in wages & salaries

Source: CPCS analysis of U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics data, 2021.

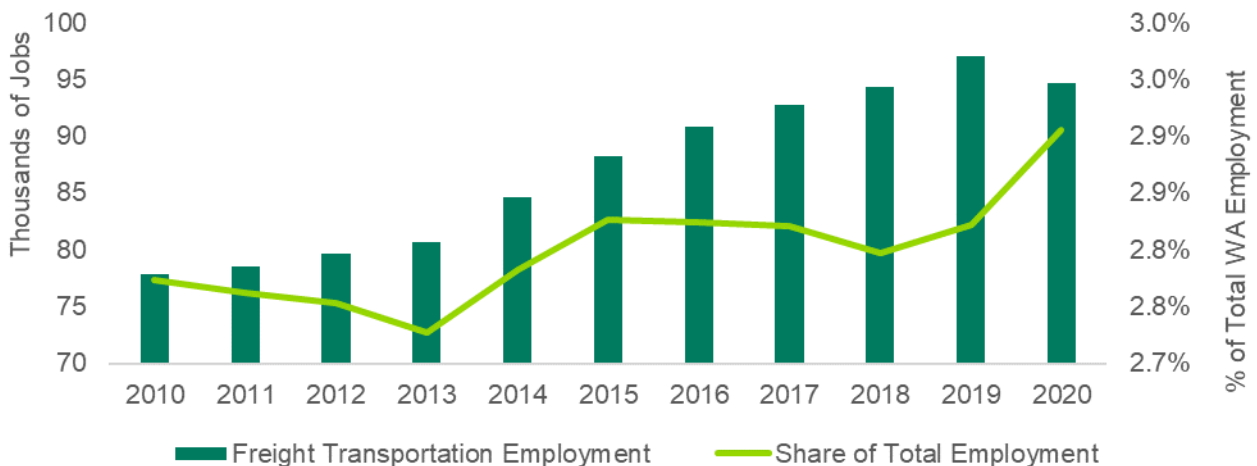
Figure 10: Freight transportation fast facts

22,207	3,200	22	22	46,000
Centerline miles of truck corridors	Active railroad route miles	Deepwater marine ports	Airports providing cargo service	Pipeline system miles

Source: Pipeline safety, Washington Utilities and Transportation Commission. (n.d.). <https://www.utc.wa.gov/public-safety/pipeline-safety>

Demand for freight transportation is created by activity in other sectors of the economy, and Washington’s increased demand for goods and freight transportation services has driven growth. Figure 11 illustrates how employment in freight transportation grew by about 23% between 2010 and 2020, as well as the growth of the share of Washington’s total employment associated with freight transportation.

Figure 11: Washington freight transportation jobs and share, 2010-2020



Source: CPCS analysis of U.S. Bureau of Labor Statistics data, 2021.

Washington’s freight transportation industry has grown in response to increasing demand for freight transportation services.

Freight transportation has value beyond its own direct impacts: it provides a critical service for many other industries, such as agriculture, manufacturing, natural resources, and retail. Without the freight transportation industry, Washington’s freight system would be unable to handle the estimated 596.2 million tons of cargo worth \$677.3 billion that is processed by the state.

In 2017, Washington's multimodal freight system handled 596.2 million tons of cargo worth \$677.3 billion.⁵

Major freight transportation trends



Workforce Shortage: The American Trucking Association estimates that the trucking industry is short 80,000 drivers, a shortage that is forecasted to double by 2030 as the aging workforce retires and relatively fewer people choose trucking as a career.⁶ This shortage affects the reliability of transportation service as well as the cost of transportation; when drivers are limited, companies may have to pay a premium to move their goods or may be unable to move them on schedule. These potential problems are relevant to freight-reliant industries across Washington.



Climate Change: In Washington, climate change is anticipated to result in more extreme temperatures, increased precipitation events, sea-level rise, and other effects that will impact pavement, rail track, and maritime infrastructure. Phenomena like these can damage infrastructure and disrupt the safe, reliable, and efficient operation of freight transportation. At the same time, efforts to address the climate change impacts of air emissions from freight movement are driving research and investment in alternative fuels and electrification for trucks, locomotives, vessels, and aircraft.



Resiliency Events: Washington is susceptible to significant disruptive threats, such as earthquakes, flooding, major snowfall, landslides, and wildfires. Major earthquakes in the Cascadian Subduction Zone, flooding along I-5, and major snow events on I-90 are some examples that can potentially disrupt the movement of freight.



Maritime Innovation: In 2019, Washington published Maritime Blue 2050, a vision for the maritime industry led by the Maritime Innovation Advisory Council and assembled by Governor Jay Inslee. The plan lays out three pathways guiding maritime transportation, including decarbonization and developing a global maritime innovation hub. The plan also lists demonstration projects, such as ferry electrification, charging infrastructure, and emissions tracking.⁷



E-Commerce: Consumers are flocking to e-commerce and have come to expect rapid delivery times, especially during the COVID-19 pandemic lockdown. Between 2011 and 2020, e-commerce sales grew by 290% nationally and as of Q2 2021 made up 13.3% of retail sales.⁸ These trends drive last-mile freight demand on residential roads, micro-fulfillment needs, and shifts in freight delivery methods in urban regions.

⁵ US Freight Analysis Framework Version 5, Federal Highway Administration, 2021. <https://faf.orl.gov/faf5/> | Represents 2017 base year flows for domestic movements destined for and/or originating from Washington, as well as international imports destined for and/or entering the U.S. through Washington, and international exports originating from and/or exiting the U.S. through Washington.

⁶ ATA Chief Economist Pegs Driver Shortage at Historic High, American Trucking Associations, October 2021. <https://www.trucking.org/news-insights/ata-chief-economist-pegs-driver-shortage-historic-high>

⁷ Washington Sustainable Maritime Strategy, Washington Maritime Blue, January 2019. <https://maritimeblue.org/>

⁸ E-Commerce Retail Sales, Federal Reserve Bank of St. Louis, 2021. <https://fred.stlouisfed.org/series/ECOMSA>

3. Agriculture and seafood

Washington is a major producer of agriculture and seafood. The state has key advantages for agriculture, including a diverse climate, rich soil, and ample fresh water sources. Additionally, the cold nutrient-rich waters of Puget Sound provide abundant commercial fishing and aquaculture resources. Many agricultural activities such as potato, grain, and fruit production also generate significant tonnages of freight. Together, the agricultural industry’s high volume of cargo combined with geographically specific regions of production means that the cost-effective transportation services provided by a safe and reliable freight system are critical to supporting these industries and ensuring their competitiveness in world markets. Figure 12 provides a snapshot of agriculture and seafood’s importance for Washington’s economy.

Figure 12: Washington industry snapshot – agriculture and seafood, 2019

\$4.8 billion	99,600 jobs	\$3.3 billion
Contribution to state GDP	Employment	Paid in wages & salaries

Source: CPCS analysis of U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics data, 2021.
 Note: Seafood is not included in the GDP data due to business confidentiality.

Since farms, ranges, and fisheries cannot move, reliable and safe transportation service is a key asset for the agriculture and seafood industry’s operation and competitiveness.

Washington’s top crops include apples, milk, wheat, and potatoes.⁹ Washington is also second only to Alaska in the shipment of fish, and first in aquaculture production in the U.S.¹⁰ Figure 13 provides additional fast facts about the Washington agriculture and seafood industry.

Figure 13: Agriculture and seafood fast facts



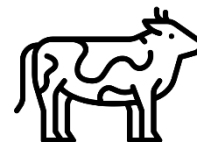
Washington is the #1 U.S. producer of apples, blueberries, hops, pears, spearmint oil and sweet cherries.



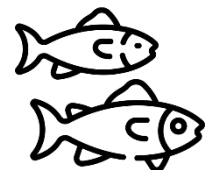
Washington is the #2 producer of potatoes, apricots, grapes, asparagus, and raspberries in the U.S..



Wheat is Washington’s third-highest export by value.



Dairy is Washington’s second largest agriculture commodity, valued at \$1.2 billion.



Washington leads in seafood production, second to Alaska for fish and shellfish and first for aquaculture.

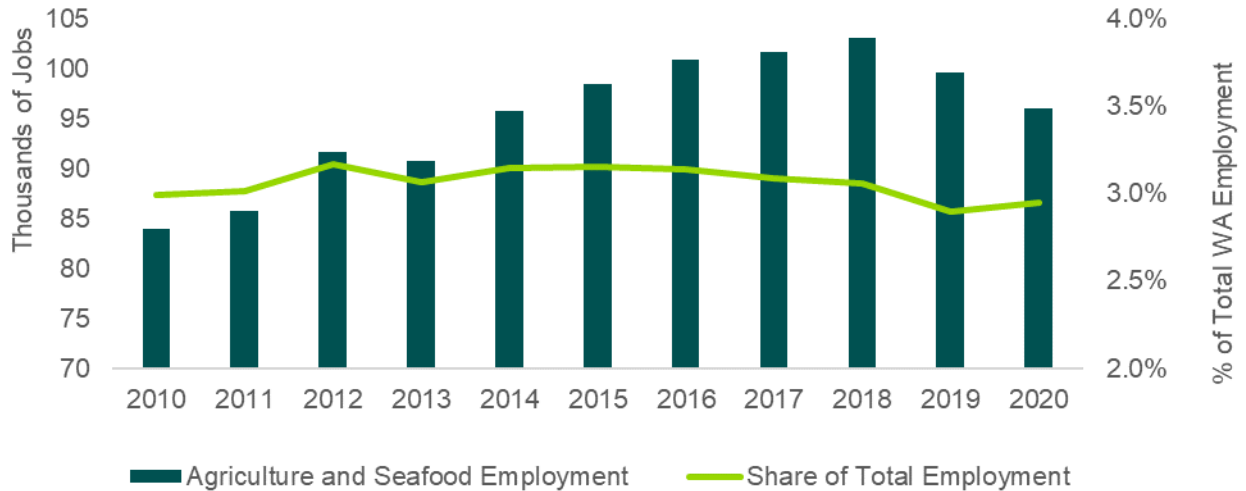
Source: Washington Agriculture Snapshot, Washington State Department of Agriculture, October 2021. <https://cms.agr.wa.gov/WSDAKentico/Documents/Pubs/641-WSDAAGInfographic-WEB.pdf?/641-WSDAAGInfographic-WEB> | 2019 Contribution of the Washington Dairy Sector to the Washington Economy, Washington State University, February 2021. http://ses.wsu.edu/impact-center/wp-content/uploads/sites/2/2021/01/Dairy_Fact_Sheet_v3.pdf | 2020-2021 Wheat Facts, Washington

⁹ Washington Agriculture Snapshot, Washington State Department of Agriculture, October 2021. <https://cms.agr.wa.gov/WSDAKentico/Documents/Pubs/641-WSDAAGInfographic-WEB.pdf?/641-WSDAAGInfographic-WEB>
¹⁰ Agriculture and Food Processing, Washington State Department of Commerce, (n.d.). <http://choosewashingtonstate.com/why-washington/our-key-sectors/agriculture-food-processing/>

Grain Commission, February 2021. https://wagrains.org/wp-content/uploads/2021/02/2020-21WheatFacts_4Web.pdf | Aquaculture in Washington, WSDA (n.d.). <https://agr.wa.gov/departments/agricultural-products/aquaculture>

Employment in agriculture and seafood has varied over the past decade, reaching a peak number of employees in 2018. Figure 14 provides an overview of employment and share of total employment associated with agriculture and seafood over the past decade.

Figure 14: Washington agriculture and seafood jobs and share, 2010-2020



Source: CPCS analysis of U.S. Bureau of Labor Statistics data, 2021.

The COVID-19 pandemic had a drastic impact on the agricultural industry as sales to traditional buyers, such as restaurants and schools, and consumers abroad were halted. The results of the Washington State Farm COVID-19 Impacts and Adaptation Survey indicate that almost half of Washington’s farms (42%) reduced employees due to COVID-19. The top reason for this reduction was reduced demand for products, with 40% of respondents indicating this was a reason for workforce reduction.¹¹

Agriculture and seafood products primarily move by truck and rail in Washington. Rail moved 49% of agricultural product tonnage and trucks moved 44% of agricultural product tonnage in 2022. Trucking is particularly important for higher-value agricultural products, as trucks moved 63% of agricultural products by value, while rail only moved 29% of products by value.¹² In general, trucking and air freight have a higher cost of shipment relative to rail and water transportation as they offer faster service. Therefore, agriculture industries producing higher-value goods such as specialty fish or finished food products often rely on trucking and air, while large bulk producing industries such as grain are relatively more reliant on water and rail shipping. Further discussion of each industries’ commodities and shipping profiles are provided in the following sections.

¹¹ COVID-19 Impacts & Adaptations among Washington State Farm Businesses, University of Washington Nutritional Sciences Program, S.M. Collier, A. Fogel, M. Moore, Y. Sipos, L. Lewis, and L. Raymond, March 2021. <https://nutr.uw.edu/cphn/wafarm/brief-1>

¹² US Freight Analysis Framework Version 5.3, Federal Highway Administration, 2022. <https://faf.ornl.gov/faf5/> | Represents 2017 base year flows with a forecast to 2022 for domestic movements destined for and/or originating from Washington, as well as international imports destined for and/or entering the U.S. through Washington, and international exports originating from and/or exiting the U.S. through Washington.

Apples

Apples are Washington's top agricultural commodity by sales volume and make up about 21% of Washington's total agricultural production by value.¹³ ¹⁴ Furthermore, Washington's apple production is important to the United States as a whole, as 69% of apples bought in the United States are harvested in Washington.¹⁵

Apple production is centered on areas around the Columbia River valley and is illustrated in Figure 16. Packing plants where apples are prepared for further shipment are located closer to urban areas, mainly near Wenatchee and Yakima.

Apple supply chain

Approximately 27% of Washington apples produced are exported, primarily to Mexico (31% of total exports) and Canada (15%), largely shipped in refrigerated containers through the Ports of Seattle and Tacoma. Other major export destinations for Washington apples include Southeast Asia (22%), China (2%), and the Middle East (5%).¹⁶

Apple sector trends



International trade barriers: Retaliatory tariffs and strict import requirements continue to constrain apple exports. India and China were the second and sixth largest export markets for U.S. apples before both countries placed high tariffs (70% in India and 55% in China) in response to the U.S. raising steel and aluminum tariffs on the two countries in 2019.¹⁷ The European Union has also blocked the import of apples from the U.S., raising issue with treatments used in the U.S. to preserve apple quality and lengthen shelf life.¹⁸



Growth in varieties: Twenty years ago, Washington apple production centered on two varieties, with Red Delicious making up nearly half of the crop. Since then, Washington apple producers made major investments in diversifying crops to provide customers greater variety. With these investments, as well as technology improvements making production more efficient, the apple sector is expecting to continue to grow in Washington, and at a minimum stabilize in the coming years.¹⁹

¹³ Washington Agriculture Snapshot, Washington State Department of Agriculture, October 2021.

<https://cms.agr.wa.gov/WSDAKentico/Documents/Pubs/641-WSDAInfographic-WEB.pdf?/641-WSDAInfographic-WEB>

¹⁴ Agriculture and Food Processing, Washington State Department of Commerce, (n.d.). <http://choosewashingtonstate.com/why-washington/our-key-sectors/agriculture-food-processing/>

¹⁵ Washington Agriculture Production Value Increases during Pandemic, Pacific Northwest Ag Network, October 2021.

<https://www.pnwag.net/2021/10/15/washington-ag-production-value-increases-during-pandemic/>

¹⁶ National Agriculture Statistics Service (NASS), USDA, May 2021.

https://www.nass.usda.gov/Statistics_by_State/Washington/Publications/Current_News_Release/2021/FRUIT.pdf

¹⁷ US Apple: Easing of tariffs on EU imports won't help US growers, Fruit Growers News, November 2021.

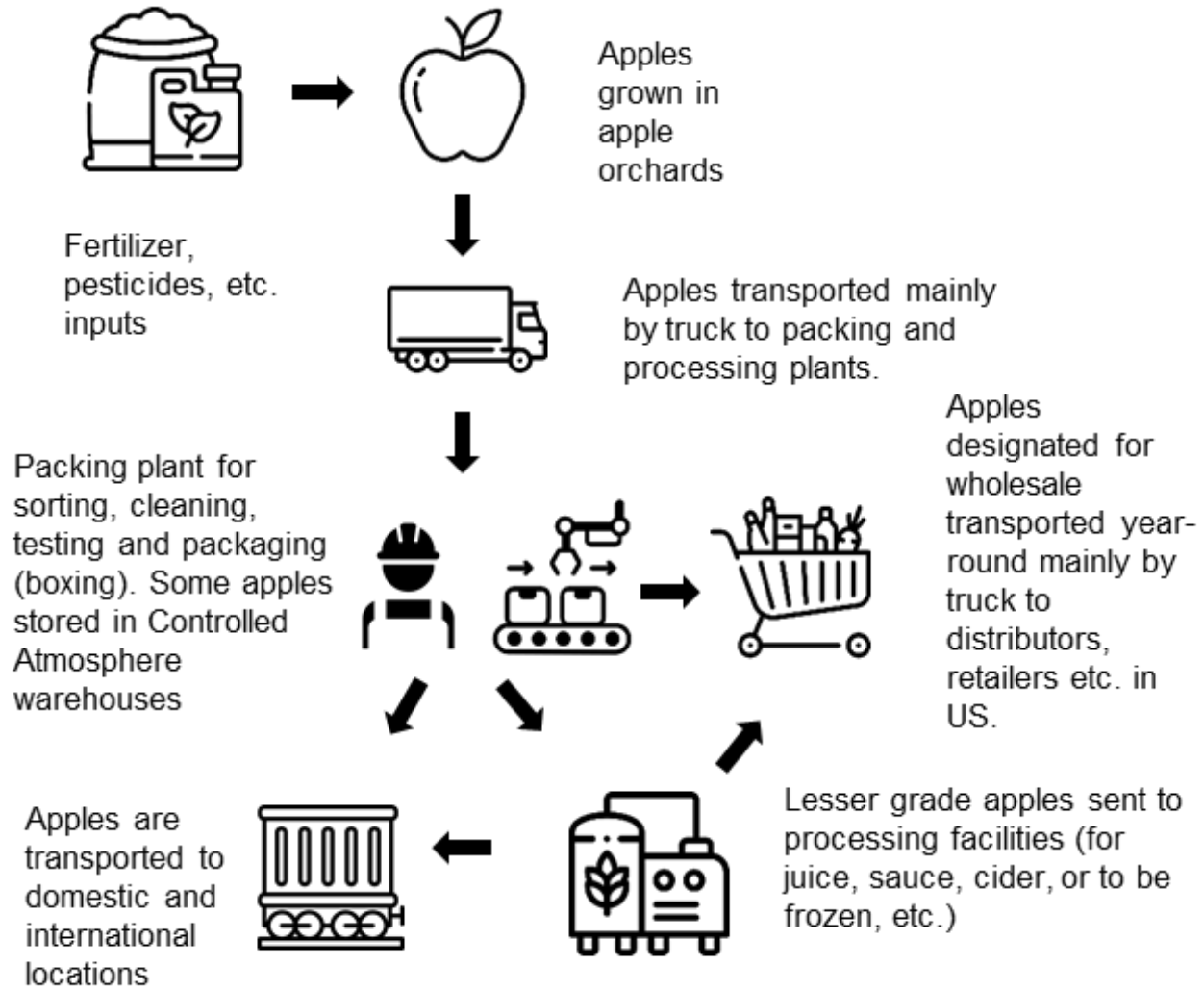
<https://fruitgrowersnews.com/news/usapple-easing-of-tariffs-on-eu-imports-wont-help-us-growers/>

¹⁸ EU blocks many US apples, *South Bend Tribune*, September 2014.

<https://www.southbendtribune.com/story/business/2014/09/19/eu-blocks-many-us-apples/116992790/>

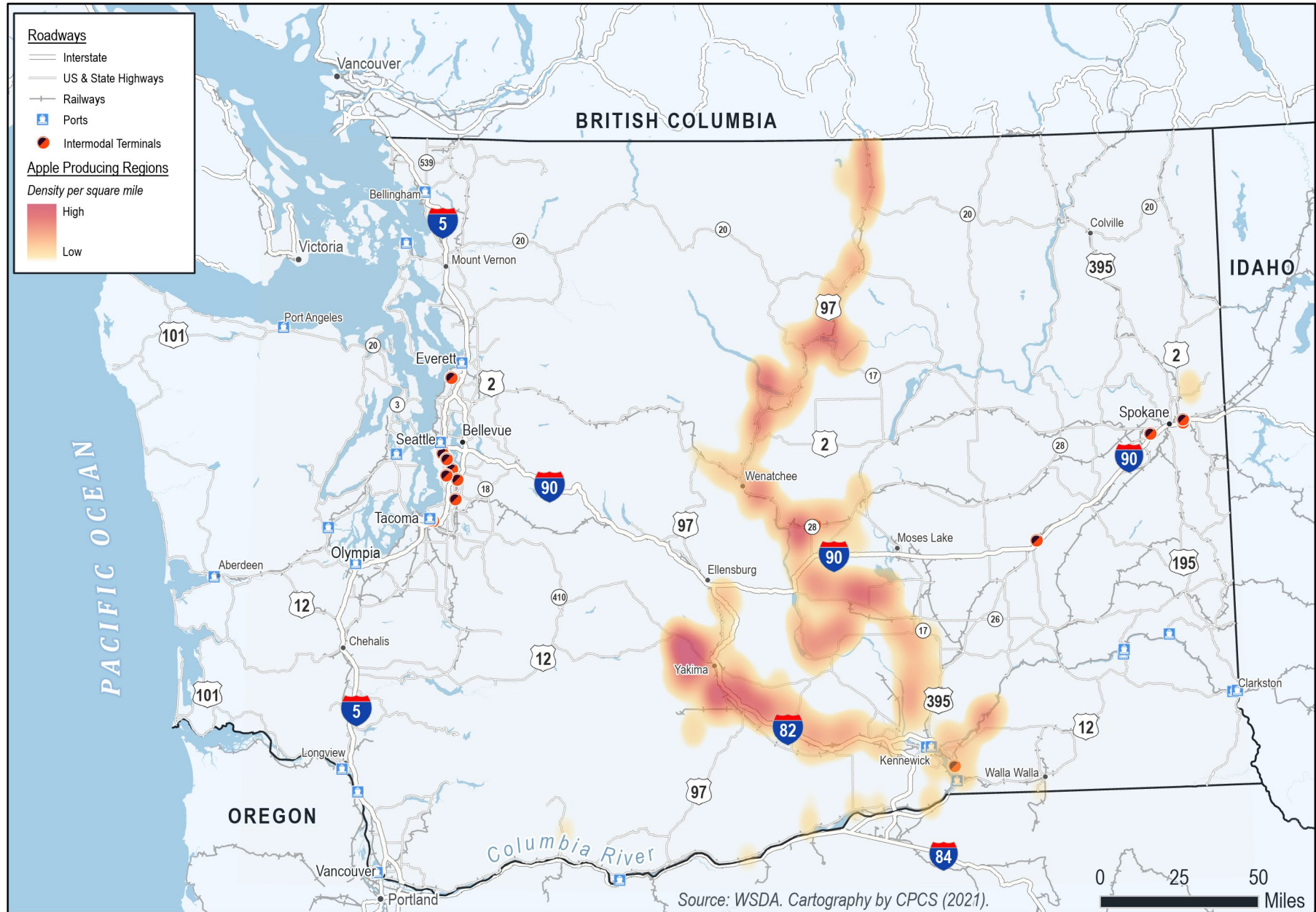
¹⁹ 2021 Washington apple crop update, *The Produce News*, September 2021. <https://theproducenews.com/apples/2021-washington-apple-crop-update>

Figure 15: Apple supply chain



Source: CPCS analysis of literature sources and industry knowledge, 2022.

Figure 16: Washington apple growing regions



Dairy

Dairy products are Washington's second-largest agricultural commodity, valued at roughly \$1.2 billion in 2019.²⁰ The state has about 300 dairy farms, and 90% of Washington's milk is processed in-state at local dairy plants.^{21 22}

A majority of Washington's dairy farms are smaller operations located in the Northwest region of the state, although several farms and processing sites are also located in central Washington around the Yakima Valley. Figure 17 shows the distribution of active dairy milking facilities across Washington and their sizes by animal numbers.

Dairy supply chain

As shown in Figure 18 the production of milk and other dairy products starts with the transport of raw milk in refrigerated tanker trucks from dairy farms to nearby processing facilities. Dairy processing plants are largely located in populated areas in-state, closer to the markets where products will be sold or exported. According to the Pacific Northwest Federal Milk Marketing Order, in 2020, 42% of milk in the region was used to produce butter, 30% for cheese products, 22% was sold as fluid milk, and 6% for yogurt, ice cream, and sour cream.

Once processed and packaged, dairy products are transported by trucks directly for sale as milk, cheese, yogurt, cream, or as powder and other less perishable products for sale in international markets. These products may be transported by truck or rail to destinations in the U.S. or to coastal ports for export.

Top export locations

Key export products in the dairy sector are cheese and milk powders. In 2019, Washington's top international dairy export products were powdered milk to Vietnam, Mexico, and Indonesia and cheese to Japan.²³

²⁰ 2019 Contribution of the Washington Dairy Sector to the Washington Economy, Washington State University, J. Shannon Neibergs and Timothy P. Nadreau, February 2021. http://ses.wsu.edu/impact-center/wp-content/uploads/sites/2/2021/01/Dairy_Fact_Sheet_v3.pdf

²¹ Ibid.

²² Washington Dairy Community Has Positive Effect on Jobs and Economy, Washington Dairy Council, (n.d.). <https://www.wadairy.org/washington-dairy-community-has-positive-effect-on-jobs-and-economy/>

²³ US State Export Data, 2019, US Census Bureau Trade Data, (n.d.). <https://www.census.gov/foreign-trade/statistics/state/data/wa.html>

Figure 17: Washington dairy production

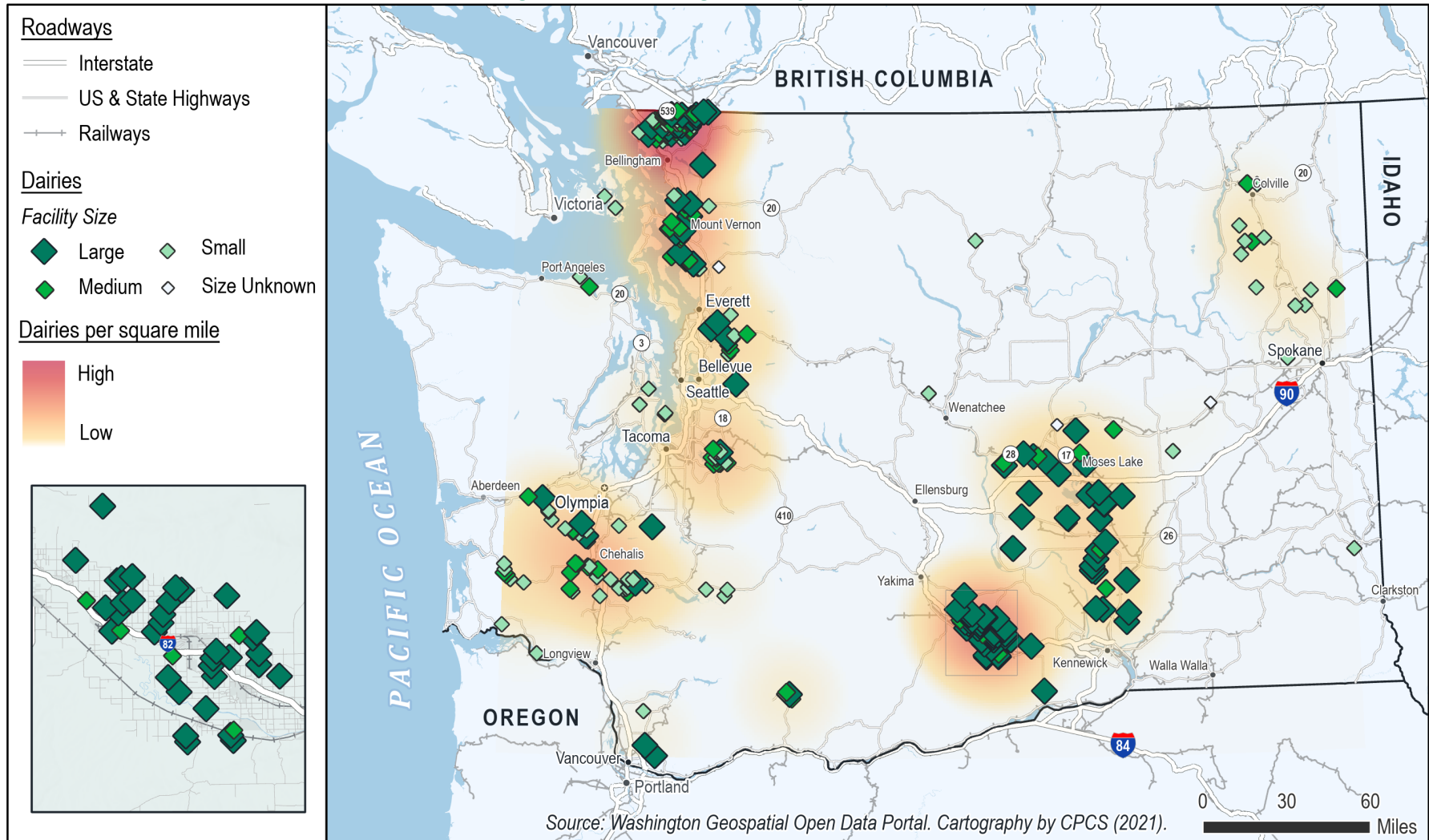
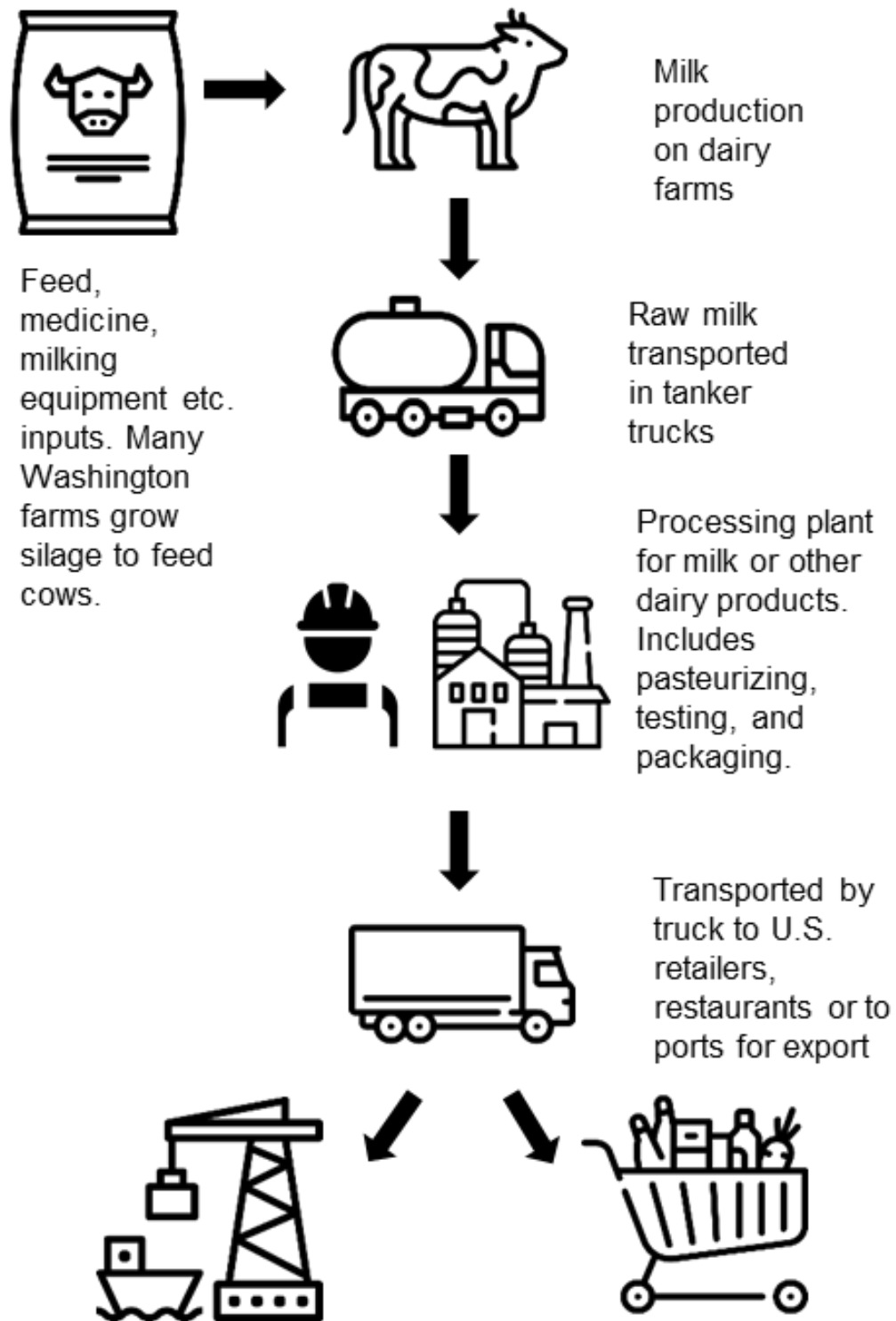
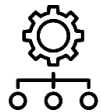


Figure 18: Dairy supply chain



Source: CPCS analysis of available literature sources and industry knowledge, 2022.

Dairy sector trends



Consolidation: While the number of cows in Washington is increasing over time, the number of farms continues to decline statewide. The number of dairy producers shrunk by more than 23% between 2015 and 2020.²⁴



Shifts in production: Increased competition for land due to development and high-value crop production has forced more dairies to move to central Washington, away from traditional dairy farming areas in the northwest.²⁵



Favorable trade conditions: The completion of the U.S. Mexico and Canada trade agreement as well as tariff exemptions passed by China in 2020 on U.S. dry whey products provide favorable conditions for growth in the export of dairy products to key markets in China and Mexico.

Darigold is one of Washington's largest dairy processors and is the subsidiary of the Northwest Dairy Association co-op, made up of more than 350 farmers from Washington, Oregon, Idaho, and Montana. Darigold recently announced plans to build a state-of-the-art protein powder and butter facility in Pasco, under an agreement with the Port of Pasco. This will be the largest protein and butter plant of its kind in North America and set to employ 200 and support more than 1,000 jobs in related industries once the plant is operational in 2023. The plant is expected to meet growing demand for dairy products from markets in Southeast Asia and China.

Source: Darigold website, 2021.

²⁴ Washington Agribusiness Status and Outlook, Washington State University, 2021. http://ses.wsu.edu/impact-center/wp-content/uploads/sites/2/2022/02/WASO_2022_v2.pdf

²⁵ Washington State Agriculture and Food Processing Economic/Fiscal Impact Study, Community Attributes, Inc., January 2015. [www.pnwer.org/uploads/2/3/2/9/23295822/cai.wa_farm_bureau_agriculture_&_food_processing_economic_and_fiscal_impact_study_2015_0121_\(1\).pdf](http://www.pnwer.org/uploads/2/3/2/9/23295822/cai.wa_farm_bureau_agriculture_&_food_processing_economic_and_fiscal_impact_study_2015_0121_(1).pdf)

Grain and wheat

In 2020, Washington was the United States' fourth-largest producer of wheat by volume.²⁶ The state's wheat is primarily bound for export to the Philippines, Japan, South Korea, and Taiwan, and in 2019, 83% of wheat was exported.²⁷ When compared to other agricultural commodities, wheat has a relatively low value per ton, and therefore is shipped in bulk. Maritime transportation on the Columbia and Snake River systems and short-line rail lines connects wheat to export ports. Figure 19 shows how Washington's grain production is concentrated in the southeast portion of the state.

Wheat supply chain

Wheat in Washington is grown largely in the southeast region of the state, is harvested between July and October, and is transported mainly to coastal ports for bulk export. Eastern Washington presents a favorable climate with the right amount of precipitation for soft white wheat, which makes up about 80% of Washington's wheat production and is used mainly for noodles and flour products.²⁸ Because of the varied climates, other varieties of wheat are produced across the state, including some production in Western Washington.

Grain transport throughout the state is multimodal and involves three major freight modes: rail, truck, and barge. Figure 20 presents an overview of the supply chain from wheat farms to end destinations. It is typically too expensive to transport grain for long distances by truck, thus transport distances average less than 20 miles.²⁹ Harvested wheat travels by truck from farms to grain elevators for storage and further shipment. From these local elevators wheat is transported by short-line rail lines to connect to barge terminals or Class 1 rail carriers for delivery to export terminals. Wheat is loaded onto cargo ships at these export terminals for transport to international destinations. This multimodal freight system for wheat shipments has resulted in the Columbia River being the nation's largest wheat export gateway in the U.S.

Washington Grain Train

The Washington Grain Train program managed by WSDOT supports greater reliability and efficiency in the movement of grain products to domestic and international markets. WSDOT, in partnership with the ports of Walla Walla, Moses Lake, and Whitman County, operates a fleet of 125 grain cars which carry wheat and barley from loading facilities in eastern Washington to export facilities in western Washington and Oregon. The WSDOT Grain Train Strategic Plan 2021-2027 outlines plans to continue to grow the fleet and better meet the needs of smaller farming operations across the state.

Top export locations

In 2019, the top international destinations for wheat from Washington by value were East and Southeast Asia. Top trading partners included the Philippines, Japan, South Korea, and Taiwan.³⁰

²⁶ 2020-2021 Wheat Facts, Washington Grain Commission, February 2021. https://wagrains.org/wp-content/uploads/2021/02/2020-21WheatFacts_4Web.pdf

²⁷ 2020 Contribution of Wheat Production to the Washington Economy, Washington State University, 2020. http://ses.wsu.edu/impact-center/wp-content/uploads/sites/2/2020/05/2020_Wheat_Fact_Sheet_v2.pdf

²⁸ 2020-2021 WSU Wheat & Barley Research Report to the Washington Grain Commission, Washington State University, 2021. <https://smallgrains.wsu.edu/additional-resources/research-progress-reports/>

²⁹ Wheat Supply Chain Data Collection, Washington State Transportation Center, Jeremy Sage and Ken Casavant, February 2016. <https://www.wsdot.wa.gov/research/reports/fullreports/853.1.pdf>

³⁰ U.S. State Export Data, 2019, US Census Bureau Trade Data, (n.d.). <https://www.census.gov/foreign-trade/data/index.html>

Figure 19: Washington map of grain production

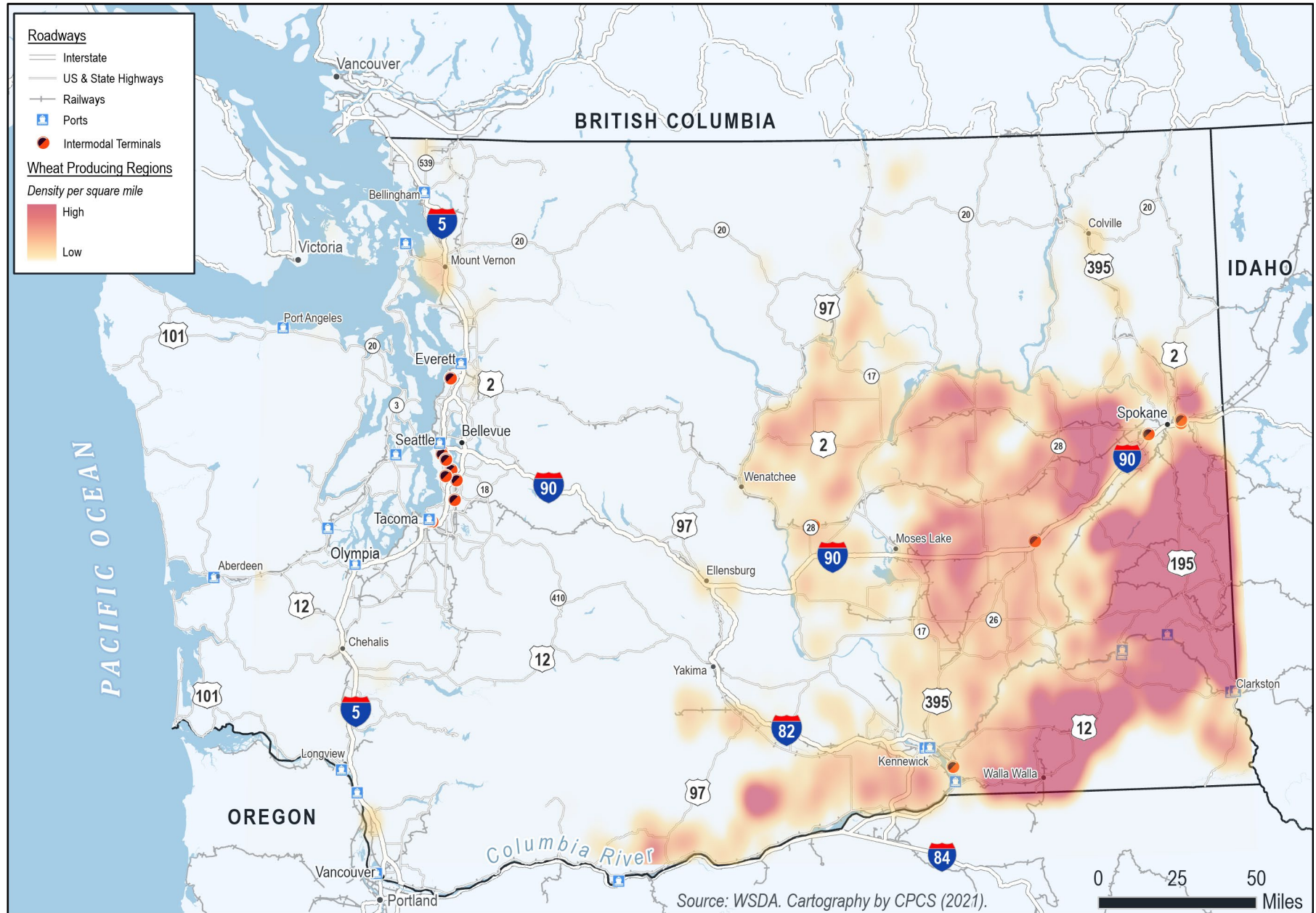
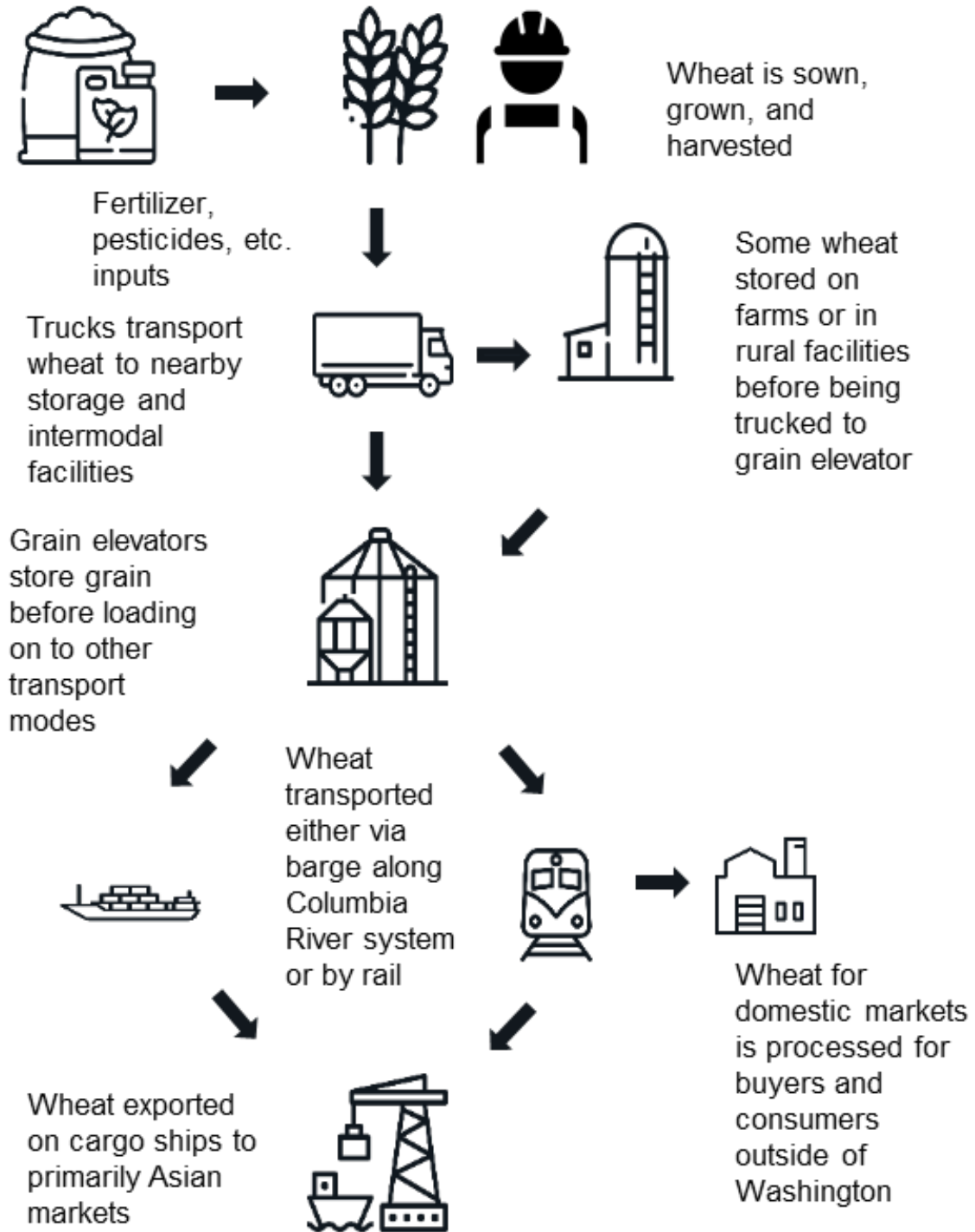


Figure 20: Wheat supply chain



Source: CPCS analysis of available literature sources and industry knowledge, 2022.

Wheat sector trends



Extreme weather affects production. As with all agricultural sectors, wheat production is dependent on favorable climate conditions. Only about 10% of wheat in Washington is produced on farms with irrigation, making rainfall critical for productive harvests.³¹ The 2021-22 harvest season has projected some of the lowest U.S. export volumes since 2015-16 due to extreme drought conditions in Washington and the Pacific Northwest region.³²



Reduced market share. Although the U.S. remains a major exporter in the global wheat market, it has fallen behind the European Union and Russia in recent years. This is partially attributed to U.S. farmers diversifying into different crops. However, lower-quality and lower-priced wheat options exported from other countries have also contributed to a reduced market share in the U.S.³³

³¹ Severe drought devastates Washington state's wheat crop, *The Seattle Times*, Nicholas K. Geranios, August 2021.

<https://www.seattletimes.com/business/severe-drought-devastates-washington-states-wheat-crop/>

³² All-wheat carryover forecast at eight-year low, *Food Business News*, Jay Ssjerven, July 2021.

<https://www.foodbusinessnews.net/articles/19085-all-wheat-carryover-forecast-at-eight-year-low>

³³ Wheat Sector at a Glance, USDA, February 2022. <https://www.ers.usda.gov/topics/crops/wheat/wheat-sector-at-a-glance/>

Potatoes

Washington is the second-largest producer of potatoes in the U.S., and has the highest potato yield per acre, producing roughly 40% greater potato yields than the national average.³⁴ ³⁵ The majority of potatoes produced in Washington (77%) undergo further value-added processing, such as the creation of french fries.³⁶ Figure 21 shows that Washington's potato production is densest in the northwest region of the state near Mount Vernon and the central south between Kennewick and Moses Lake.

Potato supply chain

The journey for potatoes in Washington starts in the main growing regions around the lower Columbia basin and the Skagit Valley in the northwest. The volcanic soil, abundant water, mild climate, and good sunlight have made these regions the most productive potato fields in the U.S.

As shown in Figure 22, potatoes are harvested between July and October and travel by truck to nearby processing or packing facilities. Some potatoes are also brought directly to special temperature-controlled warehouses for storage. These facilities are typically located close to potato farms to reduce transportation costs. Additionally, the close proximity allows for farmers and processors to collaborate on storage practices and quality control, ensuring the best treatment for potato harvests.³⁷ Potatoes can be stored for several months in specialized buildings built for storing potatoes with proper circulation, humidity, and temperature.

Trucks drop off potatoes at packing and processing facilities to be cleaned and sorted. Potatoes selected for processing may travel by truck again or continue in the same facility undergoing preparations for frozen and dehydrated products and chips. Potatoes to be sold fresh or as processed products travel in bags and boxes mainly by truck to final destinations, including retailers, distribution centers, and ports for containerized export.

Top export locations

For Washington potatoes traveling internationally, the main markets include Japan, South Korea, the Philippines, and China, largely as processed frozen french fry products.³⁸

³⁴ COVID-19 and Washington State Potatoes: Economic Losses from Reductions in Potato Demand, Impact Center at Washington State University, Timothy P. Nadreau and Suzette Galinato, 2020. http://ses.wsu.edu/impact-center/wp-content/uploads/sites/2/2020/09/WSPC_Final_v2.pdf

³⁵ Ibid.

³⁶ Washington Agribusiness Status and Outlook, Washington State University, 2021. http://ses.wsu.edu/impact-center/wp-content/uploads/sites/2/2021/01/WASO_2021_Draft_v5.pdf

³⁷ Washington State Agriculture and Food Processing Economic/Fiscal Impact Study, Community Attributes, Inc., January 2015. [www.pnw.org/uploads/2/3/2/9/23295822/cai.wa_farm_bureau_agriculture_&_food_processing_economic_and_fiscal_impact_study_2015_0121_\(1\).pdf](http://www.pnw.org/uploads/2/3/2/9/23295822/cai.wa_farm_bureau_agriculture_&_food_processing_economic_and_fiscal_impact_study_2015_0121_(1).pdf)

³⁸ U.S. State Export Data, 2019, US Census Bureau Trade Data, (n.d.). <https://www.census.gov/foreign-trade/data/index.html>

Figure 21: Washington potato production

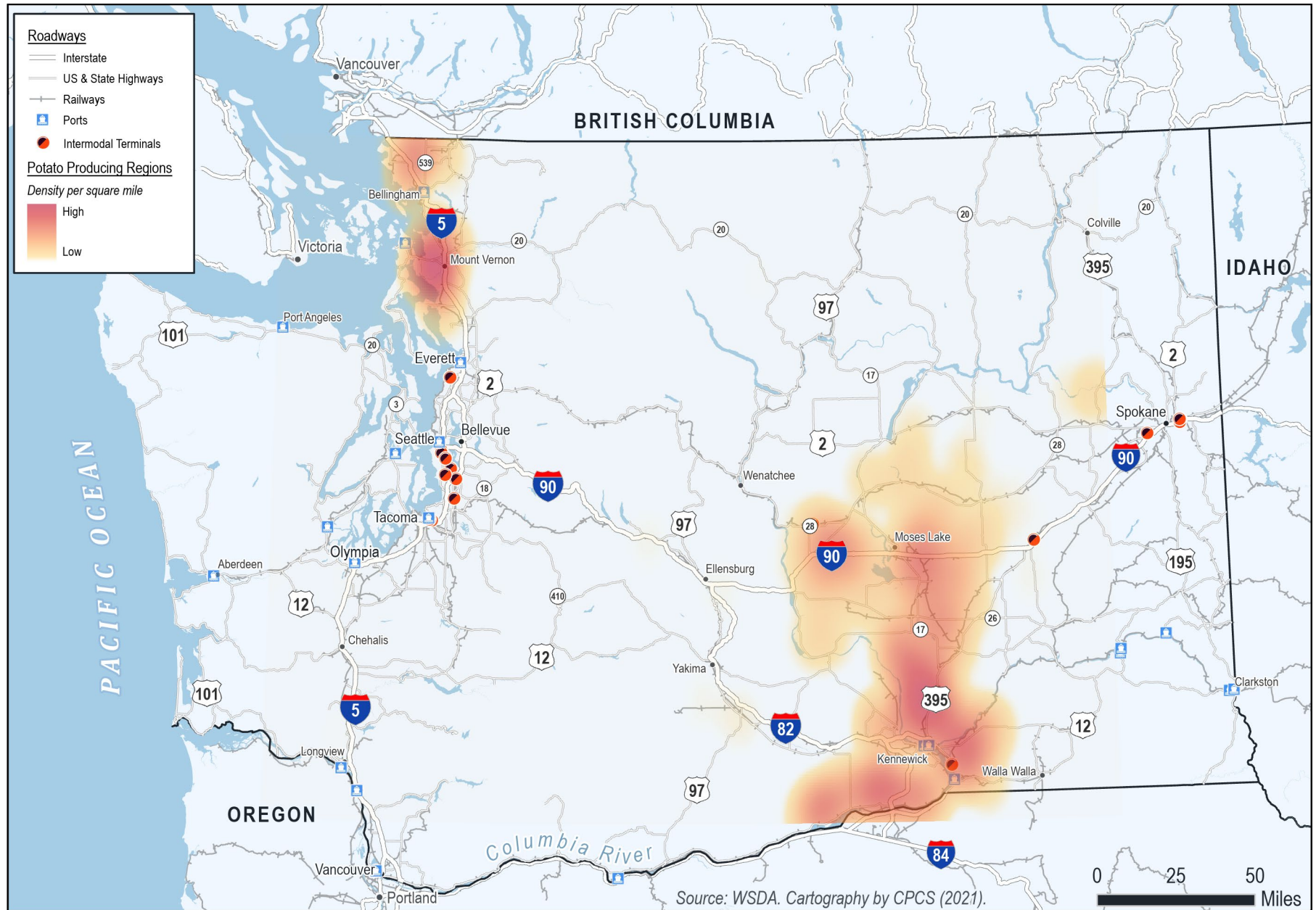
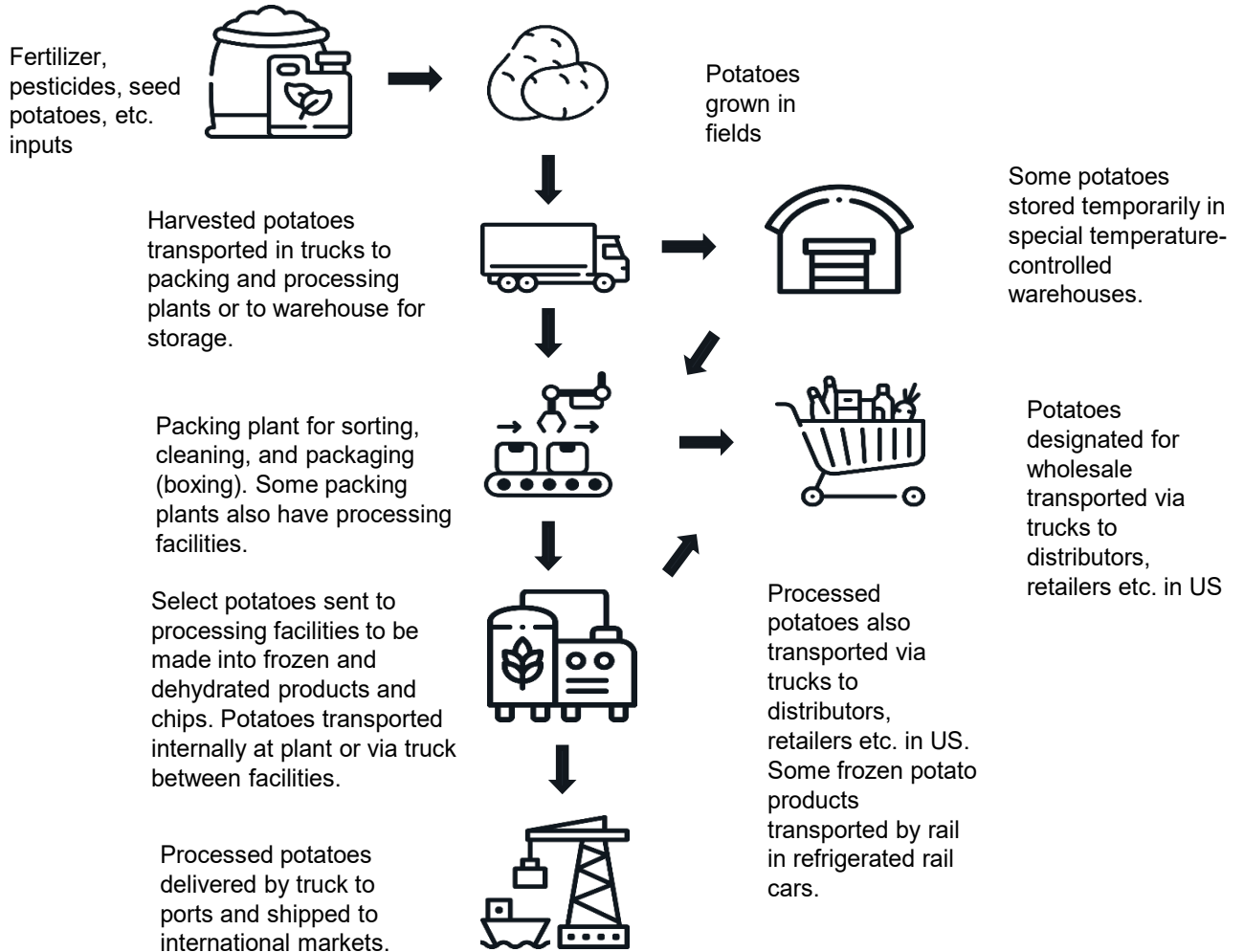


Figure 22: Potato supply chain



Source: CPCS analysis of available literature sources and industry knowledge, 2022.

Potato sector trends



Pandemic recovery. Prolonged restaurant closures and lower demand for processed potato products, such as french fries, hash browns, mashed potatoes, etc., have hurt Washington's potato sector. Reports found that growth in retail sales of potato products was not enough to make up for the 50% loss in food service sales.³⁹ In 2020, growers reduced potato acreage by around 13% and replaced many potato crops with corn.⁴⁰ Looking forward, with the return of many to restaurant and food service facilities, the potato sector outlook is positive for growth, albeit modest compared to previous years.



Rising labor costs. Potato growers have expressed concerns about the rising cost of doing business in Washington. An overtime bill for agricultural workers was passed in 2021 and goes into effect in 2022. An initial threshold of 55 hours per week will be phased out over the next three years until agriculture workers can receive overtime pay after 40-hour work weeks.⁴¹

The Port of Quincy is a major node for agriculture freight. Located near the Wenatchee and Chelan areas, which are among the largest areas for fruit packing in the world, the Port offers large cold storage facilities and an intermodal yard. Products such as frozen french fries, frozen vegetables and fresh produce, including apples, potatoes, cherries, and onions, pass through the port, bound for the ports of Seattle and Tacoma or for Midwest or East Coast markets in the U.S. WSDOT and FHWA also recently upgraded the main highway used to access the port, State Road 281, from T-2 to a T-1 truck freight corridor. The corridor's annual average tonnage totals more than 11.7 million freight tons.

Source: Central Washington Route Upgraded for Agricultural Truck Traffic, *Transport Topics*, Eric Miller, November 2021. <https://www.ttnews.com/articles/central-washington-route-upgraded-agricultural-truck-traffic>

³⁹ Washington potato growers enjoy improved outlook, *The Packer*, Tom Karst, June 2021. <https://www.thepacker.com/news/produce-crops/washington-potato-growers-enjoy-improved-outlook>

⁴⁰ COVID-19 and Washington State Potatoes: Economic Losses from Reductions in Potato Demand, Impact Center at Washington State University, Timothy P. Nadreau and Suzette Galinato, 2020. http://ses.wsu.edu/impact-center/wp-content/uploads/sites/2/2020/09/WSPC_Final_v2.pdf

⁴¹ Washington potato growers enjoy improved outlook, *The Packer*, Tom Karst, June 2021. <https://www.thepacker.com/news/produce-crops/washington-potato-growers-enjoy-improved-outlook>

Seafood

The seafood industry includes wild capture and aquaculture (finfish and shellfish), along with seafood preparations and packaging. Over 80% of jobs are in seafood preparations and finfish farming. Washington has the 3rd highest landings of seafood by volume and 4th highest by value in the U.S., totaling \$309 million.⁴² Washington also has the largest shellfish farming industry in the country, with annual production of more than \$200 million.⁴³

Figure 23 illustrates the variety of seafood sourcing areas. Shellfish are harvested most heavily near the Pacific Coast in North Bay and Willapa Bay, north of Seattle in the Puget Sound and the Salish Sea as well as around the San Juan Islands, and southwest of Seattle among the inlets near Olympia.

U.S. federal treaties with Tribes in Washington

Tribes have fished in this region for thousands of years and rely on the natural resources of this land personally, culturally, and spiritually. As sovereign nations, tribes have treaties with the U.S. federal government preserving their right to fish in “usual and accustomed grounds and stations,” including in off-reservation areas and areas that other fishermen may not operate. The U.S. federal government also has a trust responsibility to the tribes to protect their tribal trust resources through conservation efforts.⁴⁴

In western Washington, twenty tribes have treaty-reserved fishing rights: Lummi, Nooksack, Swinomish, Upper Skagit, Sauk-Suiattle, Stillaguamish, Tulalip, Muckleshoot, Puyallup, Nisqually, Squaxin Island, Skokomish, Suquamish, Port Gamble S’Klallam, Jamestown S’Klallam, Lower Elwha Klallam, Makah, Quileute, Quinault, and Hoh. These 20 tribes are represented by the Northwest Indian Fisheries Commission. In the Columbia River Basin, the Yakama, Warm Springs, Umatilla, and Nez Perce have treaty-reserved fishing rights and are represented by the Columbia River Inter-Tribal Fish Commission.

Wild capture supply chain

A large part of Washington’s commercial wild capture subsector is “homeporting” of fishing fleets that are active in Alaska’s commercial fisheries. For example, the North Pacific Fisheries Fleet Port offloads Alaska harvests of pollock, Alaskan king crab, groundfish, salmon, and other high-value species primarily at the Port of Seattle.

75% of fishing vessels use the Port of Seattle to ship Alaskan harvests⁴⁵

Many ports in the state house commercial fleets and other commercial fishing boats offload at privately-owned terminals offsite. Vessels typically operate around the Puget Sound region and off the West Coast of the Olympic Peninsula for commercial fishing. Many fishing vessels have onboard capabilities to process harvests. Some catches require specialized processors that are available aboard specific vessels or at onshore processing facilities. Catches not processed at sea are typically transferred to onshore facilities near the port of arrival. Catches that have undergone some processing at sea will often be cleaned and packaged at the port.⁴⁶ Figure 23 shows commercial fishing locations around the Washington coastal waters, Figure 24 illustrates shellfish locations, and Figure 25 provides the location of Columbia River Basin fisheries. Figure 26 presents an overview of wild-caught fish landings by

⁴² Fisheries of the United States, National Oceanic Atmospheric Administration (NOAA), 2019. <http://www.fisheries.noaa.gov/national/sustainable-fisheries/fisheries-united-states>

⁴³ Aquaculture in Washington, Washington State Department of Agriculture, (n.d.). <https://agr.wa.gov/departments/agricultural-products/aquaculture>

⁴⁴ Understanding Tribal Treaty Rights in Western Washington, Northwest Indian Fisheries Commission, 2014. <https://nwifc.org/w/wp-content/uploads/downloads/2014/10/understanding-treaty-rights-final.pdf>

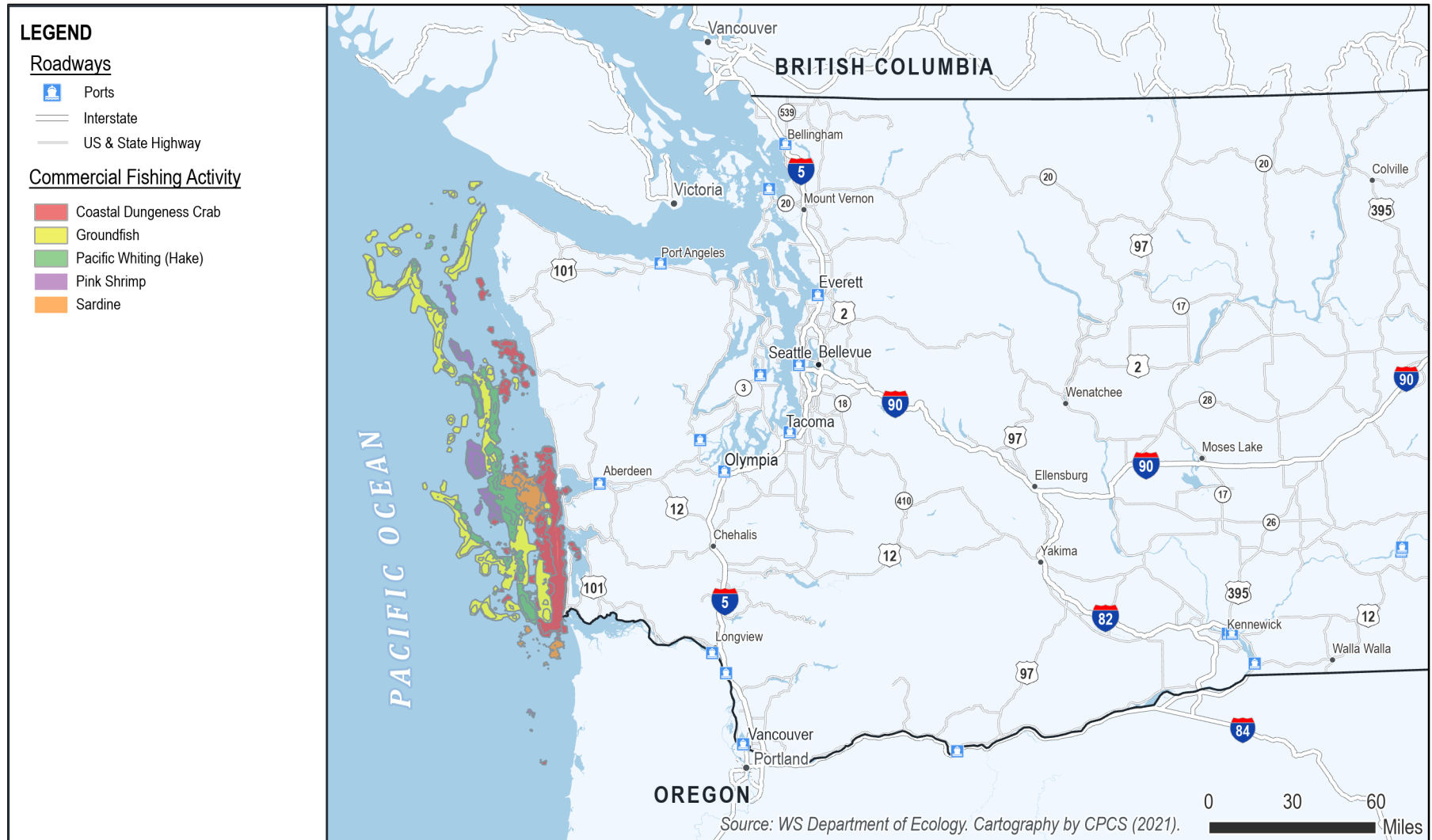
⁴⁵ Marine Cargo Economic Impact Analysis, The Northwest Seaport Alliance, January 2019. https://www.portseattle.org/sites/default/files/2019-01/CAI_NWSA_Marine_Cargo_Economic_Impacts_190122.pdf

⁴⁶ Washington State Maritime Sector Economic Impact Study, Community Attributes, Inc., April 2017. https://www.maritimefederation.com/uploads/2/9/9/6/29962189/cai.wmf.maritime_cluster_study_2017_update.2017_0413.pdf

Washington port areas. Trucks will transport some processed fish products or fresh fish to markets for restaurants or retail in the U.S. Other processed fish products will often be loaded on ships at the port for international destinations.

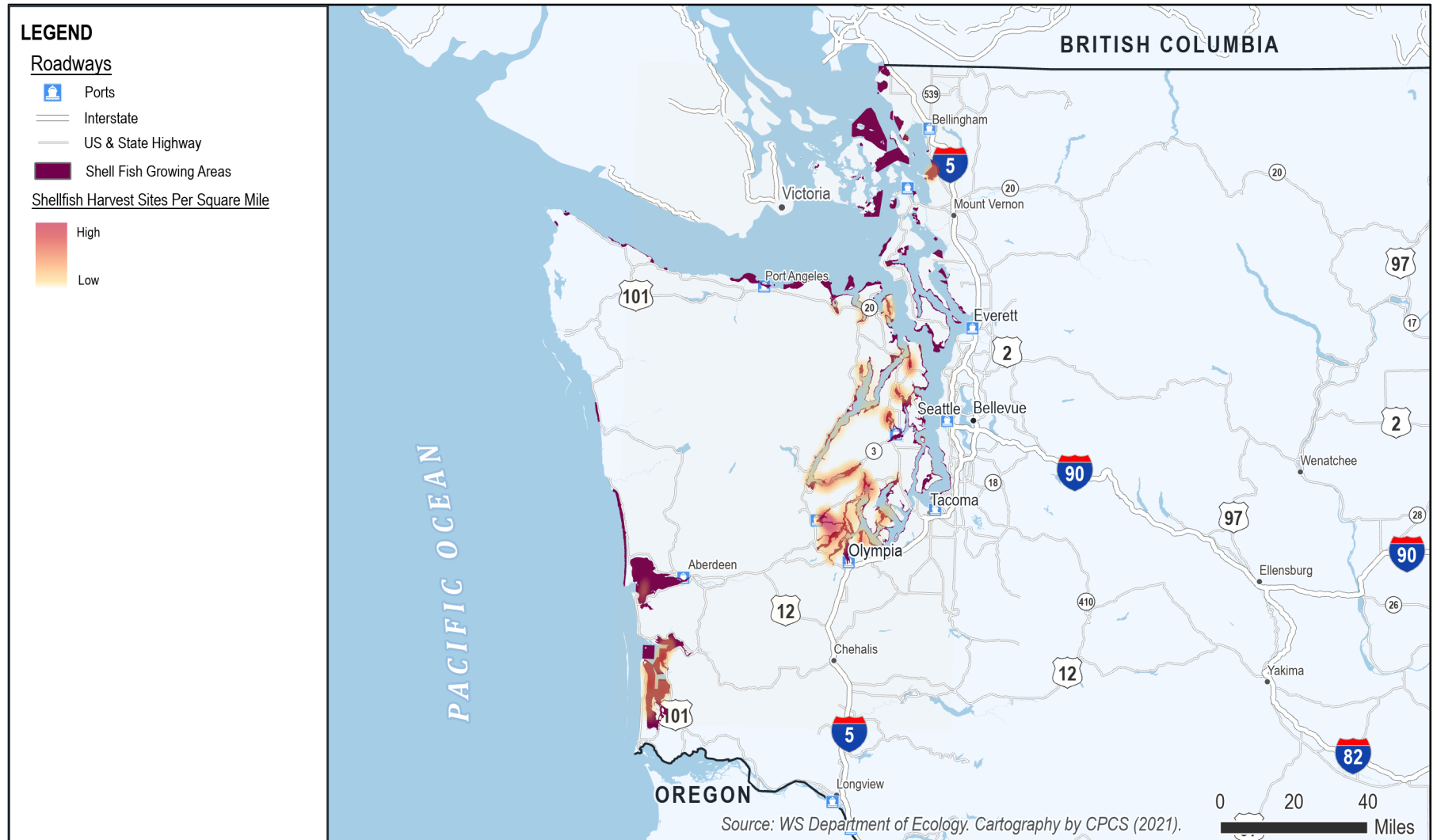
Trident Seafoods is the largest seafood company in the United States. They harvest fish in Alaskan waters, principally Wild Alaska Pollock. Fish are caught, prepared, and frozen on-board Trident fishing vessels and transferred to shoreside processing facilities in Alaska and Washington. Trident has **three processing plants in Washington (Anacortes, Bellingham, and Everett) which produce frozen seafood products.** Pollock, cod, salmon, and halibut are processed through various methods of marinating, battering, breading, frying, and smoking and freezing in single portions for sale in the fresh market and for purchase by foodservice and restaurant buyers, as well as grocery stores. Trident products are shipped throughout the US and exported to China, Japan, Germany, and throughout Europe.

Figure 23: Washington commercial fishing areas



Note: Map shows Washington medium and high concentration commercial fishing regions and does not include recreational fishing, salmon and tuna fishing, or Treaty Tribe-exclusive fishing locations.

Figure 24: Washington shellfish growing and harvest areas



Note: Map shows Washington commercial shellfish growing and harvest locations and does not include Treaty Tribe-exclusive locations.

Figure 25: Washington Columbia River basin fisheries

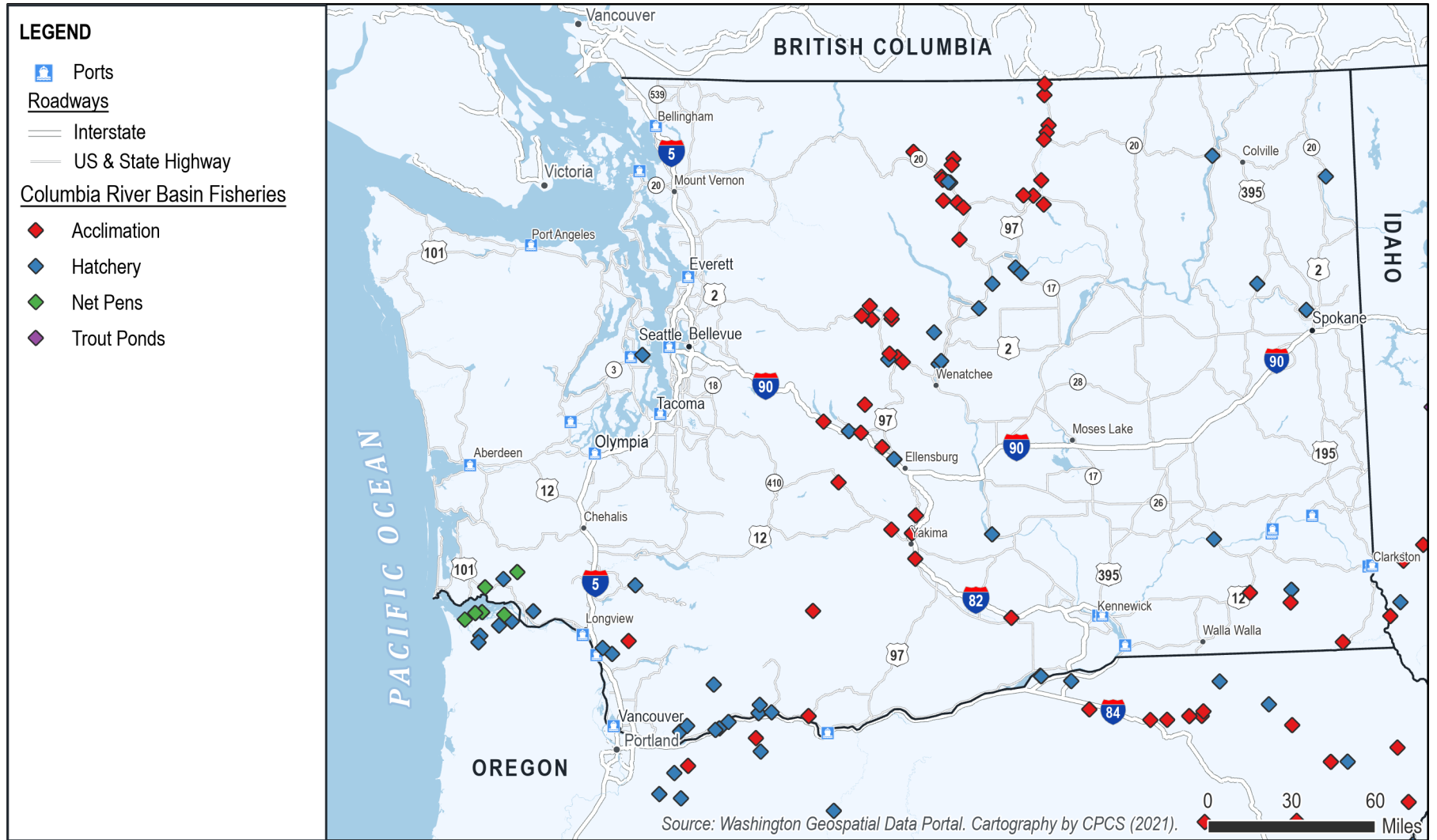
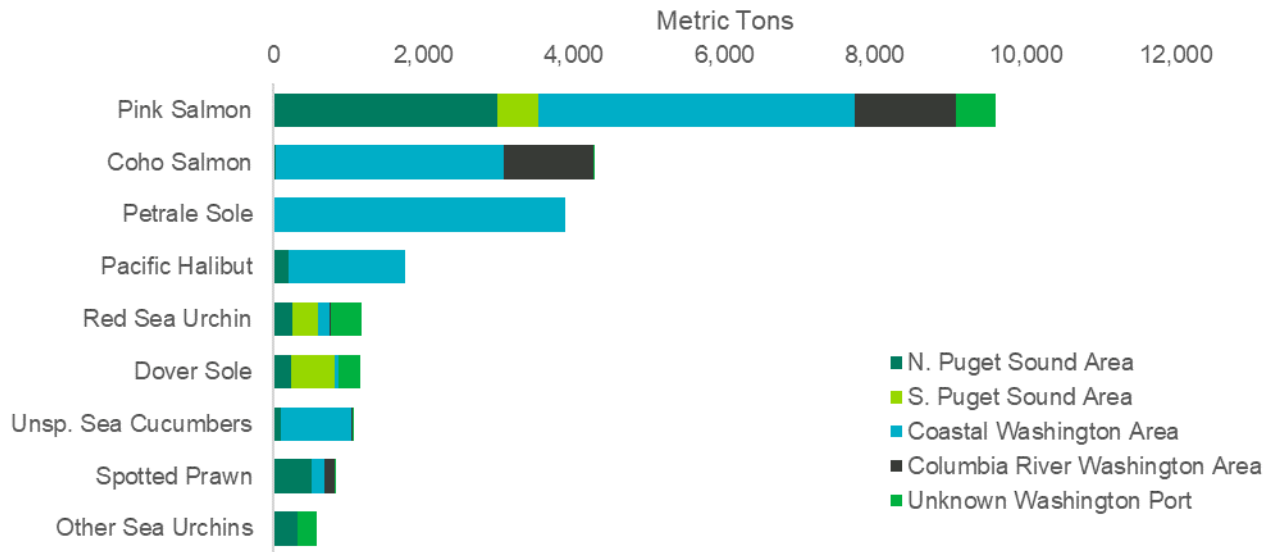


Figure 26: Top ten species by Washington landings, 2019



Source: CPCS analysis of Pacific Fisheries Information Network, 2021.

Aquaculture supply chain

In the aquaculture subsector, the supply chain for farm-raising of shellfish and finfish in Washington is largely vertically-oriented. Farmers, such as leading producer Taylor Shellfish Farmers, own and operate their tidelands; nurseries for raising oysters, clams, mussels, and geoducks (clams); shucking operations as well as freezing, packaging, and retail. Taylor Shellfish Farms is unique as they have their own on-site fabrication shop for building equipment (large boats, nursery equipment) and repairs. However, most farmers purchase equipment – often from Europe. Shellfish products are shipped mainly by refrigerated truck, or in some cases by air. Other shipping needs may include the transportation of young seed oysters from Hawaii for growing in Washington.⁴⁷ In some cases, oysters are shipped from Washington to Hawaii in the winter to avoid the growth-slowing hibernation that can occur in the colder waters of Puget Sound.⁴⁸

Washington finfish farming is mainly for rainbow trout/steelhead raised in net pens in the Puget Sound area. Finfish farming has a similar supply chain as shellfish farming, except for the equipment needs required to transfer fish between farming sites, feed barges, and well-boats to processing facilities. Food processing in the aquaculture sector includes shellfish preparation (shucking and canning).

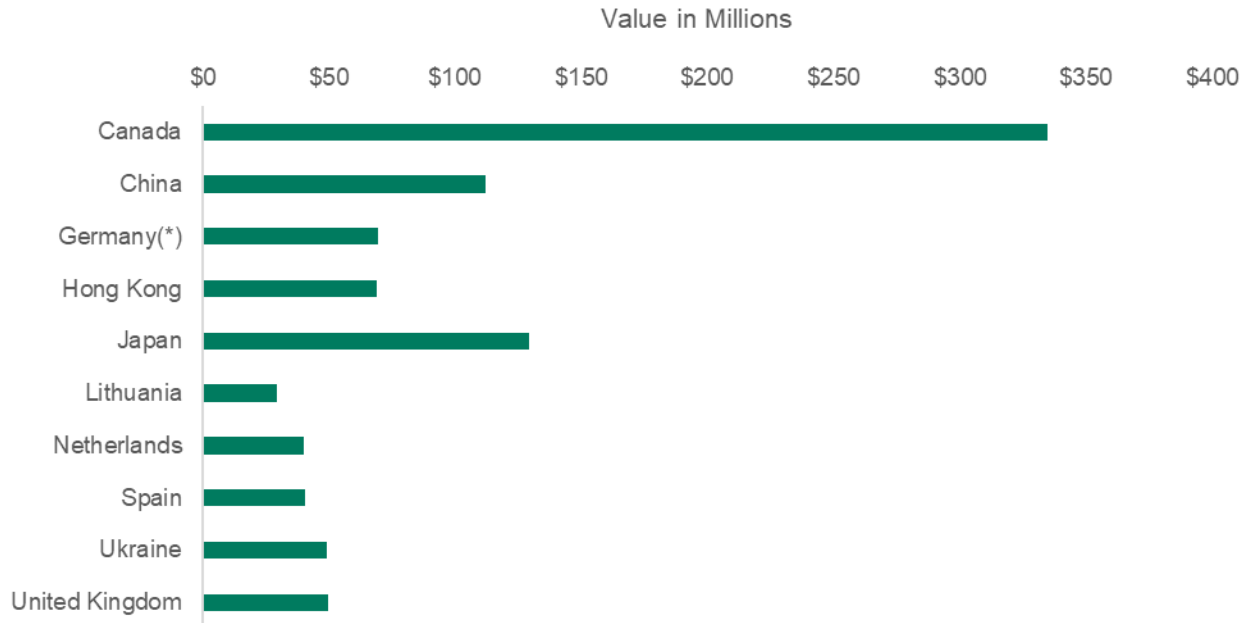
Top export locations

Washington seafood exports are primarily destined for markets in Canada, Japan, and China (Figure 27).

⁴⁷ Washington oyster grower builds Hawaiian solution to OA, *Hatchery International*, Tom Walker, March 2017. <https://www.hatcheryinternational.com/washington-oyster-grower-builds-hawaiian-solution-to-oa-1164/>

⁴⁸ Washington State Agriculture and Food Processing Economic/Fiscal Impact Study, Community Attributes, Inc., January 2015. [www.pnwer.org/uploads/2/3/2/9/23295822/cai.wa_farm_bureau_agriculture_&_food_processing_economic_and_fiscal_impact_study_2015_0121_\(1\).pdf](http://www.pnwer.org/uploads/2/3/2/9/23295822/cai.wa_farm_bureau_agriculture_&_food_processing_economic_and_fiscal_impact_study_2015_0121_(1).pdf)

Figure 27: Top ten export destinations for Washington seafood, 2019



Source: CPCS analysis of U.S. Census trade data, 2021.

Seafood sector trends



Return of demand. Demand for many Washington seafood products has continued to grow, recovering from pandemic lows. Production of frozen Alaskan pollock products has ramped up especially to service record level orders from the U.S. Department of Agriculture (USDA) to supply federal assistance food programs. Washington-based processors, including Trident Seafood, have been awarded at least one of these large USDA contracts, with more to be announced.⁴⁹



Climate Change. Coastal areas are expected to experience rising sea levels as polar caps melt, which will reduce low tidal habitats for marine life. Warming oceans also impact fish migration and breeding patterns. Increased carbon pollution also leads to ocean acidification, which is harmful to shellfish, coral, and plankton populations.⁵⁰ In response to these threats, the Washington Department of Fish and Wildlife assessed climate change vulnerability of 268 species of greatest conservation need and 80 ecological systems. The state also published an Integrated Climate Response Strategy with a wide range of stakeholders and partners to respond to climate impacts.

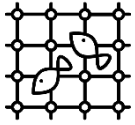


Reduction of Fish Supply. Habitat destruction, hydroelectric dam construction, overfishing, and competition between hatchery and wild fish have all contributed to reductions in fish supply. The National Oceanic and Atmospheric Administration (NOAA) determined in August 2018 that five Pacific salmon stocks are "overfished," and the Upper Columbia River summer-run Chinook salmon is "subject to overfishing."⁵¹ To address salmon management, the state and tribal nations participate in Pacific Fishery Management Council and North of Falcon fish management processes to co-manage restoration of fish habitat and establishment of hatchery production standards.

⁴⁹ USDA wants nearly 8 million pounds of Alaska pollock for food assistance programs, *National Fisherman*, Christine Blank, August 2021. <https://www.nationalfisherman.com/seafoodsource/usda-wants-nearly-8-million-pounds-of-alaska-pollock-for-food-assistance-programs>

⁵⁰ Climate Change, Washington Department of Fish and Wildlife, (n.d.). <https://wdfw.wa.gov/species-habitats/habitat-recovery/climate-change>

⁵¹ Status of Salmon Stocks Managed Under the Magnuson-Stevens Act on the West Coast, National Oceanic and Atmospheric Administration (NOAA), 2019. <https://www.fisheries.noaa.gov/west-coast/sustainable-fisheries/status-salmon-stocks-managed-under-magnuson-stevens-act-west-coast/>



Continuing industry improvements. Technology and techniques for shellfish and finfish farming are continuing to be refined, which may improve output and industry growth.

Washington has recently legalized fish traps for sustainable commercial fishing on the Columbia River, allowing for improved hatchery harvests and reduced impacts to wild fish populations.⁵²

⁵² Washington Takes Historic Step to Legalize Fish Traps for Sustainable Commercial Fishing on the Columbia River, Wild Fish Conservancy Northwest, April 2021. <https://wildfishconservancy.org/washington-takes-historic-step-to-legalize-fish-traps-for-sustainable-commercial-fishing-on-the-columbia-river>

4. Food manufacturing

The food manufacturing industry refers to the value production of food and beverage products from raw or semi-processed inputs. The industry is a major employer in the state, with global companies including Darigold, Trident Seafoods (discussed in the previous section), and others operating large production facilities. The following section takes a closer look at wine production in Washington and Figure 28 provides some fast facts about food manufacturing in Washington.

Figure 28: Washington food manufacturing industry snapshot, 2019

\$4.9 billion	49,500 jobs	\$2.4 billion
Contribution to state GDP	Employment	Paid in wages & salaries

Source: CPCS analysis of U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics data, 2021.

Figure 29: Food manufacturing fast facts



Food manufacturing includes cutting, freezing, and preserving agriculture, animal, and seafood products.



Largest sub-sectors employed include frozen fruit and vegetable manufacturing, fruit and vegetable canning and drying, and wineries.



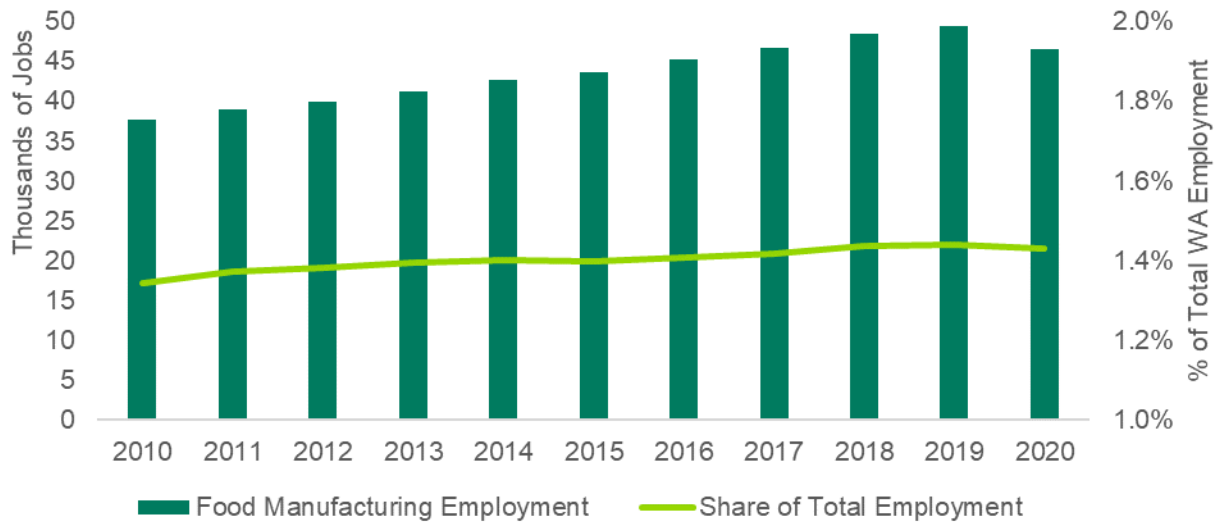
Washington is the second largest producer of wine in the U.S., after California.

Source: Washington State Department of Commerce and Washington State Agriculture & Food Processing Economic/Fiscal Impact Study, January 2015

As shown in Figure 30, food manufacturing jobs increased steadily through 2019 as exports from Washington increased and food manufacturers diversified products. In 2020 the pandemic led to declining demand for food manufacturers due to restaurant and other food service operations restrictions. As an example, Lamb Weston, one of the largest producers of frozen potato products in the world and key employer of food manufacturing jobs in Washington, had a 21% net drop in income between third-quarter sales in 2020 compared to 2019.⁵³

⁵³ Lamb Weston Reports Fiscal Third Quarter 2020 Results; Withdraws Fiscal Year 2020 Outlook Due to Uncertainties from the COVID-19 Pandemic's Effect on Global Restaurant Traffic and Consumer Demand, Lamb Weston Holdings, April 2020. <https://investors.lambweston.com/news-releases/2020/04-01-2020-133025013>

Figure 30: Washington food manufacturing jobs and share, 2010-2020

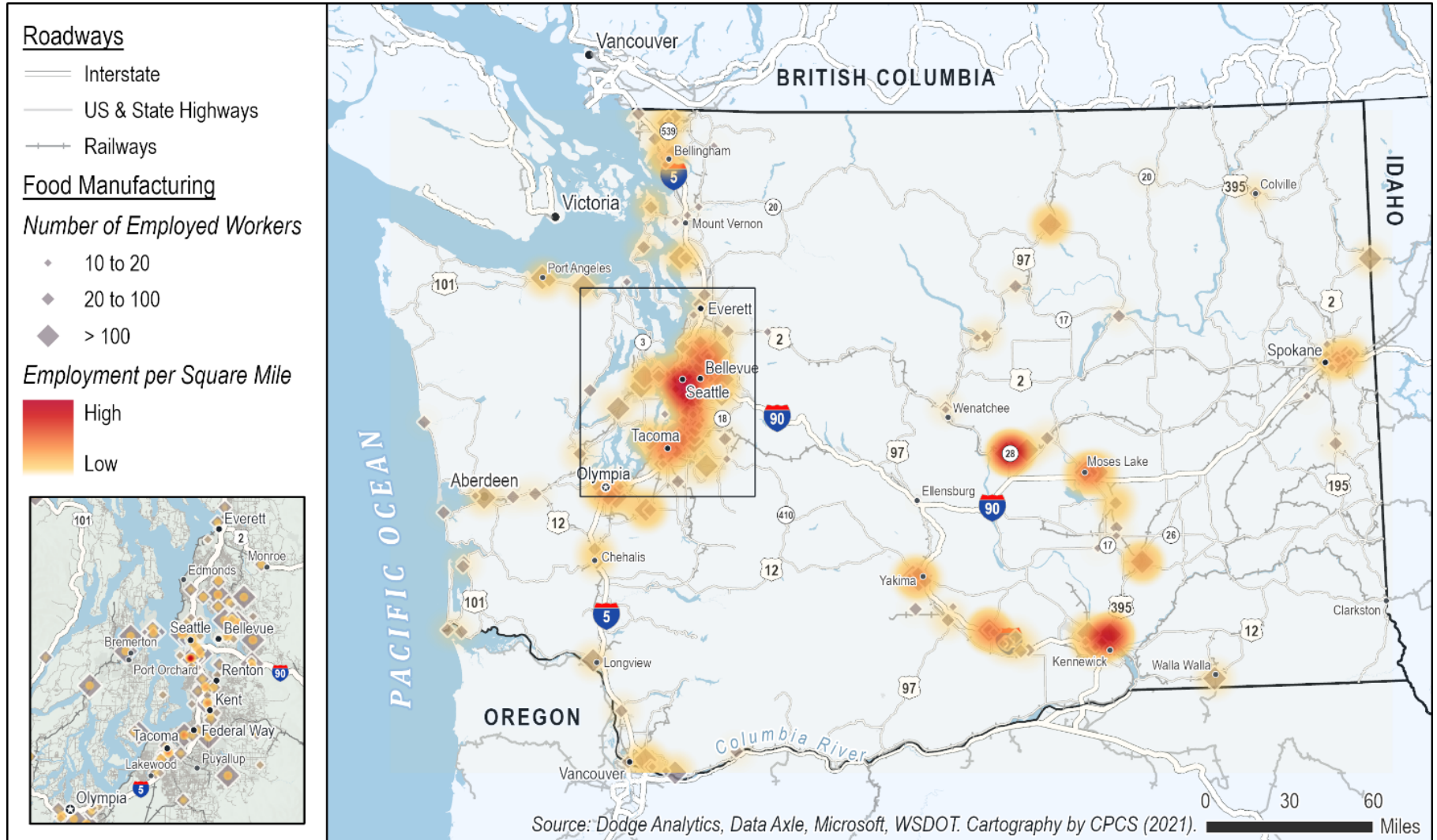


Source: CPCS analysis of U.S. Bureau of Labor Statistics data, 2021.

Food manufacturers in Washington benefit from inexpensive hydroelectric power, abundant water sources, and Washington’s robust trade network equipped with numerous ports supporting exports.⁵⁴ Figure 31 illustrates that food manufacturing employment is sprinkled throughout Washington, with hotspots around metropolitan areas such as Seattle, Kennewick, and Quincy.

⁵⁴ Agriculture: The Cornerstone of Washington’s Economy, Washington Policy Center, Chris Cargill, March 2016. <https://www.washingtonpolicy.org/publications/detail/agriculture-the-cornerstone-of-washingtons-economy>

Figure 31: Washington food manufacturing



Wine production

There are more than 1,000 wineries and 400 grape growers in the state, producing at least 17 million cases of wine annually.⁵⁵ More than 80 varieties of wine are produced across Washington's 19 American Viticultural Areas (AVAs). However, most red and white varieties include Cabernet Sauvignon (the most produced grape in Washington), Chardonnay, Riesling, and Merlot. Making less than 5,000 cases of wine per year, 90% of wineries are small-scale producers.⁵⁶ Figure 32 shows how wine production in Washington is concentrated in the central-south region of the state.

Wine supply chain

Wine production in Washington typically begins in eastern Washington where nearly all of Washington's wine grapes are grown. Planting conditions in the east are drier, and sandy soils around the Columbia Valley are rich in nutrients, ideal for many wine varieties. Additionally, the region receives almost two more hours of sunlight than California during the summer months. Only a small minority of wine is produced in the cooler, rainier, west coast region around Puget Sound.

Bigger wineries, such as Washington's largest winery St. Michelle Wine Estates, handle much of the wine production process in-house, from growing grapes to bottling and selling, including selling on-site. Smaller wine producers may source grapes from grape growers, and handle some production in-house, such as grape crushing, fermenting, or blending, and rely on wine distributors for processing steps like bottling, labeling, packaging, storing, and distributing.

Refrigerated trucks are largely used in the local production process and distribution of Washington wine, with some wine also traveling by refrigerated rail cars for distribution on the East Coast. Ste. Michelle, which accounts for 60% of all of Washington's wine sales by volume, has traditionally relied on refrigerated rail car service for transport between their main distribution center in Wallula and destinations across the Midwest and East Coast.

Key inputs such as glass bottles are typically sourced from outside the U.S. and brought in by cargo shipments. Forty percent of wineries in the U.S. source glass bottles from China.⁵⁷

Washington wine is largely transported by truck to domestic retailers or restaurants throughout the U.S., although direct-to-consumer (DtC) sales are growing. According to the 2021 Direct-to-Consumer Wine Shipping Report, 4.9% of Washington wine was shipped DtC in 2020, a 24.9% increase in volume from 2019.⁵⁸ The full wine supply chain is presented in Figure 33.

Top export locations

International sales of Washington wine have also continued to grow, though exports still only make up about 5% of sales. In 2021 Washington wineries exported wine to more than 60 countries, with top markets including Canada, Sweden, Germany, and South Korea.⁵⁹

⁵⁵ Fast Facts, Washington State Wine Commission, (n.d.). <https://www.washingtonwine.org/fast-facts/>

⁵⁶ Ibid.

⁵⁷ The weight of that wine bottle doesn't indicate quality, and it's hurting the planet, *the Washington Post*, Dave McIntyre, November 2021. <https://www.washingtonpost.com/food/2021/11/04/wine-bottle-carbon-footprint-cop26/>

⁵⁸ Direct to Consumer Wine Shipping Report: 2020 Year in Review, Sovos ShipCompliant, 2021.

<https://www.sovos.com/shipcompliant/wp-content/uploads/sites/9/2021/01/2021-Direct-to-Consumer-Wine-Shipping-Report.pdf>

⁵⁹ International Program, Washington State Wine Commission, (n.d.). <https://www.washingtonwine.org/international/>

Figure 32: Washington wine production areas

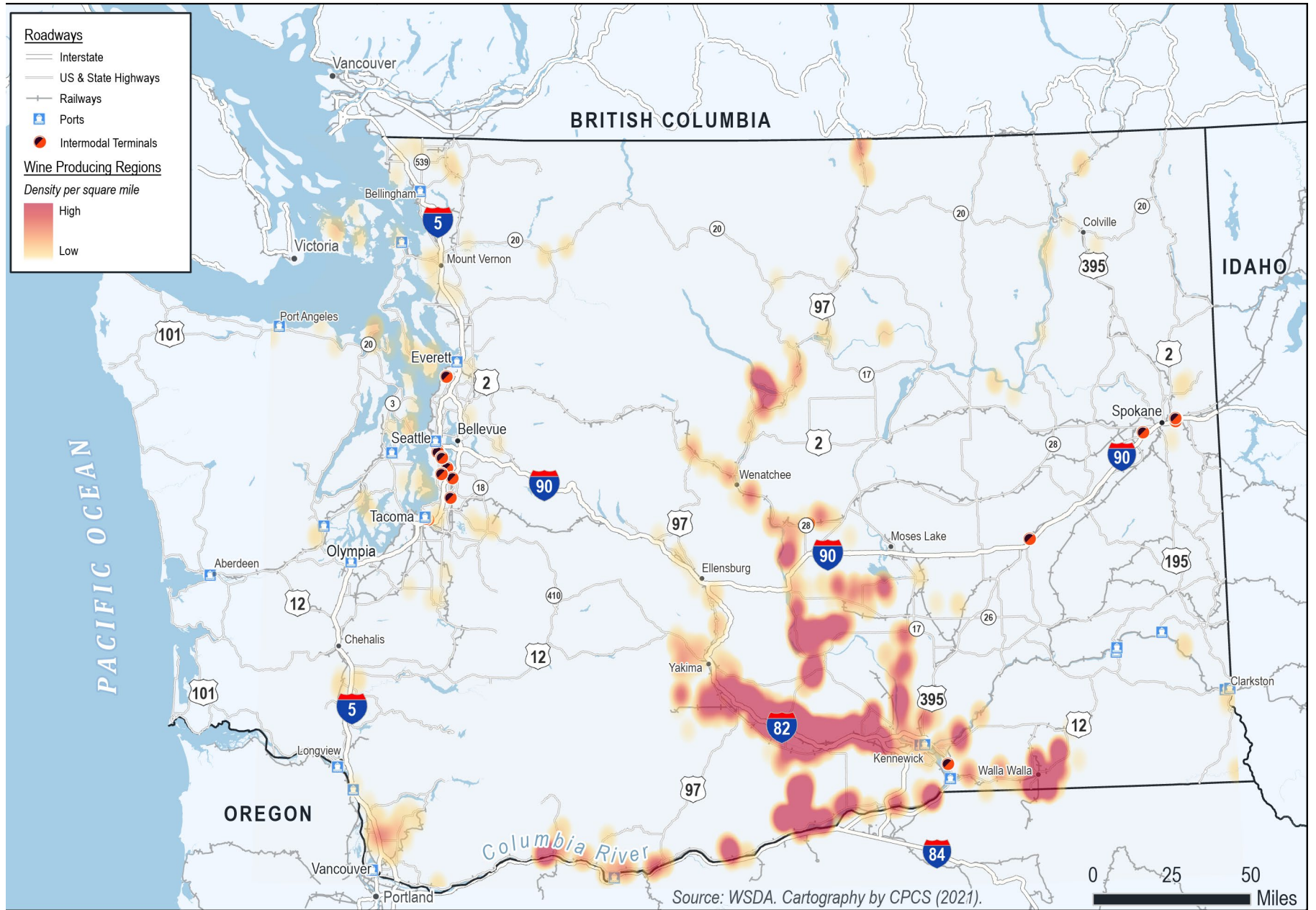
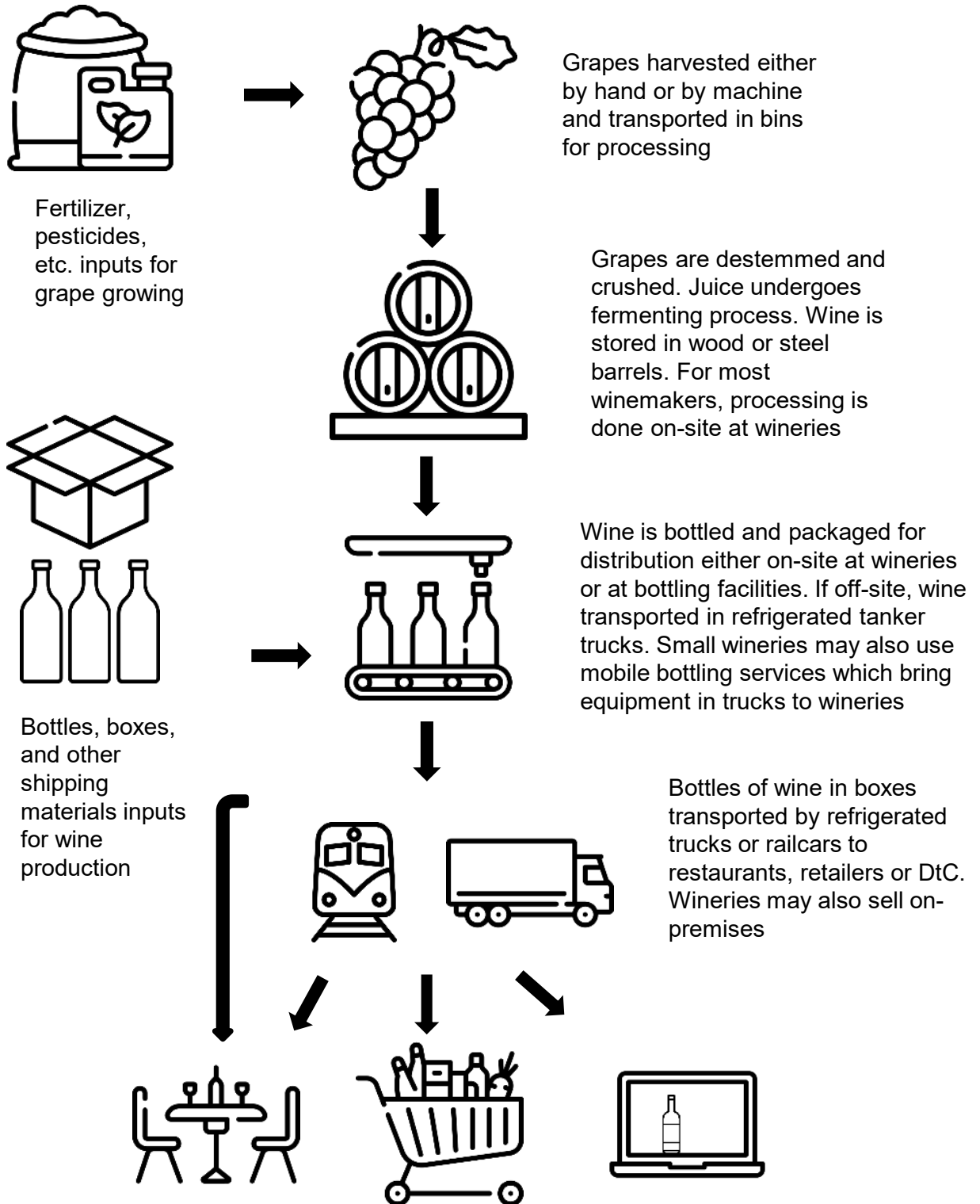


Figure 33: Wine supply chain



Source: CPCS analysis of available literature sources and industry knowledge, 2022.

Wine sector trends



Sustainable food production practices are becoming more important to Washington's food producers. Wine producers in Washington are embracing alternative packaging, such as aluminum cans or boxes with plastic separators, which are lighter weight for transporting, more economical, and easier to recycle than traditional glass.⁶⁰ Other agriculture producers, such as grape juice producer Welch's, transitioned to transporting grape concentrate mainly by rail in place of trucks to reduce greenhouse gas emissions. Their plant in Grandview is the largest juice tank farm in the U.S. and ships by rail drums of juice concentrate harvested by grapes grown in Washington to Welch's bottling facilities across the U.S.⁶¹



Increase in Direct-to-Consumer (DtC) sales. The challenge of restaurant closures and on-site venue closures due to COVID-related restrictions affected Washington wineries as well as those across the U.S. While restaurant sales and tourism to wineries are expected to return, the levels are not expected to return to pre-COVID amounts for some years – if ever. Selling and purchasing habits are expected to shift more online and wineries are also projected to focus efforts on improved DtC models.⁶²

⁶⁰ Planet-Friendly Wines, *Washington Tasting Room Magazine*, Pam and Gary Baker, February 2021.

<https://www.washingtontastingroom.com/taste/planet-friendly-wines>

⁶¹ Grapes, Season 5, Episode 7, *Washington Grown*, December 2018. <https://wagrown.com/episodes-and-clips/d-bARn8Tqqc>

⁶² State of the US Wine Industry 2021, Silicon Valley Bank, Rob McMillan, (n.d.).

<https://www.svb.com/globalassets/trendsandinsights/reports/wine/sotwi-2021/svb-state-of-the-wine-industry-report-2021.pdf>

5. Forestry products

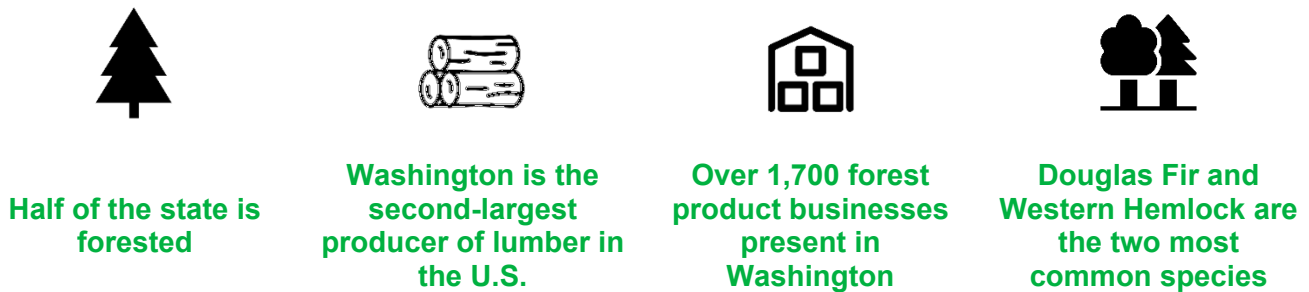
Forestry has played an important role in the state’s economy and is critical to many rural areas, tribes, ports, the state government, and many supply chains that use forestry inputs. Figure 35 illustrates the economic importance of forestry in Washington.

Figure 34: Washington forest industry snapshot, 2019



Source: CPCS analysis of U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics data, 2021.
 Note: GDP data not available.

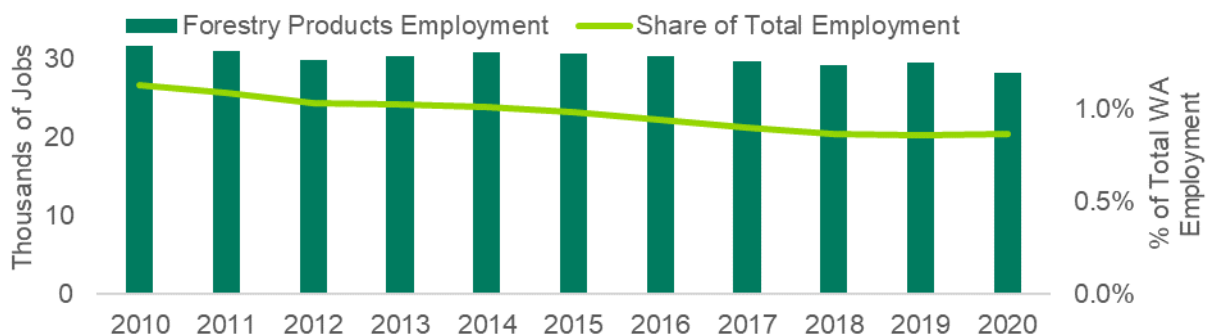
Figure 35: Forestry products industry fast facts



Source: Washington's Forests, Timber Supply, and Forest-Related Industries, Washington Department of Natural Resources, (n.d.). from https://file.dnr.wa.gov/publications/em_fwfeconomiclow1.pdf | CPCS analysis of Data Axle 2019 Business Establishment Data, 2021 | Washington Forest Protection Association. Forest Products Industry Economic Impact, Washington Forest Protection Association, 2015. from https://www.wfpa.org/wp-content/uploads/2017/11/2015-16-leg-fact-sheet-forestry-is-an-economic-engine_4.pdf

The forestry industry supports about 30,000 jobs as of 2019, decreasing steadily since 2010, along with recent declines in timber harvests.

Figure 36: Washington forestry products jobs and share, 2010-2020



Source: CPCS analysis of U.S. Bureau of Labor Statistics data, 2021.

Forestry products primarily move by truck in Washington, with trucks carrying over 87% of such products by weight and over 77% by value in 2022.⁶³ Lumber also moves by rail for export through ports such as Grays Harbor, Olympia, and Everett. In particular, logging trucks oftentimes navigate difficult terrain on a variety of state, private, or forestry roads while hauling heavy equipment and tree logs. Improving safety

⁶³ US Freight Analysis Framework Version 5, Federal Highway Administration (FHWA), 2021. <https://faf.oml.gov/faf5/> | Represents 2017 base year flows for domestic movements destined for and/or originating from Washington, as well as international imports destined for and/or entering the U.S. through Washington, and international exports originating from and/or exiting the U.S. through Washington.

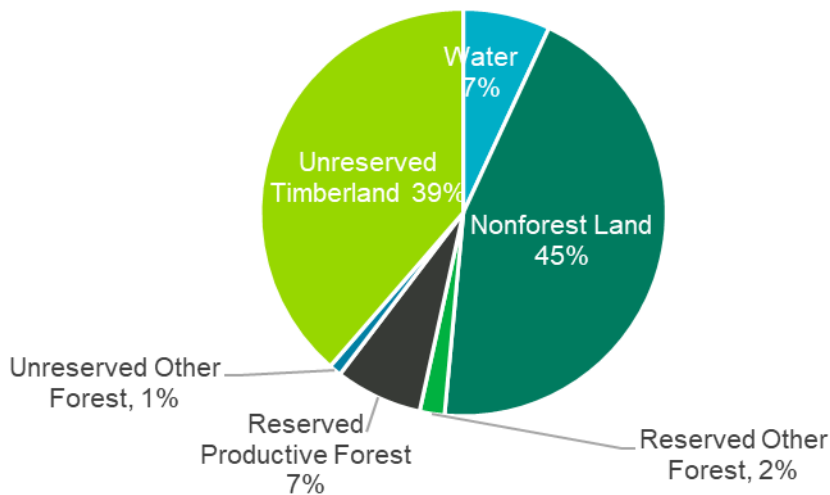
features and signage while ensuring road construction projects are completed efficiently is critical to support the industry.

Forestry land composition

Of Washington’s 43 million acres of land, about 50% (21 million acres) is forested. Approximately 85% of the forested acres are “timberland.” Except for two million acres that are protected by law and prohibited from timber harvest, all the remaining timberlands are unreserved and are considered working forests.⁶⁴

Figure 37 illustrates the state’s forested areas. The coastal forest region stretches along the west coast of the state where Sitka Spruce, Western Red Cedar, and Western Hemlock thrive under heavy rainfall. Between the coastal region and the Cascades, the state produces Douglas-Fir, Western Hemlock, and Western Red Cedar Timber. Forestry is also prevalent in mountainous regions of the Olympic Mountains and the Cascades. On the east side of the state, lower rainfall and higher temperatures during the summer season make Ponderosa Pine, a drought-resistant species, the most common tree in the area.

Figure 37: Forestry land composition



Source: CPCS analysis of U.S. Forest Service Land Cover data, 2021.

Figure 38 shows that Washington’s forested areas are centered in three main areas of the state: in the southwest around Olympic National Forest and south of the Puget Sound region, in the northwest between North Cascades National Park and Mt Baker-Snoqualmie National Forest, and in the northeast between Kettle Falls and Spokane.

⁶⁴ Washington’s Forests, Timber Supply, and Forest-Related Industries, Washington Department of Natural Resources, (n.d.). https://file.dnr.wa.gov/publications/em_fwfeconomiclow1.pdf

Figure 38: Washington forested areas



Manufacturing of forestry products

Forestry product manufacturing is Washington's second-largest manufacturing sector, with products that range from traditional cutting and lumber production to chips, sawdust, wood flooring, shingles, tiles, millwork, laminated veneer, and fencing. Pulp, paper, and other value-added products, such as doors, window frames, and stairs diversify Washington's forest products. Douglas Fir, the most common tree in the state, makes Washington the second largest producer of softwood in the U.S.⁶⁵

Washington Douglas Fir is crucial to toilet paper manufacturing

Toilet paper is made from mixing virgin wood fibers, which are a combination of softwood and hardwood trees. Softwood trees, such as Douglas Fir, provide strength to the paper with their long fibers. Hardwood trees like maple and oak give the paper softness. The production of toilet paper involves multiple manufacturing facilities that serve various functions.

1. Cut trees are sent to *sawmills* to debark and preserve as much wood as possible, followed by chopping wood into small pieces and separating it into batches.
2. Wood chips are transported to pulp mills to be cooked in large pressure cookers with chemicals. This step produces pulp, which contains lignin, fivers, cellulose, and other substances. The pulp is washed and bleached to only contain the usable fiber.
3. Pulp is sent to paper mills to be pressed and dried to a paper stock, 5% of moisture and 95% of fiber.
4. Paper stock is delivered to toilet paper production facilities for cutting and rolling, and finally delivered to distribution centers, warehouses, or retail stores.

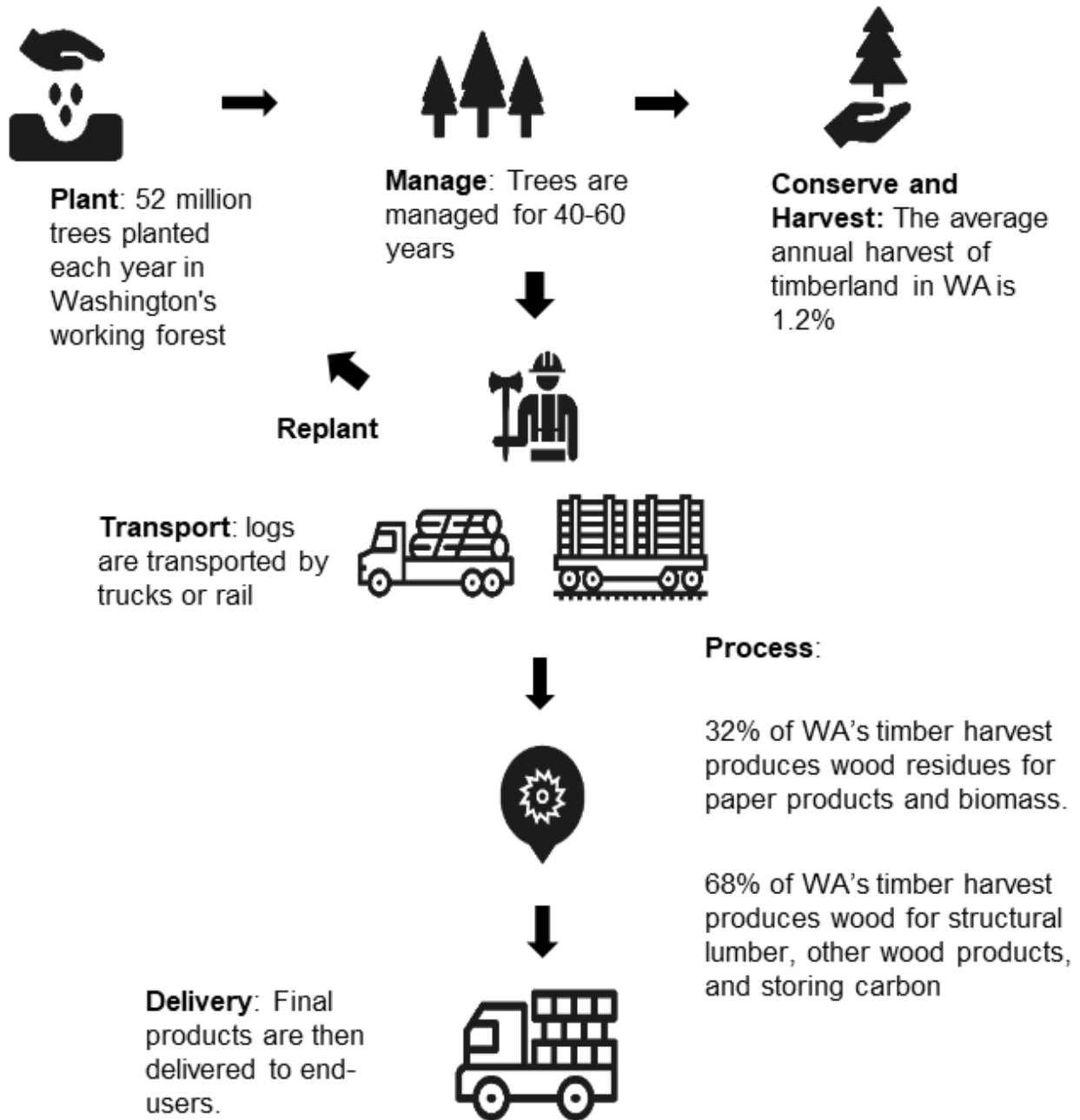
Source: How Toilet Paper Is Made – Basic Overview, Industrial Shredders, November 2015.
<http://www.industrialshredders.com/resources/how-toilet-paper-is-made-basic-overview>.

Forestry products supply chain

Figure 39 illustrates the forestry supply chain. Washington plants about 52 million trees in its working forest annually. After 40 to 60 years of careful management, the trees are either conserved or harvested. Annual harvest occurs on approximately 1.2% of the timberland in the state. The “plant-manage- conserve/harvest-replant” cycle is crucial to sustaining the supply chain of forestry products. After being harvested, the logs are transported primarily by truck to paper mills or sawmills to be turned into various types of products before reaching end users.

⁶⁵ Forest Sector Supply Chain, Washington Forest Protection Association, (n.d.). <https://www.wfpa.org/sustainable-forestry/forest-sector-supply-chain/>

Figure 39: Washington’s forest products supply chain



Source: CPCS analysis of available literature sources and industry knowledge. 2022.

Forestry products trends



Climate Change: Climate change can impact precipitation patterns, temperatures, and the number and severity of storms, forest fires, and more. In recent years, the Pacific Northwest experienced dryer and warmer days as well as an increasing number of flood events. Changing climate conditions also impact air and soil moisture levels, increasing the mortality of trees and threatening to reduce timber production. The industry works to reduce climate impacts through sustainable forestry practices and operates at below net zero carbon emissions according to a 2020 University of

Washington study.⁶⁶ The industry also supports fish passage across 60,000 miles of streams running through Washington's forests through forest practices established in the historic Washington Forest and Fish Law of 1999.



Workforce Vulnerability: The skilled forestry workforce is aging, with at least half of loggers 45 years of age or above. Manual labor is often used at steep slopes and other geographically challenging areas, which leads to high injury and fatality rates. In 2020, the Washington legislature passed a law to encourage forestry workforce development, supporting the recommendations proposed in the Department of Natural Resource's Plan for Climate Resilience and the Department of Commerce's Washington's Green Economy.⁶⁷



Technology and Innovative Products: New technologies are increasing productivity and safety in the industry. For instance, biotechnology improved fiber quality and increased tree tolerance to outside disturbances. Mechanized harvesting systems and sawmill technology also provide safer working environments and enable manufacturers to attain more value and volume from harvested trees.⁶⁸ The forestry industry is also increasingly producing new products. Cross-laminated timber (CLT) is made up of compressed and glued low-quality wood boards to produce material with a strength similar to that of steel and concrete. It requires fewer resources than steel and concrete to transport and is thus more sustainable. Currently, two CLT manufacturing facilities are strategically located in eastern Washington due to this region's proximity to forests and its easy access to the freight network.⁶⁹

⁶⁶ Global Warming Mitigating Role of Wood Products from Washington State's Private Forests, *Forests* 11, no. 2: 194, Indroneil Ganguly, Francesca Pierobon, and Edie Sonne Hall, 2020. <https://doi.org/10.3390/f11020194>

⁶⁷ RCW 76.04.521: Forest sector workforce development, Washington Legislature, (n.d.). <https://app.leg.wa.gov/RCW/default.aspx?cite=76.04.521>

⁶⁸ Wood and Paper Products, Washington Forest Protection Association, (n.d.). <https://www.wfpa.org/sustainable-forestry/wood-and-paper/>

⁶⁹ Second CLT factory Comes to Eastern Washington, Washington Forest Protection Association, October 2017. <https://www.wfpa.org/news-resources/blog/second-clt-factory-comes-eastern-washington/>

6. Energy

The energy industry supports all economic activity within Washington. Washington’s energy industry relies heavily on renewable sources. However, the transportation of renewable energy itself does not occur on the multimodal freight system (road, rail, maritime, aviation, or pipeline). Thus, the content in this section focuses on the state’s petroleum industry, which travels by pipeline, water, truck, and rail, and is a crucial energy source for the freight transportation industry. Petroleum powers the freight transportation industry from trucks, trains, ships, aircraft, forklifts, and fishing boats to farm and manufacturing equipment and beyond. Figure 40 and Figure 41 offers some fast facts about the industry.

Figure 40: Washington energy industry economic profile

\$5.0 billion	2,800 jobs	410 million
Contribution to state GDP	Employment	Paid in wages & salaries

Source: CPCS analysis of U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics data.
 Note: data includes only petroleum energy.

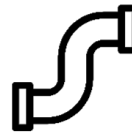
Figure 41: Energy industry fast facts



WA has the fifth largest petroleum refining capacity in the nation



Petroleum made up over 94% of Washington’s transportation energy consumption in 2019



About 43% of all oil movements in Washington travel by pipeline



WA produces over a quarter of the nation’s hydropower, more than any other state

Source: Washington - State Energy Profile Overview, U.S. Energy Information Administration, (n.d.). <https://www.eia.gov/state/?sid=WA> | Energy Flow Charts: Charting the Complex Relationships among Energy, Water, and Carbon, Lawrence Livermore National Laboratory, 2021. <https://flowcharts.llnl.gov/> | Oil Movement in Washington State, Washington Department of Ecology, 2007-2017. <https://apps.ecology.wa.gov/publications/documents/1708014.pdf> | Where hydropower is generated, U.S. Energy Information Administration, 2022. <https://www.eia.gov/energyexplained/hydropower/where-hydropower-is-generated.php>

Energy generation

Washington consumes twice the amount of energy it produces, meaning the state is a net energy importer – primarily through pipeline.

At the same time, Washington is among the most efficient energy users with per capita energy consumption lower than three-fifths of U.S. states. Washington also leads the country in renewable energy generation. Nearly 75% of the energy produced in Washington comes from renewable sources, compared to just over 6% nationally.⁷⁰ The state’s significant production of renewables is driven by the state’s significant water assets, which power many dams, including the Grand Coulee Dam, the nation’s largest. In fact, Washington is the country’s top hydropower producer, generating 27% of the country’s total hydroelectricity in 2020.⁷¹

⁷⁰ Washington State Profile and Energy Estimates, US Energy Information Administration, 2019. <https://www.eia.gov/state/?sid=WA#tabs-4>

⁷¹ Where Hydropower is Generated, US Energy Information Administration, 2022. <https://www.eia.gov/energyexplained/hydropower/where-hydropower-is-generated.php>

Washington has no crude oil or natural gas reserves, nor does it have active coal mines. Most crude oil comes from Alaska by ship, the Bakkens in North Dakota by rail, or Canada Oil Sands by pipeline. Washington has the fifth-largest crude oil refining capacity of any state and refined petroleum products are exported to neighboring states.

As of 2021, the five refineries listed in Figure 42 have a joint capacity of almost 652,000 barrels of crude oil per day.⁷²

Figure 42: Petroleum refineries in Washington

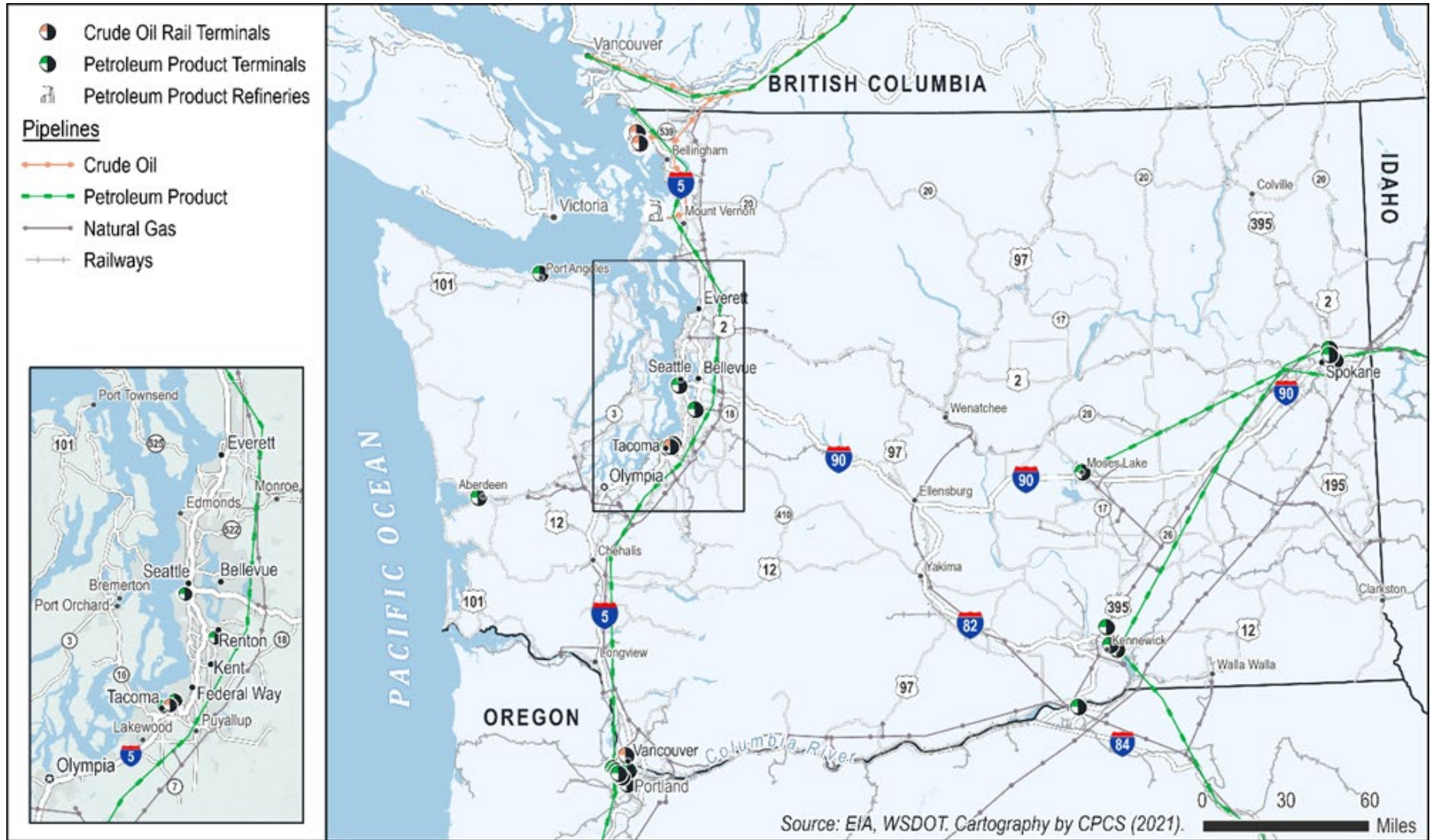
Refinery	Location	Processing capacity (barrels per day)	Products
BP West Coast Products	Blaine	242,000	Gasoline, diesel oil, jet fuel, calcinated coke
Phillips 66 Company	Ferndale	105,000	Gasoline, diesel oil, jet fuel, liquid petroleum, residual fuel oil
Shell Oil Products	Anacortes	145,000	Gasoline, diesel oil, jet fuel, propane, coke, sulfur, and tetramer (used in a variety of plastic products)
Tesoro	Anacortes	119,000	Gasoline, diesel oil, turbine & jet fuel, liquid petroleum gas, residual fuel oil
U.S. Oil & Refining	Tacoma	40,700	Gasoline, diesel oil, jet fuel, marine fuel, gas oils, emulsified & road asphalt

Source: Capacity of Operable Petroleum Refineries by State as of January 1, 2021, U.S. Energy Information Administration, <https://www.eia.gov/petroleum/refinerycapacity/table3.pdf> | The Economic Contribution of Washington State's Petroleum Refining Industry in 2011, Washington Research Council, August 2012. <https://researchcouncil.files.wordpress.com/2013/08/2012refineryreportfinal040913.pdf>

Figure 43 illustrates the geographic distribution of Washington's petroleum industry facilities, including the state's five refineries, petroleum product manufacturers, wholesalers, and infrastructure network. As shown, petroleum activity is concentrated along the I-5 corridor in Puget Sound, with clusters in Southwest Washington near Vancouver, in Eastern Washington around Spokane, Central Washington near Wenatchee, Moses Lake, Ellensburg, Yakima, and in Southeast Washington around Kennewick and Walla Walla.

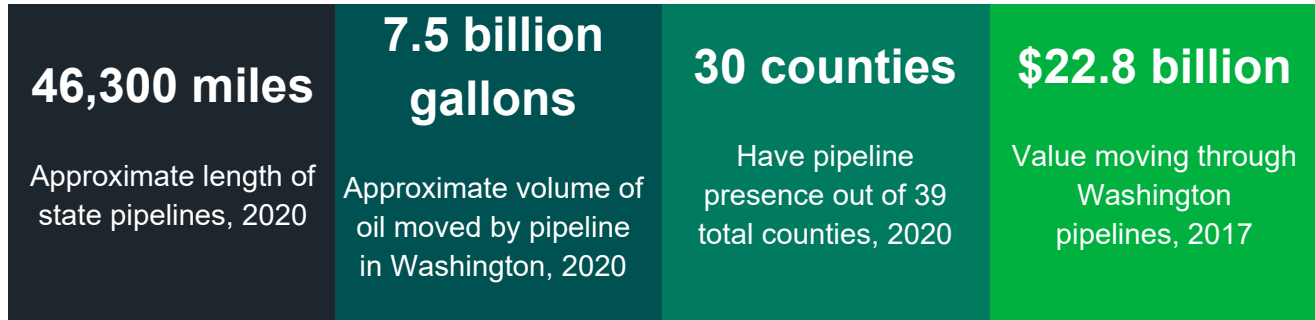
⁷² Washington – State Energy Profile Overview, US Energy Information Administration, (n.d.). <https://www.eia.gov/state/?sid=WA>

Figure 43: Washington energy map



The petroleum industry is supported by a robust network of pipeline, as noted in Figure 44. In 2017, about 43% of all oil in Washington traveled by pipeline.⁷³ The remaining petroleum products moved primarily by truck and maritime. Commodities are exported to domestic consumers such as Oregon and California as well as British Columbia, Canada.

Figure 44: Washington’s pipeline network



Source: CPCS analysis of USDOT, Pipeline and Hazardous Materials Safety Administration, State of Washington Department of Ecology, Washington Utilities and Transportation Commission, and FAF5 data, 2021.

The largest pipeline in Washington, running the 400 miles from Blaine, Washington, to Portland, Oregon, is BP’s Olympic Pipeline. The pipeline transports gasoline, diesel, and jet fuel from four refineries in Whatcom and Skagit Counties to locations including Sea-Tac International Airport, Washington cities Renton, Tacoma, and Vancouver, and Portland, Oregon.⁷⁴

Energy consumption

94% of the energy consumed in Washington’s transportation sector is petroleum⁷⁵ – making transportation the most petroleum-dependent sector in the state.

The industrial, commercial, and residential sectors also consume significant quantities of petroleum, natural gas, and biofuels. Figure 45 displays Washington’s energy consumption by sector and highlights the importance of energy – particularly petroleum – for transportation and industrial manufacturing applications.

Freight transportation also has an important role in renewable energy generation because it supports the construction of renewable energy plants such as dams, wind turbines, and solar farms. The construction of these renewable energy plants requires materials like concrete, oversized turbine blades, and photovoltaic cells, which must be transported on the state’s freight system.

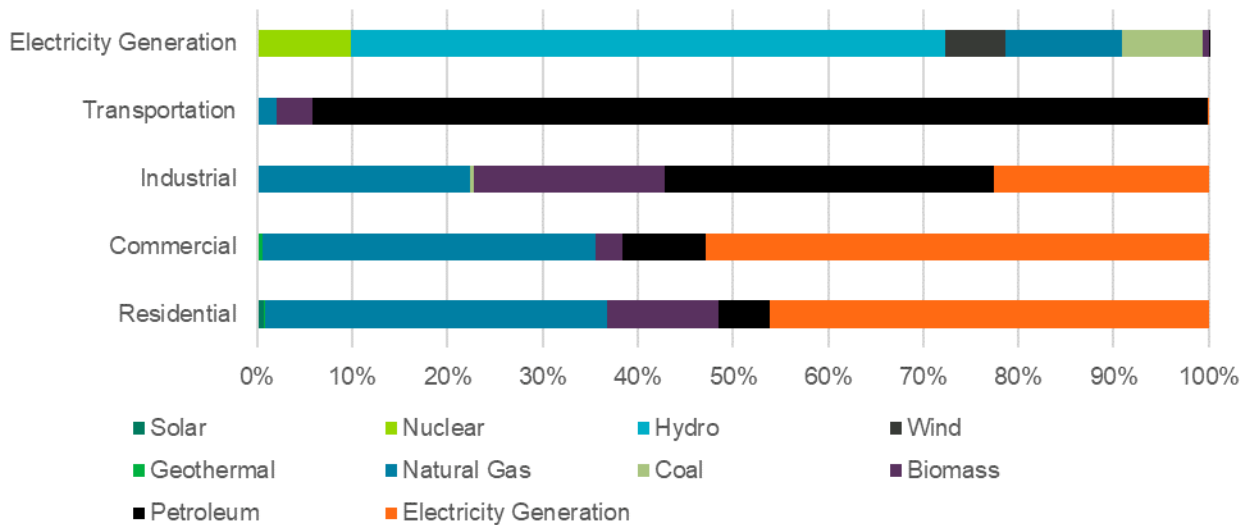
⁷³ Oil Movement in Washington State 2007-2017, Washington Department of Ecology, October 2021.

<https://apps.ecology.wa.gov/publications/documents/1708014.pdf>

⁷⁴ Our pipelines: Olympic Pipeline, BP United States, (n.d.). https://www.bp.com/en_us/united-states/home/products-and-services/pipelines/our-pipelines.html#accordion_olympic

⁷⁵ Washington – State Energy Profile Overview, US Energy Information Administration, (n.d.). <https://www.eia.gov/state/?sid=WA>

Figure 45: Washington energy consumption by sector, 2019



Source: CPCS analysis of Lawrence Livermore National Laboratory Estimated Energy Consumption Flow Chart Data, 2021. <https://flowcharts.llnl.gov/commodities/energy>

Energy trends



Washington’s Climate Commitment Act: Washington passed a wide-ranging climate agenda in 2021 that establishes a cap-and-invest program mandating that certain businesses must lower their emissions or obtain emissions allowances. The act also emphasizes environmental justice to improve air quality in underrepresented communities and reduce health disparities.⁷⁶ It is important to note that some renewable energy sectors have specialized freight requirements for oversize/overweight inputs (e.g., solar panels, wind turbines) that impact the state’s roads and maritime ports. As the industry shifts to more renewable sources, the freight system will also need to accommodate these changing freight needs.



Alternative energy freight vehicles: Some companies in Washington are committing to convert their fleets to alternative energy sources. For example, Amazon ordered 1,800 electric vans from Mercedes and an additional 100,000 from start-up Rivian Automotive in 2020.⁷⁷ Amazon has also pledged to use zero-carbon ocean vessels before 2040.⁷⁸ While more efforts are required to meet state climate goals, these types of private-sector initiatives may result in a gradual decline in the freight system’s reliance on petroleum products.



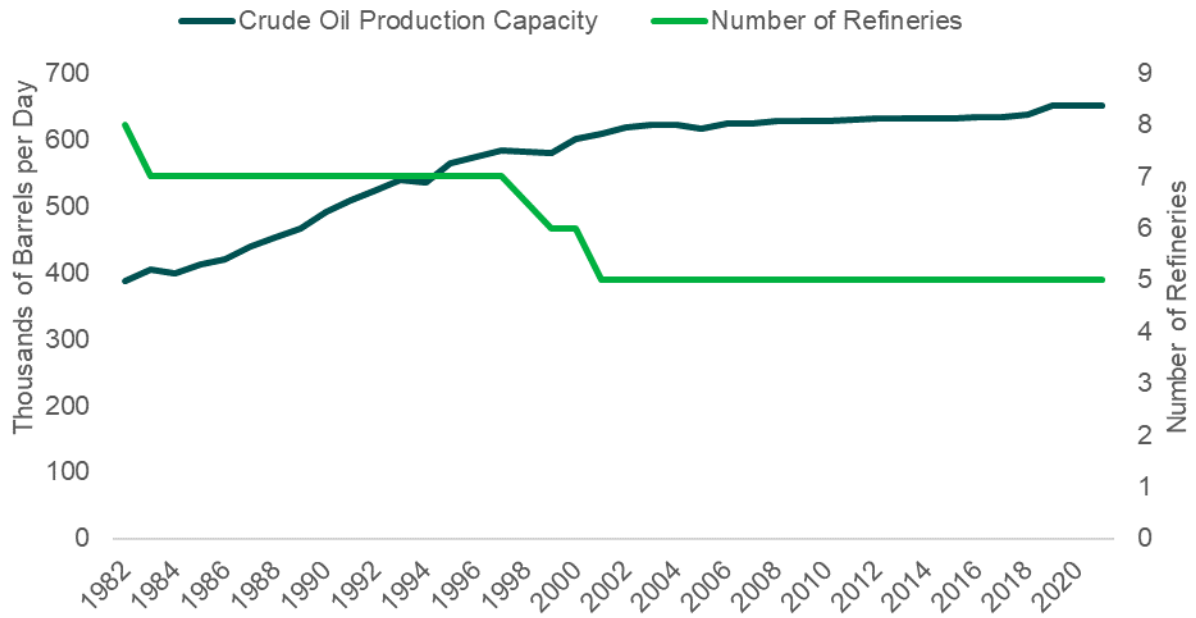
Consolidation of petroleum refineries: Figure 46 shows that the number of petroleum refineries in Washington decreased from eight in the 1980s to five today. Meanwhile, refining capacity at Washington refineries continued to increase from below 400,000 barrels per day in the early 1980s to over 650,000 in 2021. This means that petroleum products traveling on the state’s freight system are generated from relatively fewer but more-concentrated locations.

⁷⁶ Climate Commitment Act, Washington Department of Ecology, (n.d.). <https://ecology.wa.gov/Air-Climate/Climate-change/Reducing-greenhouse-gases/Climate-Commitment-Act>

⁷⁷ Amazon expands zero-emission fleet with Mercedes-Benz electric van order, *Forbes*, Greg Gardner, August 2020. <https://www.forbes.com/sites/greggardner/2020/08/28/amazon-orders-1800-mercedes-benz-electric-vans/>

⁷⁸ Amazon’s new net-zero carbon pledge is focused on the oceans, as shipping giants pursue alternative fuels, *ESG Impact*, Alicia Doniger, October 2021. <https://www.cnbc.com/2021/10/19/amazon-backs-zero-carbon-ocean-shipping-by-2040-.html>

Figure 46: Washington refinery count and production capacity, 1982-2021



Source: CPCS analysis of U.S. Energy Information Administration's Number and Capacity of Petroleum Refineries data, 2021. https://www.eia.gov/dnav/pet/pet_pnp_cap1_dcu_SWA_a.htm.
 Note: Data is missing from 1996 and 1998.

7. Construction

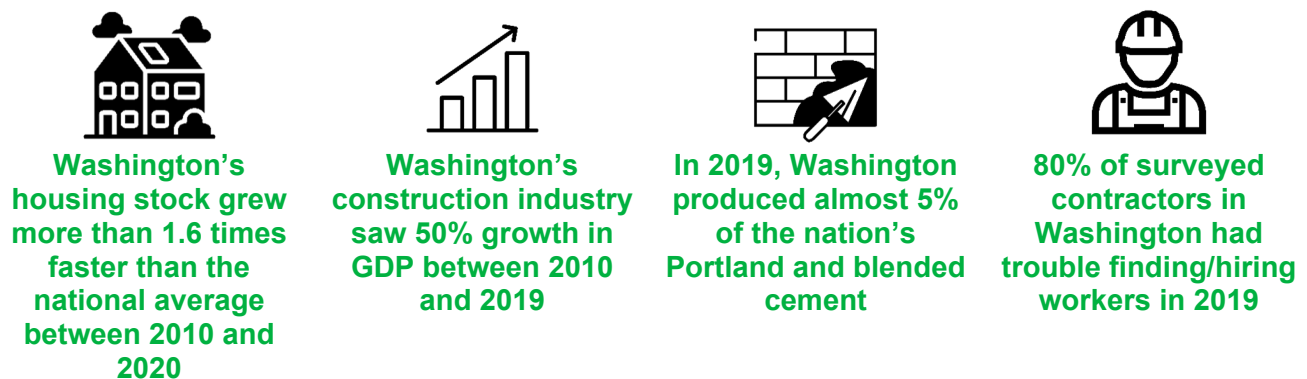
Washington has one of the fastest-growing populations in the U.S., spurring strong demand for construction services. In turn, construction activity drives demand for the movement of building materials such as aggregate, concrete, asphalt, steel, wood, and hardware. Over the last decade, real GDP in Washington’s construction industry grew by 50%. This exceeds the state’s overall 40.7% growth in real GDP. It also exceeds the 35.5% growth in the national construction industry.⁷⁹ Figure 48 illustrates the importance of the construction industry.

Figure 47: Washington construction industry snapshot, 2019



Source: CPCS analysis of U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics data, 2021.

Figure 48: Construction industry fast facts

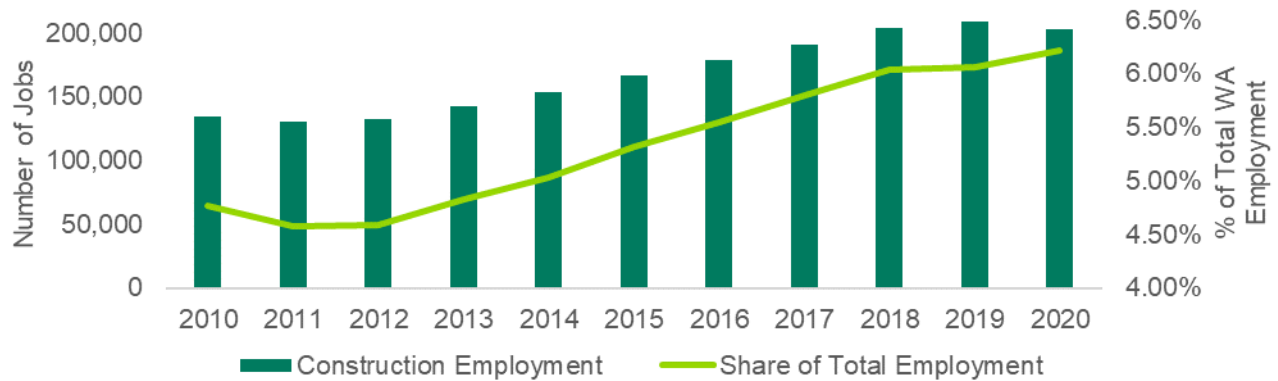


Source: WASHINGTON: 2020 Census, U.S. Census Bureau, August 2021. <https://www.census.gov/library/stories/state-by-state/washington-population-change-between-census-decade.html> | Growth in Housing Units Slowed in the Last Decade, U.S. Census Bureau, August 2021. <https://www.census.gov/library/stories/2021/08/growth-in-housing-units-slowed-in-last-decade.html> | CPCS analysis of U.S. Bureau of Economic Analysis data, 2021. | Mineral Industry Surveys, U.S. Geological Survey, April 2020. <https://www.usgs.gov/centers/nmic/cement-statistics-and-information> | Eighty Percent of Contractors Report Difficulty Finding Qualified Craft Workers to Hire, Associated General Contractors of America, August 2019. <https://www.agc.org/news/2019/08/27/eighty-percent-contractors-report-difficulty-finding-qualified-craft-workers-hire>

Employment in the construction industry in Washington increased over the last decade, not only in nominal numbers but also as a share of total employment (Figure 49). This is due primarily to migration to Washington and demand for multifamily housing units as well as new industrial developments to support the freight demand of the growing population. Figure 51 illustrates retail and industrial construction activity over the last 20 years. Construction activity is most prevalent in the Puget Sound Region between Everett and Tacoma, along with hotspots in Vancouver, Yakima, Kennewick, and Spokane, and along the I-5 corridor.

⁷⁹ CPCS analysis of US Bureau of Economic Analysis data, 2021. Data uses in 2012 chained dollars.

Figure 49: Washington construction jobs and share, 2010-2020



Source: CPCS analysis of U.S. Bureau of Labor Statistics data, 2021.

Construction supply chain

The construction industry is dependent on many inputs. Figure 52 examines how common construction inputs like cement, steel, and wood arrive at a construction site.

Trucks are the primary mode used to transport construction inputs, supporting about 89% of freight weight and about 87% of value for the industry in 2017.⁸⁰ Thus, maintaining key roads in good condition is critical to support construction in Washington.

Construction trends



Rapid Growth: Between 2010 and 2020, Washington saw its stock of housing units grow 11%, faster than the 6.7% national growth. The five fastest-growing counties for new housing were Franklin, Benton, Clark, King, and Thurston. King County added the most units at nearly 118,000 over the last decade.^{81 82} Figure 50 provides further information about the change in these counties.

Figure 50: Counties with largest percent change in housing units

County	Growth in Housing Stock
Franklin	21.8%
Benton	16.7%
Clark	16.5%
King	13.9%
Thurston	12.3%

Source: CPCS analysis of U.S. Census data, 2021

⁸⁰ US Freight Analysis Framework Version 5, Federal Highway Administration (FHWA), 2021. <https://faf.ornl.gov/faf5/> | Represents 2017 base year flows for domestic movements destined for and/or originating from Washington, as well as international imports destined for and/or entering the U.S. through Washington, and international exports originating from and/or exiting the U.S. through Washington.

⁸¹ WASHINGTON: 2020 Census, US Census Bureau, August 2021. <https://www.census.gov/library/stories/state-by-state/washington-population-change-between-census-decade.html>

⁸² Growth in Housing Units Slowed in the Last Decade, US Census Bureau, August 2021. <https://www.census.gov/library/stories/2021/08/growth-in-housing-units-slowed-in-last-decade.html>

Figure 51: Washington retail and industrial construction activity density

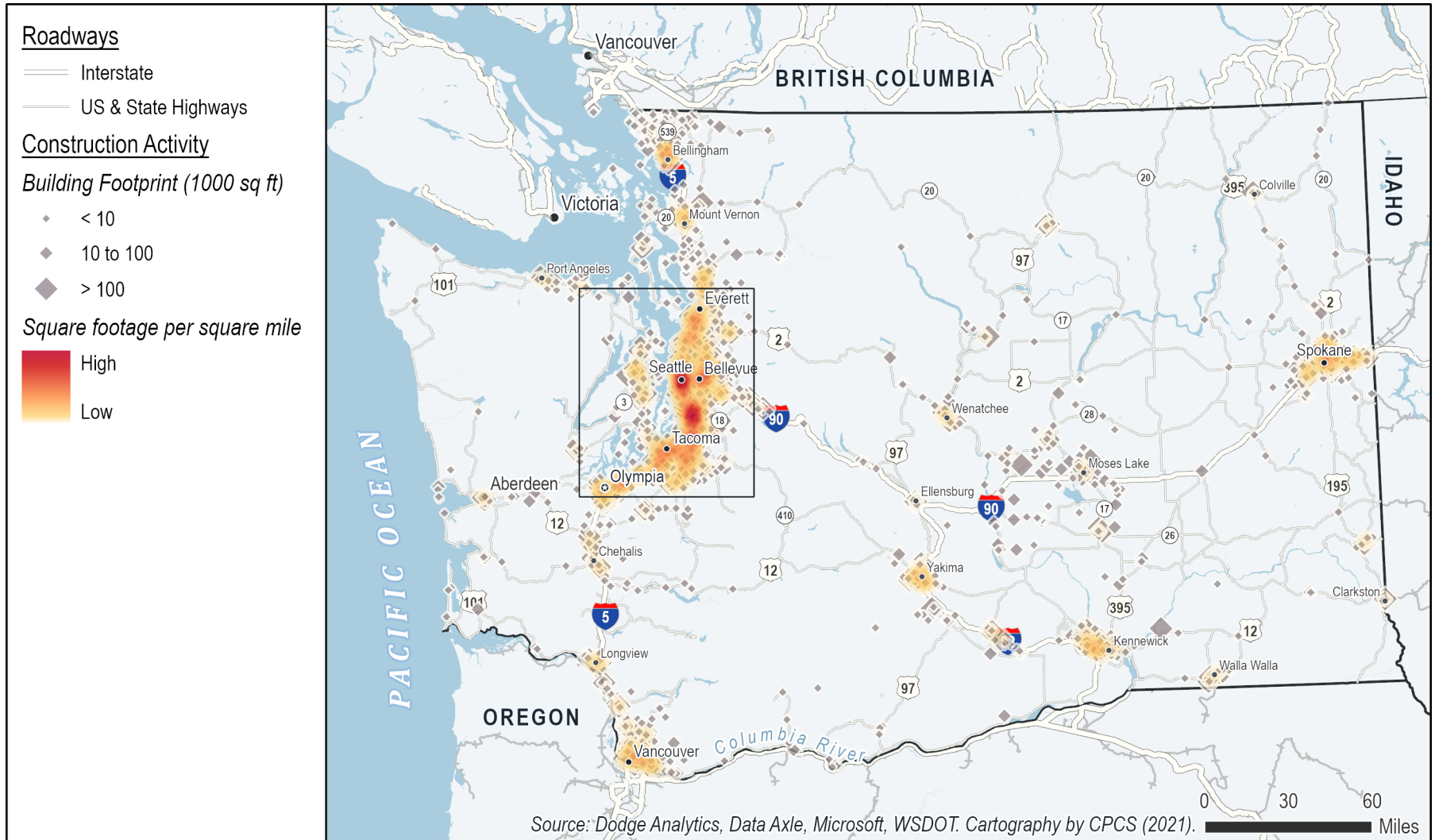
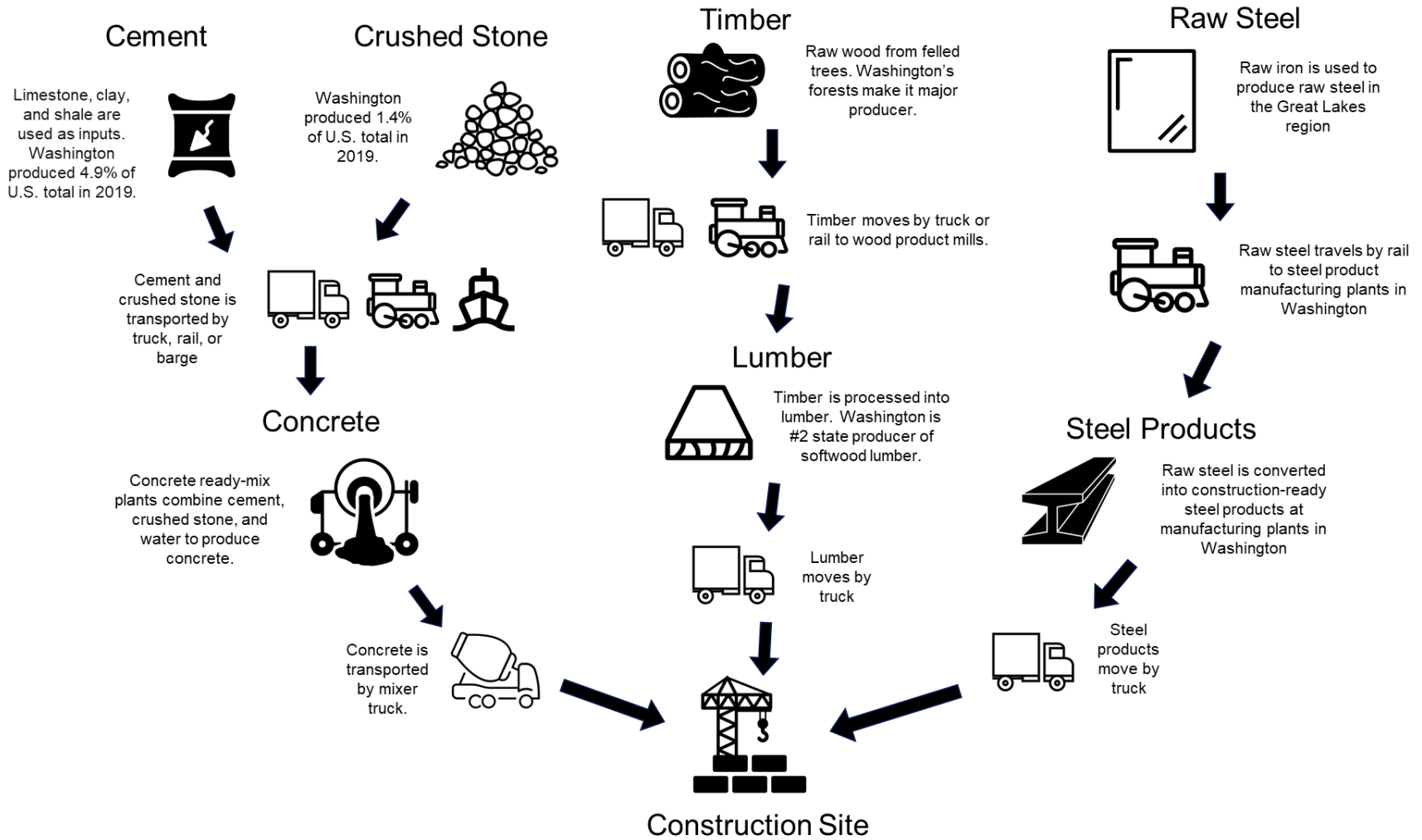


Figure 52: Washington construction supply chain



Source: CPCS analysis of USGS Mineral Industry Surveys and FHWA FAF5 data, 2021. | No. 1 in softwood lumber, Oregon Forest Resources Institute, (n.d.). <https://oregonforests.org/index.php/softwood-lumber>

Rapid growth (continued): In Washington, newly-constructed housing tends to be higher density and located in urban areas. Over the last decade, 57% of new housing units were multi-family and 71% were constructed in one of Washington’s five largest metropolitan areas.⁸³ The state’s industrial real estate market also continues to grow rapidly as more industrial facilities are being co-located near ports to improve efficiency. Rising e-commerce demand is also resulting in a transition from retail to warehousing, particularly in the Puget Sound region.⁸⁴ ⁸⁵ These trends will continue to place pressure on freight infrastructure in urban centers



Sustainable development: Sustainable construction practices are expanding quickly. In 2018, Governor Inslee signed EO 1801, which establishes requirements for embodied carbon in the construction of state buildings.⁸⁶ ⁸⁷ The City of Seattle also has its own embodied carbon incentives, including expedited permit review and additional development capacity in exchange for green construction.⁸⁸ Greener building practices may incur lower operating costs, reduce construction waste, decrease carbon emissions, conserve water, and even increase occupant comfort through improved lighting and climate control. Of particular note is the adoption of Deconstruction—a sustainable development practice that recycles construction materials like steel and concrete from existing buildings or nearby landfills instead of producing new materials. This practice works to reduce freight movements and increase the lifecycle of existing materials.



Workforce shortage: Despite the booming construction industry, there is a shortage of necessary workforce. In August 2019, 80% of surveyed contractors in Washington had trouble finding and hiring workers.⁸⁹ The onset of the COVID-19 pandemic also exacerbated these labor shortage problems. As of 2021, 88% of U.S. contractors reported moderate to high levels of difficulty finding the right workers.⁹⁰ Labor shortages mean higher labor costs for construction industries.



Rising prices for materials: Figure 53 illustrates trends in the producer price indices for three construction inputs: steel mill products, cement, and rubber and plastic. All three have seen increasing prices over the last decade.⁹¹ Supply chain disruptions and depressed material production during the pandemic, as well as U.S.-China trade tariffs in 2018, have resulted in an additional hike to construction material prices. Relative to 2010, 2021 prices are approximately 35% higher.

Increasing prices do not appear to be depressing demand for construction across the state. However, elevated prices increase the cost of construction, freight movements, and WSDOT’s asset preservation efforts for road construction and rehabilitation.

⁸³ State population steadily increases, tops 7.7 million residents in 2021, Office of Financial Management, June 2021.

<https://ofm.wa.gov/about/news/2021/06/state-population-steadily-increases-tops-77-million-residents-2021>

⁸⁴ Report: Puget Sound industrial market stays on a tear, *Puget Sound Business Journal*, Shawna De La Rosa, September 2021.

<https://www.bizjournals.com/seattle/news/2021/09/29/puget-sounds-industrial-market-continues-strong.html>

⁸⁵ Ibid.

⁸⁶ Embodied carbon refers to the environmental efficiency of building construction and use.

⁸⁷ What is a Buy Clean Policy?, Carbon Leadership Forum, (n.d.). <https://carbonleadershipforum.org/what-is-a-buy-clean-policy/>

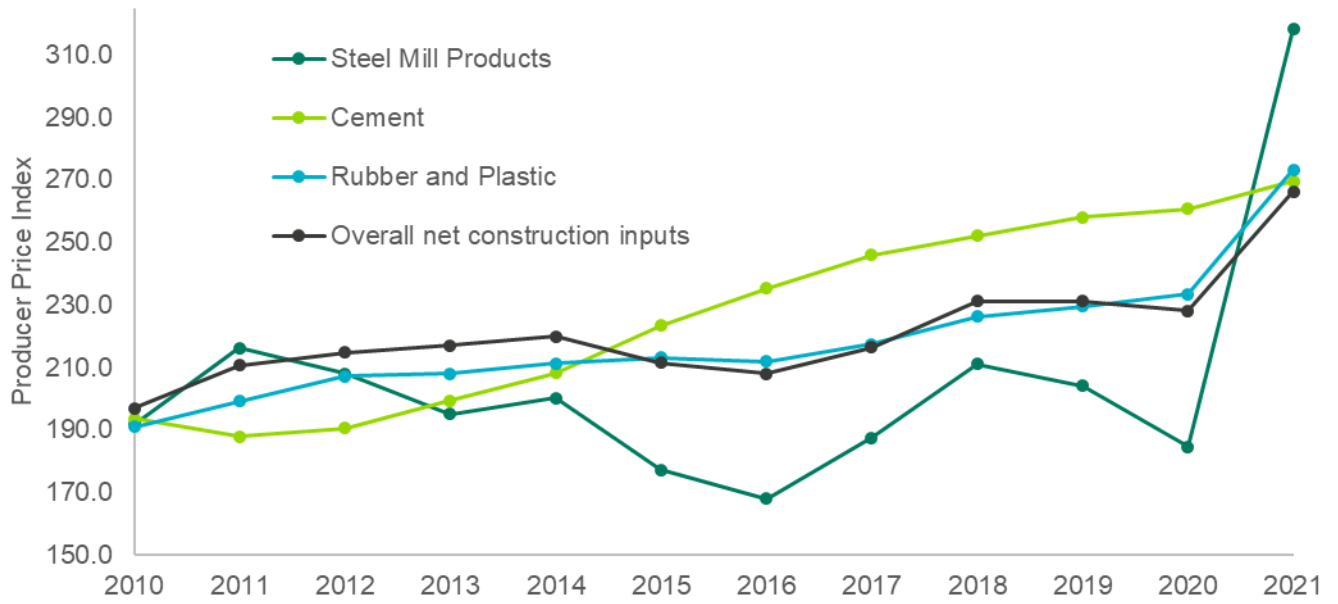
⁸⁸ Green Building Permit Incentives, Seattle Department of Construction & Inspections, (n.d.). <http://www.seattle.gov/sdci/permits/green-building>

⁸⁹ Eighty Percent of Contractors Report Difficulty Finding Qualified Craft Workers to Hire, Associated General Contractors of America August 2019. <https://www.agc.org/news/2019/08/27/eighty-percent-contractors-report-difficulty-finding-qualified-craft-workers-hire>

⁹⁰ New Report Finds Construction Contractors Struggling to Find Workers, Building Materials, US Chamber of Commerce, Thaddeus Swaneck, June 2021. <https://www.uschamber.com/infrastructure/new-report-finds-construction-contractors-struggling-find-workers-building>

⁹¹ CPCS analysis of US Bureau of Labor Statistics data: WPU1017, WPU1322, WPU0721, and WPU1P2300001, 2021.

Figure 53: U.S. producer price indices for construction inputs



Source: CPCS analysis of U.S. Bureau of Labor Statistics data: WPU1017, WPU1322, WPU0721, and WPUIP2300001, 2021.

8. Manufacturing

Manufacturing is a major industry in Washington, contributing over 10% of the state’s GDP and employing roughly 9% of the state’s workforce. The state produces a wide variety of goods, from electronics to airplanes to oral healthcare products. Figure 55 provides some fast facts about the manufacturing industry in Washington.

Figure 54: Washington manufacturing industry snapshot, 2019

\$64.7 billion	305,000 jobs	\$24.8 billion
Contribution to state GDP	Employment	Paid in wages & salaries

Source: CPCS analysis of U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics data, 2021.

Figure 55: Manufacturing industry fast facts



Manufacturing in Washington includes a diverse range of products including electronics, ultrasounds, and oral healthcare products.



Cannabis is Washington’s fourth most valuable crop and is used to manufacture high-value marijuana products.



Aerospace and transportation equipment production is the largest manufacturing sector by value.

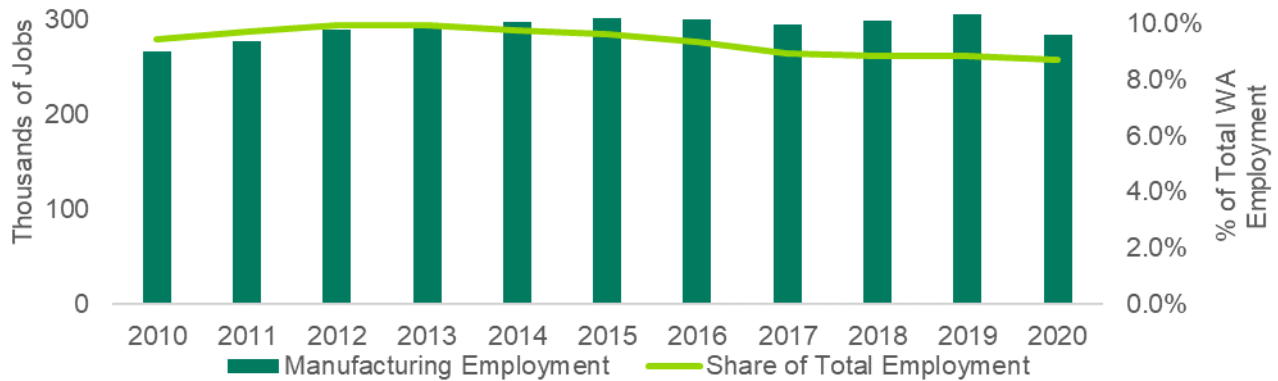
Source: Cannabis is Washington’s 4th most valuable crop, industry report says, *The Seattle Times*, Paul Roberts, November 2021. <https://www.seattletimes.com/business/cannabis-is-washingtons-4th-most-valuable-crop-industry-report-says/> | 2020 Washington Manufacturing Facts, National Association of Manufacturers, (n.d.). <https://www.nam.org/state-manufacturing-data/2020-washington-manufacturing-facts/>

Figure 56 shows that manufacturing employment has remained relatively steady but makes up a shrinking proportion of total jobs over the last decade, primarily due to the cost of labor and automation. Manufacturing commodities primarily move by truck, as well as multiple modes in Washington.⁹² Thus, maintaining safe and efficient trucking routes is critical to supporting the manufacturing industry.

As shown in Figure 57, employment in manufacturing is located throughout Washington, with hotspots in the Puget Sound region, Vancouver, and Spokane. The I-5 corridor in particular houses significant manufacturing employment along its length.

⁹² US Freight Analysis Framework Version 5, Federal Highway Administration (FHWA), 2021. <https://faf.ornl.gov/faf5/> | Represents 2017 base year flows for domestic movements destined for and/or originating from Washington, as well as international imports destined for and/or entering the U.S. through Washington, and international exports originating from and/or exiting the U.S. through Washington.

Figure 56: Washington manufacturing jobs and share, 2010-2020



Source: CPCS analysis of U.S. Bureau of Labor Statistics data, 2021.

A sampling of the wide variety of Washington manufacturers



Northwest Cannabis Solutions is one of the largest producers of recreational cannabis products in Washington. The company boasts a 30,000 square foot growing facility in Olympia. More generally, the cannabis growing and manufacturing industry is seeing rapid growth. In 2020, cannabis became the state’s fourth most valuable crop, with revenues of over \$650 million.⁹³



Schweitzer Engineering Laboratories, headquartered in Pullman, Washington, manufactures electronic technologies that help manage power systems. For example, the firm produces devices that help to pinpoint the exact location of a power system fault so that maintenance is more targeted and power restoration occurs more quickly. All of the company’s manufacturing occurs in the U.S., including in Washington.^{94 95}



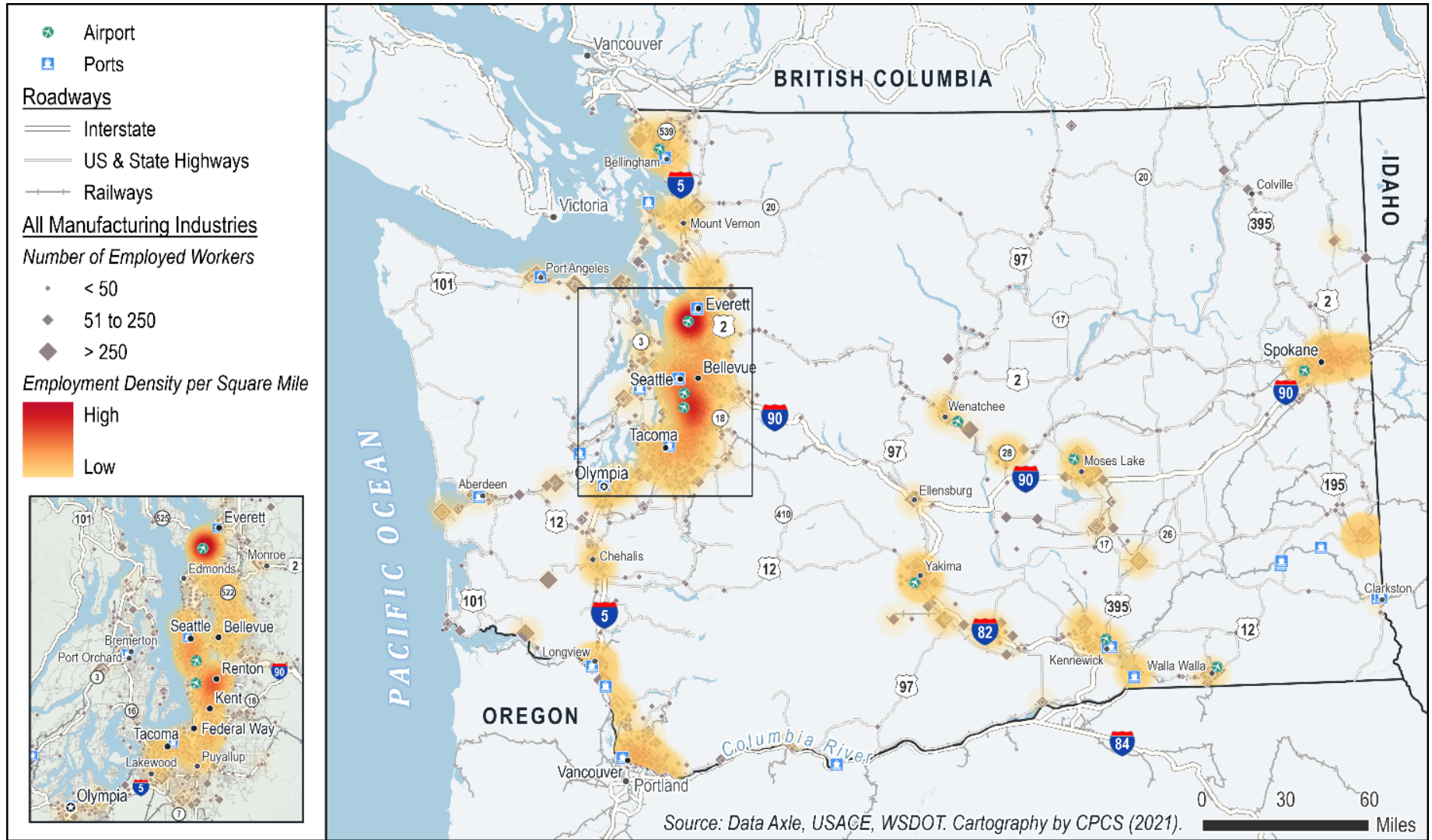
Philips Healthcare operates a manufacturing plant in Bothell, Washington, where it produces oral healthcare products, ultrasounds, cardiac care, and defibrillator equipment. As of 2013, Philip’s Bothell location employed about 2,000 people.⁹⁶



HP Inc., a global producer of printers and personal computers, has a corporate headquarters located in Vancouver, Washington. HP is currently in the process of acquiring an additional 68 acres of land in eastern Vancouver where it will eventually move its corporate offices. The new location’s extensive footprint may also one day house research and development and manufacturing facilities.^{97 98} Additive manufacturing may change how manufacturing is conducted, permitting on-site production and reducing the need for freight transportation of individual components.

⁹³ Cannabis is Washington’s 4th most valuable crop, industry report says, *The Seattle Times*, Paul Roberts, November 2021. <https://www.seattletimes.com/business/cannabis-is-washingtons-4th-most-valuable-crop-industry-report-says/>
⁹⁴ The Journey of Electric Power, Schweitzer Engineering Laboratories, (n.d.). <https://selinc.com/company/our-part/electric-journey/>
⁹⁵ Quality Philosophy, Schweitzer Engineering Laboratories, (n.d.). <https://selinc.com/company/quality-philosophy/>
⁹⁶ Gov. Inslee gets ‘epic’ tour of Philips manufacturing in Bothell, *Bothell-Kenmore Reporter*, Matt Phelps, October 2013. <https://www.bothell-reporter.com/news/gov-inslee-gets-epic-tour-of-philips-manufacturing-in-bothell-photos/>
⁹⁷ Vancouver City Council approves master plan for new HP campus, *The Columbian*, Calley Hair, May 2021. <https://www.columbian.com/news/2021/may/17/vancouver-city-council-approves-master-plan-for-new-hp-campus/>
⁹⁸ Amid takeover talk, HP Inc. betting big on Vancouver, 3D printing, *The Columbian*, Anthony Macuk, December 2019. <https://www.columbian.com/news/2019/dec/05/amid-takeover-talk-hp-inc-betting-big-on-vancouver-3d-printing/>

Figure 57: Washington manufacturing employment map



9. Aerospace manufacturing

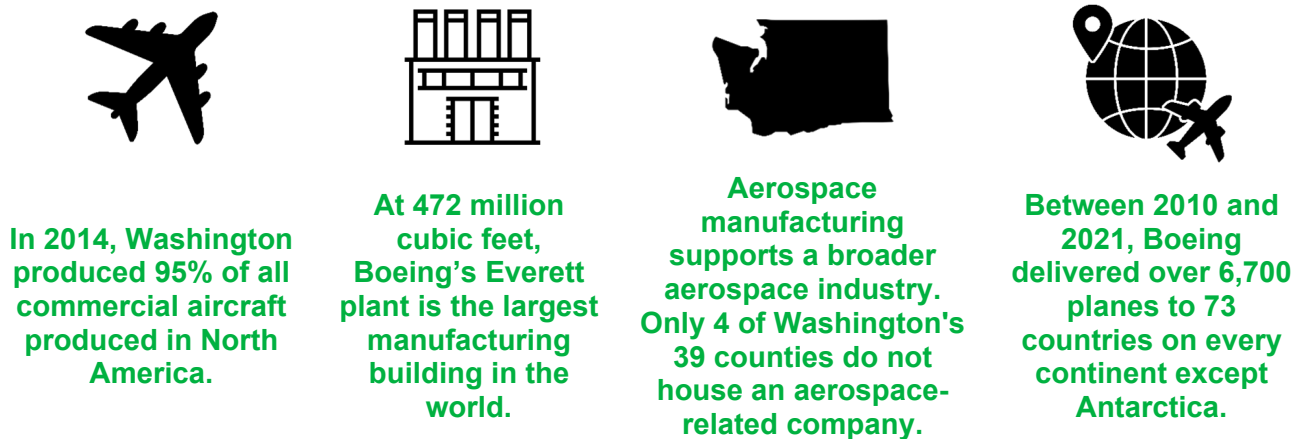
Washington is an economic powerhouse for aerospace manufacturing, an industry that sources high-value components from across the world and thus relies heavily on reliable freight transportation. Figure 59 provides some fast facts that highlight the significance of this industry.

Figure 58: Washington aerospace manufacturing snapshot, 2019



Source: CPCS analysis of U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics data. 2021.
Note: GDP data not available.

Figure 59: Aerospace manufacturing industry fast facts



Source: Office of Aerospace, Washington Governor's Office, (n.d.). <https://www.governor.wa.gov/issues/issues/economy/aerospace> | Everett Production Facility, Boeing, (n.d.). <https://www.boeing.com/company/about-bca/everett-production-facility.page>

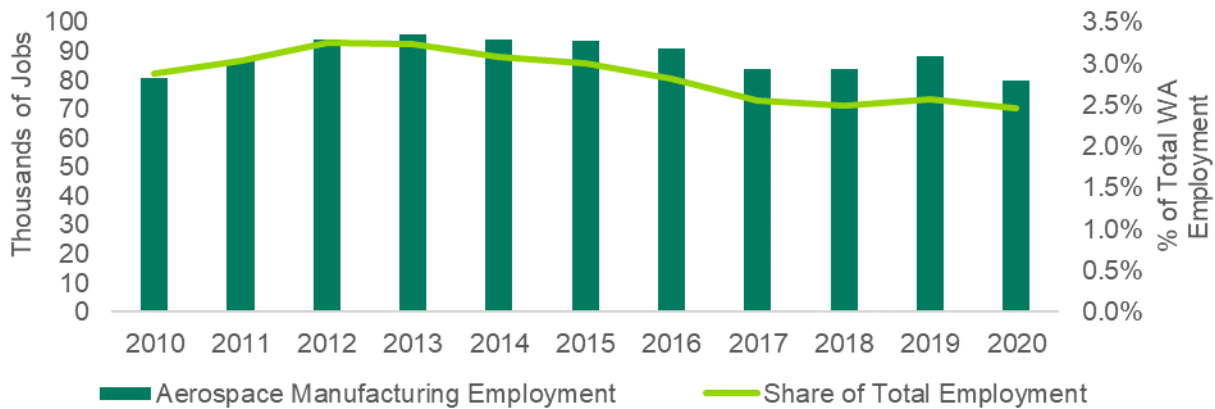
Despite the importance of aerospace manufacturing in Washington, employment in the industry has declined since 2013 both nominally and as a share of total jobs (Figure 60). This is due to a rise in automation, Boeing-specific business activities, and the relocation of some manufacturing to other regions.⁹⁹

Figure 62 illustrates the concentration of aerospace manufacturing sprinkled throughout Washington. Aerospace manufacturing is heavily concentrated in the Puget Sound Region between Everett and Tacoma. Spokane, Yakima, and Moses Lake are also home to aerospace manufacturing clusters. Aerospace manufacturing supports the broader aerospace industry, which has a major presence in Washington. Only 4 of the state's 39 counties do not house an aerospace-related company.¹⁰⁰

⁹⁹ Boeing moving all 787 production away from Seattle area, possibly costing 1,000 jobs, *Forbes*, Nicholas Reimann, October 2020. <https://www.forbes.com/sites/nicholasreimann/2020/10/01/boeing-moving-all-787-production-away-from-seattle-area-possibly-costing-1000-jobs/?sh=4bd1b4ab1e52>

¹⁰⁰ Office of Aerospace, Washington Governor's Office, (n.d.). <https://www.governor.wa.gov/issues/issues/economy/aerospace>

Figure 60: Washington aerospace manufacturing jobs and share, 2010-2020

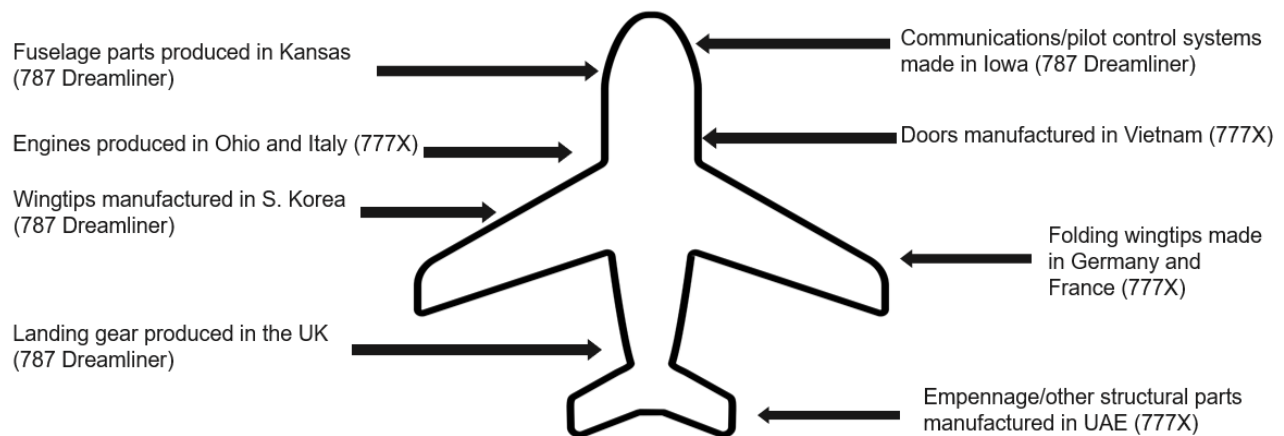


Source: CPCS analysis of U.S. Bureau of Labor Statistics data, 2021.

Aerospace manufacturing supply chain

Airplanes are made up of over 500,000 parts and components, sourced from both domestic and international locations. Some of the representative parts are shown in Figure 61.¹⁰¹

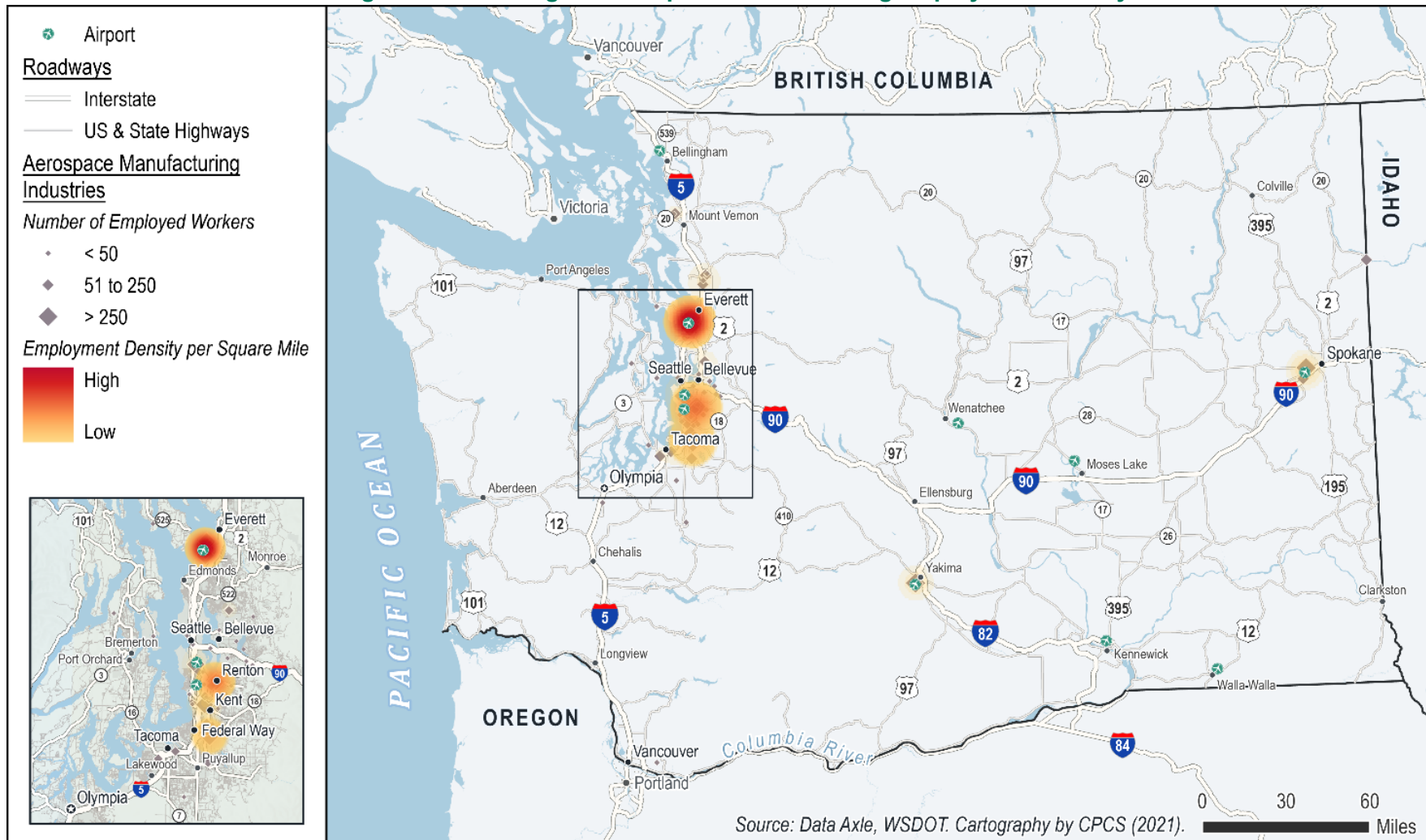
Figure 61: Aerospace manufacturing supply chain example



Source: CPCS analysis of available literature sources and industry knowledge, 2022.

¹⁰¹Where Does Boeing Build Aircraft?, Simple Flying, Linnea Ahlgren, October 2021. <https://simpleflying.com/boeing-build-locations/> | Where Are Parts for the Boeing 777X Being Built?, Simple Flying, Emily Derrick, August 2021. <https://simpleflying.com/boeing-777x-parts-manufacture-site/> | How Aircraft Wings Are Made, Simple Flying, Pranjal Pande, December 2020. <https://simpleflying.com/how-aircraft-wings-are-made/> | Dreamliner: Where in the world its parts come from, CNN Business, Parija Kavilanz, January 2013. <https://money.cnn.com/2013/01/18/news/companies/boeing-dreamliner-parts/index.html>

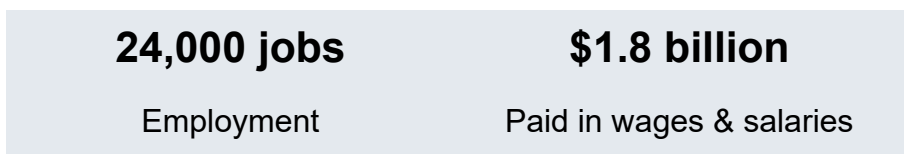
Figure 62: Washington aerospace manufacturing employment density



10. Transportation equipment

Washington is a major producer of transportation equipment. Transportation manufacturing goods primarily move by truck, multiple modes, and air in Washington.¹⁰² Thus, maintaining freight infrastructure like roads and airports is critical to support the transportation equipment manufacturing industry in Washington. This chapter focuses on the shipbuilding industry, given its importance to the state. Among various types of transportation equipment, Washington’s abundant water, lumber, and metal resources and its longstanding maritime economy make Washington a national shipbuilding leader. A quarter of the nation’s shipyards reside in Washington. The shipbuilding industry not only contributes to the manufacturing industry but also provides the equipment necessary to support the maritime industry. Figure 63 highlights the economic contributions of the industry and Figure 64 provides industry fast facts.

Figure 63: Washington transportation equipment industry snap shot, 2019



Source: CPCS analysis of U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics data, 2021.
 Note: GDP data not available.

Figure 64: Transportation equipment fast facts



WA has a quarter of the U.S.’s 117 shipyards.



The shipbuilding sector supported 32% of total maritime jobs in WA.



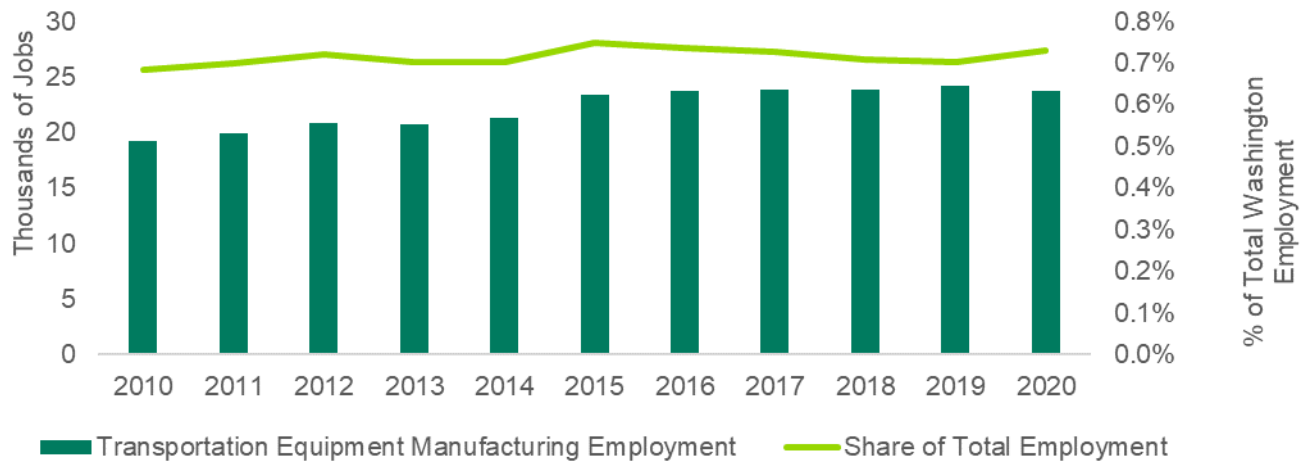
Washington State Ferries plans to electrify/hybridize more than half of its vessels by 2024.

Sources: Maritime Industry, Washington State Department of Commerce, (n.d.). <https://www.choosewashingtonstate.com/why-washington/our-key-sectors/maritime/> | Maritime Blue, (n.d.). <https://maritimeblue.org> | ABB and vigor are helping Washington State electrify its iconic ferries, *Forbes*, Jim Vinoski, August 2020. <https://www.forbes.com/sites/jimvinoski/2020/08/05/abb-and-vigor-are-helping-washington-state-electrify-its-iconic-ferries/>

Figure 65 shows that transportation equipment manufacturing jobs remained relatively constant since 2015 at around 24,000 jobs, suggesting that this industry’s important role supporting freight and manufacturing industries has not changed significantly.

¹⁰² US Freight Analysis Framework Version 5, Federal Highway Administration (FHWA), 2021. <https://faf.ornl.gov/faf5/> | Represents 2017 base year flows for domestic movements destined for and/or originating from Washington, as well as international imports destined for and/or entering the U.S. through Washington, and international exports originating from and/or exiting the U.S. through Washington.

Figure 65: Washington transportation equipment manufacturing jobs and share, 2010-2020



Source: CPCS analysis of U.S. Bureau of Labor Statistics data, 2021.

Figure 66 illustrates the densest centers of transportation equipment manufacturing, which coincides with the boat and ship building clusters in Kitsap, King, Pierce, Skagit, and Whatcom Counties. The largest employment concentration center is at the Puget Sound Naval Shipyard in Bremerton. Recreational boat building and boating activities are mainly located in King County, spread across the state’s inland waterways, including the Columbia River.

Major shipyards in the Puget Sound region include:

- Puget Sound Naval Shipyard:** The Puget Sound Naval Shipyard was the first dry-dock and ship repair facility in the Northwest region and is one of the largest industrial installations in Washington. The Shipyard in Bremerton, Washington, continues to perform full-service maintenance on and recycling of inactive surface ships and submarines with the Shipyard’s six drydocks and adjacent piers.¹⁰³
- Harbor Island Shipyard:** Located at the mouth of Duwamish River in Seattle, Harbor Island is not only the largest man-made island in the U.S. but also the home to Vigor Industrial’s 27-acre shipyard that specializes in ship repair and modernization and Washington State Ferries production. The shipyard constructs and repairs midsized to large vessels. The types of ships built in the Harbor Island shipyard include fishing vessels, ferries, barges, military ships, and offshore oil and gas vessels.¹⁰⁴ The Vigor shipyard serves a diverse range of clients, such as U.S. and Royal Australian Navies, the United States Coast Guard, and the Washington State Ferries.

Trends: Ship electrification



Washington State Ferries (WSF), the largest operating public ferry system in the U.S, is taking the lead to electrify or hybridize their fleets as part of the Ferries System Electrification Plan (SEP). WSF partnered with Vigor and ABB to launch its new hybrid-ferry new build program in 2019. The program is currently converting the existing Olympic Class design to diesel-electric. WSF expects the converted Olympic Class vessels to reduce carbon emission by 94% during the vessels’ lifespan.¹⁰⁵

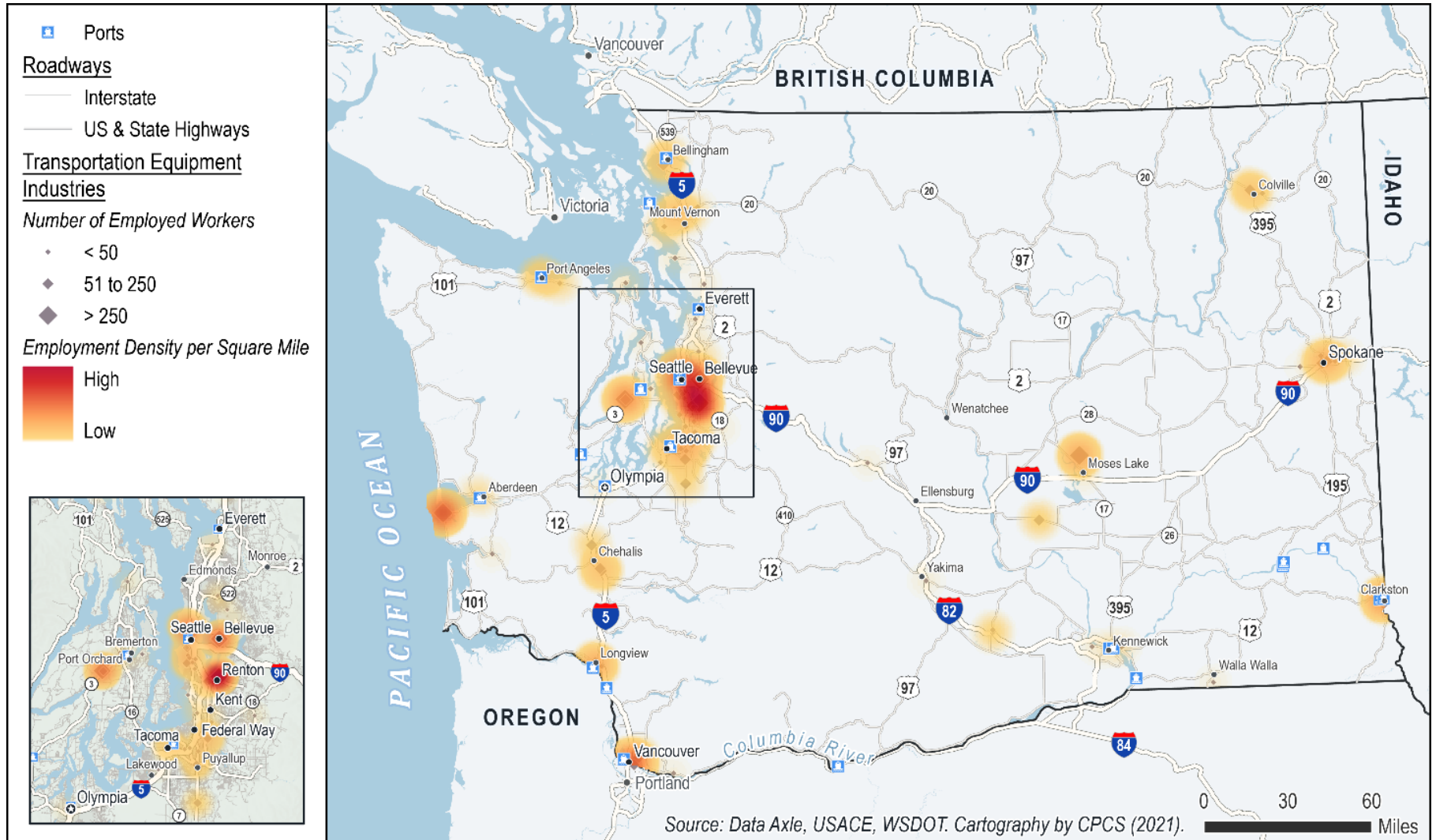
¹⁰³ Puget Sound Naval Shipyard & Intermediate Maintenance Facility, US Navy, (n.d.). <https://www.navsea.navy.mil/Home/Shipyards/PSNS-IMF/History/>

¹⁰⁴ Seattle, WA Facility, Vigor, (n.d.). from <https://vigor.net/facilities/seattle>.

¹⁰⁵ ABB and vigor are helping Washington state electrify its iconic ferries, Forbes, Jim Vinoski, August 2020.

<https://www.forbes.com/sites/jimvinoski/2020/08/05/abb-and-vigor-are-helping-washington-state-electrify-its-iconic-ferries/>

Figure 66: Washington transportation equipment manufacturing map



11. Retail, dining, and disposal

The retail, dining, and disposal industry covers a range of sectors involving the direct transportation of goods to consumers. This includes retailers, restaurant establishments, and waste and disposal services. The retail and dining industries are major employment generators for the state. Additional key indicators for the retail, dining, and disposal sectors are provided in Figure 67.

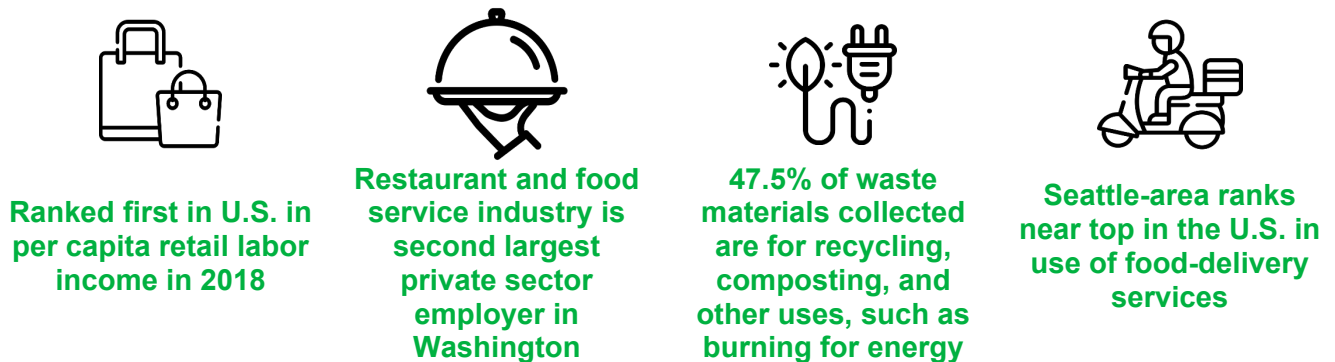
Figure 67: Washington retail, dining, and disposal industry snapshot, 2019

\$67.7 billion	653,000 jobs	\$31.4 billion
Contribution to state GDP	Employment	Paid in wages & salaries

Source: CPCS analysis of U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics data, 2021.

With the rapid growth of e-commerce as well as on-demand delivery, freight networks across the U.S. are seeing growth in last-mile delivery services to these industries, which have significant cost and logistics implications. A reported 28% of the entire supply chain cost can be attributed to the cost of the last-mile delivery.¹⁰⁶ Commodities for retail, dining, and disposal primarily move by truck in Washington.¹⁰⁷ Thus, maintaining important freight roads is critical to support the retail, dining, and disposal sectors.

Figure 68: Retail, dining, disposal fast facts



Sources: The Economic Impact of the U.S. Retail Industry, National Retail Federation, May 2020. <https://cdn.nrf.com/sites/default/files/2020-06/RS-118304%20NRF%20Retail%20Impact%20Report%20.pdf> | Ordering in: Food delivery surged in the Seattle areas as COVID-19 pandemic took hold, *The Seattle Times*, Gene Balk, November 2021. <https://www.seattletimes.com/seattle-news/data/ordering-in-food-delivery-surged-in-the-seattle-area-as-covid-19-pandemic-took-hold/> | Waste Generation and Recovery Data, Washington Department of Ecology, (n.d.). <https://ecology.wa.gov/Research-Data/Data-resources/Solid-waste-recycling-data> | National Restaurant Association VP Shares COVID-19 Impact, KPQ, Kalie Drago, April 2020. <https://www.kpq.com/national-restaurant-association-vp-shares-covid-19-impact/>

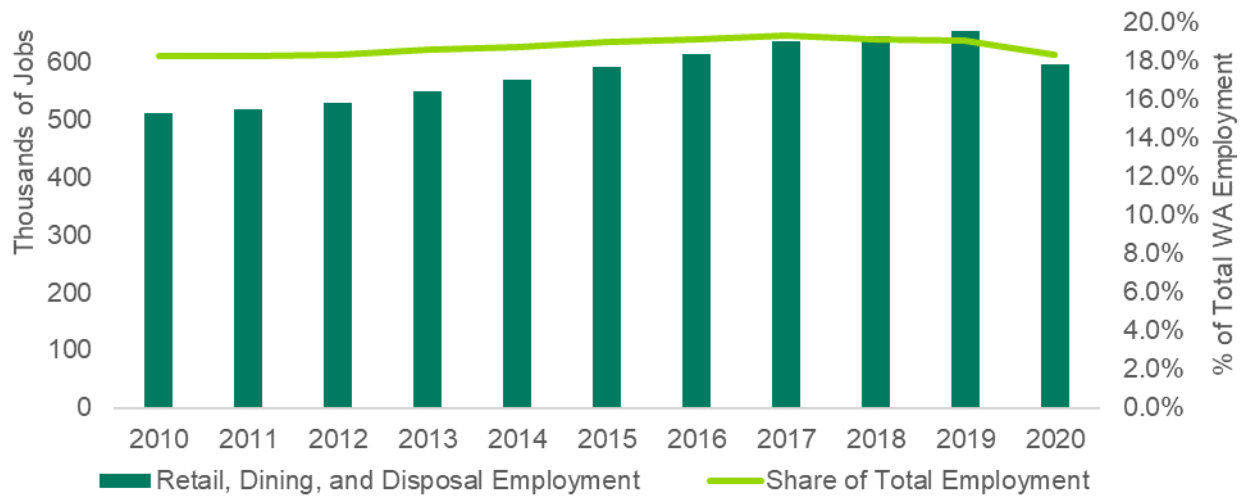
Figure 69 shows how employment in these sectors took a major hit between 2019-2020. The decline is mainly attributed to the impacts of COVID-19 on the restaurant industry, which was one of the hardest hit sectors in Washington. Three out of every four restaurant industry workers in Washington were either furloughed or laid-off between April 2019 and April 2020, according to the National

¹⁰⁶ In the Supply Chain Journey, Every Mile Matters, Association for Supply Chain Management, Kamal Anand, February 2018. <https://www.ascm.org/ascm-insights/in-the-supply-chain-journey-every-mile-matters/>.

¹⁰⁷ US Freight Analysis Framework Version 5, Federal Highway Administration (FHWA), 2021. <https://faf.ornl.gov/faf5/> | Represents 2017 base year flows for domestic movements destined for and/or originating from Washington, as well as international imports destined for and/or entering the U.S. through Washington, and international exports originating from and/or exiting the U.S. through Washington.

Restaurant Association.¹⁰⁸ Declines like this have a direct impact on the volume of freight being shipped to restaurants and stores.

Figure 69: Washington retail, dining, and disposal jobs and share, 2010-2020



Source: CPCS analysis of U.S. Bureau of Labor Statistics data, 2021.

Restaurant and retail supply chain

E-commerce is growing rapidly – 55% of Washington residents surveyed responded they were shopping more online, second only to California (56.5%).¹⁰⁹

Before e-commerce, last-mile delivery for retail, dining, and disposal traditionally included goods moving on pallets from manufacturing facilities, warehouses, or distribution centers to retail and other business stores. Products were moved in large volumes quickly and efficiently through supply chains. With the boom in e-commerce, shipments have shifted, now with numerous small orders destined for different locations.¹¹⁰ Last-mile deliveries also are more commonly taking place in urban areas and require an expanded network of distribution centers, at times cutting out retailers.

A pilot for a **zero-emission hub for last-mile deliveries** took place in early 2021 set in a Seattle neighborhood. The study was conducted by various companies in collaboration with University of Washington Urban Freight Lab. Key findings included the assessment that an **e-cargo bike is able to replace a truck mile for mile** and use of e-cargo bikes **reduced CO2 emissions by 30%** for each package delivered. The study also found that networked neighborhood delivery hubs were also effective for reducing truck traffic.

Source: The Seattle Neighborhood Delivery Hub Pilot Project, Supply Chain Transportation & Logistics Center at the University of Washington, September 2021. http://depts.washington.edu/sctlctr/sites/default/files/research_pub_files/UFL-Sea-Neighborhood-Delivery-Hub_Final-Report.pdf

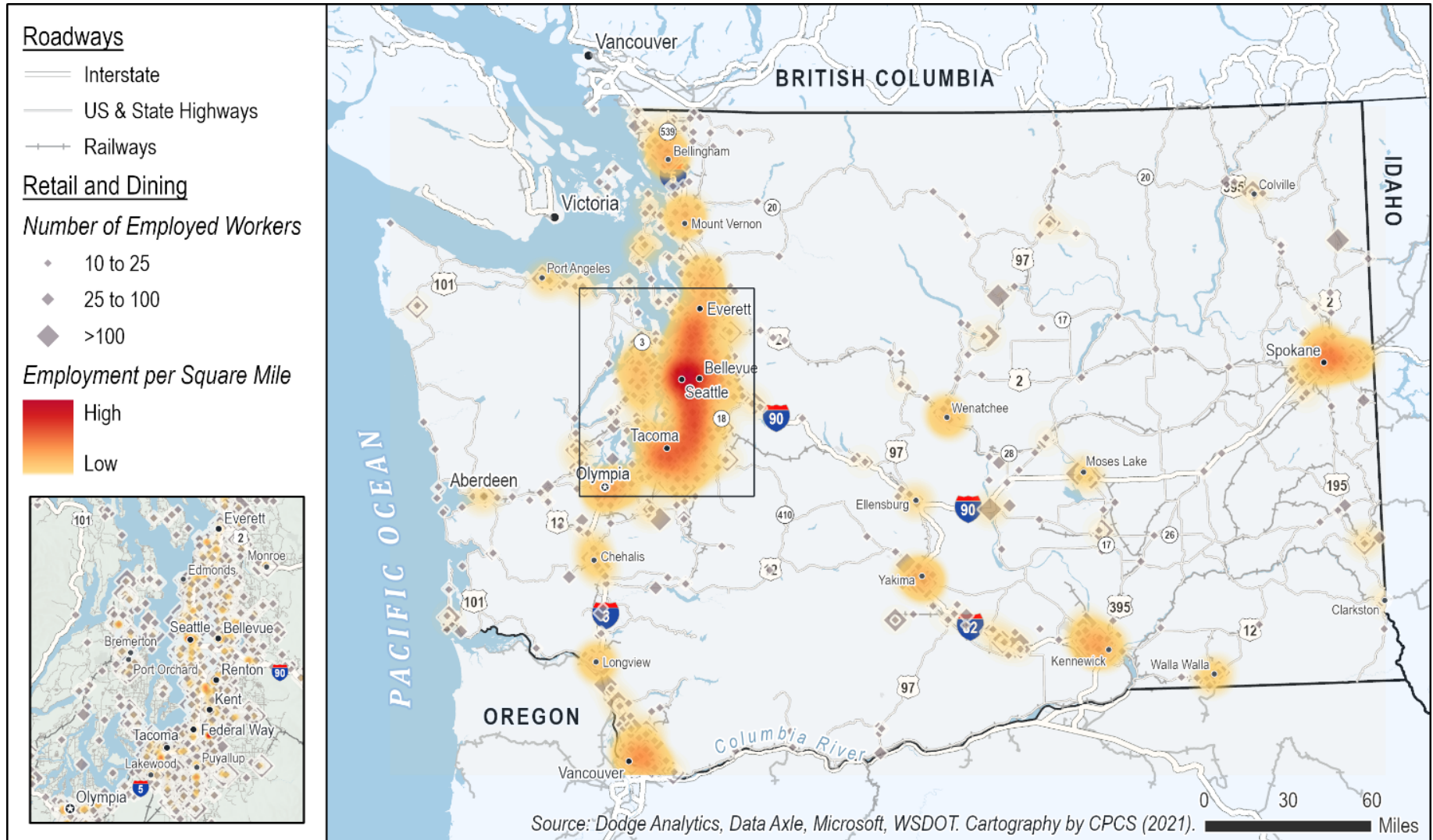
Figure 70 illustrates that retail and dining employment in Washington is concentrated in and around population centers. Thus, the highest concentrations are found in the Puget Sound region and around Kennewick, Spokane, Vancouver, and Yakima.

¹⁰⁸ National Restaurant Association VP Shares COVID-19 Impact, KPQ, Kalie Drago, April 2020. <https://www.kpq.com/national-restaurant-association-vp-shares-covid-19-impact/>

¹⁰⁹ Nearly Half of Americans are Making More Online Purchases Amid Pandemic, Lending Tree, Devon Delfino, October 2020. <https://www.lendingtree.com/personal/more-online-purchases-study/>

¹¹⁰ Last Mile Delivery: The Ultimate Guide for 2021, GoFor Industries Inc., Brad Rollo, (n.d.). <https://www.gofordelivers.com/blog/what-is-last-mile-delivery>

Figure 70: Washington retail and dining employment map



The increasing adoption of e-commerce for retail shopping is having a significant impact on the freight transportation system as well as urban residents. A study of curb use in Seattle was conducted by the University of Washington Supply Chain Transportation and Logistics Center Urban Freight Lab in 2017 and reveals some insights into how these new delivery systems work in Washington. The study found that about 25% of all commercial vehicles parked along curbs were delivery vehicles (i.e., box trucks and cargo vans). Of these delivery vehicles, 81% parked for 30 minutes or less.¹¹¹ As freight demand becomes increasingly urbanized across Washington, WSDOT freight planning must consider how new delivery systems impact freight needs.

Waste disposal

Waste disposal consists of garbage transportation from residential or business sites to regional landfills. Due to the high precipitation levels west of the Cascades, landfills are costly to construct and operate. Many landfills on the western side of the state are also at or nearing capacity. Due to limited capacity and high operating cost, much of Washington's garbage often must travel long distances on multiple modes to reach larger facility sites in eastern Washington.¹¹² Figure 71 shows the waste collection sites across Washington and waste volumes.

With a 40-year capacity of 120 million tons, Roosevelt Landfill is one of the largest in the nation. It is situated in the southern central region of the state, with access to I-84, a railyard in Roosevelt, Washington, and the Columbia River. The Roosevelt Landfill accepts trash from many counties across Washington, Alaska, and British Columbia.^{113 114 115} The second-largest landfill is Cedar Hills Regional, located in King County, and is nearing capacity. Plans were approved in 2019 to relocate facilities to allow adequate intake capacity through at least 2028.¹¹⁶

Figure 71 shows that waste collection sites are sprinkled throughout the state, with a high concentration in the Puget Sound region. The figure also reveals that Roosevelt Regional Landfill to the south on the Columbia River and Cedar Hills Regional Landfill southeast of Seattle are the two largest landfills in Washington.

¹¹¹ The Final 50 Feet of the Urban Goods Delivery System: Tracking Curb Use in Seattle, Supply Chain Transportation & Logistics Center at the University of Washington, 2019. <https://depts.washington.edu/sctlctr/research/publications/final-50-feet-urban-goods-delivery-system-tracking-curb-use-seattle>

¹¹² Competing for your trash: the huge, hidden landfills of the Columbia River Gorge, *NW News Network*, Tom Banse, September 2017. <https://www.nwnewsnetwork.org/economy-business-finance-and-labor/2017-09-21/competing-for-your-trash-the-huge-hidden-landfills-of-the-columbia-river-gorge>

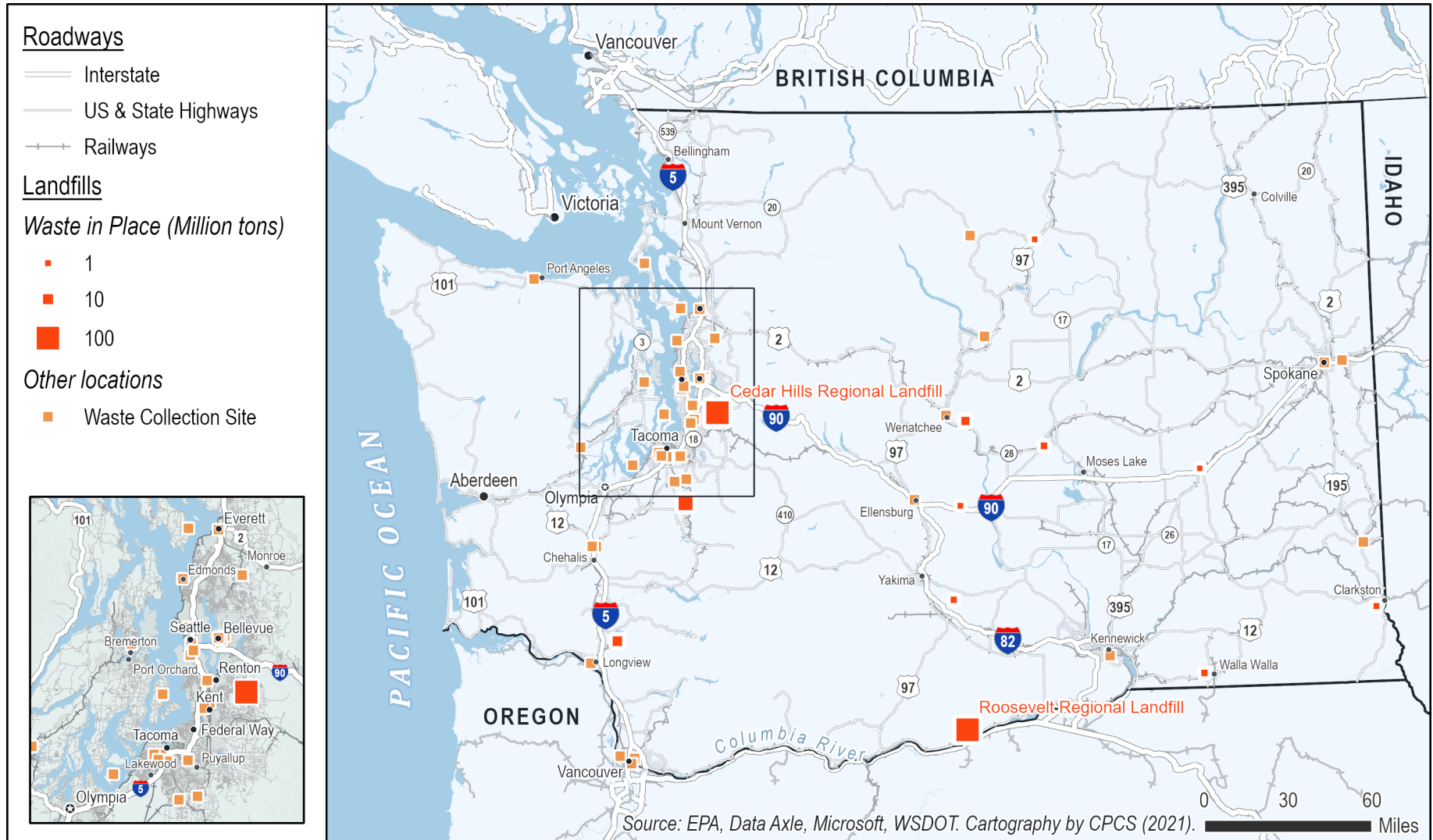
¹¹³ Roosevelt Regional Landfill, Republic Services, (n.d.). <https://www.republicservices.com/roosevelt-landfill>

¹¹⁴ Competing for your trash: the huge, hidden landfills of the Columbia River Gorge, *NW News Network*, Tom Banse, September 2017. <https://www.nwnewsnetwork.org/economy-business-finance-and-labor/2017-09-21/competing-for-your-trash-the-huge-hidden-landfills-of-the-columbia-river-gorge>

¹¹⁵ Roosevelt Regional Landfill, Washington, The Center for Land Use Interpretation, (n.d.). <https://clui.org/ludb/site/roosevelt-regional-landfill>

¹¹⁶ Cedar Hills Regional Landfill 2020 site development plan and facilities relocation, King County Department of Natural Resources and Parks Solid Waste Division, (n.d.). <https://kingcounty.gov/depts/dnrp/solid-waste/facilities/landfills/cedar-hills-development.aspx>

Figure 71: Washington waste collection sites and capacity



Waste delivery supply chain

The process for disposal processing in Washington typically starts with commercial haulers picking up garbage from curbs or dumpsters and, in some cases, individuals hauling garbage to transfer stations or rural drop boxes. Commercial haulers deliver collected garbage to the closest transfer stations in counties. County staff also transport garbage from rural drop box sites to the nearest transfer stations. Figure 72 illustrates the waste supply chain.

At transfer stations, garbage is compacted into cubes, which are pushed into shipping containers. Trucks then take shipping containers to the nearby landfills, or the nearest Regional Disposal Company Rail Loading Facility if waste is meant for distant landfills that have greater capacity, such as the Roosevelt landfill. Some waste is also transported to facilities, such as recycling facilities, composting facilities, and in the case of Spokane county, a waste-to-energy facility for processing. Waste bound for the Roosevelt landfill will be loaded onto trains in containers and travel to the town of Roosevelt. In Roosevelt, containers will be loaded onto trucks again for transport to the landfill.¹¹⁷

Waste delivery trends



Innovation in recycling services. Washington is a leader in waste prevention and recycling – almost half of Washington’s waste is recovered for recycling, composting, or energy production.¹¹⁸ After China imposed new restrictions in 2018 to limit further intake of recyclables that had previously been shipped from the U.S., Washington invested in expanding local recycling facilities and services. Furthermore, the Recycling Development Center of Washington, created in 2019 by the Washington State Legislature is tasked with reducing overall waste and increasing recycling rates in the state.¹¹⁹ This reduces the volume of waste exported from Washington’s ports.



Emphasis on waste prevention. Washington is continuing to shift waste management strategies upstream, in line with guidelines from the Environmental Protection Agency and as adopted in the Revised Code of Washington. Washington’s recently implemented state-wide ban on single-use plastic bags is one example of waste prevention efforts. The state’s waste prevention efforts reduce the volume of waste traveling on Washington’s roads to landfills.



Changes in collection. As residents were quarantined at home during the COVID-19 pandemic, solid waste generation shifted from businesses to residential areas. Decluttering of households also created a spike in self-haul customers. In Snohomish County, an 8% increase in the number of self-haul customers was reported between 2019 and 2020. Businesses and commercial hauling saw a 7% decrease throughout the same year. The continuation of this trend and the overall impact on the freight system remain uncertain.¹²⁰

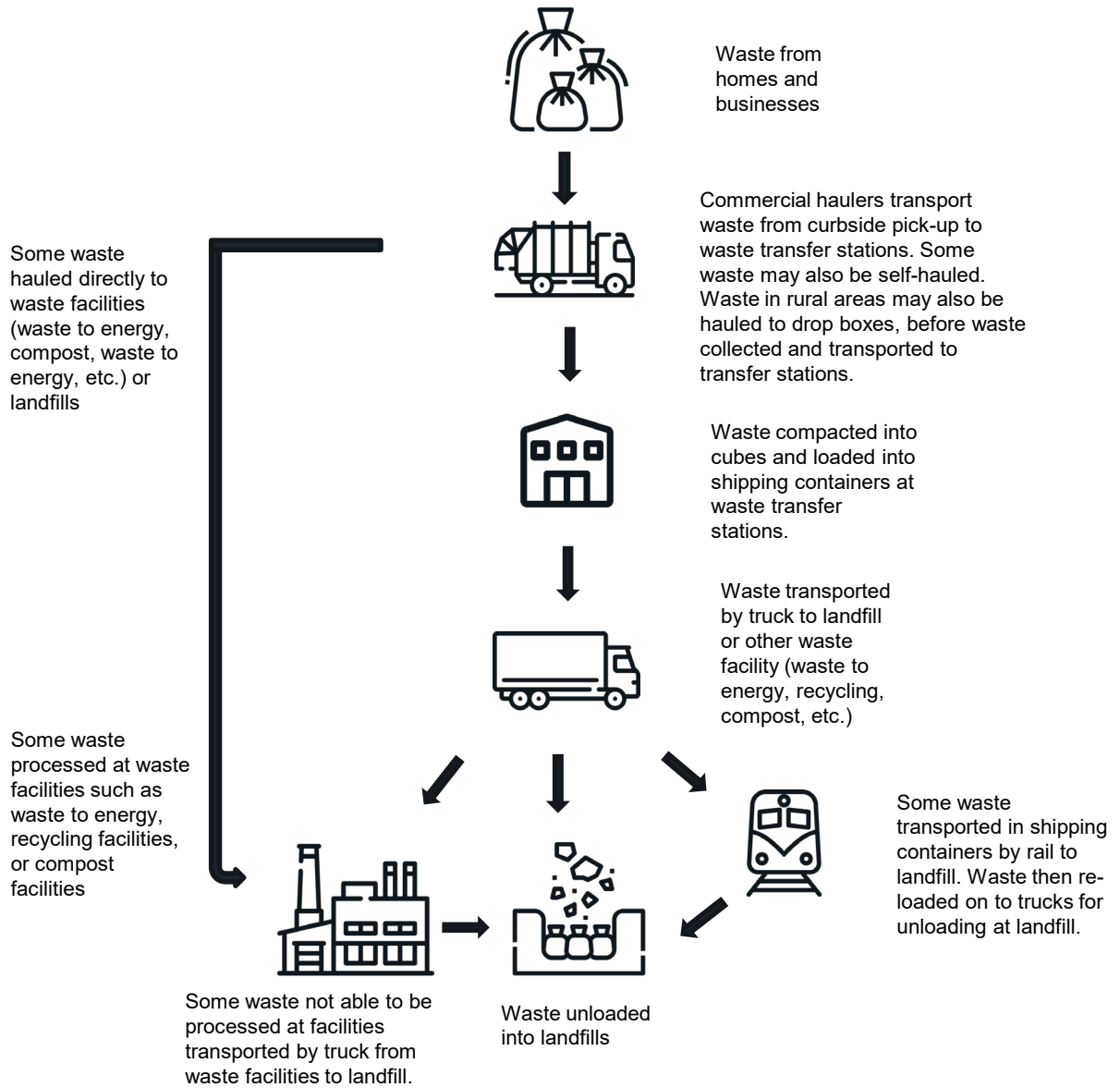
¹¹⁷ Getting Down to Basics: Where does our Garbage Go?, Snohomish County Public Works, (n.d.). <https://snohomishcountywa.gov/DocumentCenter/View/44630/Where-Does-Our-Garbage-Go--English?bidId>

¹¹⁸ Waste Generation and Recovery Data, Washington Department of Ecology, 2018. <https://ecology.wa.gov/Research-Data/Data-resources/Solid-waste-recycling-data>

¹¹⁹ With recycling’s dirty truths exposed, Washington works toward a cleaner, more sustainable system, *The Seattle Times*, Sandi Doughton, April 2020. <https://www.seattletimes.com/pacific-nw-magazine/with-recyclings-dirty-truths-exposed-washington-works-toward-a-cleaner-more-sustainable-system/>

¹²⁰ Comprehensive Solid and Hazardous Waste Management Plan – 2021, Preliminary Draft Copy, Snohomish County Public Works, July 2021. <https://snohomishcountywa.gov/DocumentCenter/View/83227/SnoCoCompSolidHazWastePlanCombinedDRAFT20210628>

Figure 72: Waste delivery supply chain



Source: CPCS analysis of available literature sources and industry knowledge. 2022.

12. Wholesale, warehousing, and storage

The wholesale industry purchases goods in bulk at a discount, which are then sold to retailers and consumers. The industry requires adequate storage and warehousing space to accommodate variation in demand and supply chain performance, leading to significant growth in warehousing and storage space over the last two decades. Figure 74 provides some fast facts about the wholesale, warehousing, and storage industry in Washington.

Figure 73: Washington wholesale, warehousing, and storage industry snapshot



Source: CPCS analysis of U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics data, 2021.

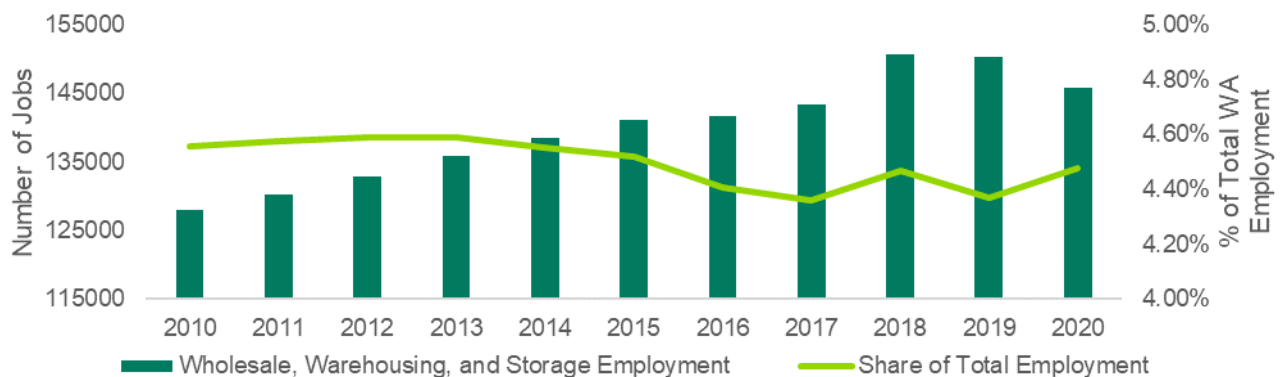
Figure 74: Wholesale, warehousing, and storage fast facts



Source: CPCS analysis of Dodge Retail and Industrial Construction Data, 2000-2021 | WCMD Commodity Warehouses CCC Approved & USWA Licensed, USDA, 2019.
https://publicdashboards.dl.usda.gov/t/MPR_PUB/views/WCMDDashboard/WCMDDashboard?%3AisGuestRedirectFromVizportal=y&%3Aembed=y

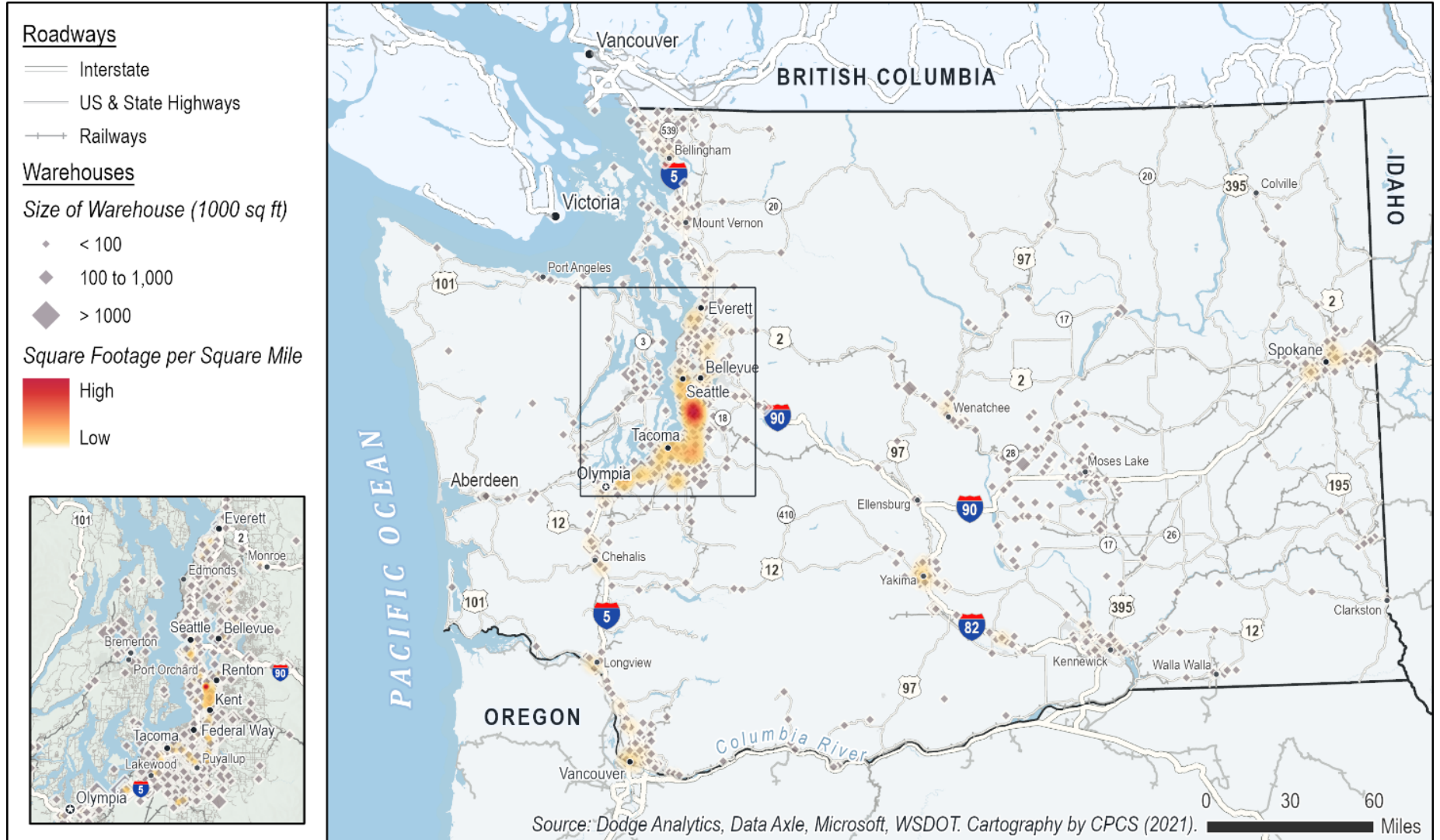
The wholesale, warehousing, and storage industry employed 150,227 people in 2019. Over the last decade, the share of employment remained steady at around 4.5%, primarily to meet growing population and business demands (Figure 75). Figure 76 displays the geographic density of warehouses by size – warehousing is concentrated in King and Pierce Counties, along the I-5 corridor, in central Washington, and around Spokane.

Figure 75: Washington wholesale, warehousing, and storage jobs and share, 2010-2020



Source: CPCS analysis of U.S. Bureau of Labor Statistics data, 2021.

Figure 76: Washington warehousing map



Warehousing trends



Warehouse Construction: Warehouse construction generally follows broader economic trends. The number of new warehouses constructed in Washington dipped after the Great Recession in 2009 but returned to pre-recession levels by the late 2010s (Figure 77). During the same period, the average area of new warehouses grew over the last two decades, with a significant increase around 2013 (Figure 78).

Figure 77: Number of new warehouses in Washington, 2000-2021



Figure 78: Average area of new warehouses in Washington, 2000-2021



Source: CPCS analysis of Dodge retail and industrial development data, Washington State, 2000-2021.

The spikes in the average area of new warehouses seen in the figures for the years 2013, 2015, 2018, and 2019 can be explained by the construction of large warehouses, such as by Amazon. Figure 79 lists the warehouses with the largest area for each of these four target completion years.

Figure 79: New warehouses with the largest area for select years

Year	Name	Location	Area (square feet)
2013	Amazon Distribution Center	Dupont, WA	Nearly 1.6 million
2015	Amazon Fulfillment Center	Kent, WA	800,000
2018	IPT Logistics Center	Tacoma, WA	Over 1.2 million
2019	Amazon Rose Project Fulfillment Center	Spokane, WA	2.6 million

Source: CPCS analysis of Dodge retail and industrial development data, Washington State 2000-2021.



Multi-Story Warehousing: In 2018, Prologis built the nation’s first multi-level industrial warehouse in Seattle. Amazon leased this warehouse in 2019. Multi-story warehouses may proliferate as industrial land becomes both scarcer and more expensive.¹²¹

¹²¹ Amazon’s new multistory warehouse aims to cut delivery times, *The Wall Street Journal*, Keiko Morris and Jennifer Smith, September 2019. <https://www.wsj.com/articles/amazons-new-multistory-warehouse-aims-to-cut-delivery-times-11568113201>.



Rise of Urban E-Grocery Sales and Micro-Fulfillment Centers: Online grocery shopping grew 54.0% in 2020, reaching \$95.8 billion against the backdrop of the COVID-19 pandemic.¹²² Retailers fulfill online orders from: 1) purpose-built large-scale fulfillment centers, 2) conventional brick-and-mortar stores, and 3) micro-fulfillment centers (introduced below). One example of micro-fulfillment is GoPuff, a

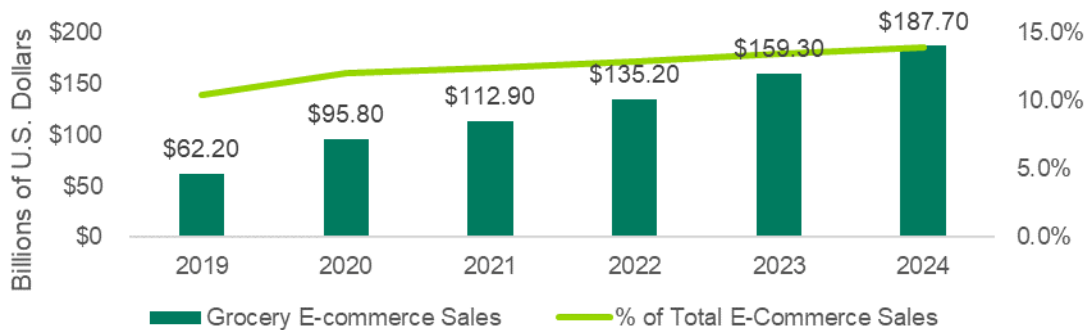
rapid online grocery service operating over 500 micro-fulfillment centers across the country. In Washington, the company operates four fulfillment centers in the Seattle metropolitan area and three in the Spokane market. The company leverages micro-fulfillment centers’ selected inventory and proximity to end-users to provide under 30-minute delivery for a \$1.95 flat fee. Each micro-fulfillment center stores about 3,000 products.

What are micro-fulfillment centers?

A micro-fulfillment center (MFC) is a fulfillment center that is usually 10,000 square feet or less and serves e-commerce and in-store pick-ups. Their smaller footprint and accessible locations expedite delivery time to end consumers. Micro-fulfillment centers are often highly automated to increase the fulfillment process efficiency. Micro-fulfillment centers can be in existing stores or warehouses. Increasingly, businesses are also converting existing retail spaces into MFCs for additional capacity.

Figure 80 illustrates the rapid recent growth (2019–2021) of e-grocery sales across the country and forecasted growth through 2024.¹²³

Figure 80: U.S. grocery ecommerce sales, 2019-2024¹²⁴



Source: In 2021, online grocery sales will surpass \$100 billion, *Insider Intelligence*, February 2021. <https://www.insiderintelligence.com/content/2021-online-grocery-sales-will-surpass-100-billion>



Retail-to-Industrial Conversions: In land-constrained urban areas, retail-to-industrial conversions are occurring to develop new micro-fulfillment centers also known as ‘ghost stores’ since they have—in some cases—been closed to the public and repurposed to exclusively fulfill e-grocery order. These conversion projects are expected to see 29%

growth in 2022.¹²⁵

¹²² In 2021, online grocery sales will surpass \$100 billion, *Insider Intelligence*, February 2021. <https://www.insiderintelligence.com/content/2021-online-grocery-sales-will-surpass-100-billion>

¹²³ Note: includes products or services ordered using the internet, regardless of the method of payment or fulfillment; grocery products include food and beverage (both perishable and non-perishable items) and household consumables such as cleaning, personal care, and pet products that you would typically find at a grocery store; excludes food services and drinking place sales.

¹²⁴ In 2021, online grocery sales will surpass \$100 billion, *Insider Intelligence*, February 2021. <https://www.insiderintelligence.com/content/2021-online-grocery-sales-will-surpass-100-billion>

¹²⁵ US real estate market outlook 2021, CBRE US, (n.d.). <http://cbre.vo.llnwd.net/grgservices/secure/US-Outlook-2021.pdf?e=1657679220&h=b0f55b39ad8ad94da2c2143433a1997f>



Rise of Mega Distribution Centers: The large size of mega distribution centers enables them to reach a broad client base. In Washington, 10 mega distribution centers were developed since 2014. These centers are ripe candidates for automation due to the need to operate 24/7. For example, the Amazon mega fulfillment center outside of Kent (BF14) was one of the first facilities built with an automation system and robot-only zones (2016).

Characteristics of a mega distribution center

- A large area of 400,000 sq ft or more
- Usually employs more than 100 workers
- Normally operates 24*7
- Locational advantage that allows it to connect to a diverse range of markets
- High integration of technology to deal with storage, retrieval, and material handling

Source: Rise of Mega Distribution Centers and Its Impact on Logistics, Addverb Technologies, Nanda Kumar, April 2020. <https://addverb.com/rise-of-mega-distribution-centers-and-its-impact-on-logistics/>

Amazon’s mega distribution centers in Spokane County

In June 2020, Amazon opened its first 640,000 square-foot mega distribution center in West Plains (GEG1), Spokane. About a year later, the Seattle-based e-commerce giant opened the second mega fulfillment center of 1.3 million square feet in Spokane Valley (GEG2). West Plains Center, or GEG1, incorporates Amazon Robotics into the distribution process. Workers work alongside with highly automated robots to pick, pack, and ship orders to customers. GEG2 also uses automation technology to fulfill larger items from 40-lbs dog food to outdoor sports equipment, such as kayaks, skis, and fishing gear. The large fulfillment centers will enable faster shipping times for customers.

Source: Amazon opens fulfillment center in Spokane Valley, *The Spokesman-Review*, Amy Edelen, September 2021. <https://www.spokesman.com/stories/2021/sep/08/amazon-opens-fulfillment-center-in-spokane-valley/> | Amazon opens more than 1,000 full-time jobs at New Spokane Valley Fulfillment Center, KXLY, Olivia Roberts, September 2021. <https://www.kxly.com/amazon-opens-more-than-1000-full-time-jobs-at-new-spokane-valley-fulfillment-center/>

Figure 81 lists the twelve mega distribution centers that have been built since 2014 or that are in development. Six of these centers are or will be located in the Puget Sound region, while two are located in Southwest Washington (Clark County). The remaining new mega distribution centers are geographically-dispersed in South Central Washington (Yakima, Benton, and Adams Counties), and Spokane.

Figure 81: Mega distribution centers built in Washington since 2014

City	County	Year Completed
Spokane	Spokane	2014
Seattle	King	2014
Sunnyside	Yakima	2015
Ridgefield	Clark	2016
Kent	King	2017
Kent	King	2018
Othello	Adams	2018
Richland	Benton	2019
Ridgefield	Clark	2020
Kent	King	2020
Spanaway	Pierce	In Planning
Fredericks	Pierce	In Planning

Source: CPCS analysis of Dodge Data, 2021.

Warehousing trends suggest that micro-fulfillment centers will proliferate in urban areas while mega distribution centers will develop in the urban periphery to serve large regional markets. All types of warehousing are expected to grow quickly to serve the growing demand from consumers and businesses. A primary aim of the 2022 Washington State Freight System Plan Update is to identify the development patterns of warehousing and the associated infrastructure needs—especially the first/last mile highway facilities that connect distribution and fulfillment centers to the state’s multimodal freight network to accommodate current and future e-commerce growth.

Reference Chapter A: Definition of freight-dependent industries

This section provides definitions for freight-dependent industries based on NAICS codes used in the economic snapshots (Figure A-1) and commodities belonging in each industry based on SCTG codes (Figure A-2).

Figure A-1: Definition of washington freight-dependent industries

Industry	NAICS Description
Agriculture and seafood	Agriculture, forestry, fishing, and hunting
Forestry Products	Accounted for under Agriculture category
Energy	Petroleum and coal products manufacturing (excluded here to avoid double-counting under manufacturing)
Construction	Construction and quarrying
Manufacturing	Manufacturing
Last-Mile Delivery	Retail trade, waste management, and food services and drinking places
Wholesale, Warehousing, Storage	Wholesale trade, warehousing, and storage
Freight Transportation	Transportation and warehousing, but excludes transit and ground passenger transportation and warehousing and storage (to avoid double-counting)

Source: CPCS analysis of Freight-Dependent Industries from U.S. Bureau of Economic Analysis, 2021.

Figure A-2: SCTG industry to Washington freight-dependent industry crosswalk

SCTG Code	SCTG Description	Freight-Dependent Industry
01	Live animals/fish	Agriculture & Seafood
02	Cereal grains	Agriculture & Seafood
03	Other ag prods.	Agriculture & Seafood
04	Animal feed	Agriculture & Seafood
05	Meat/seafood	Food Manufacturing
06	Milled grain prods.	Food Manufacturing
07	Other foodstuffs	Food Manufacturing
08	Alcoholic beverages	Food Manufacturing
09	Tobacco prods.	Clothing and Misc. Manufacturing
10	Building stone	Construction
11	Natural sands	Construction
12	Gravel	Construction
13	Nonmetallic minerals	Industrial Manufacturing
14	Metallic ores	Industrial Manufacturing
15	Coal	Energy
16	Crude petroleum	Energy
17	Gasoline	Energy
18	Fuel oils	Energy
19	Coal-n.e.c.	Energy
20	Basic chemicals	Industrial Manufacturing
21	Pharmaceuticals	High-Tech Manufacturing
22	Fertilizers	Industrial Manufacturing
23	Chemical prods.	Industrial Manufacturing
24	Plastics/rubber	Industrial Manufacturing
25	Logs	Forestry Products
26	Wood prods.	Forestry Products
27	Newsprint/paper	Forestry Products
28	Paper articles	Forestry Products
29	Printed prods.	Forestry Products
30	Textiles/leather	Clothing and Misc. Manufacturing
31	Nonmetal min. prods.	Industrial Manufacturing
32	Base metals	Industrial Manufacturing
33	Articles-base metal	Industrial Manufacturing
34	Machinery	High-Tech Manufacturing
35	Electronics	High-Tech Manufacturing
36	Motorized vehicles	Transportation Equipment
37	Transport equip.	Transportation Equipment
38	Precision instruments	High-Tech Manufacturing
39	Furniture	Clothing and Misc. Manufacturing
40	Misc. mfg. prods.	Clothing and Misc. Manufacturing
41	Waste/scrap	Last-Mile Delivery
42	Mixed freight	Last-Mile Delivery

Source: CPCS analysis of SCTG Codes in the FHWA Freight Analysis Framework Version 5, 2021.