ORNL’s Research into the Sustainability of Southeastern US Wood Pellet Production

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USFS SRS

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This presentation does not contain any proprietary, confidential, or otherwise restricted information.
ORNL’s Bioenergy Sustainability Research for the US Department of Energy (DOE)

‘Sustainability’ is the capacity of an activity to continue while maintaining options for future generations

- ORNL's research agenda includes
  - Defining environmental & socioeconomic cost and benefits of bioenergy systems
  - Quantifying opportunities & risk associated with sustainable bioenergy and specific context.
  - Communicating the challenges & paths forward for sustainable bioenergy to a range of stakeholders
  - Deploying approach in case studies & thereby refining approach

- Key challenges
  - Scientific consensus on definition of sustainability
  - Quantitative & consistent way to implementing indicators & methodology for evaluating & improving sustainability
US industrial wood pellet trade has been growing

Dissertation Defense, Esther S. Parish

The UK, Netherlands & Belgium have been the 3 largest importers of US wood pellets

In 2015, there were 16 dedicated industrial pellet mills shipping to Europe from 6 SE US ports.

Only a small portion of SE US timberland removals are used for pellets

Controversy surrounds this renewable energy resource.
Many are investigating “neutral” carbon emissions
Other issues pertaining to Sustainability also need investigation

• How does SE US pellet production for export to Europe differ from business-as-usual case of no pellet production?
  ➢ Under what conditions does the pellet industry complement or compete with pulpwood use?
  ➢ Will pellet industry alter amount of land staying in the forest?

• Are there significant changes to key indicators?
  ➢ Biodiversity.
  ➢ GHG emissions.
  ➢ Soil quality.
  ➢ Jobs.
  ➢ Water & air quality.
  ➢ Preserving land as forest.

• How can forest conditions be monitored & good practices implemented?
  ➢ Analysis of Forest Inventory & Analysis (FIA) data.
  ➢ Best Management Practices (BMPs).
  ➢ Other.

Participants of ORNL’s April 2016 Bioenergy Study Tour are helping address these questions. See Dale et al. (2017) GCB Bioenergy.
Over half of US wood pellets ship to Europe from Norfolk & Savannah

- We wanted to look for timberland changes in the two fuelsheds supplying these ports before and after export pellet production began in 2009.
- Our hypothesis was no change.

Source: E. Parish, V. Dale, K. Kline (2017) *World Biomass*
We used annual Forest Inventory and Analysis (FIA) data collected by the US Forest Service.
Considered 2 case study areas supplying wood to 2 major ports:

- Savannah: mostly intensively managed pine plantations
- Chesapeake (Norfolk): both pine & mixed hardwoods

**Fuelsheds:** Counties within 120 km (75 miles) of pellet mills that supply ports

Each fuelshed area has an area of ~12 million ha.

**Chesapeake Fuelshed:**
- 33 NC counties
- 69 VA counties

**Savannah Fuelshed:**
- 22 SC counties
- 54 GA counties
- 7 FL counties


Counties used to extract FIA data to develop timberland variables

<table>
<thead>
<tr>
<th>Port</th>
<th>Pellet Mill Name</th>
<th>City</th>
<th>State</th>
<th>Longitude</th>
<th>Latitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chesapeake</td>
<td>Equustock LLC Equustock</td>
<td>Chester</td>
<td>Virginia</td>
<td>-77.31</td>
<td>37.35</td>
</tr>
<tr>
<td>Chesapeake</td>
<td>Potomac Supply LLC</td>
<td>Kinsale</td>
<td>Virginia</td>
<td>-76.60</td>
<td>38.02</td>
</tr>
<tr>
<td>Chesapeake</td>
<td>Trae Fuels Ltd</td>
<td>Bumpass</td>
<td>Virginia</td>
<td>-77.78</td>
<td>37.96</td>
</tr>
<tr>
<td>Chesapeake</td>
<td>Enviva Ahoskie</td>
<td>Ahoskie</td>
<td>North Carolina</td>
<td>-76.97</td>
<td>36.27</td>
</tr>
<tr>
<td>Chesapeake</td>
<td>Enviva Northampton</td>
<td>Garysburg</td>
<td>North Carolina</td>
<td>-77.56</td>
<td>36.45</td>
</tr>
<tr>
<td>Chesapeake</td>
<td>Enviva Southampton</td>
<td>Courtland</td>
<td>Virginia</td>
<td>-77.07</td>
<td>36.72</td>
</tr>
<tr>
<td>Chesapeake</td>
<td>Wood Fuel Developers</td>
<td>Waverly</td>
<td>Virginia</td>
<td>-77.10</td>
<td>37.04</td>
</tr>
<tr>
<td>Savannah</td>
<td>Georgia Biomass</td>
<td>Waycross</td>
<td>Georgia</td>
<td>-82.41</td>
<td>31.26</td>
</tr>
<tr>
<td>Savannah</td>
<td>ATP-SC LLC</td>
<td>Allendale</td>
<td>South Carolina</td>
<td>-81.18</td>
<td>33.00</td>
</tr>
<tr>
<td>Savannah</td>
<td>Low Country BioMass</td>
<td>Ridgeland</td>
<td>South Carolina</td>
<td>-81.02</td>
<td>32.48</td>
</tr>
</tbody>
</table>

From E. Parish, V. Dale, K. Kline, E. Tobin (2017) *Data in Brief*
## Ten timberland variables pulled from FIA data

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Variable Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vol Nat</td>
<td>Volume of Natural stands (millions of cubic meters)</td>
</tr>
<tr>
<td>Vol Plan</td>
<td>Volume of Plantations (millions of cubic meters)</td>
</tr>
<tr>
<td>Area LD</td>
<td>Area of Large Diameter stands (thousands of hectares)</td>
</tr>
<tr>
<td>Area MD</td>
<td>Area of Medium Diameter stands (thousands of hectares)</td>
</tr>
<tr>
<td>Area SD</td>
<td>Area of Small Diameter stands (thousands of hectares)</td>
</tr>
<tr>
<td>StDead Nat</td>
<td>Standing Dead trees in Natural stands (number per hectare)</td>
</tr>
<tr>
<td>StDead Plan</td>
<td>Standing Dead trees in Plantations (number per hectare)</td>
</tr>
<tr>
<td>Carbon SLL</td>
<td>Carbon stored in Soil &amp; Leaf Litter (millions of metric tons)</td>
</tr>
<tr>
<td>Carbon HM</td>
<td>Carbon stored in Harvestable (live) woody Material (millions of metric tons)</td>
</tr>
<tr>
<td>Carbon NHM</td>
<td>Carbon stored in NonHarvestable (dead) woody Material (millions of metric tons)</td>
</tr>
</tbody>
</table>

From E. Parish, V. Dale, K. Kline, E. Tobin (2017) *Data in Brief*
Are pellet exports affecting SE US forests?

Analyzed FIA data for changes in:

- timberland volume & area (natural vs. plantation)
- tree diameters
- # of standing dead trees
- carbon pools
- etc.

Figure 1 from V. Dale, E. Parish, K. Kline & E. Tobin (2017)
Results of ORNL’s assessment of SE US timberland characteristics pre- and post-export pellet production in 2009

<table>
<thead>
<tr>
<th>Timberland Characteristic</th>
<th>Savannah Fuelshed</th>
<th>Chesapeake Fuelshed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naturally regenerating stand volume</td>
<td>Increased</td>
<td>No change</td>
</tr>
<tr>
<td>Plantation volume</td>
<td>Increased</td>
<td>Increased</td>
</tr>
<tr>
<td>Large-diameter tree area</td>
<td>Increased</td>
<td>Increased</td>
</tr>
<tr>
<td>Medium diameter tree area</td>
<td>No change</td>
<td>No change</td>
</tr>
<tr>
<td>Small diameter tree area</td>
<td>No change</td>
<td>No change</td>
</tr>
<tr>
<td>Standing dead tree density of natural stands (#/ha)</td>
<td>Increased</td>
<td>No change</td>
</tr>
<tr>
<td>Standing dead tree density of plantations (#/ha)</td>
<td>Decreased</td>
<td>No change</td>
</tr>
<tr>
<td>Carbon content of soil and leaf litter</td>
<td>Increased</td>
<td>No change</td>
</tr>
<tr>
<td>Carbon content of live harvestable material</td>
<td>Increased</td>
<td>Increased</td>
</tr>
<tr>
<td>Carbon content of dead non-harvestable material</td>
<td>Increased</td>
<td>No change</td>
</tr>
</tbody>
</table>

Research results were summarized in a trade journal provided to attendees of the October 2017 US Industrial Pellet Association (USIPA) conference:

Wood markets are needed to retain SE US land in forest

From E. Parish, V. Dale, K. Kline (2017) *World Biomass*
Income from pellet exports might encourage SE US forest owners to invest in forest management (e.g., thinning)

From E. Parish, V. Dale, K. Kline (2017) *World Biomass*
Published FIA dataset was used by Tennessee teachers to create 3 new math lesson plans

Lessons may be downloaded from: https://orise.orau.gov/stem/k-12/bioenergy-workforce-development-for-educators.html
Next steps with help from USFS SRS staff

Use TPO data to redefine case study fuelsheds

- Average procurement distance is ~50 miles (not 75 miles)
- Use break point of 2011 based on pellet production capacity (rather than 2009)

Update timberland change analyses

- Use 2016 FIA data to test for changes from 2011 to 2016
- Consider remeasured plots within each fuelshed
Potential benefits of wood pellet trade suggested by qualitative telecoupling analysis


**Environmental benefits**
- Enhanced management of SE US forests using income from bioenergy products can benefit water quality, biodiversity, carbon sequestration, & forest productivity
- Reduction in
  - Toxic air emissions related to coal combustion
  - GHG emissions from energy production
  - Air pollution due to reduced burning of woody debris
- Preservation of EU forest land & associated ecosystem services

**Social economic benefits**
- Additional market opportunity for woody biomass helps SE US land remain in forest
- Avoided job losses in rural SE US & increased jobs in Europe
- Reduced risk of wildfire and disease/pest outbreaks in SE forests when income from pellet shipments is used for increased forest management
Goal for DOE BETO:

- Collect spatiotemporal data for as many of the 35 recommended ORNL bioenergy sustainability indicators as possible
- Appropriately aggregate them within a framework that can be adjusted according to stakeholder priorities

Thank you!

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Works Cited

Baskaran L, Dale VH (forthcoming) Framework to assess how wood pellet production affects species of concern: An example using gopher tortoise (Gopherus polyphemus).


US timberland removal types & wood products

**Feedstock Types**

- **Roundwood** of various diameters, species & quality (conventional log types\(^2\) are illustrated with typical minimum dbh in inches):
  - Sawtimber (12" & up)
  - Pulpwood (6" & up)
- **Mill residues** (i.e., wood & bark residues generated by processing roundwood into primary products)
- **Logging residues\(^1\)** & other forest removals

**Wood Products**

<table>
<thead>
<tr>
<th>Wood product</th>
<th>Minimum size in dbh(^b), but this value varies by species, market, and mill specifications</th>
<th>Quality(^c) of the wood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veneer</td>
<td>16 inches (40.6 cm)</td>
<td>High</td>
</tr>
<tr>
<td>Lumber</td>
<td>10 inches (25.4 cm)</td>
<td>High</td>
</tr>
<tr>
<td>Pallets</td>
<td>10 inches (25.4 cm)</td>
<td>Low</td>
</tr>
<tr>
<td>High valued pulp (e.g., cosmetics, toiletries)</td>
<td>6 inches (15.2 cm)</td>
<td>High</td>
</tr>
<tr>
<td>Low valued pulp (e.g., paper &amp; cardboard)</td>
<td>6 inches (15.2 cm)</td>
<td>Variable</td>
</tr>
<tr>
<td>Pellets and clean chips (e.g., co-firing, small animal care)</td>
<td>6 inches (15.2 cm)</td>
<td>Low</td>
</tr>
<tr>
<td>Dirty chips (e.g., mulch, onsite process heat)</td>
<td>6 inches (15.2 cm)</td>
<td>Low</td>
</tr>
</tbody>
</table>

From E. Parish, V. Dale, K. Kline, R. Abt (2017) *WIREs*
Factors affecting availability of woody feedstocks for pellets

From E. Parish, V. Dale, K. Kline, R. Abt (2017) WIREs
Survey of 900 private forest land owners on biomass for energy:

- 50% disagreed with statement that they would harvest biomass for energy from their land
- 50% indicated that only residual material after other timber harvest would be for bioenergy
- Concern for the overall environment is paramount
- Potential impacts on existing industries are a concern
- There was a willingness to support use of biomass for energy as long as
  1. Land health is not compromised
  2. The price is right

Hodges, Poudyal, Kline & Dale (in progress)
Range of the Gopher tortoise (*Gopherus Polyphemus*)

- 80% of the GT range (~13,403 hectares) overlaps counties within 120 km of pellet mills in the SE US

Baskaran L, Dale VH (forthcoming) Framework to assess how wood pellet production affects species of concern: An example using gopher tortoise (*Gopherus polyphemus*).