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Logistics for Biomass

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Initial Information

- Biomass estimates are critical to determine the most efficient logistical system
- There are many ‘rules of thumb’ for how much biomass is available for collection.
  - I.E. 70% of allometric estimates for tops and branches
  - 0.5/1.0 BDT per Mbf

Allometric Studies

- Bureau of Business and Economic Research
  - Developed a ratio estimator that can estimate biomass using various utilization standards from FIA data

Allometric Studies

- University of Montana Bureau of Business and Economic Research: Logging Utilization Research
  - Logging residues are estimated by sampling recently felled trees in active logging sites before trees are yarded to a landing.
  - The ratio of growing-stock residue volume/mill delivered volume can be applied to planned timber harvest volumes to predict residue production at the stand, landscape, or state-level.
    - For example - the residue ratio = 29 cubic feet of growing-stock residue generated per 1,000 cubic feet of mill-delivered volume for the 4-state NARA project area (2008-2013 data).
  - Bole, branch, and foliar biomass (i.e., non-growing stock portions of logging) residues can then be estimated with allometric equations.

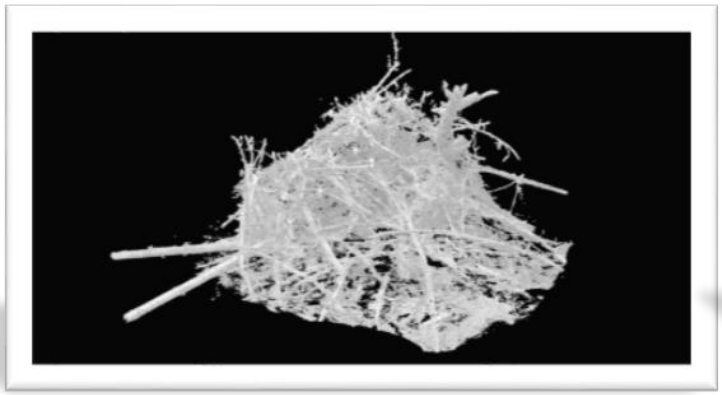
Stand Level Approach

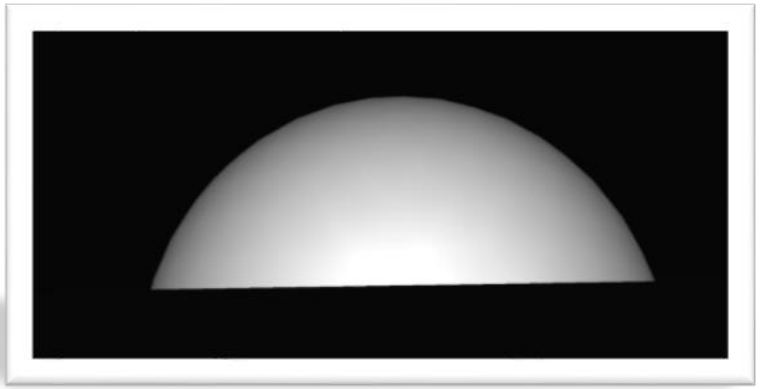
- Total growing-stock residue volume is predicted, but where that volume ends up- in the forest or in the residue pile, is unknown.
- BBER staff and Boston are working together to produce models that will enable land managers to predict the fraction of the total residue available in piles as a function of logging systems employed and other readily available variables.

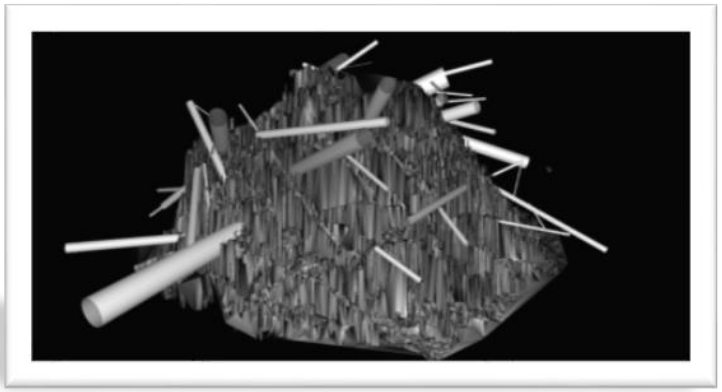
Direct Measurements

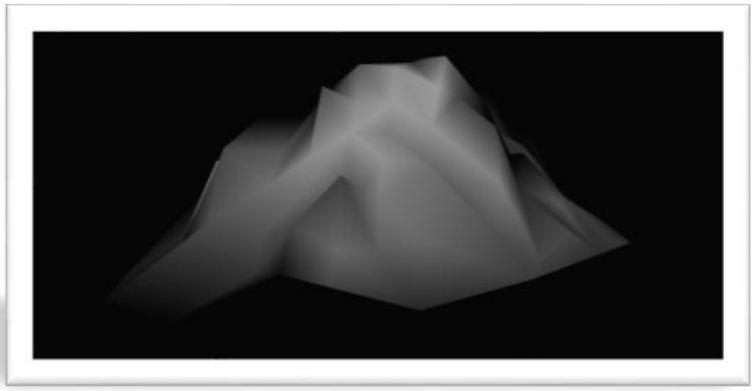
- Geometric method – found to be to inconsistent from person to person
- LiDAR – difficulty to process - expensive
- Laser-range finder – compared well with LiDAR estimates

The different methods

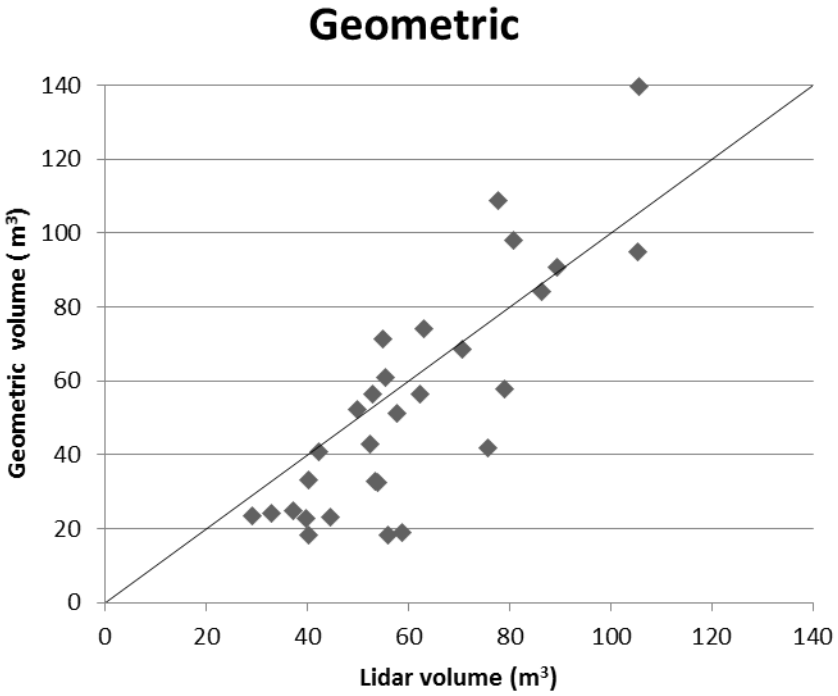


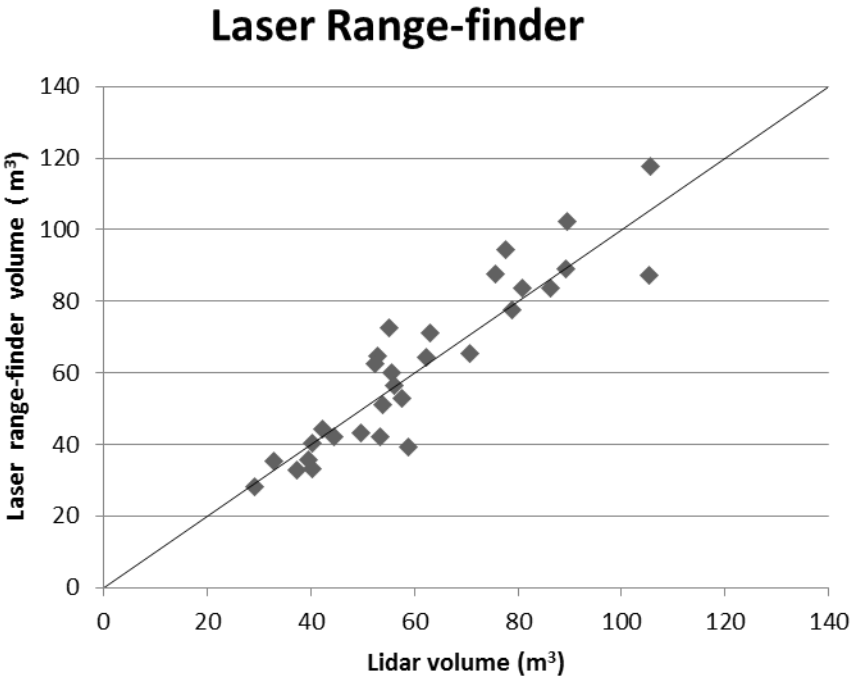






Comparison of methods





Long and Boston, 2014. An Evaluation of Alternative Measurement Techniques for Estimating the Volume of Logging Residue. Forest Science. Vol 60:200-204

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Total Available by System

	Unit Area (Ac)	Residual Volume (Cy/Ac)	Transect Std. (Cy/Ac)	Total Biomass (Cy)	Percent In Piles
Mixed					
Fernhopper – WV	40.6	38	4.4	3,254	**53.6%**
Shovel					
Numskull - WV	70.2	42	4.8	6,883	59.4%
High Deck -CAS	9.8	21	17.6	796	75.0%
System Average					**67.2%**
Cable					
Shot Pouch - CAS	66.7	51	19.7	5,751	42.7%
Four Way – OC	60.7	45	12.8	4,630	41.9%
Euchre - OC	33.0	25	2,8	1,772	54.8%
System					**46.5%**

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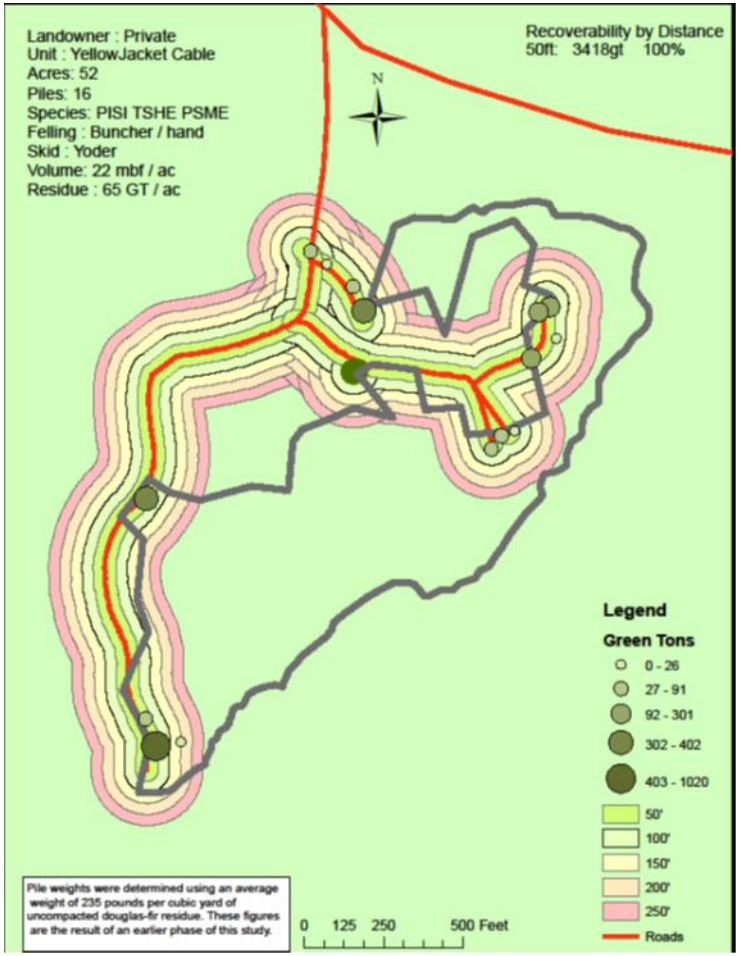
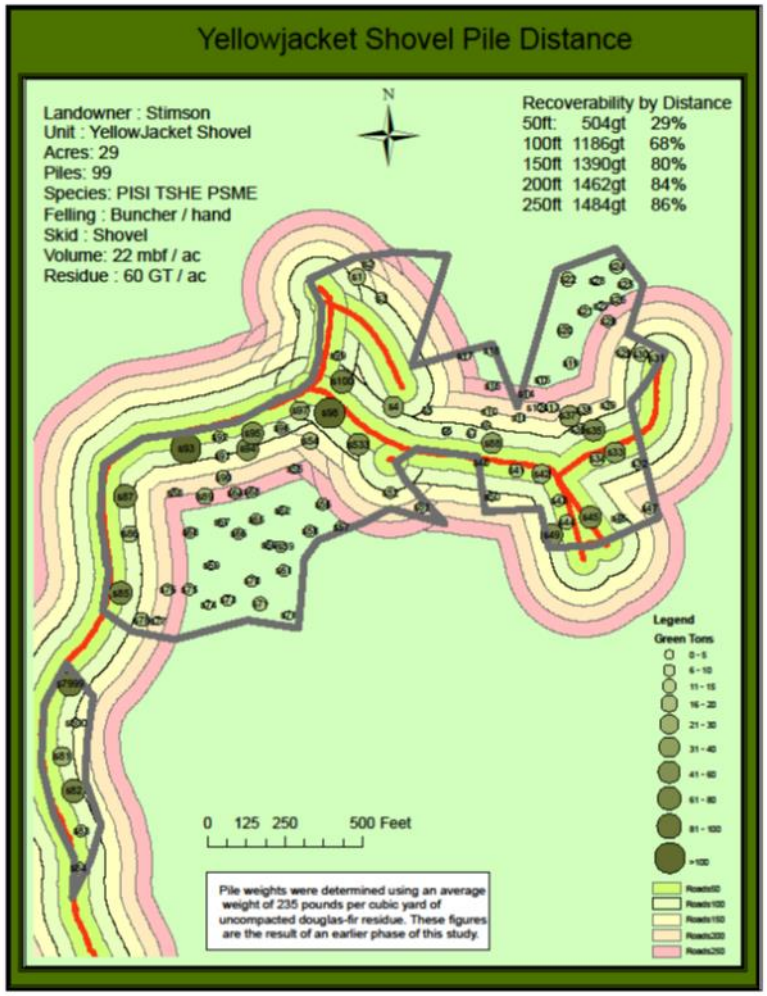
Ground vs Cable – location and size





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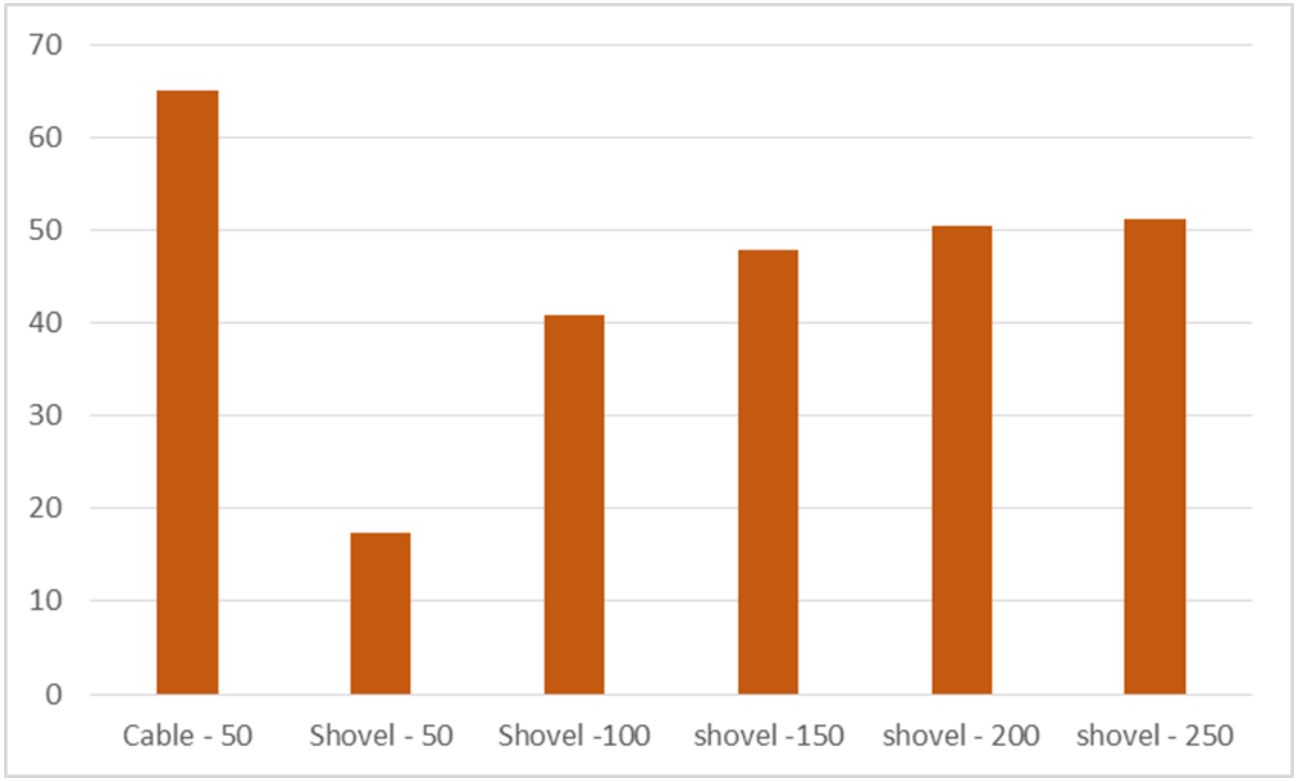
Distance from road



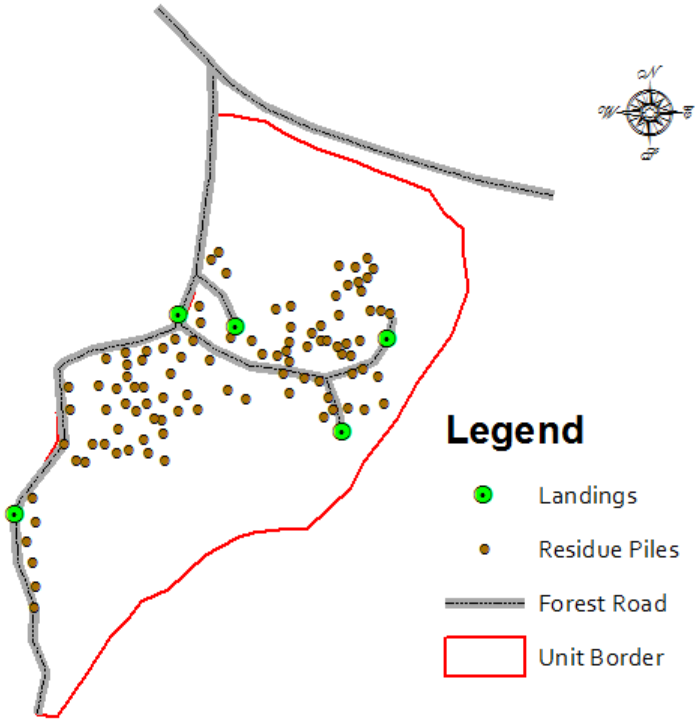
Factors affecting the economics

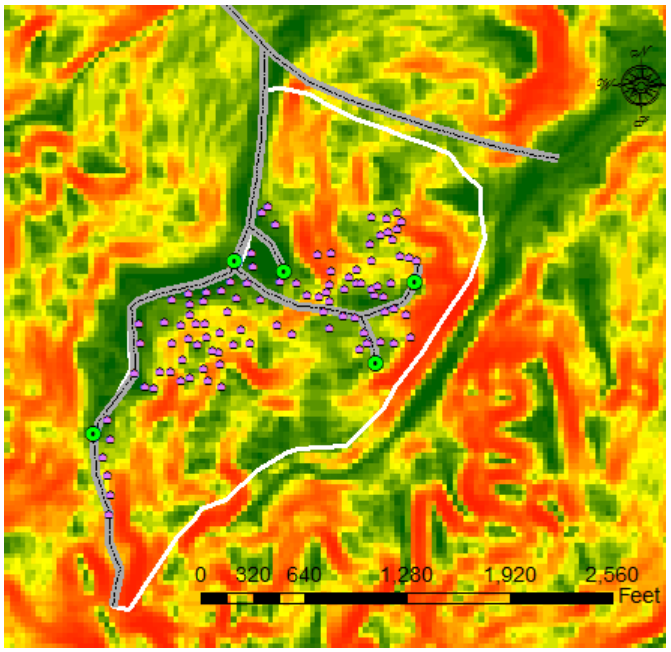
- Distance from the grinder/chipper landing not distance from the road
- Different technologies for collection: Shovel only, Forwarder only, shovel-forwarder, bin trucks etc.
- Access to chip vans: turn-arounds and turn-outs
- Path from the pile to the landing is not a straight line always: Terrain conditions matters ---> Slope matters for ground-based equipment
- Processing equipment and equipment interactions
- Transportation distance in forest and in highway: Time matters more than distance

Step 1: Field work on existing operations

- Measure of pile locations
- Measure of volume at each pile
- Location of potential grinding landings with access for chip-vans (turn-around available)

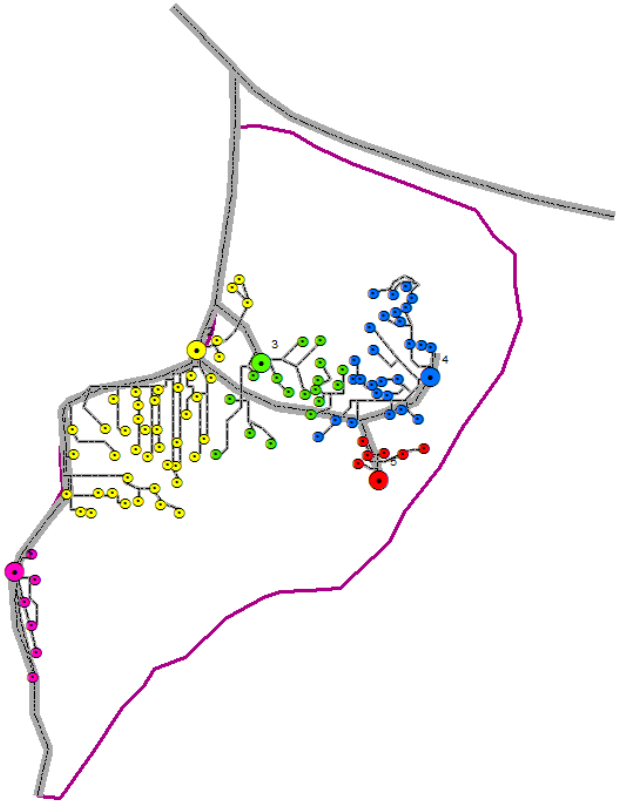
Step 2: Mapping and Spatial information, slope

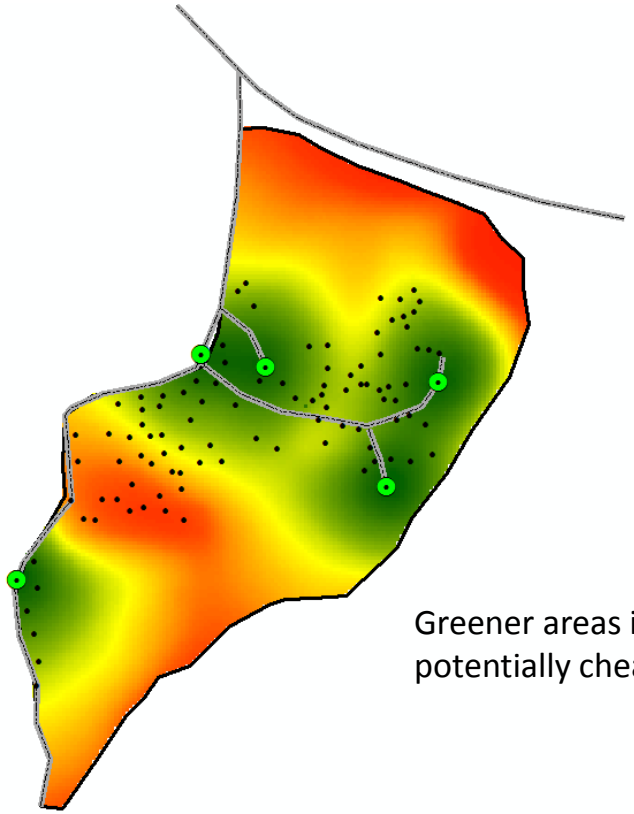




10 meter DEM, with slope

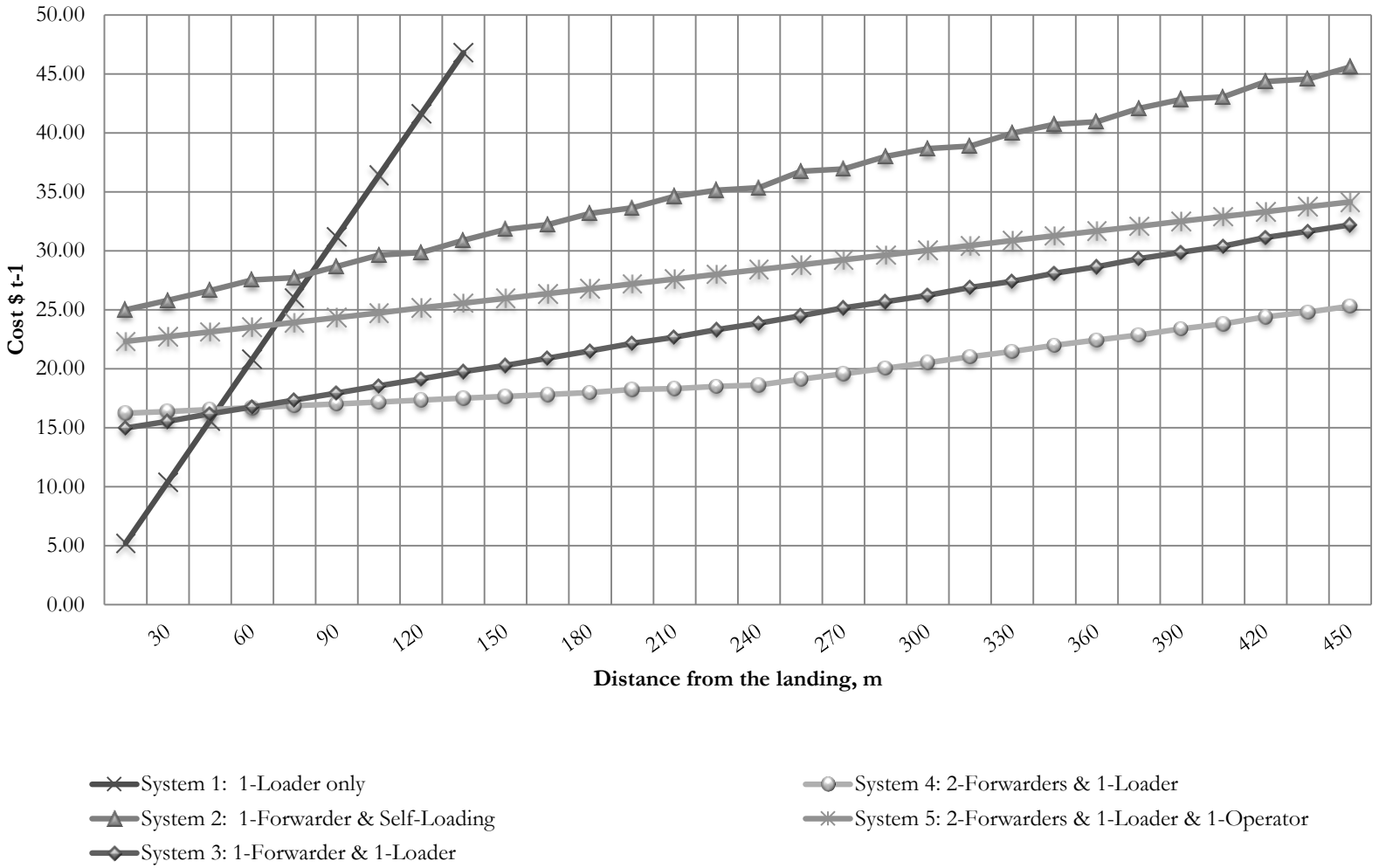
Step 3: Least cost path to landing as a function of distance and Network Analyst extension





Greener areas indicate potentially cheaper biomass

Collection Costs



- **Marginal cost ($/BDT) to bring forest residues to landing as a function of collection method and distance to landing. Mobilization costs are not considered (from Zamora and Sessions 2015).**

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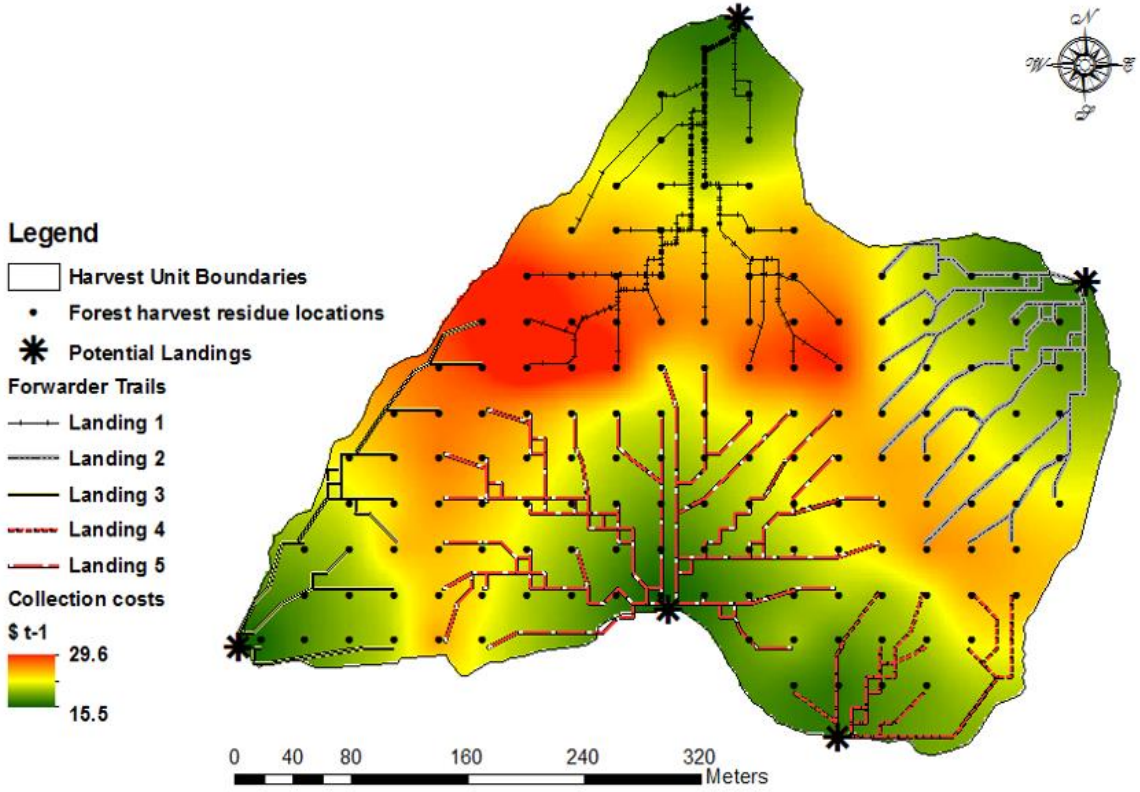
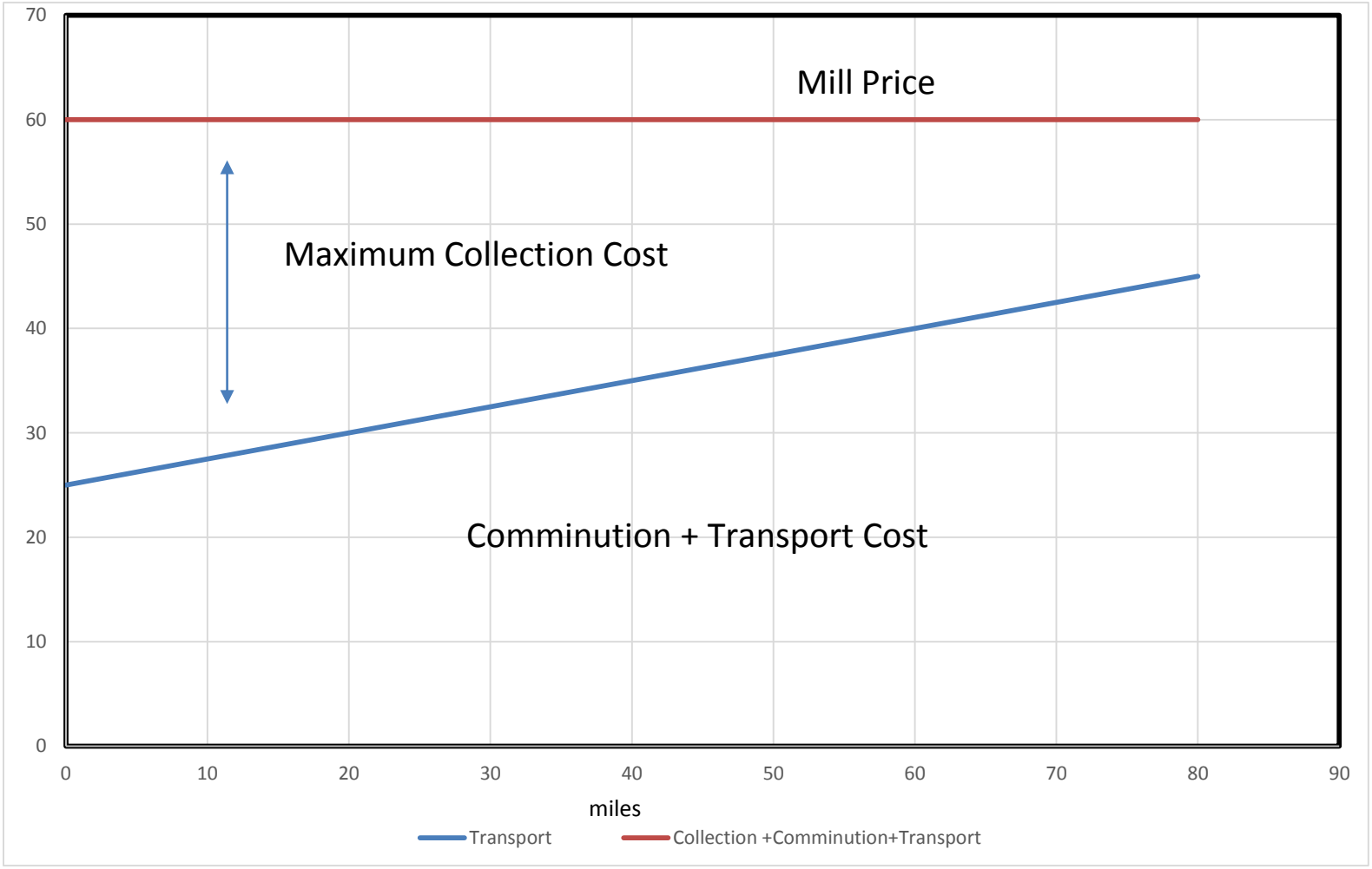
Current work

- Determining the amount available for various costs.



From Zamora and Sessions, 2015

Collection vs Transport



Tradeoffs between collection and transport (Berry 2015)

% Area by Harvest System and Distance from Road (NARA region composite)

REGION	# PLOTS	%AVAIL	G1 -150'	G2- 300'	G3 300+	%C
OR	1973	87.24%	11.14%	11.14%	43.88%	33.83%
WA	2093	87.61%	12.16%	12.16%	47.76%	27.92%
ID	675	89.83%	9.02%	9.02%	43.29%	38.67%
MT	1419	92.27%	2.86%	2.86%	66.29%	28.00%

WHERE

G1= GROUND-BASED SYSTEMS % LAND AREA 0-150' ROAD OFFSET

G2= GROUND-BASED SYSTEMS % LAND AREA 150-300' ROAD OFFSET

G3= GROUND-BASED SYSTEMS % LAND AREA > 300' + OFFSET

C= CABLE-BASED SYSTEMS % LAND AREA

% AVAIL = LAND AREA THAT HAS NOT BEEN RECENTLY HARVESTED

- State and Private FIA Plot Assessment (from Berry 2015)

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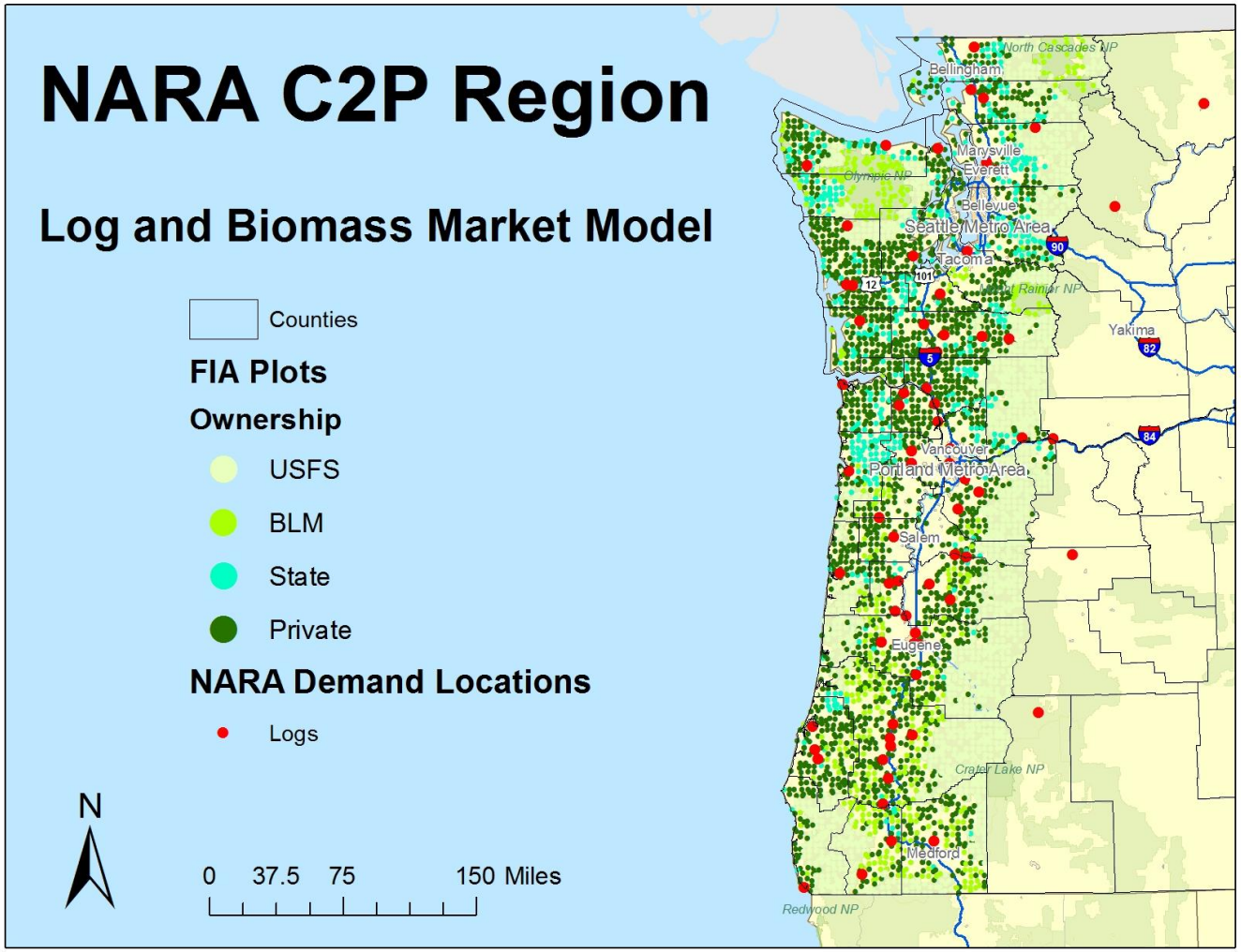
Basic Biomass Supply Model



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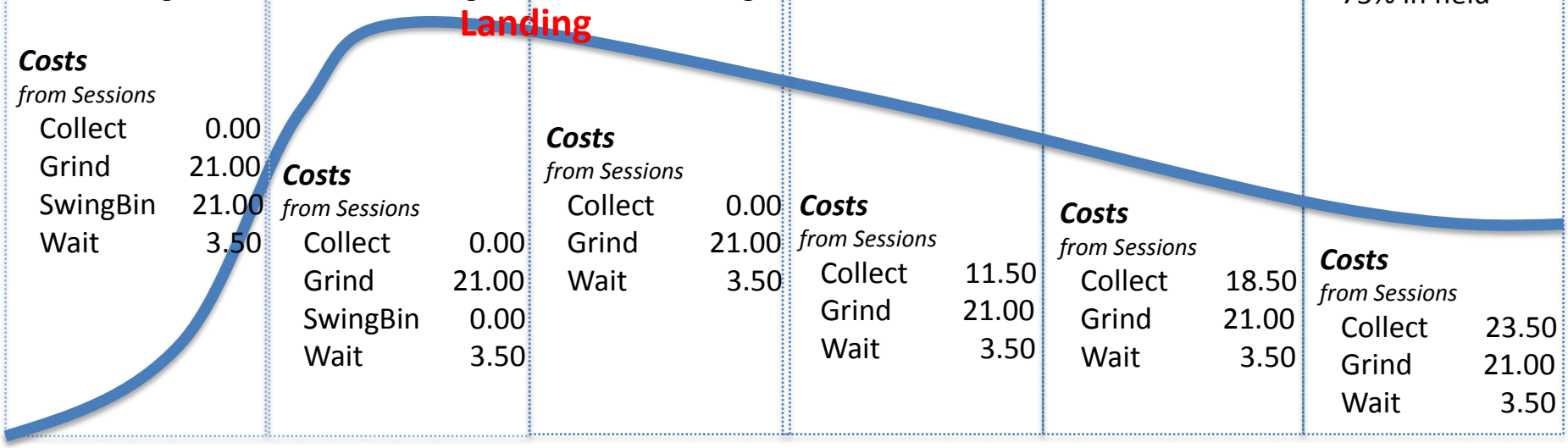
Biomass Model Assumptions

Cable In unit	Cable At landing	Ground At landing	Ground < 150’	Ground 150 – 300’	Ground 300’ +
Availability	***Availability***	***Availability***	***Availability***	***Availability***	***Availability***
from Boston	*from Boston*	*from Boston*	*from Boston*	*from Boston*	*from Boston*
46.5%	46.5%	67.2%	67.2%	67.2%	67.2%
from Berry	*from Berry*	*from Berry*	*from Berry*	*from Berry*	*from Berry*
Plot specific	Plot specific	Plot specific	Plot specific	Plot specific	Plot specific
from Sessions	*from Sessions*	*from Sessions*	*from Sessions*	*from Sessions*	*from Sessions*
75% swing	25% no swing	25% at landing	75% in field	75% in field	75% in field
Costs	***Costs***	***Costs***	***Costs***	***Costs***	***Costs***
from Sessions	*from Sessions*	*from Sessions*	*from Sessions*	*from Sessions*	*from Sessions*
Collect 0.00	Collect 0.00	Collect 0.00	Collect 11.50	Collect 18.50	Collect 23.50
Grind 21.00	Grind 21.00	Grind 21.00	Grind 21.00	Grind 21.00	Grind 21.00
SwingBin 21.00	SwingBin 0.00	Wait 3.50	Wait 3.50	Wait 3.50	Wait 3.50
Wait 3.50	Wait 3.50				



Older Assumptions for all ground: *Collect 20.0*
Grind 17.5

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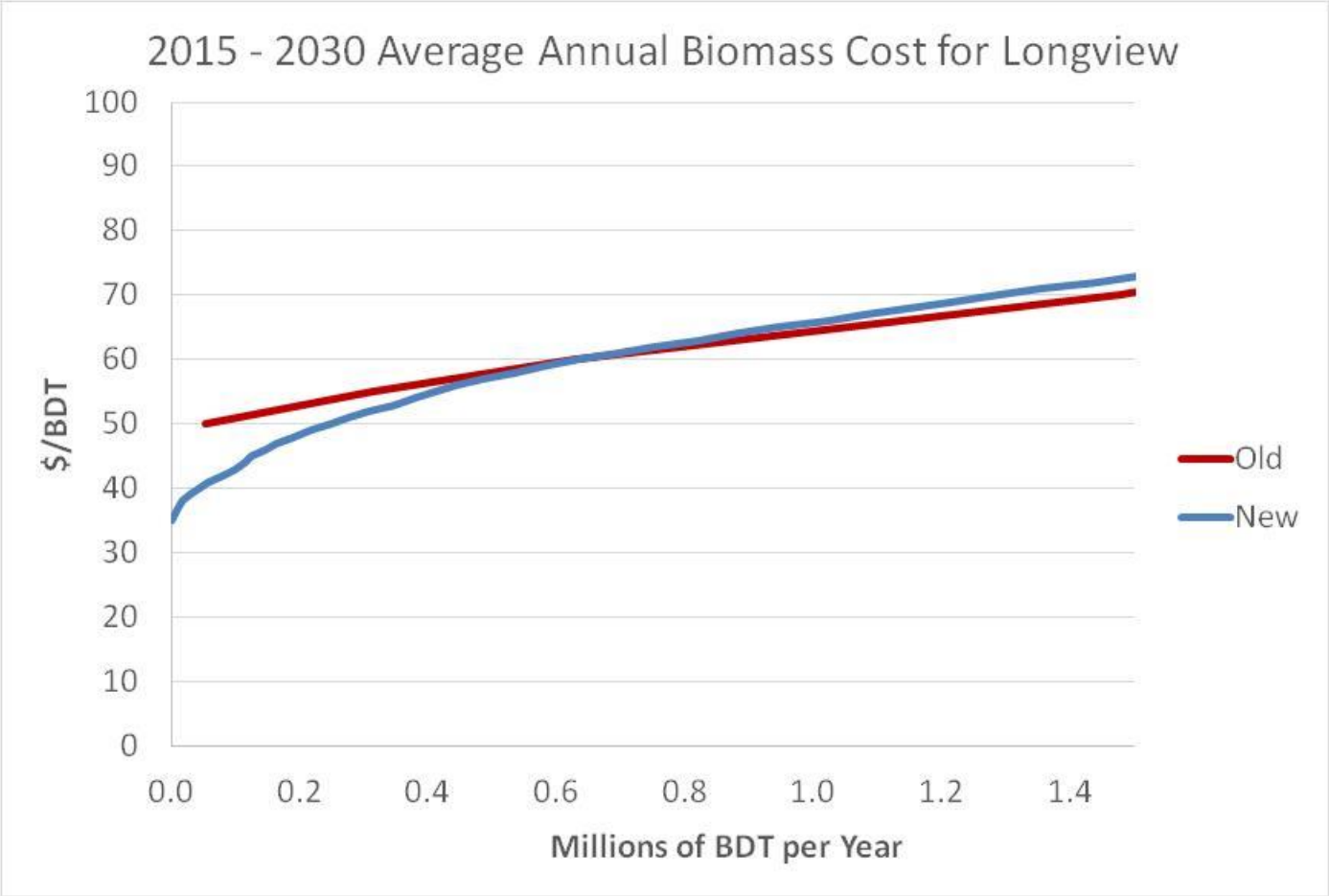
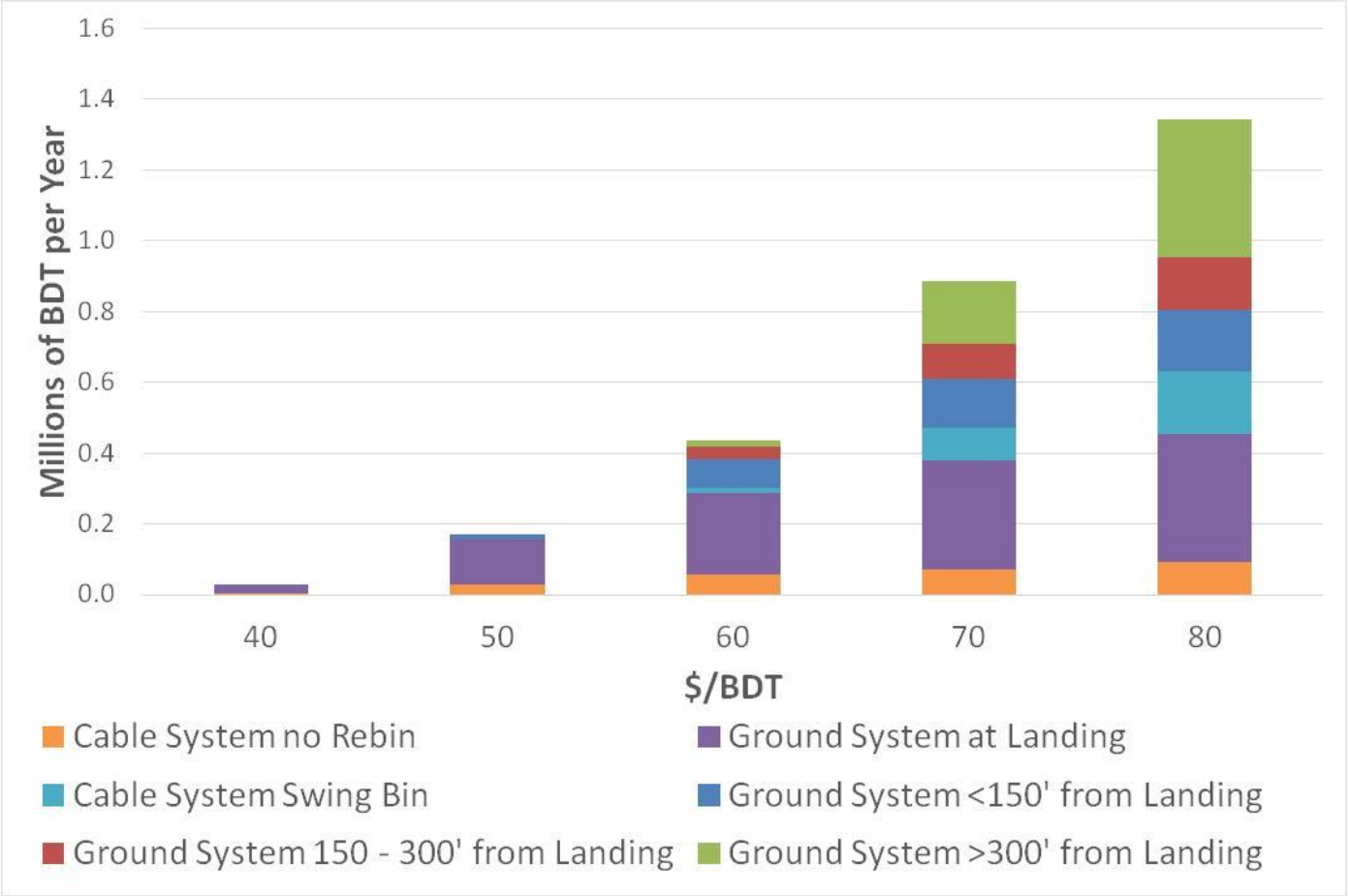
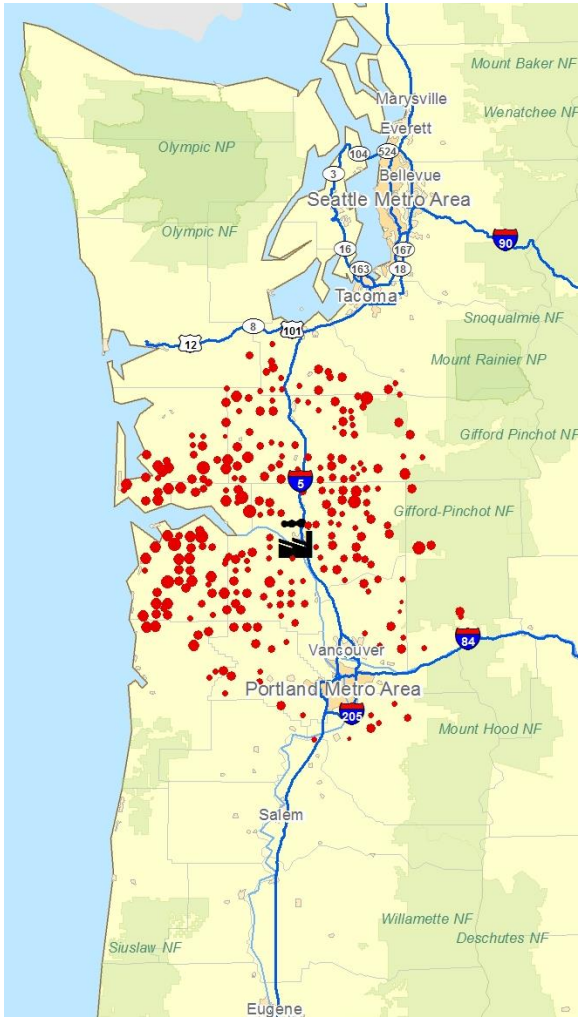
Biomass Supply Curve



Disaggregated Biomass Supply Curve



Supply at $65/bdt for Longview



Old 975,521 bdt/yr

New 944,001 bdt/yr

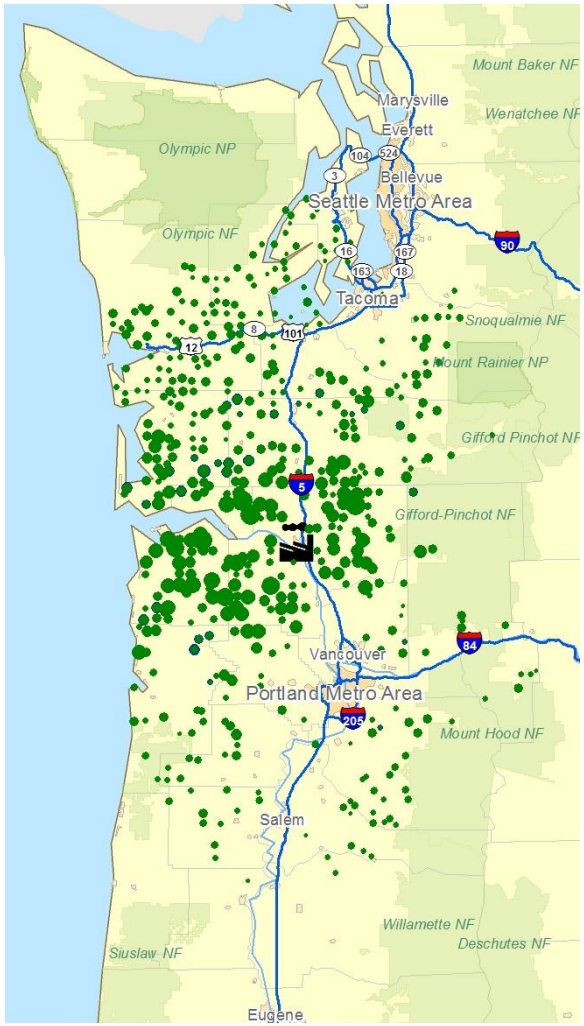
Scale

Bdt/year

- 0 - 250
- 250 - 500
- 500 - 750
- 750 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500
- 2500 - 3000
- 3000 - 3500
- 3500 - 4000
- 4000 - 4500
- 4500 - 5000
- 5000 - 5500
- 5500 - 6000
- 6000 - 6500
- 6500 - 7000
- 7000 - 8000
- 8000 - 9000
- 9000 - 10000
- 10000 +

N

0 20 40 80 Miles



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