Assessing the Sustainability of Virginia’s Commercial Wood Supply

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College of Natural Resources and Environment
Virginia Tech
Is Virginia’s wood usage sustainable?

• Virginia’s forests have
  • Economic importance
  • Environmental importance

• Forests require a long-term view

• Spatial distribution is critical

• Ownership matters

Photo credit: Charlie Becker
Is Virginia’s wood usage sustainable?

• Current demands on forests
• Anticipated changes in forest area
• Data-driven baseline assessment, considering
  • Spatial distribution of resource
  • Forest ownership patterns
  • Analyzing what’s available
  • Relevant metrics
• Modeling the future
Current Demands on Forests

Pulp & Paper

Photo credit: David B. Hollingsworth, Virginian-Pilot

Saw and Veneer

Photo Credit: Fitzgerald log & lumber co.
Current Demands on Forests

Biomass for Renewable Energy

Photo credit: ESI

Wood pellets

Photo credit: Enviva
Current Demands on Forests
Current Demands on Forests

Mill data source: UGA Wood Demand Research Program
Current Demands on Forests

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Mill data source: UGA Wood Demand Research Program
Anticipated changes in forest area

USGS Land Cover Projection - 2010
Anticipated changes in forest area

USGS Land Cover Projection - 2060
Anticipated changes in forest area

**Mill Type**

<table>
<thead>
<tr>
<th>2010 - 2060</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 50% loss</td>
</tr>
<tr>
<td>20% - 50% loss</td>
</tr>
<tr>
<td>10% - 20% loss</td>
</tr>
<tr>
<td>5% - 10% loss</td>
</tr>
<tr>
<td>Less than 5% loss</td>
</tr>
<tr>
<td>No loss</td>
</tr>
<tr>
<td>No forest in 2010</td>
</tr>
</tbody>
</table>

USFS Forest Cover Projection 2010 - 2060
Anticipated changes in forest area

USFS: RPA Assessment
USGS: LandCarbon
A1B, A2, B2: IPCC Scenarios
Data-driven baseline assessment

- Quantify inventory, growth and removals (harvest)
- Forest area & distribution
- Focus on the private forest
- What portion of inventory is “available”?
- Relevant metrics about supply/demand, growth/removals

Photo credit: John Pemberton
Data-driven baseline

- USGS Land cover (NLCD)
- Forest inventory (USFS FIA)
- Land Ownership (DCR)
- Terrain (USGS DEM)
- Soil drainage classes (NRCS)
- Population density (US BOC)
- Harvest locations (VDF)
- Mill locations (UGA WDRP)
Analyzing Availability

• Identify “available”:
  • VDF Harvest data shows where harvests have occurred
  • Are some landscapes less likely to experience harvest?
  • E.g., slope steepness shows decreasing harvest likelihood with increasing terrain slope
Analyzing Availability

Slope
Population Density
Distance to Road

Logistic Regression

Harvest Probability
Forest ownership patterns

• 82% of Virginia’s forests are privately owned
• Forest tract size has significant impact on harvesting efficiency and options available
  • How much private forest is in small parcels?
  • What proportion of harvests occur in these small parcels?
  • To what extent are landowner decisions about harvesting related to size of parcels owned?
Statewide, 23% of private forest occurs in parcels with less than 20 acres of forest.
Statewide, only 10.6% of forest harvest occurs in patches of less than 20 acres.
Analyzing Available Supply
## Relevant metrics - results by region

<table>
<thead>
<tr>
<th>Metric</th>
<th>Coastal Plain</th>
<th>Southern Piedmont</th>
<th>Northern Piedmont</th>
<th>Northern Mountains</th>
<th>Southern Mountains</th>
<th>STATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private Inventory (k tons)</td>
<td>235,809</td>
<td>216,971</td>
<td>175,551</td>
<td>106,823</td>
<td>179,005</td>
<td>914,158</td>
</tr>
<tr>
<td>Available private Inventory (k tons)</td>
<td>225,898</td>
<td>210,431</td>
<td>162,476</td>
<td>93,046</td>
<td>146,276</td>
<td>838,126</td>
</tr>
<tr>
<td>Growth on Available (k tons)</td>
<td>9,301</td>
<td>8,369</td>
<td>4,494</td>
<td>2,519</td>
<td>4,066</td>
<td>28,748</td>
</tr>
<tr>
<td>Removals/Harvest (k tons)</td>
<td>5,517</td>
<td>5,757</td>
<td>1,722</td>
<td>1,228</td>
<td>1,191</td>
<td>15,414</td>
</tr>
<tr>
<td>Growth:Removals ratio</td>
<td>1.7</td>
<td>1.5</td>
<td>2.6</td>
<td>2.1</td>
<td>3.4</td>
<td>1.9</td>
</tr>
<tr>
<td>Surplus growth (k tons)</td>
<td>3,784</td>
<td>2,612</td>
<td>2,772</td>
<td>1,291</td>
<td>2,875</td>
<td>13,334</td>
</tr>
</tbody>
</table>
Relevant metrics – results by product

• Inventory measures trees; standardized definition for sawtimber

• Markets measure products
  • Distinction between sawtimber and pulpwood can change over time, across regions, etc.

• Balancing growth from inventory with removals by product cannot be exact
## Relevant metrics – results by product

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Softwood Sawtimber</th>
<th>Softwood Pulpwood</th>
<th>Hardwood Sawtimber</th>
<th>Hardwood Pulpwood</th>
<th>STATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>All removals (FIA, 2012)</td>
<td>3,798</td>
<td>3,432</td>
<td>5,106</td>
<td>3,971</td>
<td>16,308</td>
</tr>
<tr>
<td>Removals from private land (FIA, 2012)</td>
<td>3,385</td>
<td>3,216</td>
<td>4,467</td>
<td>3,179</td>
<td>14,247</td>
</tr>
<tr>
<td>Timber Product Output (USFS, 2011)</td>
<td>2,614</td>
<td>5,851</td>
<td>3,360</td>
<td>4,066</td>
<td>15,891</td>
</tr>
<tr>
<td>Harvest Data (VDOF, 2011)</td>
<td>3,189</td>
<td>5,609</td>
<td>5,076</td>
<td>2,967</td>
<td>16,841</td>
</tr>
<tr>
<td>UGA Wood Demand Res. Pgm. (2013)</td>
<td>4,516</td>
<td>6,821</td>
<td>2,889</td>
<td>5,429</td>
<td>19,655</td>
</tr>
</tbody>
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## Relevant metrics - results by product

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</thead>
<tbody>
<tr>
<td>Private Inventory (k tons)</td>
<td>131,192</td>
<td>74,813</td>
<td>409,936</td>
<td>298,217</td>
<td>914,158</td>
</tr>
<tr>
<td>Available private Inventory (k tons)</td>
<td>124,681</td>
<td>71,435</td>
<td>371,518</td>
<td>270,493</td>
<td>838,126</td>
</tr>
<tr>
<td>Growth on Available (k tons)</td>
<td>8,576</td>
<td>3,200</td>
<td>12,908</td>
<td>4,065</td>
<td>28,748</td>
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<tr>
<td>Removals/Harvest (k tons)</td>
<td>2,536</td>
<td>5,676</td>
<td>3,259</td>
<td>3,944</td>
<td>15,414</td>
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<tr>
<td>Growth:Removals ratio</td>
<td>3.4</td>
<td>0.6</td>
<td>4.0</td>
<td>1.0</td>
<td>1.9</td>
</tr>
<tr>
<td>Surplus growth (k tons)</td>
<td>6,040</td>
<td>(2,476)</td>
<td>9,649</td>
<td>121</td>
<td>13,334</td>
</tr>
</tbody>
</table>
Relevant metrics - results by product

- Corroborates results from Rose, 2015:
  
  “Forest land in Virginia is maturing. Area of large-diameter stands has been increasing, while that of medium and small diameter stands has been decreasing.”

Modeling the future

• Baseline assessment is a look at the recent past
• Need a model that looks into the future
• Our approach: the Spatial Wood Supply Simulator (SWSS)
  • Agent-based model
  • Large, spatially-defined datasets
  • Simulates wood supply chain
  • Accommodates scenario analysis
Modeling the future

- Mill locations/demands within and near Virginia
- Forest inventory/location
- Transportation network: costs
- Simulation of bidding behavior by wood buyers
- Growth of forest volume over time

- 869 mills/demand points
- 292,902 forest patches/plots
- Quarterly time steps for 30 years = 120 cycles
- Multiple simulation runs to assess variability
Modeling the future

Timber sale in Shenandoah County, VA
- 103.5 acres
- 1,023 tons hardwood sawtimber
- 3,027 tons hardwood pulpwood
- 839 tons softwood sawtimber
- 1,736 tons softwood pulpwood
Modeling the future

Timber sale in Shenandoah County, VA: Buyers within 100 miles:
- 15 hdwd sawtimber buyers
- 0 hdwd pulpwood buyers
- 7 sftwd sawtimber buyers
- 1 sftwd pulpwood buyer
Modeling the future

Timber sale in Shenandoah County, VA
- 15 hdwd sawtimber buyers
- 0 hdwd pulpwood buyers
- 7 sftwd sawtimber buyers
- 1 sftwd pulpwood buyer

Road distances in miles
Modeling the future

Timber sale in Shenandoah County, VA
- 15 hdwd sawtimber buyers
- 0 hdwd pulpwood buyers
- 7 sftwd sawtimber buyers
- 1 sftwd pulpwood buyer

Simulated bid prices per ton for hardwood sawtimber
Modeling the future

Winning bidders for each product

Compute:
- Total stumpage revenue to landowner,
- Harvesting and transportation costs,
- Delivered prices to mills
Modeling the future

Mills update inventory

If clearcut harvest, stand is regenerated, age reset to zero
Modeling the future

- Repeat bidding process for:
  - 869 mills/demand points
  - 292,902 forest patches/plots
  - Quarterly time steps for 30 years = 120 cycles
  - Multiple simulation runs to assess variability

- Repeat analyses with different assumptions regarding:
  - Anticipated future demand
  - Impact of new facilities
  - Changes in policies to incentivize reforestation
  - Etc.
Modeling the future: example outputs

Harvest Removals - Tons

- Hwd Pulp
- Swd Pulp
- Hwd Saw
- Swd Saw

Millions

Years: 2015 to 2040
Modeling the future: example outputs

Inventory - Tons

Hwd Saw: +96.8%
Hwd Pulp: -4.4%
Swd Saw: +77.3%
Swd Pulp: -18.8%
Modeling the future: example outputs

Surplus Growth - Tons

- Hwd Pulp
- Swd Pulp
- Hwd Saw
- Swd Saw
Modeling the future: example outputs

Product Price Index (1.0 = 2012)
Summary

• Forest sustainability is crucial
  • Environmentally
  • Economically

• Thorough assessment requires:
  • Huge datasets
  • Spatial specificity
  • Dynamic approach

• Work continues...
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