



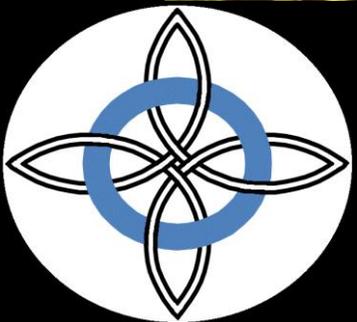
Wisconsin Wood Supply Assessment

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Objectives

- Use data on recent harvests to distinguish available wood supply
- Assess current forest inventory by region, ownership, broad product categories
- Project Wisconsin wood supply in the future using agent-based simulation model
- Sensitivity analysis: vary assumptions and assess results

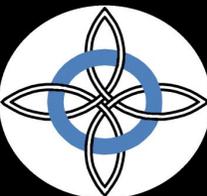


Key Data Sources

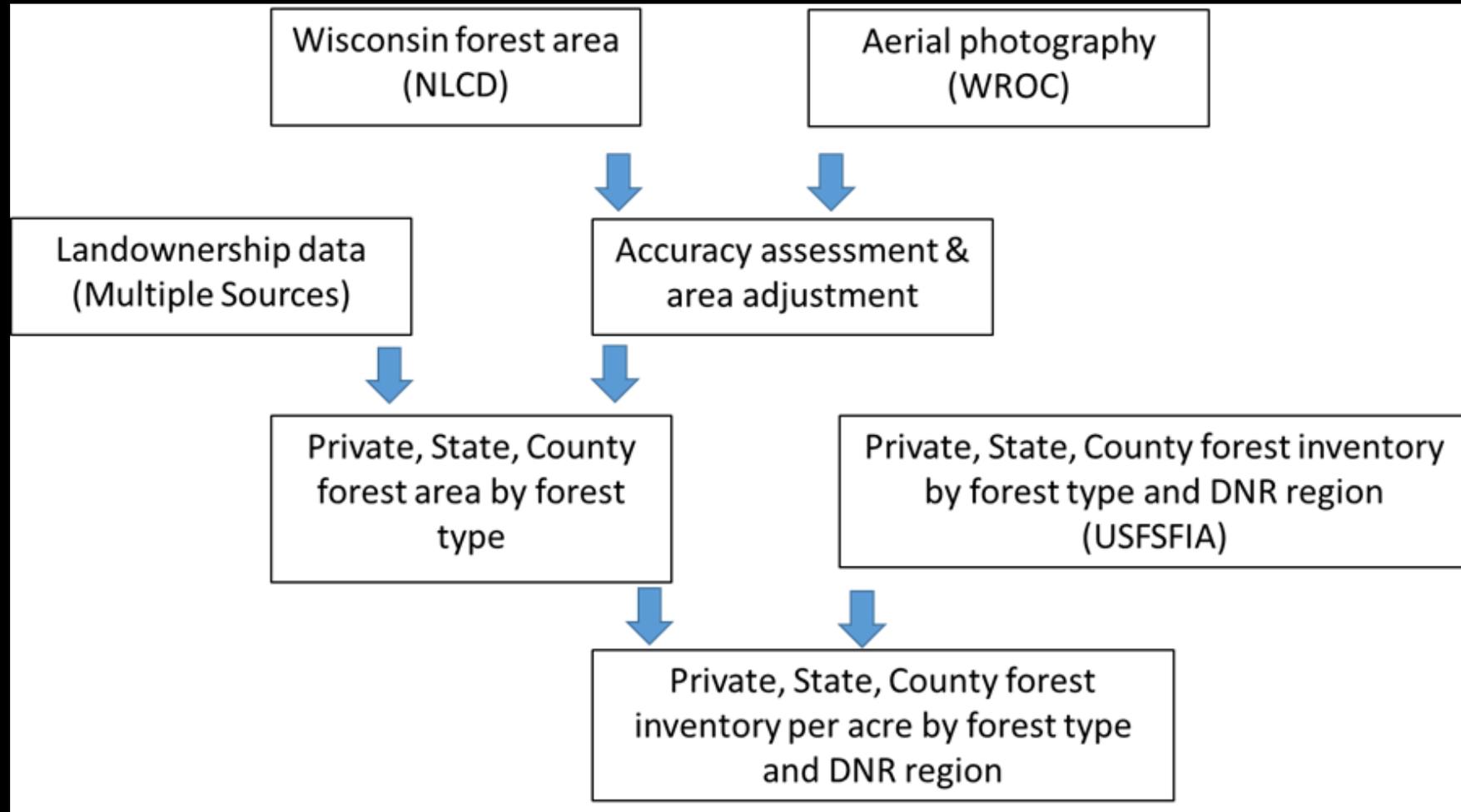
- Forest inventory: 2013 FIA (plots measured 2009 – 2013)
- Forest land distribution: USGS National Land Cover Data
- Ownership: WI DNR, counties, Protected Areas Database
- Wood demand: USFS TPO, UGA Wood Demand Research Program



Mill data source: UGA Wood Demand Research Program



Estimating Forest Availability



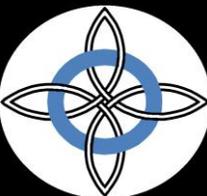
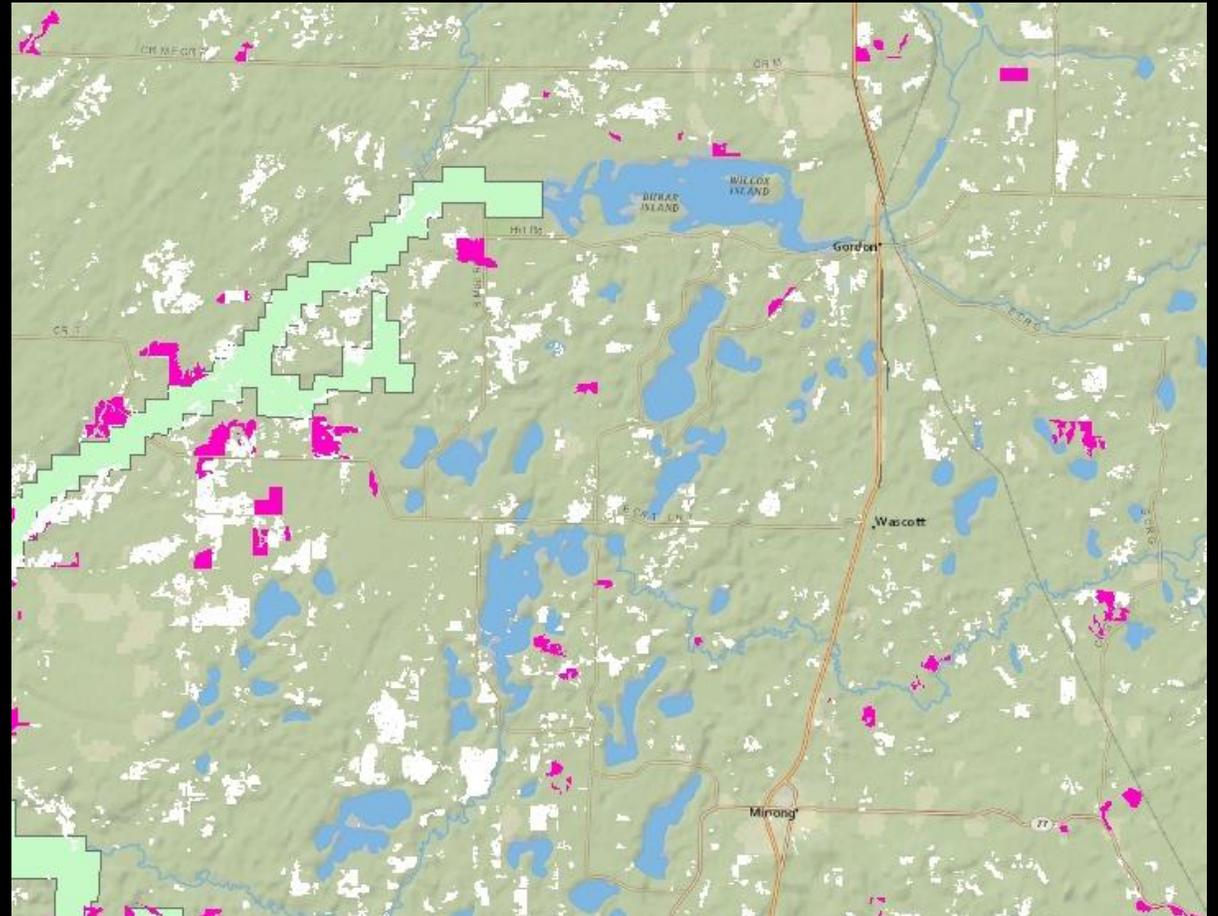
Estimating Forest Availability

- Have FIA average inventory tons/ac by DNR region per NLCD forest acre
- Excludes federal lands
- Excludes easements that indicate harvesting restrictions (PAD)



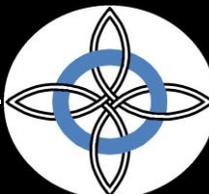
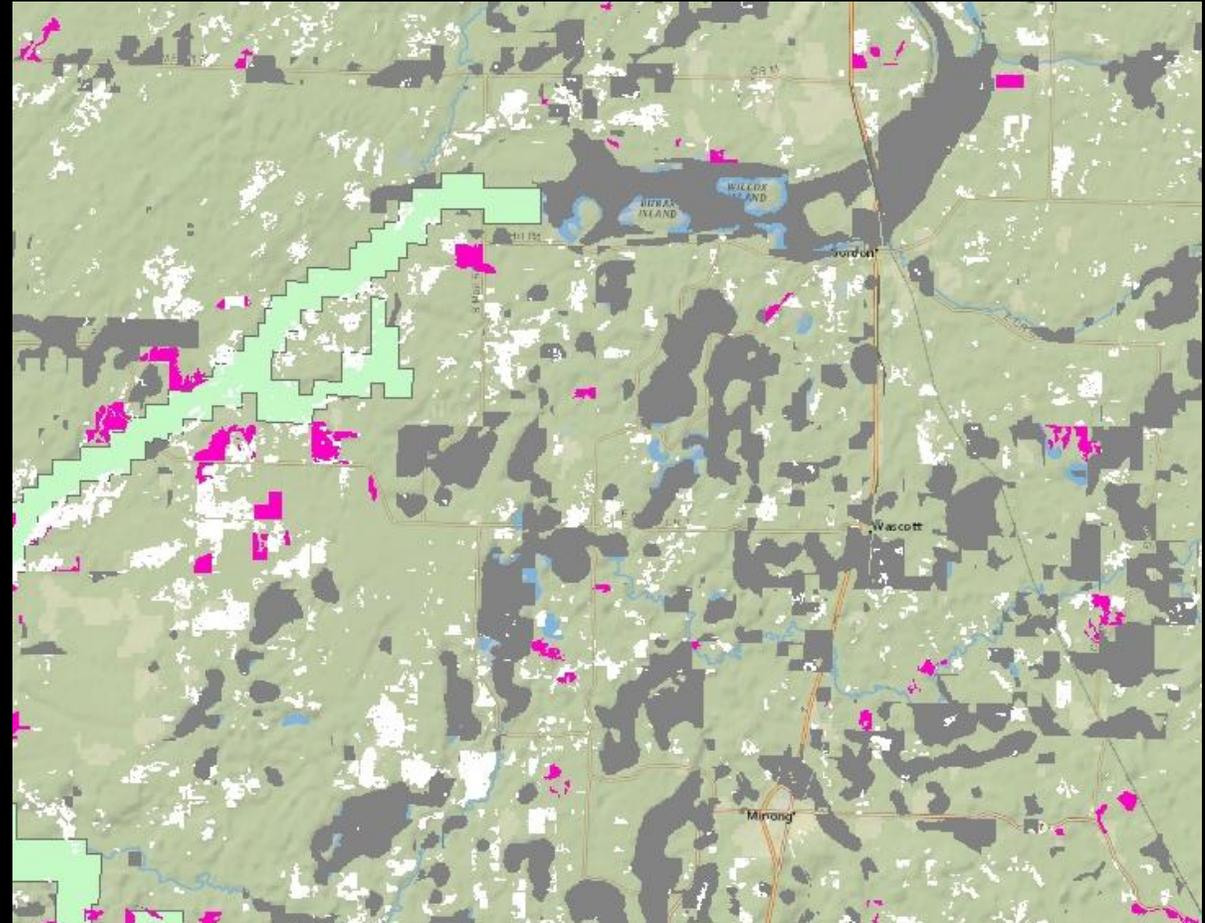
Estimating Forest Availability

- Next, identify harvest locations:
 - County cutting notices
 - WisFIRS (magenta)
 - Global forest change database (white)
- Analyze what characteristics are common to harvested areas



Estimating Forest Availability

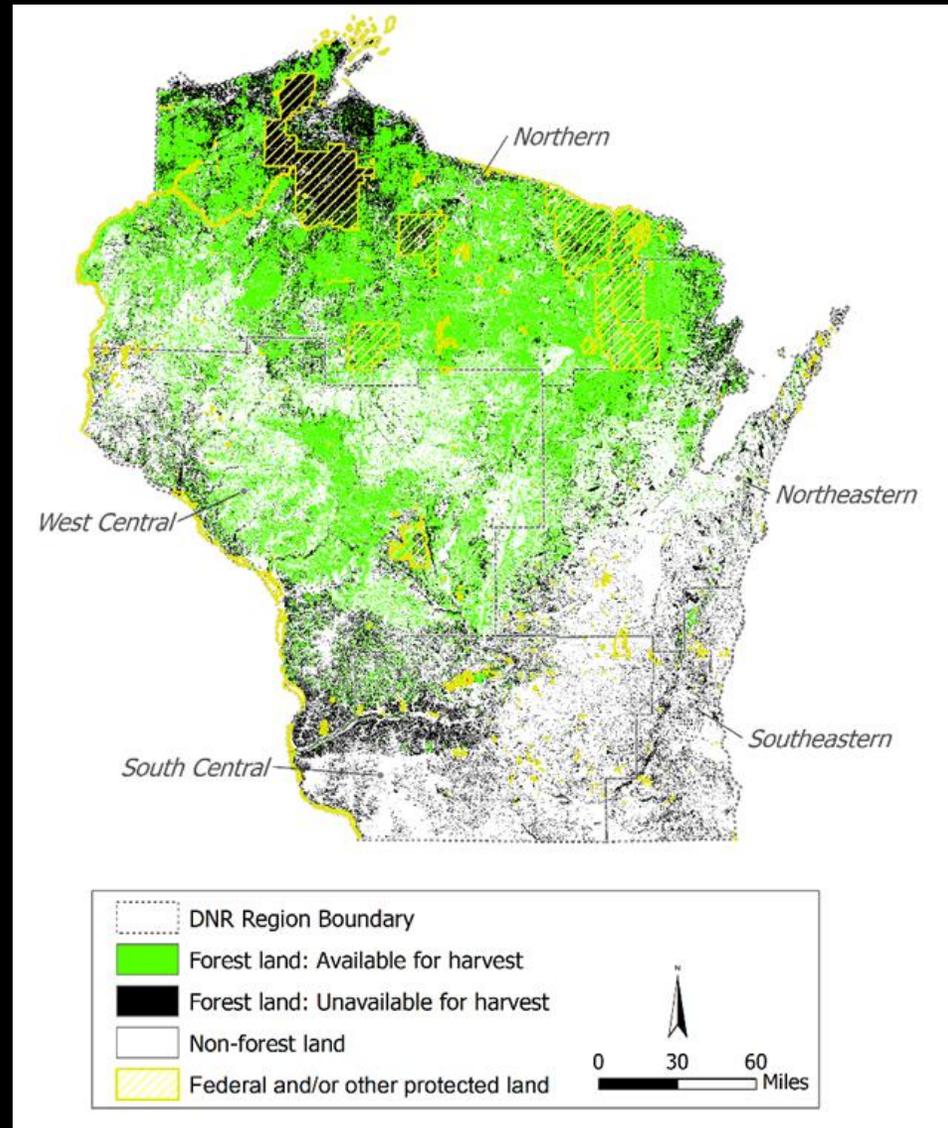
- Variables that predict likelihood of harvest:
 - Percent wetland (from NWI), % area within a 50-ac circle
 - Distance to public road
 - Mill density (within 100-mile radius)
 - Ownership:
 - Private, non-MFL
 - Private, MFL
 - State/County



Estimating Forest Availability

Nonfederal forest acres (thousands) by availability status and region

Region	Total	Avail.	% Avail
Northeastern	2,497	1,537	61.6%
Northern	6,515	4,968	76.3%
West Central	4,234	2,940	69.4%
South Central	1,446	30	2.1%
Southeastern	487	0	0.0%
STATE	15,179	9,476	62.4%



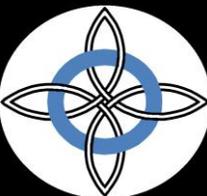
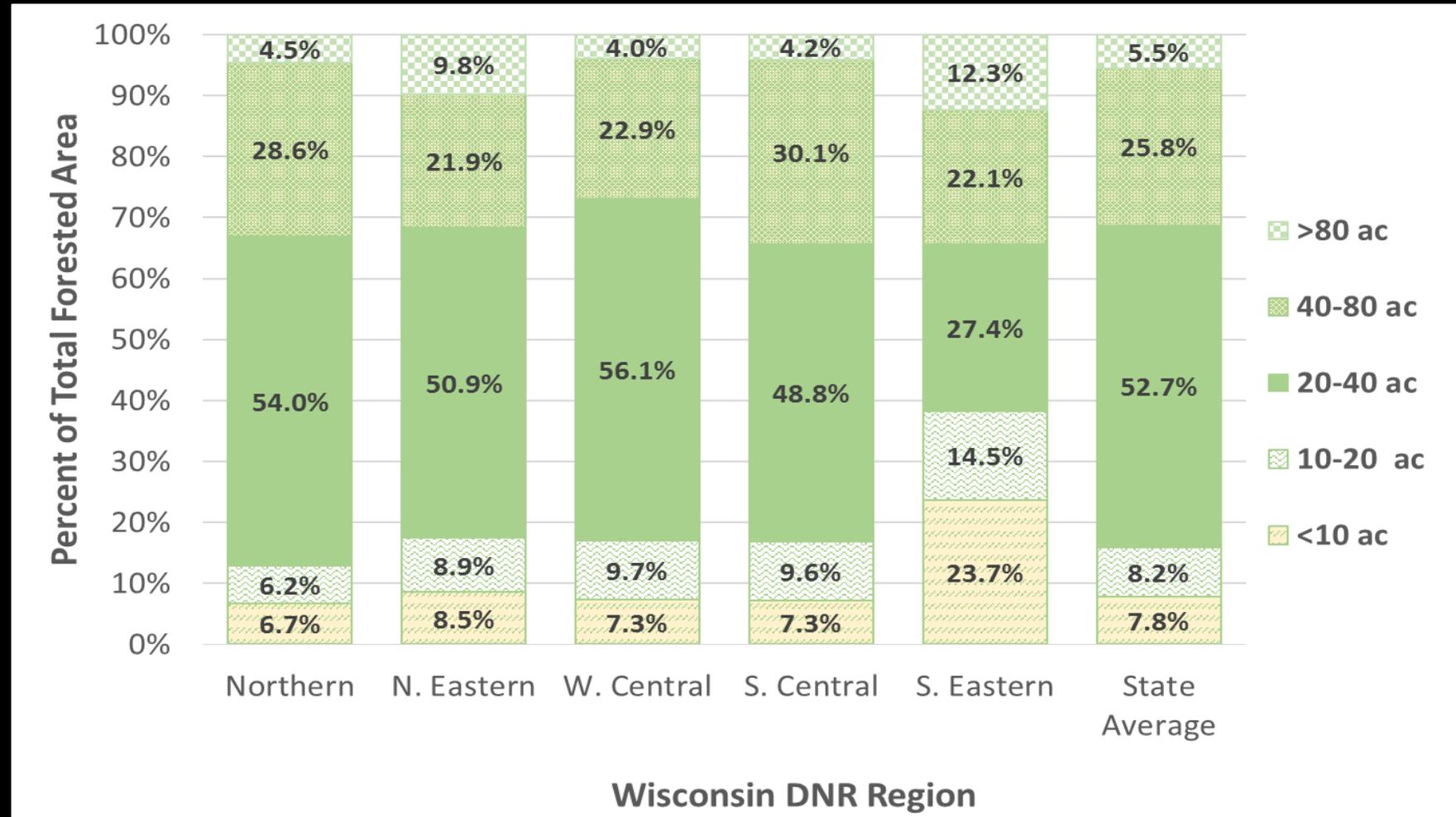
Forest ownership patterns

- Purpose: to determine the parcel size distribution of Wisconsin's private forests
 - By ownership *parcel* size class
 - By forest *tract* within parcel size class
- Sample of 28 counties
- Obtained forest acres per parcel
- Summarized by region



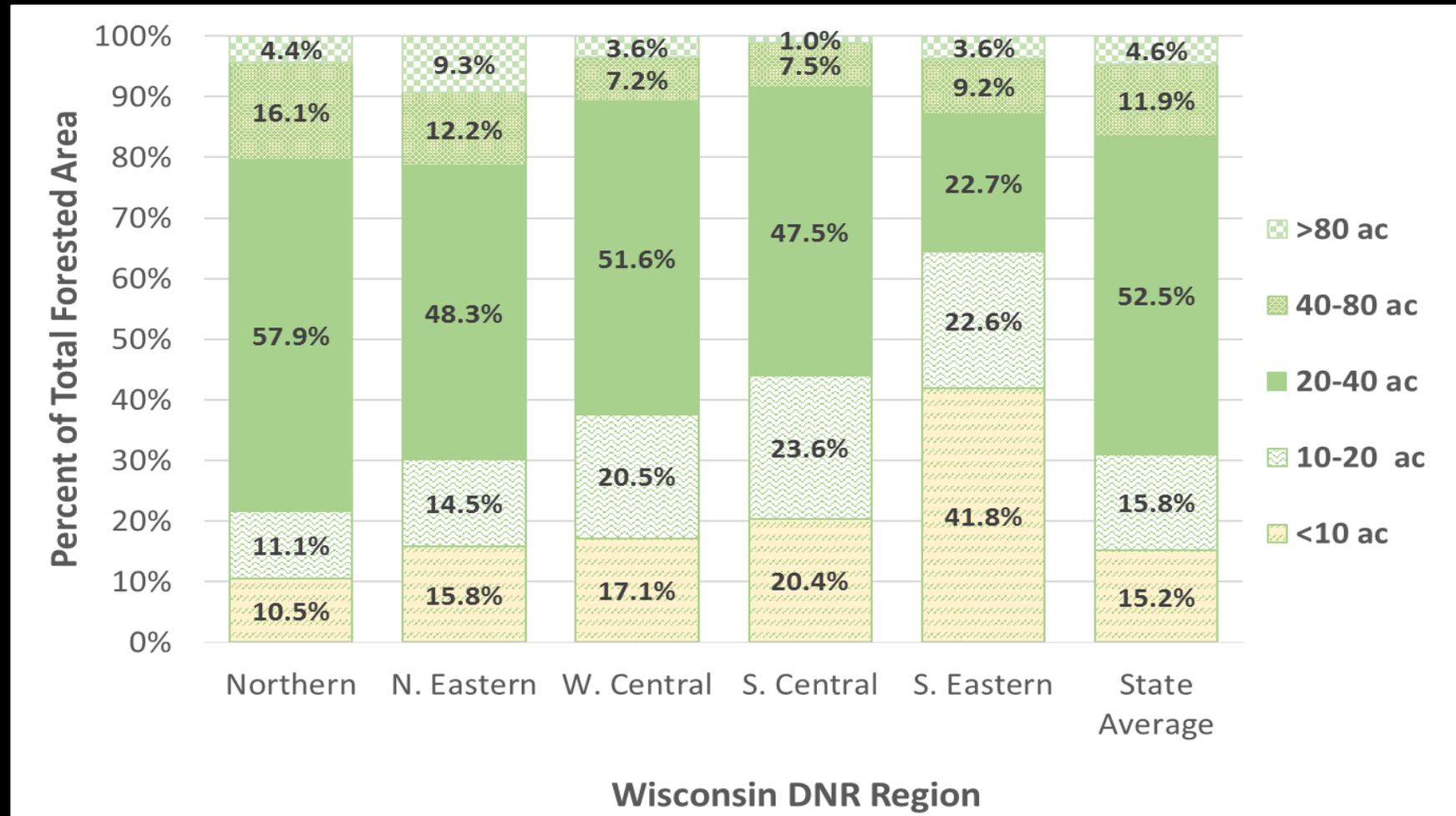
Forest ownership patterns

By
ownership
parcels



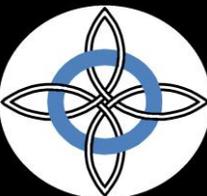
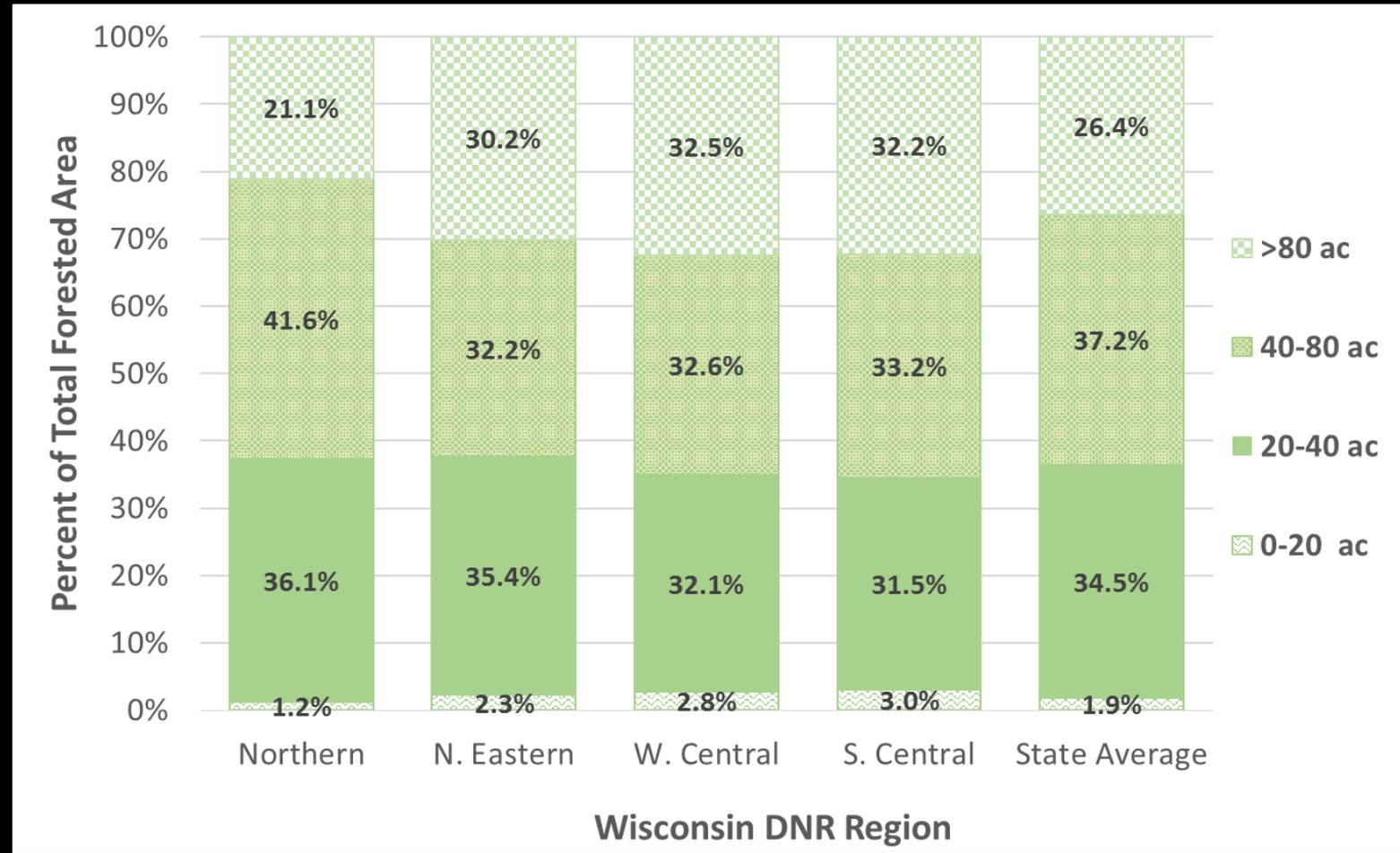
Forest ownership patterns

By forest tracts



Forest ownership patterns

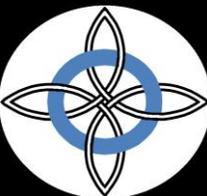
By harvest
area



Assessment Results

Total nonfederal forest inventory (thousand tons)

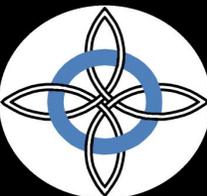
	Aspen		Hardwood		Softwood		
DNR Region	Saw	Pulp	Saw	Pulp	Saw	Pulp	Total
Northeastern	3,562	5,629	33,776	38,833	22,944	13,865	118,610
Northern	12,841	23,321	68,485	98,449	37,044	25,730	265,869
West Central	4,662	7,656	65,288	73,612	15,979	10,283	177,480
South Central	1,854	1,405	27,133	27,148	1,362	1,281	60,182
Southeastern	228	422	6,637	6,279	891	583	15,039
State Total	23,146	38,433	201,318	244,321	78,219	51,743	637,180



Assessment Results

Available nonfederal forest inventory (thousand tons)

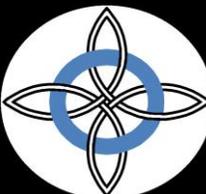
	Aspen		Hardwood		Softwood		
DNR Region	Saw	Pulp	Saw	Pulp	Saw	Pulp	Total
Northeastern	2,308	3,664	22,002	25,210	13,433	8,122	74,739
Northern	10,098	18,375	54,089	77,566	27,428	18,973	206,529
West Central	3,219	5,293	45,090	50,881	11,271	7,274	123,028
South Central	42	31	620	618	23	22	1,355
Southeastern	0	0	2	2	0	0	4
<i>State Total</i>	15,666	27,363	121,802	154,277	52,156	34,390	405,655



Assessment Results

Annual growth on available nonfederal forest (thousand tons)

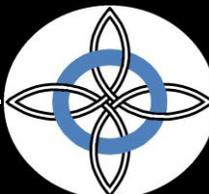
	Aspen		Hardwood		Softwood		
DNR Region	Saw	Pulp	Saw	Pulp	Saw	Pulp	Total
Northeastern	87	115	722	686	469	253	2,333
Northern	306	698	1,770	1,330	832	646	5,582
West Central	139	178	1,421	1,257	505	391	3,890
South Central	1	0	17	18	1	2	39
Southeastern	0	0	0	0	0	0	0
State Total	532	992	3,930	3,291	1,807	1,292	11,844



Assessment Results

Annual harvest removals on available nonfederal forest (thousand tons)

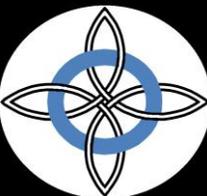
	Aspen		Hardwood		Softwood		
DNR Region	Saw	Pulp	Saw	Pulp	Saw	Pulp	Total
Northeastern	59	197	342	431	159	239	1,426
Northern	112	1,049	649	2,299	368	672	5,149
West Central	64	260	368	571	110	352	1,724
South Central	24	13	151	30	1	52	251
Southeastern	2	2	11	5	0	21	41
State Total	261	1,522	1,510	3,335	638	1,336	8,601



Assessment Results

Surplus growth on nonfederal forest (thousand tons)

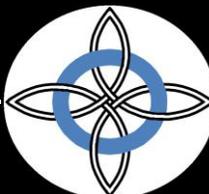
	Aspen		Hardwood		Softwood		
DNR Region	Saw	Pulp	Saw	Pulp	Saw	Pulp	Total
Northeastern	27	-81	381	255	310	15	906
Northern	194	-351	1,121	-969	464	-26	433
West Central	75	-83	1,053	687	395	39	2,166
South Central	-23	-13	-124	-12	1	-50	-222
Southeastern	-2	-2	-11	-5	0	-21	-40
<i>State Total</i>	<i>271</i>	<i>-530</i>	<i>2,240</i>	<i>-44</i>	<i>1,169</i>	<i>-44</i>	<i>3,243</i>



Assessment Results

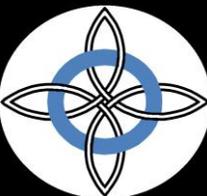
Growth:Removals ratio on nonfederal forest

	Aspen		Hardwood		Softwood		
DNR Region	Saw	Pulp	Saw	Pulp	Saw	Pulp	Total
Northeastern	1.5	0.6	2.1	1.6	2.9	1.1	1.6
Northern	2.7	0.7	2.7	0.6	2.3	1.0	1.1
West Central	2.2	0.7	3.9	2.2	4.6	1.1	2.3
South Central	0.0	0.0	0.1	0.6	1.8	0.0	0.2
Southeastern	0.0	0.0	0.0	0.0	0.0	0.0	0.0
<i>State Total</i>	<i>2.0</i>	<i>0.7</i>	<i>2.6</i>	<i>1.0</i>	<i>2.8</i>	<i>1.0</i>	<i>1.4</i>



Assessment Results

- Growth:removals discrepancies may be due to data sources:
 - Growth is based on plot measurements; pulpwood and sawtimber defined by tree diameter and quality
 - Removals are based on mill receipts
- Sometimes, trees inventoried as sawtimber go across scales at pulp/OSB mills, for reasons related to:
 - Distance from mill & transportation cost,
 - Tree quality,
 - Current demand and inventory levels.
- In such cases, growth on sawtimber may offset pulpwood removals



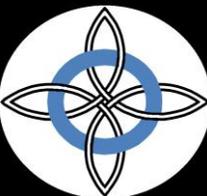
Assessment Results

- Note that for Wisconsin 2013 data, the pulpwood deficit represents:
 - About 35% of aspen pulpwood harvest and about 200% of aspen sawtimber surplus
 - About 1.3% of hardwood pulpwood harvest and about 1.8% of hardwood sawtimber surplus
 - About 3.3% of softwood pulpwood harvest and about 3.7% of softwood sawtimber surplus
- “If 1 out of 30 softwood pulpwood deliveries came from sawtimber, then softwood pulpwood G:R would be 1.0 and softwood sawtimber surplus would go down by 3.7%”



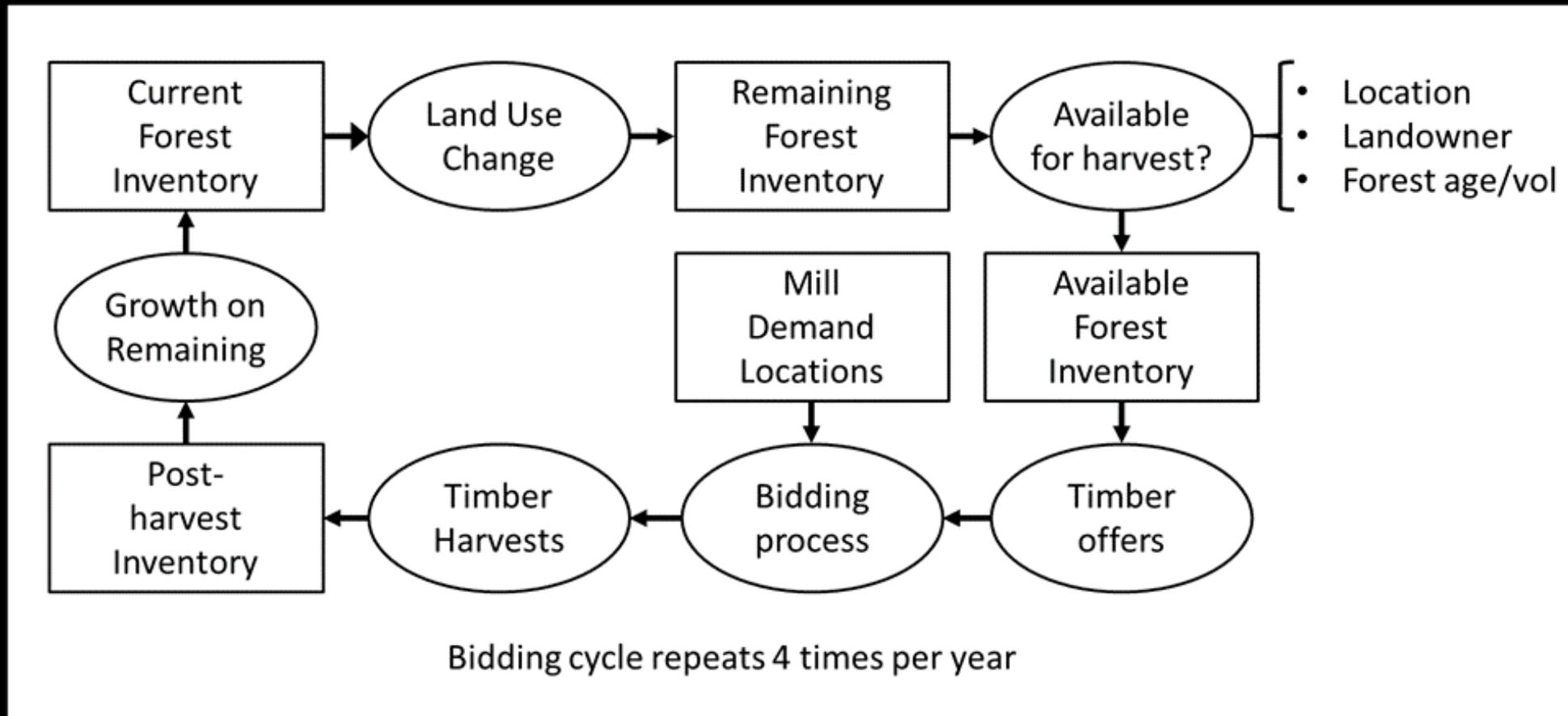
Wood Supply Projection

- Uses Spatial Wood Supply Simulator (SWSS), an agent-based simulation model
- Simulates behavior of “agents” in the wood supply chain (landowners, purchasers of wood)
- Forest tracts are simulated by “pseudoplots”- FIA plots split according to tract size distribution
- Mill demands estimated from mill locations, mill types, and recent TPO reported production levels; demand apportioned to WI forest according to service area within Wisconsin



Wood Supply Projection

Spatial Wood Supply Simulator: conceptual flow diagram



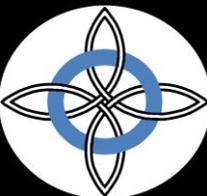
Wood Supply Projection: Baseline Assumptions

- No land use change: forest remains forest
- Location availability based on assessment availability map
- All landowners assumed to participate in timber markets
- No tracts less than 10 acres are harvested
- Stand availability: min age 20, min 50-60 tons/ac wood
- Initial stumpage/delivered prices from Timber Mart North
- Logging costs \$16.39/ton to \$17.79/ton
- Transportation cost \$7.60/ton plus \$0.19/ton/mile beyond 40 miles



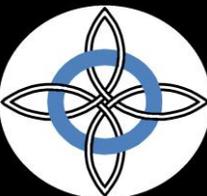
Wood Supply Projection: Bidding process

- Forest tract randomly goes up for sale: given quantities of four products (hardwood/softwood pulpwood/sawtimber)
- Wood purchasers bid on wood:
 - Based on mill demand not yet met and target delivered price/ton
 - Subtract transportation cost and logging cost to determine breakeven stumpage offer
 - Random bid near breakeven price
- Owner determines if sum of highest bids exceeds reserve price (80% of current market price)
 - If so, sells products to highest bidders

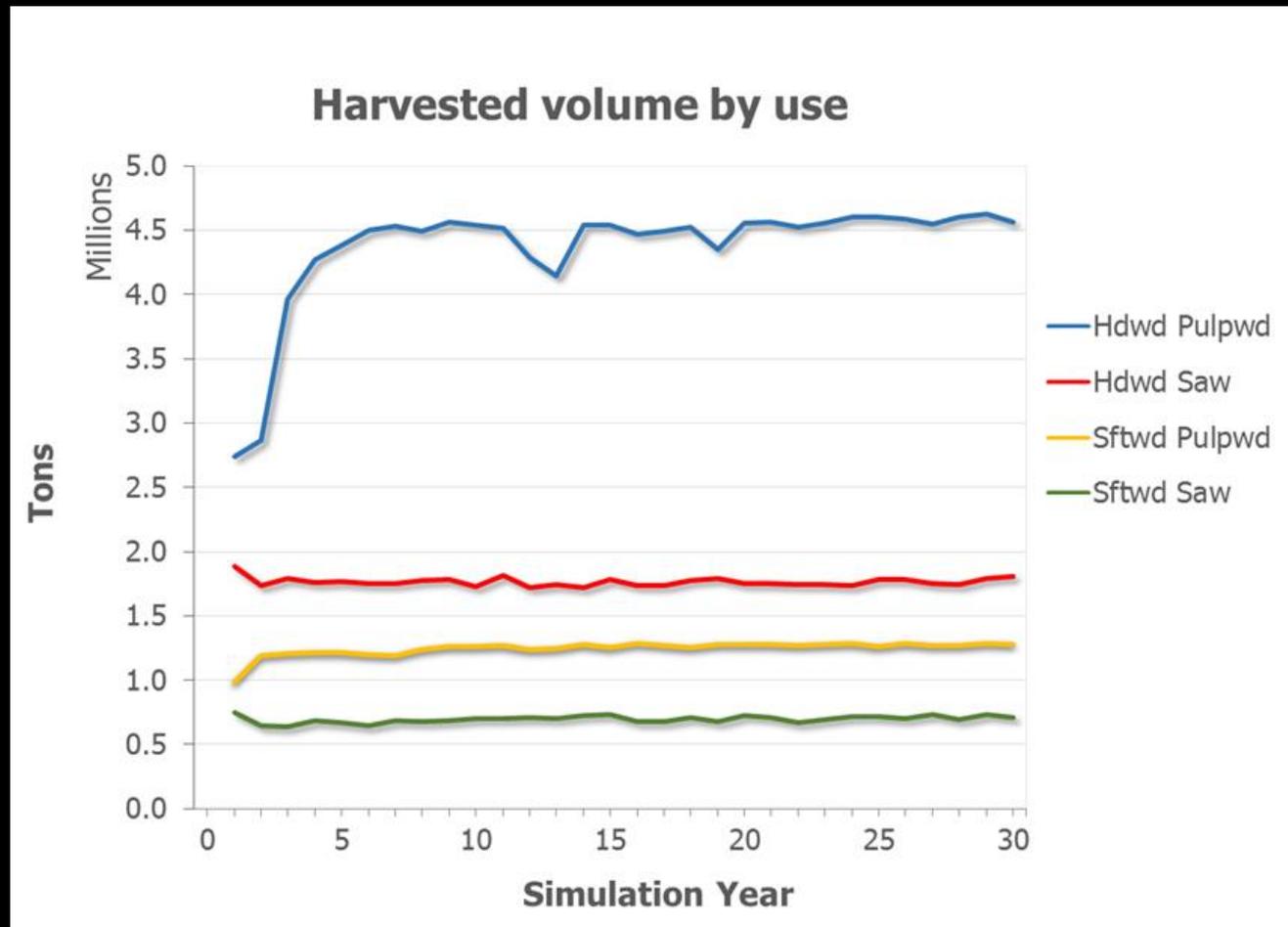


Wood Supply Projection: sawtimber substitution

- Purchasers seeking pulpwood may bid on sawtimber tons, but using their pulpwood prices
- When successful (due to low transport cost, etc.), sawtimber is harvested and delivered to pulpwood user
- We call this “sawtimber substitution”

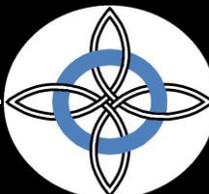


Projection Results

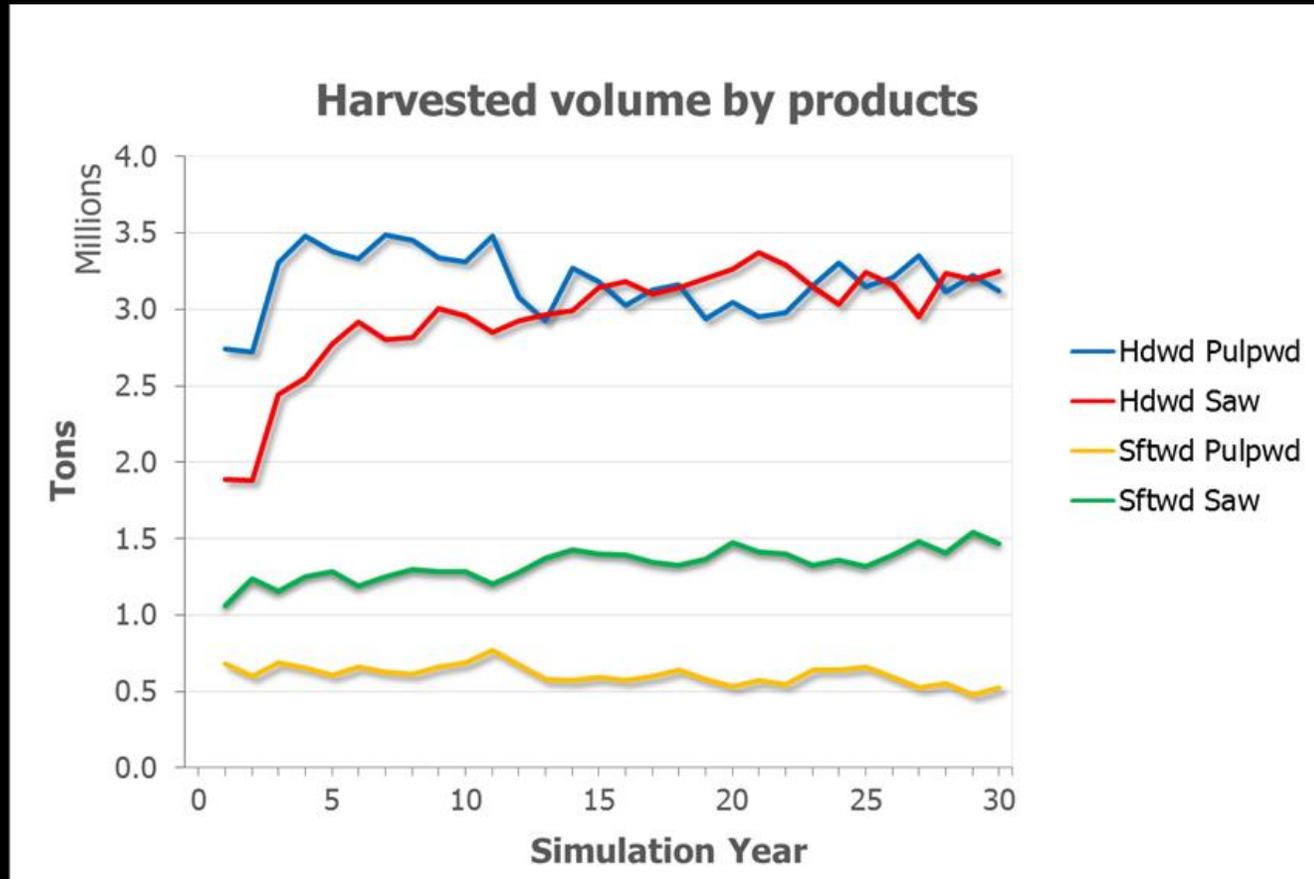


By use: Sawtimber substitution reported in pulpwood lines

Product demands are met throughout simulation

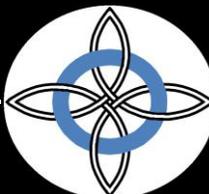


Projection Results

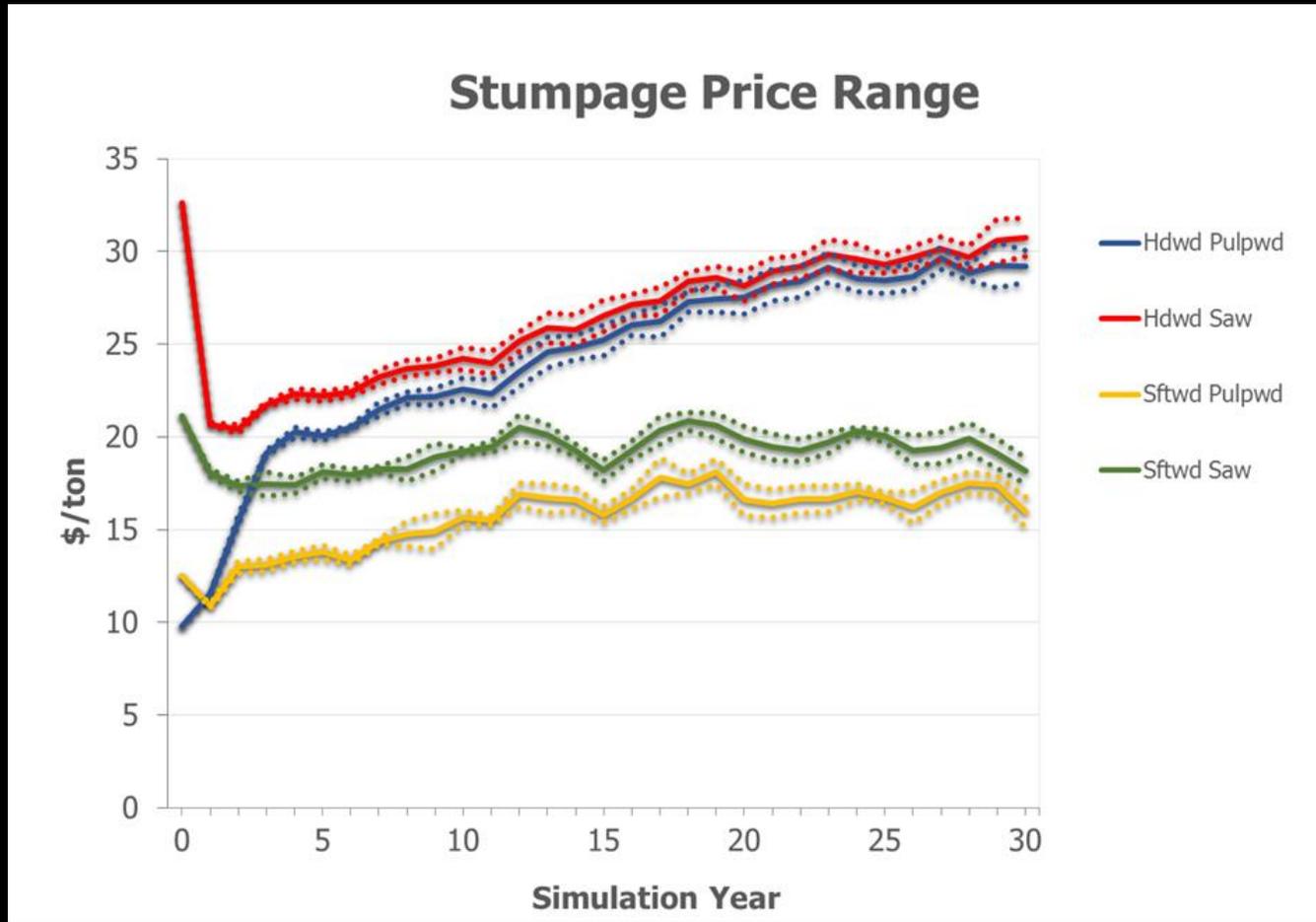


By products: Sawtimber substitution reported in sawtimber lines

Sawtimber harvests increasing to meet pulpwood demand

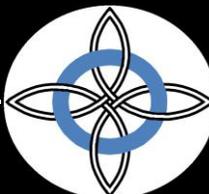


Projection Results

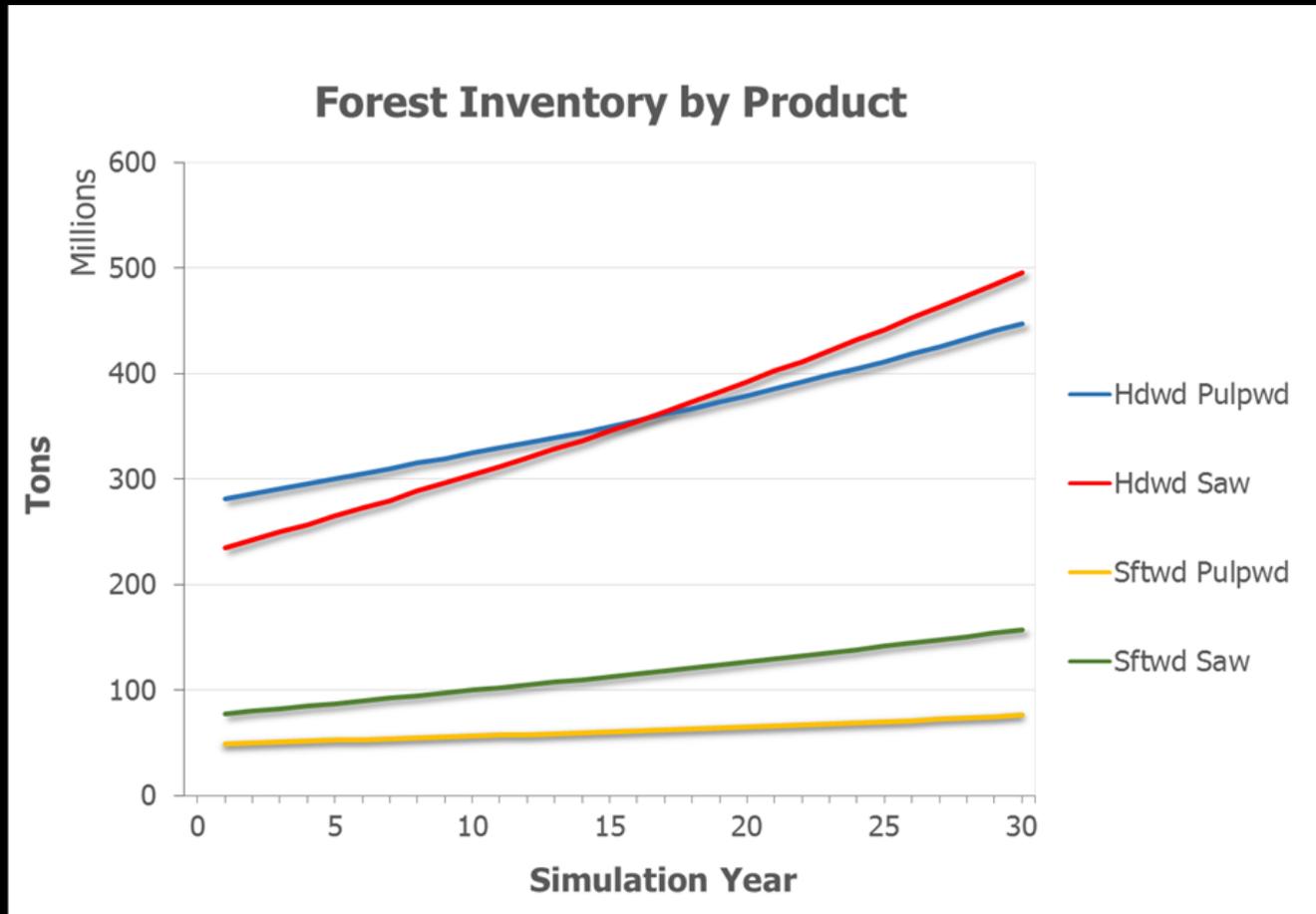


Statewide average annual stumpage prices (with standard deviation)

Hardwood pulpwood prices reaching sawtimber levels, both increasing over 30 years



Projection Results



Annual summary of total forest inventory

Total hardwood inventory continues to increase, softwood also but to smaller degree



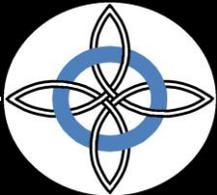
Projection Results



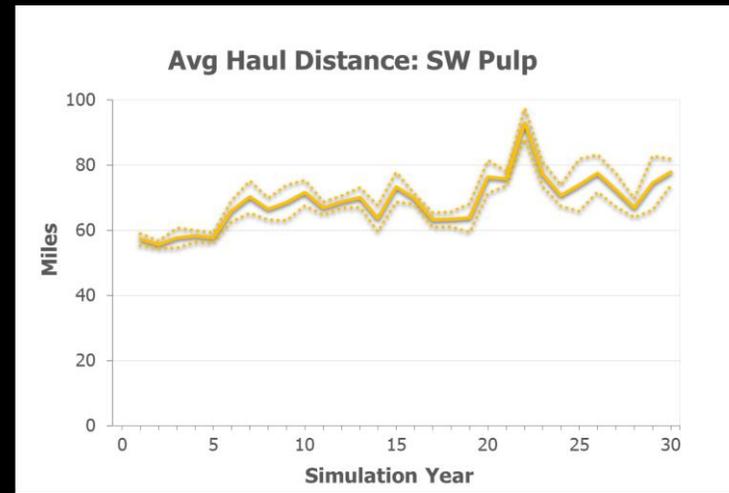
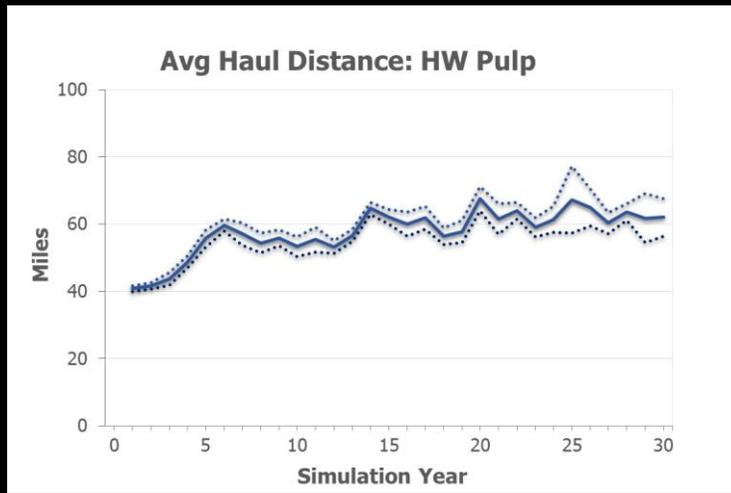
Annual summary of forest inventory by availability status

Inventory continues to increase on unavailable forest

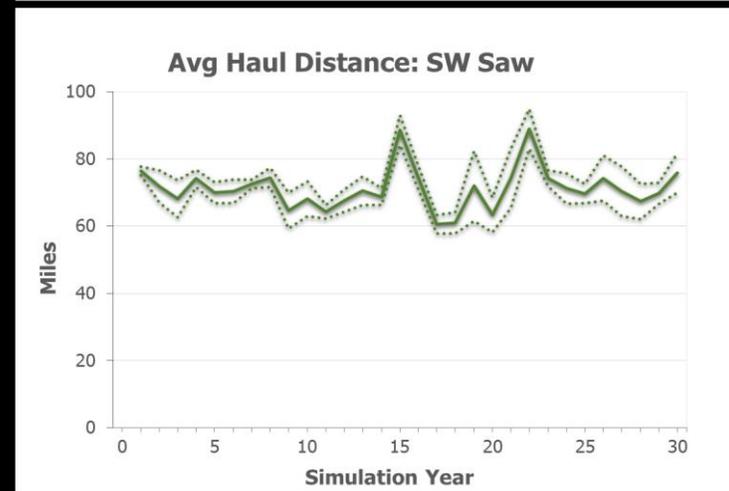
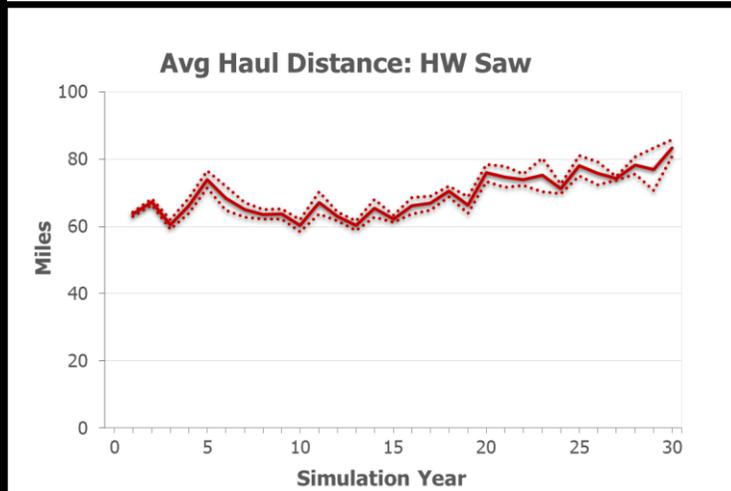
Other product classes show similar patterns



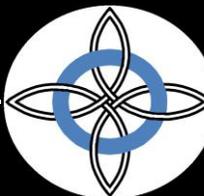
Projection Results



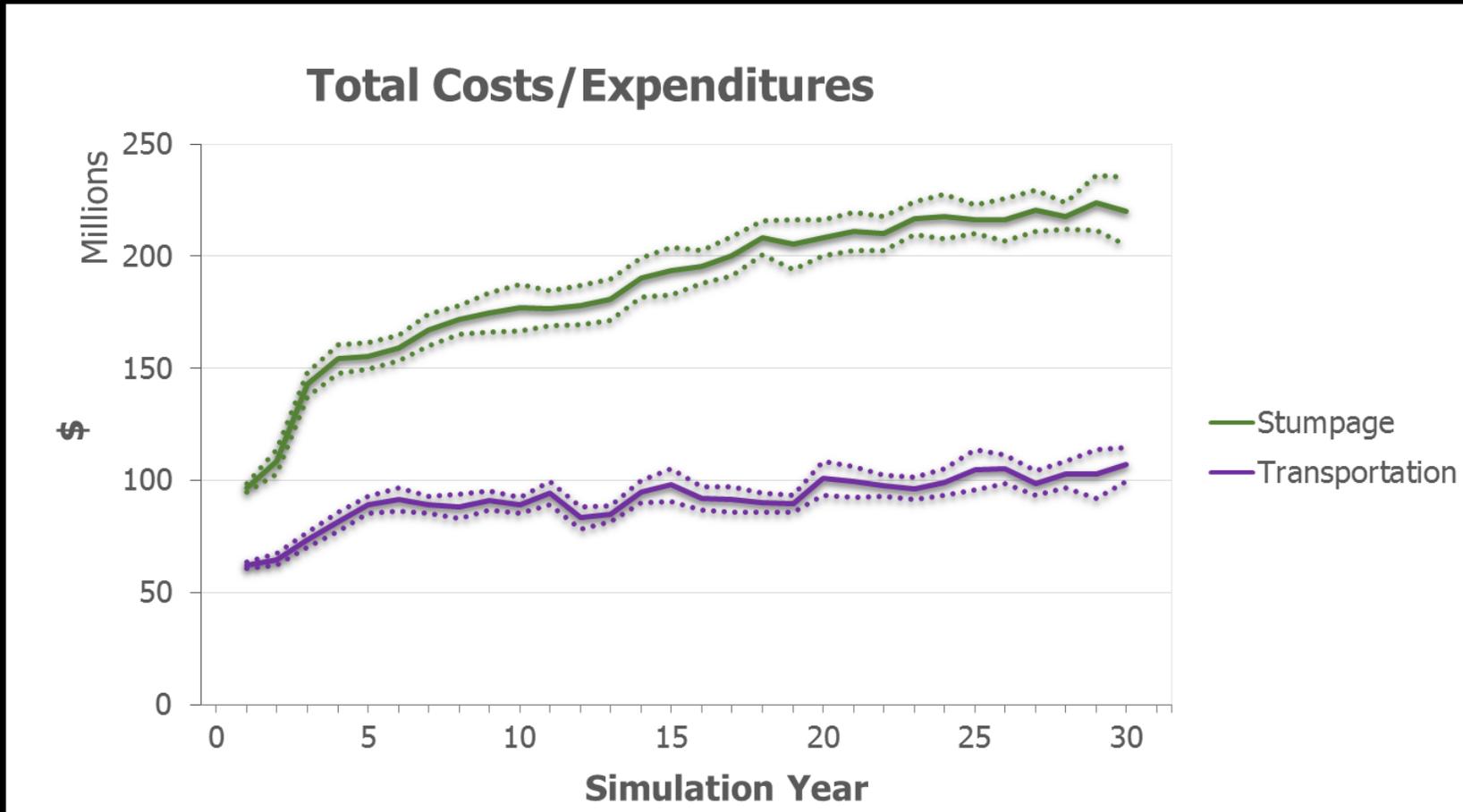
Annual average haul distances by product



Softwood hauls are longer, and sawtimber hauls are longer. All are variable with only minor trends.



Projection Results

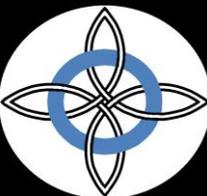
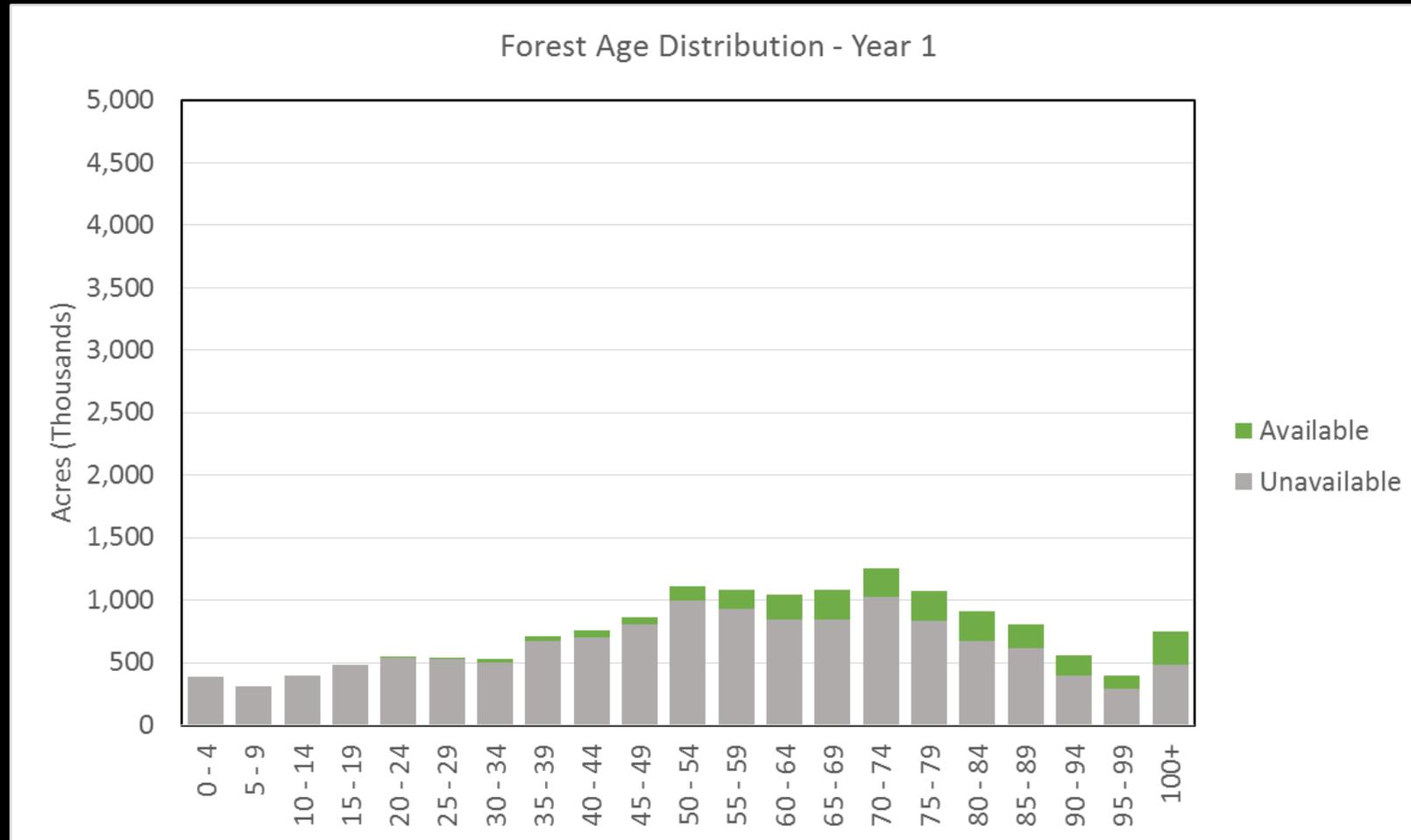


Total cost (& economic contribution) of wood supply chain over time

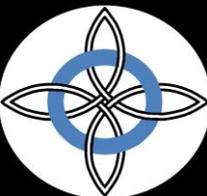
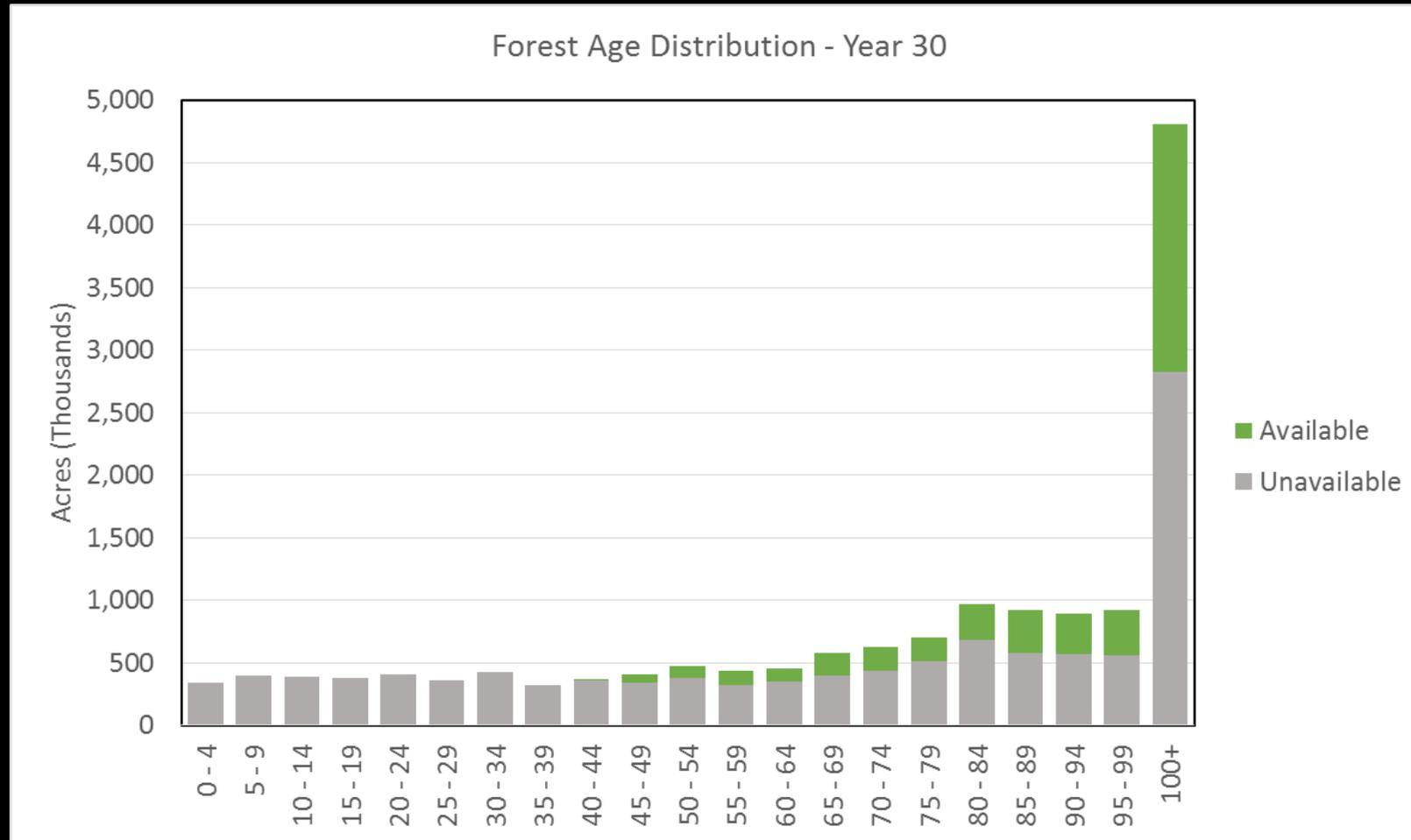
*Stumpage paid to landowners increases substantially;
transportation expense relatively stable.*



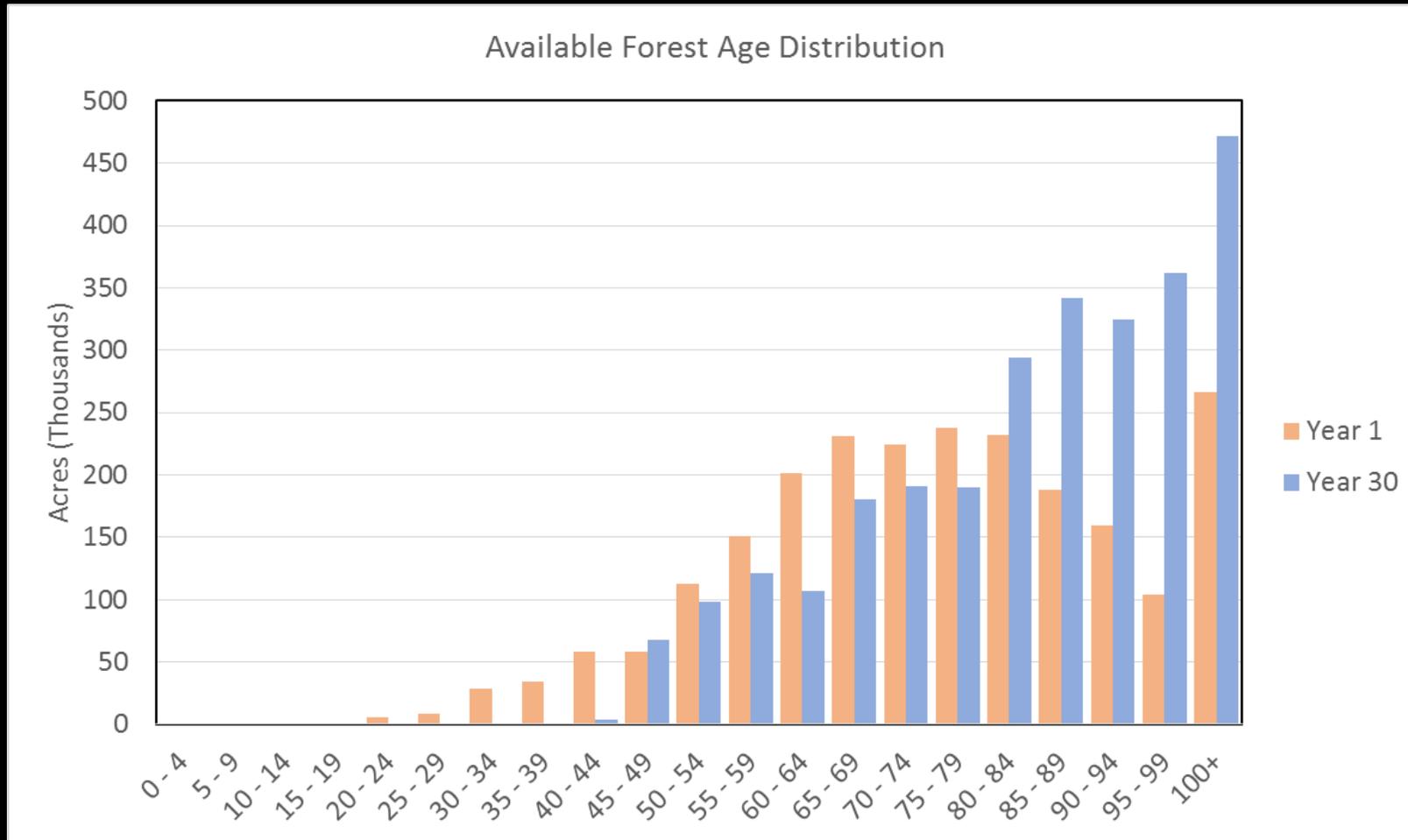
Projection Results



Projection Results

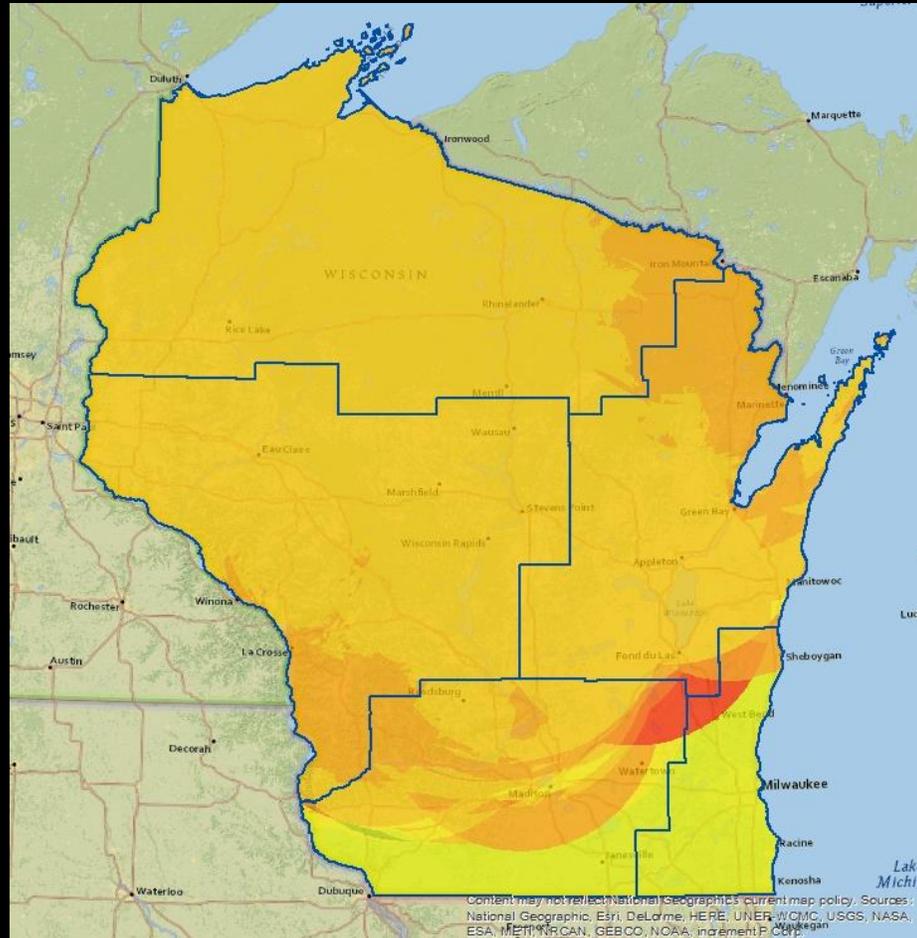


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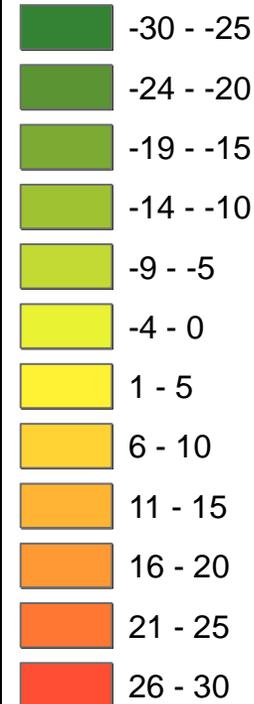
Projection Results

Hardwood Pulpwood Stumpage Price Change



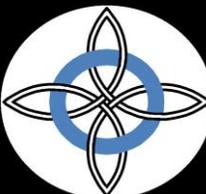
Legend

Price Difference \$/ton



Hardwood pulpwood average stumpage price differences over 20 year period

No marked geographic "hot spots" in price increases



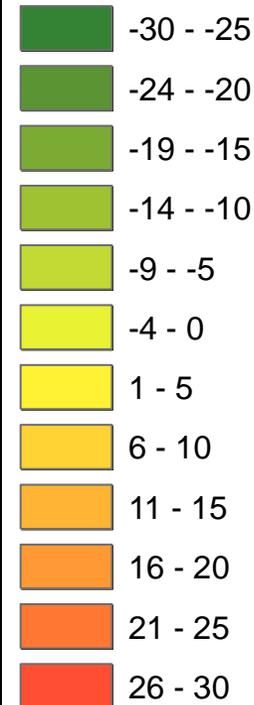
Projection Results

Softwood Pulpwood Stumpage Price Change



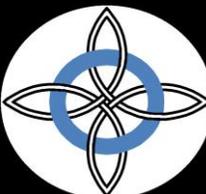
Legend

Price Difference \$/ton



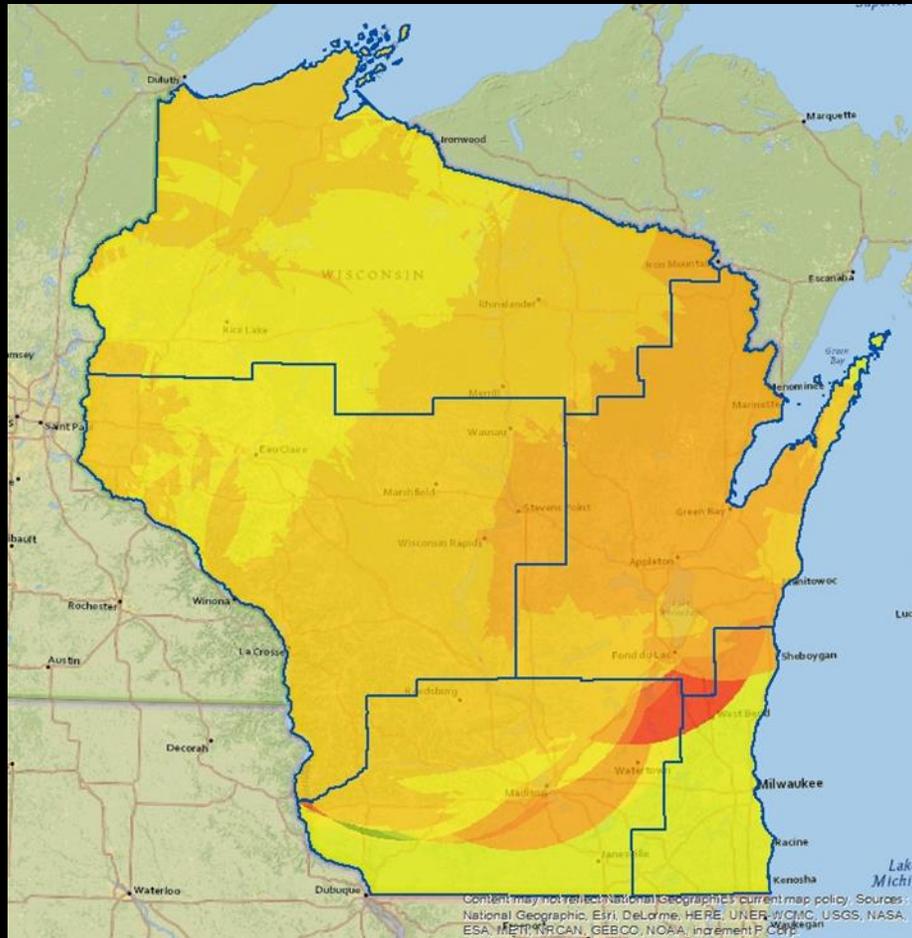
Softwood pulpwood average stumpage price differences over 20 year period

Steeper increases in far northwest portion of state



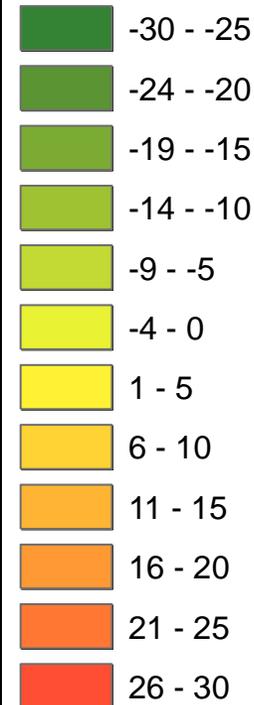
Projection Results

Hardwood Sawtimber Stumpage Price Change



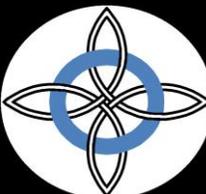
Legend

Price Difference \$/ton



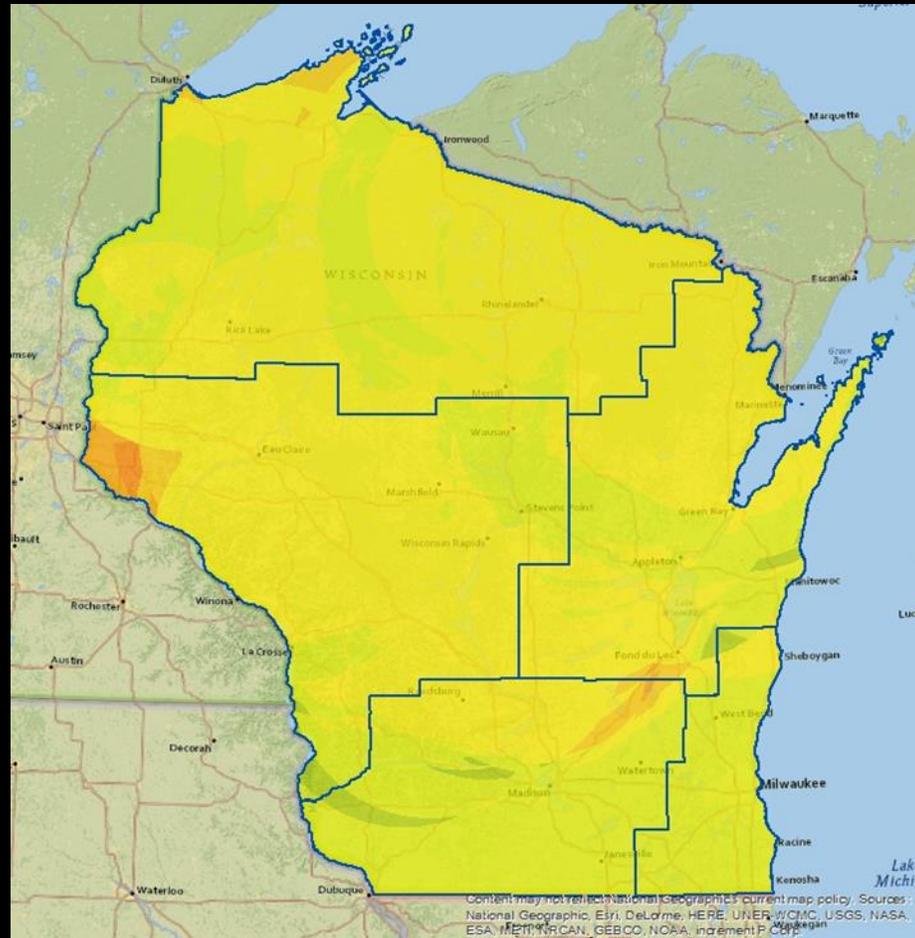
Hardwood sawtimber average stumpage price differences over 20 year period

Steepest increases in Northeastern region



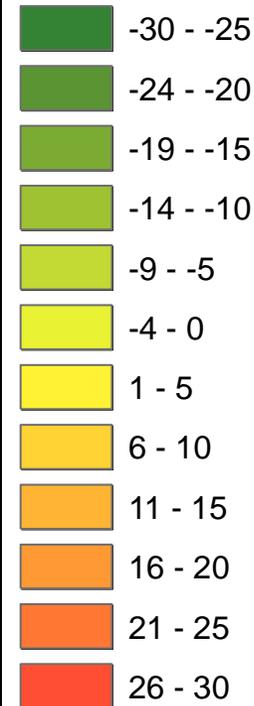
Projection Results

Softwood Sawtimber Stumpage Price Change



Legend

Price Difference \$/ton



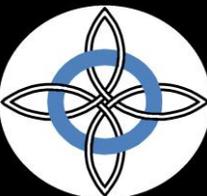
*Softwood sawtimber
average stumpage price
differences over 20 year
period*

*Lowest increases of all
products, uniform across
state*



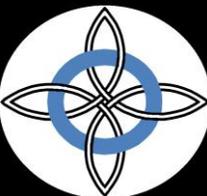
Sensitivity Analysis

- Re-run model with differing assumptions
- Changing two variables:
 - Inclusion of small (< 10 ac.) tracts
 - Incorporate results from landowner survey: willingness to sell timber
- Result: four sets of model outputs:
 - Baseline
 - Small tracts: same as baseline but includes tracts
 - Reduced willingness: same as baseline but reduces landowner willingness
 - Reduced + small tracts



Sensitivity Analysis

- Vokoun's survey included 3 questions reflecting willingness to harvest
 - Timber income ranked moderate to very important
 - Plan to eventually cut trees now on their land
 - Would accept a payment offered to harvest 1 acre of mature hardwoods
- Vokoun summarized percent of landowners responding positively by forested acreage and region
- Select maximum percent positive response among the three questions

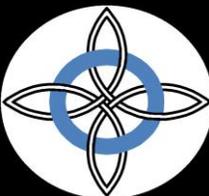


Sensitivity Analysis

Percentage of landowners assumed to be willing to harvest timber
by forested tract size and region

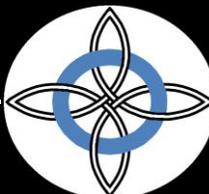
Parcel size (ac)	Northeastern	Northern	West Central	South Central	Southeastern
< 20	24.4	20.8	36.4	28.6	28.6
21 – 40	37.3	47.3	45.0	32.3	32.3
41 – 80	52.3	35.8	52.8	57.1	57.1
> 80	63.6	58.3	66.7	61.7	61.7

Survey sample did not include Southeastern region;
numbers for South Central were used



Sensitivity Analysis Results

	All landowners willing to harvest	Reduced landowners willing to harvest
No small tracts (< 10 ac)	Baseline	Reduced Willingness (worst case)
All small tracts (< 10 ac)	Small tracts (best case)	Reduced + small tracts

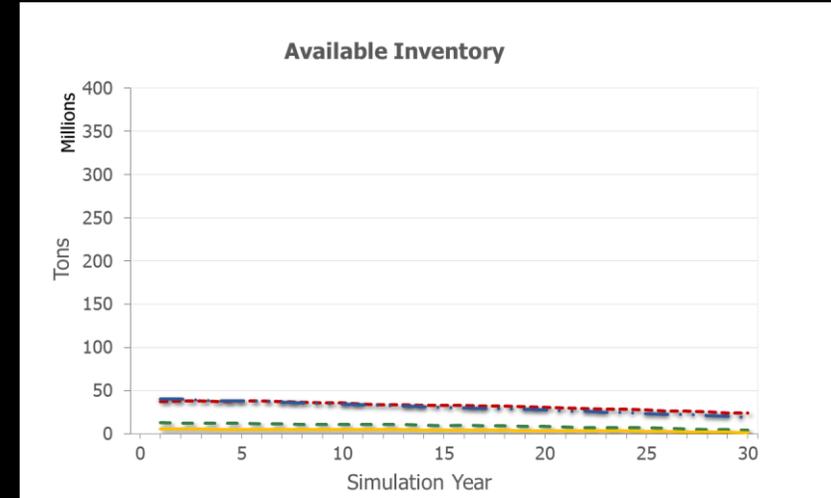
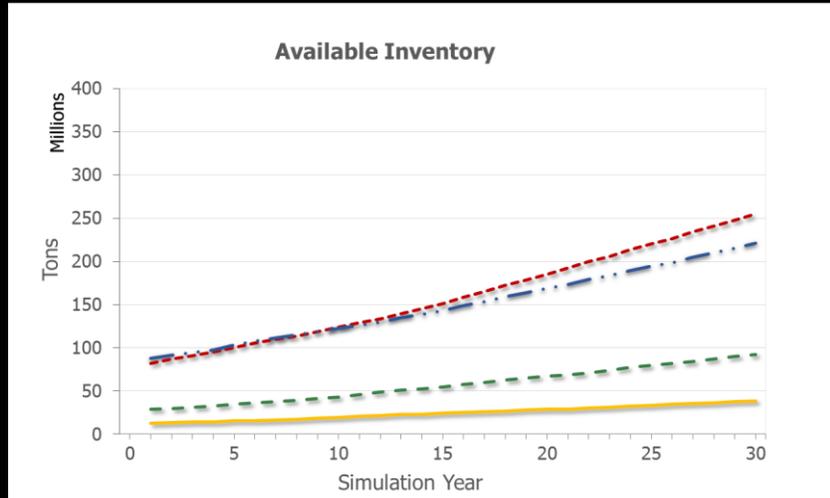


Sensitivity Analysis Results: Available tons

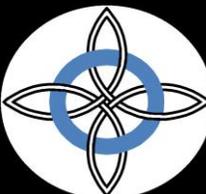
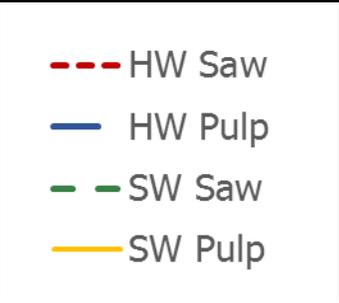
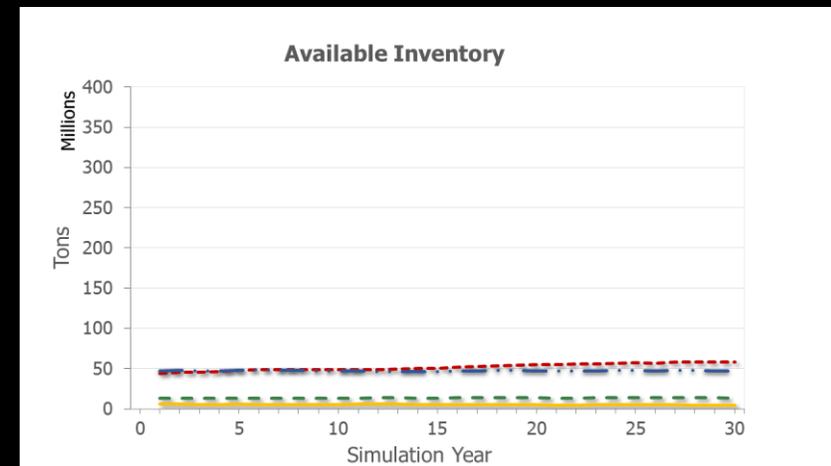
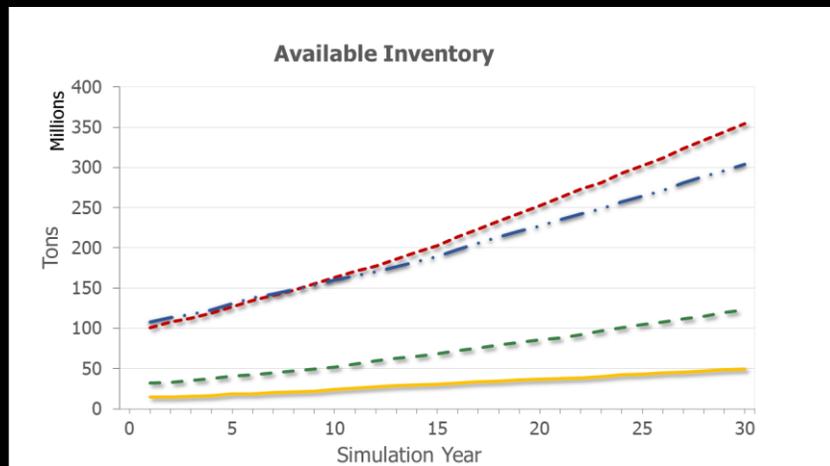
All willing

Reduced willing

No small



All small

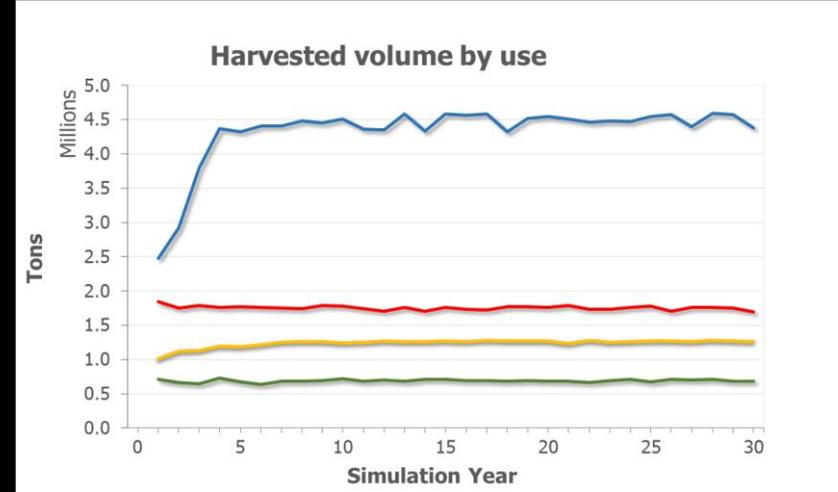
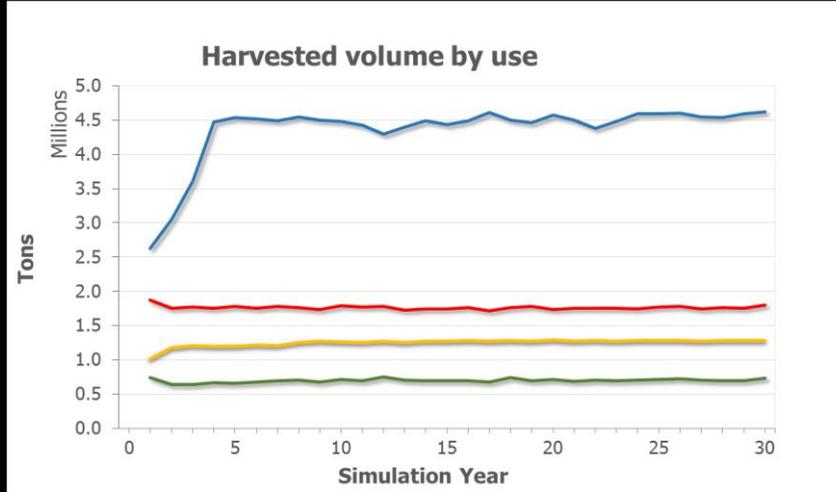


Sensitivity Analysis Results: Harvest by use

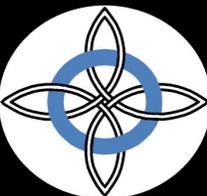
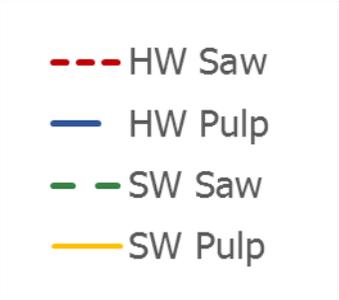
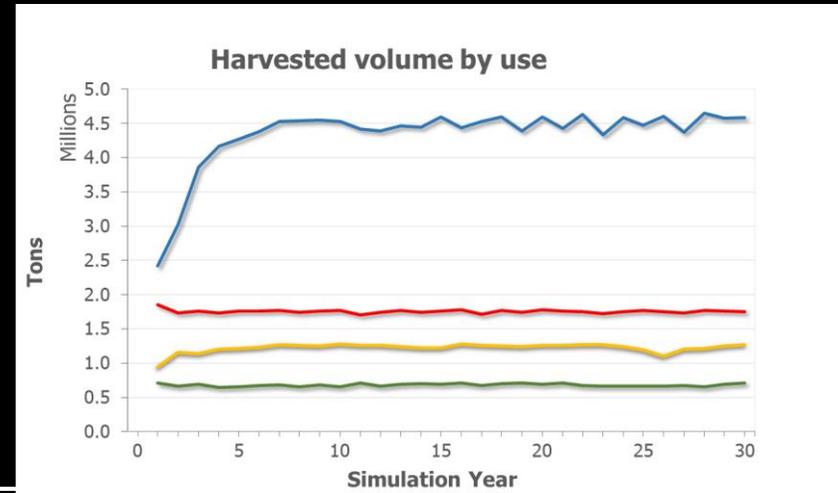
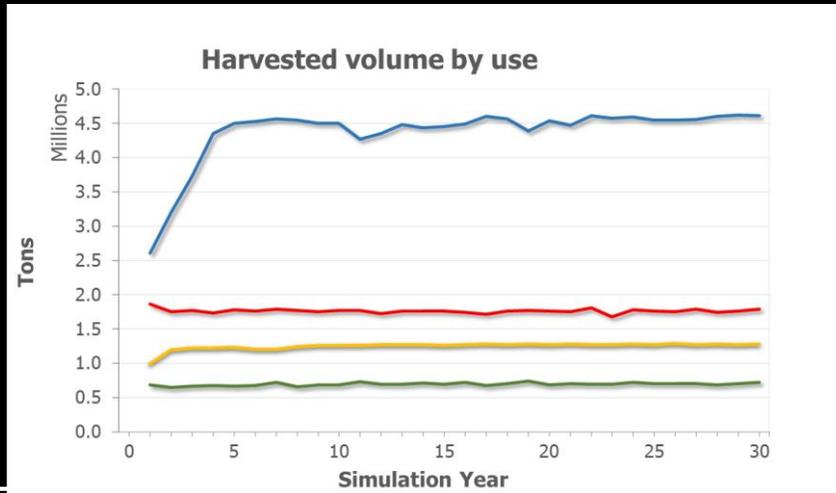
All willing

Reduced willing

No small



All small

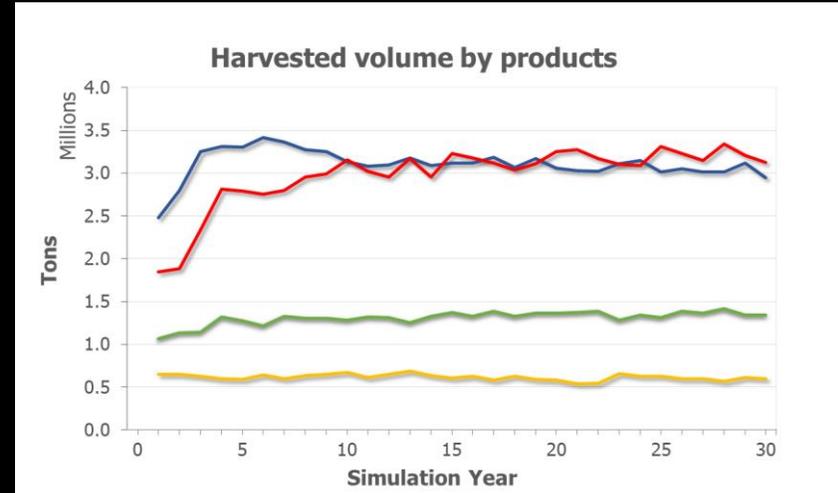
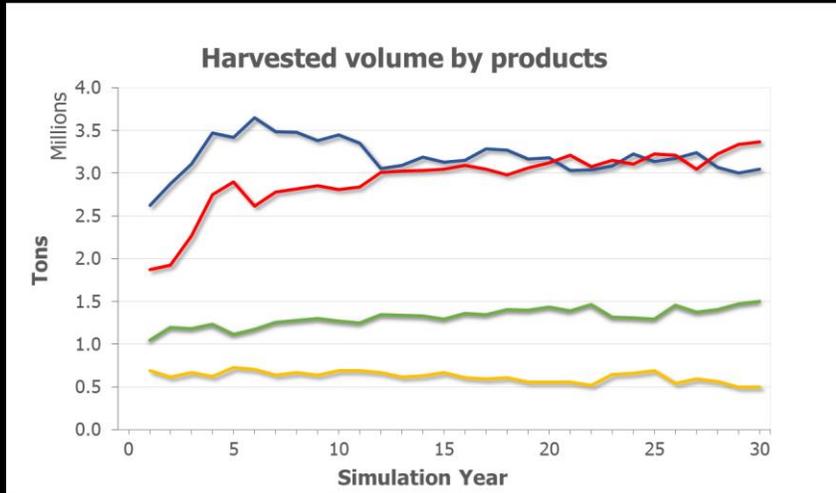


Sensitivity Analysis Results: Harvest by product

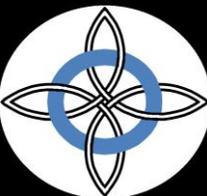
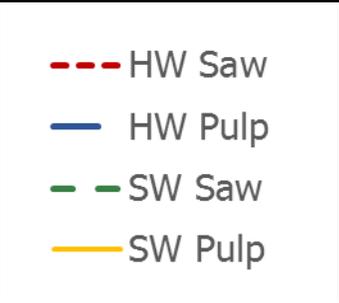
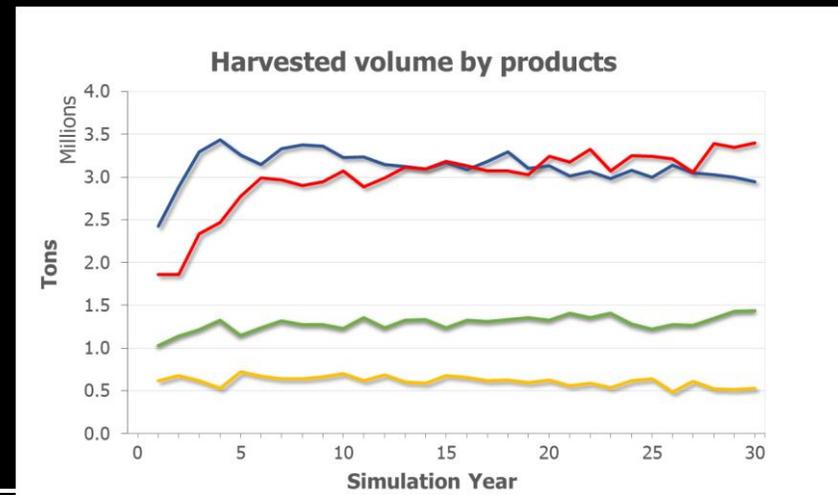
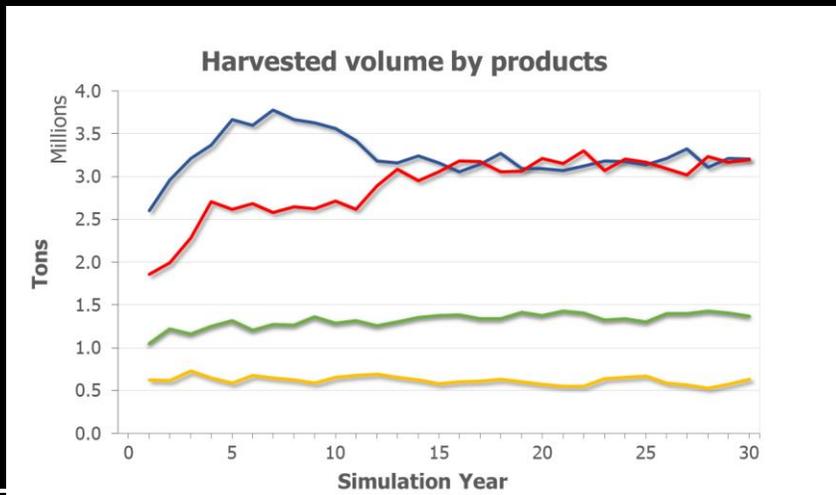
All willing

Reduced willing

No small



All small

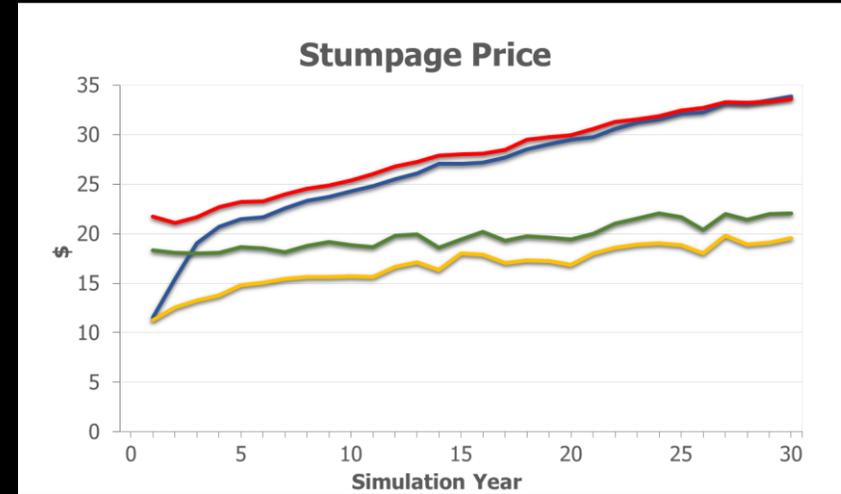
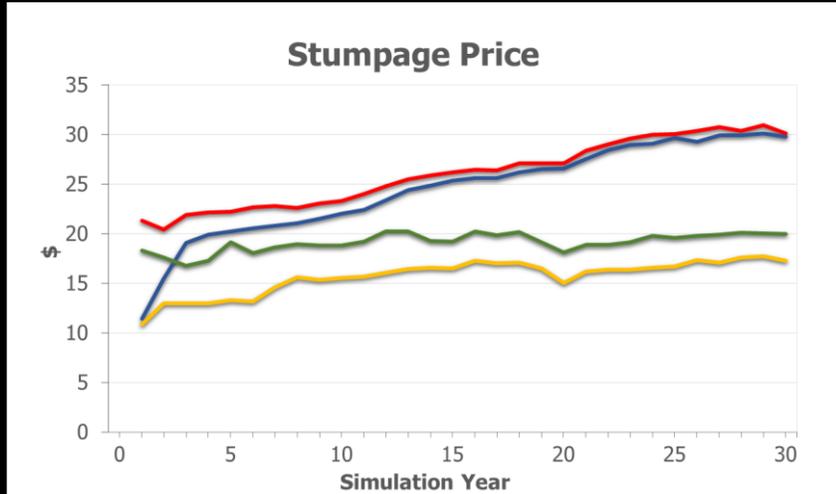


Sensitivity Analysis Results: Stumpage prices

All willing

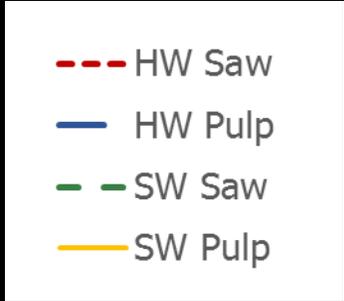
Reduced willing

No small



Reduced willingness increases HW prices by 12% over baseline by yr 30

All small

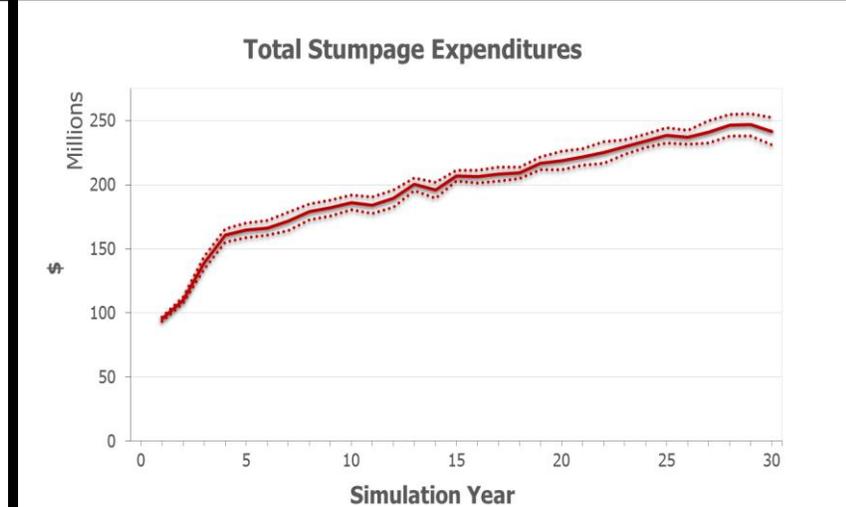
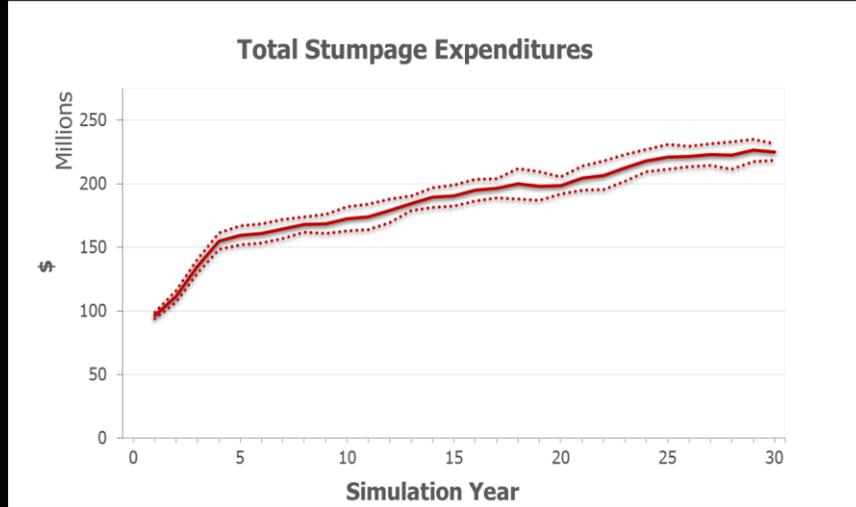


Sensitivity Analysis Results: Expenditures

All willing

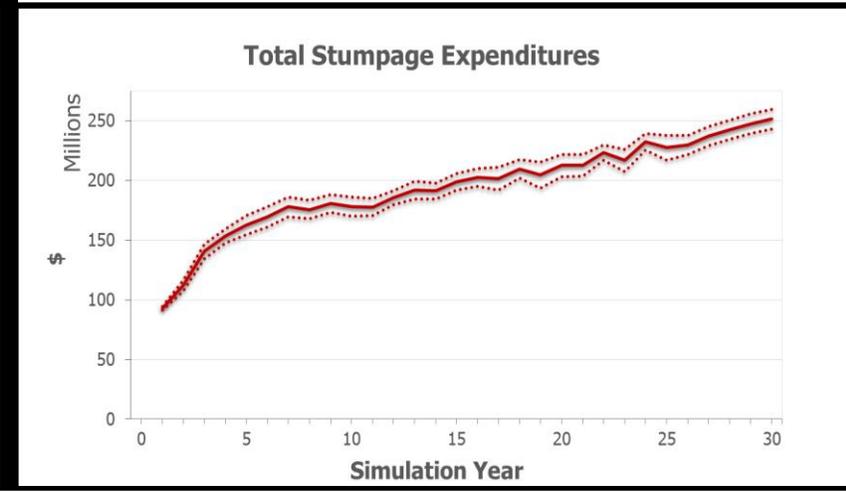
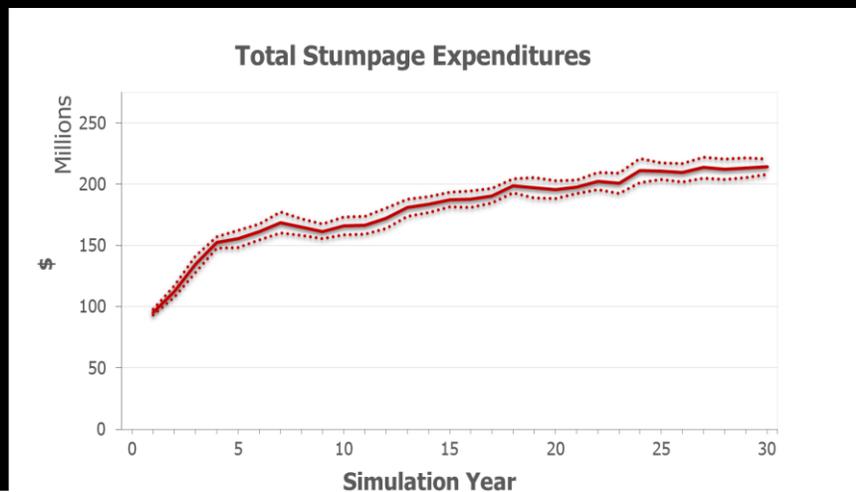
Reduced willing

No small



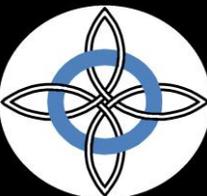
Reduced willingness costs \$16.7 million/yr more by yr 30 (over baseline)

All small



Sensitivity Analysis: Summary

- Incorporating reduced landowner willingness to harvest (from survey) has a significant impact on timber availability and subsequent stumpage price
- Including small tracts of forest (< 10 acres) has a negligible effect on simulation results (but takes 4x the processing time)
- In worst-case scenario, mills still met demand, but at cost of up to 12% stumpage price increase, totaling \$16.7 million.



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- GLTPA/WCFA for sponsorship of project
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