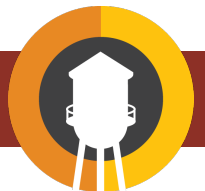




Feedstock Logistics for Aviation Fuel

John Sessions
Oregon State University
November 17, 2016

Northwest Advanced Renewables Alliance





Feedstock Logistics

Feedstock:

Forest harvest residues are byproducts from commercial timber harvest

Logistics Issues:

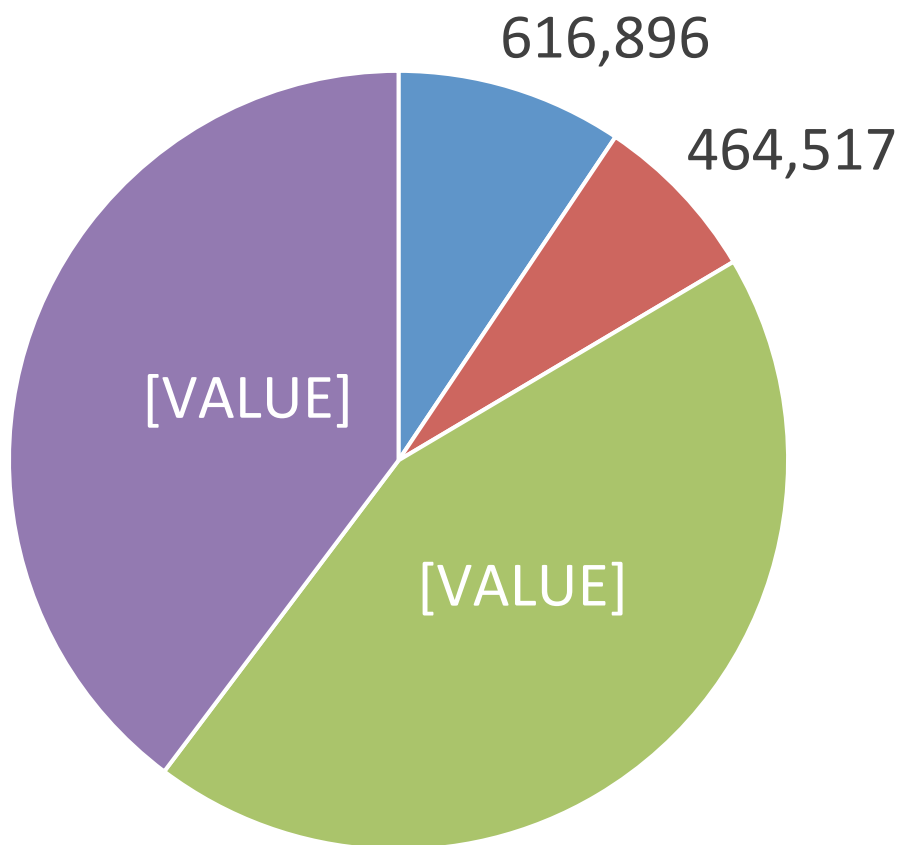
What are the most efficient forest harvest residue collection and delivery methods?



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Forest Harvest Residues on Non-Federal Forests (Oven Dry Tons)



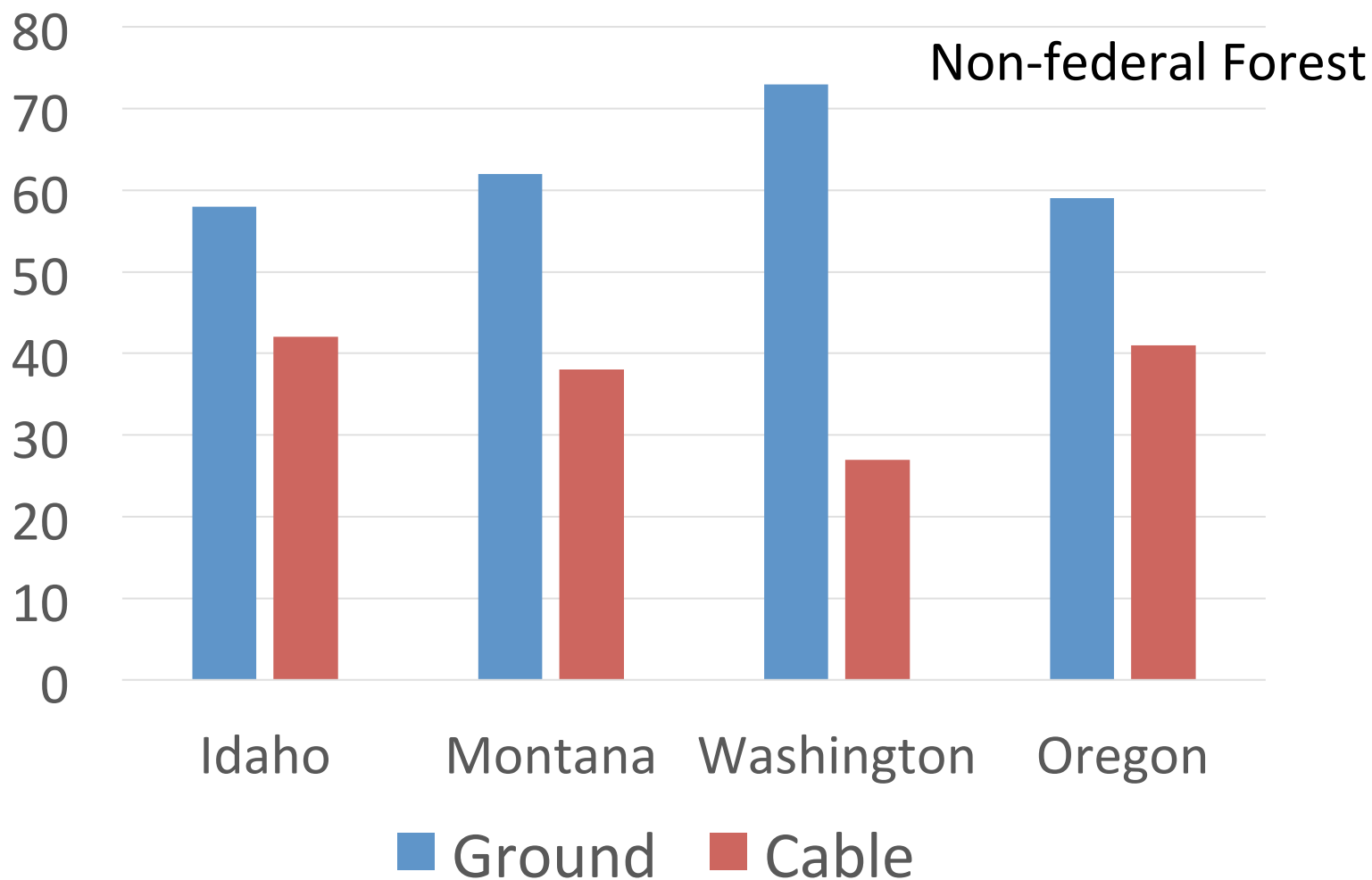
■ Idaho ■ Montana ■ Washington ■ Oregon



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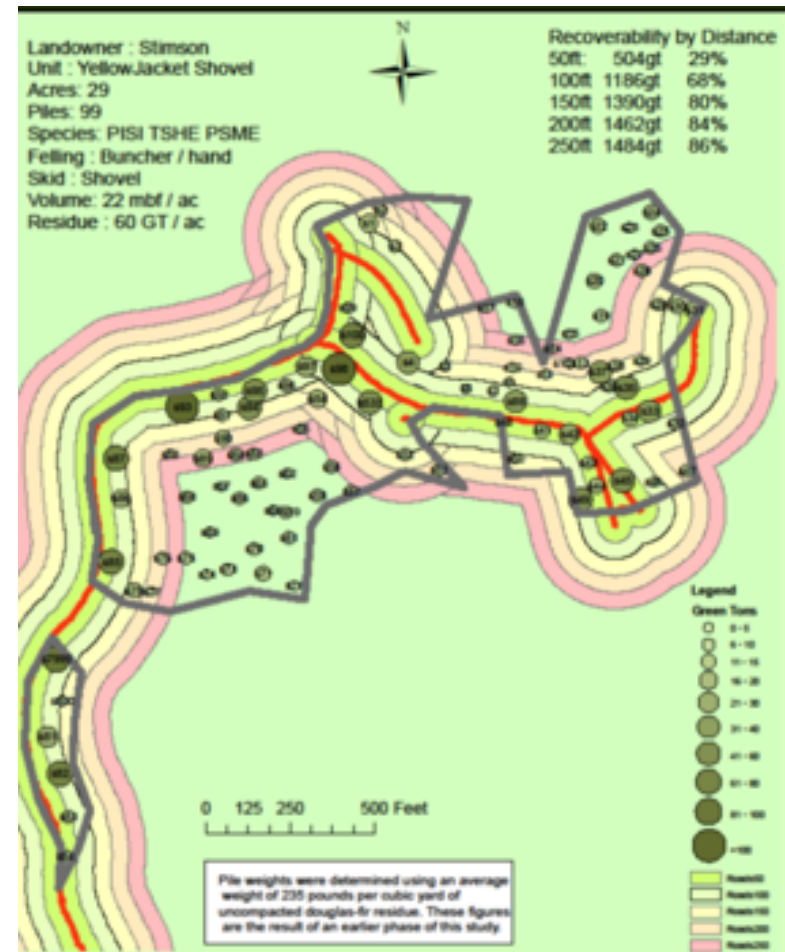
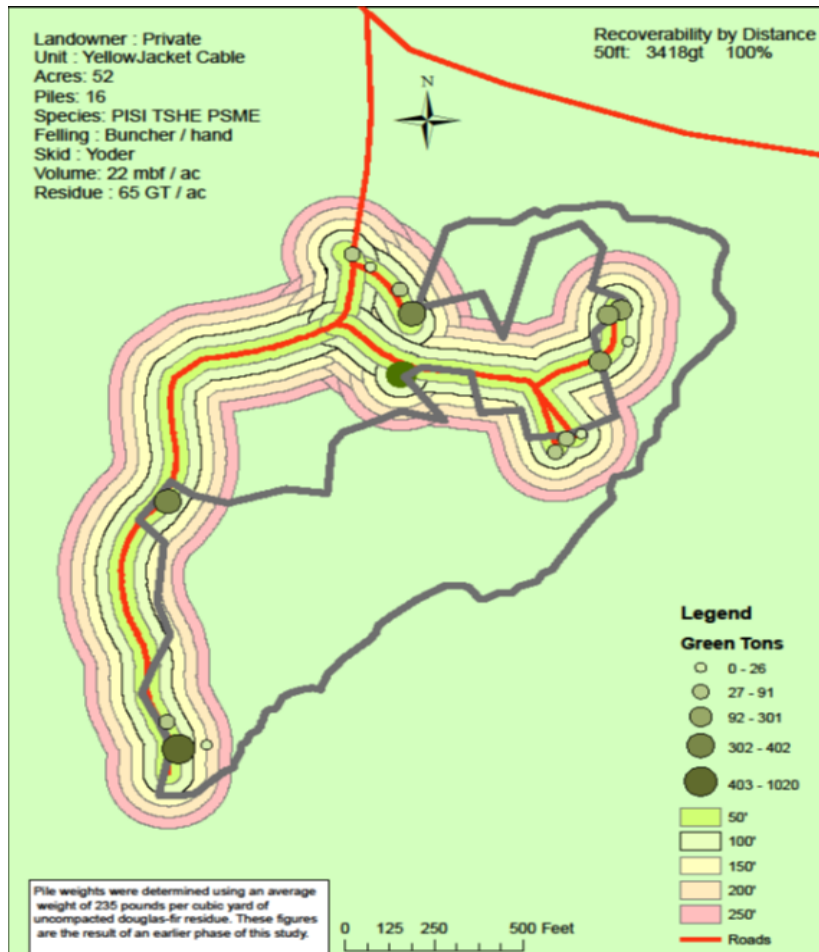
Forest Harvest Residue by Harvest System (%)



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Where is the biomass?





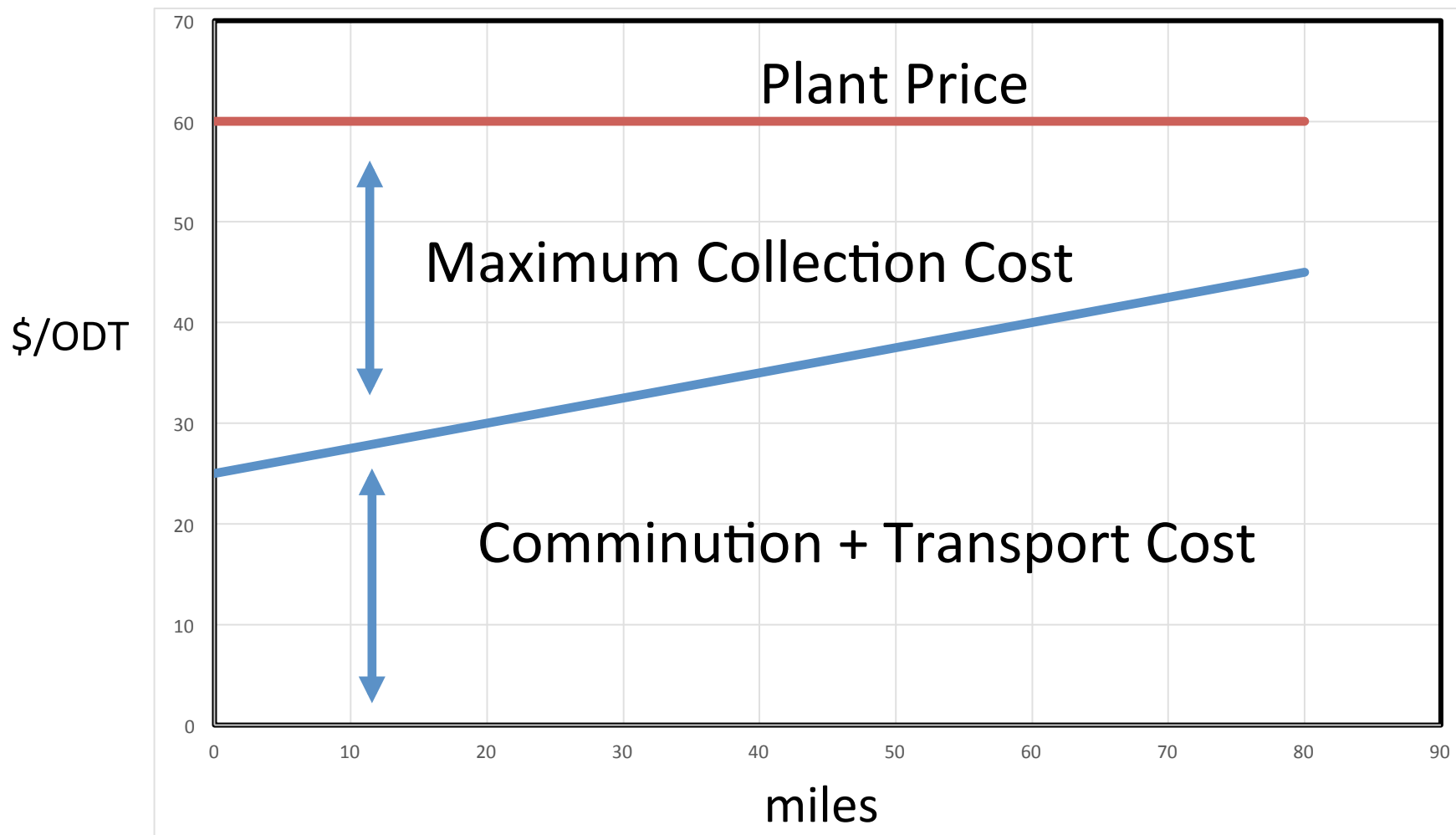
Cost Factors

- Harvest System
- Large Trailer Access to Landing
- Material Density
- Material Quality
- Transport Time to Plant



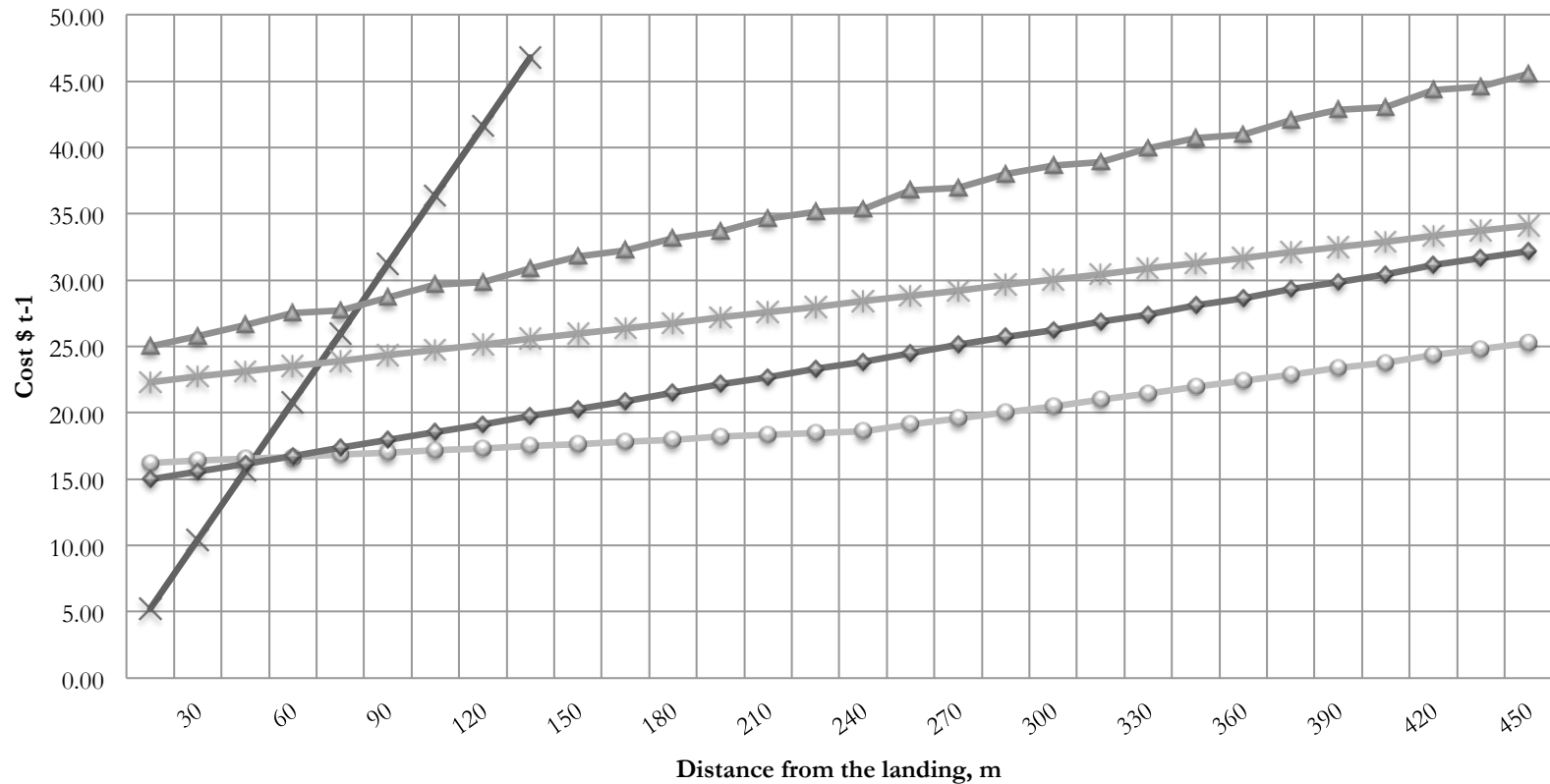


Collection vs Transport Costs





Collection Costs



✕ System 1: 1-Loader only

▲ System 2: 1-Forwarder & Self-Loading

◆ System 3: 1-Forwarder & 1-Loader

● System 4: 2-Forwarders & 1-Loader

* System 5: 2-Forwarders & 1-Loader & 1-Operator

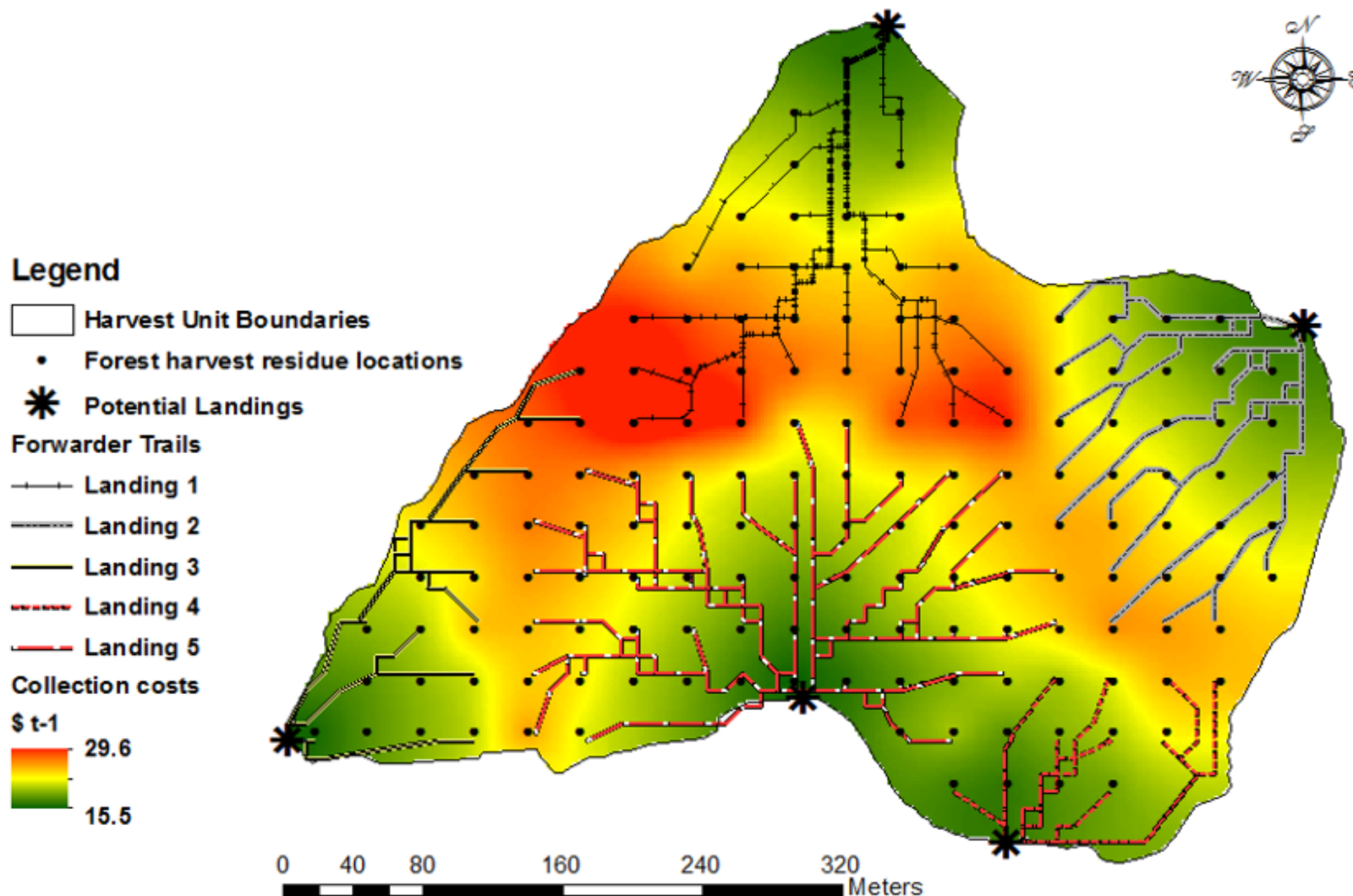
- **Marginal cost (\$/ODT) to bring forest residues to landing. Mobilization costs not included (Zamora and Sessions 2016).**



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Collection Costs at Harvest Unit

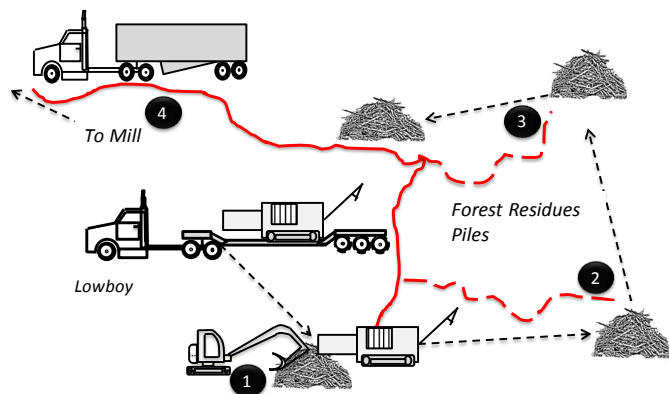


From Zamora and Sessions, 2016

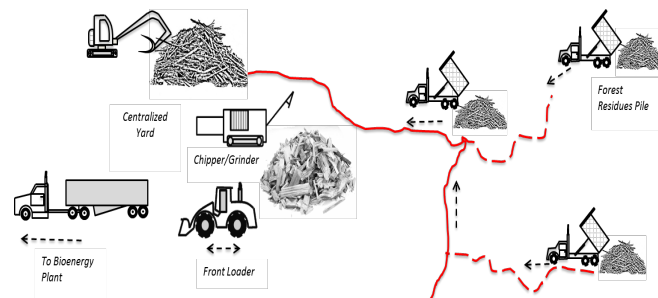
NARA



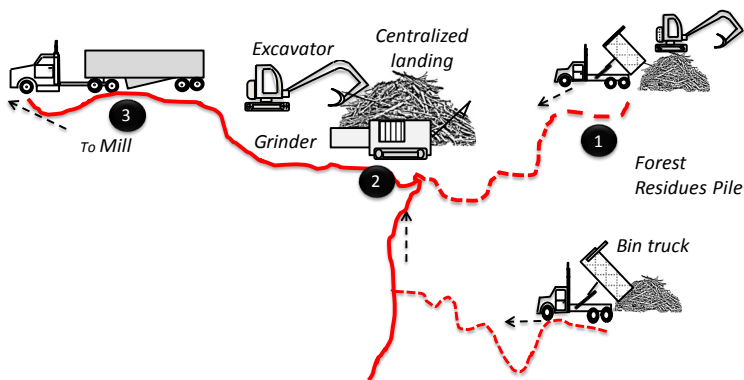
Truck Transport Options



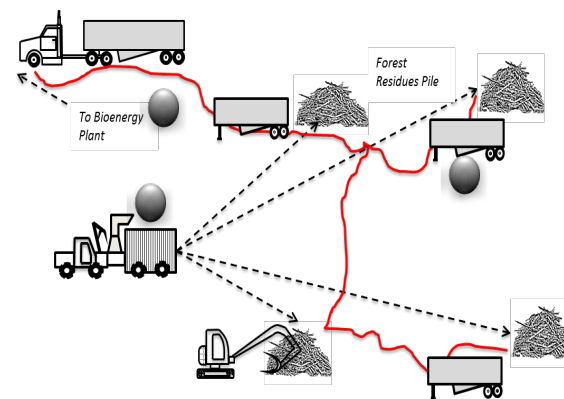
Large Trailer to Each Landing –
Grind at Each Landing



Small Truck to Each Landing – Grind
At Central Landing



Combination of Large and Small Trucks-
Grind at Some Landings



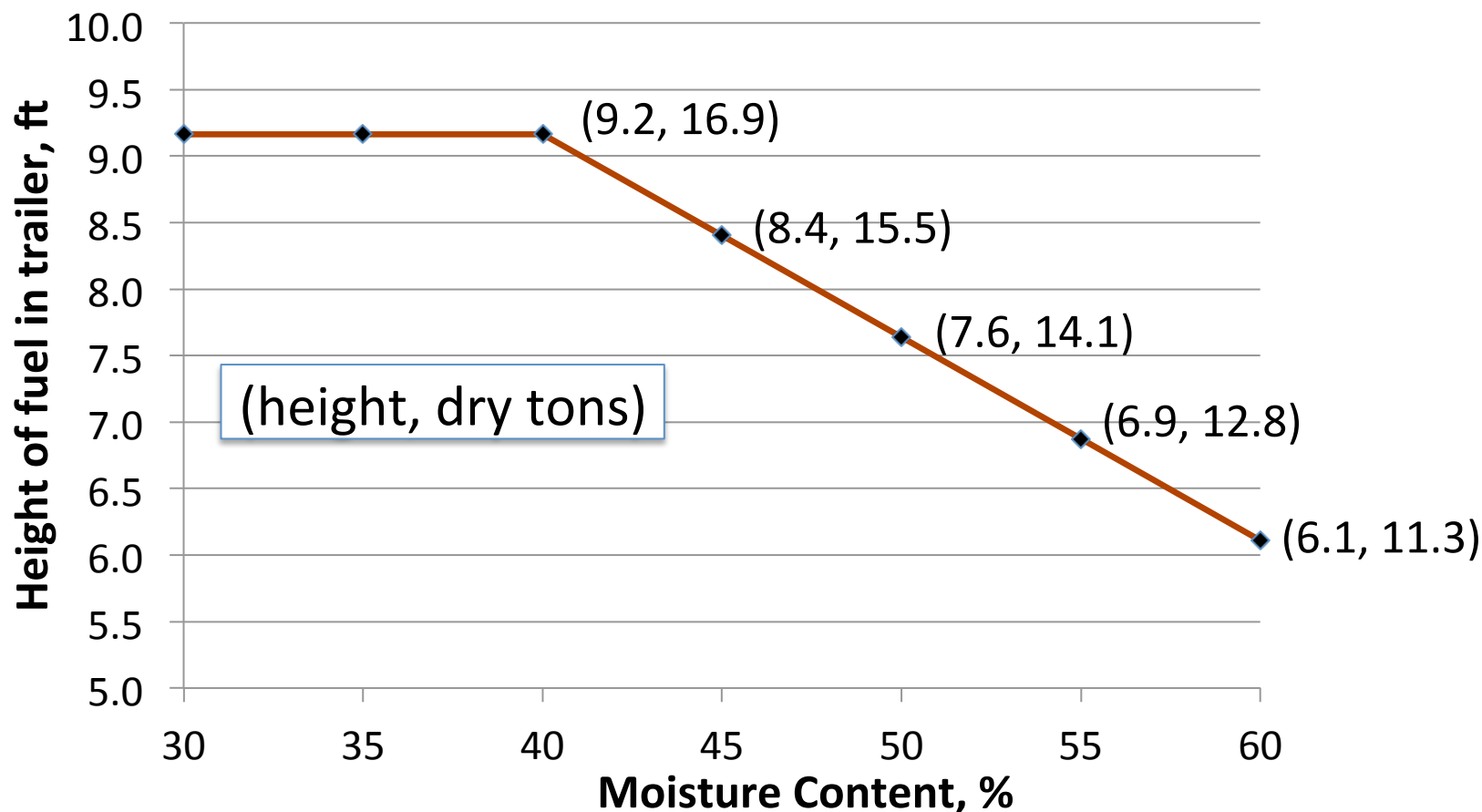
Mobile Chipper with Set-out Trailers





Moisture Management Essential

Residue Height in Trailer



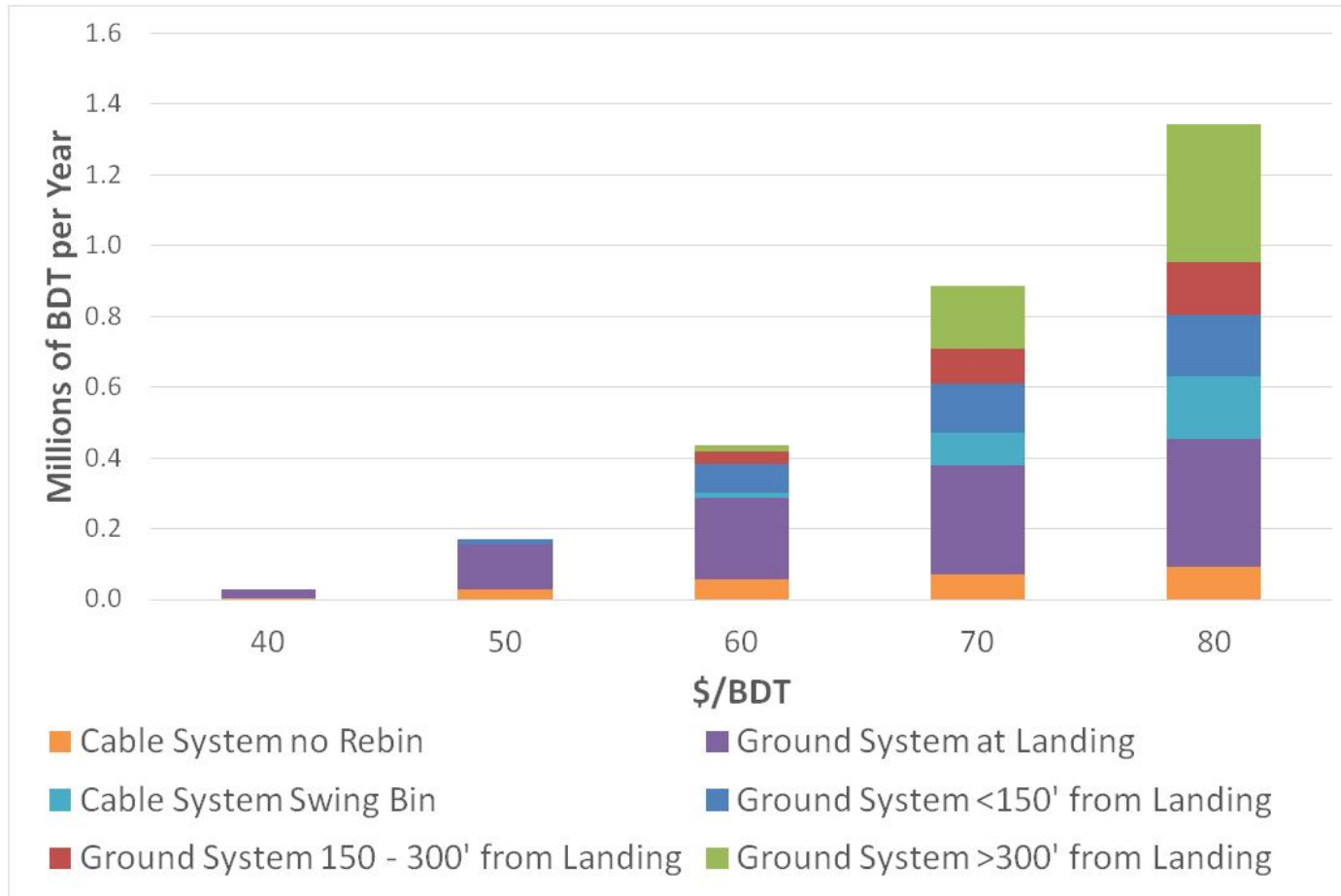
48-ft trailer, 8.3 ft wide, dry bulk density (hogfuel) = 9.3 pounds per cubic foot.



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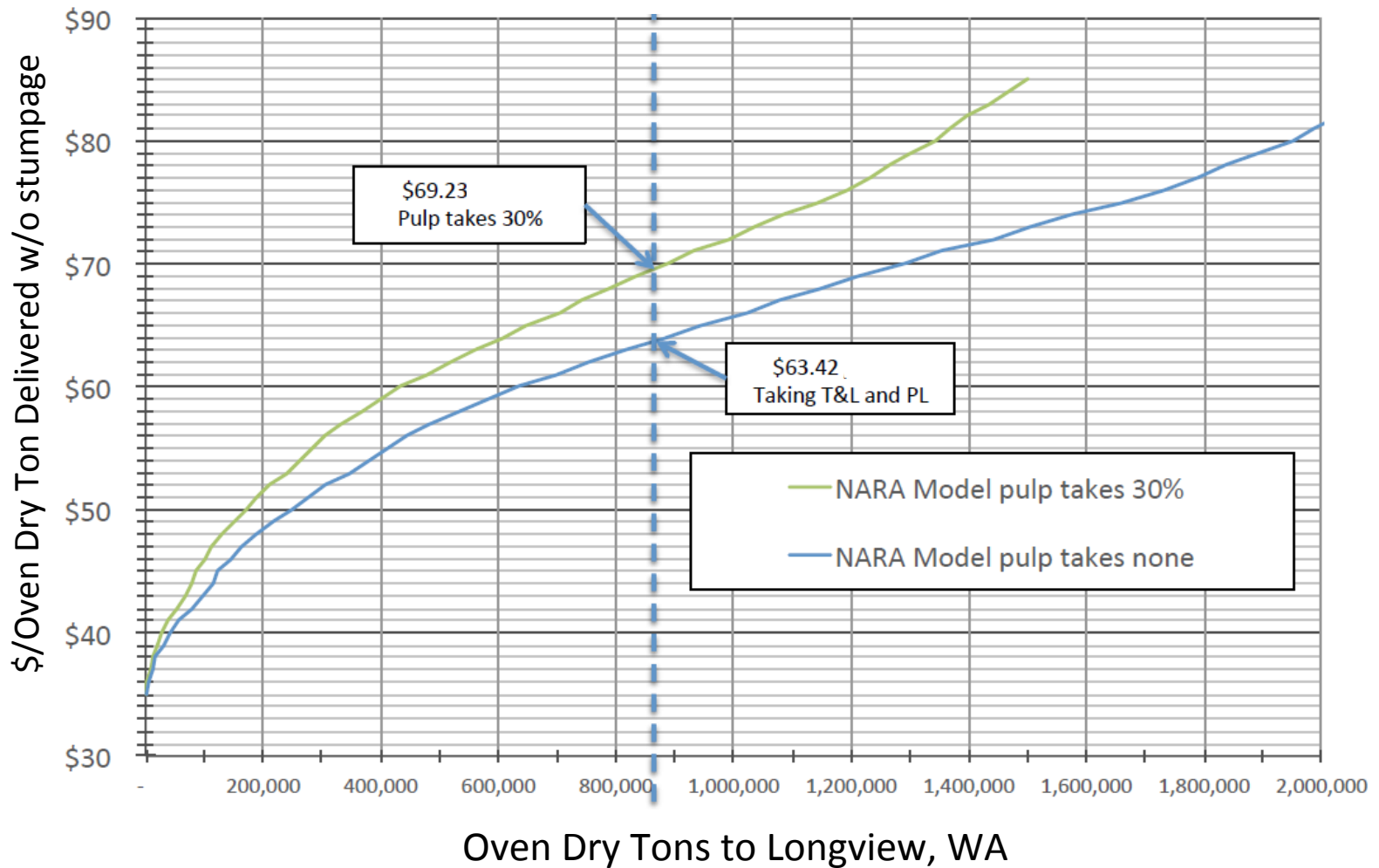


Biomass Supply Curve





Delivered Residue Cost to Longview, Washington



Fresh and Aged Forest Harvest Residues

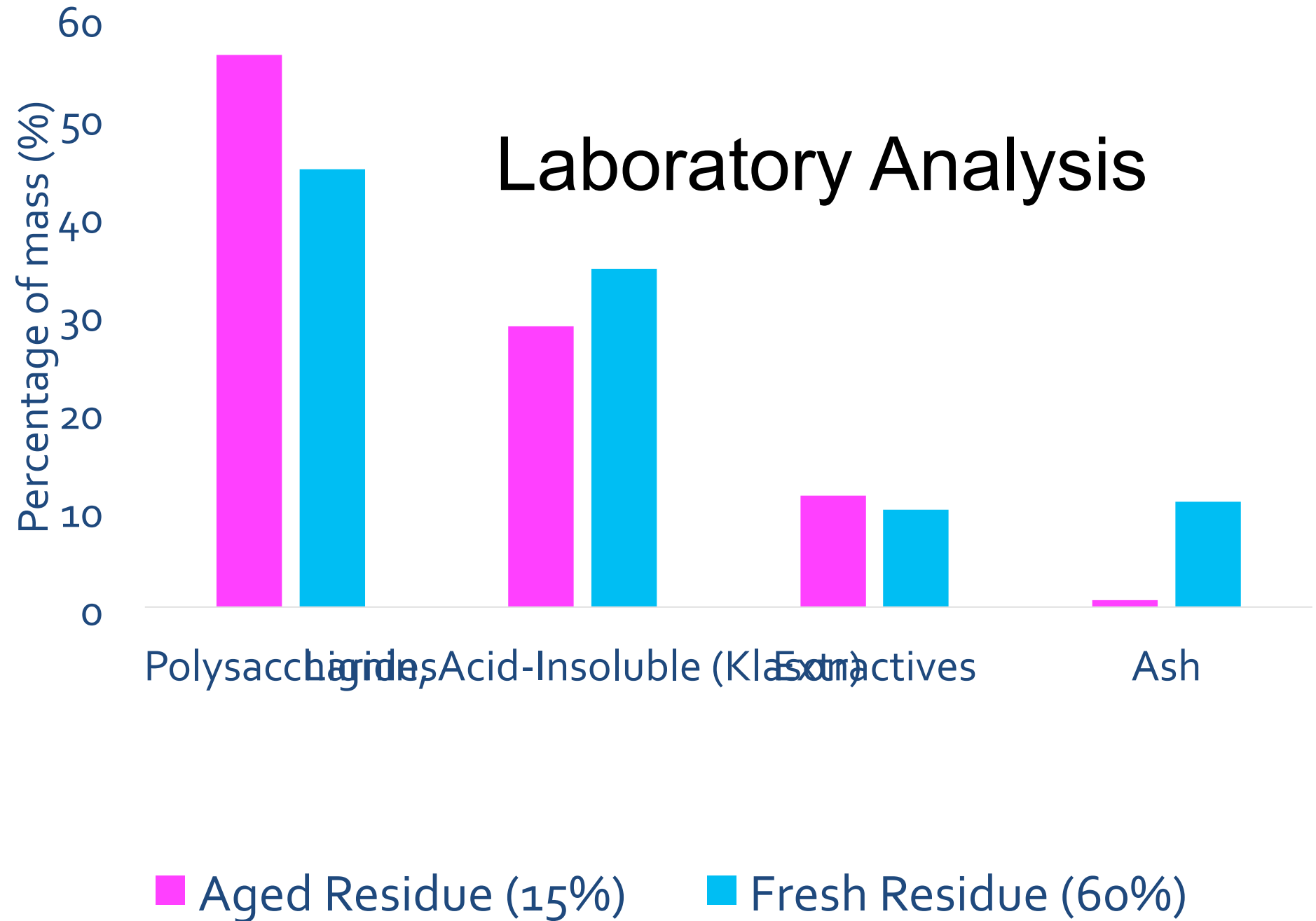
MC = 60% Wet Basis
Bark & Needles = 16.7%
of Dry Mass



MC = 15% Wet Basis
Bark & Needles = 6.2%
of Dry Mass



Laboratory Analysis



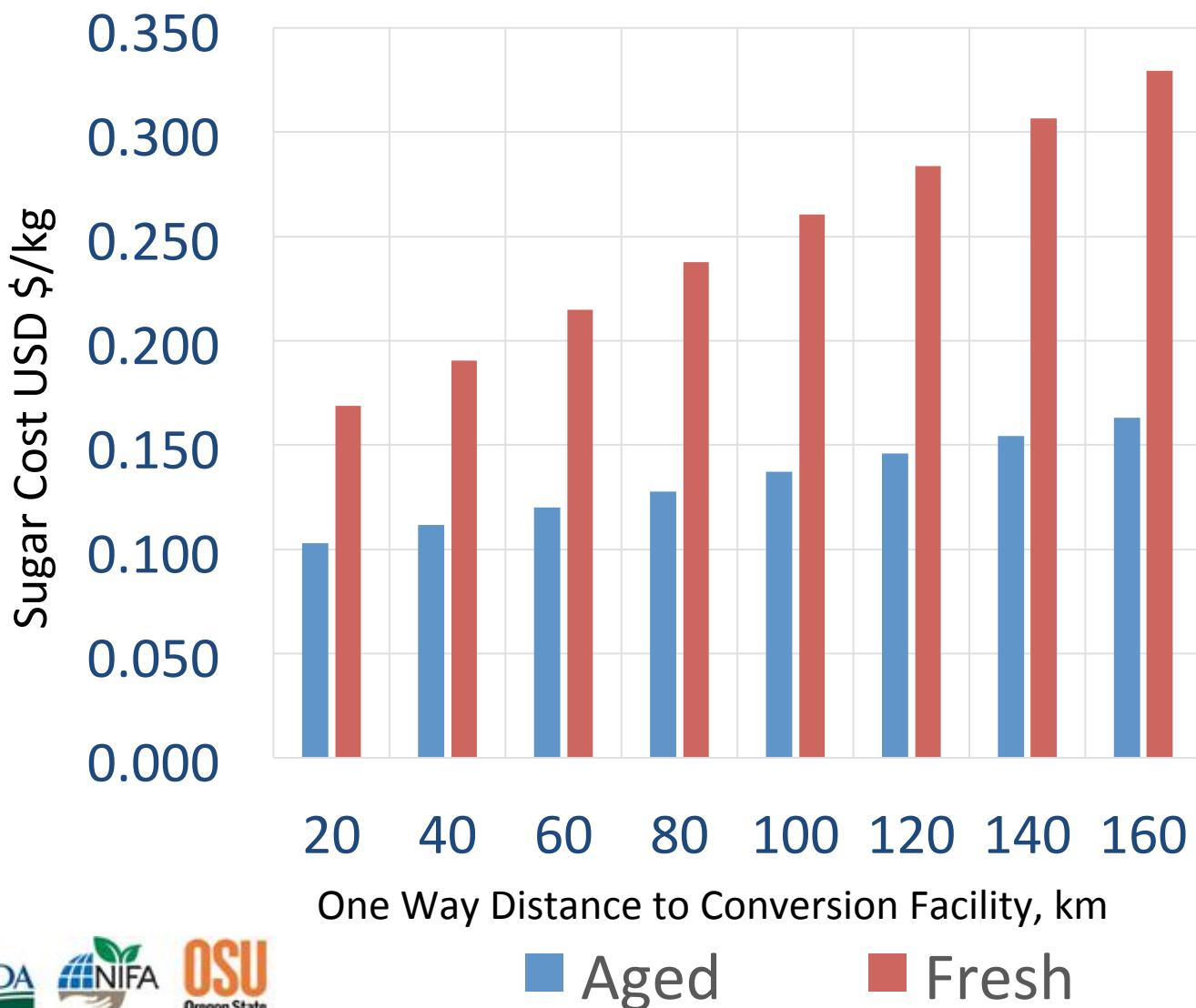


Value Difference Components at Plant

- From Analytical Test: 26% more residues need to be delivered to provide the same amount of sugar from fresh residues.
- The greater the sum of collection + grinding + transportation distance (cost), the greater the cost penalty from the reduced sugar yield



Sugar cost differences by distance





Fresh vs Aged Residues

Field Aged Residues Appear Strongly Positive

- **Collection Costs** - Volume Limited, No Difference
- **Comminution Costs** - Aged Residues Slightly More Expensive
- **Transport** – Aged Residues Much Less Expensive
- **Plant Site** - Aged Residues More Valuable due to Higher Sugar Yield
- **Environmental Considerations** – Needles, if left in forest, have micro and macro nutrients that maintain site productivity
- **Traffic** - Fewer truck loads, less impact on roads

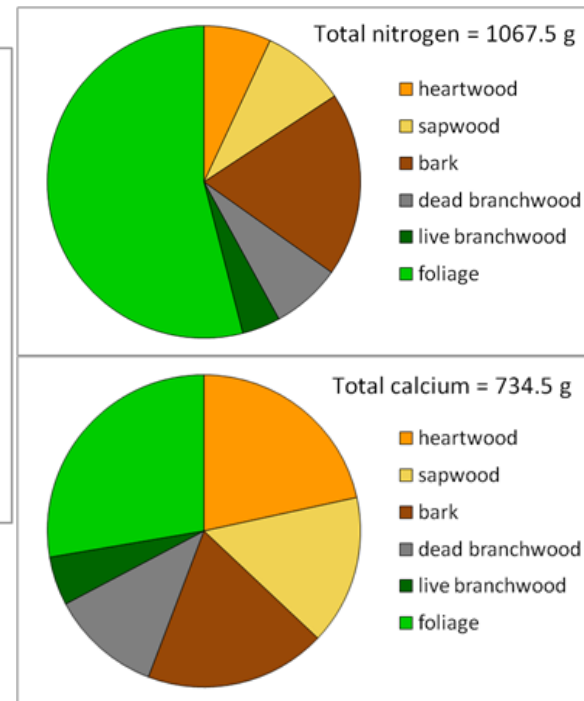
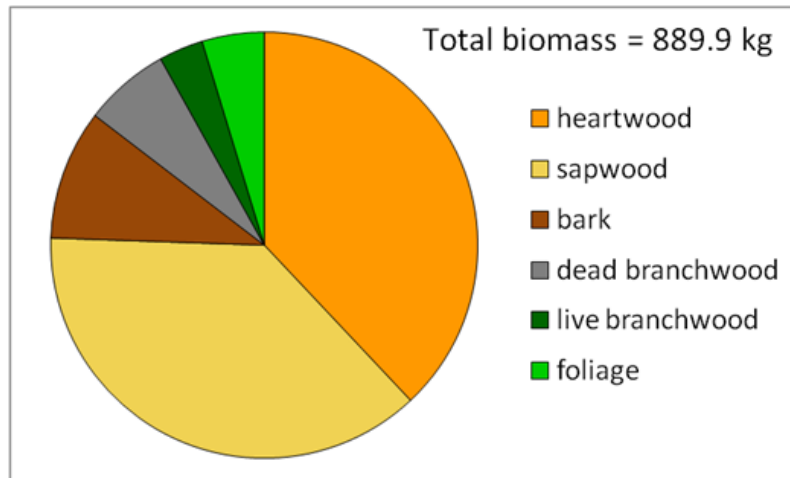


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Total above-ground nutrients

Douglas-fir tree, 38 yrs old
dbh=45.6 cm, height =33.5 m, crown length =19.9 m



Mainwaring, Maguire, and Harrison, NARA
Annual Meeting, 2015, Spokane, WA



NARA

Questions ?