Estimating logging residue volumes in the state of Idaho: preliminary predictive models

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The need: Land managers seek to quantify the amount of woody residue left on-site after logging

- Residue info. uses
  - Biomass for energy production
  - Nutrient recycling
  - Fuels management
  - Wildlife habitat
  - Operational efficiency

Could logging utilization data be used to tailor logging residue estimates to the *logging site or stand* level?

- Logging utilization studies have previously focused on the *state* level.
- Enable managers to hone their prescriptions for *site-specific* residue conditions

Research question: Can a *site-level* model be developed to meet the residue information needs of managers?

- **Objectives:**
  - **<u>Predict residues</u> (unutilized growing stock- not tops and limbs) at the *logging site*-level.**
  - **<u>Keep it simple</u>- use variables readily available to land managers.**
  - **<u>Reduce costs</u>- use existing data.**

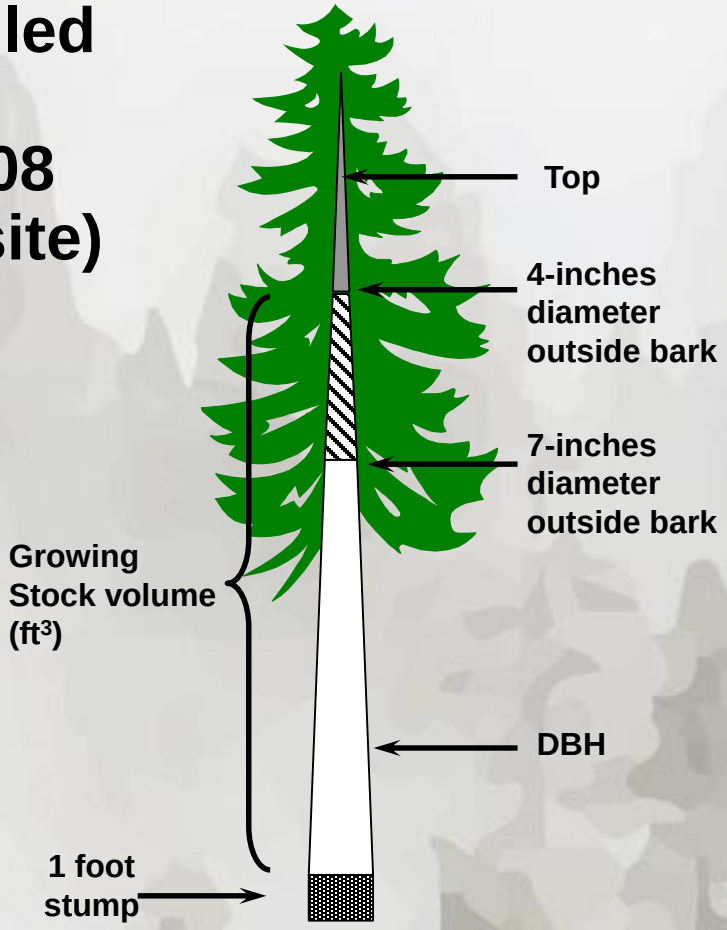
How to meet objectives

- **First, parameterize models at the *individual tree level*- gain information on important variables.**

- **Next, develop *site-level* models that predict residue production.**

Methods

- **Focus initial efforts on Idaho: data from 815 felled green trees across 33 logging sites during 2008 and 2011 (25 trees per site)**
  - **Tree measurements: outside bark diameter and section lengths ≤ 16 feet**
  - **Identify growing stock residue vs. mill delivered volume (cubic feet)**



Methods

- The <u>response variable</u> is the ratio “F3”

- F3 is a function of only *bole wood.*
- F3 is *scalable*; beneficial for land managers.

F3, the “growing stock residue factor”

=

Growing stock logging residue cubic foot volume (bole wood only)

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Delivered cubic foot volume

Analysis

Individual tree models-

- **F3 vs. variables modeled with hierarchical linear mixed models.**

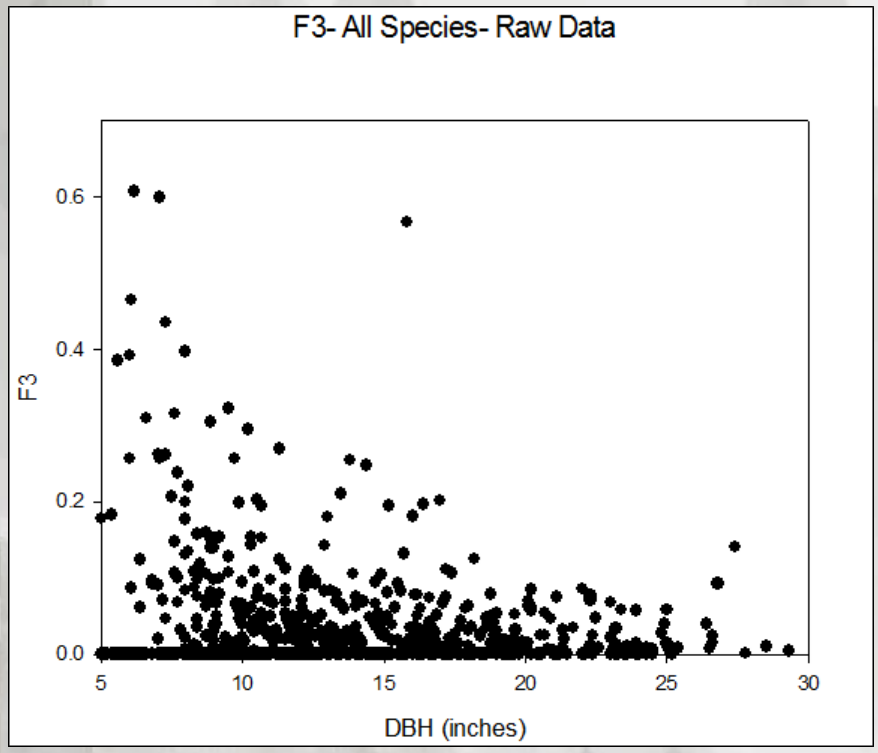
- **<u>Model goodness of fit</u>: rough analog to R^2= *.18*** (n=814 trees)

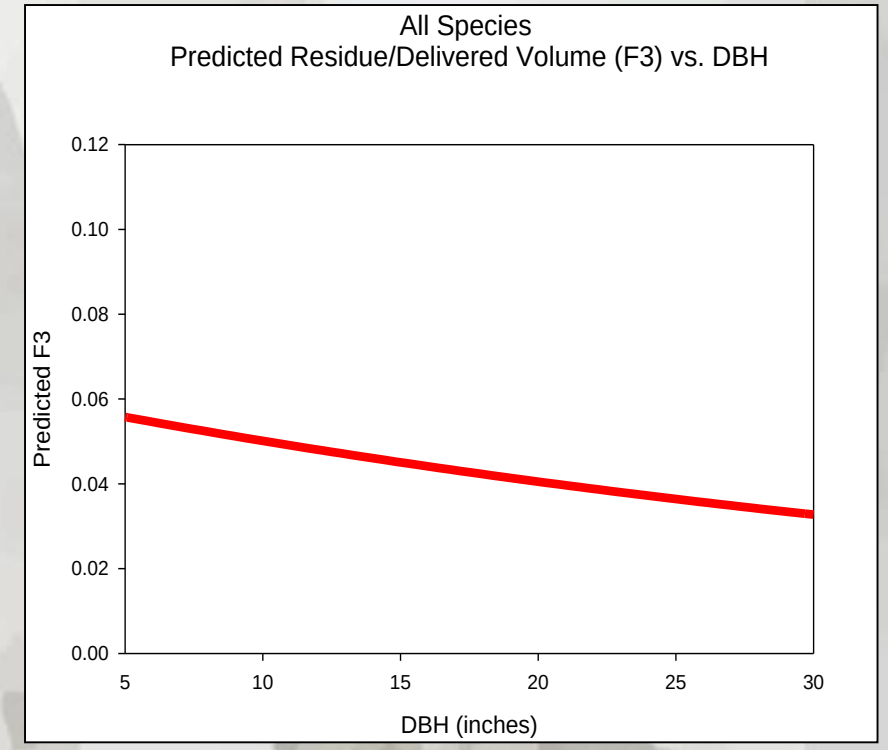
- **Why such a poor fit? Enormous variability from tree to tree.**

Analysis

Individual tree models, important variable:

- **Tree diameter- substantial variability of F3 vs. DBH.**





Analysis

Individual tree models, <u>important variable</u>:

- **<u>Merchandising</u>- Mechanized vs. by hand (chainsaw).**

Analysis

Individual tree models, important variable:

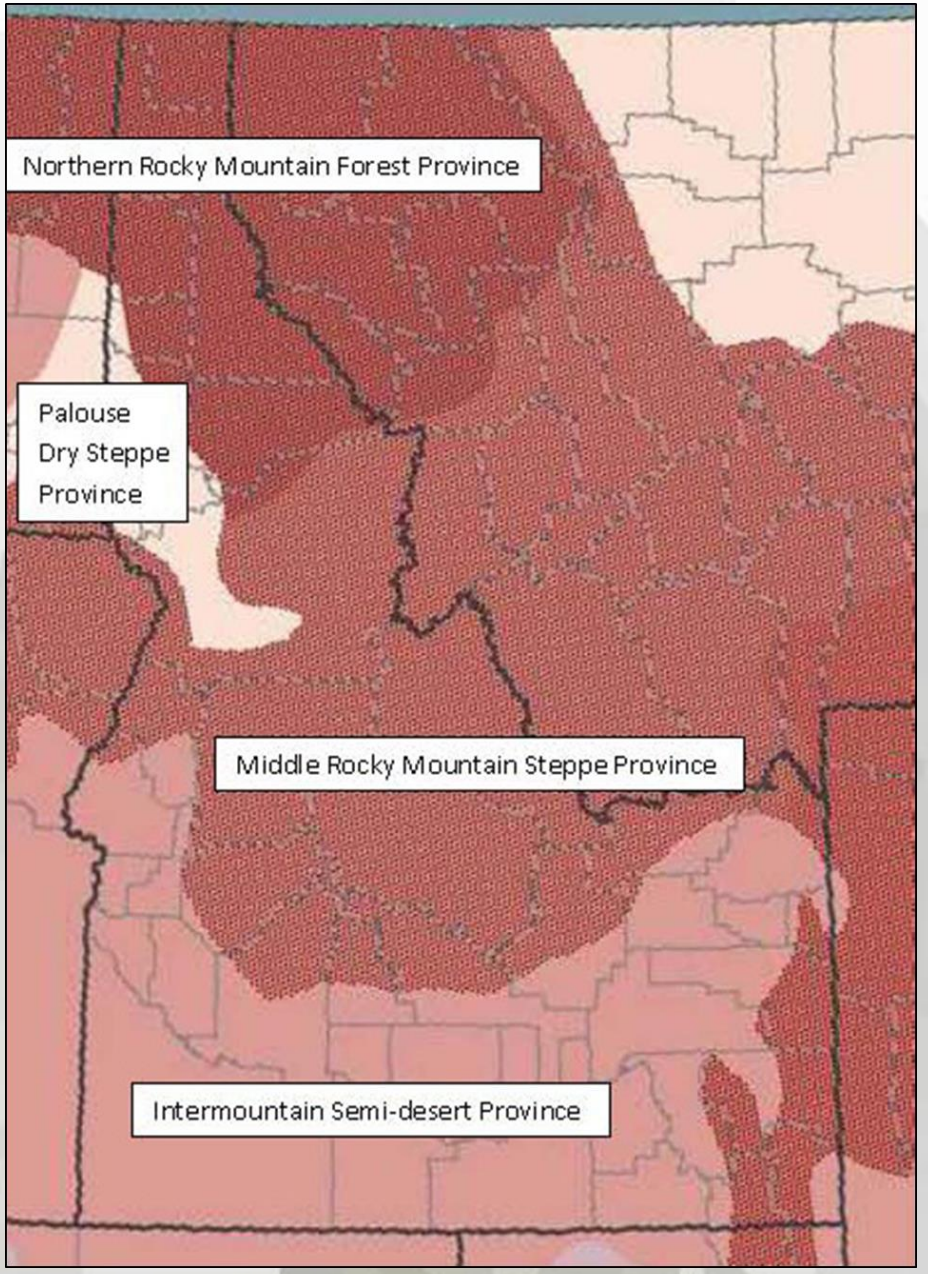
- **Taking pulp- *yes or no*.**
- **Has an *enormous* impact on F3!**
- **Can substitute smallest top-end diameter of utilized bole instead of taking pulp.**

Analysis

Individual tree models, <u>important variable</u>:

<u>Site quality</u>

- **<u>Bailey's Ecoregion Province</u>- strongly related to F3.**



Results

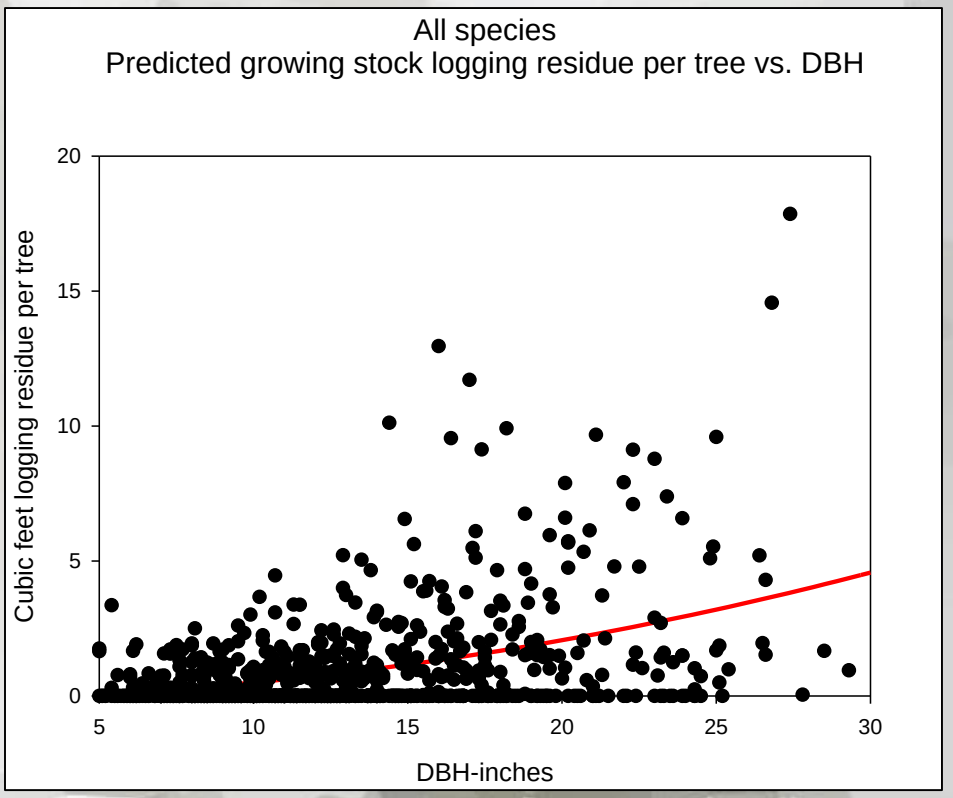
- **Individual tree; final model:**

Variable	Change in F3 (residue/delivered volume)
MERCHANDISING METHOD- mechanized vs. chainsaw. ***Mechanical falling also highly correlated to F3.***	F3 decreases when timber is mechanically processed.
DBH- fit as quadratic term	F3 decreases as DBH increases.
TAKING PULP?- yes or no (includes dbh*pulp interaction)	F3 *substantially* decreases when pulp is taken.
ECOREGION- north or southern Idaho (can subsitute habitat type series)	F3 decreases in north Idaho sites.

Results

Can we directly predict residue volume per tree and not the F3 ratio? Yes.

- **Residue volume per tree; model has same variables.**



Methods

Site-level model

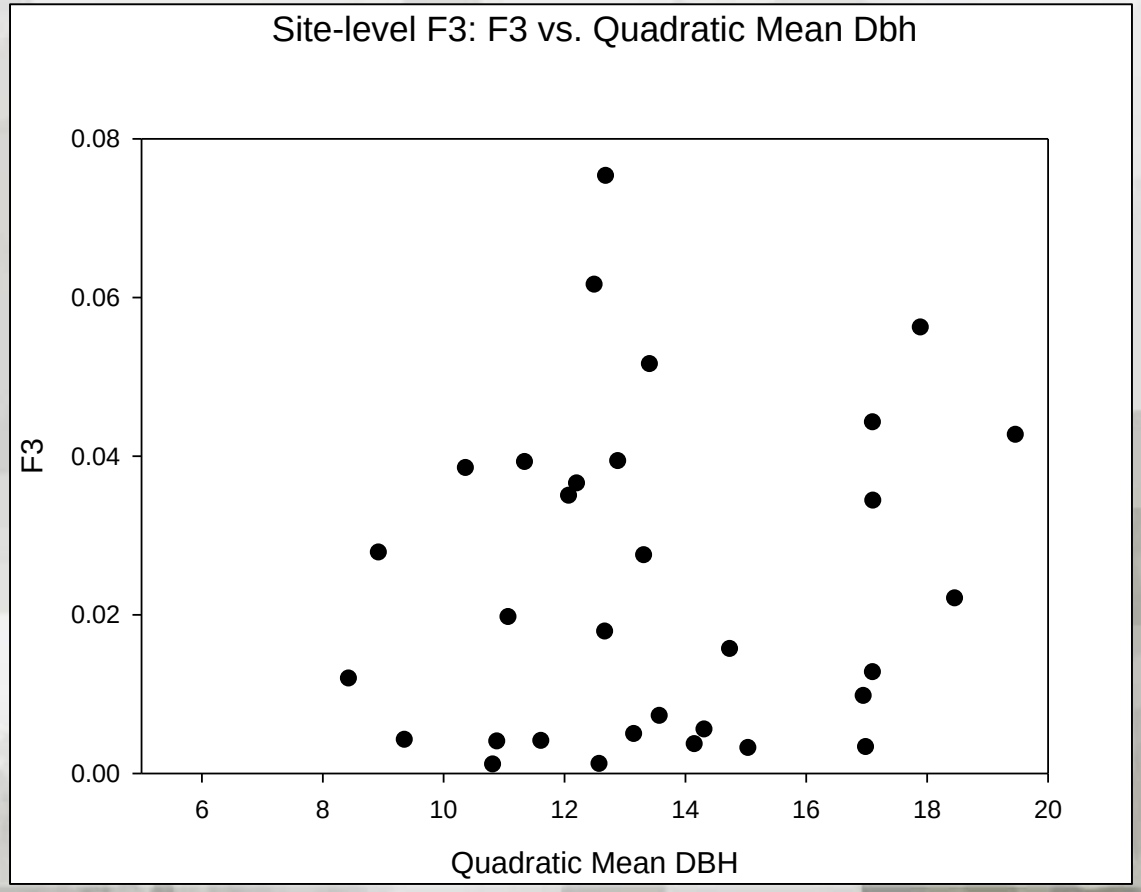
- **F3 vs. *site-level* variables modeled with linear mixed models.**

- **<u>Goodness of fit</u>: = .57** (n=33 sites)

Analysis

Site-level model

- **<u>Quadratic mean dbh</u>- *NOT* related to F3!**



Analysis

Site-level model, important variable:

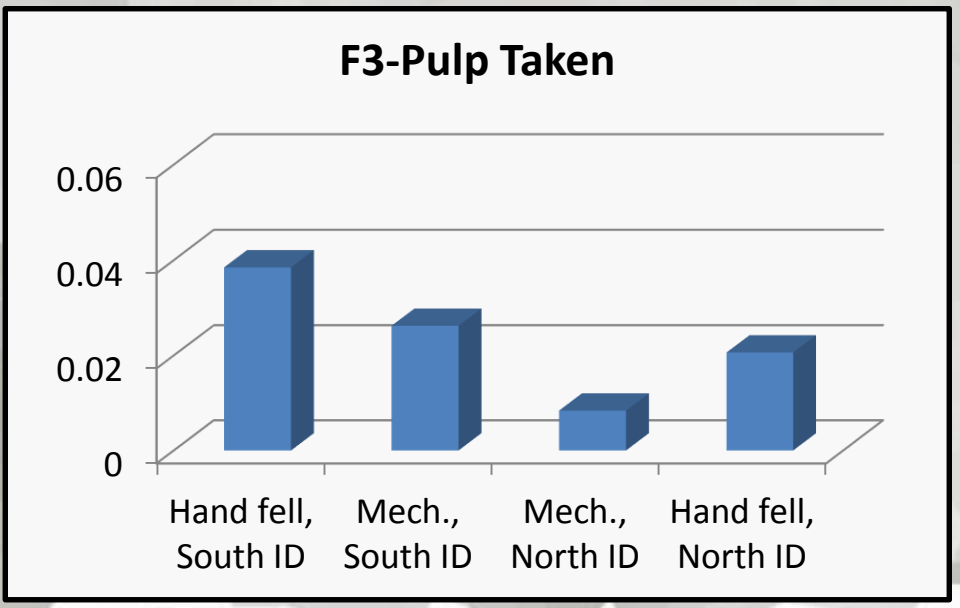
- **Falling method- Mechanized vs. by hand (chainsaw).**

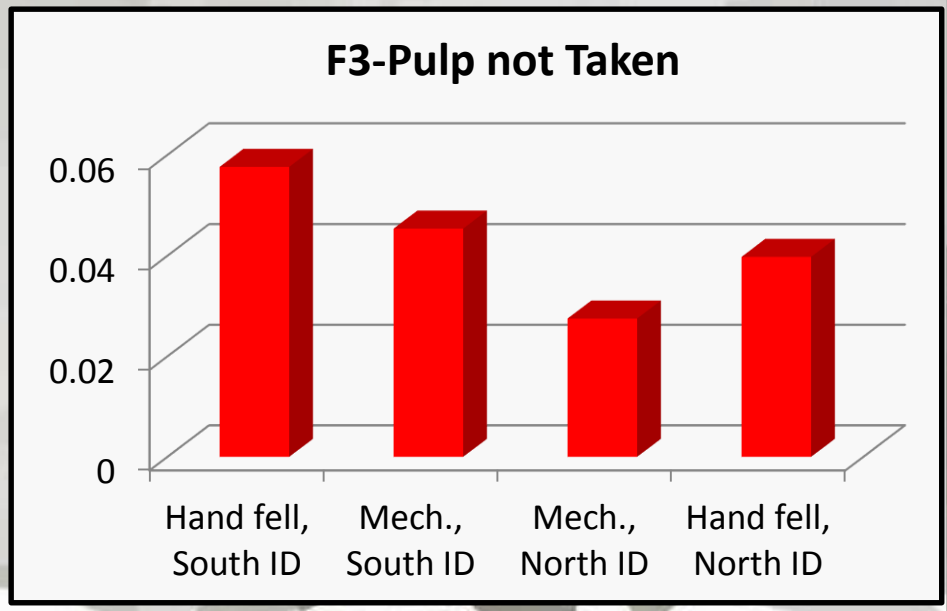
Analysis

- Site-level model- important variable:

Taking Pulp- yes or no

- **Has an *enormous* impact on F3!**
- **Can substitute smallest top-end diameter of utilized bole instead of taking pulp.**





Results

Site-level model-

Variable	Change in F3 (residue/delivered volume)
Mechanical harvesting- yes or no	F3 decreases when timber is mechanically felled (e.g. feller buncher).
Taking pulp-yes or no (can substitute smallest end diam.)	F3 *substantially* decreases when pulp is taken.
Ecoregion- north or southern Idaho (can substitute habitat type series)	F3 decreases in north Idaho.

Conclusions

- **Individual tree model: weak relationships, but gained insights about how to construct site-level models.**

- **Site level model: reasonable explanatory value and do not need a tree list to make residue predictions!**

- **Models will change with additional data as logging sites are sampled across Washington, Oregon, Idaho, and Montana.**

Applications

- **Land manager predictions of site-level residue volumes.**
- **Use models or data to calibrate predictions of activity fuels and woody debris (example- FVS activity fuels).**
- **Could adapt models to predict biomass.**
- **Build on other inventory procedures to create a comprehensive picture of fuels and available biomass feedstocks throughout the Northwest.**