Operational and Logistics Challenges with Fuel Reduction Thinning and Forest Restoration in the Southern Rockies




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Overview

- Context
  - Big picture challenges
  - Supply chain challenges
- Forest operations focus
  - Contractor survey results
  - Operations research
- Next steps
- Conclusions and questions

A Bruks chipper operating on a fuel reduction thinning at a study site in southern Colorado

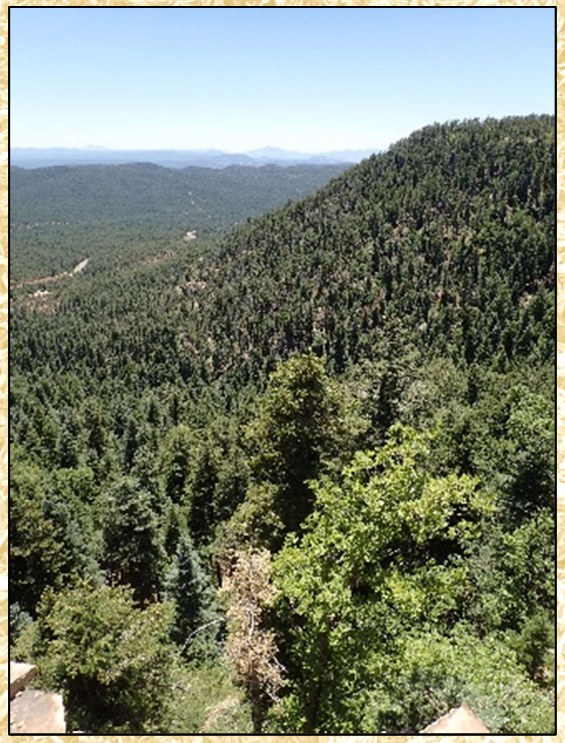
ForBio Research Team

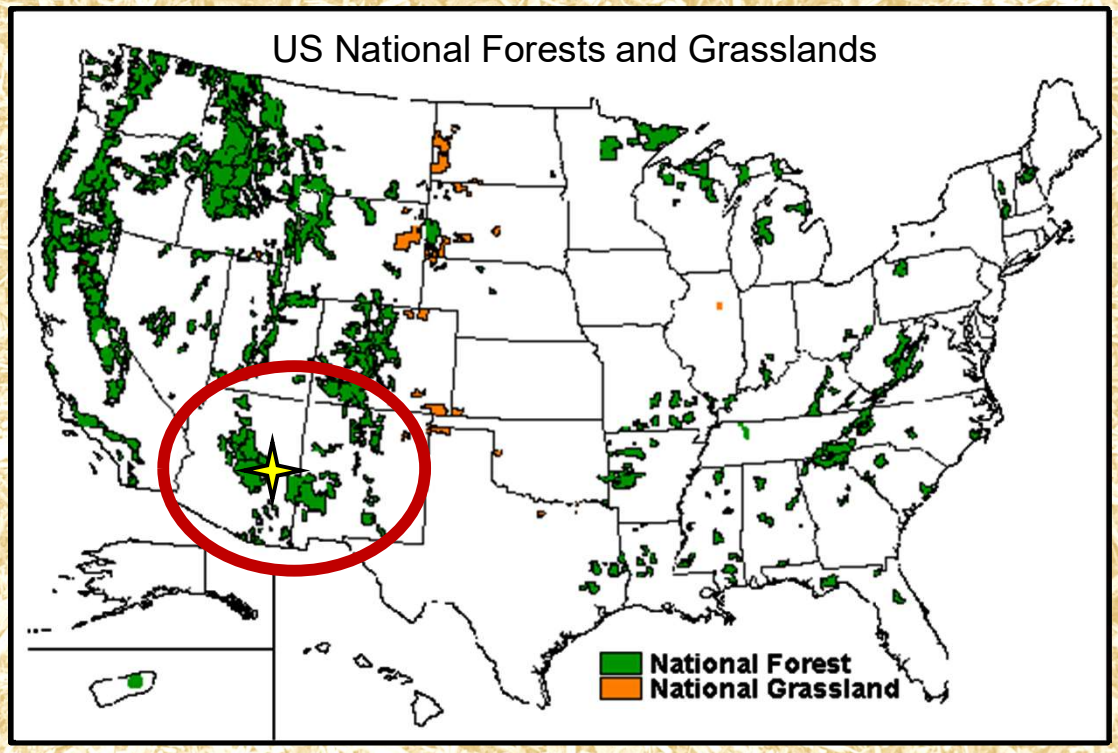
- University of Montana
  - Beth Dodson, Project Director*
  - John Goodburn+
  - Lucas Townsend*
- Northern Arizona University
  - Ching-Hsun Huangº
- U.S. Forest Service
  - Nate Anderson*
  - Mike Battaglia+
- Funded by
  - USDA – NIFA (BRDI)
  - USDA – U.S. Forest Service
  - With in-kind cost match from contractors

* Operations team
+ Ecology team
º Economics team

U.S. Forest Service

- National Forest System
  - 154 national forests and 20 national grasslands
  - 193 million acres (79 million ha, 780,000 km^2)

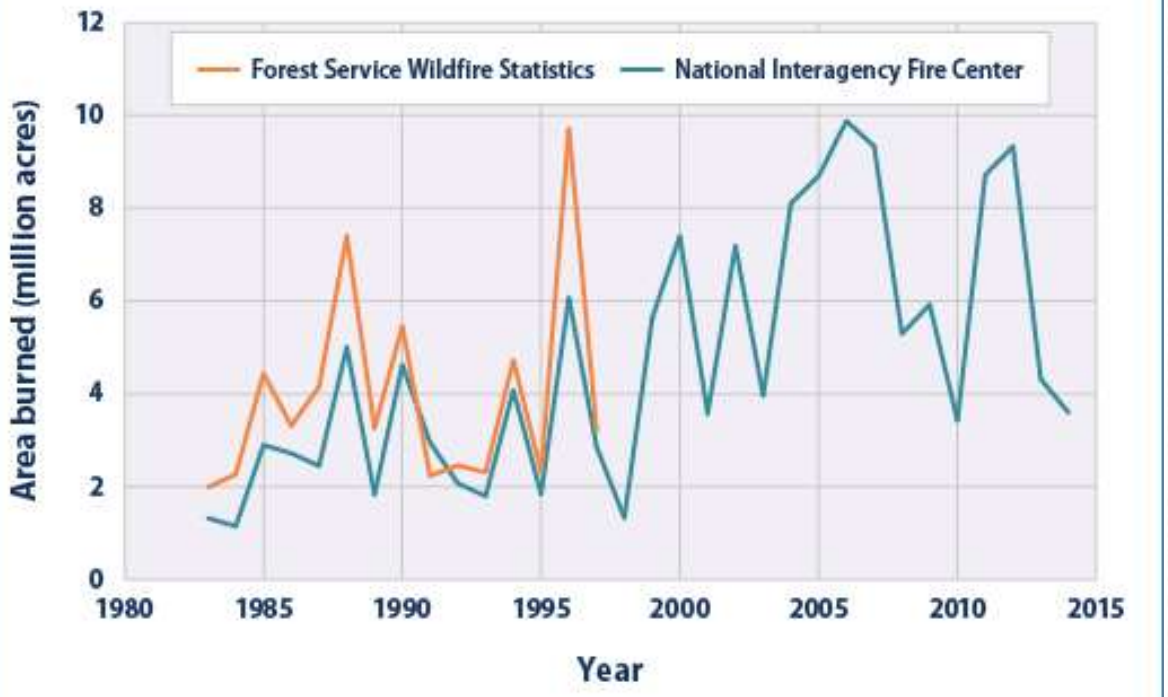


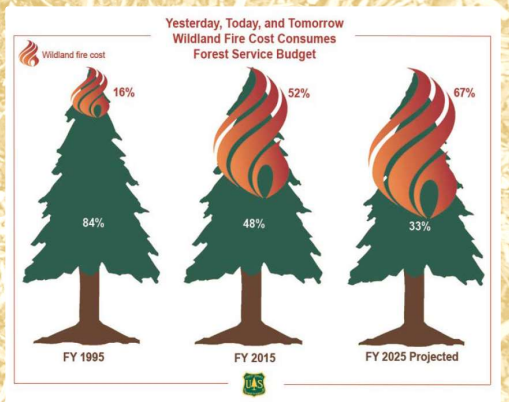


Disturbance Patterns

- Wildfire

Figure 2. Wildfire Extent in the United States, 1983–2014

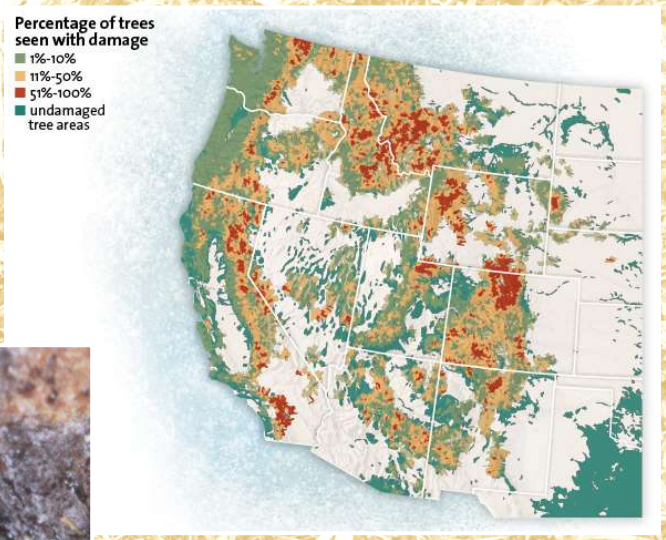




Disturbance Patterns

- Insects and disease

Beetle Impacted Forests

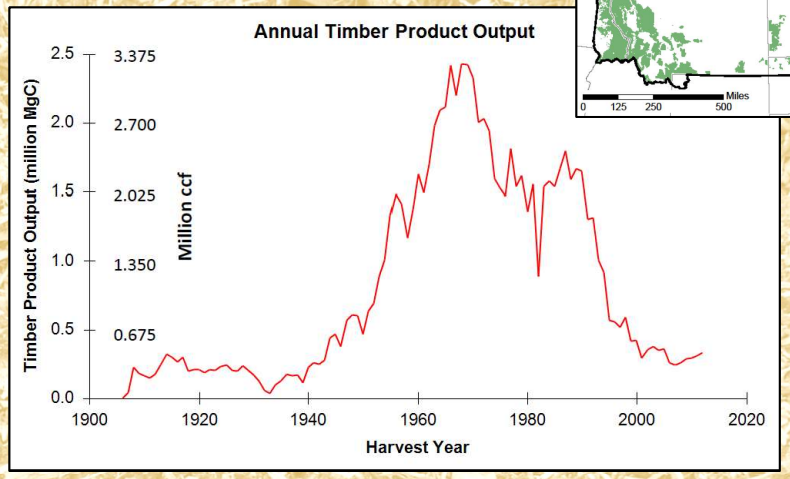


Mountain Pine Beetle
(Dendroctonus ponderosae)

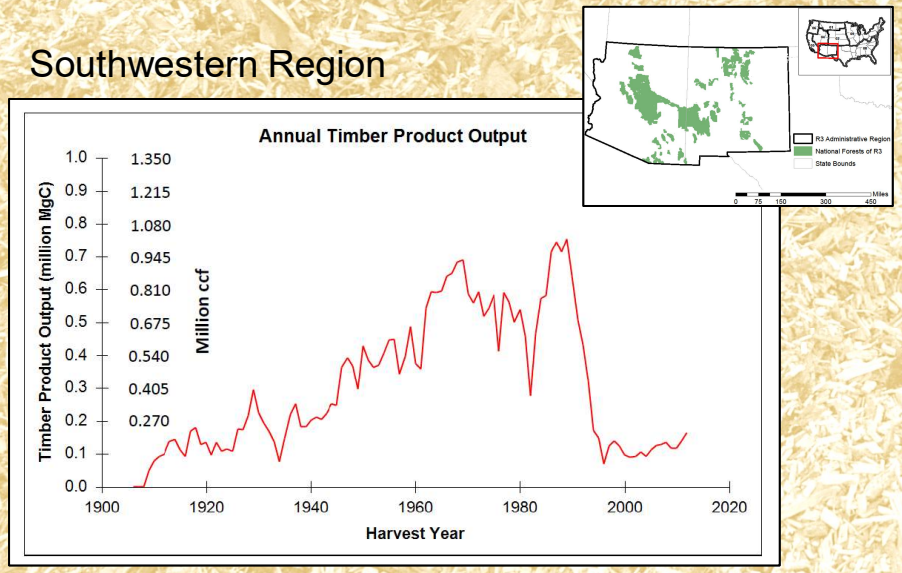
Disturbance Patterns

- Timber Harvest
  - Decline to ~10% of maximum annual harvest

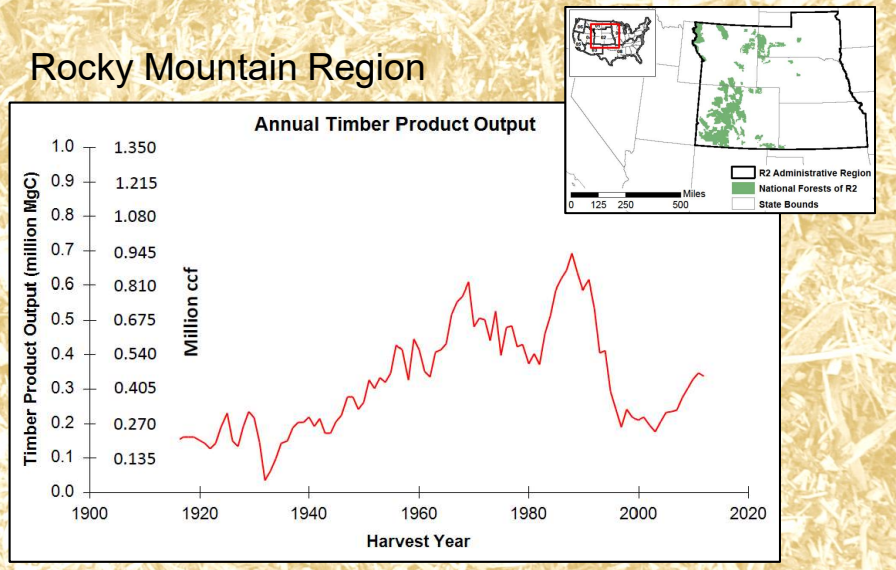
Northern Region



Southwestern Region



Rocky Mountain Region



Ecological Restoration

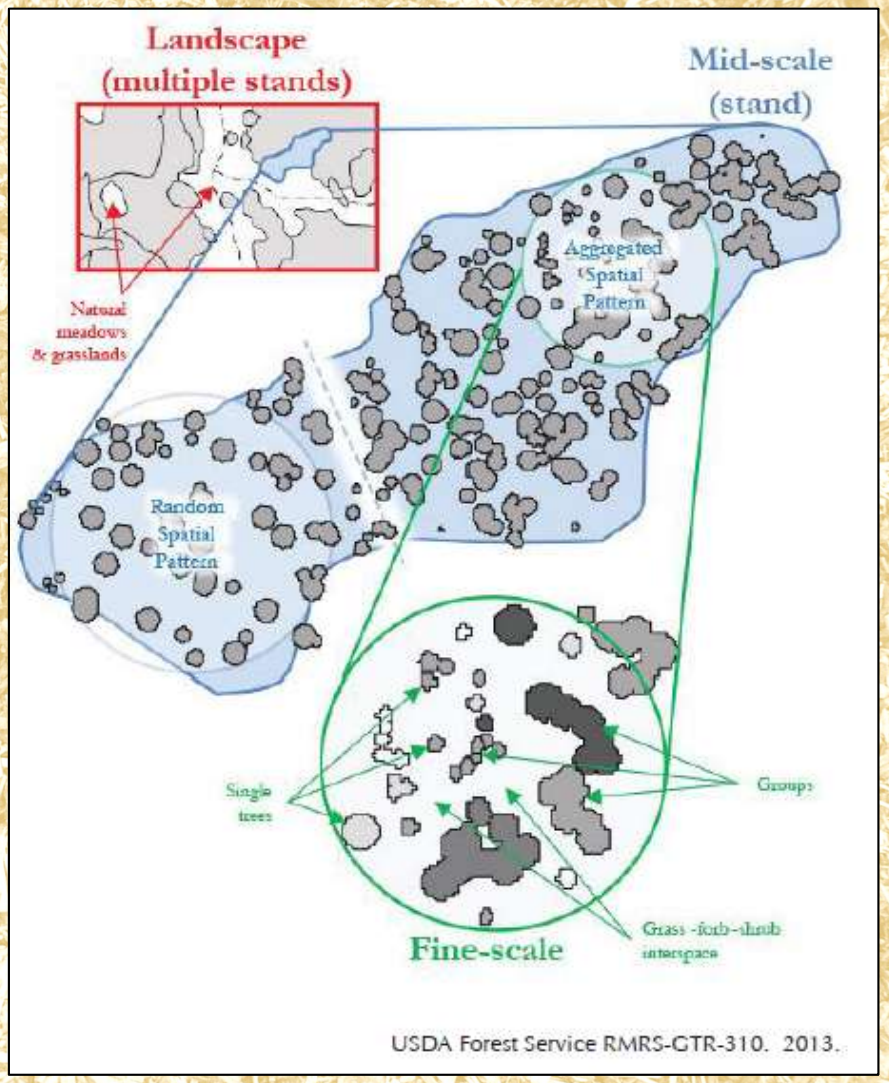
Mixed conifer, Colorado

Lodgepole pine, Colorado

Ponderosa pine, Arizona

Ecological Restoration

- Multiple scales
- Uneven-aged
- Single, random, and grouped trees of different vegetation structural stages
- See Reynolds et al. 2013, GTR-310



Market Challenges

- Poor markets for wood and fiber
- Limited markets for biomass
- Difficult cost estimation
- Variable logging capacity
- Revenues do not offset costs

Novo Biopower, Snowflake, AZ, and biochar from biomass.

Sawlogs and wood chips from restoration in Ponderosa pine.

Operational Challenges

- Difficult prescriptions
- Higher costs
- Lower product values
- Narrower margins
- More dangerous

See *Kim et al. 2017. For. Sci. 63(6):596–605.*

A beetle-kill salvage operation harvesting sawlogs, post and pole wood, firewood, and biomass.

ForBio Operations Team

- Goal
  - Reduce the cost of restoration treatments
  - Treat larger area at lower cost
  - Integrate revenues from new products & markets
  - Improve the forest bioeconomy
- Objectives
  - Establish baseline production and cost data
  - Carry out experiments to improve practices
  - Provide technology transfer and decision tools
  - Better cost estimation

Contractor Survey

- Arizona and New Mexico
- Census of logging contractors (n=17 of 21)
- Intensive, in-person interviews
- Project costing activity
  - Treatment cost estimation
  - 4x3 design
    - 4 different forest types
    - 3 operations scenarios
    - 7 to 14 distinct cost components per scenario
  - Serve as hypotheses for field operations research

Contractor Survey

- Based on “standard” prescriptions
- 4 Forest Types
  - Ponderosa pine, low stocking
  - Dry mixed conifer, medium stocking
  - Ponderosa pine, high stocking
  - Dry mixed conifer, high stocking
- 3 Operations scenarios
  - Sawlog harvest with biomass burning
  - Biomass only
  - Sawlog harvest with biomass harvest

Contractor Survey

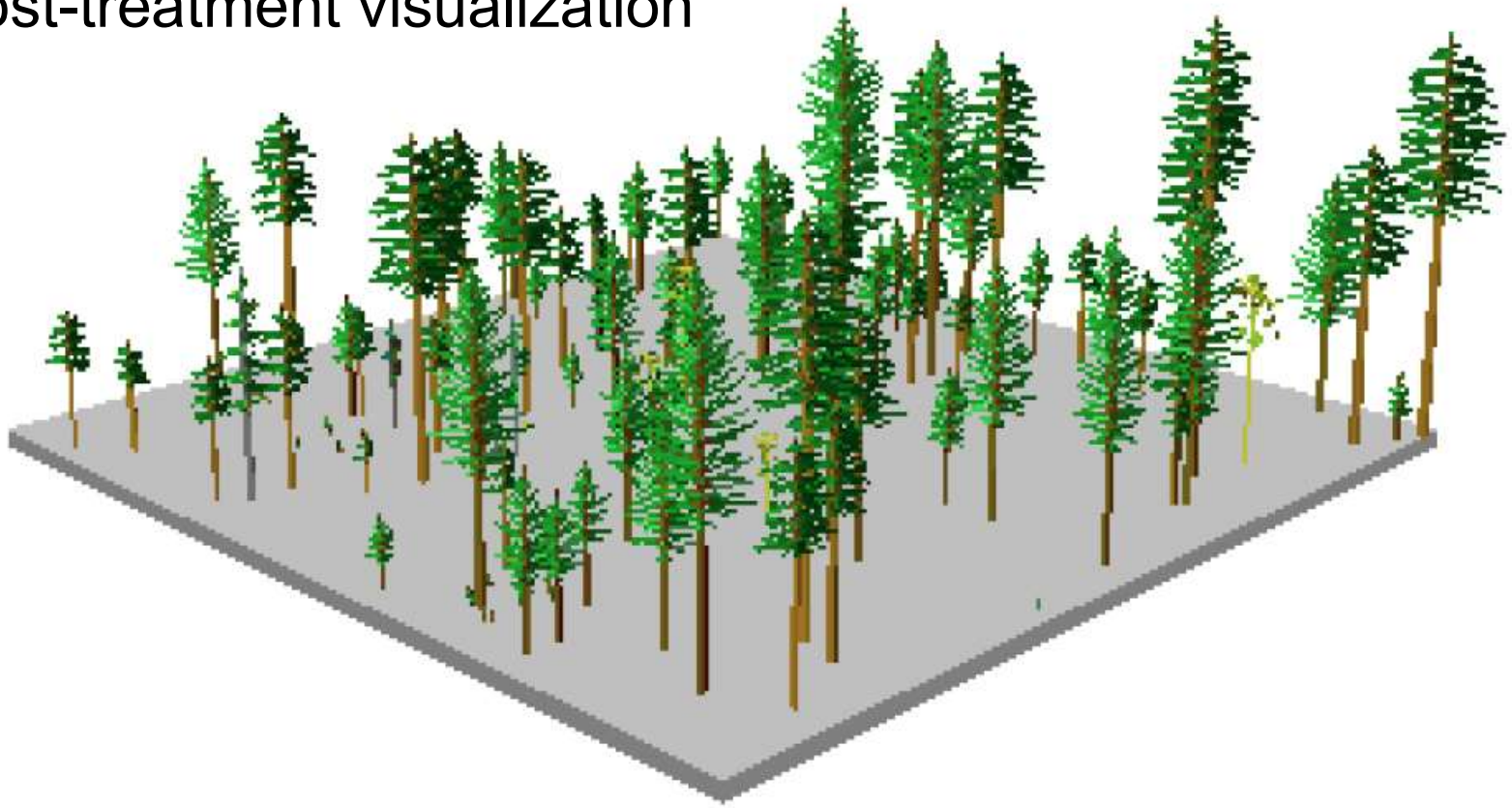
- Example: Dry mixed conifer, high stocking

Pre-treatment visualization

Contractor Survey

- Example: Dry mixed conifer, high stocking

Post-treatment visualization



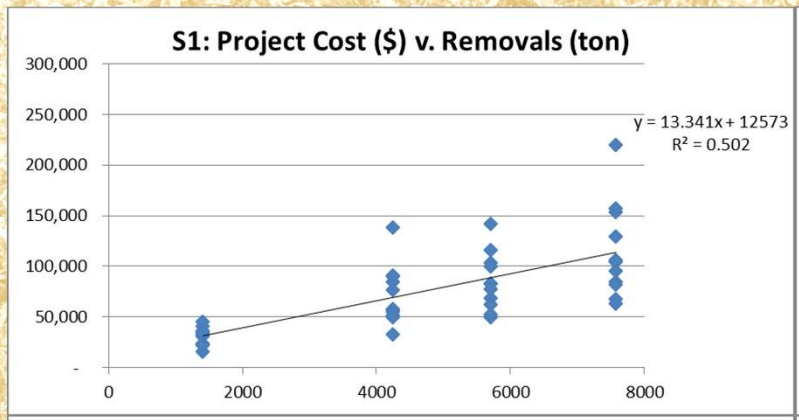
Contractor Survey

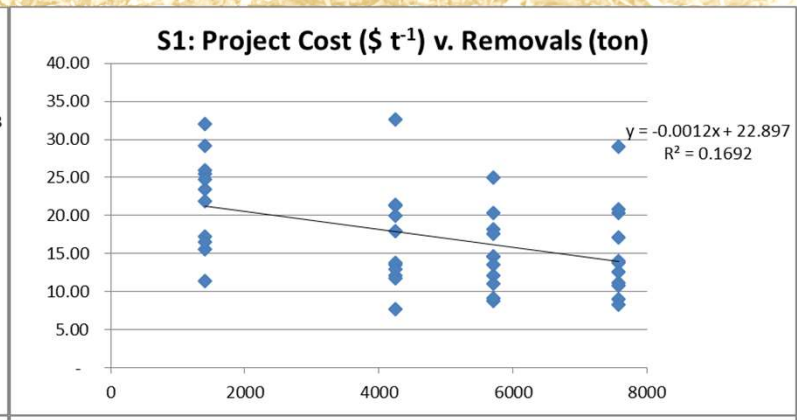
- Cost components

Cost Components	Scenario 1 Roundwood + Burning	Scenario 2 All Biomass	Scenario 3 Roundwood + Biomass
Planning, setup, and rehabilitation	Y	Y	Y
Mobilization of equipment, 120 miles RT	Y	Y	Y
Mechanical felling	Y	Y	Y
Skidding for 300, 600, 900 feet skid distances	Y	Y	Y
Topping, limbing, bucking roundwood	Y	N	Y
Loading roundwood	Y	N	Y
Grinding or chipping	N	Y	Y
Pile slash for burning	Y	N	N

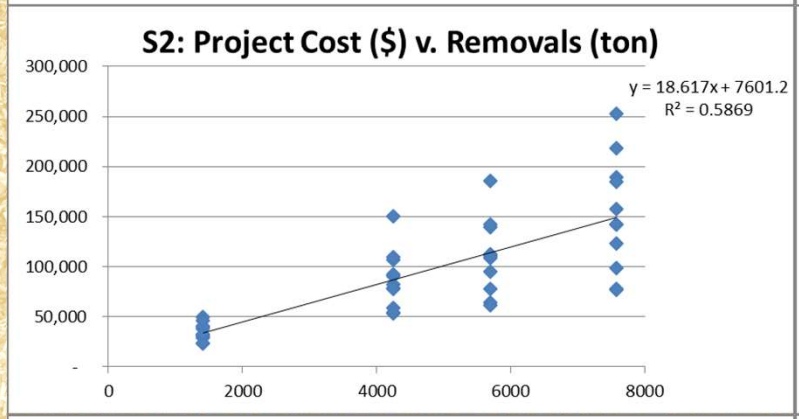
Results

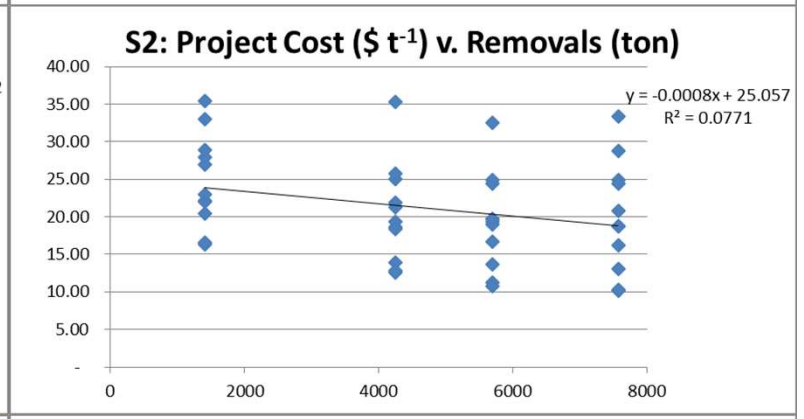
Roundwood + Burn



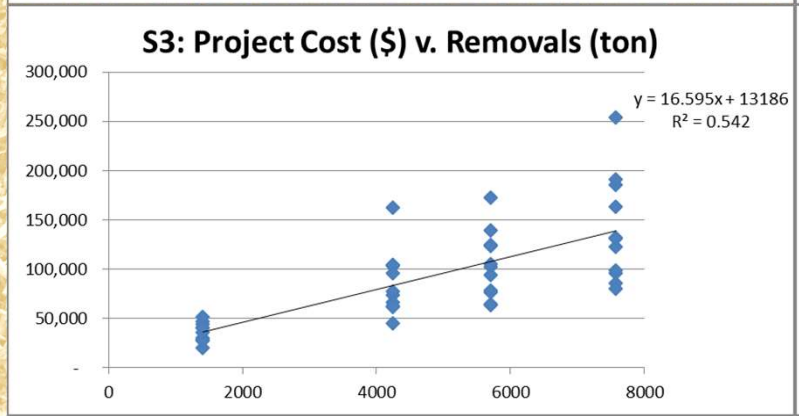


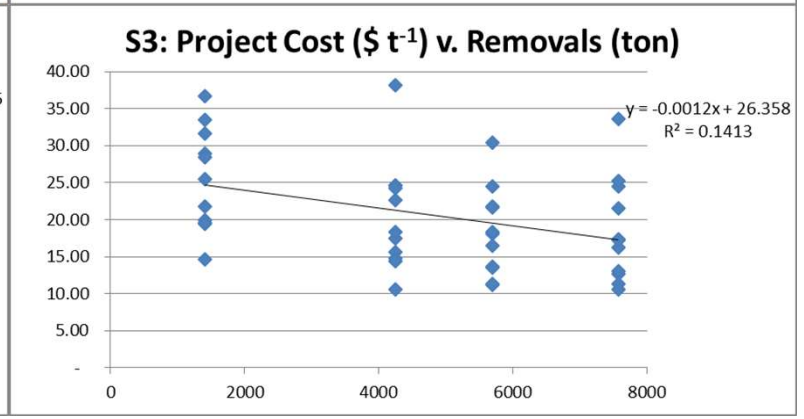
Biomass Only



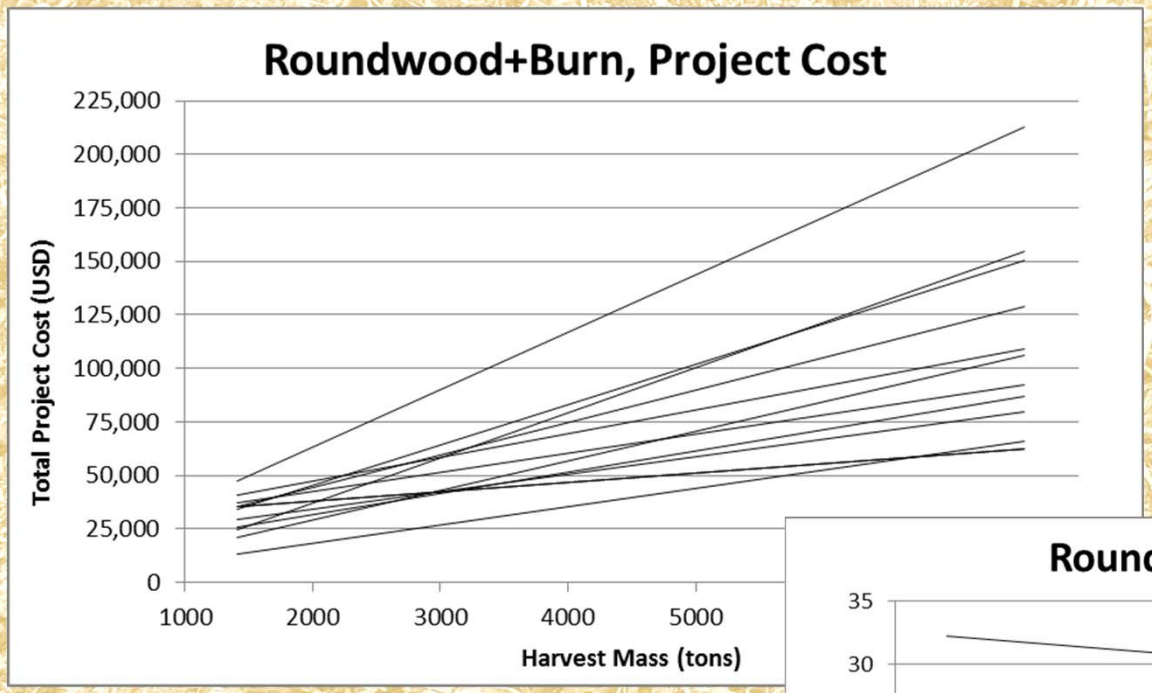


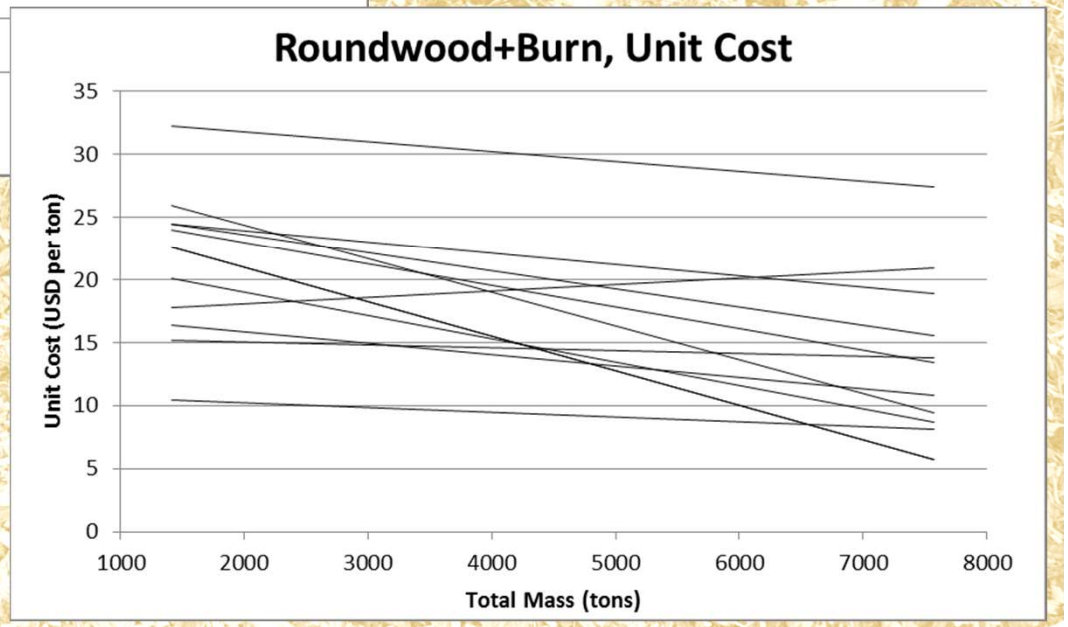
Roundwood + Biomass





Results





- Cost curves by respondent

Results

- 4 forest types x 3 production scenarios

	Production Scenarios Mean production cost (std dev) (USD per green ton)		
Forest Type	Scenario 1 Roundwood + Burning	Scenario 2 All Biomass	Scenario 3 Roundwood + Biomass
Ponderosa pine, low stocking	25.90 (16.60)	24.40 (10.75)	28.42 (17.31)
Dry mixed conifer, medium stocking	17.92 (9.06)	18.74 (7.97)	20.64 (8.61)
Ponderosa pine, high stocking	16.37 (6.89)	17.47 (6.90)	18.72 (6.83)
Dry mixed conifer, high stocking	15.32 (5.56)	17.37 (7.51)	18.03 (6.67)

Results

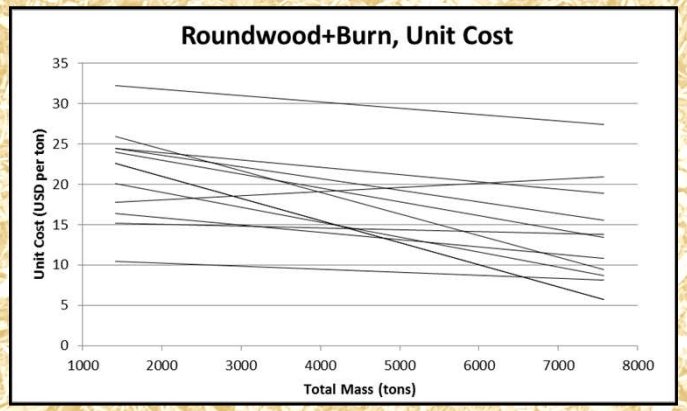
- 4 forest types x 3 production scenarios
- Significant effect of forest type
- No significant effect of production scenario

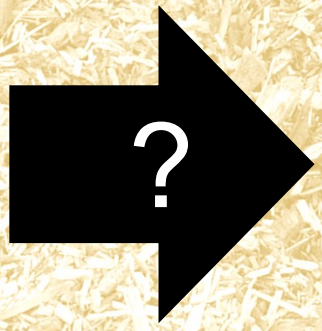
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	3075.30204	279.57291	2.84	0.0018
Error	188	18511.63723	98.46616		
Corrected Total	199	21586.93928			

Source	DF	Type I SS	Mean Square	F Value	Pr > F
STAND TYPE	3	2758.967490	919.655830	9.34	<0.0001
SCENARIO	2	241.494443	120.747222	1.23	0.2957
Interaction term	6	74.840111	12.473352	0.13	0.9929

Next Steps

- Use survey data to benchmark performance
- Good starting point for hypotheses
  - Relative importance of cost components
  - Nominal production costs of components
  - Project and unit costs and revenues
  - Optimize different configurations and conditions





Next Steps

- Establish baseline production and cost data for current forest practices
- Carry out experiments to improve practices
  - On-unit roundwood and biomass sorts
  - Phased versus integrated felling
  - Optimized slash burning

Log and biomass production from a forest restoration treatment in Apache-Sitgreaves National Forest.

Lucas Townsend, UM Graduate Student, collecting time study data in Arizona.

Next Steps: FEC 2018

- Opportunities for:
  - Precision forestry for difficult prescriptions
  - R&D to improve management
  - AI and optical sensors
  - Steep terrain harvesting
  - GPS-RF technology

Conclusions

- Forest restoration is an opportunity for operations research
  - Great need at the margin
  - Difficult residual stand conditions
  - Challenging product mix
  - Ecological emphasis
  - Limited existing models
- Opportunities to integrate ecological conditions as a production output

Contact Information

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