Logging Utilization Research in the Pacific Northwest: Residue Prediction and Unique Research Challenges

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Outline

- Introduction to timber products output (TPO)
- Logging utilization research objectives
- Methods
  - Sampling challenges
  - Sample protocol- site and tree selection, measurements
  - Simulation to check for sampling bias
- Results- residue ratio by entire project and regions
  - Simulated versus “real” data outcomes
- Residue guidelines for managers
- Future research
Why is TPO important?

Timber products and logging residues are “components of change” - carbon accounting, etc.

Accurate accounting of total removals and wood utilization relies on TPO data from mill and field studies.

TPO information is not duplicated within FIA.

  • Removals for timber products are only partially captured by P2 plot data.
  • Info on timber processors, logging residue, and mill residue are not captured at all by plot data.
Logging Utilization Research Objectives

The overall goal was to acquire and analyze the data needed to develop/update TPO harvest residue data for each state in the 4-state Pacific Northwest NARA region.

- Biomass for energy production
- Nutrient recycling- LCA
- Carbon dynamics
- Fuels management
- Fire behavior
- Wildlife habitat
- Operational efficiency
Sample design problem: comprehensive lists of logging sites do not exist, so we can’t select sample sites at random and conduct probabilistic design-based sampling

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<th>Site</th>
<th>Acres</th>
<th>Ownership</th>
<th>Silv. Rx</th>
<th>Date felled</th>
<th>Date yarded</th>
<th>Date hauled</th>
<th>Total volume harvested (MBF Scribner)</th>
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<td>25 USFS</td>
<td>SW</td>
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<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
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<td>NA</td>
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</tbody>
</table>
What to do?

- **Model-based** sampling.
- Model error serves as a surrogate for design-based sampling error.
- Sample weighting, stratification, and clustering where possible (keep the design-based tools in the toolbox).
Logging Utilization Sample Sites

Site selection

- Four strata = “Regions” based largely on Bailey’s Ecoregions.
- Distribution of sample sites proportional to 5-year harvest volumes by region
- Measurable felled trees & stumps
- Commercial products
- Not salvage
- 101 sites (2008-2013)
- Safe!
Logging Utilization Sampling Methods

- Focus was growing stock.
- Cutting card was a utilization guide.
- Checked log decks and residue piles for top diameters.
- Used FIA definitions: 1’ stump, dbh, 4” top, growing stock, etc.
- Identified each bole section as used (product) or not (residue)
Measuring trees

Methods

1 ft.
Stump

dbh

16’ Sawlog

16’ Sawlog

7” (End of Sawlog)

4” Top

End of Utilization

Tip
Methods

- The **response variable** is the residue ratio (expressed as ratio of means).
- Residue ratio is a function of only *bole wood*.
- Ratio is *scalable*; beneficial for land managers.
Analysis

- Residue ratio (RR) of means modeled with multilevel (sites within regions) linear mixed model.
- Sample weighted by regional proportion of harvest volume.
- Residue ratio also calculated with classic design-based survey sample software.
  - Why? - design-based has been “business as usual”. Have we biased our samples by not choosing sites at random?

(2001 trees sampled within 101 sites within 4 regions)
Analysis
- Again...could our logging site selection be biased?
- Simulate residue ratio distribution to obtain the “true” population; compare with “real” data.
  - But what is the theoretical distribution of the residue ratio- the “true population”?
  - Past projects: California and Montana suggest a normal, log normal, or chi square distribution
Analysis

But the 2008-2013 sample suggests an exponential distribution

Pacific Northwest sampling 2008-2013
Analysis

Decision- go with mixture distribution (mostly exponential)
Why?- sample trees consistently second growth; low stump heights, mechanized felling, pulp taken on most sites- all contribute to low RR.
Results

- Project as a whole residue ratio for 4 states = 0.027 or 27 cubic feet of growing stock residue per 1,000 cubic feet mill delivered.
- Residue ratios varied little by region.
- Design and model-based produced essentially identical residue ratios and standard errors.
- “Real data” outcomes within 1 percent of simulated (minimal bias).
Results

Could detect little bias—compared “real” data with simulated and bootstrap of real data.

Means and 95% CIs

Real data (101 sites)

Real data- 1,000 reps- bootstrap

Simulated- 1,000 reps- then 1,000 draws
Final note on sampling

- Model-based sampling is a reasonable way to structure a logging residue sampling protocol; simulation suggested that sample was likely not biased.

- But design-based sampling may be a wiser choice, if you can obtain comprehensive lists of active logging sites.

- Are there alternative ways to conduct probabilistic design-based sampling?
Residue Guidelines for Managers

**Important variables:**

- **Taking pulp-**
  - yes or no.

- **Falling method-**
  - Mechanized vs. hand (chainsaw)
Residue Guidelines for Managers

Residue Ratio by pulp removal and felling method
Summary

- Project as a whole residue ratio for 4 states = 0.027 or 27 cubic feet of growing stock residue per 1,000 cubic feet mill delivered.

- Essentially no difference in design and model-based residue ratios.

- Little difference in residue ratios by region.

- Simulation suggested minimal sample bias (but more work needed and each project area’s logging site residue ratios can be unique- hard to know distribution in advance).

- Research provides useful residue information for land managers.
Thank you for your time!

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