Linking Federal Forest Restoration with Wood Utilization: a Northern Sierra Case Study

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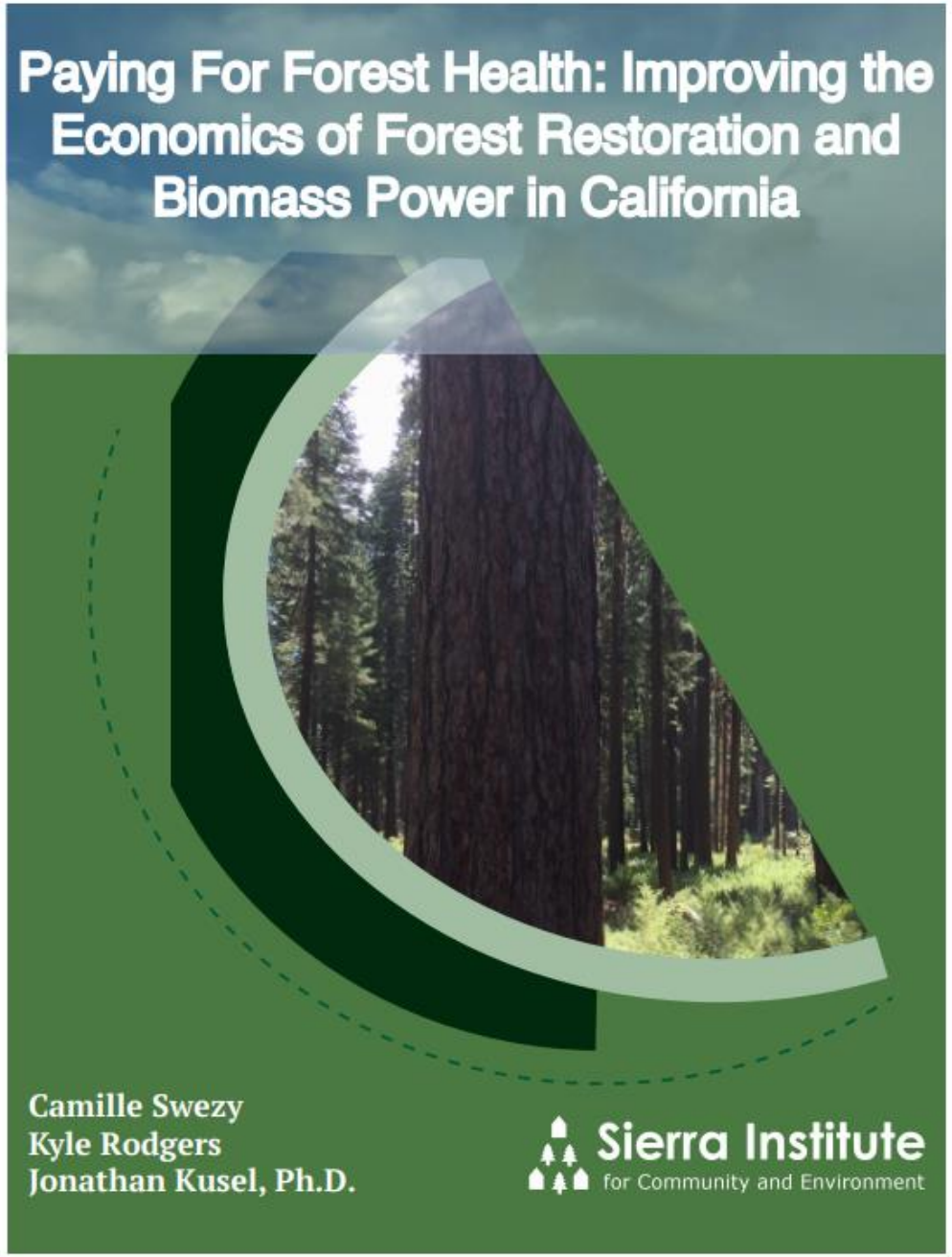
Background

Photo credit: Sierra Institute


Paying For Forest Health: Improving the Economics of Forest Restoration and Biomass Power in California
Camille Swezy
Kyle Rodgers
Jonathan Kusel, Ph.D.
Sierra Institute
for Community and Environment

Plumas County Forests = 75% Federal Ownership

Over 1m acres of USFS land in Plumas

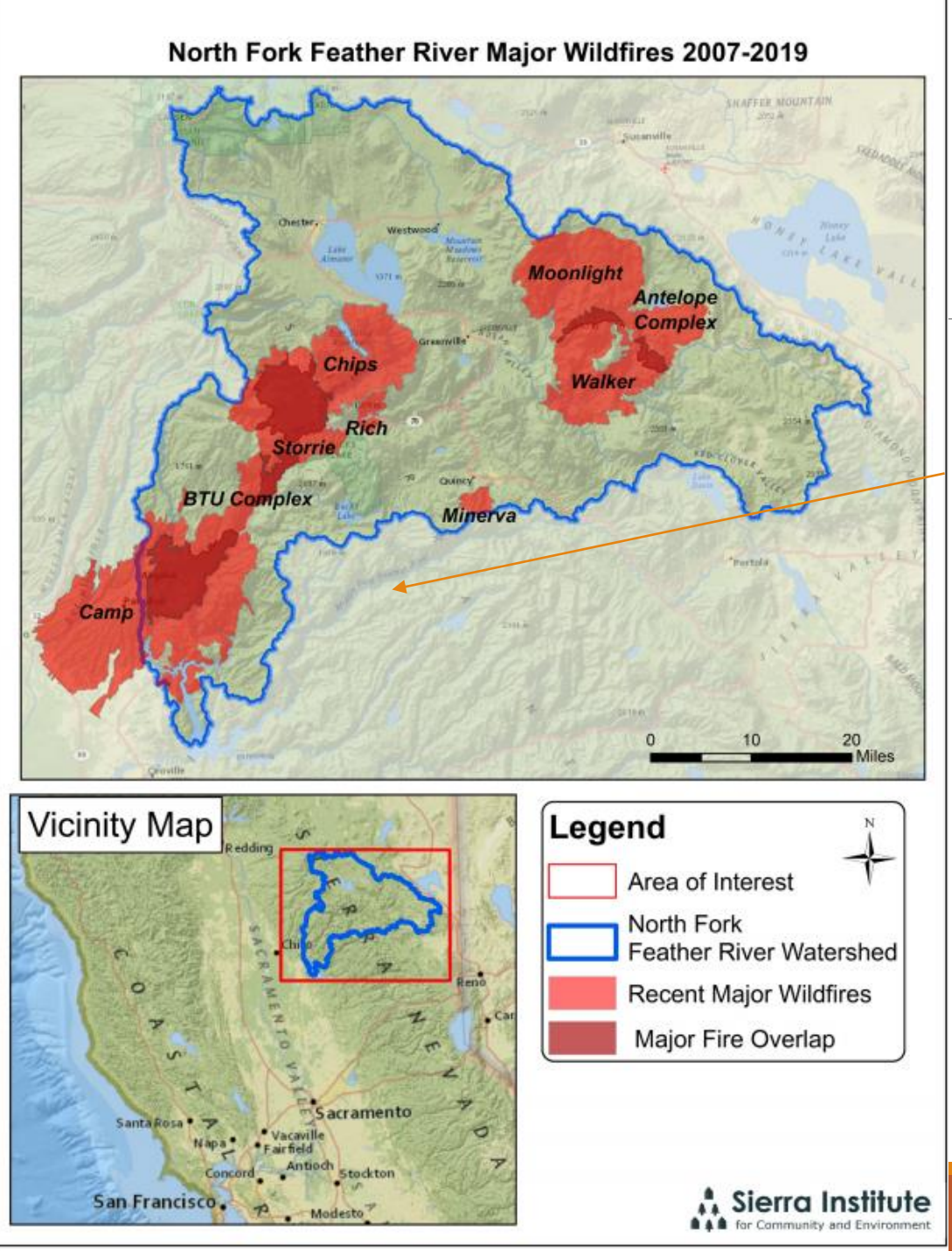
Most in need of restoration

Local sawmills prioritizing logs from salvage + private land, challenging feasibility of USFS stewardship projects

Walker Fire, 2019

We aren’t keeping up

Walker Fire, 2019



North Complex 2020
~319,000 acres
Still burning

Keeping it Local and Community-Scale: Crescent Mills Wood Products Campus

A preventative approach to fuels mgmt, pairing it w/ rural development

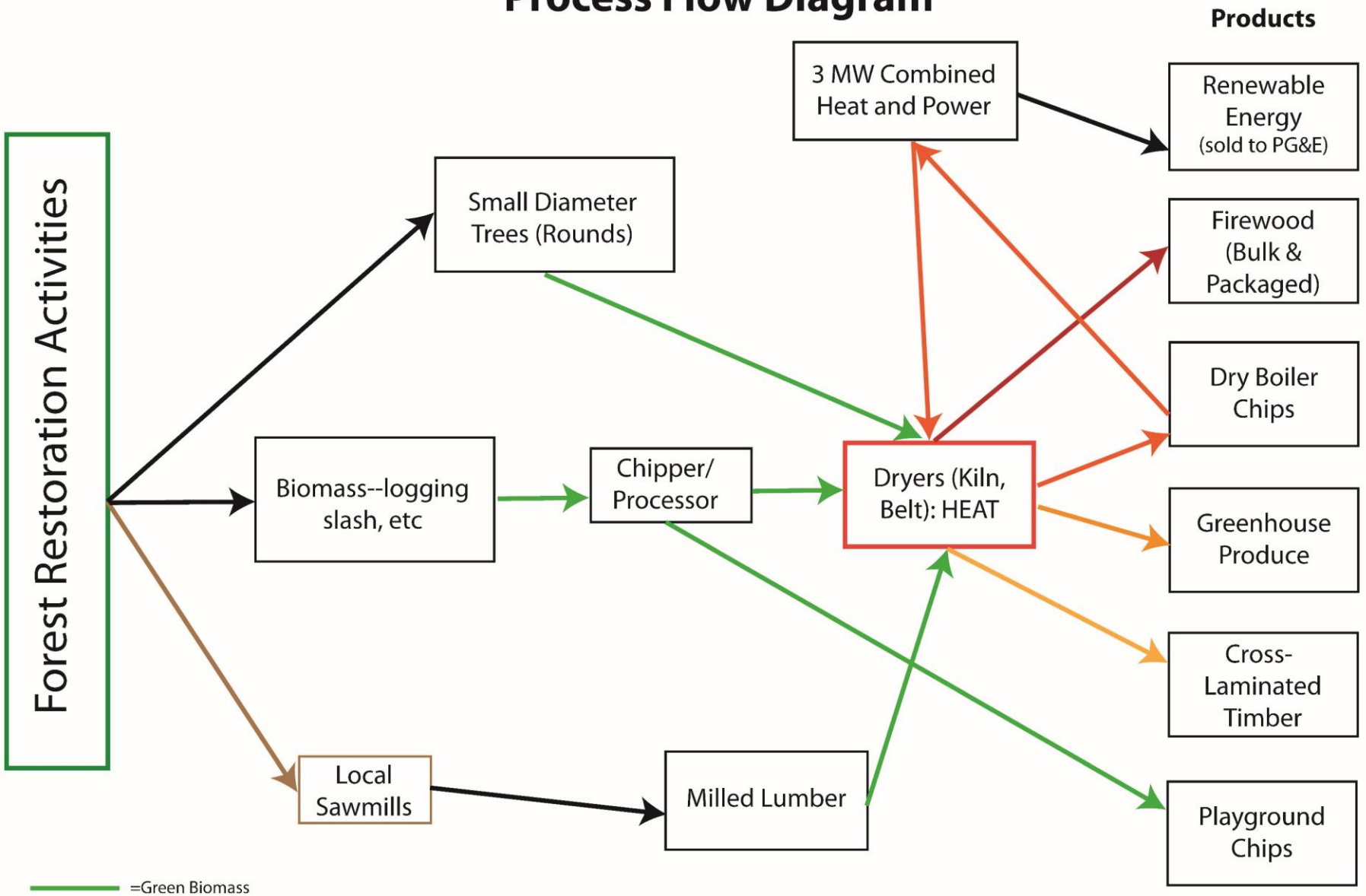
Integrated product development

Close to supply

Current focus is chip processing and storage

Photo credit: Danielle Berry

Indian Valley Wood Products Campus
Process Flow Diagram



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At what biomass price can we incentivize increased restoration on the Plumas NF?

Biomass removal on the PNF: What does it really cost?

- There is no “one price fits all”
- Region-wide estimates exist—but not site-specific, and from various land ownerships.
- Literature is limited for CA mixed conifer, USFS ownership

Study Objectives

How can we be effective in serving as a local, sustainable market for biomass from federal forest restoration?

1. Estimate $/BDT to contractor to:
   a. Cut-skid-deck-chip biomass for USFS “restoration” harvests
   b. Haul biomass to Crescent Mills vs BioRAM facilities
2. Identify productivity constraints to inform contract preparation and planning

Methods

Cruise data from USFS

- Variable density thinning treatments
- Whole tree removal + chipping

Machine rate and productivity/cost analysis

- Including detailed time study regression equations from literature

Three logging system scenarios…

Integrated Harvesting

Biomass bundled with sawlogs

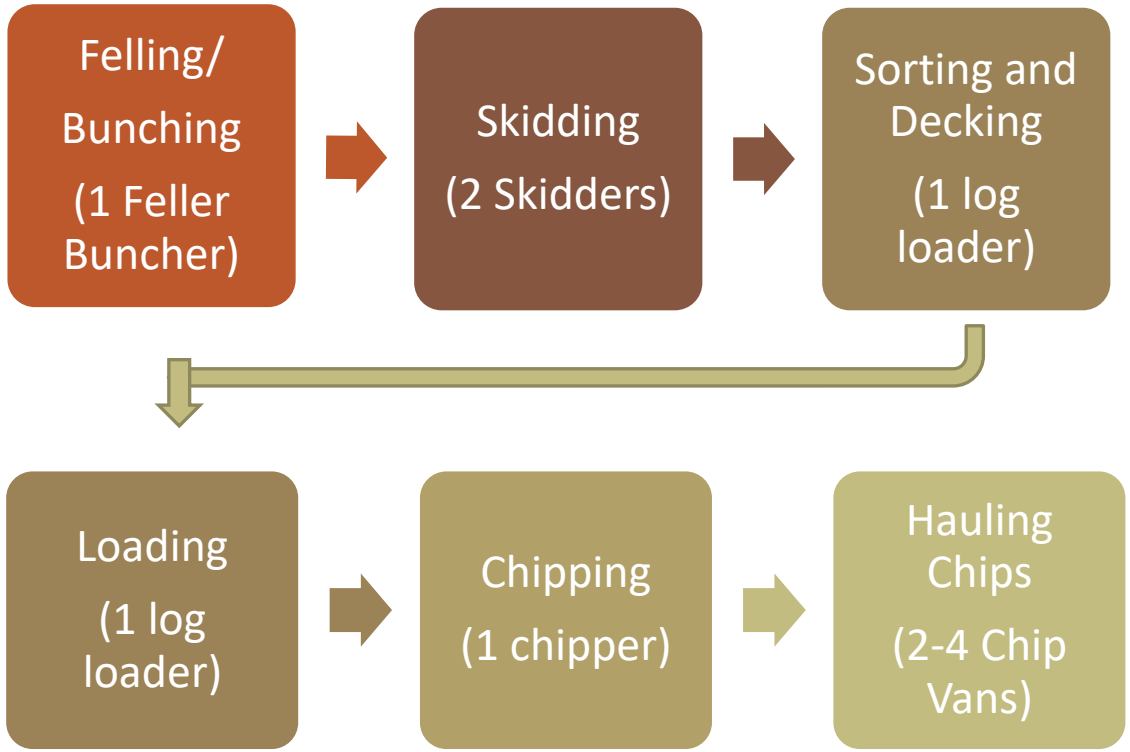
- "Single pass" harvesting

Feller buncher cuts logs and biomass at same time

Biomass is skidded, decked, then later chipped into chip van

Sawlogs can absorb fixed costs

→Stewardship contracting comes in here



Biomass Only

Assumes no sawlog removal, just biomass.

Same logging system as integrated

Other costs are added, such as:

- Landing construction
- Road maintenance, road watering
- Admin/layout
- Fire safety equipment
- Hauling equipment in/out/between landings

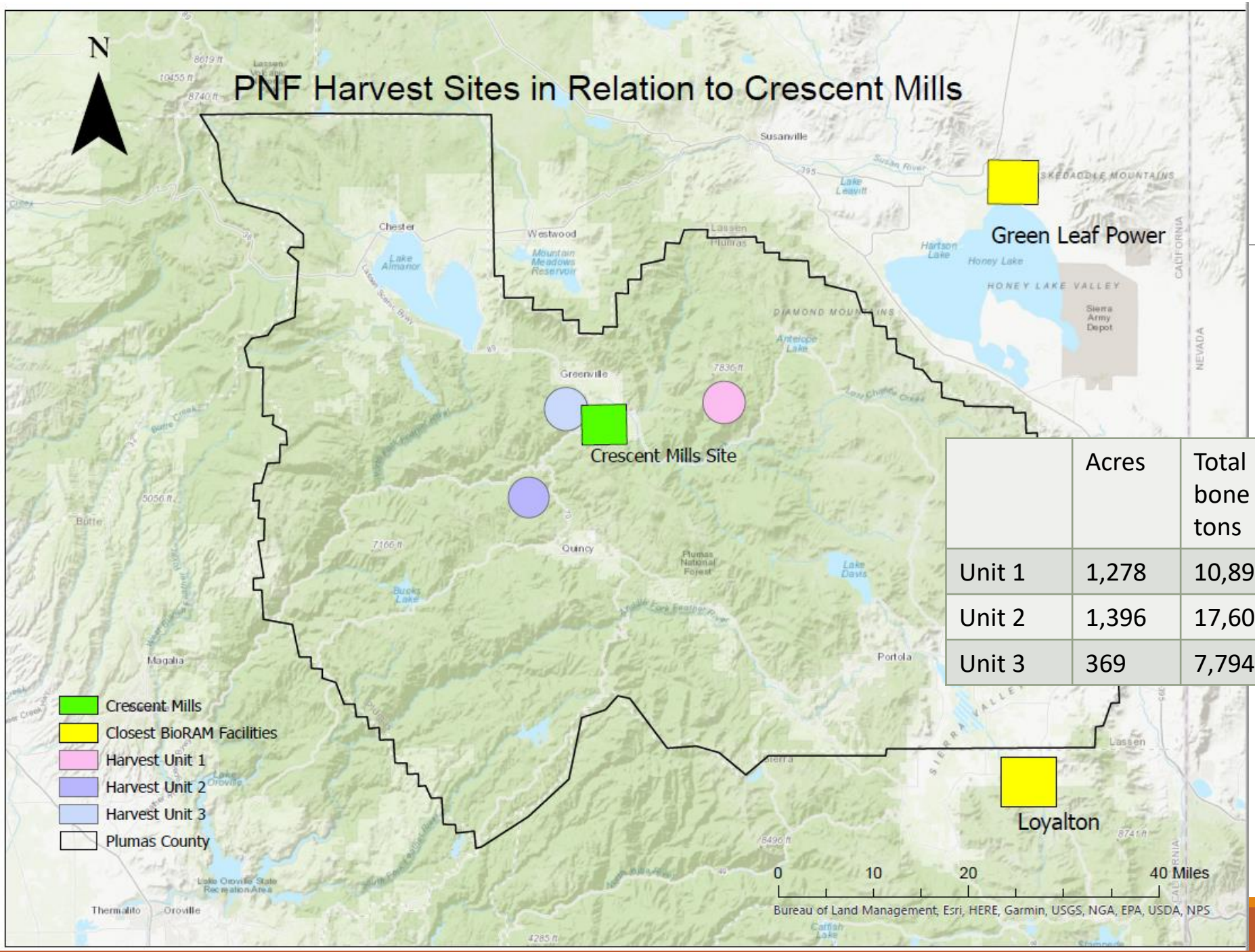
Hand Thin

No sawlog removal, just biomass

Crew of 10 hand falls trees

Mechanized skidding, decking, and chipping

Adds additional costs (see left)



	Acres	Total bone dry tons	Distance to Crescent Mills	Distance to closest BioRAM Facility
Unit 1	1,278	10,895	21 miles	52 miles
Unit 2	1,396	17,601	18 miles	68 miles
Unit 3	369	7,794	10 miles	73 miles

Machine Rate Calculations

(Miyata 1980, Brinker et al 2002)

Machine Rate Calculations*	Feller Buncher	Skidder	Loader	Loader	Chipper (Mitchell et al 07)	
Model	TIGERCAT LX 830D	John Deere 748H	Caterpillar 324D FI	Caterpillar 324D FI	Precision 1858	
Purchasing price	$ 450,000.00	$ 250,000.00	$ 280,000.00	$ 280,000.00	$ 500,000.00	
Horse power (hp)	330	193	188	188	450	
Salvage value (%)	15%	15%	30%	30%	20%	
Economic life (years)	5	5	5	5	5	
SMH/year	2000	2000	2000	2000	2000	
Interest (%)	10%	10%	10%	10%	10%	
Insurance (%)	3%	3%	3%	3%	3%	
Taxes (%)	2%	2%	2%	2%	2%	
Fuel cost ($/gallon)	3	3	3	3	3	
Fuel use rate (gal/hp-hr)	0.02633	0.028	0.02166	0.02166	0.028	
Lube cost (%)	37% of fuel cost	37% of fuel cost	37% of fuel cost	37% of fuel cost	37% of fuel cost	
Maint. & Repair (%)	100% of depr.	100% of depr.	90% of depr.	90% of depr.	100% of depr.	
Wages ($/SMH)	22	22	22	22	22	
Fringe benefits (%)	50%	50%	50%	50%	50%	
Operator wage and benefit rate ($/hr)	33	33	33	33	-	
Utilization rate (%)	70%	65%	75%	75%	69%	
Productivity Calculations:						
Regression Equation						
Feller buncher (Vitorelo et al 2020)	ln(y)=2.8623+0.3817*ln(DTT)+0.0960*ln(DTB)+0.3441*ln(TPC)					
Skidder (Vitorelo et al 2020)	y=35.28+0.9841*TED+0.7559(TLD)+skidder size^h (-22.37 for large skidder, +22.37 for small skidder)					
Loader (Pan et al 2008)	y=7.902+(0.062*#oftrees per cycle)+(0.471*DBHin)+(0.159*swingtochipperdegree)+0.094(swing back to pile degree					
Chipper (Watson et al 1986)	y=22.7 + 0.211 (DBH in inches)^3					
feller buncher	89.54	centi minutes	0.90	minutes	53.72	seconds
skidder	927.65	centi minutes	9.28	minutes	556.59	seconds
loader	31.83	centi minutes	0.32	minutes	19.10	seconds
chipper /loader	25.28	bdt/ per hour				
Cycles per PMH (based on regression)	**67.01**	**6.47**	**188.51**	**188.51**	-	
# of machines	**1.00**	**2.00**	**1.00**	**1.00**	**1.00**	
Machine Productivity bdt/PMH	20.40	11.81	68.86	68.86	25.28	
Machine Productivity bdt/SMH	14.28	7.68	51.64	51.64	17.50	
utilization function (Uf %)	70.00%	65.00%	11.15%	25.42%	69.23%	

TOTAL MACHINE COSTS						
Total cost per SMH ($/hr)	$ 156.77	$ 204.62	$ 76.70	$ 77.95	$ 141.35	
price per machine		$ 102.31				
Unit Production Costs						
$/BDT based on SMH (considering bottle	$ 10.98	$ 13.33	$ 4.99	$ 4.45	$ 8.08	
Cut Skid Deck						$ 29.30
Load to Chip						$ 12.53
Unit production costs for entire harvesting system $/BDT						**$ 41.83**

Total Project Costs						
Harvest (variable) Costs (total SMH time	$ 119,629.97	$ 145,184.00	$ 54,418.56	$ 48,532.39	$ 88,003.62	**If by total SMH**
total variable costs						**$ 455,768.54**
Fixed Costs						
Road and Landing Construction					$ -	
Total Move In/Out Costs					$ 5,544.01	
Total Fixed Costs						**$ 5,544.01**
total costs						**$ 461,312.55**

Total Production Costs		
total acres		1278.4
Total BDT harvested in entire project		10895.47
Total variable cost/BDT	$	41.83
Total fixed cost/BDT	$	0.51
Total cost/BDT	**$**	**42.34**
Haul Cost to CM	$	23.66
Total cost/BDT delivered to CM	**$**	**66.00**
Total cost for project incl haul	$	719,114.97
Total cost/acre incl haul	$	562.51
total cost/acre not incl haul	$	360.85
Total # of 10 hour work days		76.31

Can estimate:

- Machine cost $/hour (to contractor)
- Machine productivity: BDT/hour
- Total $/BDT for entire logging system
- Total project costs
- Cost/acre to cut-skid-deck-chip
- Total # of 10 hour work days

Range of Costs for Biomass Harvest, Chip, and Haul

To Crescent Mills:

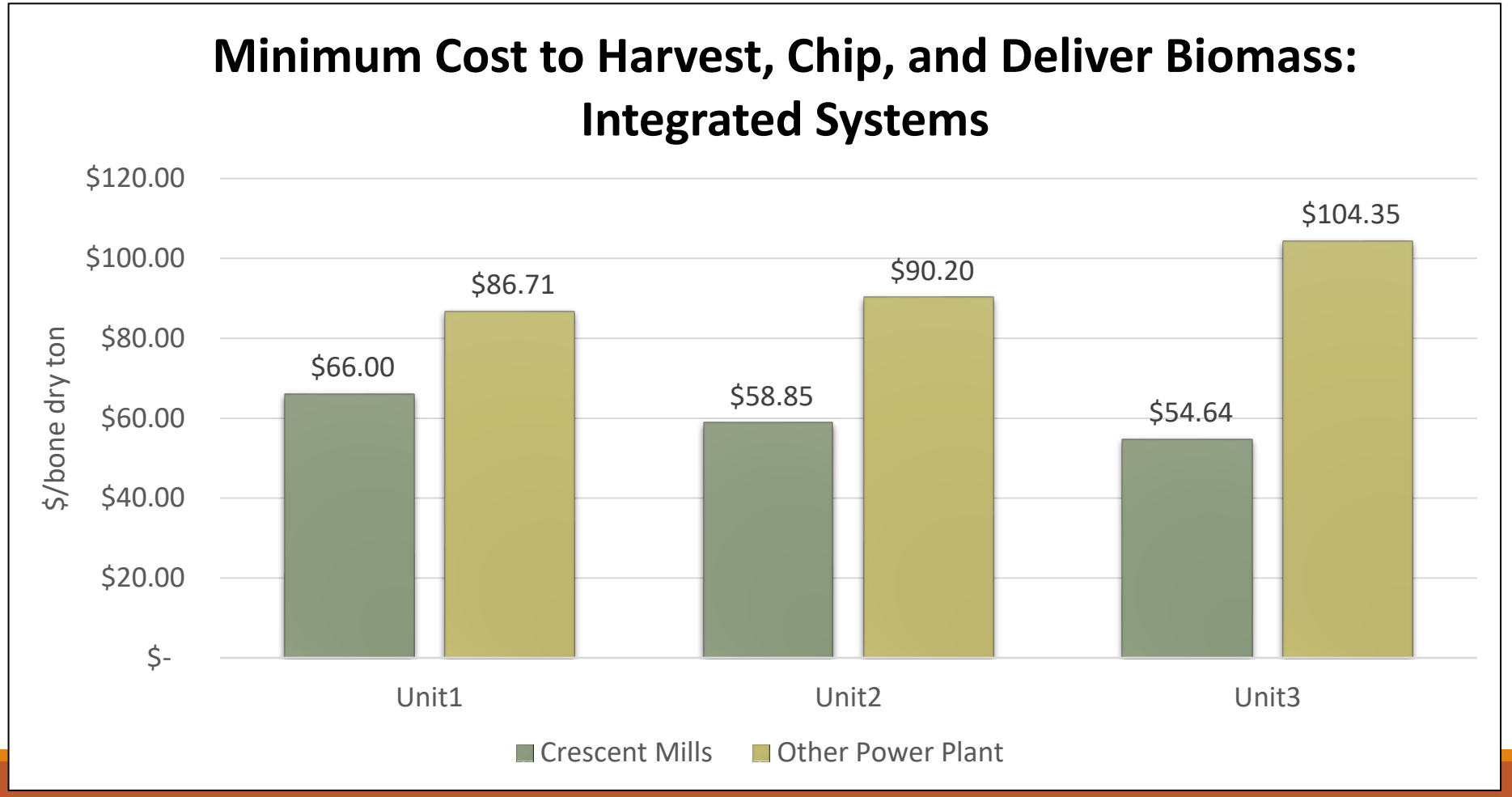
	Low End ($/BDT)	High End ($/BDT)
Integrated Harvest	$ 54.64	$ 66.00
Biomass Only	$ 66.61	$ 76.24
Hand Thin	$ 104.08	$ 121.52

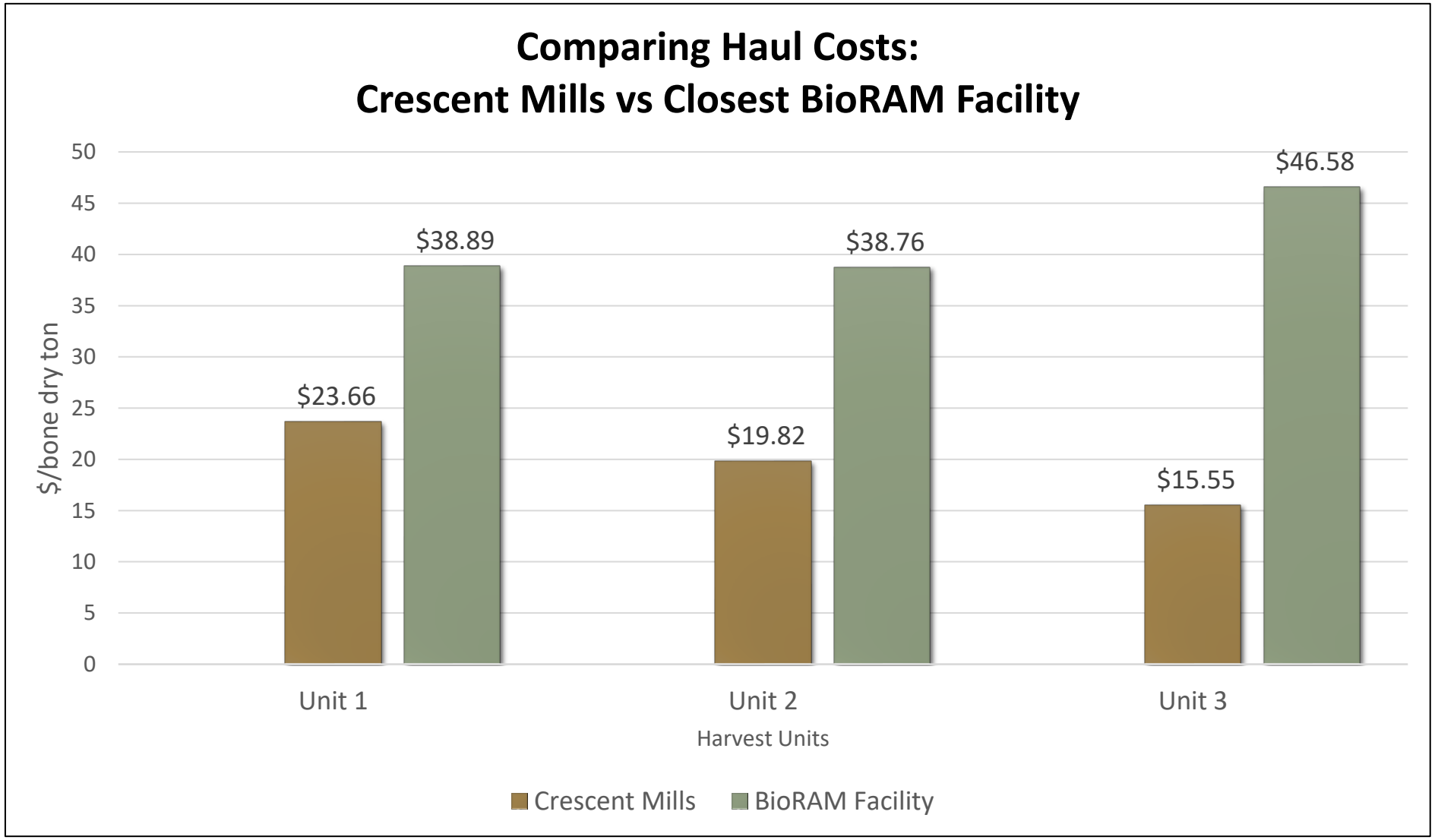
Assumes NO subsidy from FS

Does NOT include contractor overhead, profit, or contingency

Hand thin values incomplete, likely too low

Shorter Hauls Make the Difference




Comparing Haul Costs:
Crescent Mills vs Closest BioRAM Facility
$/bone dry ton
50
45
40
35
30
25
20
15
10
5
0
$23.66
$38.89
$19.82
$38.76
$15.55
$46.58
Unit 1
Unit 2
Unit 3
Harvest Units
Crescent Mills
BioRAM Facility

Constraints, Additional Considerations

Chipper utilization rate and productivity

- Related to haul distance, # of chip vans
- Longer project time= fixed daily costs extended

Harsh terrain, long skidding distances

High cost of doing business in CA

Key Takeaways

High price offerings needed to get supply from USFS restoration projects

Integrated harvesting is lowest cost, but still high

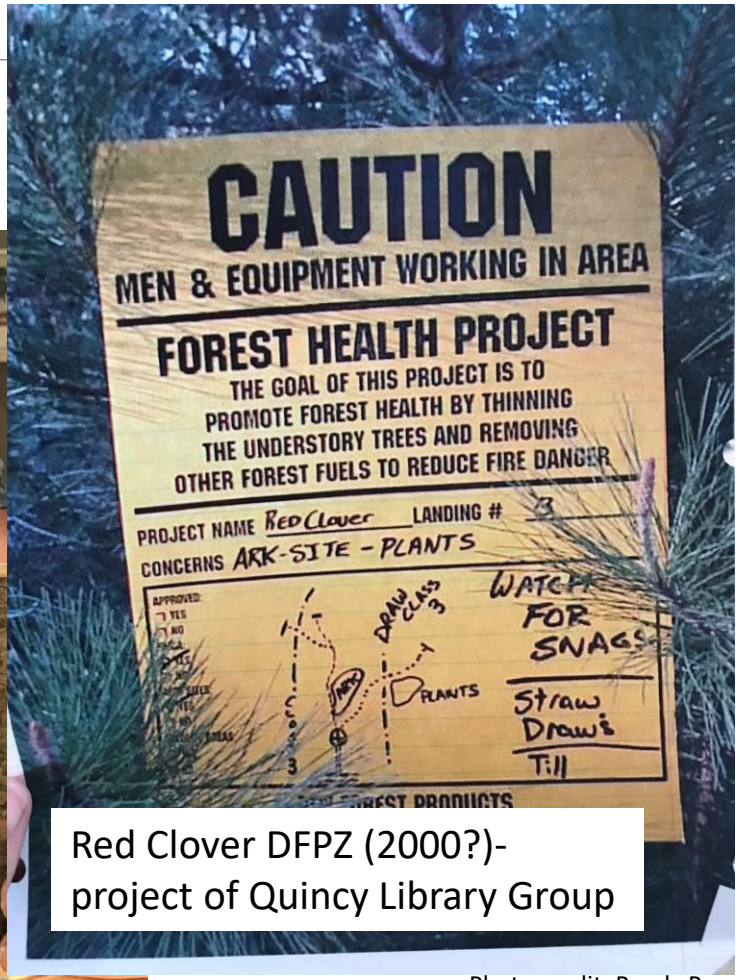
Subsidies (ie service contracts) help lower cost to contractor

Key Takeaways

Outlets close to supply = lower production/haul costs

Wood utilization campuses could play important role in supporting increased USFS stewardship work

Getting Contractors to the Table



Red Clover DFPZ (2000?)- project of Quincy Library Group

Photo credit: Randy Pew

Questions?

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