2011 Billion Ton Update – Assumptions and Implications Involving Forest Resources

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Billion Ton Study: What can be Learned about Bioenergy Sustainability

Workshop: September 29-30, 2011

Oak Ridge, TN

***BTU included 50 contributors**

Forest Resources

- **Forestland resources in U.S.**
  - **504 million acres of timberland**
  - **91 million acres of other forestland**
- **Forest resource feedstocks**
  - **Composite (combination of logging residues and forest thinnings)**
    - **Logging residues**
    - **Forest thinnings (health treatments on timberlands)**
  - **Thinnings on other forestlands**
  - **Other removal residues**
  - ***Conventional wood***
  - **Fuelwood**
  - **Primary mill residues**
  - **Secondary mill residues**
  - **Pulping liquors**
  - **Urban wood residues**

Forestland – minimal of 1 acre and 10% live tree cover

Timberland – capable of growing 20 ft^3/acre/year
Other Forestland – other than timberland or reserved land

Reserved forestland – administratively removed from production

Currently used
- Fuelwood
- Mill residue
- Pulping Liquor
- MSW

Potential
- Composite
- Other removal residue
- Thinnings on other forestlands
- Mill residues
- Urban
- Conventional wood to energy

Assumed Integrated Logging to Estimate Logging Residues, Thinnings, and Composite Feedstocks Categories

Logging Residues (Current)

Logging Residues (Assumed)

Thinnings

Integrated Logging = Merchantable Materials + Biomass

Composite Feedstock Category = Selected Portion of Logging Residues + Selected Portion of Thinnings

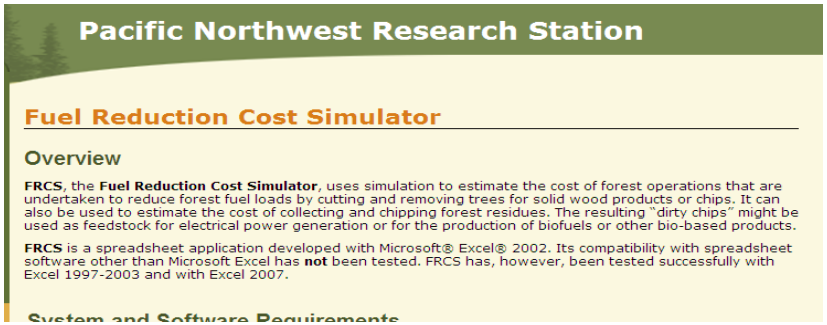
Approach to Supply Curve Estimation

- **Separate methods for agriculture and forest resources**
- **Forestland resources**
  - **Resource cost analysis used to estimate supply curves (cost-quantities) for forestland resources**
    - **Used USDA/FS data (FIA, TPO, RPA)**
    - **Used Fuel Reduction Cost Simulator**
    - **Developed requirements and approaches for resource sustainability**
    - **Made assumptions on access, recovery, merchantability, and management/production approaches**
    - **Generated stumpage price estimates**
    - **Secondary processing residues and wastes are estimated using technical coefficients**
    - **Contributing authors helped develop technical assumptions and input data and workshops used to develop scenarios**

Forest Resources Data Sources

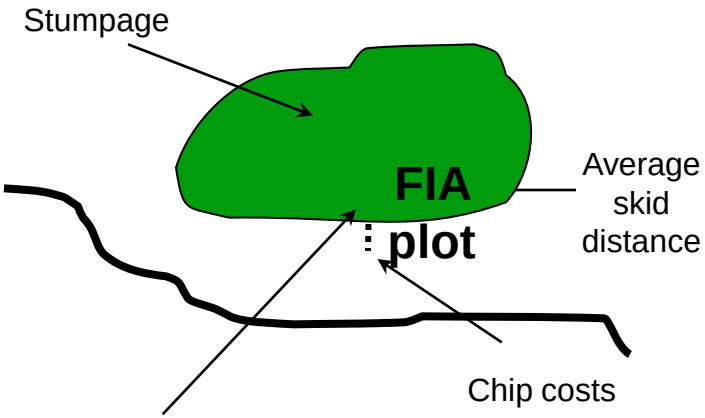
- U.S. Forest Service Forest Inventory and Analysis (FIA)
  - Downloaded data from FIA DataMart4 (February/March 2010) - http://199.128.173.17/fiadb4-downloads/datamart.html
  - Used specific data for biomass
    - Small trees (1-5 inch dbh in East and 1-7 inch dbh in West)
    - Non-merchantable tree components of trees great than 5/7 inch dbh
      - Limbs and tops
      - Non-merchantable bole
      - Dead trees
- Includes new method for calculating the non-merchantable volumes of the merchantable trees
  - Component ratio method (CRM)
  - Consistently lower volumes vs. old method
    - 6-8% generally
    - Up to 30% for specific species and stand type
- 2009 RPA (Resource Planning Act) Assessment (Smith et al.)
  - Growth projections
- 2005 RPA Timber Assessment
  - Harvest projections
- RPA Timber Products Output (TPO) database
  - Logging and other removal residue
  - Downloaded (March 2010)
  - http://srsfia2.fs.fed.us/php/tpo_2009/tpo_rpa_int1.php

Forest Cost and Sustainability Methodology



http://www.fs.fed.us/pnw/data/frcs/frcs.shtml

Updating FRCS, the Fuel Reduction Cost Simulator, for National Biomass Assessments Dennis Dykstra, Bruce Hartsough, and Bryce Stokes http://www.fs.fed.us/pnw/pubs/journals/pnw_2009_dykstra001.pdf



Harvest cost (FRCS) =
fn (30% max SDI, slope, …)
Small diameter trees only

Costs

- **Residues and thinning – chipping only at average of $13 per dry ton**
- **Conventional – full costs for cut, skid, and chip**

FIA data (~37,000 permanent field plots)

- **Exclude roadless areas and reserved, steep, and wet lands**
- **All fire regime condition classes**
- **Treated if greater then 30% of maximum stand density for forest type/ecoregion**
- **Thin over 30-year period**

Forest Sustainability Approach

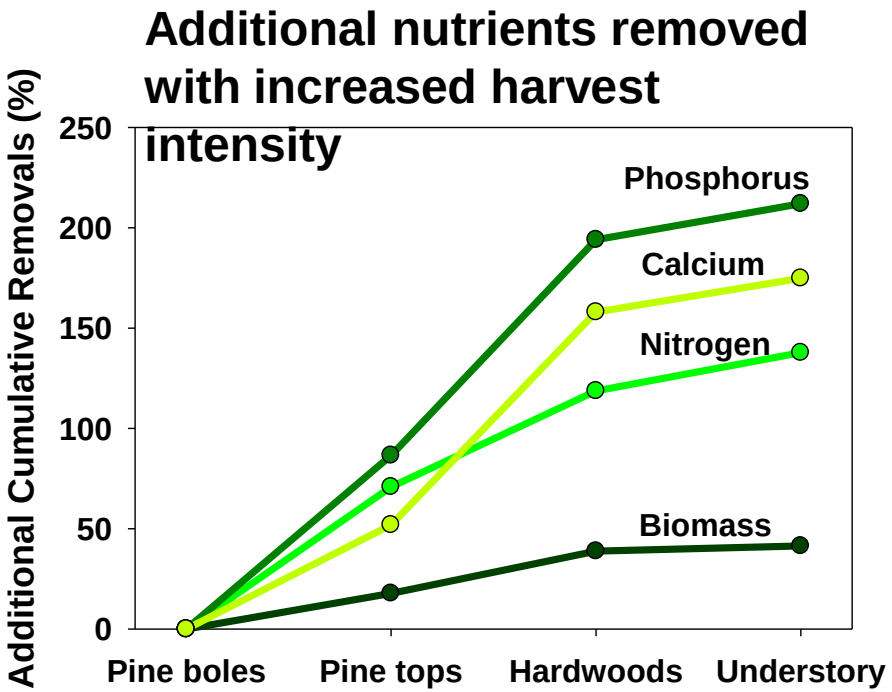
- **Evaluated biomass removal sustainability (erosion, soil nutrients, biodiversity, soil-organic carbon, and long-term soil productivity) – used to develop assumptions**

Andy Scott - FS

- **Sustainability based on biomass retention levels by slope class**
  - **Logging residues - 30% left on-site**
  - **Thinnings**
    - **Slope <40% = 30% left on-site**
    - **Slope >40% to <80% = 40% left on site**
    - **Slope >80% = no removal**
- **Removed reserved and roadless designated stands**
- **Removed steep and wet areas, and sites requiring cable systems**
- **Only thinned over-stocked stands and used uneven-aged prescription**
- **Used costs incorporated for BMP implementation as surrogate for other non-biomass retention related criteria, e.g. biodiversity, habitat, stream crossings, etc.**
- **No removals greater than growth by state**
- **Merchantable capacity limits by state**
- **30 year for thinning return**

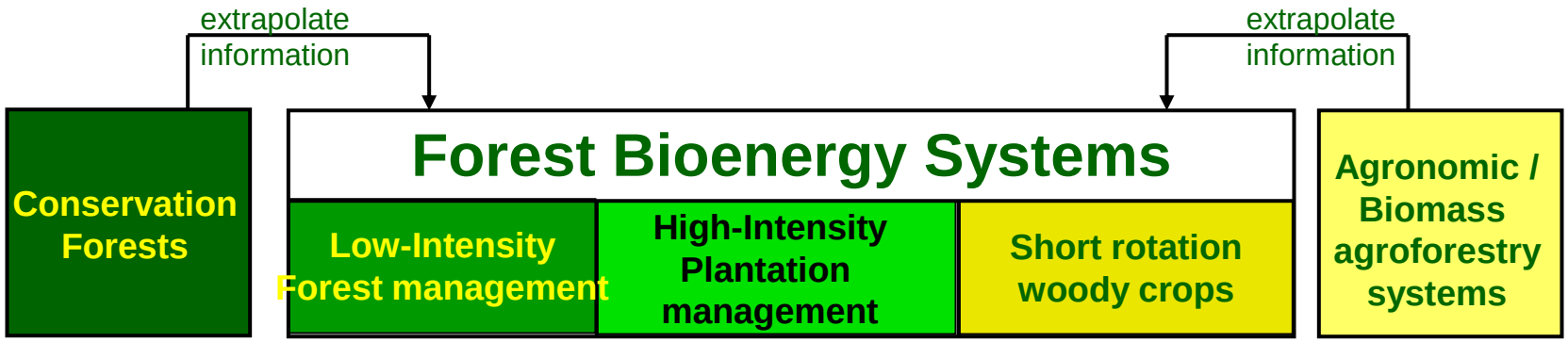
Major concerns of forest biomass (residue) removal

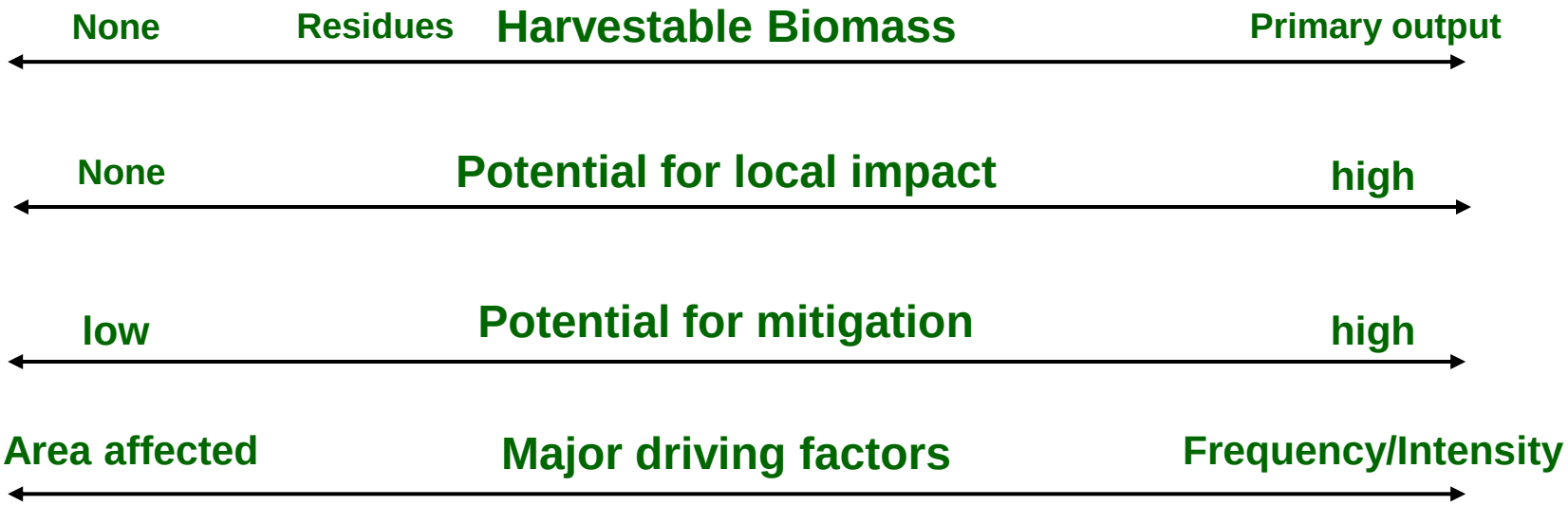
- Nutrient extraction
  - Atmospheric pollution
- Carbon storage
  - Above vs. belowground



- Biodiversity/habitat
- Operations
  - Erosion, compaction
- Fuel
  - Wildfire behavior

Biomass Harvest across Management Gradient





Forest Biomass Harvest: Environmental Sustainability

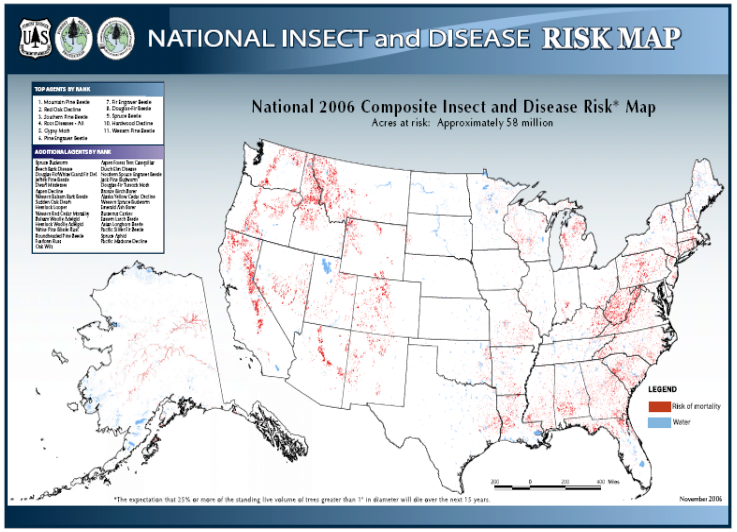
- **Major concerns**
  - **Vary based on biomass harvest scenario**
    - Intensity, frequency, material harvested
  - **Regional differences in soils, forests, atmospheric pollution**

- **What do we know?**
  - **Biomass harvesting generally benign to productivity**
    - Can exacerbate existing deficiencies (southern pine & phosphorus)
    - Problems when combined with soil tillage, atmospheric pollution
      - Carbon loss, Calcium loss with acid rain

- **What don't we know?**
  - **Refined, regional, site-based guides**
    - What sites have inherent deficiencies?
    - What sites are affected by other factors (pollution)
  - **Long-term ecological interactions**
    - Pests, diseases, fire

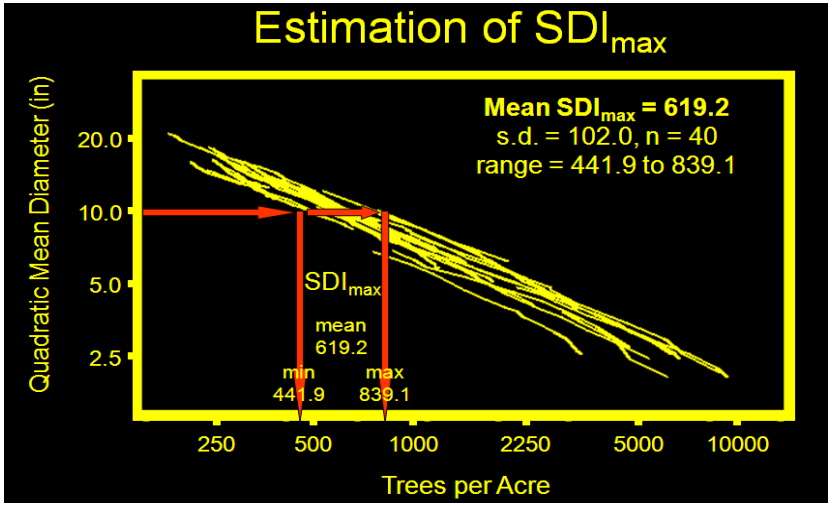
Other Assumptions

- No road building (0.5 mile)
- Cut, skid, process at deck, and chip biomass (whole tree to deck)
- Integrated logging
- Biomass
  - Small stems
  - 1-5 inch dbh in East
  - 1-7 inch dbh in West
  - Limbs and top, and cull components of merchantable trees
  - Dead trees
- Federal land separated
- No stumpage on federal land
- Logging residues and thinnings – chipping cost only
- Conventional - all costs and wood go to biomass
- Thinnings on 30% greater than max SDI

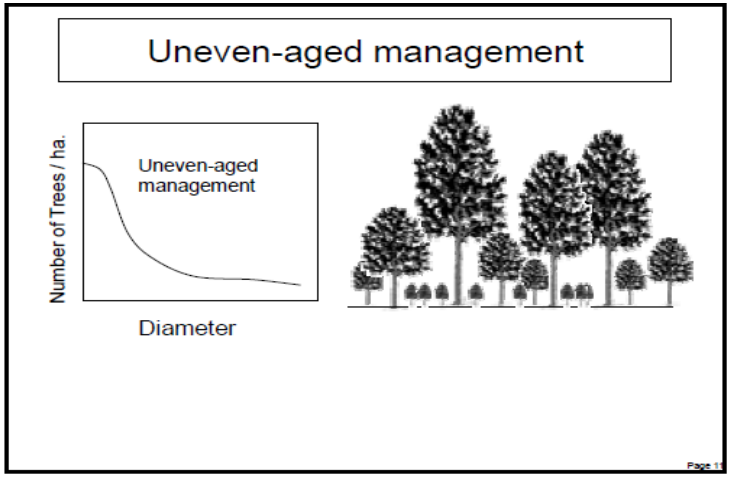


- Recovery
  - 70% for logging residues, thinnings and conventional
  - 50% for other removals
- Merchantability – FIA biomass equations

Forest Thinning Methodology



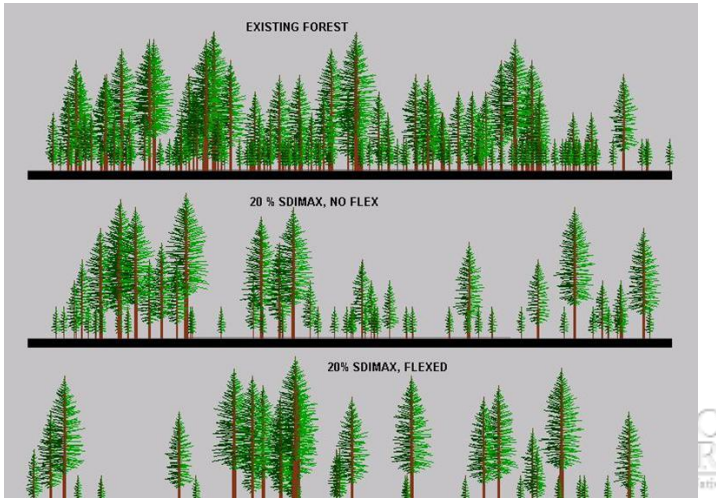
Poage, Marshall, and McClellan – www.growthmodel.org



www.science.siu.edu

Before Thin

After Thin



Forest Feedstock Supply Curve Estimation

- **Key forest feedstocks**
  - **Forest Residues from integrated logging (sawlogs/pulpwood + biomass)**
    - **Composite estimate sources – logging residue data, forest thinning simulations**
  - **Conventionally sourced wood (i.e., pulpwood) from 1) additional harvests and 2) shift from current pulpwood uses to bioenergy**
- **Estimation elements**
  - **Supply amount by price (= stumpage cost + harvest cost)**
  - **Limits on amounts of supply**
- **Only Baseline Scenario for Forest Resources**

Forest Residue Stumpage Prices

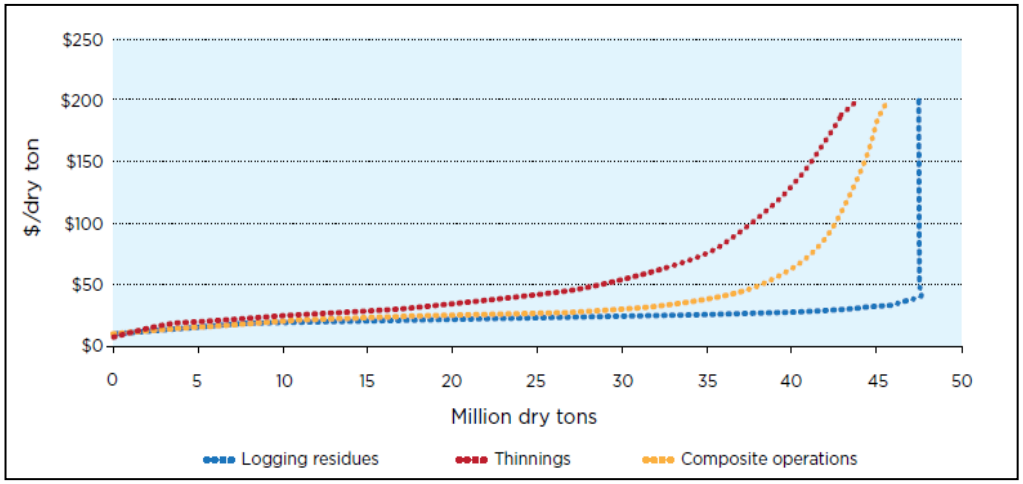
- **With low supply - stumpage price of $4/dry ton for tops/branches, increases to 90% of pulpwood stumpage price with high supply**

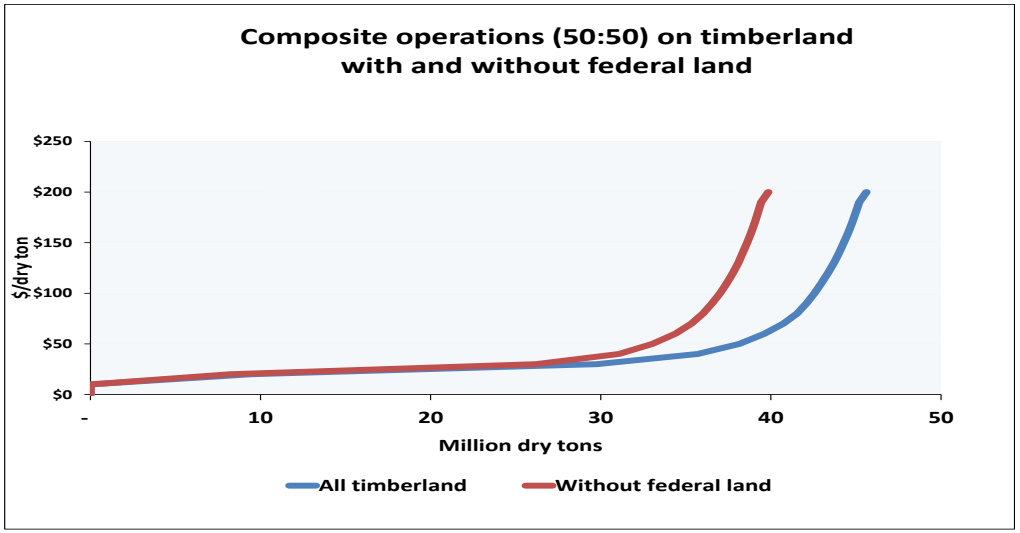
- **Use Regional Pulpwood stumpage prices**
  - **Hardwoods: North $15.40/dry ton; South - $13.30/dry ton**
  - **Softwoods: North - $20.70/dry ton; South - $15.70/dry ton**
  - **West - $27.60/dry ton**

Forest Residues - Composite Results

- Estimates
  - $20-$200/dry ton
  - Current - 2012
  - Potential – 2017-2030
  - Federal and non-federal (ESIA exclusion)
- Roadside supply curves
  - Includes stumpage & chipping costs
  - Fuel Reduction Cost Simulator model for harvesting
  - Projections based on latest RPA/TPO
  - With & without federal land
  - Based on integrated logging

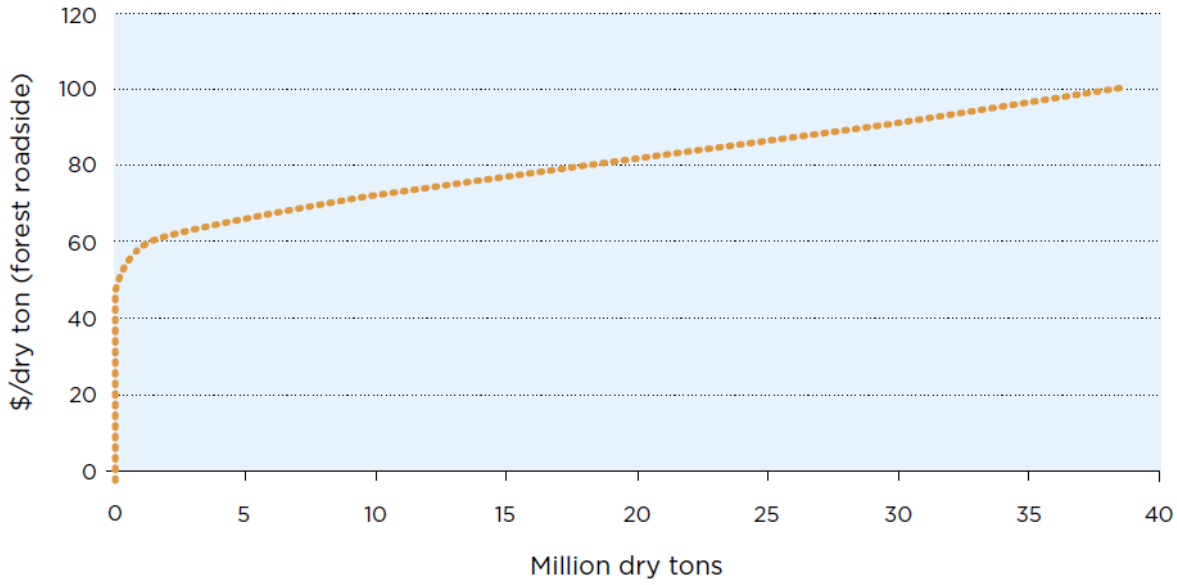
Example Supply Curves





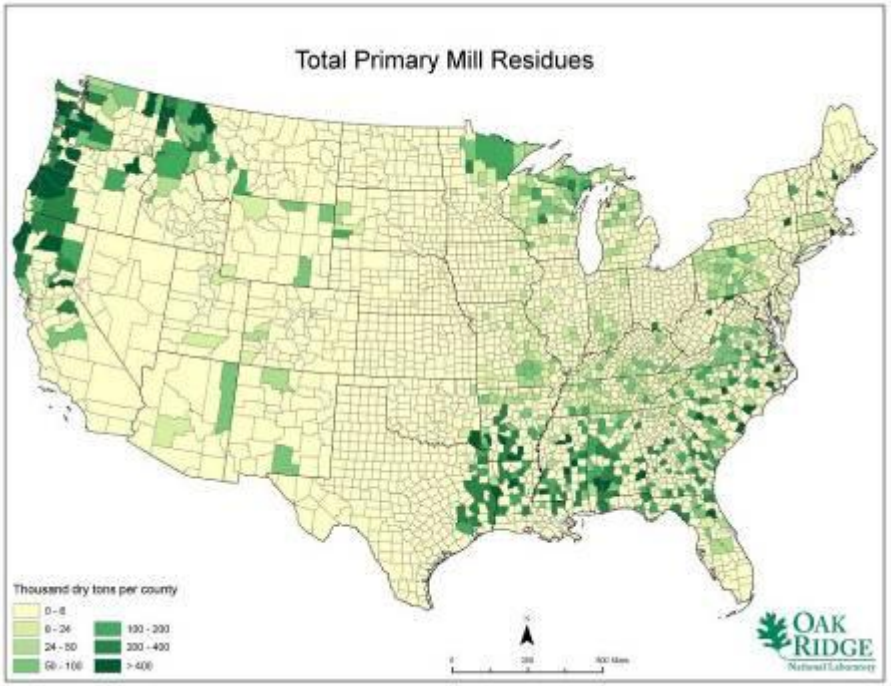
Forest Biomass – Conventionally Sourced Wood (Pulpwood)

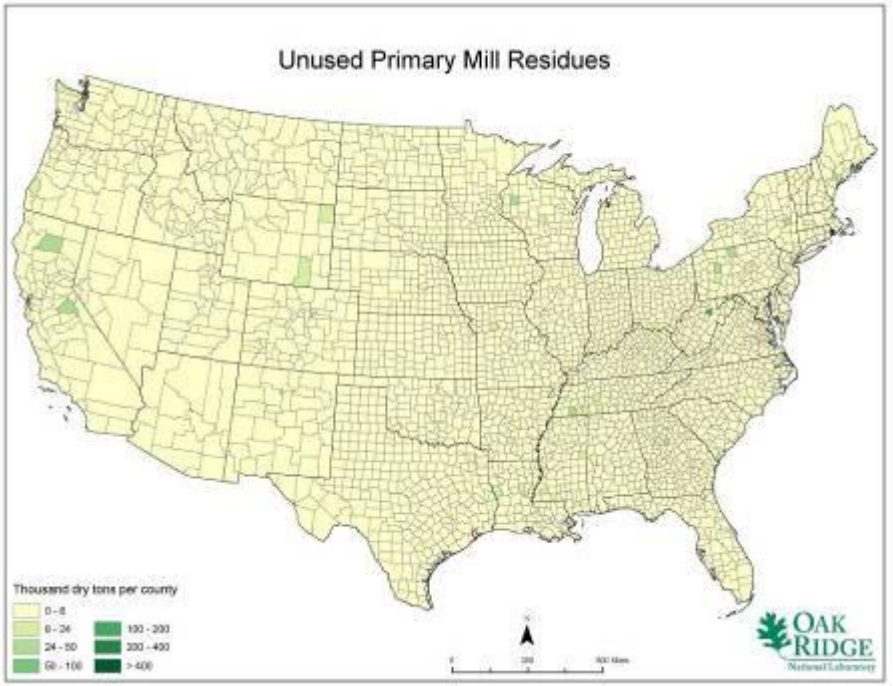
- **Sources:**
  - **Additional harvest of sites for pulpwood – for biomass only – no sawlogs**
  - **Shift of pulpwood use from current users to bioenergy use (away from pulp / panel production)**
- **Prices – based on recent pulpwood price and elasticities of supply & demand**
- **Limitations:**
  - **Additional harvest for biomass cannot exceed current timber growth by state**
  - **Shift from current use cannot exceed 20% of current use in a state**
- **Caveats**
  - **Rough estimates**
  - **Short range**
  - **Estimates will change with pulpwood market conditions and forest growth**



PRIMARY MILL RESIDUES

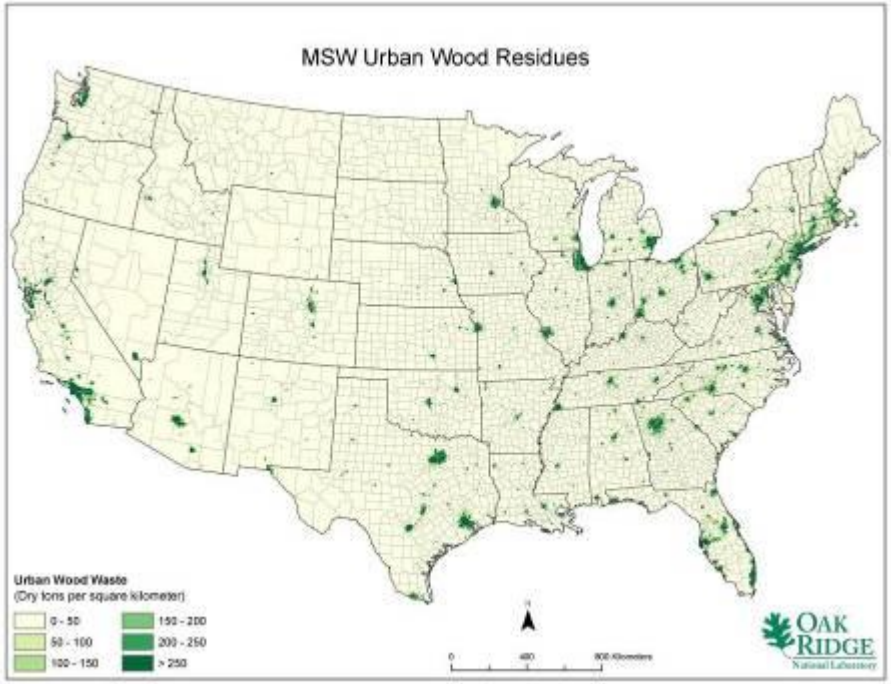
- Very little primary mill residue goes unused
- Potential to divert some lower value uses (e.g., mulch) to bioenergy





URBAN WOOD WASTES

- **Urban wood residues are the woody component in MSW and C&D landfills**
- **Projections based on population growth subject to improvements in reduction, reuse, and recycling**



for the U.S. Department of Energy

Currently Used Forest Biomass Feedstocks

Table 2.1 Projected Consumption of Currently Used Biomass Feedstocks (Million Dry Tons per Year)

Source	Current	2017	2022	2030
Forest				
Fuelwood	38	72	96	106
Mill residue	32	38	39	42
Pulping liquors	45	52	54	58
MSW sources	14	20	20	20
Total forest	**129**	**182**	**209**	**226**

Potential Forest Biomass and Wood Wastes for 2012

Table 3.3 Summary of Potential Forest Biomass and Wood Wastes (2012)

Feedstock ($ per dry ton)	<$20	<$30	<$40	<$60	<$80	<$100
			Million dry tons			
Other Removal Residue	4.4	12	12	12	12	12
Composite Operations	9.5	30	36	40	42	43
Without Federal Land	8.3	26	31	35	36	37
Treatment Thinnings, Other Forestland	0	0	0	3.2	6.4	6.4
Without Federal Land	0	0	0	1.8	3.6	3.6
Mill residue, unused primary	1.3	1.3	1.3	1.3	1.3	1.3
Mill residue, unused secondary	6..1	6.1	6.1	6.1	6.1	6.1
Urban Wood Waste – C & D	4.4	11	14	22	22	22
Urban Wood Waste – MSW	7.7	8.7	9.2	10	10	10
Conventional Pulpwood to Energy*	0	0	0	1.5	19	40
Total – All Land	**33**	**70**	**79**	**97**	**119**	**142**
Total – Without Federal Land	*32*	*66*	*75*	*90*	*111*	*133*

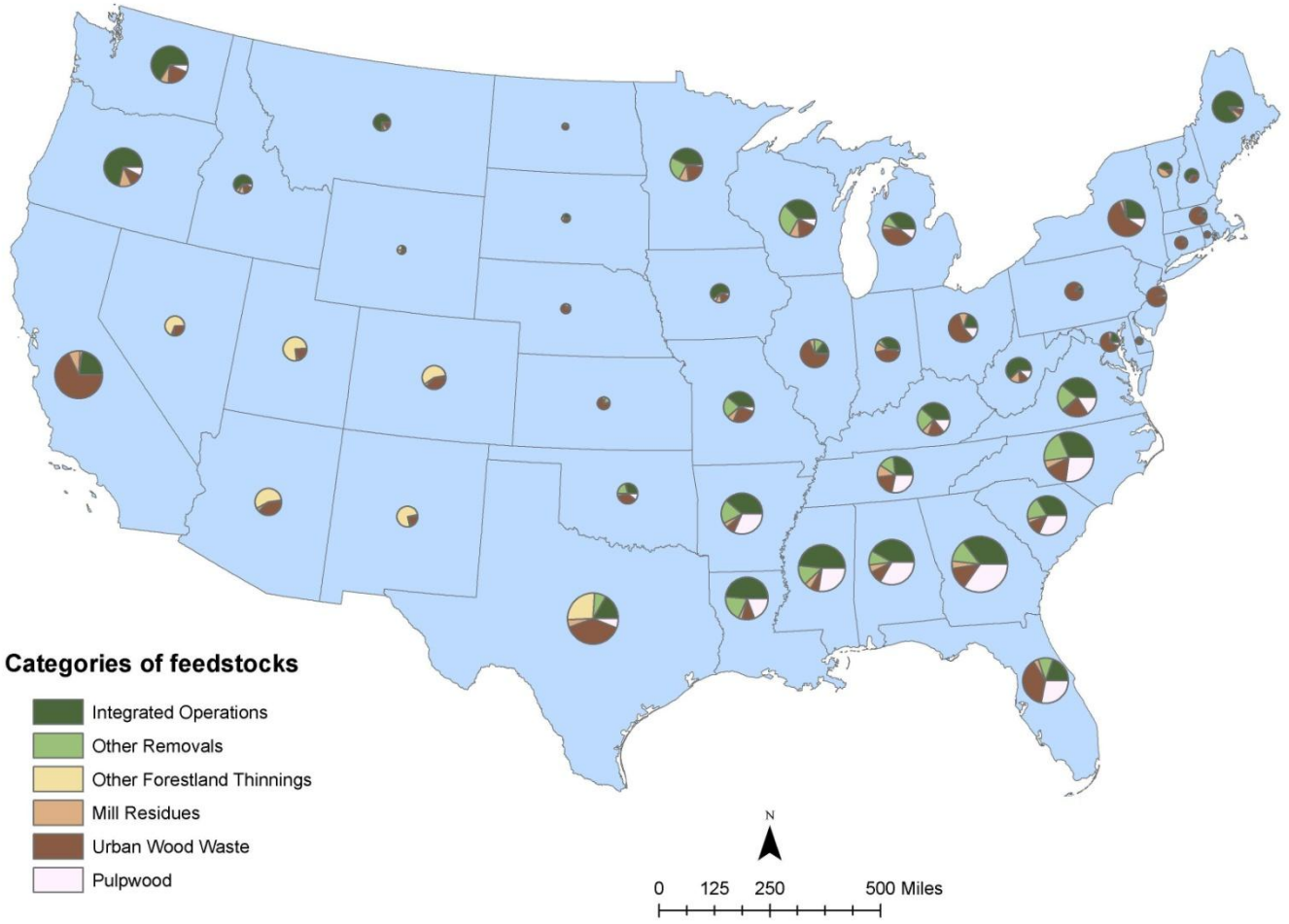
Notes: *Does not include currently used biomass from Chapter 2. Totals may not add up correctly due to rounding*

Summary of Baseline Potential Forest Biomass and Wood Wastes at Selected Roadside Prices

Feedstock ($ per dry ton)	40	50	60	40	50	60	40	50	60	40	50	60
	2012			2017			2022			2030		
	Million dry tons											
Other Removal Residues	12	12	12	12	12	12	13	13	13	13	13	13
Conventional Pulpwood to Energy	0.0	0.1	1.5	0.0	0.1	1.6	0.0	0.1	1.8	0.0	0.1	1.9
Composite Operations	36	38	40	36	39	40	37	39	41	37	39	41
Without Federal Land	31	33	35	32	34	35	32	34	35	32	34	36
Treatment Thinnings, Other Forestland	0.0	0.0	3.2	0.0	0.0	3.2	0.0	0.0	3.2	0.0	0.0	3.2
Without Federal Land	0.0	0.0	1.8	0.0	0.0	1.8	0.0	0.0	1.8	0.0	0.0	1.8
Mill residue, unused secondary	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1
Mill residue, unused primary	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.4	1.4	1.4	1.4
Urban Wood Waste – C & D	14	22	22	15	23	23	15	23	23	16	25	25
Urban Wood Waste – MSW	9.2	10	10	9.5	10	10	10	11	11	10	11	11
Total – All Land	**79**	**91**	**97**	**81**	**92**	**98**	**82**	**93**	**100**	**83**	**95**	**102**
Total – Without Federal Land	*75*	*86*	*90*	*76*	*87*	*92*	*77*	*88*	*93*	*79*	*90*	*95*

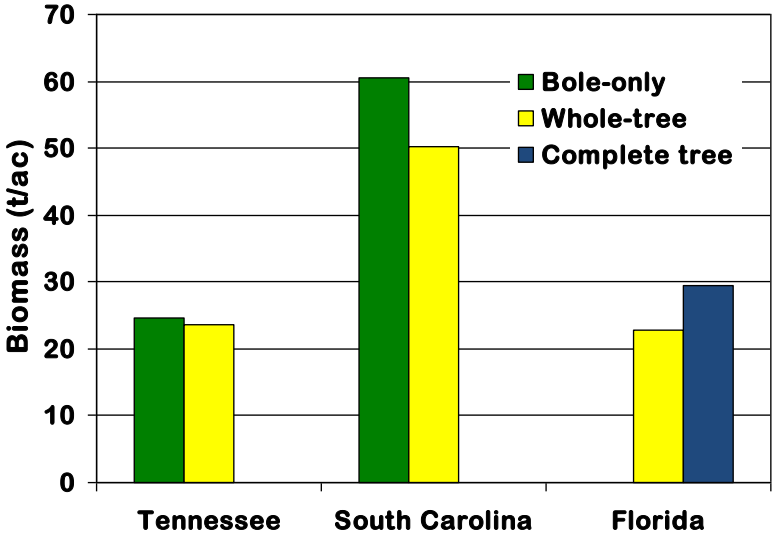
Potential to Supply Forest Residues by State

- **Forest residues are widespread in the Southeast, North, and Northwest**

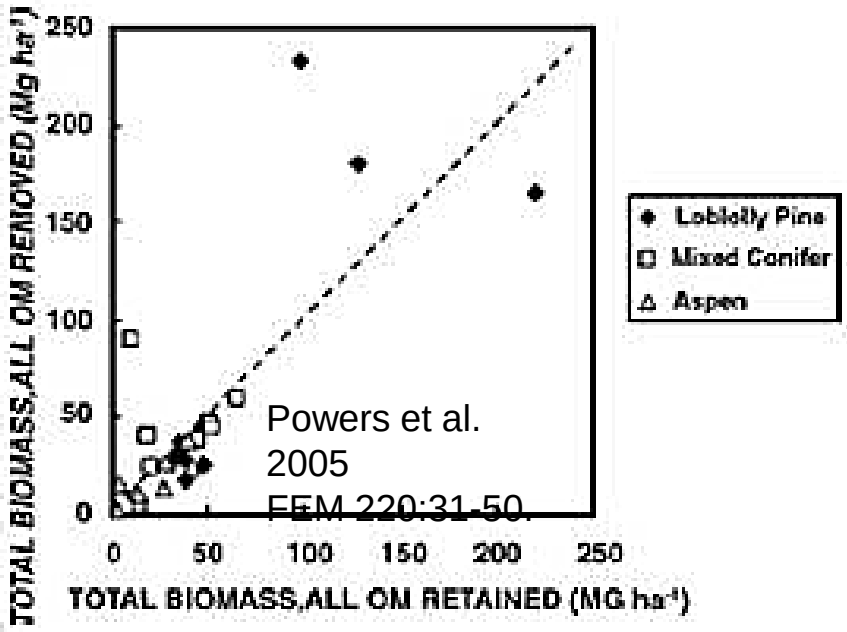


The End or Thereabout

Biomass harvest & productivity



Johnson et al. 2002. Env. Poll. 116 S201–S208



Powers et al. 2005 FEM 220:31-50.

Scott et al. 2007. GTR PNW 689:331-340