Logging Utilization: Decision Support Tools for Land Managers

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Introduction

To answer the post-logging woody residue information needs of land managers, University of Montana (UM) researchers have investigated logging utilization of live tree biomass across the 4 state NARA area over the past 3 years. Using sample data from more than 2000 felled trees located within 81 logging sites, the authors are developing manager-friendly information summaries and forecasting tools that predict logging residue volumes and biomass at the state, region, logging site, and tree levels.

State-level Summaries

Logging utilization studies quantify timber volumes cut and delivered to the mill or left as logging residue. They provide valuable insights about the volume removal efficiency of commercial timber harvesting at the state or regional level. Logging utilization studies characterize timber removals and woody residue production by variables such as tree diameter (fig. 1), and logging systems employed (fig. 2).

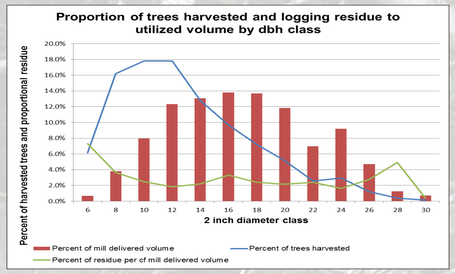

FIGURE 1: Idaho percent logging residue, mill delivered cubic foot (cf) volume, and number of trees harvested by diameter class.

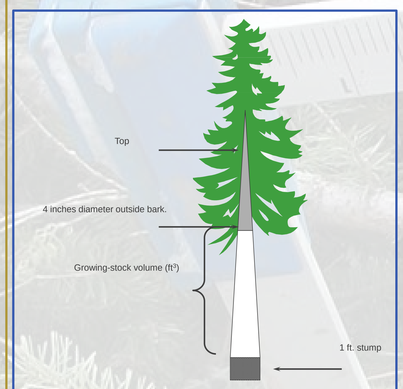

FIGURE 4: Growing stock : live tree ≥ 5.0 inches dbh, minimum one 8 foot log.

Method Type	Idaho			California			Montana		
	Percent total mill delivered	Percent total logging residue	Percent residue to mill delivered	Percent total mill delivered	Percent total logging residue	Percent residue to mill delivered	Percent total mill delivered	Percent total logging residue	Percent residue to mill delivered
Felling									
Hand	34	50	4	76	81	6	37	41	6
Mechanical	57	39	2	15	13	5	63	59	5
Mixed	9	10	3	9	6	4	0	0	0
Yarding									
Ground	89	86	2	79	73	5	77	74	5
Cable	11	14	3	21	27	7	23	26	6
Skiding									
Tree Length	84	76	2	20	17	5	78	78	5
Log Length	16	24	4	80	83	6	22	22	6
Merchandising Location									
In Unit	13	17	3	80	83	6	15	18	6
At Landing	87	83	2	20	17	5	85	82	5
Merchandising Method									
Hand	16	28	4	88	90	6	28	31	6
Mechanical	84	72	2	12	10	5	72	69	5

FIGURE 2: Montana, Idaho, and California percent mill delivered cf volume, residue cf volume, and residue to mill delivered cf volume by logging systems.

Biomass Estimator

Logging utilization study results can be used in concert with timber harvest data to estimate residue volumes. When combined with biomass conversion factors and top and limb data from other sources, analysts can estimate total tree biomass residue. Land managers can use this information to make informed decisions on how to manage residues for bioenergy applications at the stand, landscape, or state level (fig. 3).

Estimates of total logging residue for private lands in Idaho by county based on commercial timber harvest volume

County	2010 Timber harvest volume MBF	Total logging residue in green tons	County	2010 Timber harvest volume MBF	Total logging residue in green tons
Adams	9,118	14,826	Fremont	76	124
Bannock	88	143	Idaho	13,799	22,437
Bear Lake	0	0	Kootenai	38,767	63,035
Benewah	111,670	181,575	Latah	54,853	89,191
Bingham	0	0	Lemhi	0	0
Boise	18,927	30,775	Lewis	1,742	2,832
Bonner	44,118	71,735	Madison	0	0
Bonneville	60	98	Nez Perce	888	1,444
Boundary	16,522	26,865	Owyhee	0	0
Camas	0	0	Shoshone	91,880	149,398
Caribou	300	488	Teton	0	0
Clark	0	0	Valley	20,723	33,695
Clearwater	138,950	225,933	Washington	56	92
Elmore					
Sub total	339,753	552,438		222,784	362,247

	MBF	Residue
Total	562,537	914,685

FIGURE 3: Idaho state timber harvest and logging residue volumes and biomass by county .

Residue prediction models

Land managers seek ***stand-specific*** residue information to inform their prescription efforts. Using logging utilization sample data collected in 2008 and 2011 from 815 felled trees within 33 Idaho logging sites (25 to 30 trees per site), the authors developed linear mixed models that relate the growing stock (fig. 4) residue factor, F3 (growing stock residue cf volume/mill delivered cf volume; fig. 5), to variables easily obtained by landowners: whether or not pulp is removed, logging systems employed, and geographic area (fig. 6). This stand-level modeling approach does not require a tree list. Because F3 is a ratio, it can be applied to the landowner's stand-level cf timber harvest volume regardless of stand area to estimate stand-level bole residue production. Minimum top-end utilized bole diameter (e.g. 4 inches) can be substituted for the pulp removal variable in a variant of the model.

F3, the "growing stock residue factor" =

Logging residue volume (bole wood only)

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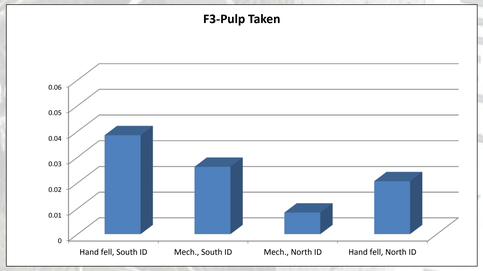
Delivered volume

FIGURE 5: The growing stock residue factor, F3- cubic feet of logging residue vs. cubic feet of mill delivered timber



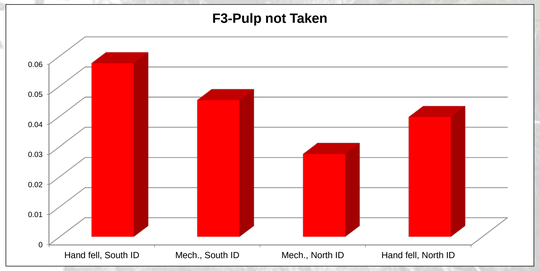
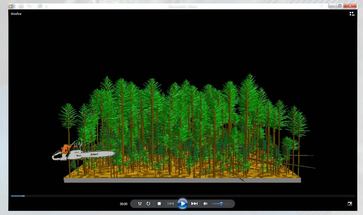


FIGURE 6: Site level residue prediction model. F3, growing stock residue cf volume/mill delivered cf volume, is reduced (less residue per delivered volume) when timber is mechanically felled (Mech.) and on productive sites in north Idaho . Removing pulp substantially reduces logging residue.

Improving Forest Vegetation Simulator (FVS) residue predictions

The Forest Vegetation Simulator (FVS) growth and yield model can predict logging residue volumes and biomass created during timber harvest (fig. 7). FVS users must estimate the number of trees left during logging operations. However, most users have only anecdotal knowledge about how many trees will be left unused. Using logging utilization research results, UM researchers are working with FVS staff to quantify residue volumes and improve the residue prediction capabilities of FVS.



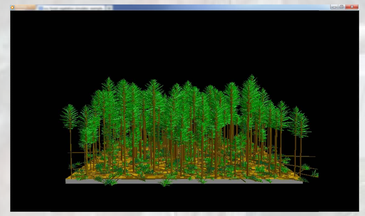


FIGURE 7: FVS simulated tree cutting residue production.

Predicting available woody biomass in forest landing residue piles

Oregon State University (OSU) scientists (Long and Boston 2014) have developed a sampling protocol that estimates woody biomass found in residue piles (fig. 8). UM and OSU scientists have joined forces to link UM's logging utilization research to OSU's residue pile estimation work. OSU and UM researchers will develop correlative models that relate within-pile biomass (derived from OSU pile-based residue estimates) to total forest residue (derived from UM logging residue factors). OSU's research will then be leveraged with BBER's efforts to estimate available biomass feedstocks on any westside site.

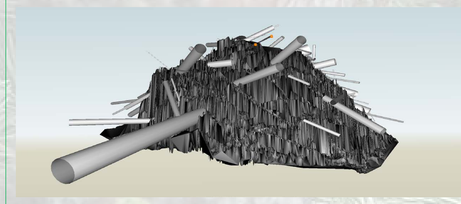


FIGURE 8: Three-dimensional model of a residue pile; compiled from a mesh and pipes image fitted to a laser range finder point cloud (Long and Boston 2014).

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