

# **Bundled Slash: A Potential New Biomass Resource for Fuels and Chemicals**

by

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## Study site:

- The bundler study was performed on Potlatch Corporation timberlands in eastern Arkansas.
- Potlatch staff were full study participants and supervised all activities on their harvest sites.
- Harvests at the study sites were coordinated to be performed immediately prior to slash bundling to insure the availability of fresh slash.

**Bundled biomass contained a mix of harvest residue from the forest floor. Limbs, tops, needles, partially rotted limbs and tree residue:**



# Bundler cradle exit following slashing:



Bundles distributed on mowed study aging site:



## Objectives:

- Examine drying characteristics of bundled harvest residue over time to determine:-
  - Determine post-harvest residue yield;
    - Potential moisture content reduction to increase biomass energy yield and to increase energy yield;
    - Determine ability to utilize the chipped bundle material as feed stock for pyrolysis.

## Stand characteristics:

Study site	Stand size and (age) ac	Stand vol GT/ac	Stand BA sq. ft.	Post-harv BA sq. ft.
1 <sup>st</sup> thin	12.6 (14)	132.8	115	80
2 <sup>nd</sup> thin	8.9 (25)	165.4	83	70
Mature	8.7 (54)	189.1	73	0

Green needles: 154 % MC; mature wood 100 to 115% MC; juvenile wood averages 147% MC



## Harvested and bundled volumes by stand type:

Study site	Harv. merch. vol. GT/ac	Bundled residue vol. GT/ac	Bundled residue as % merch. vol. %
1 <sup>st</sup> thin	28.9	6.4	22.0
2 <sup>nd</sup> thin	29.3	5.2	17.6
Mature	56.0	12.0	21.5

**At approximate monthly intervals bundles from each stand type were weighed for moisture content determination; 3 were cut into 5 sections and needle and stem components were separated and dried:**

- Late July: Initial green condition
- Late August: End of first monthly period
- Late September: End of second monthly period
- Late October: End of third monthly period
- Late November: End of fourth monthly period

**Bundles were marked and broken down by chain sawing into randomly selected sections**



# Stem residue drying in biomass drier:



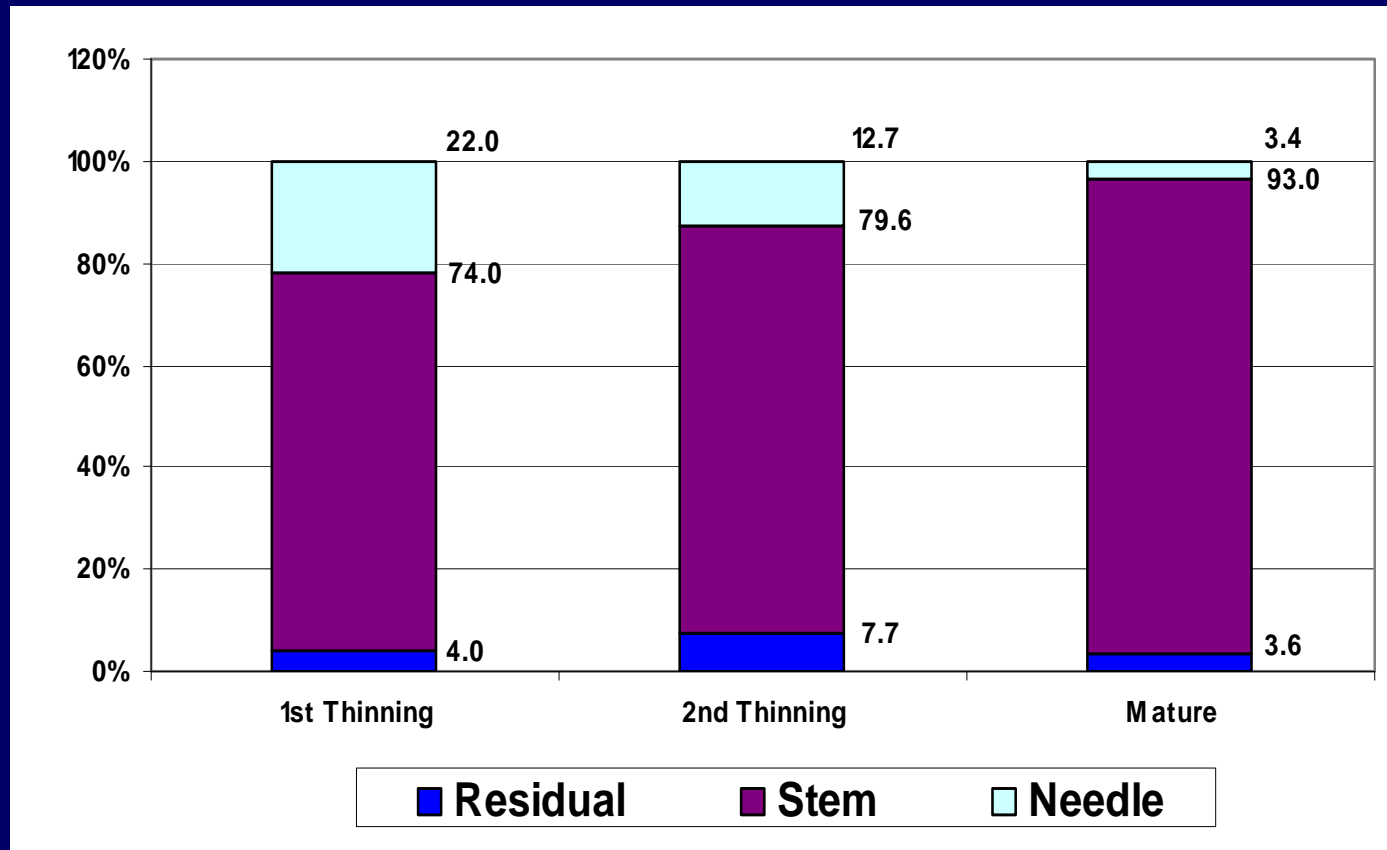
## Separated needles:



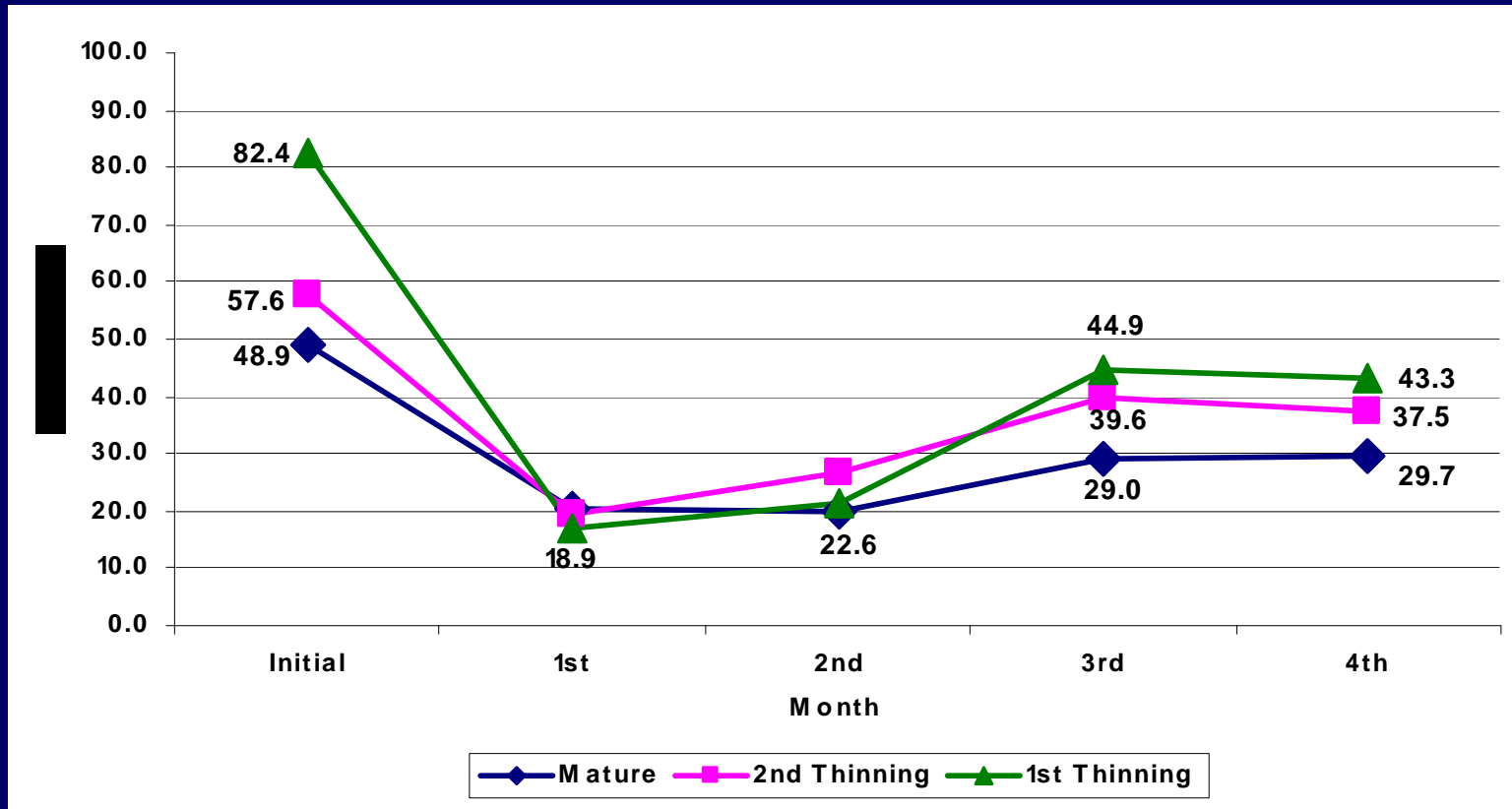
**Decomposed bundle biomass from which most of the residual component came; this residual component averaged about 6% of bundle weight:**



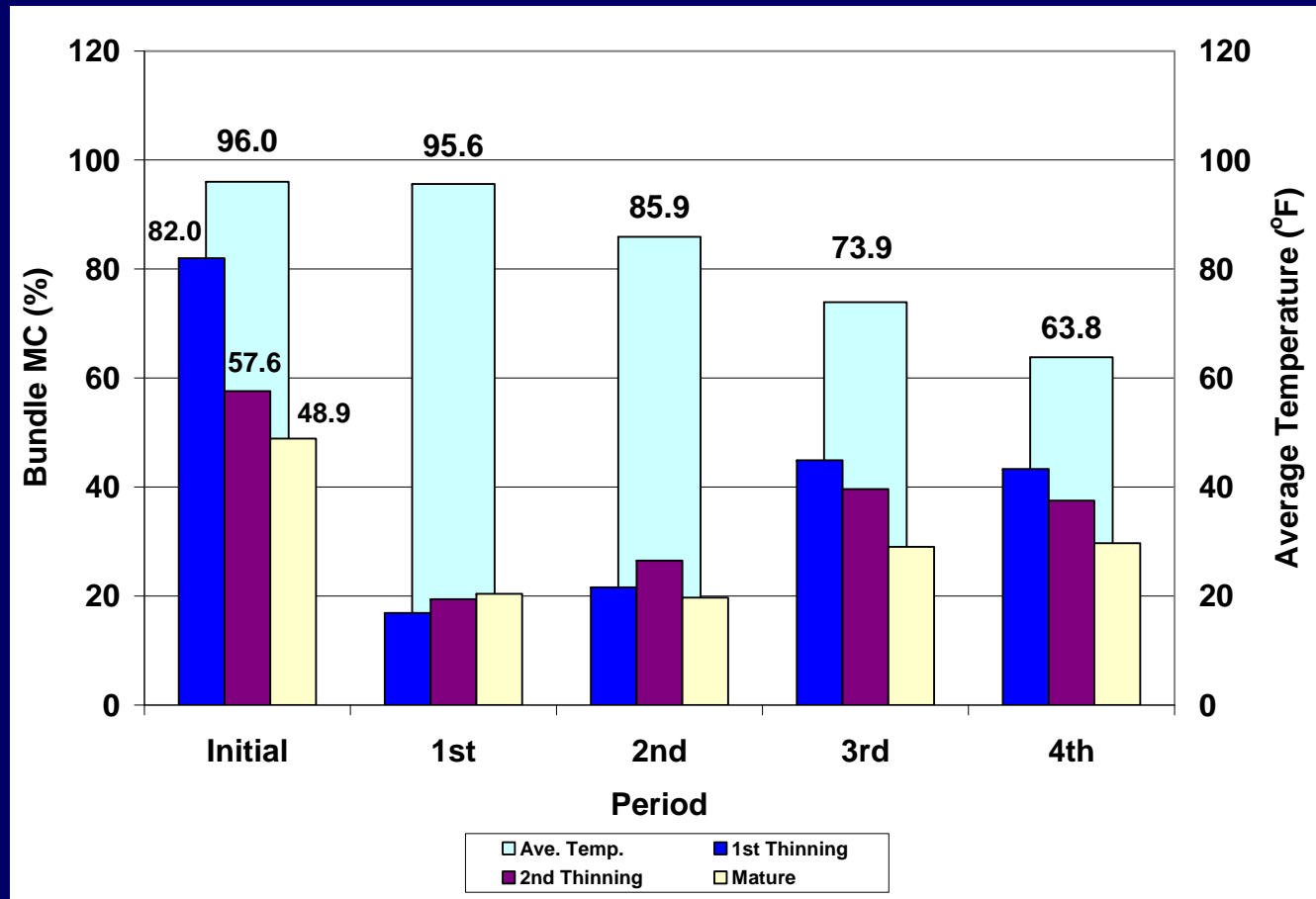
# Bundle needle, stem and residual volumes by stand type (oven-dry basis):



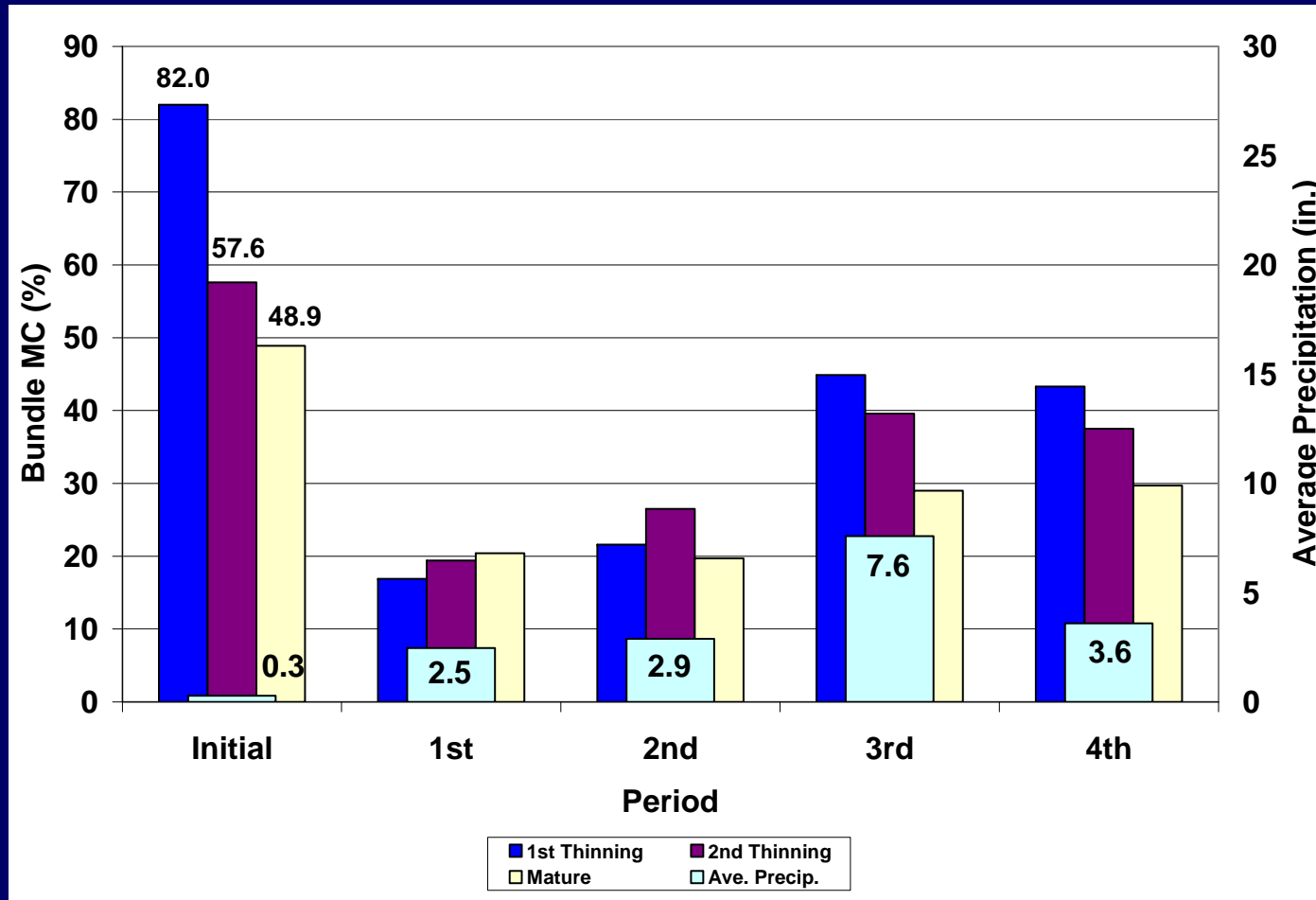
# Mean bundle moisture content by monthly period:



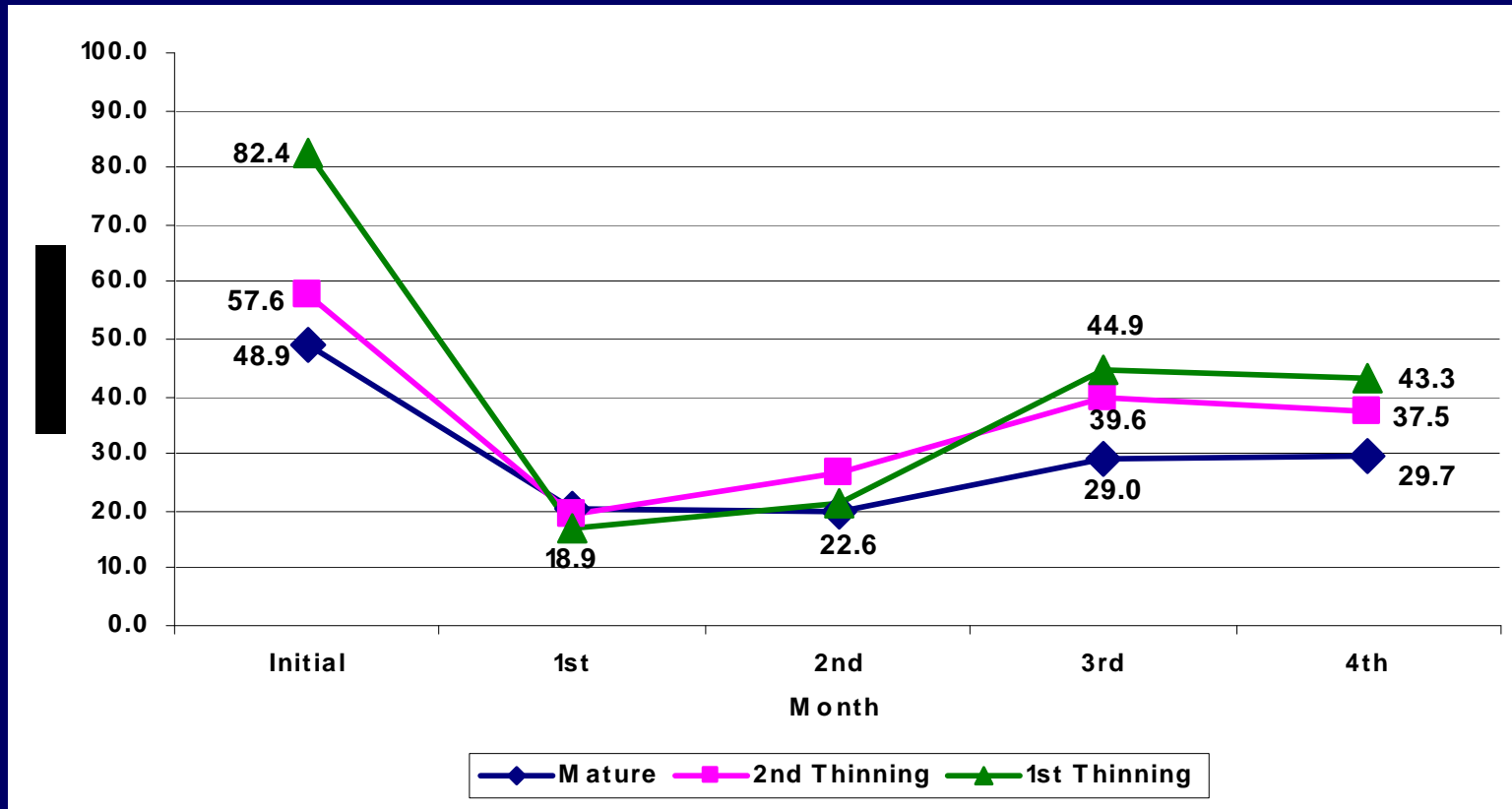
# Mean bundle moisture content by stand type compared to environmental temperature by monthly period:



# Mean bundle moisture content by stand type compared to environmental precipitation by monthly period:



# Mean bundle moisture content by monthly period:



**A regression model was developed to test the influence of needle percentage, precipitation level and temperature on bundle moisture content. All effects were highly significant indicating that needle percentage was an important factor influencing bundle moisture content variation over time.**

# **Bundle moisture contents changed rapidly over time influenced by:**

- Temperature fluctuations
- Significant precipitation differences
- These environmental factors caused the most rapid and greatest changes in the bundles from the younger stands that contained a high proportion of needles

# Production rate and cost per bundle:

	1 <sup>st</sup> thin	2 <sup>nd</sup> thin	Clear cut
Green metric Tons/hr	9.21	9.6	6.4
Bundles/hr	21.1	23.2	16.1
Cost per bundle	\$9.53	\$8.72	\$12.56

## Pyrolysis test:

- Bundler slash was chipped to ½-in. (and smaller) chips followed by hammer milling to 2-4 mm particles.
- No feeding problems were encountered during pyrolysis
- Bio-oil produced from slash feed stocks had slightly higher water content (20 vs 16%), viscosity (35 vs 30 cSt) and pH (2.9 vs 3.2): all are within acceptable range of quality

## Summary:

- Relative bundle juvenile wood and needle volumes correlate to stand type by age.
- Higher juvenile wood and needles volume content give considerably higher initial bundle weights.
- Slash bundling collected about 1/5<sup>th</sup> of merchantable volume regardless of stand type.

## Summary, cont'd:

- The juvenile and needle components also resulted in increased bundle response to temperature and precipitation.
- Bundle moisture contents can be dramatically lowered during hot periods with low precipitation; however, methods to curtail subsequent moisture increase need to be developed.

## Summary, cont'd:

- Bio-oil of good quality was produced from the bundled slash feed stock