Washington Wood Basket Study: Projecting Supply and Demand

Carbon and Forest Management Work Group

July 10, 2024

Evergreen Economics

www.evergreenecon.com

Outline and Objectives

1. Wood Supply – 60 minutes
   - Lay out project tasks
   - A little history/context
   - Wood Supply Potential
   - Wood Supply Existing Industry

2. Modeling Moving Forward– 90 minutes
   - Considering the rest of the country
   - Considering the rest of the economy
   - Carbon 101

3. Discussion – 30 minutes

Evergreen Scope of Work (11 Tasks)

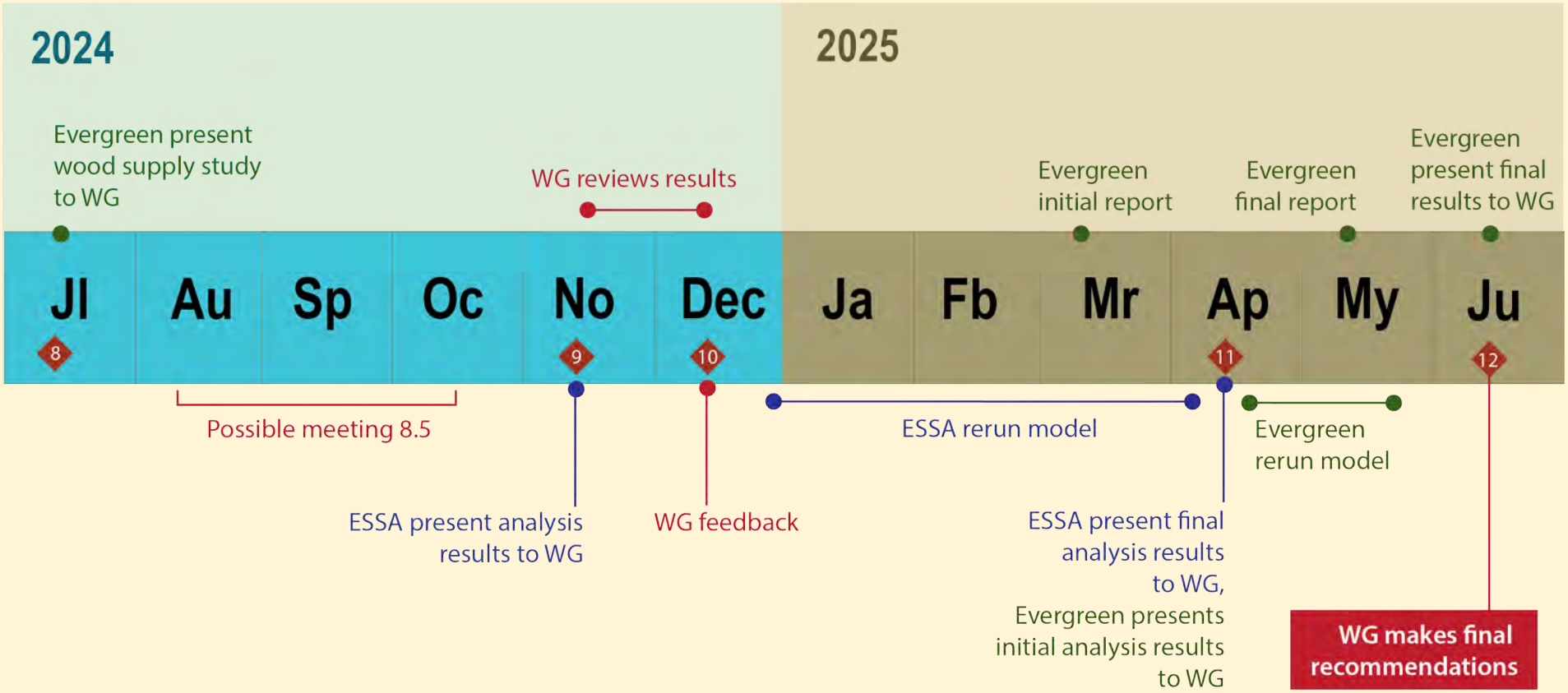
1. Attend February 2024 work group meeting to present qualifications and experience and provide high-level overview of the project.
2. Development of the wood supply study by June 14, 2024.
3. Present draft results of the wood supply study at the July 2024 work group meeting.
4. Model all scenarios (including DNR baseline) for western Washington State using harvest volumes provided by DNR.
5. Prepare initial report by March 11, 2025.
6. Present results for all scenarios at the April 2025 work group meeting.
7. Incorporate any changes to the methodologies agreed to by work group and CONTRACTOR and model all scenarios using updated scenarios and harvest volumes provided by DNR by June 30, 2024.
8. Prepare the final report by May 21, 2025.
9. Present results for all scenarios at the June 2025 work group meeting.
10. Attend other work group meetings as needed.
11. Hold monthly meetings with DNR, including kickoff meeting.

The Broader Scope

The broader project scope involves both Evergreen & ESSA

- Evergreen builds model of western Washington's (WWA) forest products sector
  - This model is the baseline (or backdrop) for the work to follow
- ESSA implements a range of forest management scenarios for DNR-managed lands
  - Provides estimates of carbon outcomes on DNR-managed lands
  - DNR provided Evergreen with ESSA's key word files developed in FVS
- Evergreen implements a subset of ESSA's scenarios in the WWA forest sector model
  - Provides estimates of impacts on private timber producers, western WA forest products producers, and local economies

Timeline – Carbon & Wood Supply



Focusing on Timber Supply

This study is a precursor to the evaluation of how changes in DNR management might affect the industry and local economies

- The primary task is to evaluate a set of scenarios
- DNR's *business-as-usual* is the baseline against which we evaluate each scenario

Focusing on Timber Supply

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- The primary task is to evaluate a set of scenarios
- DNR's *business-as-usual* is the baseline against which we evaluate each scenario

But – there are two additional components to consider

1. Potential Timber Supply – what is the highest level of harvest that can be maintained?
2. Existing Infrastructure – what level of harvest is required to maintain current milling capacity?

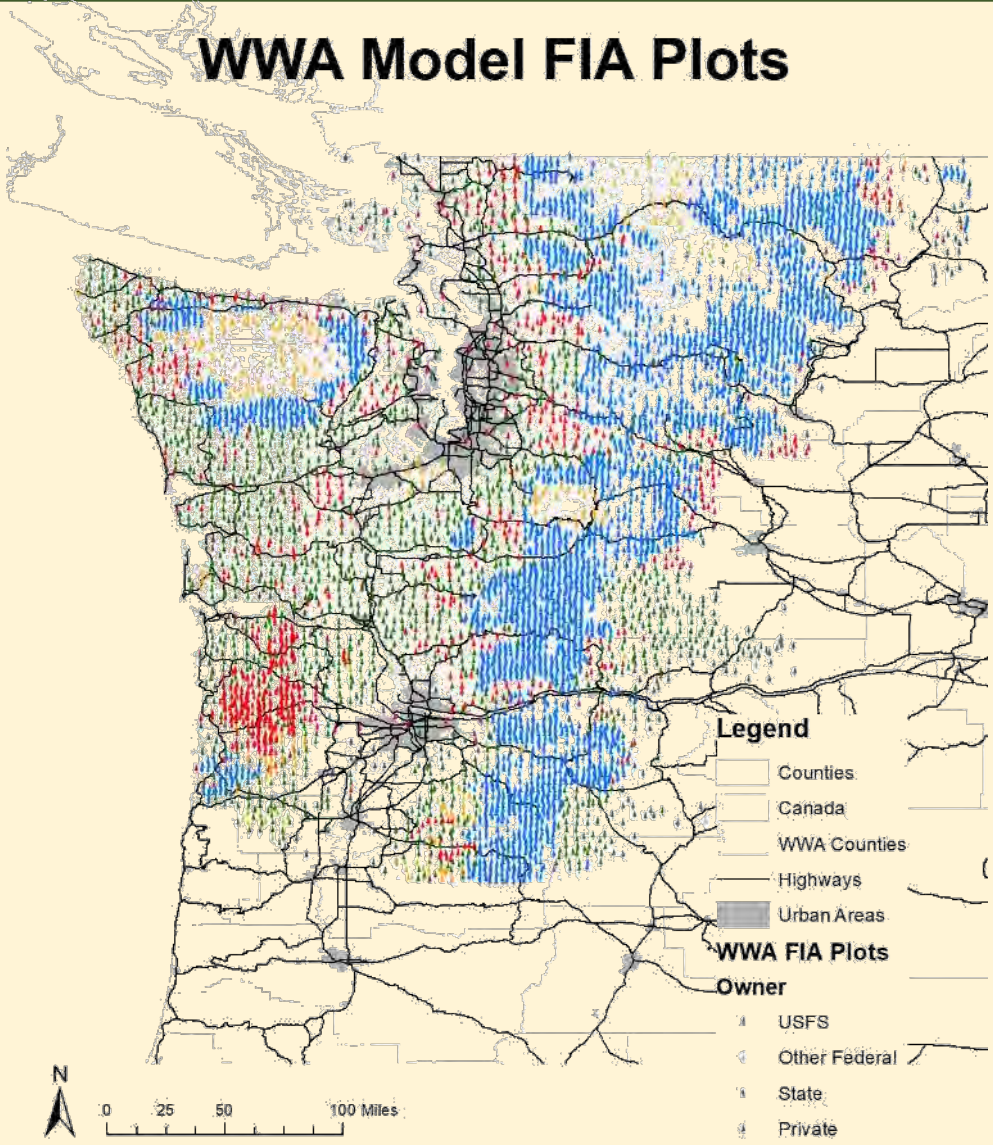
Potential Wood Supply

The Base *Supply* Question: What level of harvest could the forests of western Washington support?

The answer requires:

1. A representation of the forest land base and current stocking level
2. A projection of growth and yield to move that forest through time
3. A harvest scheduling model that allocates forest acres to managements to meet some goal

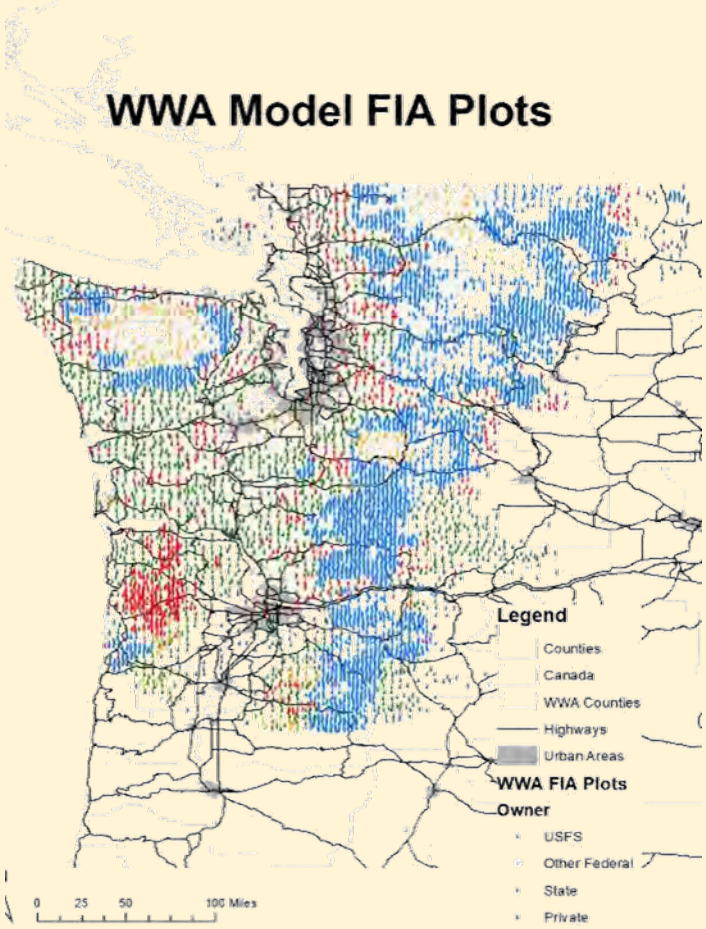
Modeling Wood Supply – forest inventory



We are using USDA Forest Inventory and Analysis (FIA) plots as the basis for our "WWA" model

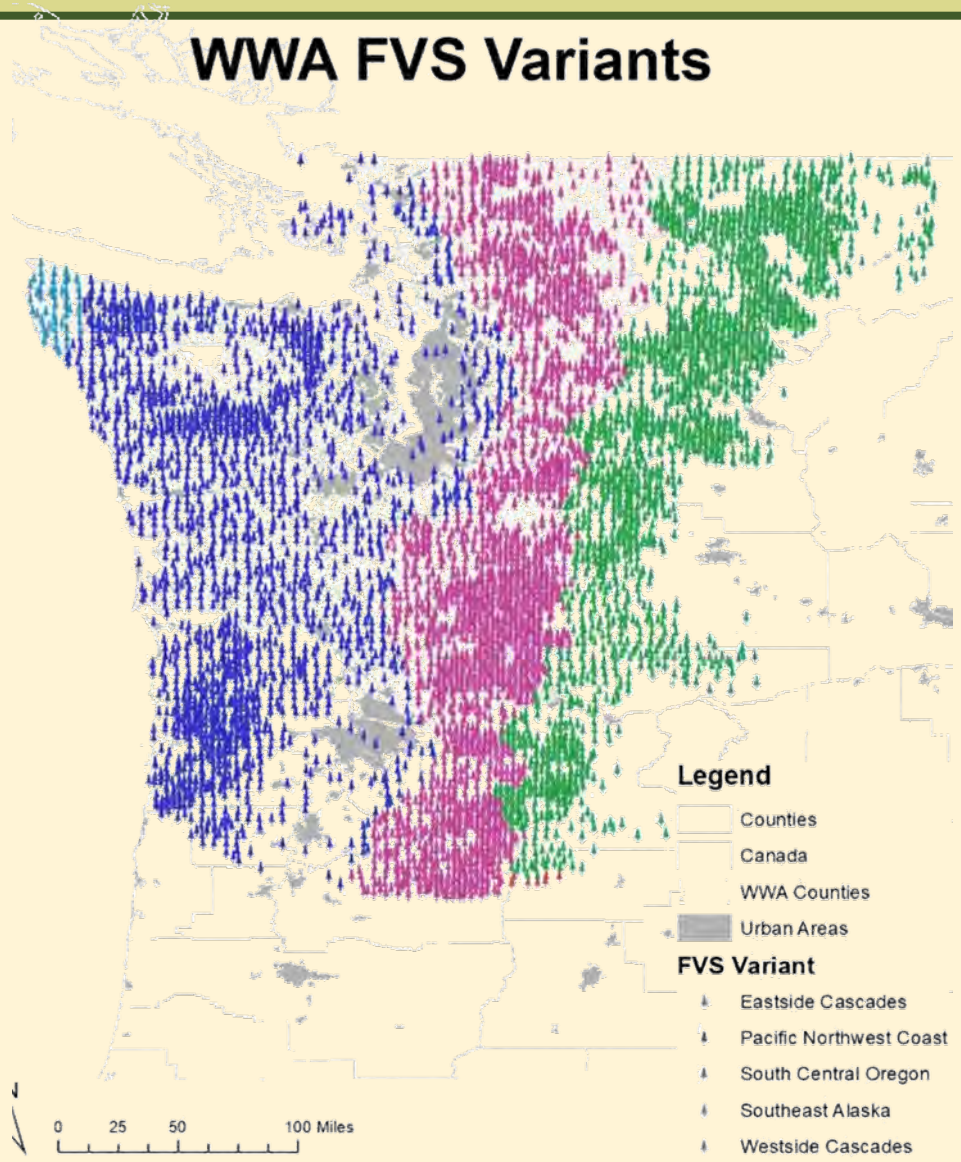
- 1/10th of the plots measured each year from 2011-2020
- We include plots in Oregon, as well as in central and eastern Washington within 100 miles of WWA to reduce "edge" effects of our model
- We have nearly completed the process of swapping in DNR-measured inventory data

Modeling Wood Supply – forest inventory



Ownership	Western Washington	Oregon Buffer	Central/Eastern Washington Buffer
	---------- *thousand acres* ----------		
National Forest	3,310	1,400	3,124
Other Federal	1,202	274	134
State	1,537	597	682
Local	385	88	18
Private (Including Tribal)	5,156	2,534	1,409
Total	**11,590**	**4,894**	**5,367**
	---------- plots ----------		
National Forest	1,821	840	1,594
Other Federal	192	107	25
State	391	442	142
Local	86	24	5
Private (Including Tribal)	1,219	568	294
Total	**3,709**	**1,981**	**2,060**

Modeling Wood Supply – forest growth



We are using the USDA Forest Vegetation Simulator (FVS)

- Individual tree distance independent growth model
- We are using three variants:
  1. Pacific Northwest Coast
  2. Westside Cascades
  3. Eastside Cascades
- At this point, we have only applied basic even-aged silviculture was used (clearcut then regenerate)

Modeling Wood Supply – regeneration

Regenerated stand species and density are a function of:

1. Geography
   - FVS Variant
   - Ecoprovince
2. Forest Type
   - Planted
   - Natural Regen
3. Site Productivity
   - 7 FIA site classes

Example: PN variant, Cascade Mixed Forest - Coniferous Forest - Alpine Meadow Province, Site 3

Tree Species	Planted Douglas-fir	Natural Douglas-fir	Hardwood	Natural Softwood
	trees per acre			
Douglas-fir	244	127	47	39
Western Hemlock	101	119	20	420
Red Alder	28	18	179	23
Bigleaf Maple	6	9	32	0
Western Redcedar	5	31	20	76
Other Softwood	7	12	7	90
Other Hardwood	6	3	6	13
Total	**396**	**317**	**311**	**661**

Modeling Wood Supply – harvest schedule

The model was set up to maximize net present value for 100 years while requiring harvest in any time-period to be within 5% of the 100-year average harvest level. (less constraining than true non-declining even flow)

Other key assumptions:

- **Time periods** - We used 21 five-year time periods
- **Terminal conditions** – post-harvest private inventory at the end of 100 years must be greater than or equal to the initial inventory
- **DNR harvest** constrained at county level to match average of 2014-2023 harvest level provided by DNR
- **Other public harvest** constrained at the county level to match average of 2013-2022 harvest level from BBER[1]

1. BBER Bureau of Business and Economic Research (https://www.bber.umt.edu/FIR/HarvestWA.aspx)

Wood Supply Study – *preliminary results*

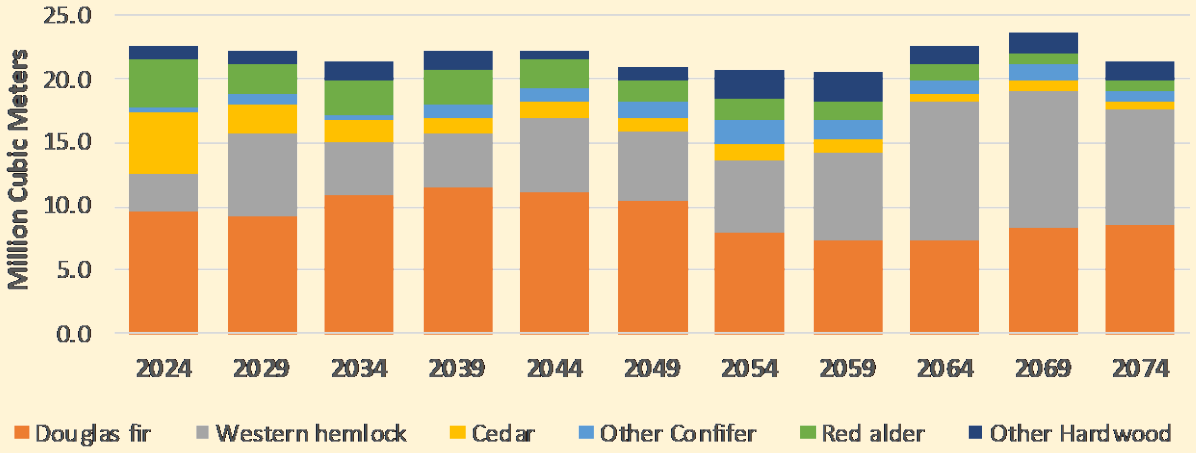
Why preliminary?

The Wood Supply model will be the basis against which scenario effects will be measured, for this reason…

- We will be updating and improving over next couple months
- We will incorporate/address feedback from DNR and the work group
- We will add more silvicultural options
- We will incorporate log demand *(more on that later today)*

Wood Supply Study – preliminary results

Projected Harvests in Western Washington by Species



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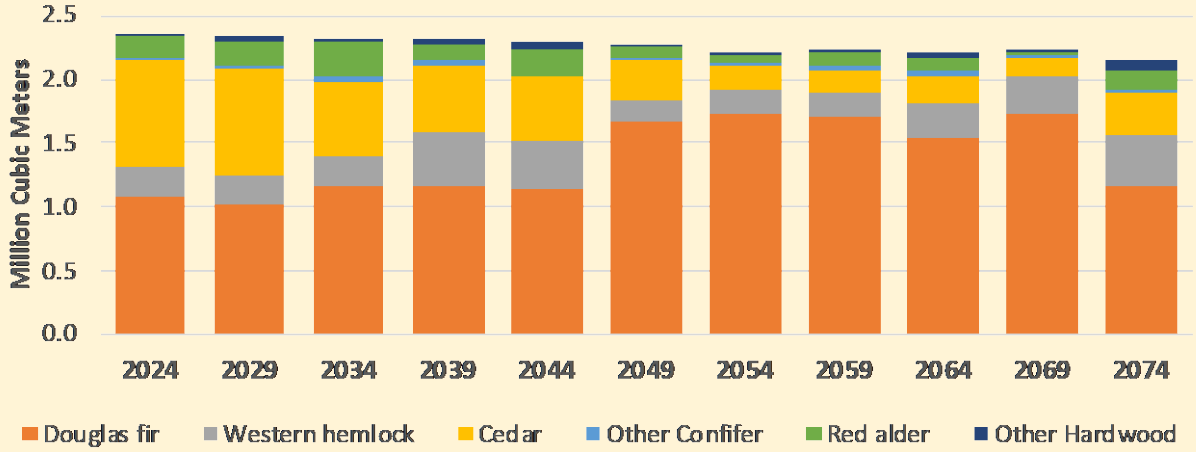
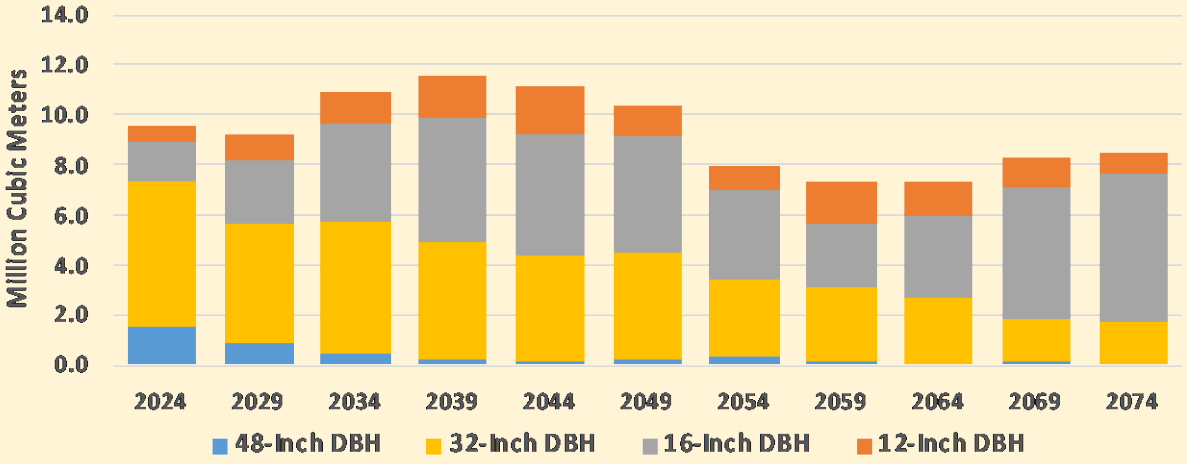


<<< State Forestlands

Wood Supply Study – preliminary results

Projected Douglas Fir Harvests in Western Washington



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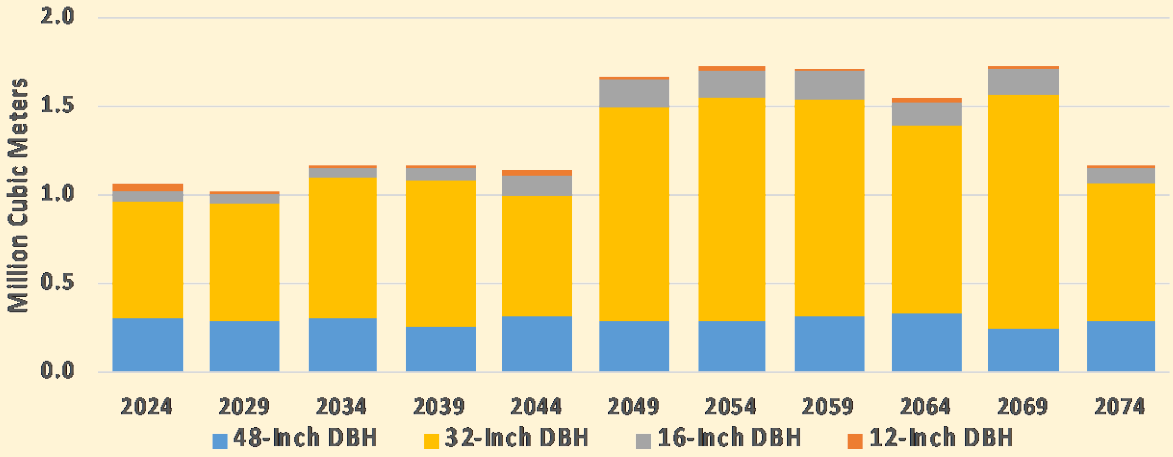

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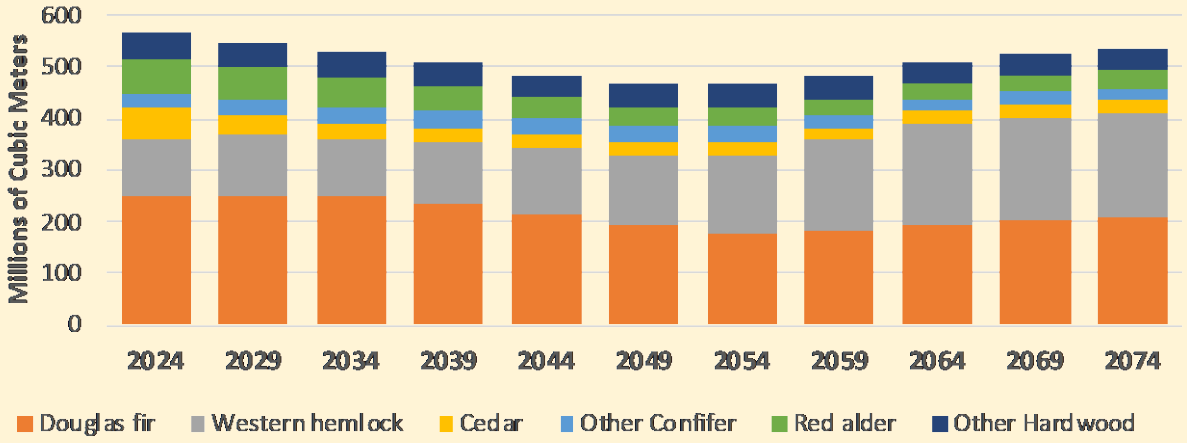
Wood Supply Study – preliminary results

Projected Forest Inventory in Western Washington



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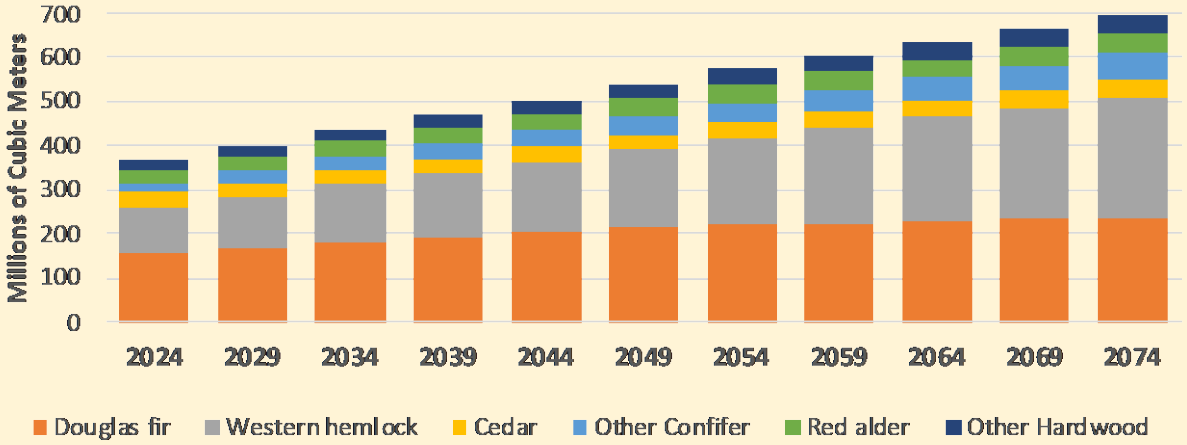

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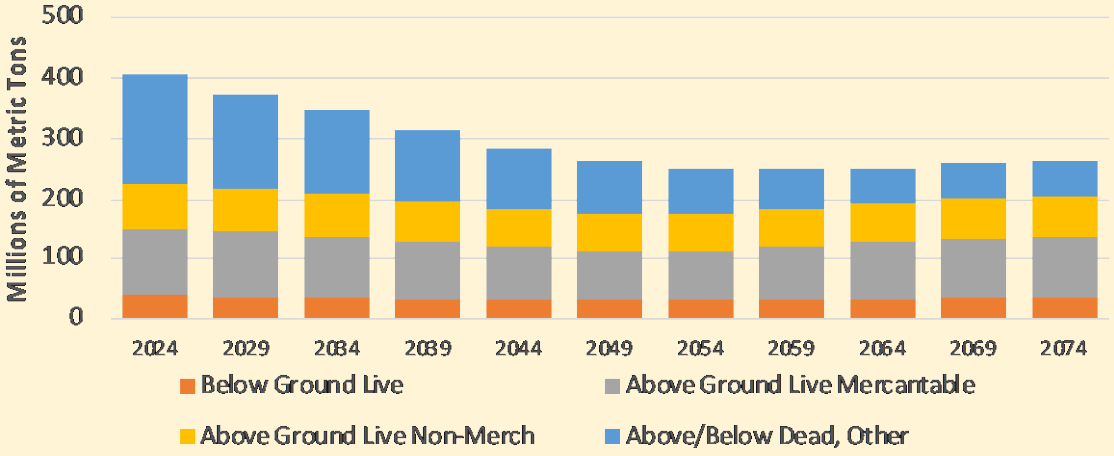
Wood Supply Study – preliminary results

Projected Forest Carbon Stored in Western Washington



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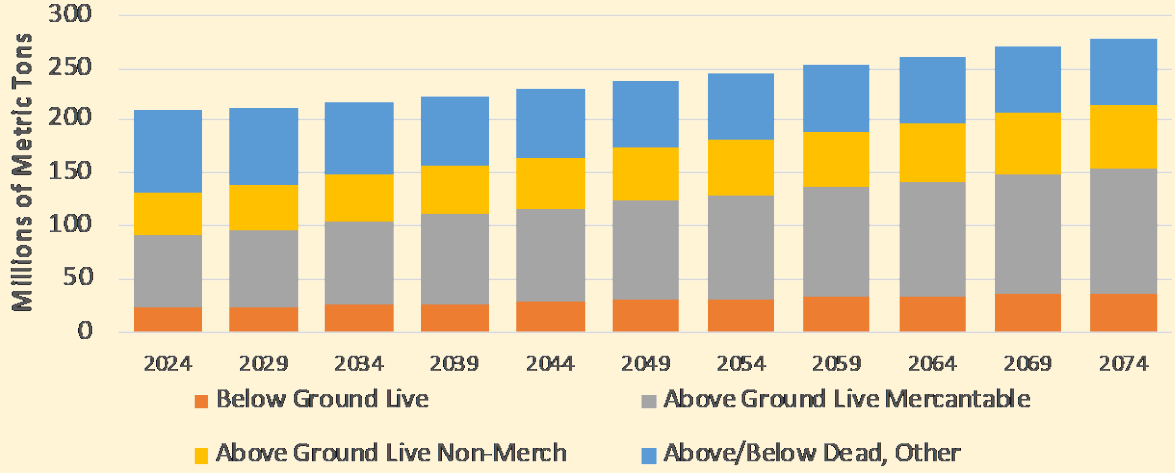


<<< State Forestlands

Wood Supply Study – preliminary results

Economic Contribution of Forest Industries in Western Washington, 2022

- Forest industries of western Washington contributed nearly $11 billion in economic output and provided $3 billion in labor income.
- Nearly half of employees work in sawmills
- Average employee compensation is similar across industries

Industry	Employment	Labor Income*	Average Employee Compensation*	Total Output
Forestry	960	$84,361,275	$87,843	$147,106,713
Commercial Logging	6,762	$570,641,518	$84,396	$1,107,312,883
Sawmills	16,064	$1,427,058,094	$88,837	$5,664,786,731
Veneer and Plywood Manufacturing	2,104	$196,837,223	$93,560	$746,858,333
Engineered Wood Manufacturing	2,438	$207,697,756	$85,191	$949,055,494
Miscellaneous Wood Manufacturing	653	$52,947,374	$81,022	$208,869,073
Pulp and Paper Mills	5,195	$457,482,353	$88,055	$1,904,782,900
Total	**34,176**	**$2,997,025,593**	**$86,986**	**$10,728,772,126**

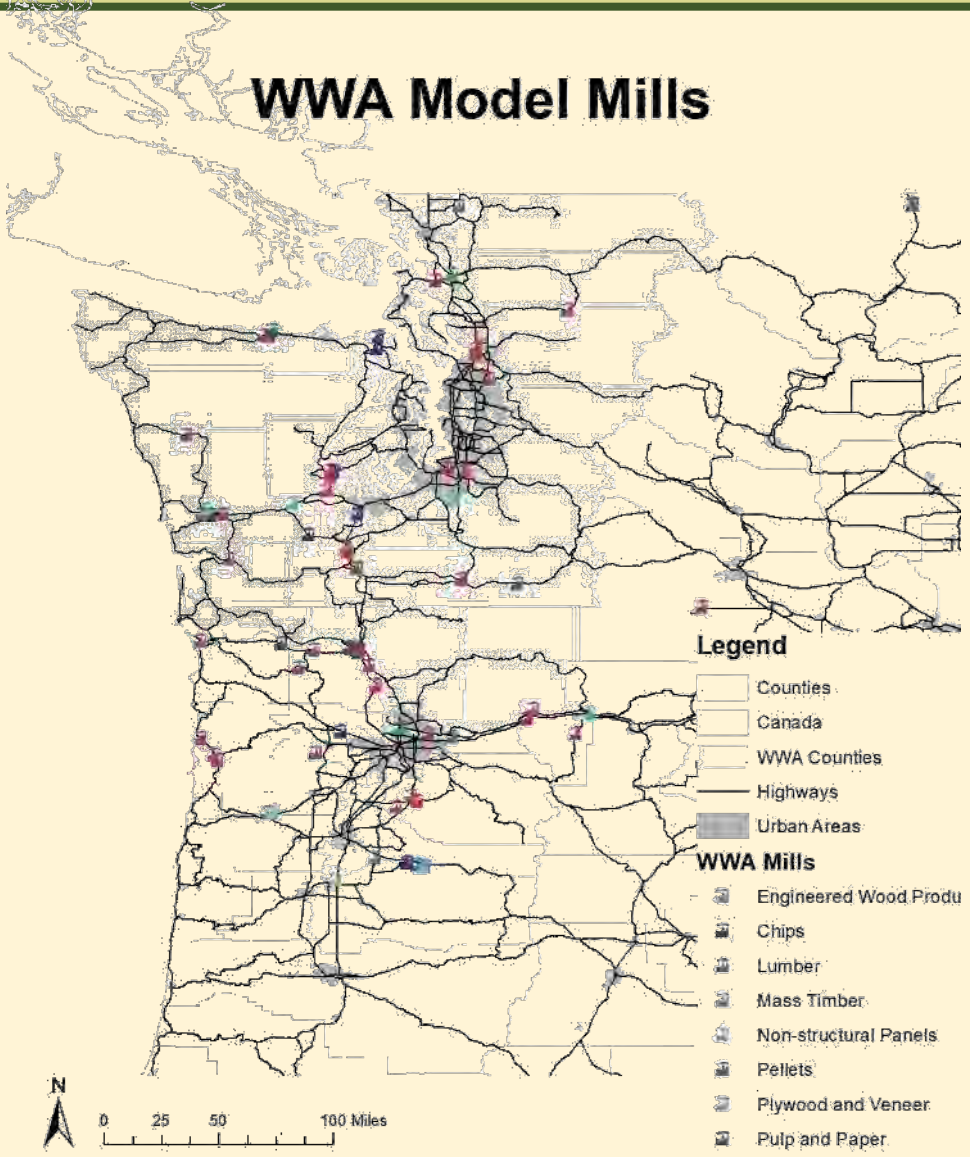
* Total value of wages & benefits

Source: IMPLAN 2022 data for model region including all western Washington counties.

Wood Supply Study – Wood Demand

“What is the level of wood required to maintain existing timber industry infrastructure in Washington State?”

Western Washington Demand



We start with Mills

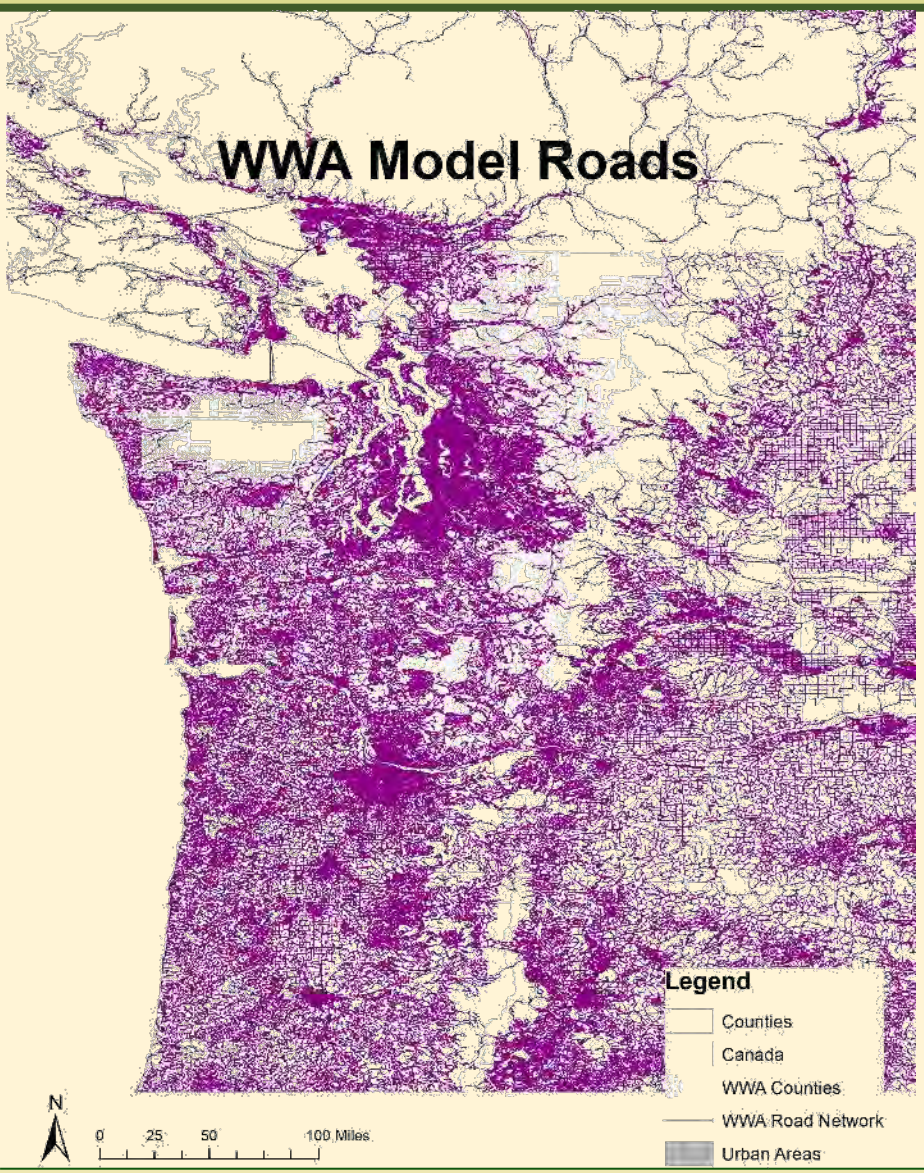
- We gathered data from number of sources including DNR, BBER, and others to compile a list of forest products processing facilities in western Washington.
- For this we consider facilities within 200 miles of WWA

Wood Supply Study – Existing Wood Supply

Why look a mills outside of western Washington?

- Western Washington forestlands and forest products manufactures are part of a larger market.
- By extending beyond western Washington to include forestlands and forest products manufacturers in parts of Oregon and central/eastern Washington, we greatly reduce the spatial "edge effect."
- Extending the geographic extent of the analysis to minimize spatial edge is analogous to imposing terminal conditions to minimize temporal edge.

Wood Supply Study – Existing Wood Supply

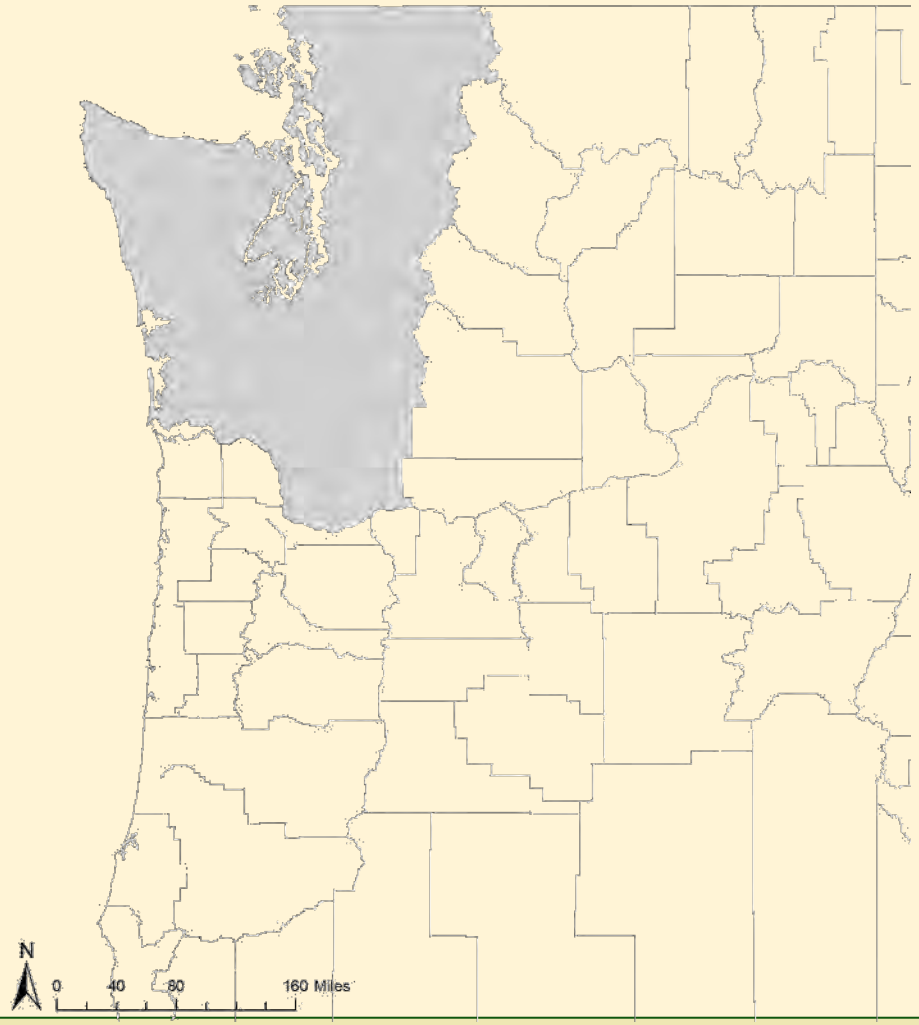


Roads – Connecting Logs & Mills

- Capturing the spatial nature of the market requires we include the road network
- Covers entire region (and buffer) and includes type of road and mph
- From it we get the miles and hours required to calculate haul costs from plots to mills, plots to ports, mills to ports, and mills to mills

Pokharel, R., and G. Latta. 2020. A network analysis to identify forest merchantability limitations across the United States. Forest Policy and Economics. 116(2020):102181.

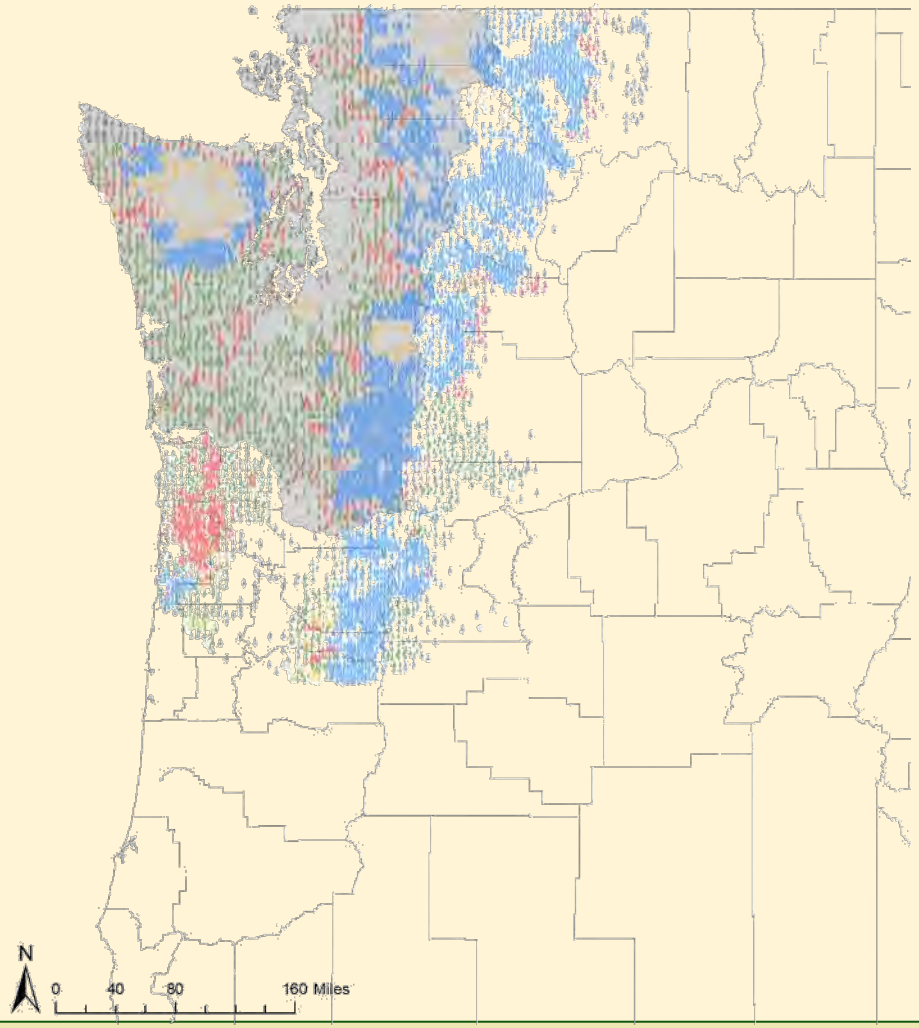
Wood Supply Study – Existing Wood Supply



Linking Forests & Mills

1. Western Washington region

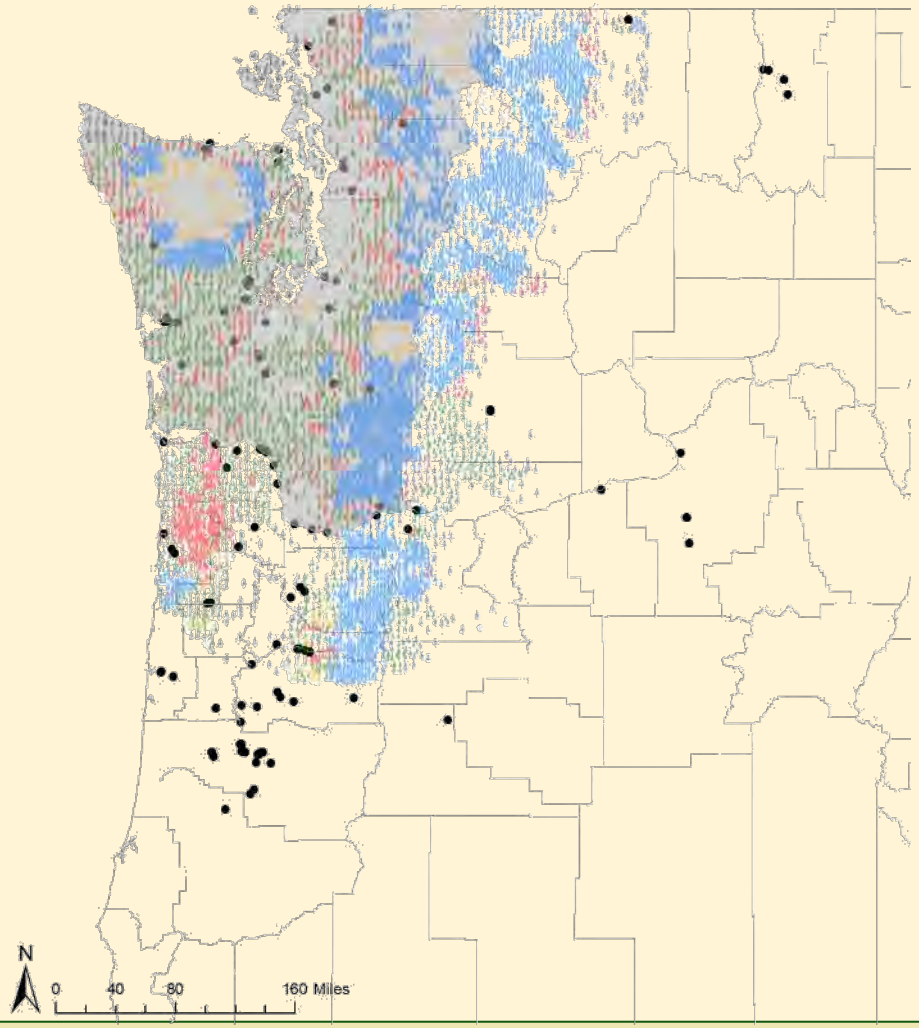
Wood Supply Study – Existing Wood Supply



Linking Forests & Mills

1. Western Washington region
2. Add plots within 100 miles
   - These plots are included as they could supply wood to WWA mills

Wood Supply Study – Existing Wood Supply



Linking Forests & Mills

1. Our region
2. Add plots within 100 miles
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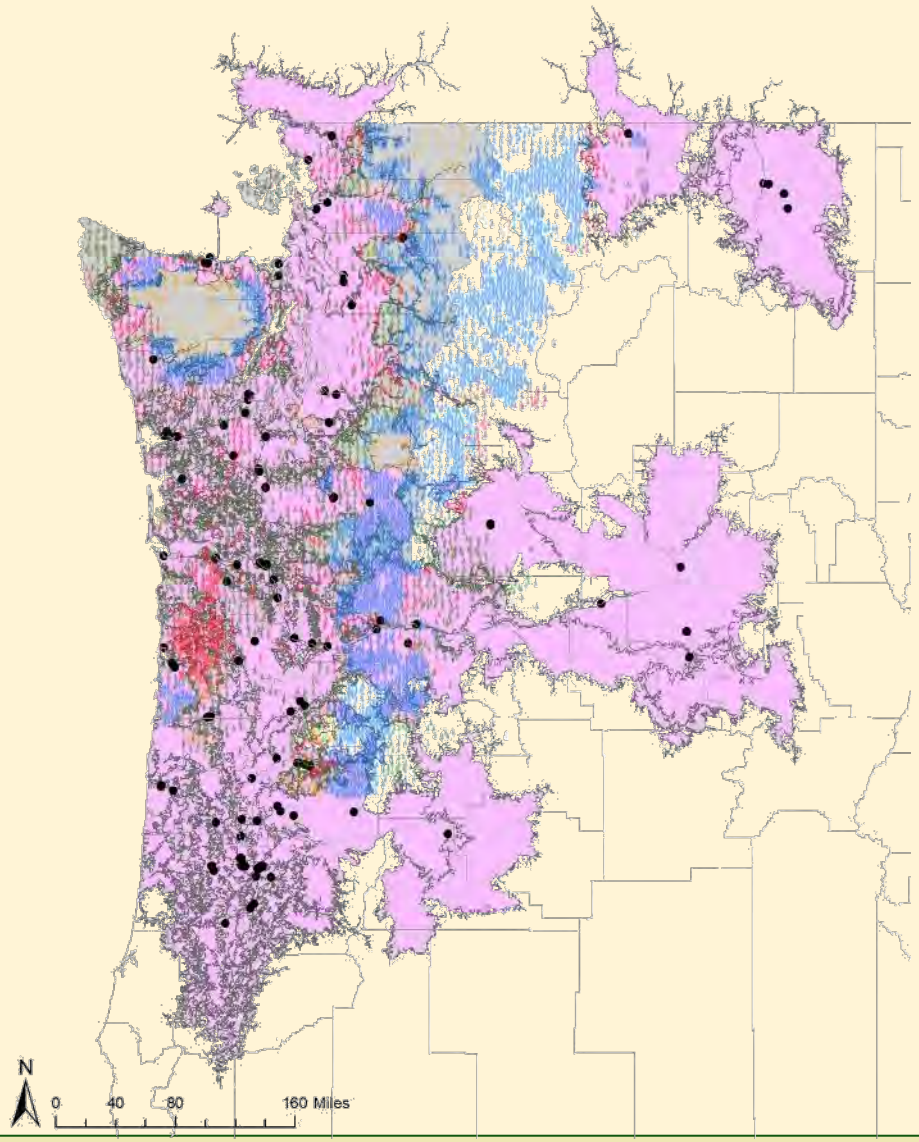
3. Add mills within 200 miles
   - These mills are included as they could use wood from the plots in the model

Wood Supply Study – Existing Wood Supply



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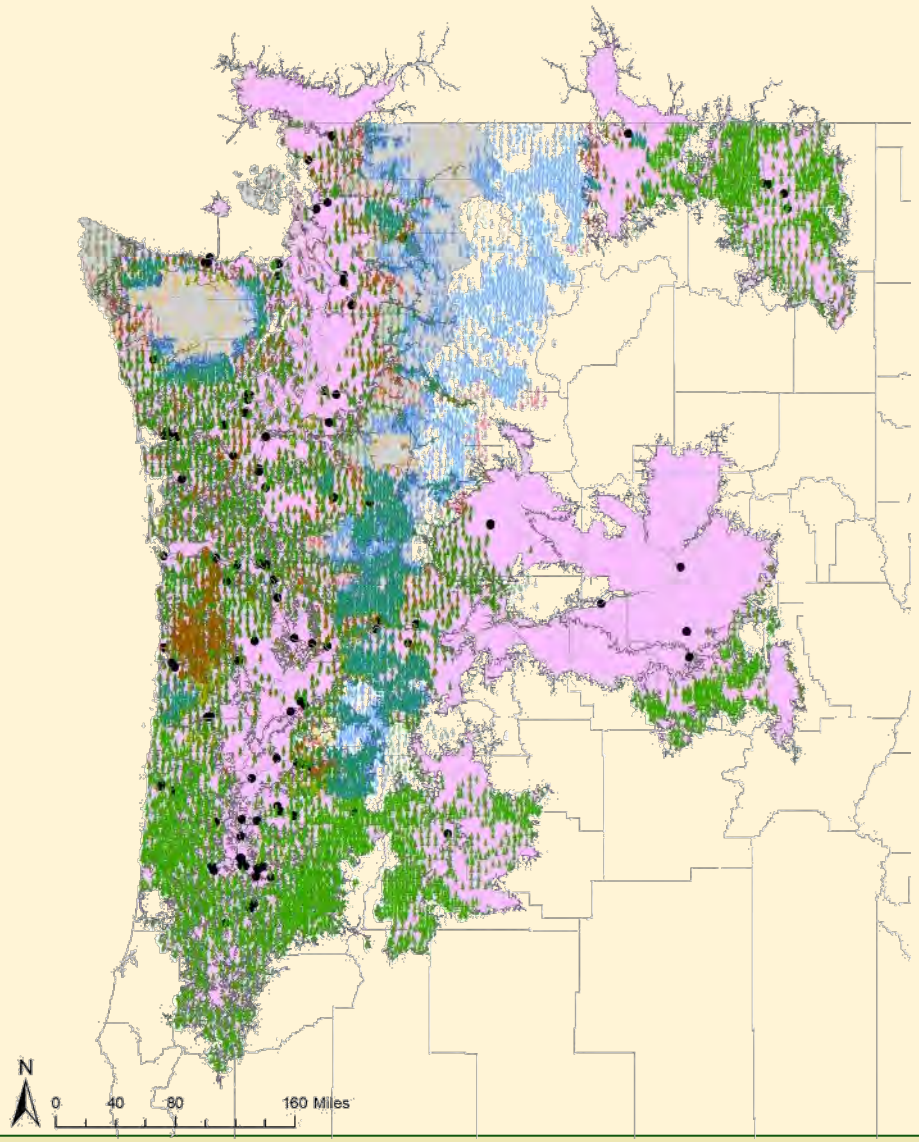
   - We assume they will source within that zone

Wood Supply Study – Existing Wood Supply



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4. Generate 1.5-hour service areas for each mill
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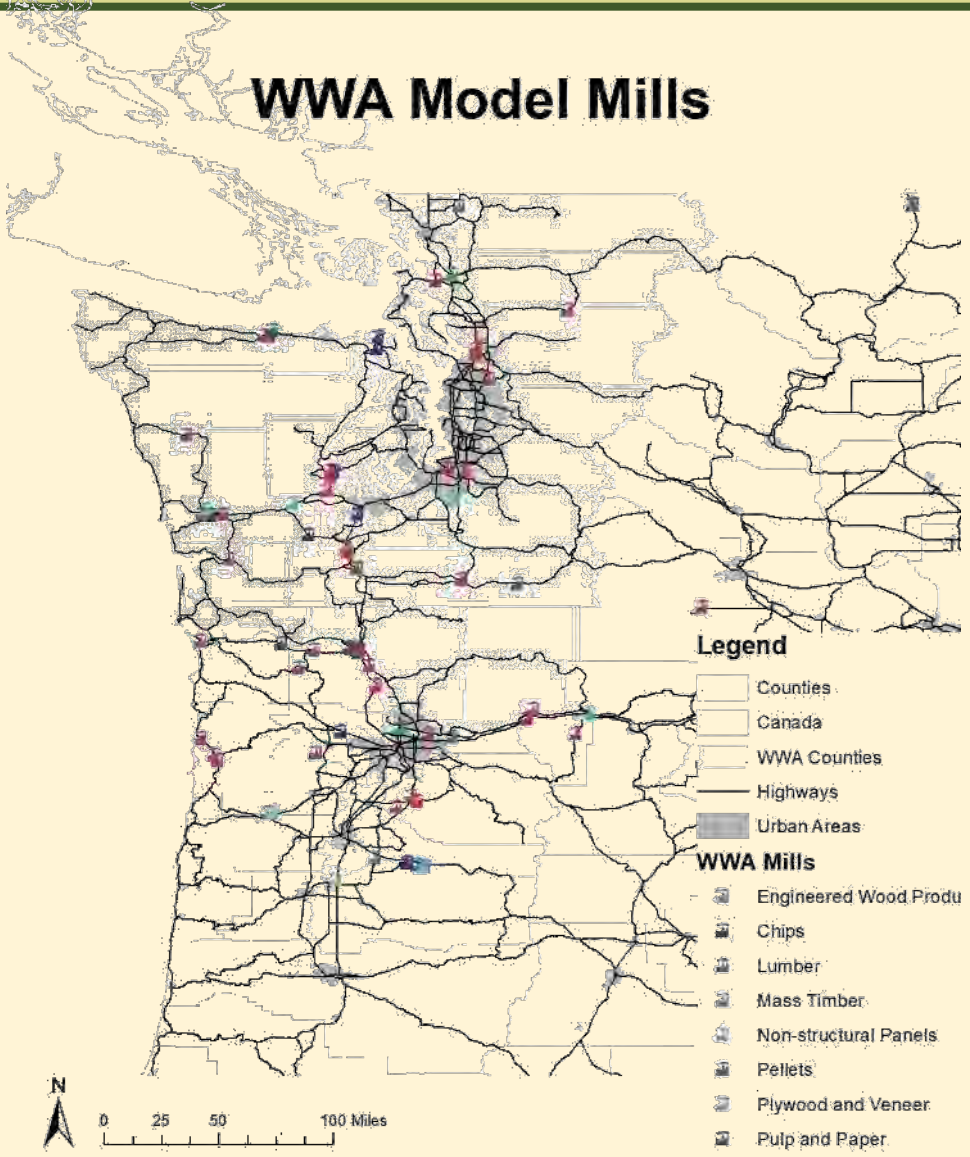
5. Intersect with the full FIA plot dataset
   - Calculate proportion of forested service area of each mill that is in our plot dataset
   - Reduce mill capacity to match that proportion
   - If 25% of the forested plots for a mill are within 100 miles of WWA that mill must get 25% of its supply from those plots

Western Washington Demand

WWA Model Mills

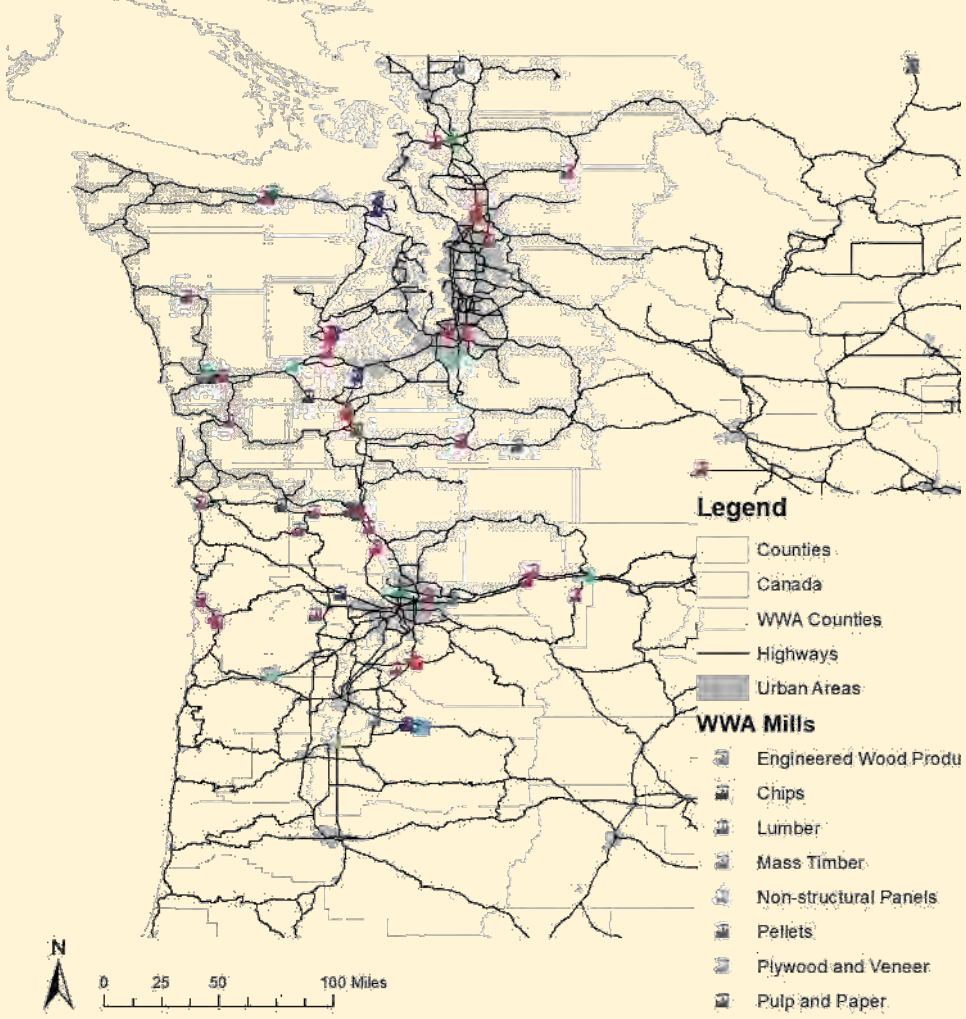


Mills Considered in Analysis

Product	Western Washington	Oregon Buffer	Central/Eastern Washington Buffer
	number of facilities		
CLT plywood		1	
Glulam	2	3	
Hardboard		1	
HW Chip	2	2	
HW Lumber	4	2	
MDF			1
Newsprint	1		
P_W_Paper	1		
Paperboard	5		
Particleboard		1	
Pellet	2	7	
Pulp HW Chem	2	1	
Pulp Recycled	4		
Pulp SW Chem	3	1	
Pulp SW Mech	1		
SW Chip	7	4	1
SW Lumber	24	19	3
SW Plywood	3	6	1
SW Veneer	3	6	1
Tissue		1	
Total	**64**	**55**	**7**

Western Washington Demand

WWA Model Mills



Log-Use by Mill Type

Product	Western Washington	Oregon Buffer	Central/Eastern Washington Buffer
	thousand cubic meters		
CLT plywood			
Glulam			
Hardboard		174	
HW Chip	853	412	
HW Lumber	1,805	824	
MDF			251
Newsprint			
P_W_Paper			
Paperboard			
Particleboard		1,026	
Pellet	259	842	
Pulp HW Chem	588	434	
Pulp Recycled			
Pulp SW Chem	5,343	1,735	
Pulp SW Mech	1,135		
SW Chip	2,848	528	118
SW Lumber	15,620	12,167	781
SW Plywood		1,634	135
SW Veneer	1,242	2,760	135
Tissue			
Total	25,992	21,596	1,302

Note: chipped logs not included in total to avoid double counting

Western Washington Demand

S. Scott
2020 Washington Tables
Posted June 2024

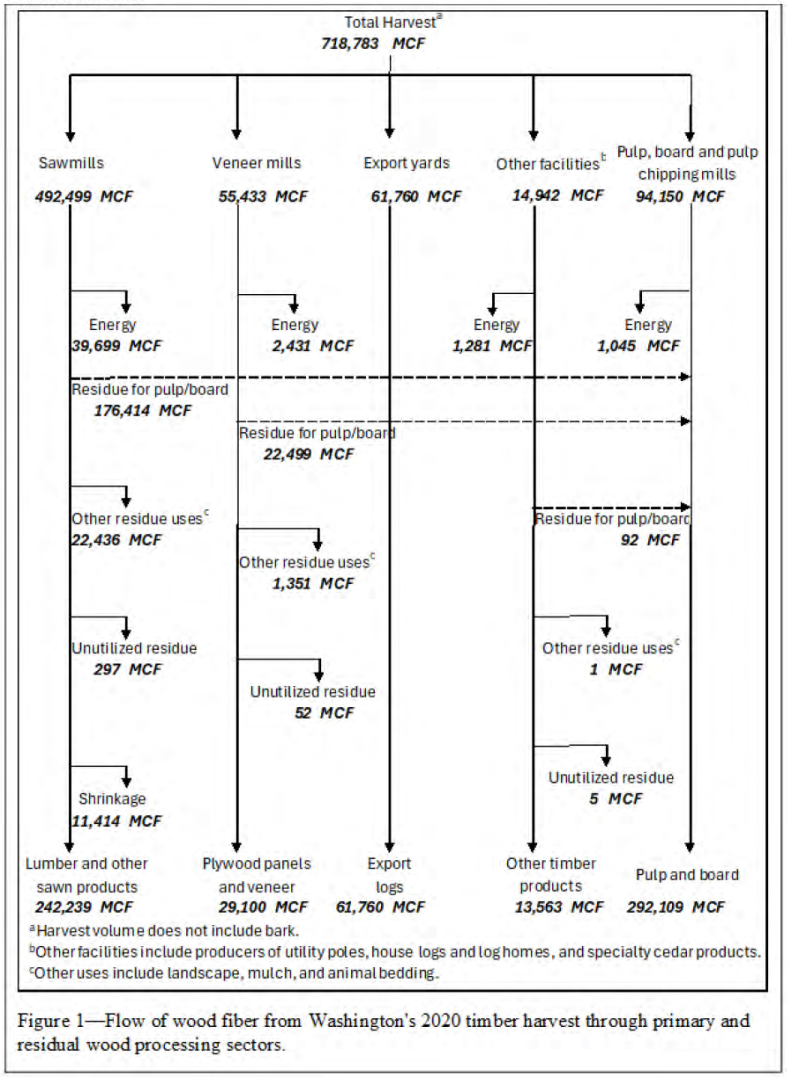


Figure 1—Flow of wood fiber from Washington's 2020 timber harvest through primary and residual wood processing sectors.

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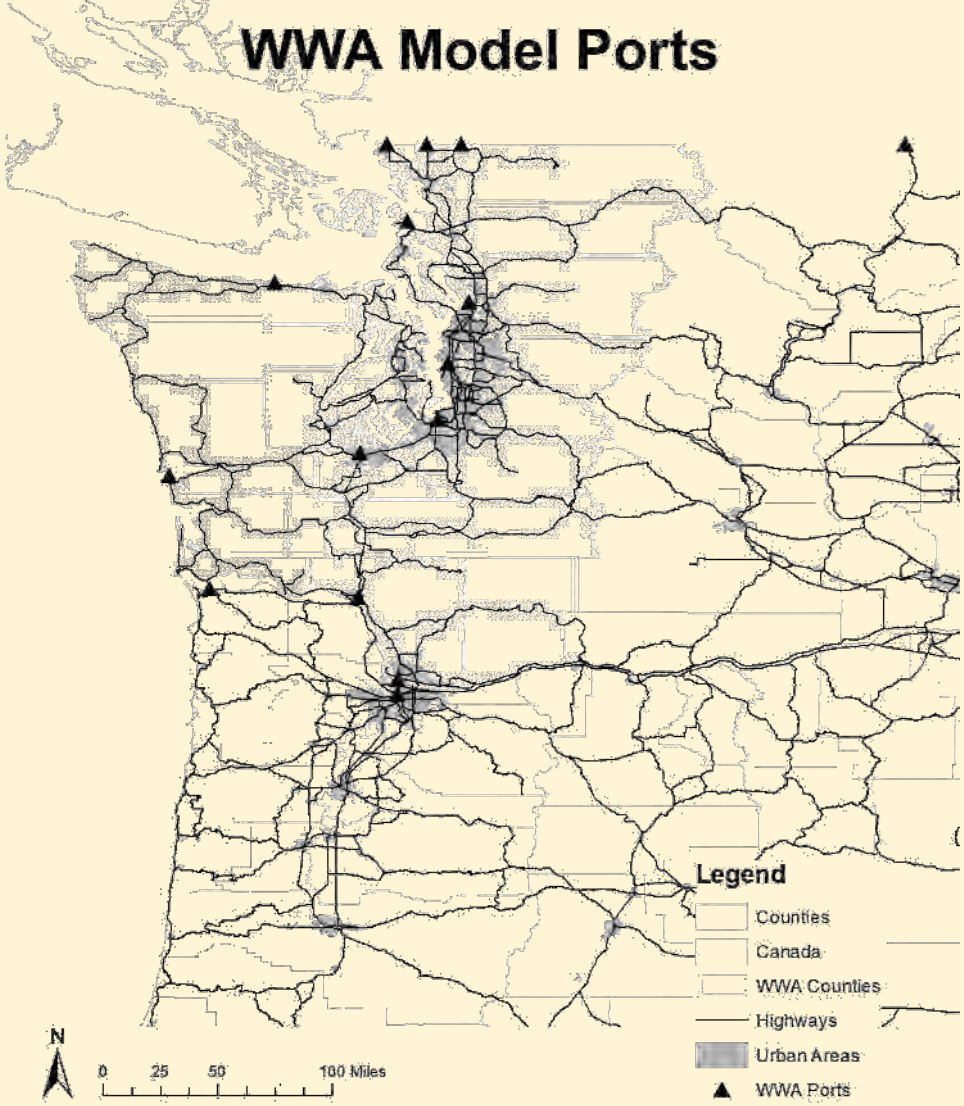
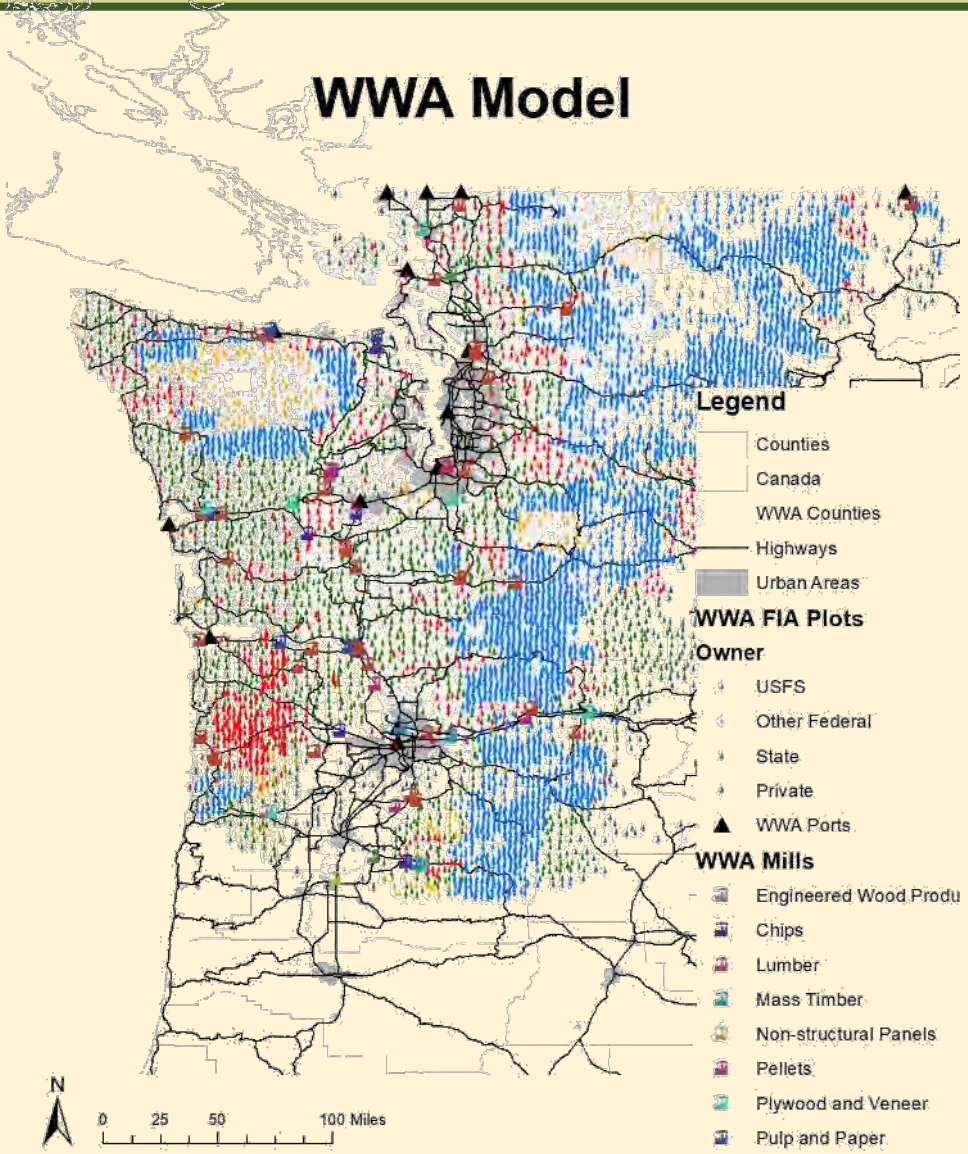
Western Washington Demand - Ports



Trade

- Not all western Washington logs or chips stay in the US
- Not all logs or chips processed in western Washington originate in the US
- Finished wood products are also imported and exported from regional ports

Western Washington Model

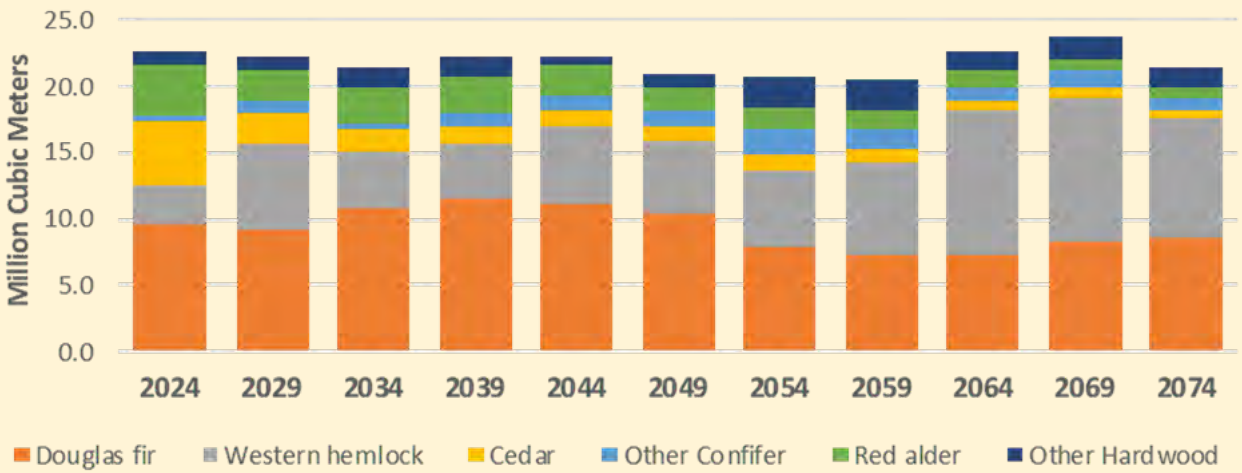


Bringing it all together

- Forest stands
- Road network
- Primary mills
- Secondary mills
- Exports

Wood Supply Study – Existing Mills

Let's try to not get too hung up on the units thing – Clearly that is a discussion item



Private Potential harvest – from a few slides ago

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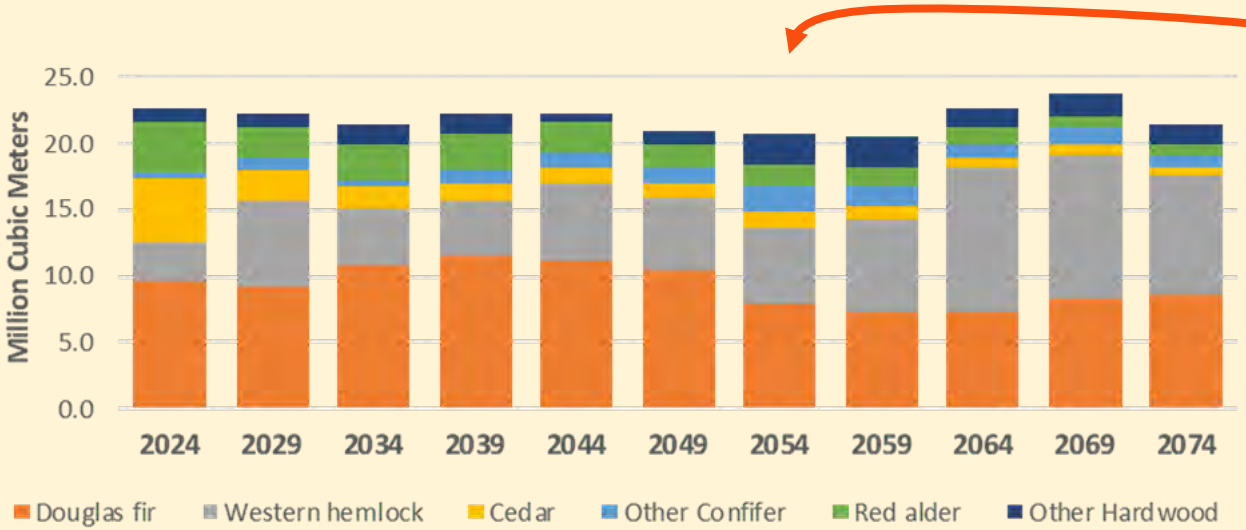


Private Potential harvest – from a few slides ago

23 million cubic meters

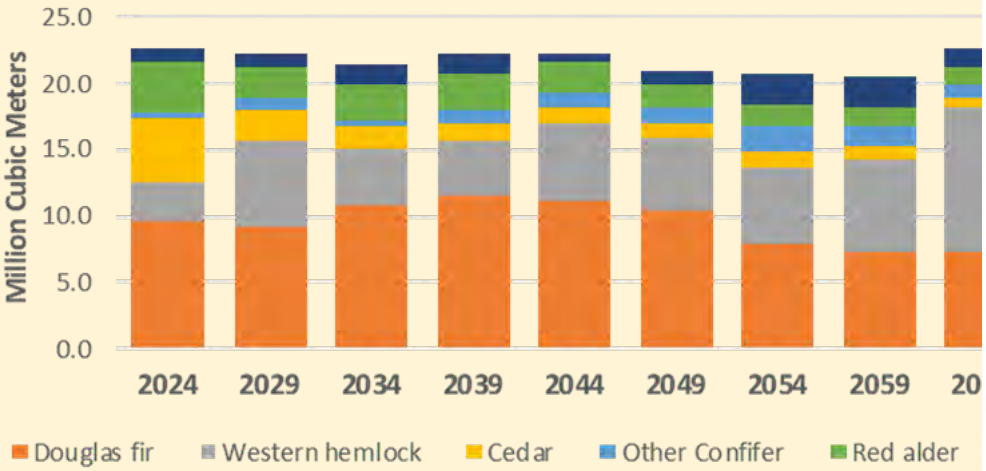
X

35.315 cubic feet per cubic meter

= 812 million cubic feet

Wood Supply Study – Existing Mills

Note: For accuracy, we will conduct the analysis using cubic meter, but will optimally buck each log to derive MBF



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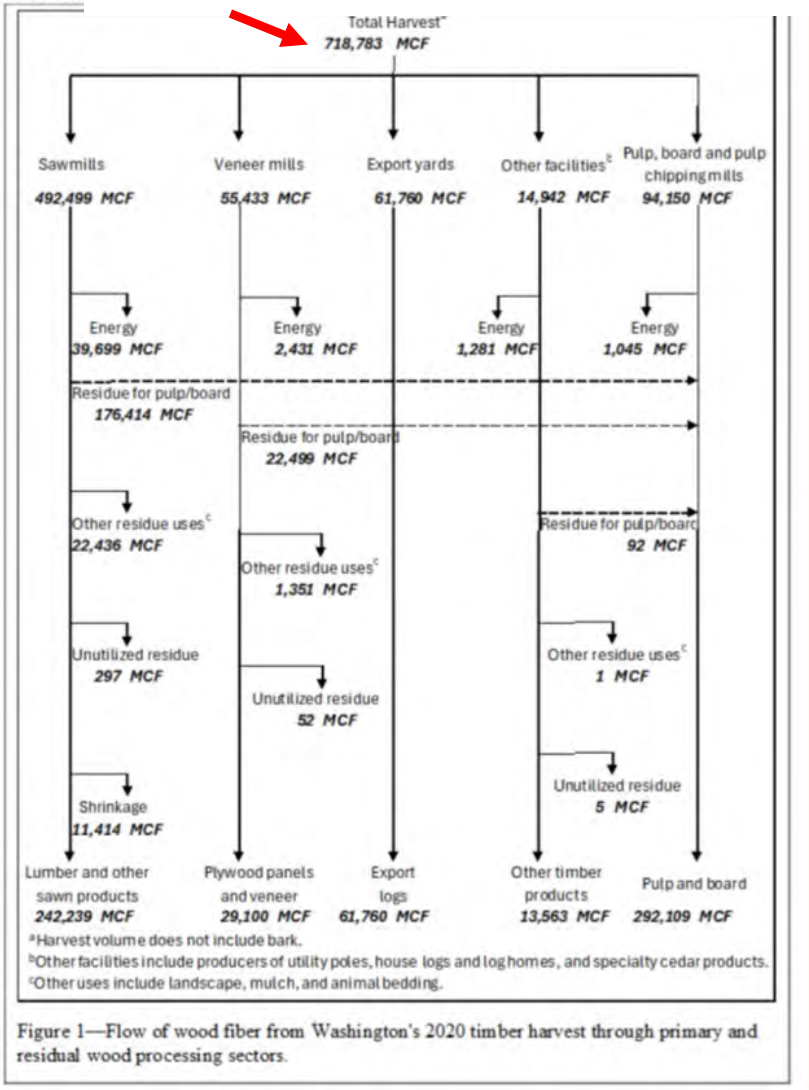
719 million cubic feet



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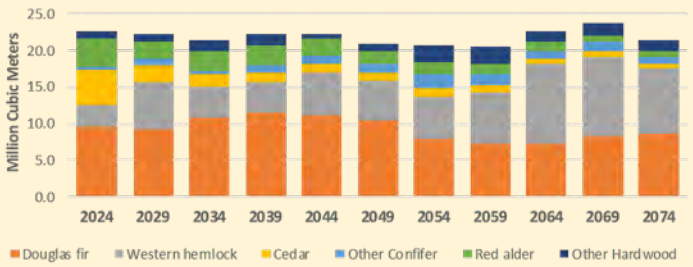
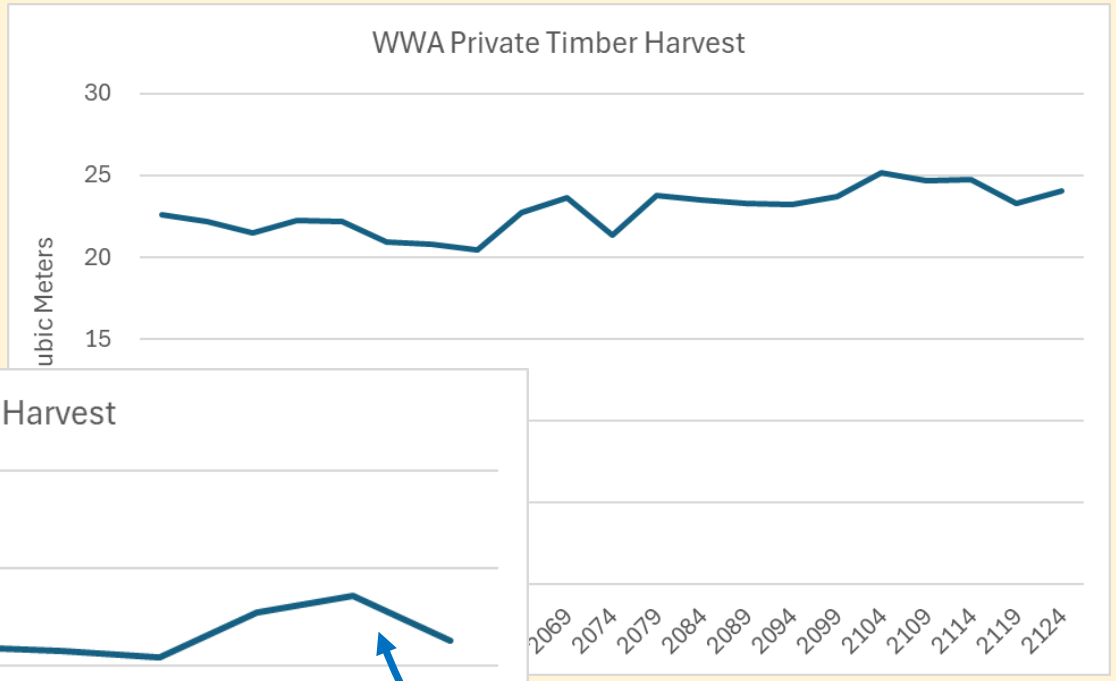
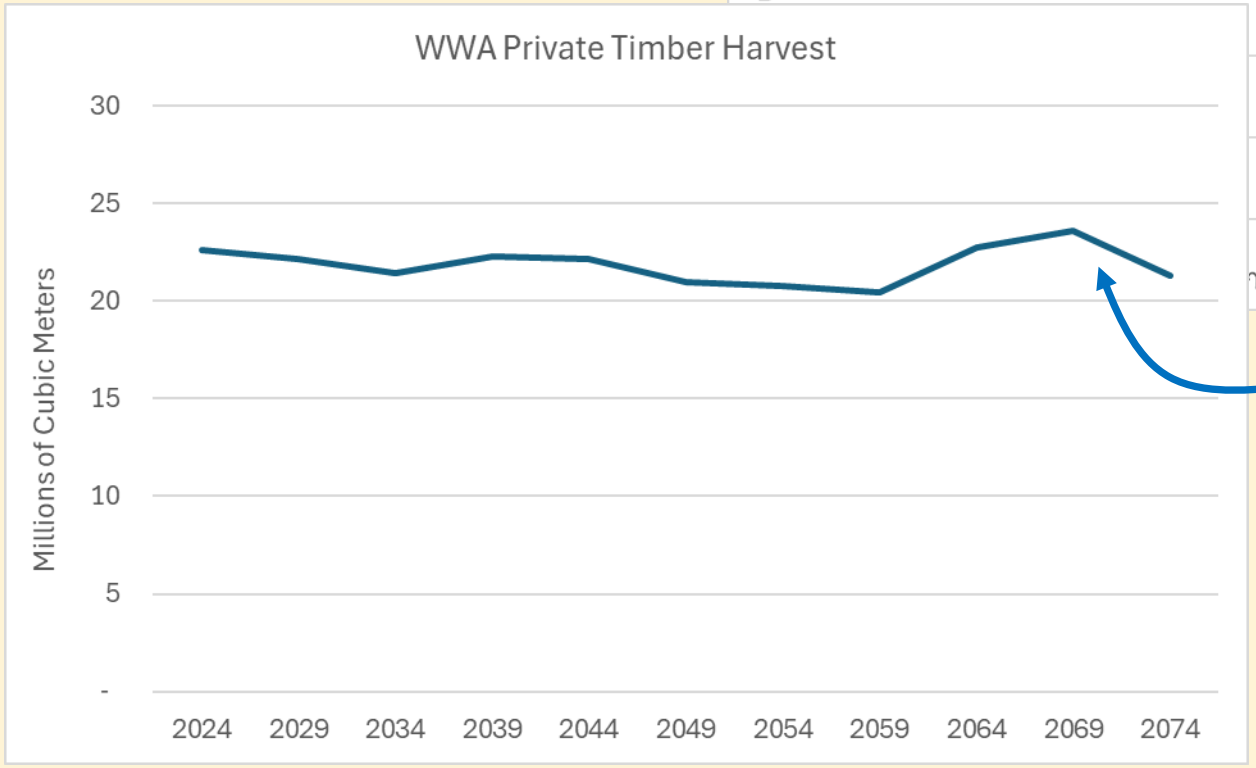
Wood Supply Study – Existing Mills

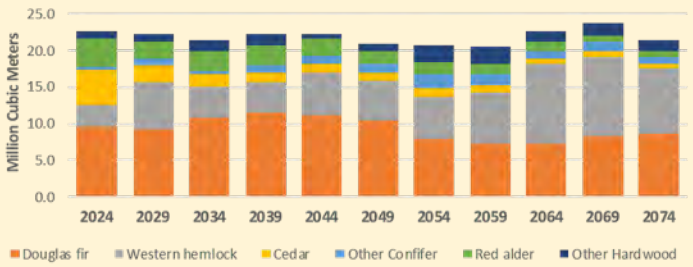


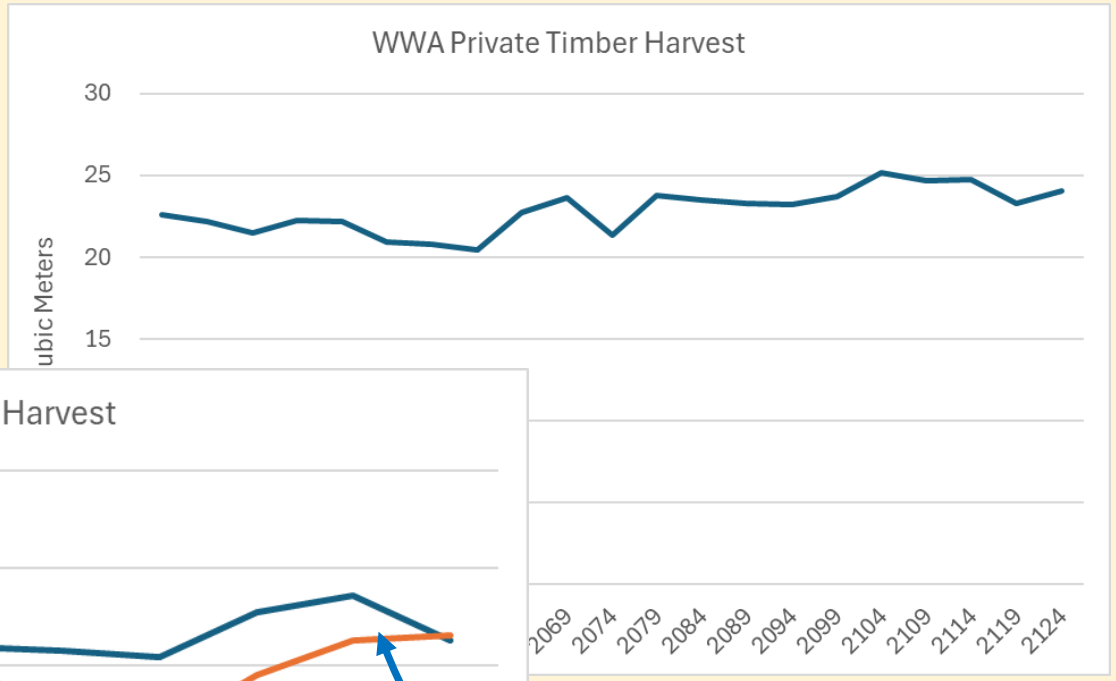


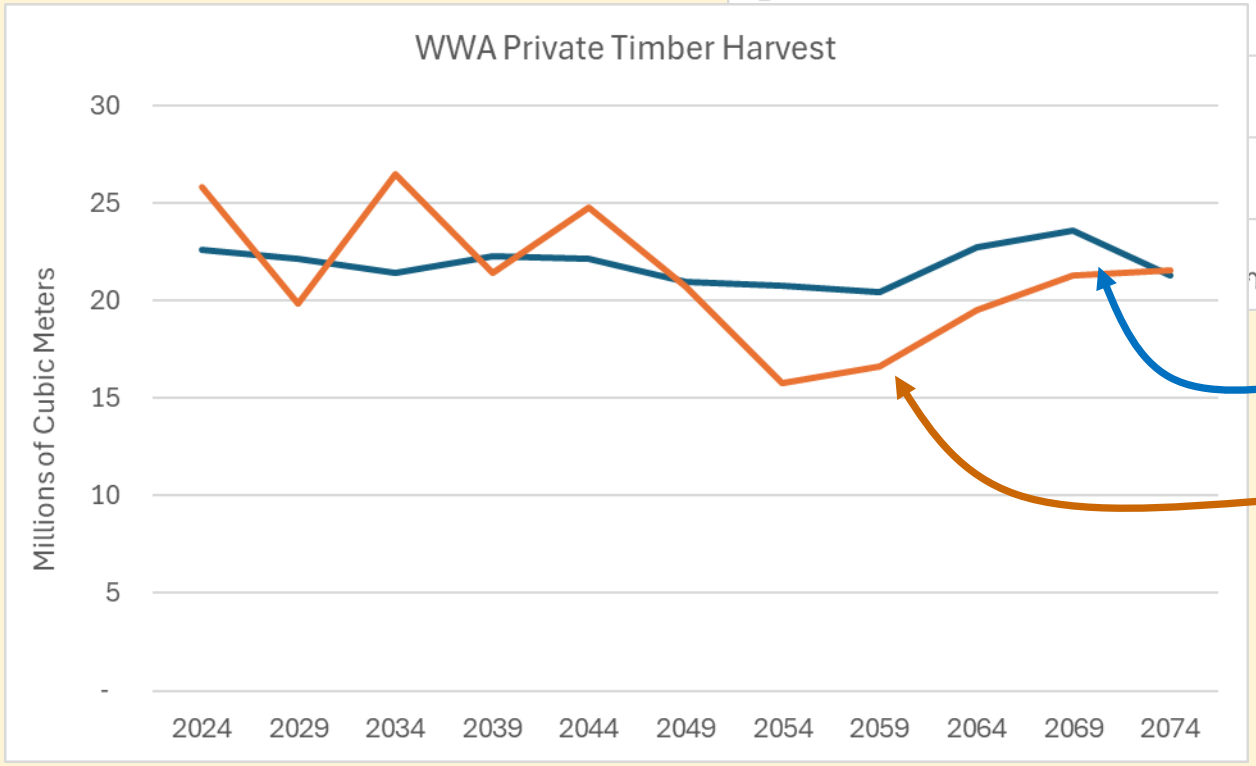


Potential Harvest

Wood Supply Study – Existing Mills





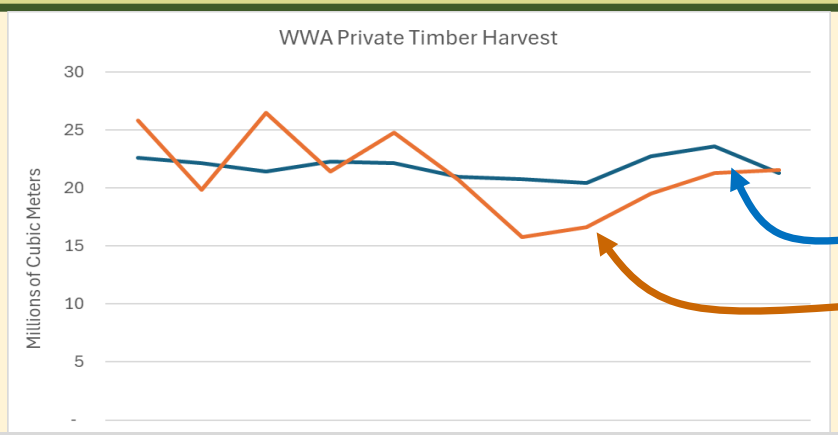


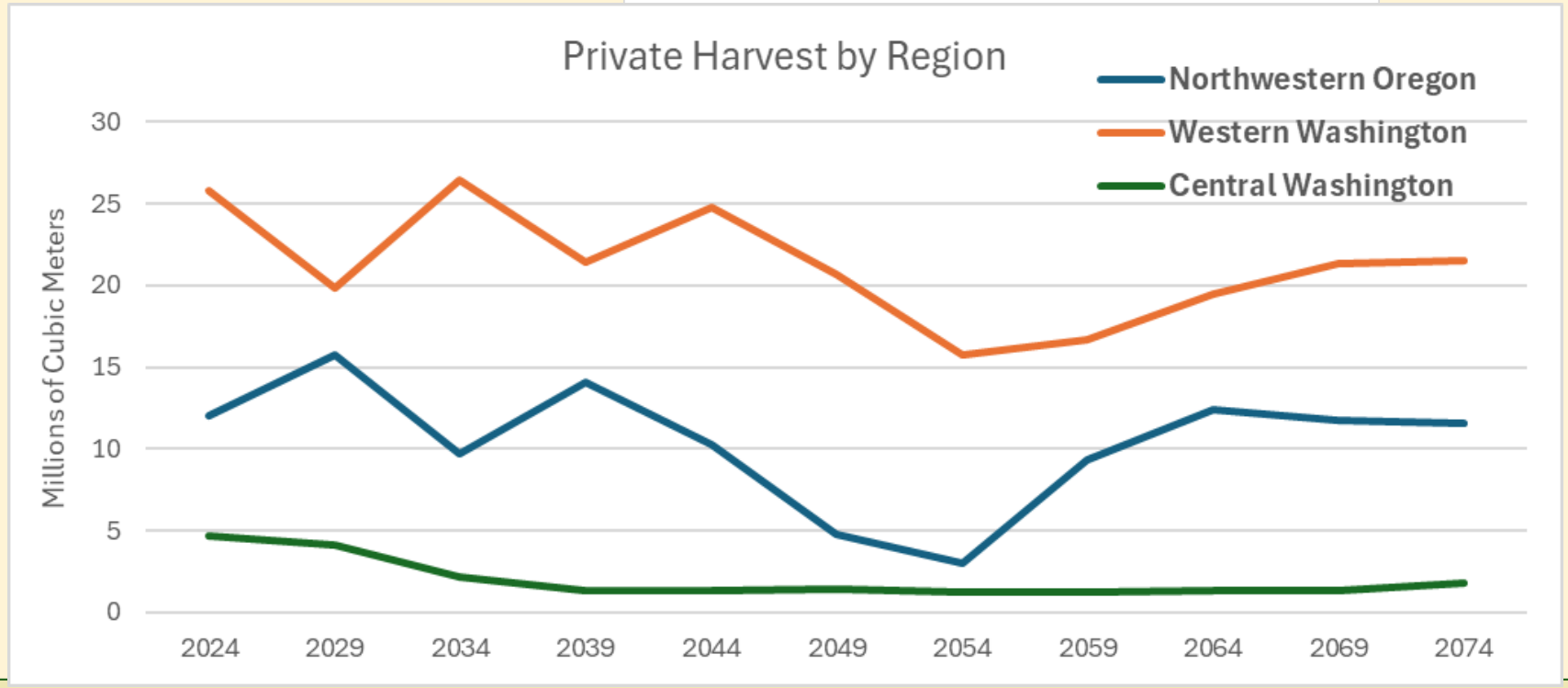
Potential Harvest

Harvest with Existing Infrastructure

Wood Supply Study – Existing Mills

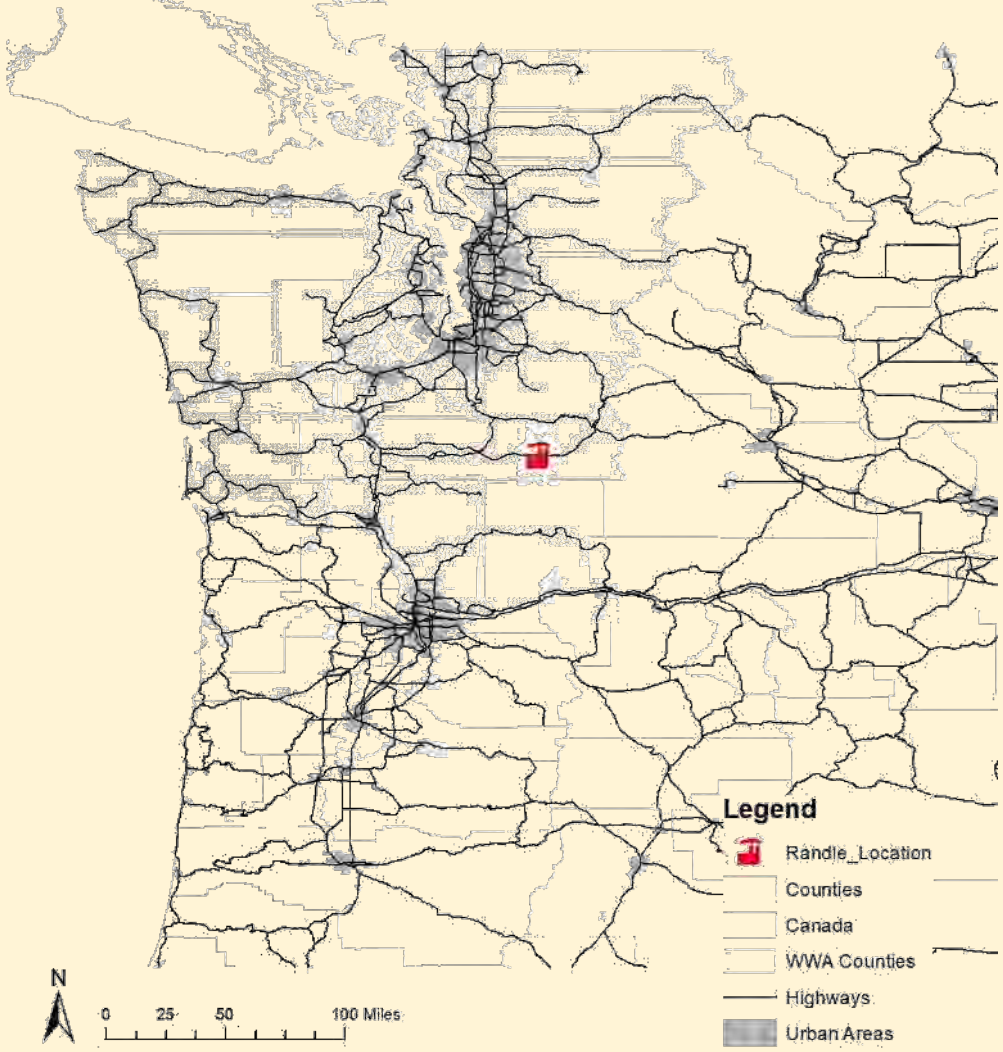
This is where it is important to look outside of western Washington





Wood Supply Study – Existing Mills

Looking at the Sawmill in Randle

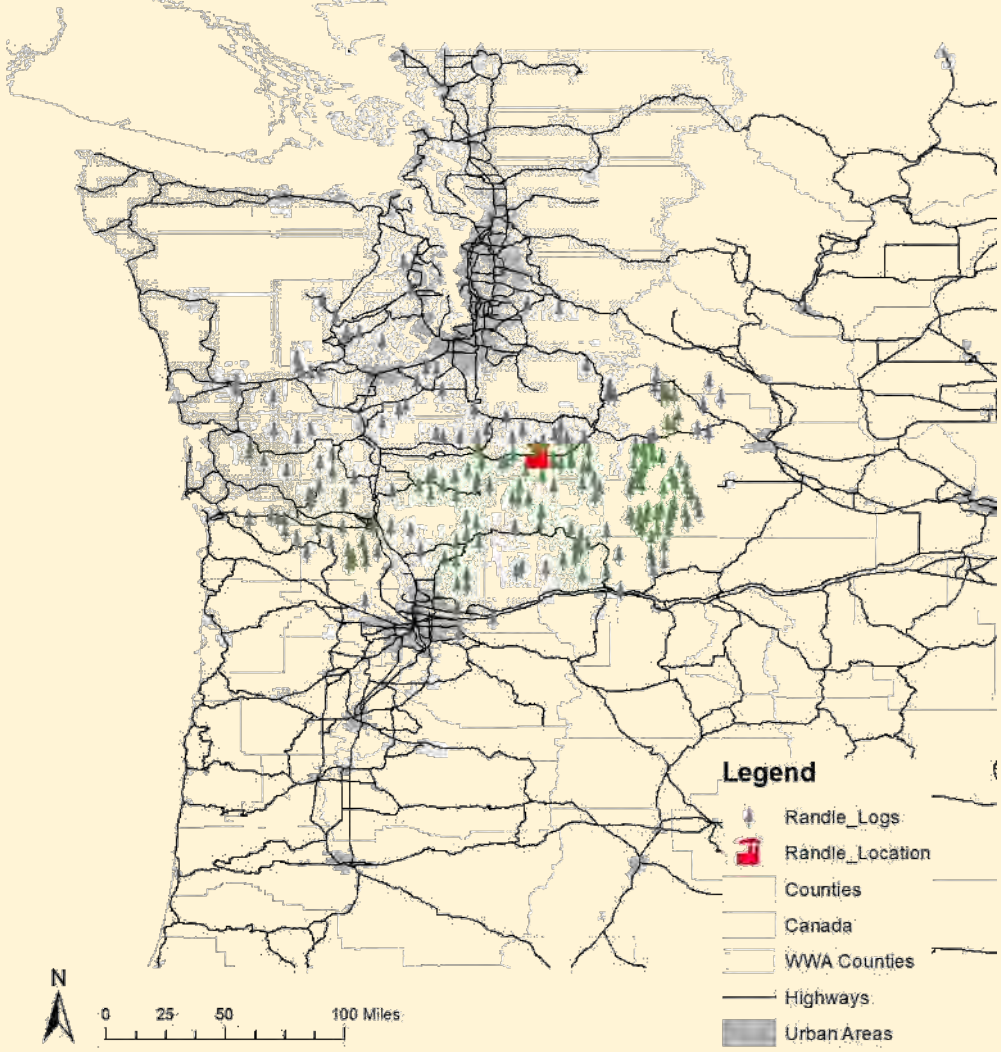


Focus on a WWA Mill

- Randle, WA
- Softwood lumber mill

Wood Supply Study – Existing Mills

Looking at the Sawmill in Randle



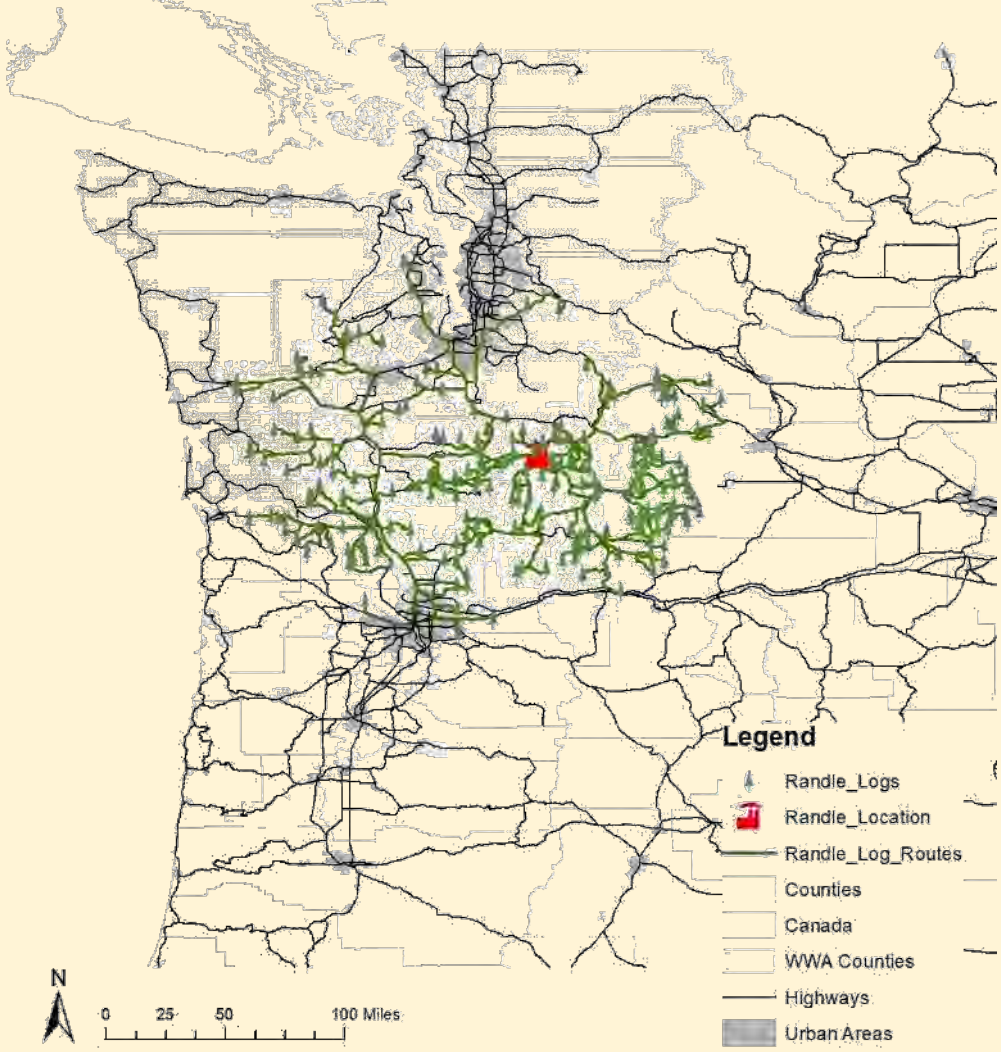
Focus on a WWA Mill

- Randle, WA
- Softwood lumber mill
- Plots that supply logs to mill

Note: when you harvest those plots, there may also be trucks heading to hardwood mills, pulp mills, etc.

Wood Supply Study – Existing Mills

Looking at the Sawmill in Randle



Focus on a WWA Mill

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- Plots that supply logs to mill

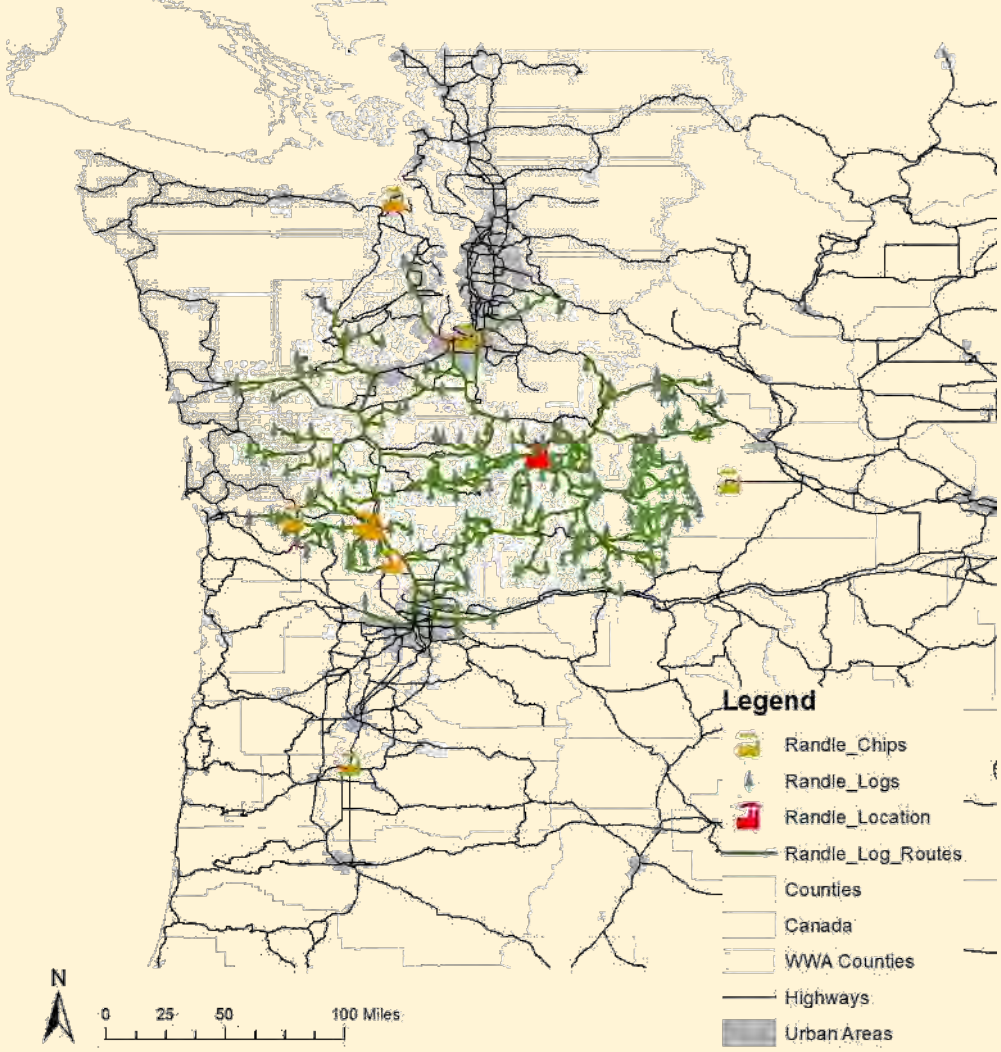
Note: when you harvest those plots, there may also be trucks heading to hardwood mills, pulp mills, etc.

- Logs use the road network

We track hours and gallons of fuel used, which provides an estimate of labor and emissions effects.

Wood Supply Study – Existing Mills

Looking at the Sawmill in Randle



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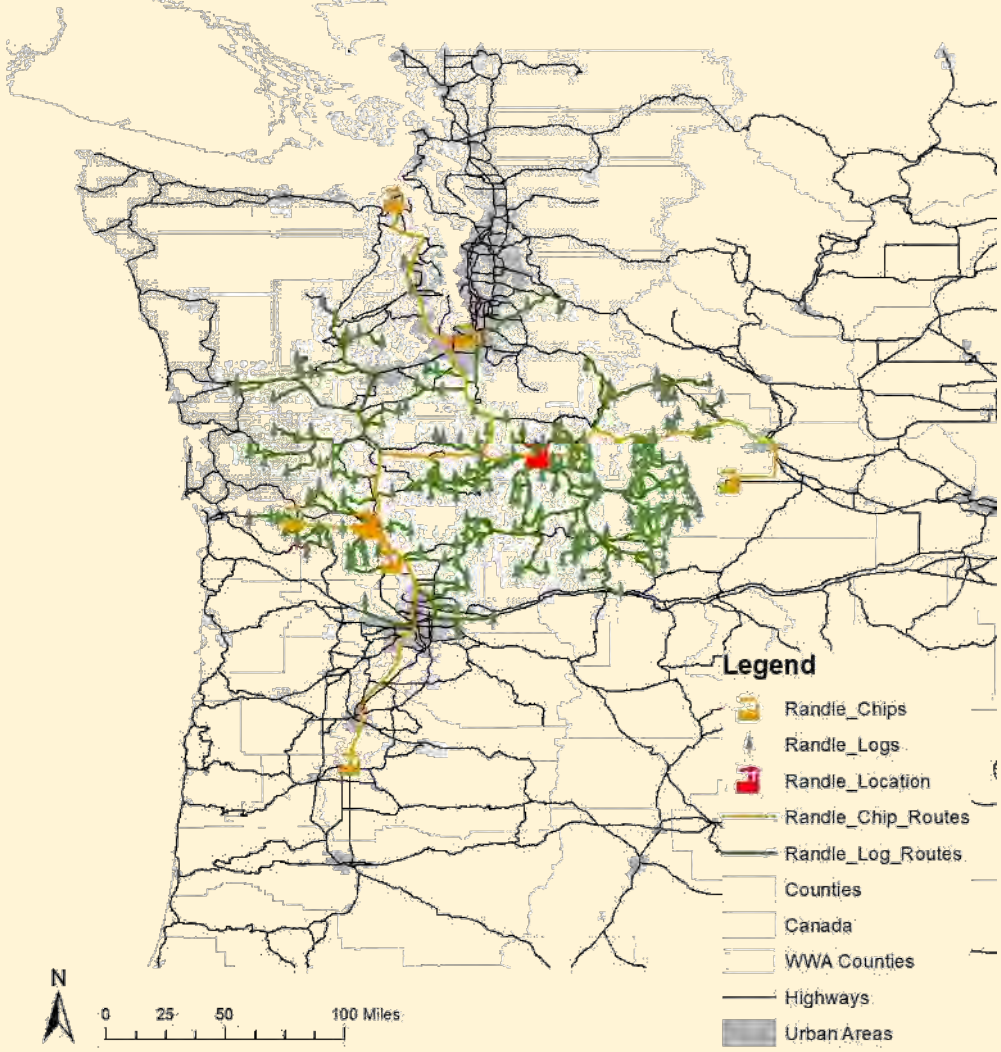
- Residues are shipped to other mills

Note: we are modeling the forest products industry, not just harvest.

Wood Supply Study – Existing Mills

Looking at the Sawmill in Randle



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Note: when you harvest those plots, there may also be trucks heading to hardwood mills, pulp mills, etc.

- Logs use the road network

We track hours and gallons of fuel used, which provides an estimate of labor and emissions effects.

- Residues are shipped to other mills

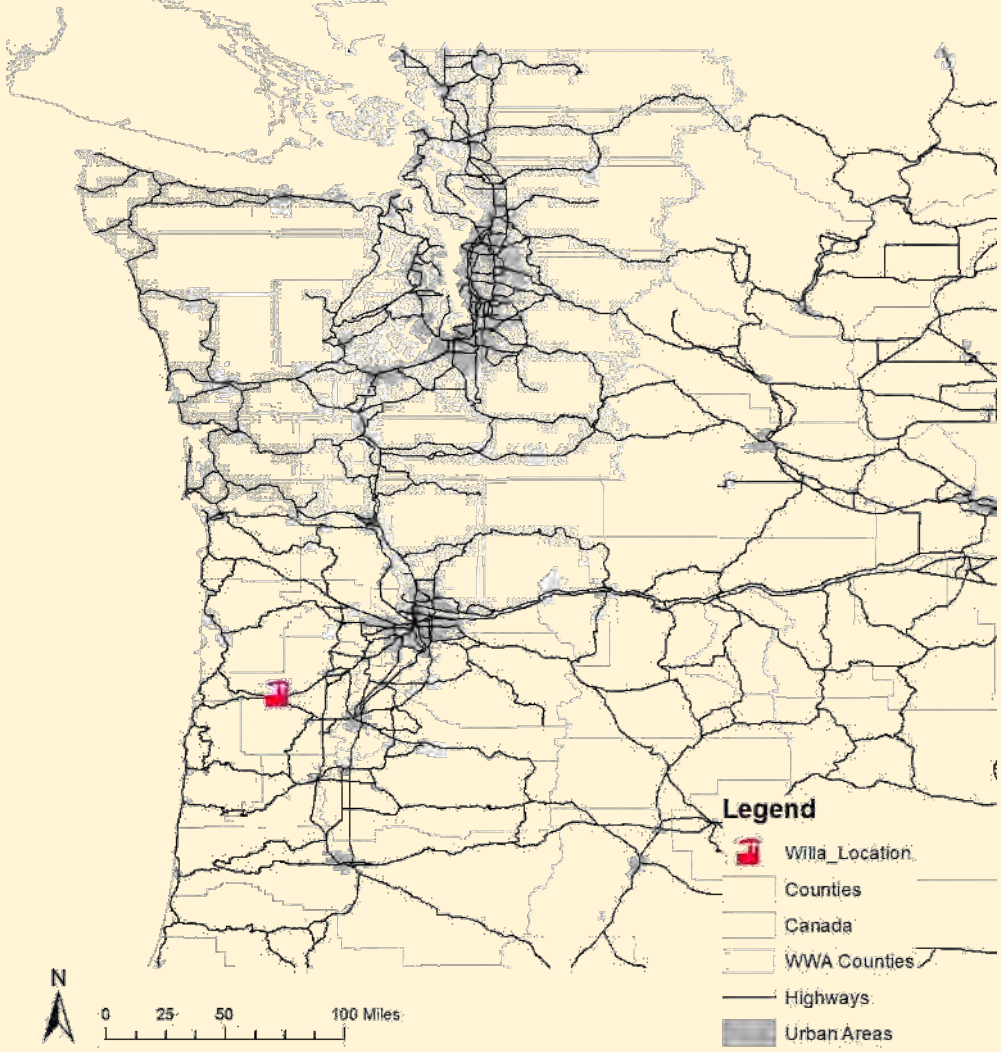
Note: we are modeling the forest products industry, not just harvest.

- Residuals also use roads

So again, we have hours and gallons used – we can get an idea on labor and emissions effects

Wood Supply Study – Existing Mills

Looking at the Sawmill in Willamina

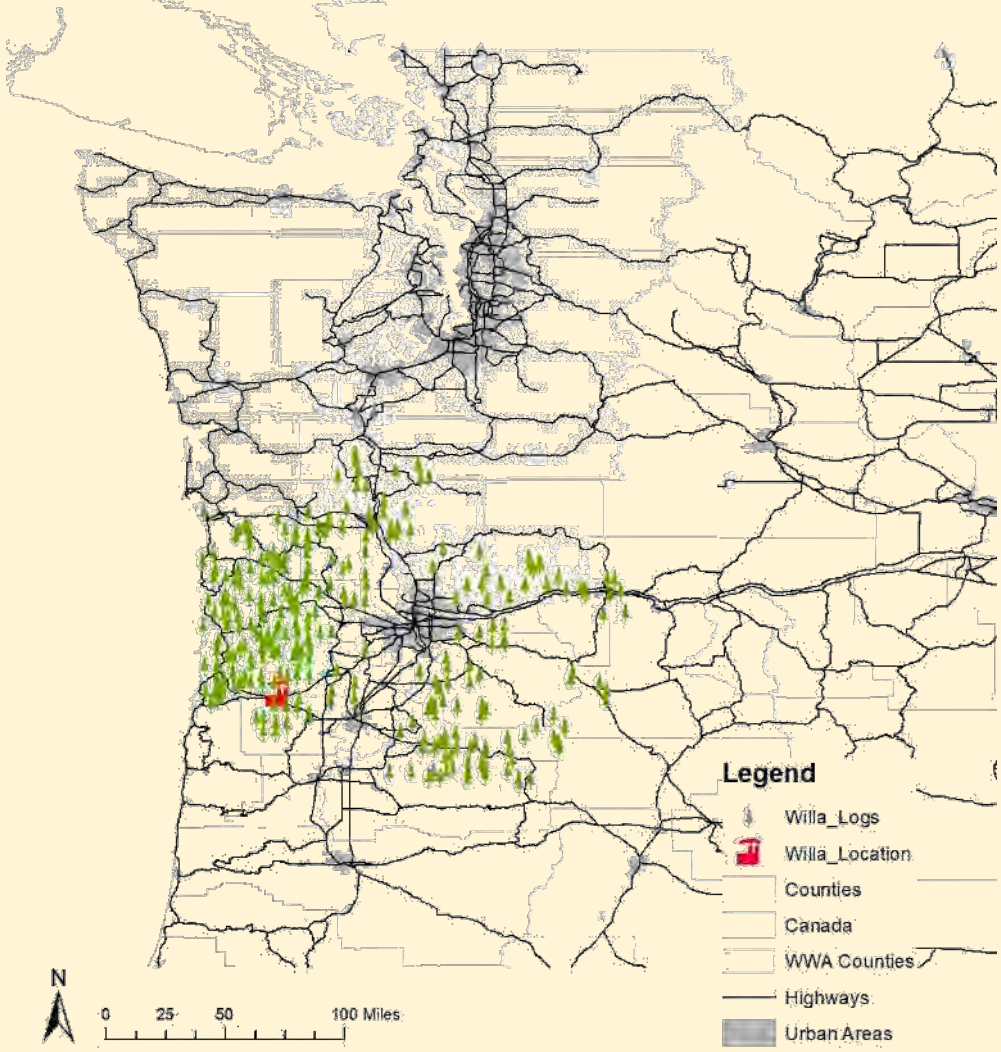


Focus on a WOR Mill

- Willamina, OR
- Softwood lumber mill

Wood Supply Study – Existing Mills

Looking at the Sawmill in Willamina



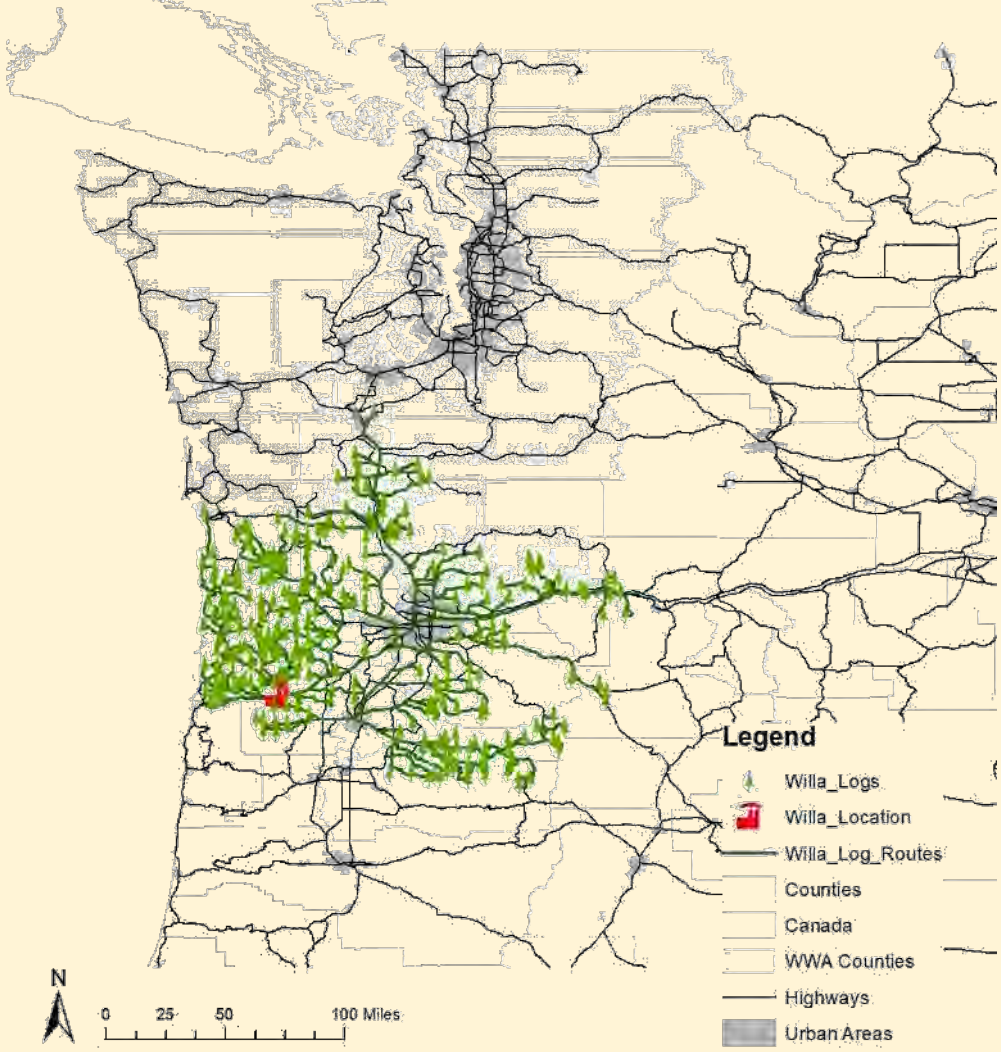
Focus on a WOR Mill

- Willamina, OR
- Softwood lumber mill
- Plots that supply logs to mill

Note: when you harvest those plots, there may also be trucks heading to hardwood mills, pulp mills, etc.

Wood Supply Study – Existing Mills

Looking at the Sawmill in Willamina



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Wood Supply Study – Existing Mills

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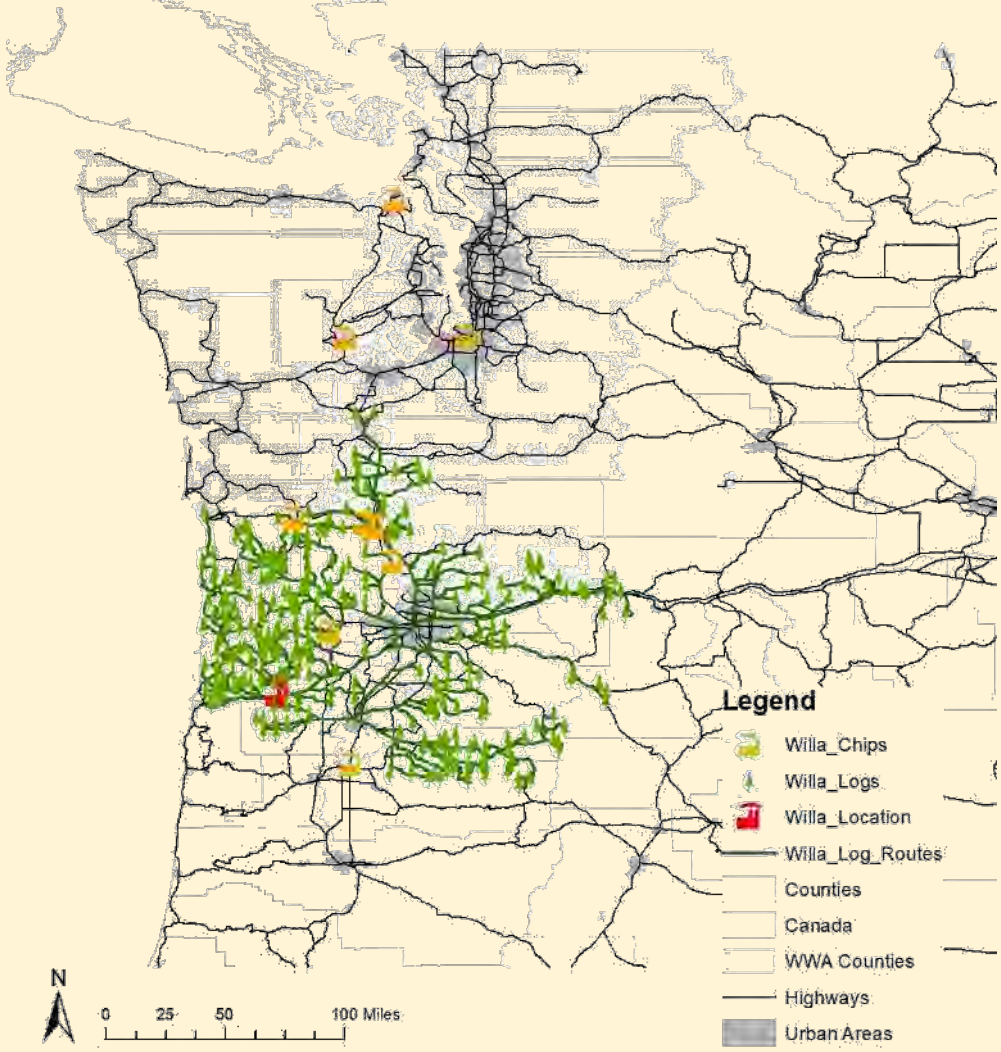

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Wood Supply Study – Existing Mills

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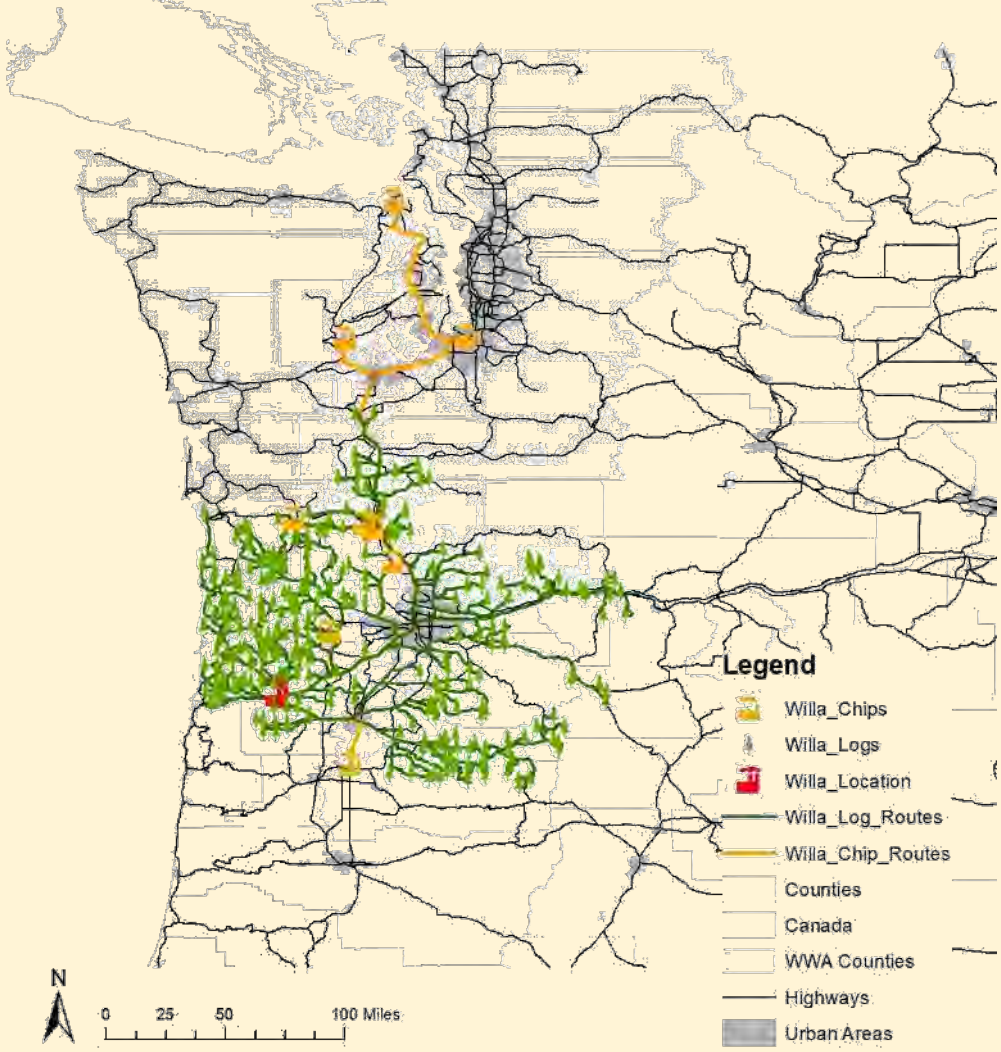

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  So again, we have hours and gallons used – we can get an idea on labor and emissions effects

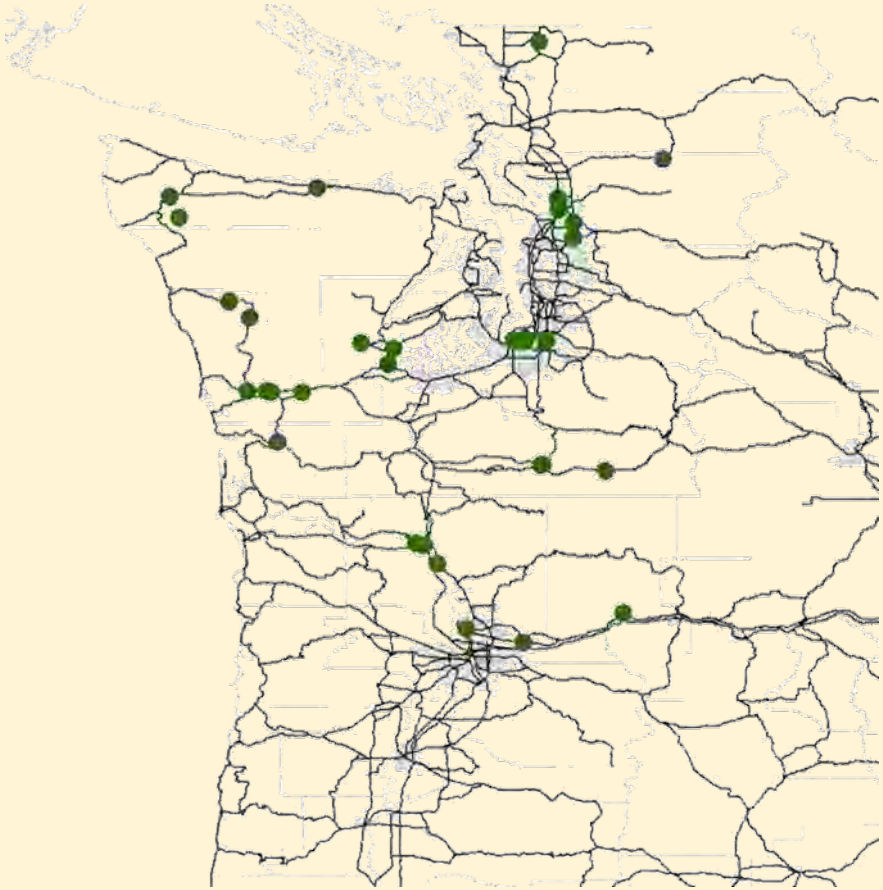
Wood Supply Study – Existing Mills

Another thing to consider is to what extent we hold locations

and

capacities at those location fixed

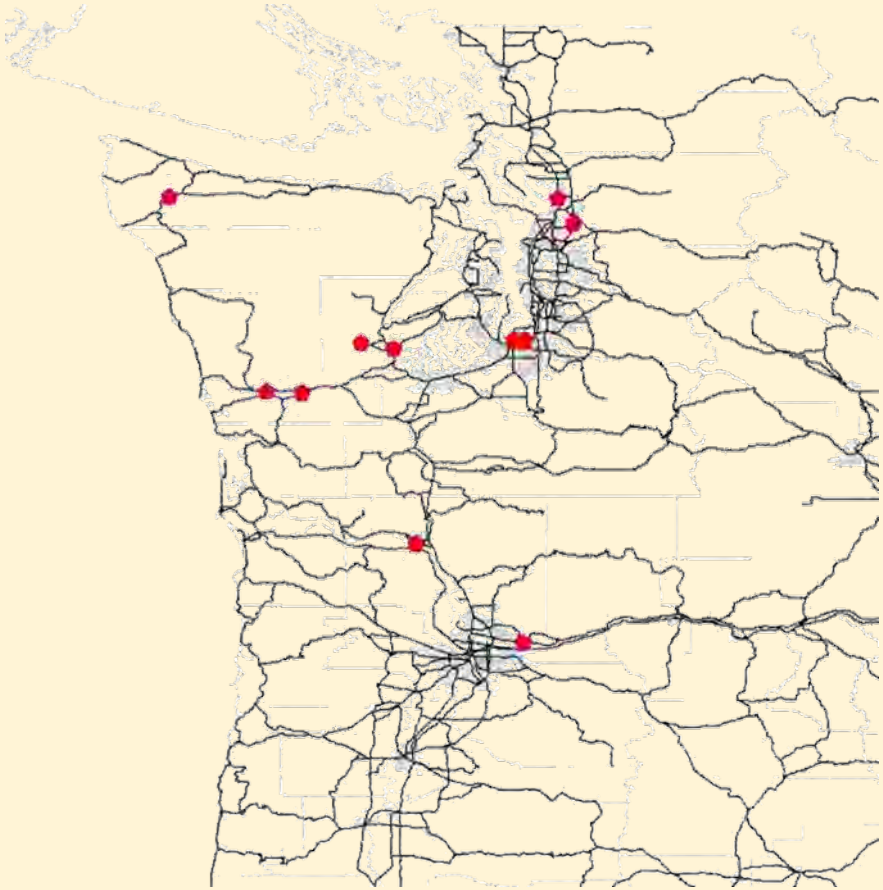
Existing Wood Supply – maintaining infrastructure



Mills & Milling Capacity

- **Sawmills operating in 2002**

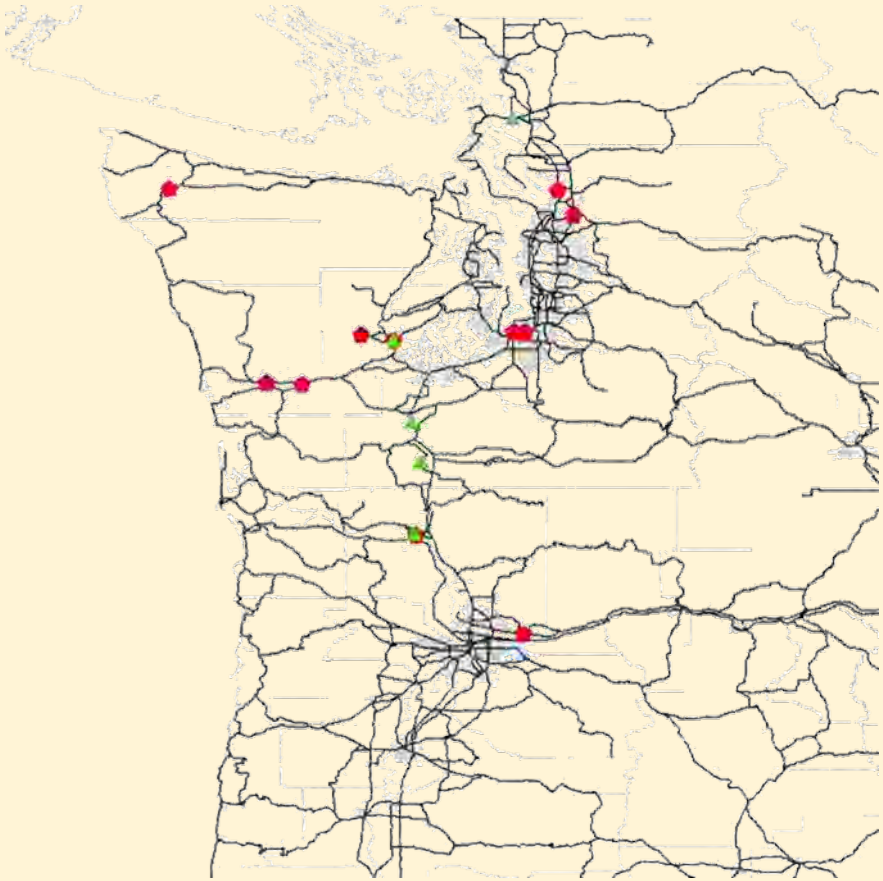
Existing Wood Supply – maintaining infrastructure



Mills & Milling Capacity

- Sawmills operating in 2002
- **Some mills closed**

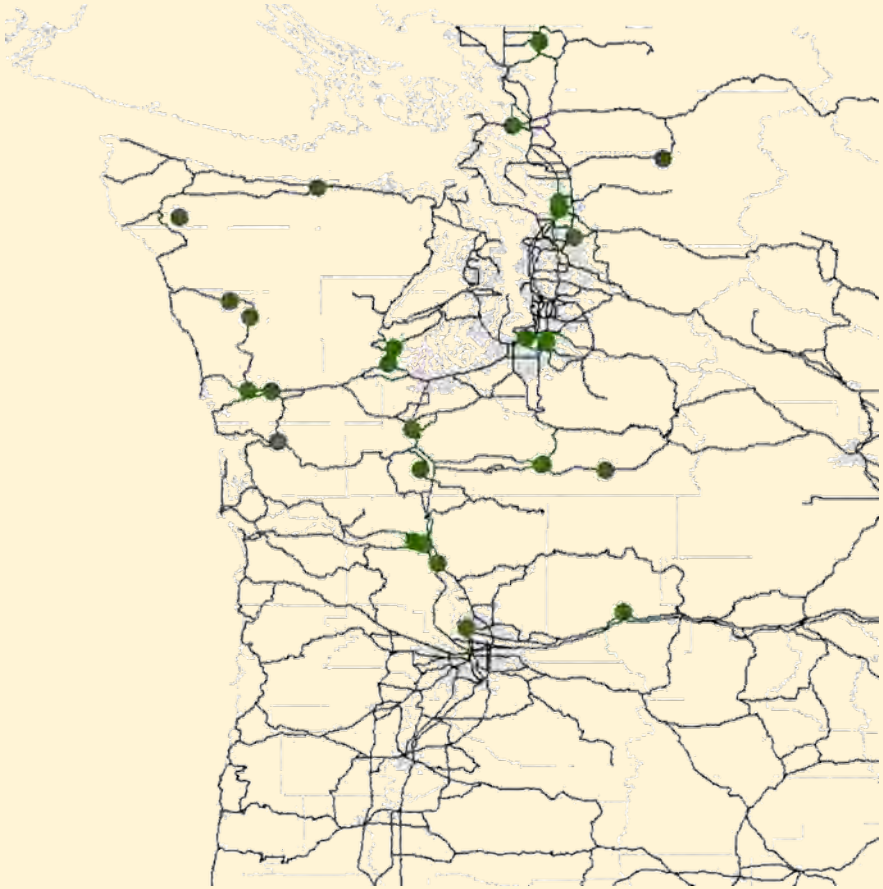
Existing Wood Supply – maintaining infrastructure



Mills & Milling Capacity

- Sawmills operating in 2002
- Some mills closed ⬟
- **Some mills opened ▲**

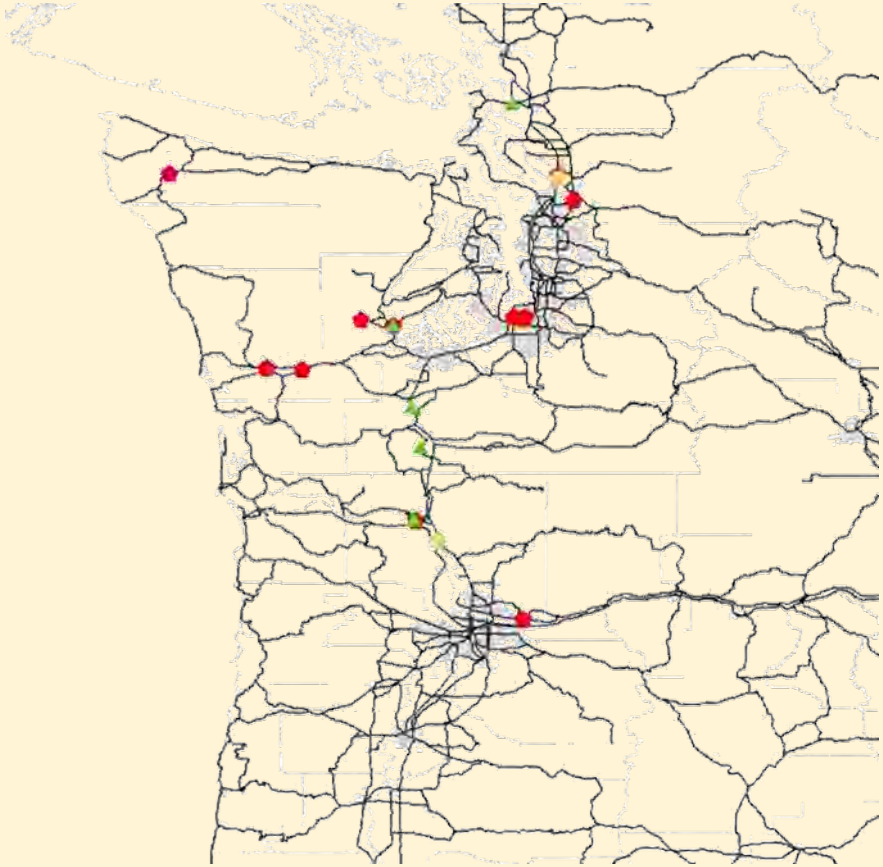
Existing Wood Supply – maintaining infrastructure



Mills & Milling Capacity

- Sawmills operating in 2002
- Some mills closed
- Some mills opened
- **Sawmills operating today**

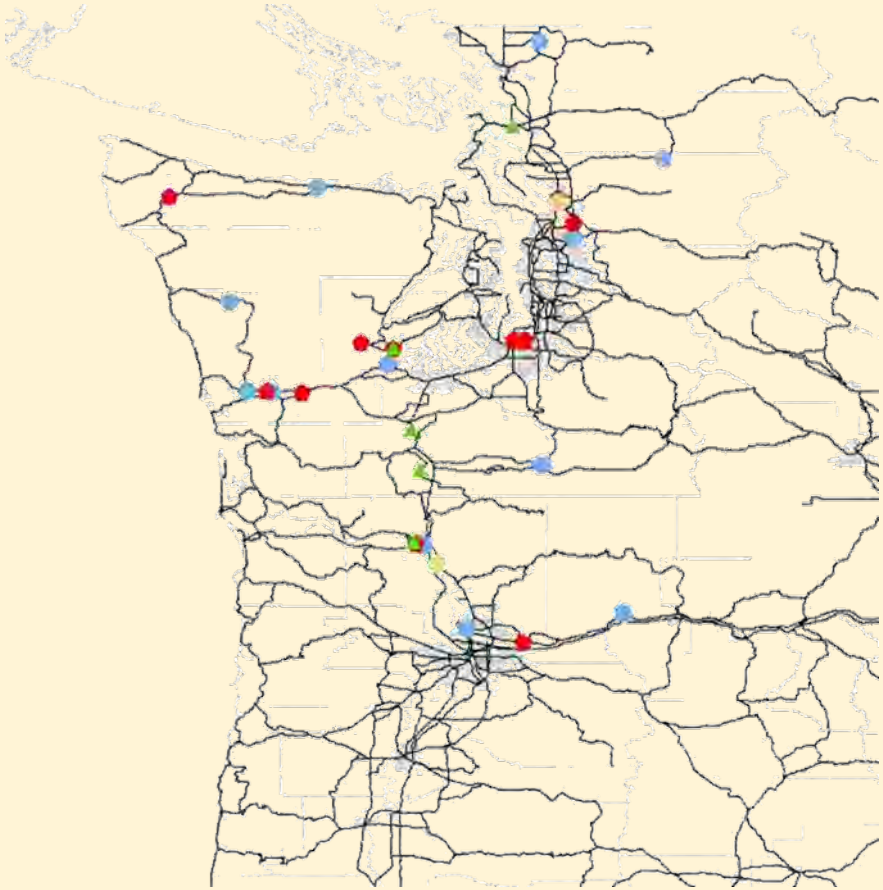
Existing Wood Supply – maintaining infrastructure



Mills & Milling Capacity

- Sawmills operating in 2002
- Sawmills operating today
- Some of them closed ⬟
- Some opened ▲
- **Some decreased capacity** ●

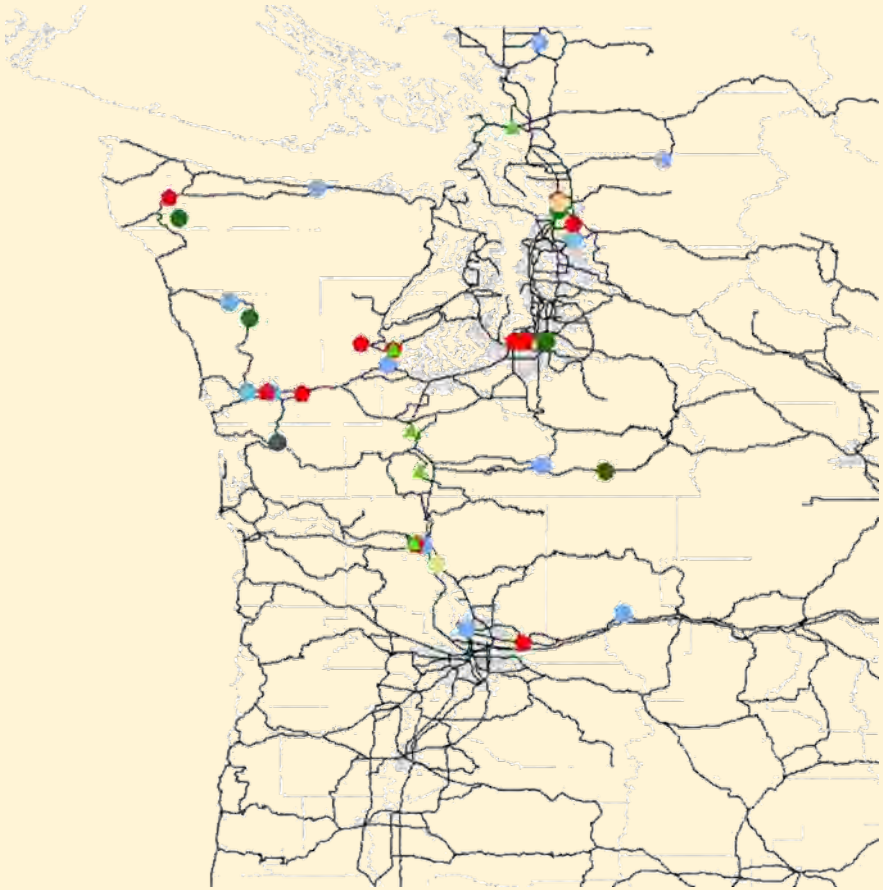
Existing Wood Supply – maintaining infrastructure



Mills & Milling Capacity

- Sawmills operating in 2002
- Sawmills operating today
- Some mills closed
- Some mills opened
- Some decreased capacity
- **Some increased capacity**

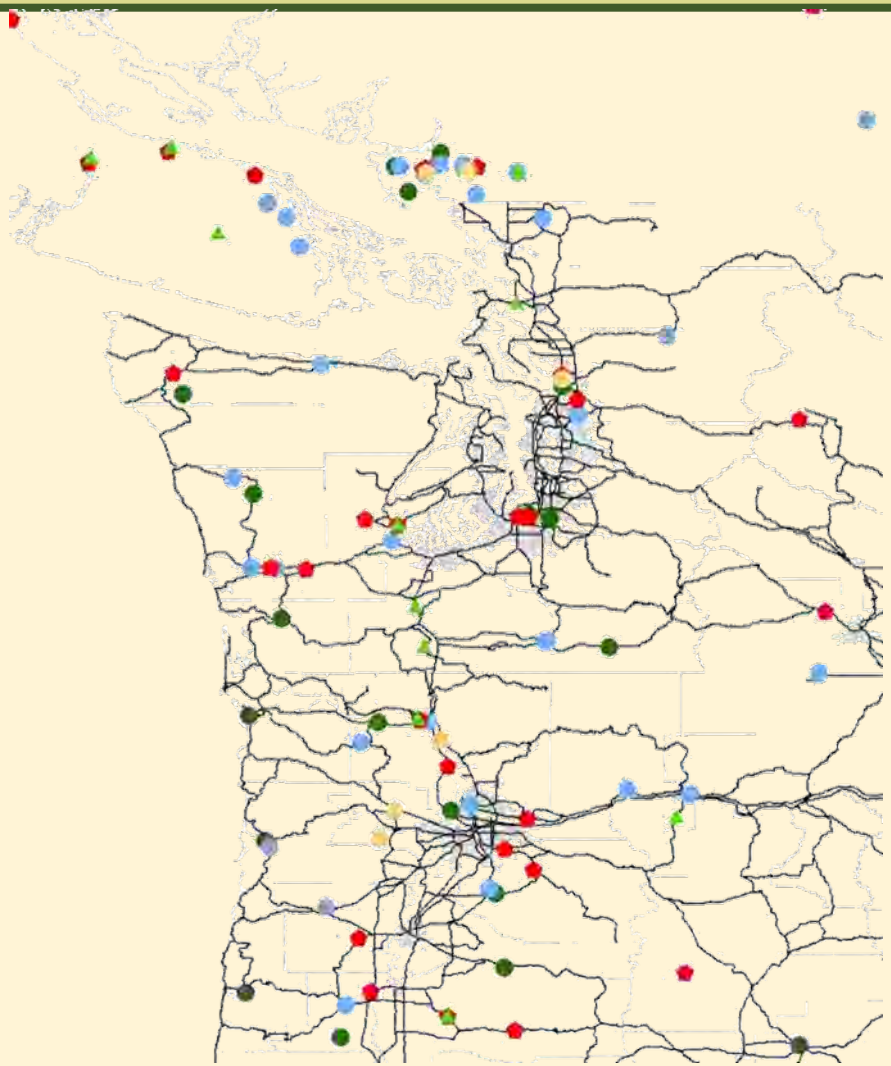
Existing Wood Supply – maintaining infrastructure



Mills & Milling Capacity

- Sawmills operating in 2002
- Sawmills operating today
- Some mills closed
- Some mills opened
- Some decreased capacity
- Some increased capacity
- **A few stayed the same**

Existing Wood Supply – maintaining infrastructure



Mills & Milling Capacity

- Sawmills operating in 2002
- Sawmills operating today
- Some mills closed
- Some mills opened
- Some decreased capacity
- Some increased capacity
- A few stayed the same
- **This occurred western WA**

What does maintaining infrastructure mean?

Capacity will follow the wood

Wood Supply Study – National Markets

Now we look at the larger US Forest Products markets

- The US South may be a bigger risk to local mills than any changes considered by DNR
- To fully understand how the scenarios will impact local mills, we need to consider the greater US wood products market
- To do this, we use the **LURA** model

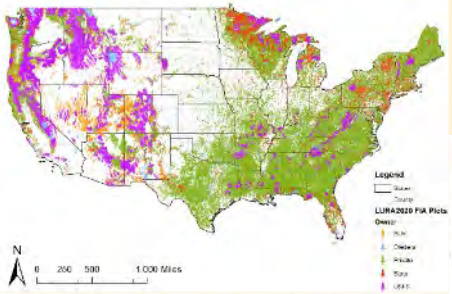
LURA Model background

Latta, G., J. Baker and S. Ohrel. 2018. A land use and resource allocation (LURA) modeling system for projecting localized forest CO2 effects of alternative macroeconomic futures. *Forest Policy and Economics* 87(2018):35-48.

Balance national supply and demand with price sensitive demand

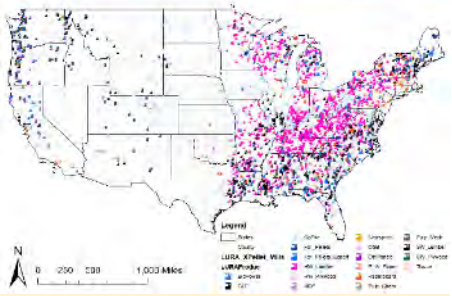
1. Which has a forest land base representation (164k plots)
2. And a forest products market representation (3.4k mills)

LURA Static Supply Forest Ownership

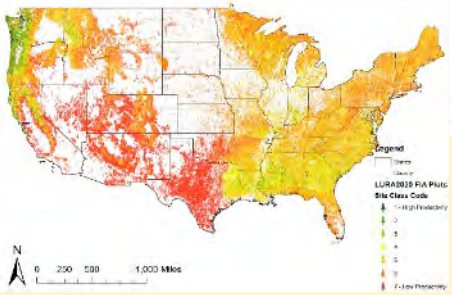


Owner	Acres	Percent
BLM	31,101,654	5%
Ofederal	20,505,041	3%
Private	427,520,906	63%
State	60,609,602	9%
USFS	136,510,772	20%
Total	676,247,974	100%

LURA Static Demand Mill Locations



LURA Static Supply Forest Productivity



LURA Combined Forest Sector

126 Ports/Border Crossings

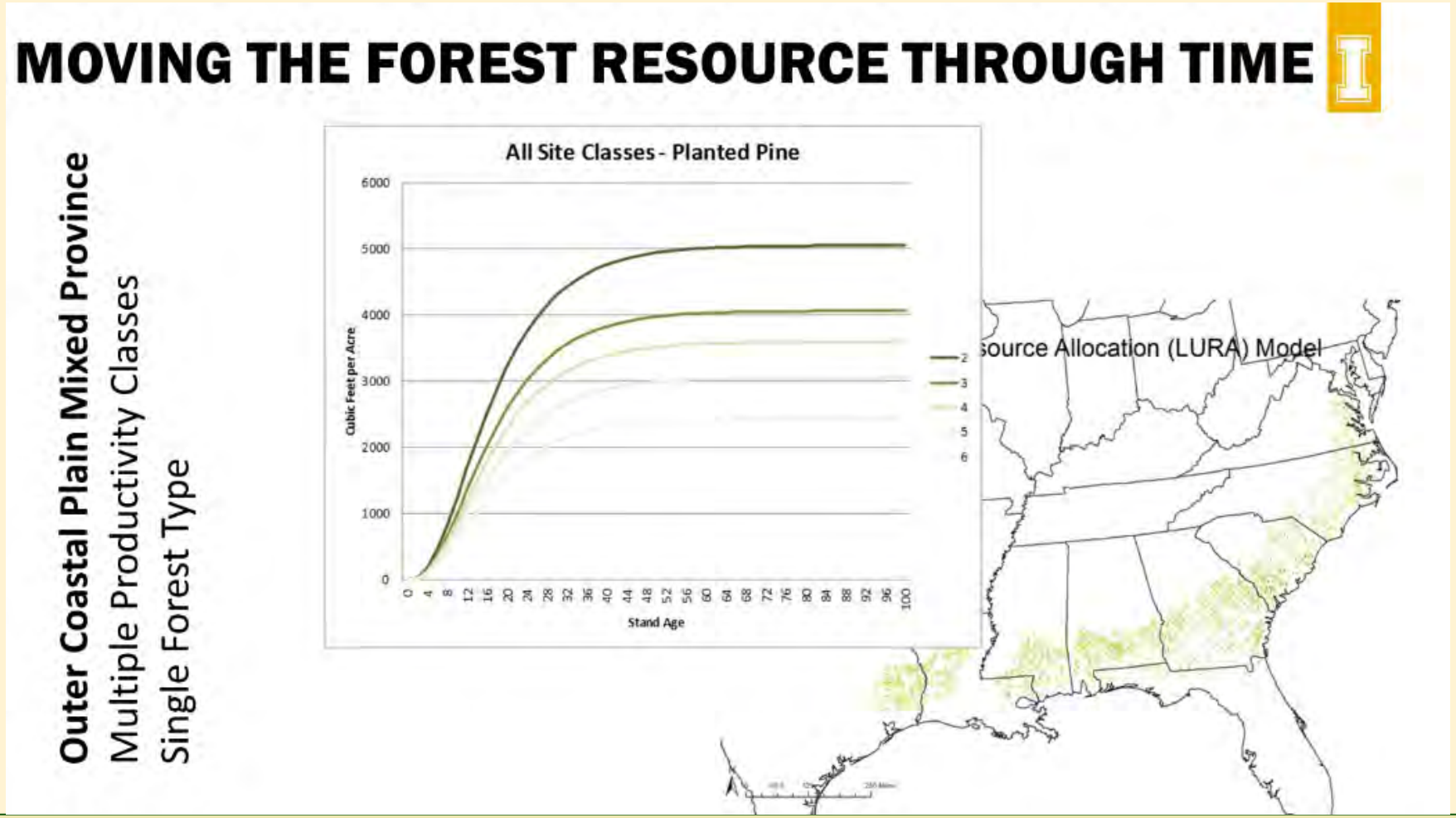
3,365 Manufacturing Facilities

164,723 FIA forest plots

LURA Model background – *Dynamic Supply*

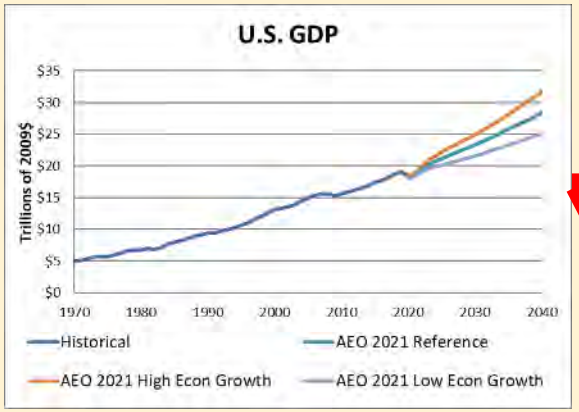
Balance supply and demand with price sensitive demand

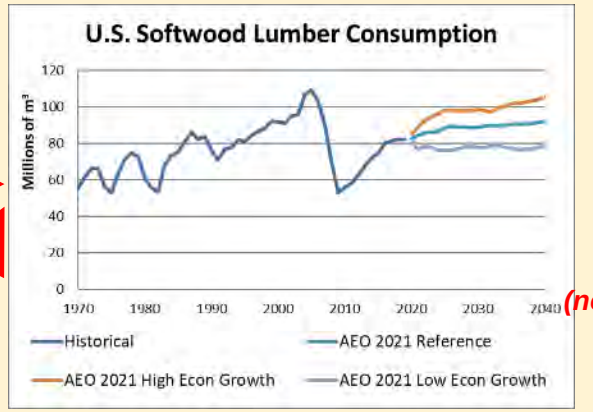
1. You need to move the resource through time

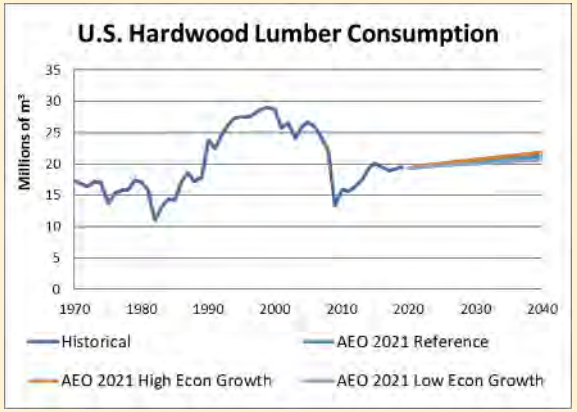


LURA Model background – *Dynamic Demand*

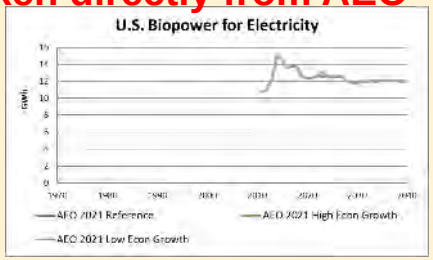
2) And move demand through time



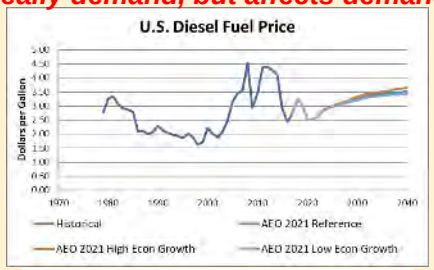


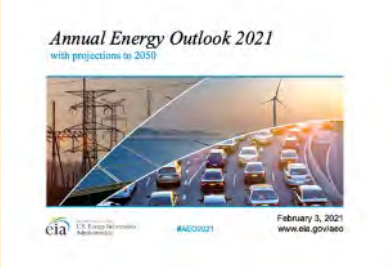


Taken directly from AEO



Taken directly from AEO
(not really demand, but affects demand)





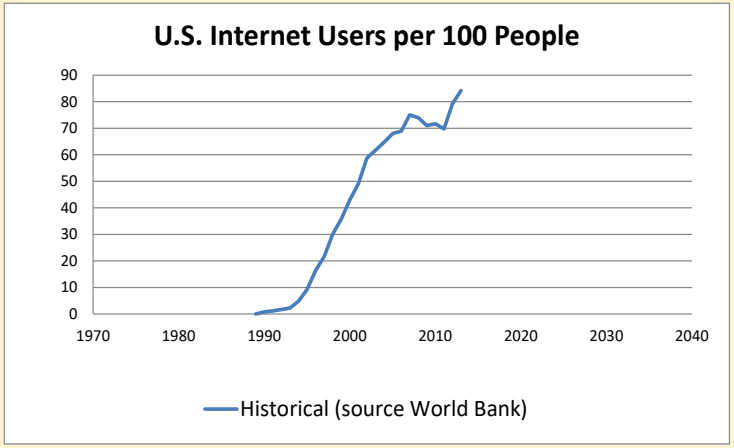
https://www.eia.gov/outlooks/aeo/

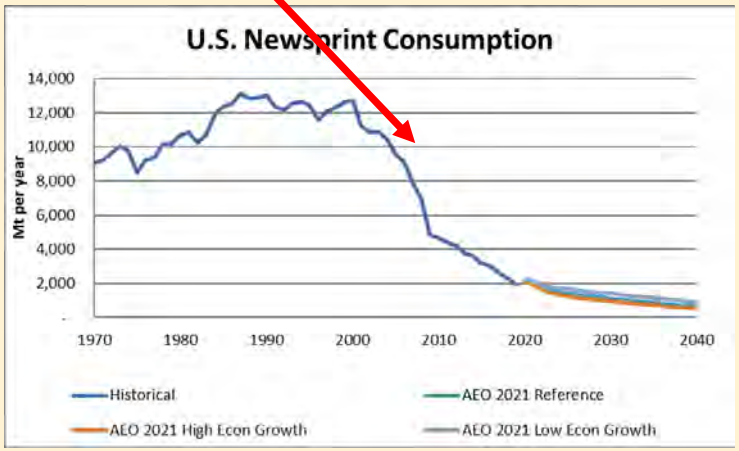
MOVING FOREST PRODUCTS THROUGH TIME

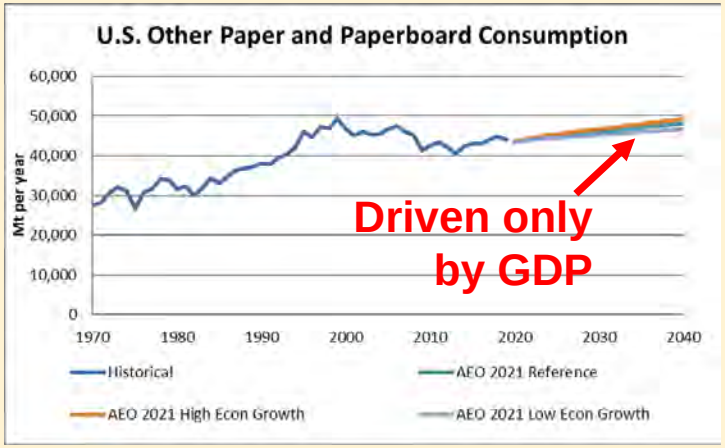
Pulp Market Demand Projections
Multiple economic indicators
Multiple future economic scenarios

Latta, G., Plantinga, A., and M. Sloggy. 2016. The effects of Internet use on global demand for paper products. *Journal of Forestry* 114(4): 433-440.

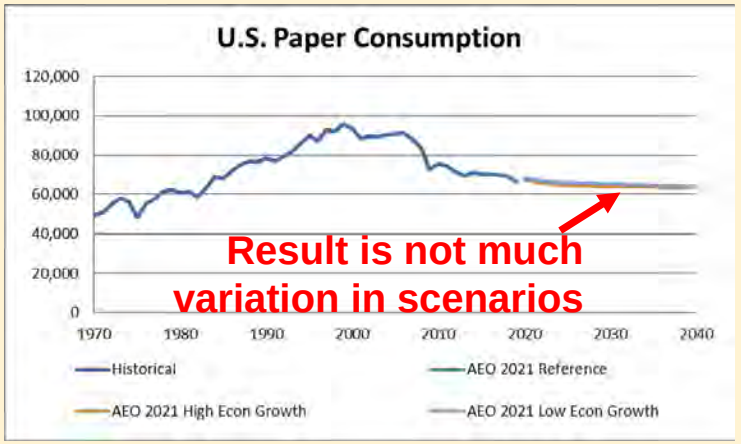
Driven by GDP but shifted due to internet usage





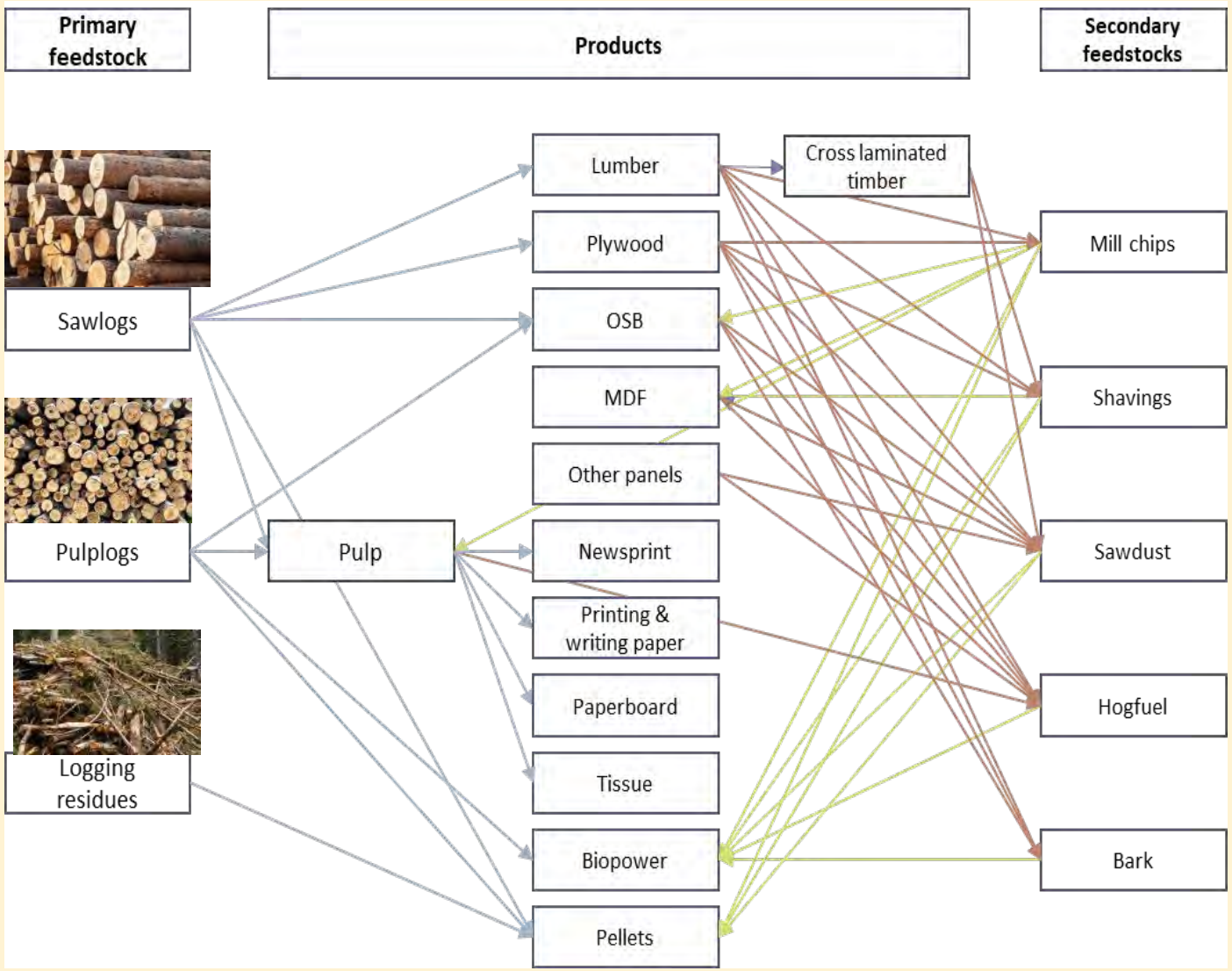


Driven only by GDP



Result is not much variation in scenarios

LURA Cascading wood flow



Primary feedstocks used in wood products and energy

Residues generated in wood products production

Residues used in wood products and energy

Wood Supply Study – Other Sectors

- We are also evaluating the economic impacts of each scenario using IMPLAN, to create an input-output "base" model of western Washington and individual counties or county groups.
- For each scenario, we will estimate the…
  - Direct economic impacts to the forest product industry
  - Indirect & induced economic impacts to other businesses
- Impacts include jobs, employee compensation, economic output, and state and local taxes

Contact Information

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davidford27@gmail.com