College of Forestry - Forestry and Natural Resources Extension

UP IN SMOKE: COSTS AND CONSTRAINTS OF PILE BURNING IN WESTERN FORESTS

Pile burning on the Sierra National Forest (from the Sierra NF Facebook Page)

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Oregon State University

Introduction

- Title: *Assessing costs and constraints of forest residue disposal by pile burning*
- Co-authors
  - Jimmy Voorhis – Kodama Systems
  - Sinead M. Crotty – Carbon Containment Lab
- Research supported by Carbon Containment Lab
- Travel and presentation supported by Oregon State University Forestry and Natural Resources Extension

Yale SCHOOL OF THE ENVIRONMENT
The Forest School

Carbon Containment Lab

Kodama Systems™

Oregon State University Extension Service

Background

- **Context**
  - What is pile burning?
    - Disposal of residual forest biomass
  - Where?
    - Dry conifer forests (National Forests for this study) – sometimes mixed moist forests
  - Why?
    - Post-harvest
    - Fuels reduction

From Sierra NF Facebook

Background

- **Methods**
  - Built by **Hand**
    - Small, numerous, hard to get to
  - Built by **Machine**
    - Larger, easy to access

- **Burned** 6+ months later after wildfire season (late fall, early winter, sometimes into spring)

From deschutescollaborativeforest.org

From seattle.gov

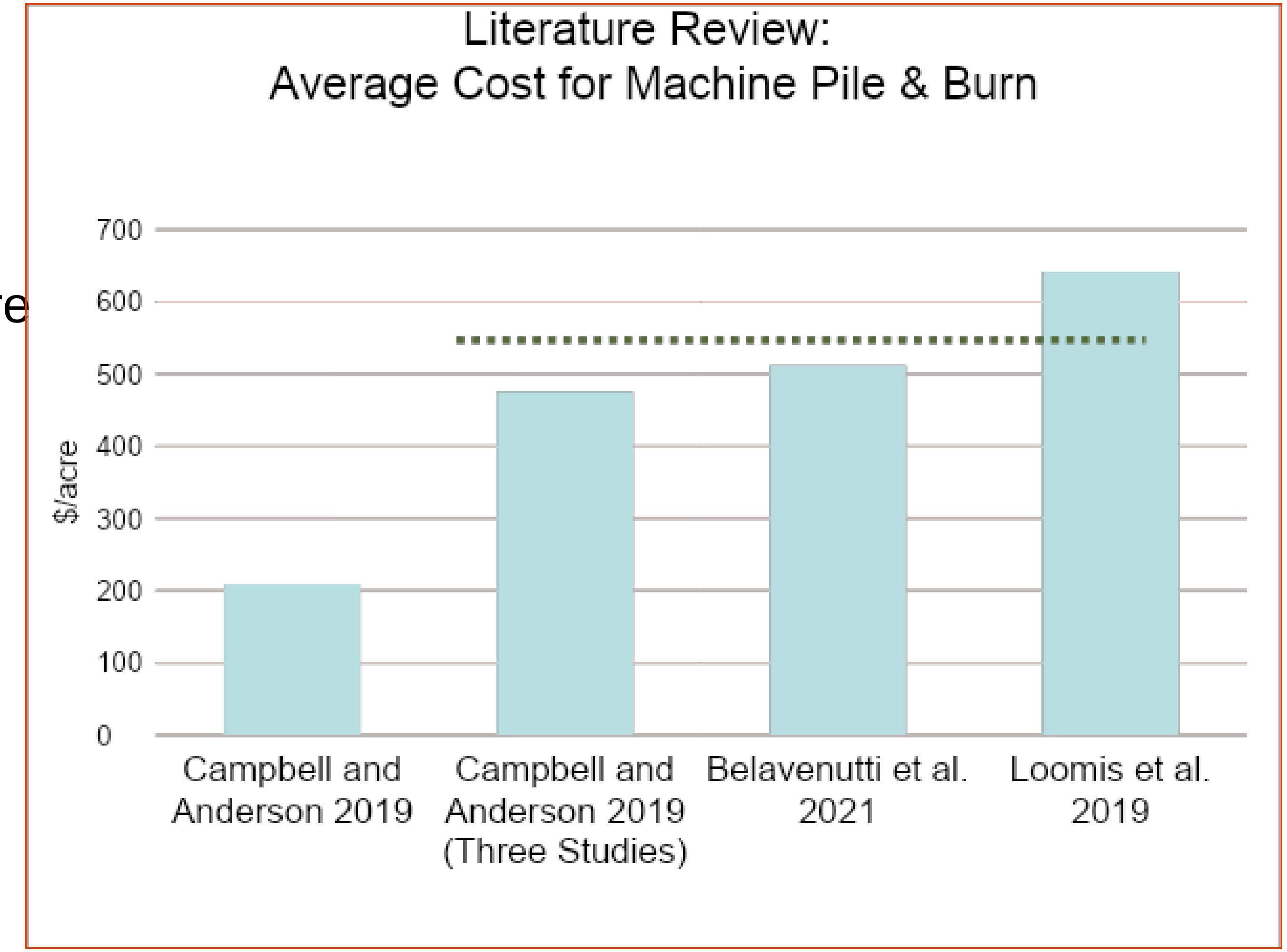
Background

- **Left as Wildlife Habitat** Piles with a mix of material size for mammals and amphibians to create habitat after operations

From OFRI

Background

- Research Gap
  - Machine pile burning:
    - Average costs: $543/acre
  - Hand pile burning:
    - Limited information



Objectives

1. Quantify the costs of cutting and yarding, piling, and burning forest residues in dry western national forests in California, Oregon and Washington

2. Identify key cost drivers, implementation constraints, and opportunities for efficiency improvements

3. Estimate emissions impacts from pile burning

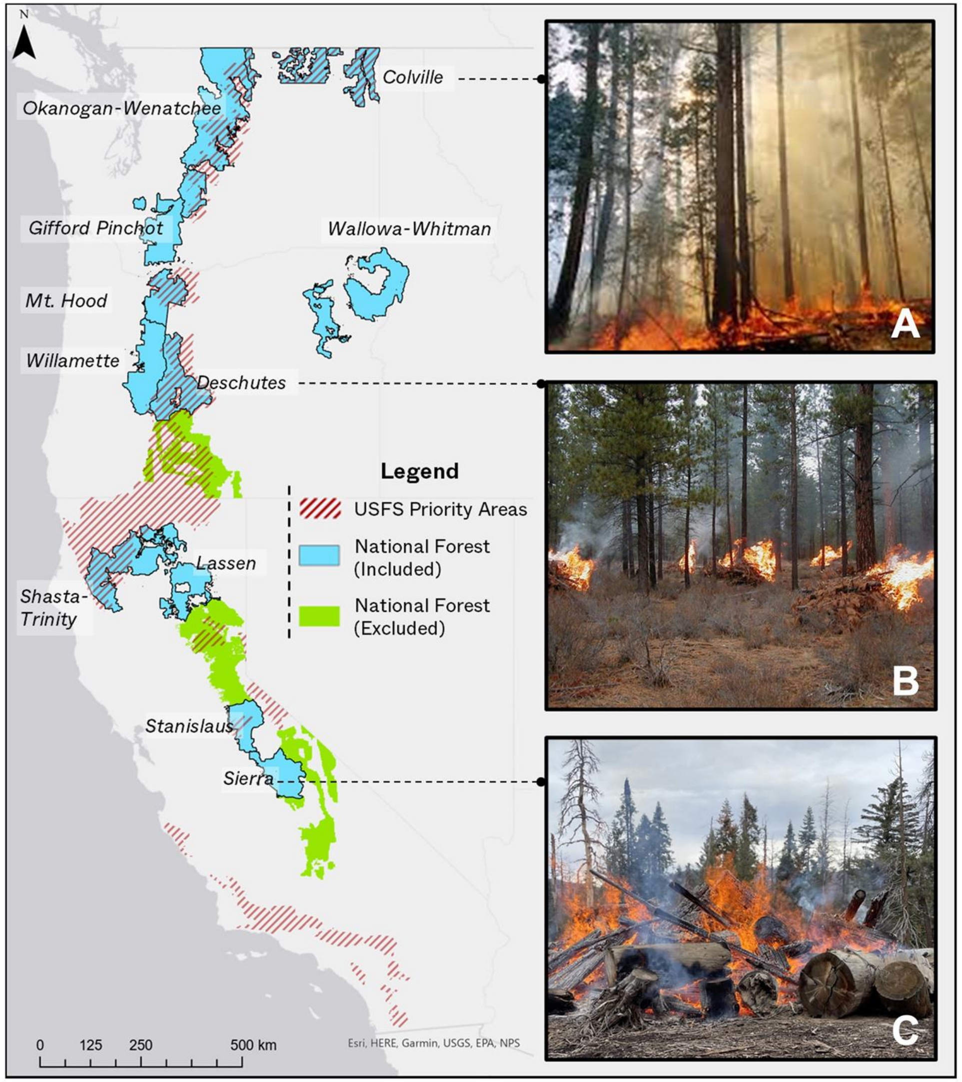
Methods

1. Data from the USDA Forest Service's FACTS database (2019–2023)

2. Interviews with 11 USDA Forest Service fire management professionals across CA, OR, and WA (20% response rate)

3. Geospatial analyses to correlate terrain and accessibility with costs

4. Emissions estimate with CONSUME model and compare CDR efficiencies



Map of National Forests in the study region. **(A)** broadcast burning on the Colville National Forest (photo credit Colville National Forest), **(B)** hand pile burning on the Deschutes National Forest (photo credit Deschutes National Forest), and **(C)** machine pile burning at a landing on the Sierra National Forest (photo credit Sierra National Forest).

Key Findings: Cost Analysis

Hand Piles

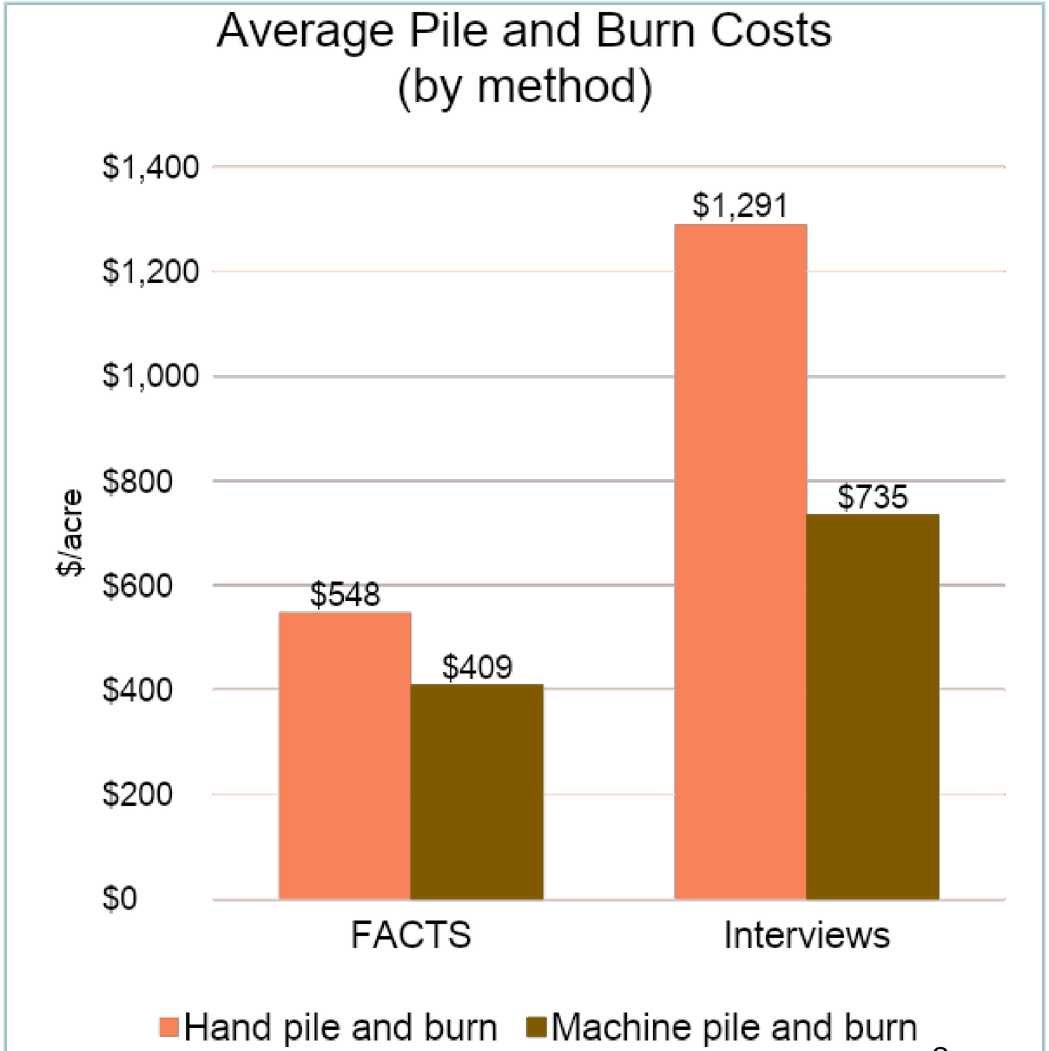
- Interviews reported costs 135% higher than FACTS

Machine Piles

- Interviews reported costs 80% higher than FACTS, 35% than literature

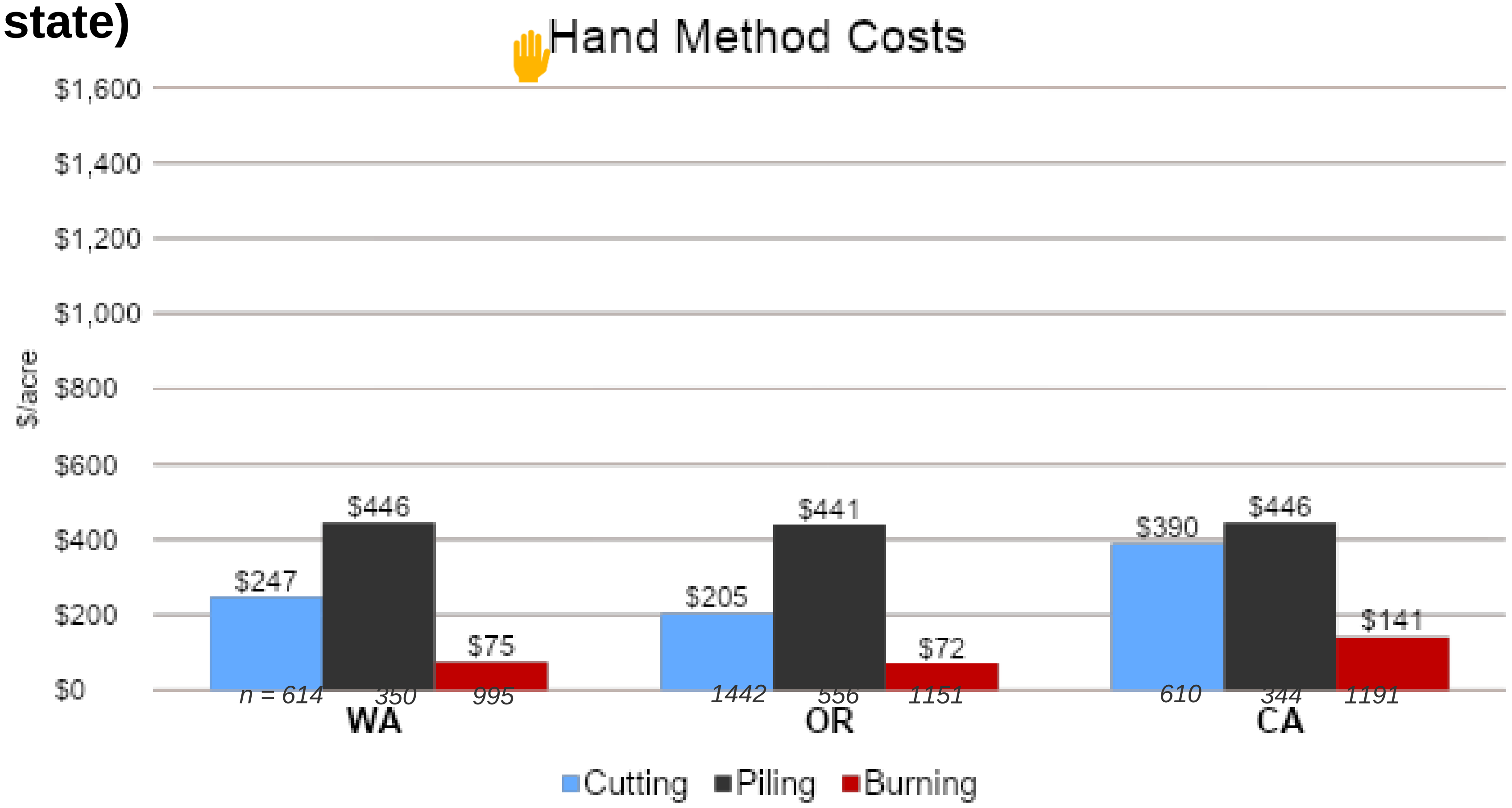
Planning

- Long-term: $1.45/acre
- Day-of: $15.37/acre



Key Findings: Cost Analysis

FACTS Database Insights (by state)



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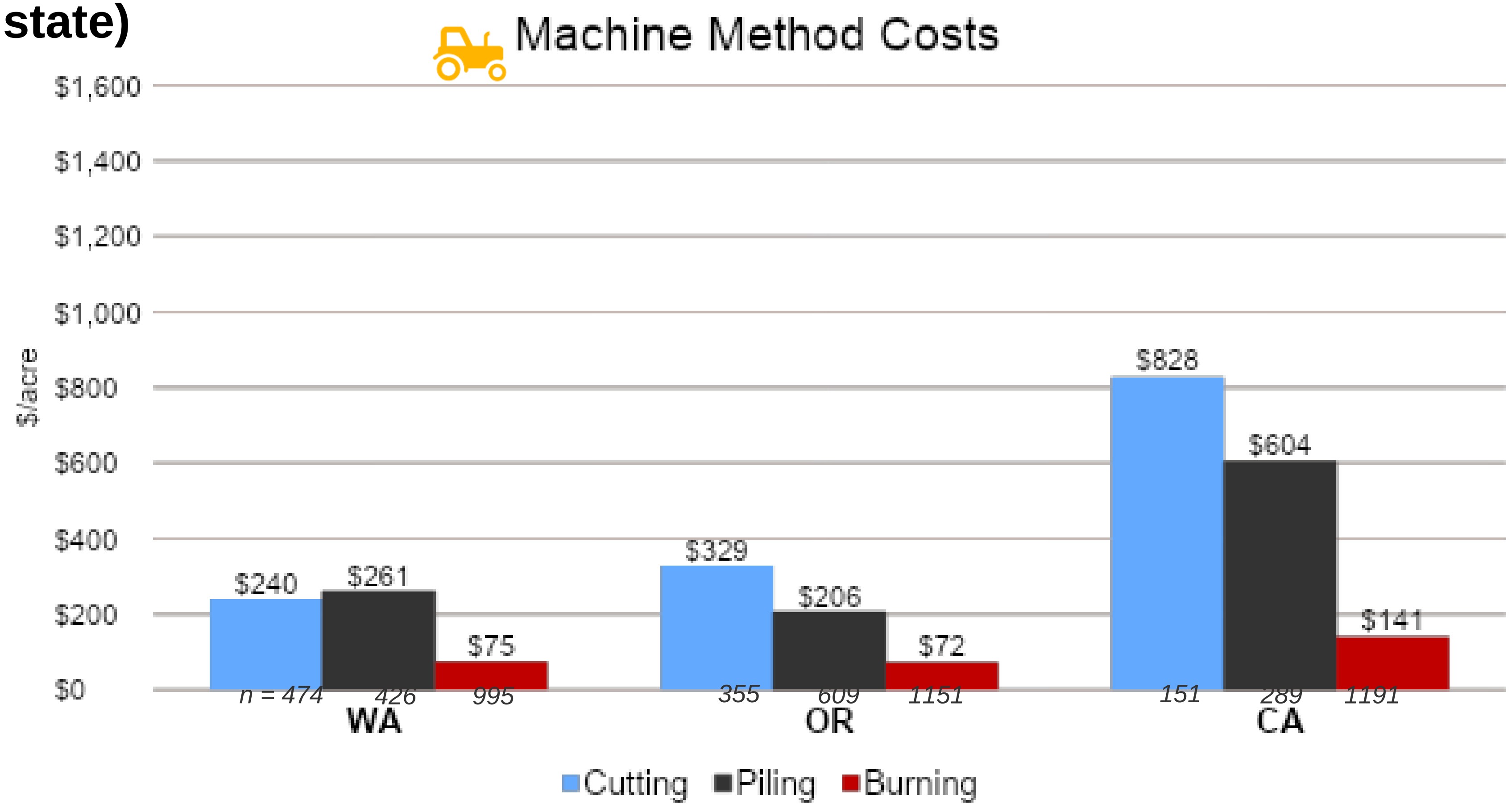

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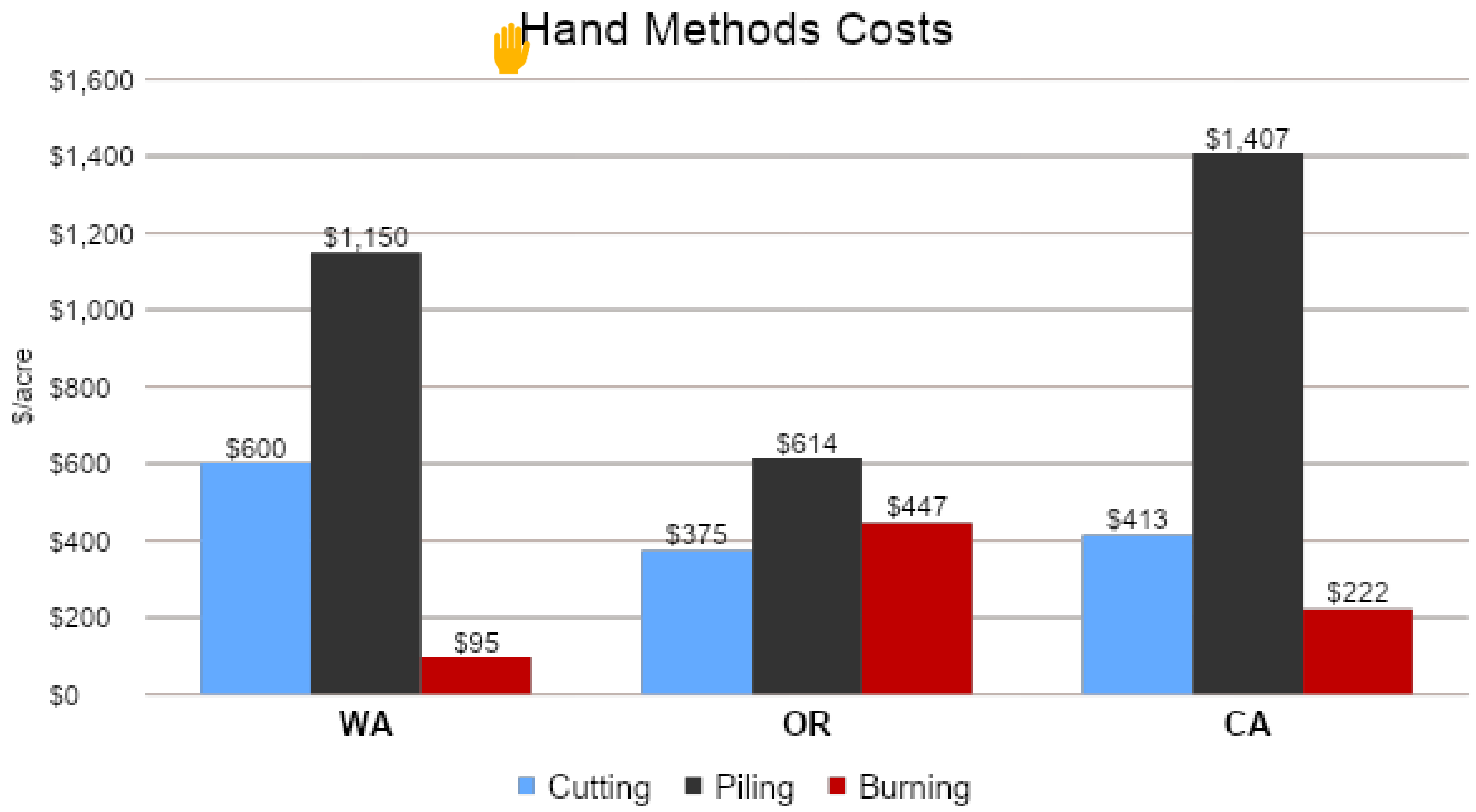
Interview Insights (by state)



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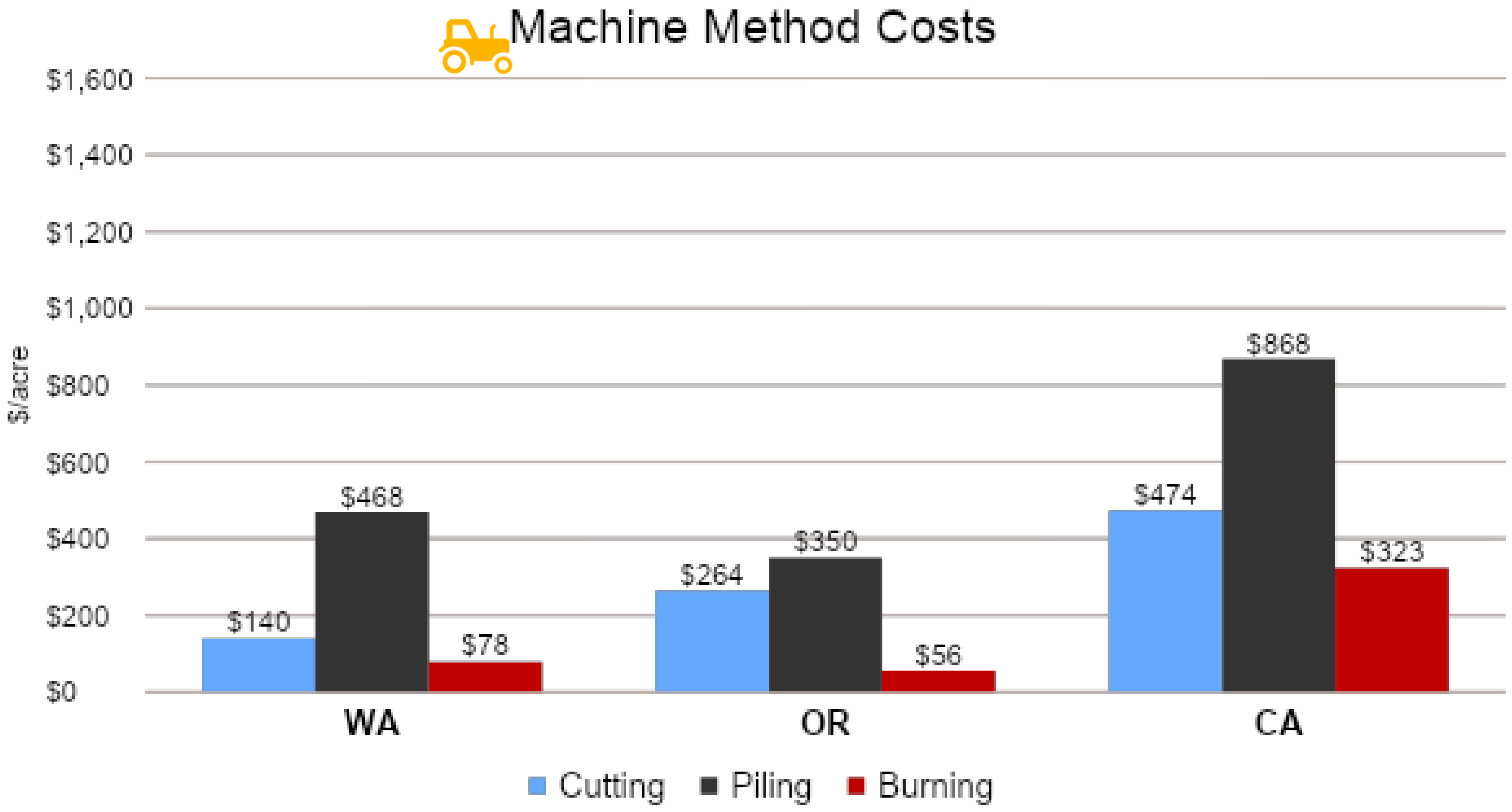


Key Findings: Interview Highlights

- **Cutting and Yarding**
  - Slope restrictions and social and ecological constraints
- **Piling**
  - Pile construction quality is key and based on method/prescription/NEPA
- **Burning**
  - Pile construction quality, difficulty with salvage piles
  - Weather, seasonality, workforce fatigue
  - Building faster than burning!

Key Findings: Interview Highlights

- **Planning**
  - NEPA authorizes large areas for burning, burn plans updated annually
  - Day-of planning includes check-ins with admins
  - Emergency situations take priority

- **Alternatives**
  - Some familiarity, but had rarely seen implemented alternatives

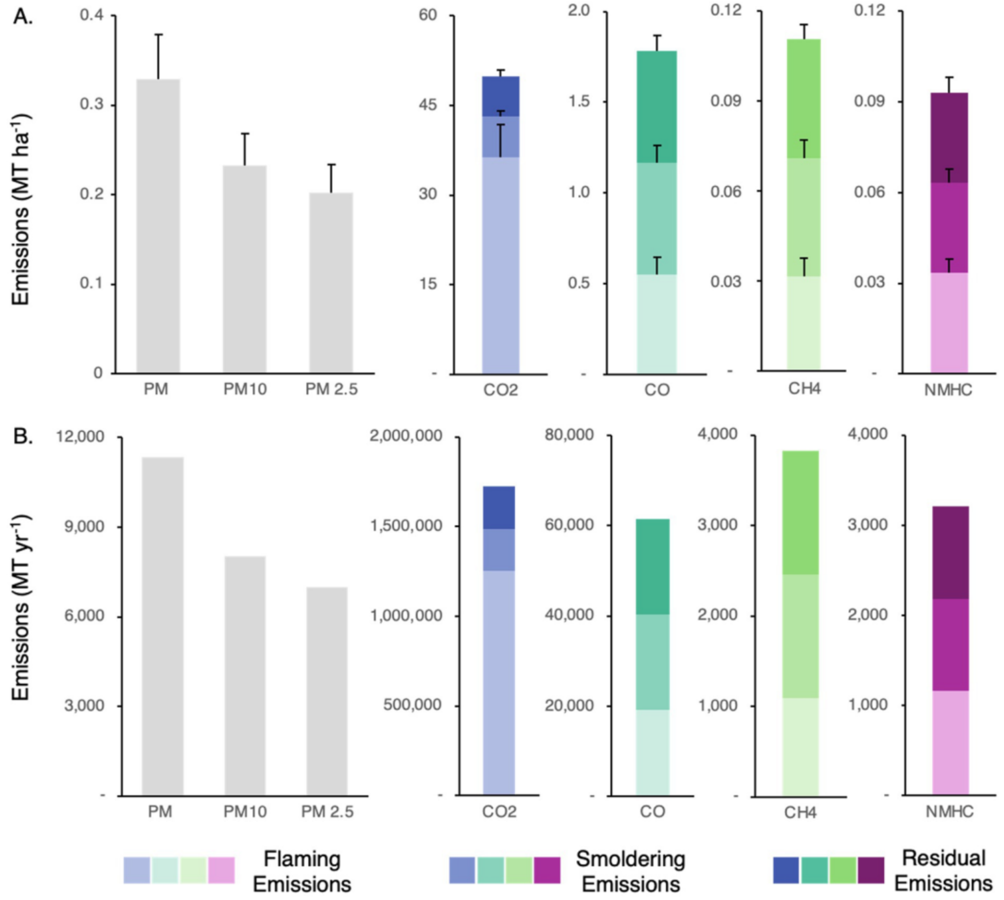
Cost Drivers and Constraints

- **Identified Cost Drivers:**
  - Proximity to roads (accessibility)
  - Terrain features like slope and elevation
- **Geospatial Analysis:**
  - Positive correlation between higher elevations and increased costs
  - Road density inversely related to costs; more roads equate to lower costs
- **Operational Constraints:**
  - Challenges in planning and executing burns due to terrain and accessibility
  - Variability in crew sizes and planning efforts based on site-specific

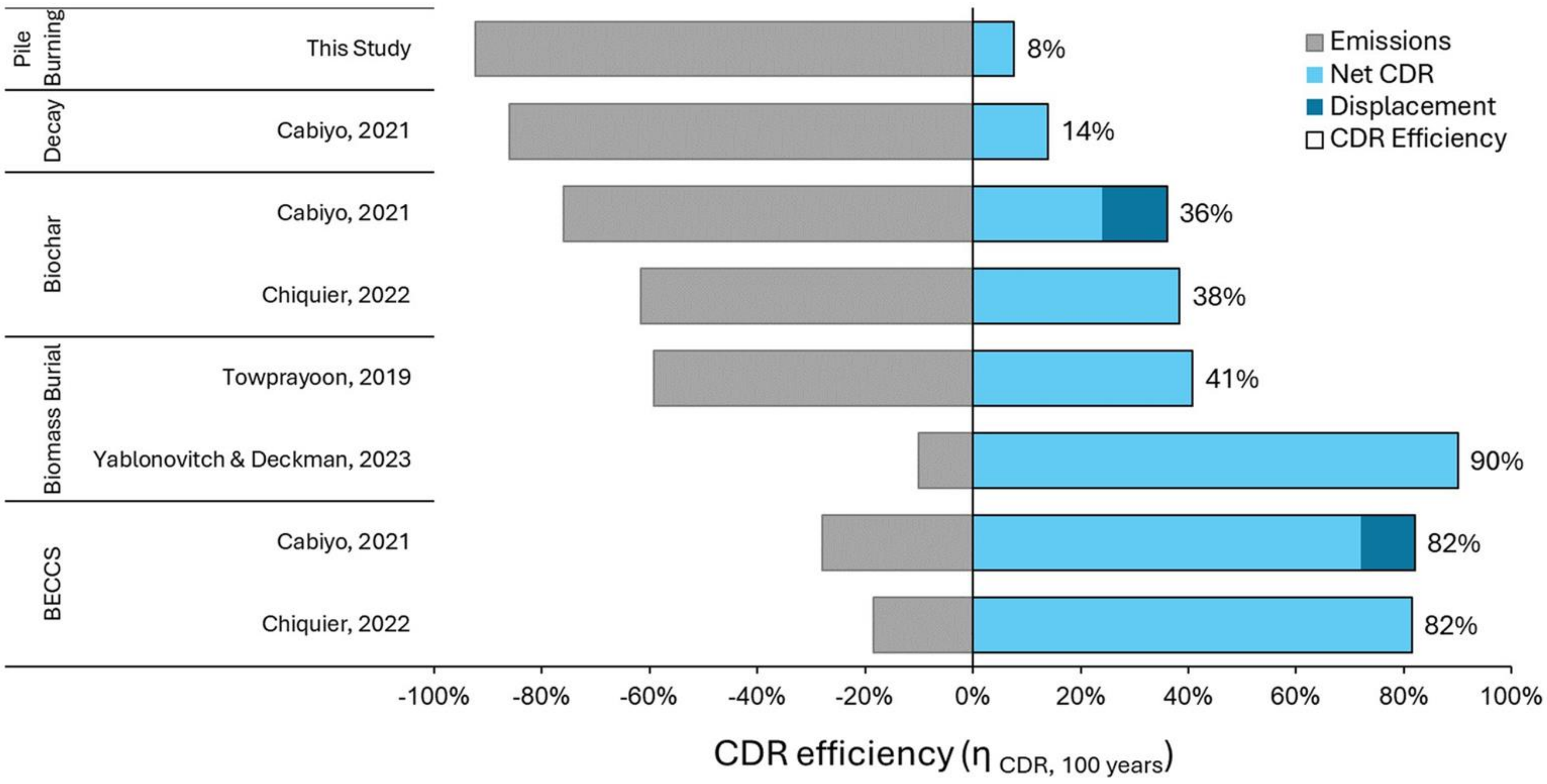
Photo: Jacob Putney

Environmental Impacts

- **Emissions from Pile Burning:**
  - Annual emissions include 11,322 metric tons of particulate matter, over 1.7 million metric tons of CO_2, 61,515 metric tons of carbon monoxide, 3,823 metric tons of methane, and 3,211 metric tons of non-methane hydrocarbons.
- **Implications:**
  - Significant contributions to air pollution and greenhouse gas emissions.
  - Need for evaluating alternative residue disposal methods to mitigate environmental impacts.



Environmental Impacts



Policy Recommendations and Alternatives

- **Alternative Approaches:**
  - Encourage residue removal for bioenergy or other utilizations
- **Incentivization Strategies:**
  - Implement subsidies for feedstock production, transport, or offtake to promote alternative disposal methods
  - $30-54 per bone dry MT of biomass
- **Long-Term Benefits:**
  - Potential for carbon-negative outcomes and reduced reliance on pile burning

From www.ncuaqmd.org

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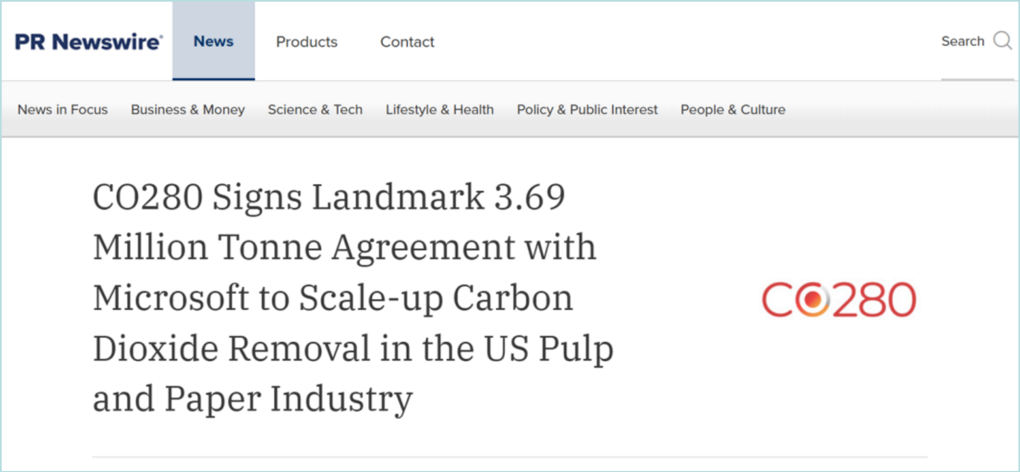

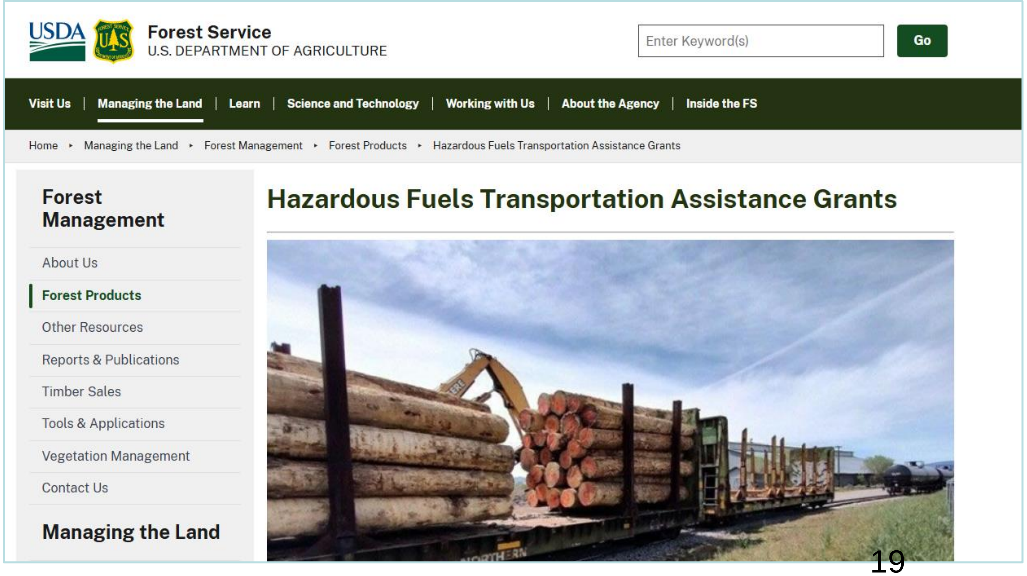

Thank You – and Questions?

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Citations

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Geospatial

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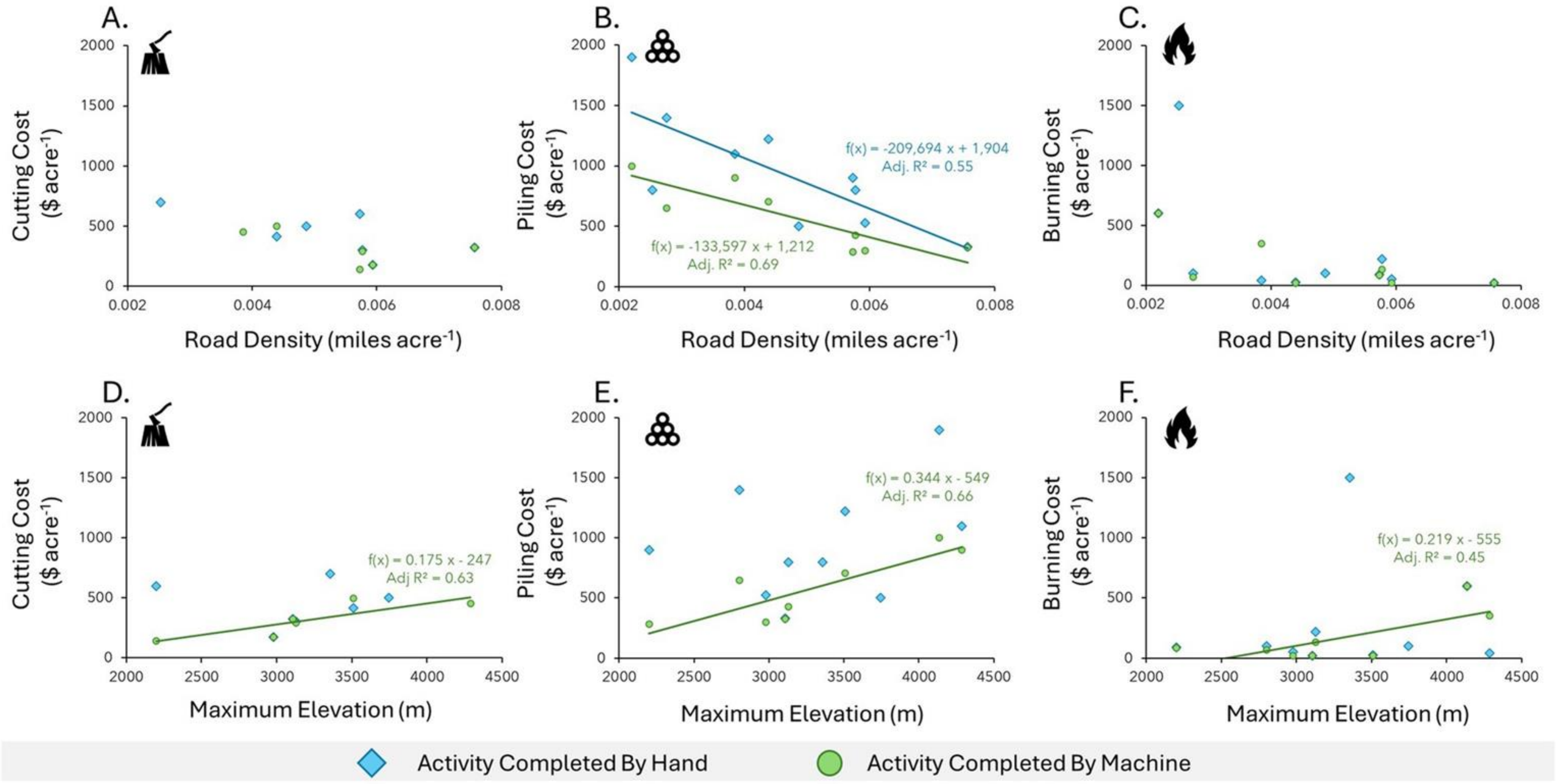

	WA	OR	CA	Average
Hand				
Cutting	$247 ± $133 ac^{-1} ($610 ± $329 ha^{-1}) [n = 614]	$205 ± $113 ac^{-1} ($507 ± $279 ha^{-1}) [n = 1,442]	$390 ± $408 ac^{-1} ($964 ± $1,008 ha^{-1}) [n = 610]	$257 ± $235 ac^{-1} ($635 ± $581 ha^{-1}) [n = 2,666]
Piling	$446 ± $317 ac^{-1} ($1,102 ± 783 ha^{-1}) [n = 350]	$441 ± $216 ac^{-1} ($1,091 ± $535 ha^{-1}) [n = 556]	$446 ± $493 ac^{-1} ($1,152 ± 1,218 ha^{-1}) [n = 344]	$450 ± $340 ac^{-1} ($1,112 ± $840 ha^{-1}) [n = 1,250]
Burning	$75 ± $59 ac^{-1} ($185 ± $146 ha^{-1}) [n = 995]	$72 ± $59 ac^{-1} ($177 ± $145 ha^{-1}) [n = 1,151]	$141 ± $207 ac^{-1} ($348 ± $512 ha^{-1}) [n = 1,191]	$98 ± $134 ac^{-1} ($242 ± $331 ha^{-1}) [n = 3,337]
Total, Pile + Burn	$521 ac^{-1} ($1,287 ha^{-1})	$513 ac^{-1} ($1,268 ha^{-1})	$607 ac^{-1} ($1,500 ha^{-1})	$548 ac^{-1} ($1,354 ha^{-1})
Total	$768 ac^{-1} ($1,898 ha^{-1})	$718 ac^{-1} ($1,774 ha^{-1})	$997 ac^{-1} ($2,464 ha^{-1})	$805 ac^{-1} ($1,989 ha^{-1})
Machine				
Cutting	$240 ± $84 ac^{-1} ($593 ± $208 ha^{-1}) [n = 474]	$329 ± $345 ac^{-1} ($813 ± $853 ha^{-1}) [n = 355]	$828 ± $563 ac^{-1} ($2,046 ± $1,391 ha^{-1}) [n = 151]	$363 ± $369 ac^{-1} ($897 ± $912 ha^{-1}) [n = 980]
Piling	$261 ± $85 ac^{-1} ($645 ± $210 ha^{-1}) [n = 426]	$206 ± $70 ac^{-1} ($509 ± 173 ha^{-1}) [n = 609]	$604 ± $579 ac^{-1} ($1,493 ± 1,431 ha^{-1}) [n = 289]	$311 ± $320 ac^{-1} ($768 ± 791 ha^{-1}) [n = 1,324]
Burning	$75 ± $59 ac^{-1} ($185 ± $146 ha^{-1}) [n = 995]	$72 ± $59 ac^{-1} ($177 ± $145 ha^{-1}) [n = 1,151]	$141 ± $207 ac^{-1} ($348 ± $512 ha^{-1}) [n = 1,191]	$98 ± $134 ac^{-1} ($242 ± $331 ha^{-1}) [n = 3,337]
Total, Pile + Burn	$336 ac^{-1} ($830 ha^{-1})	$278 ac^{-1} ($686 ha^{-1})	$745 ac^{-1} ($1,841 ha^{-1})	$409 ac^{-1} ($1,011 ha^{-1})
Total	$576 ac^{-1} ($1,423 ha^{-1})	$607 ac^{-1} ($1,499 ha^{-1})	$1,573 ac^{-1} ($3,887 ha^{-1})	$772 ac^{-1} ($1,908 ha^{-1})

Results were aggregated to the state level for confidentiality purposes.

Table 2: Reported average costs for cutting, piling, and burning for hand and machine methods from the FACTS hazardous fuels reduction activity database for forests in our study area from 2019 to 2023.

	WA	OR	CA	Average
Hand				
Cutting	$600 ac^{-1} ($1,483 ha^{-1})	$375 ± $226 ac^{-1} ($927 ± $559 ha^{-1})	$413 ± N/A ac^{-1} ($1,021 ha^{-1})	$419 ± $197 ac^{-1} ($1,035 ± $487 ha^{-1})
Piling	$1,150 ± $354 ac^{-1} ($2,842 ± $874 ha^{-1})	$614 ± $230 ac^{-1} ($1,516 ± $568 ha^{-1})	$1,407 ± $431 ac^{-1} ($3,476 ± $1,066 ha^{-1})	$997 ± $474 ac^{-1} ($2,464 ± $1,170 ha^{-1})
Burning	$95 ± $7 ac^{-1} ($235 ± 17 ha^{-1})	$447 ± $708 ac^{-1} ($1,105 ± $1,748 ha^{-1})	$222 ± $327 ac^{-1} ($549 ± $808 ha^{-1})	$294 ± $488 ac-1 ($726 ± $1,206 ha-1)
Total, Pile + Burn	$1,245 ± $361 ac^{-1} ($3,076 ± $891 ha^{-1})	$1,061 ± $872 ac^{-1} ($2,621 ± $2,156 ha^{-1})	$1,629 ± $756 ac^{-1} ($4,025 ± $1,869 ha^{-1})	$1,291 ± $717 ac^{-1} ($3,190 ± $1,772 ha^{-1})
Total	$1,545 ± $64 ac^{-1} ($3,818 ± $157 ha^{-1})	$1,436 ± $1,082 ac^{-1} ($3,547 ± $2,674 ha^{-1})	$1,767 ± $686 ac^{-1} ($4,366 ± $1,696 ha^{-1})	$1,570 ± $762 ac-1 ($3,880 ± $1,884 ha-1)
Machine				
Cutting	$140 ac^{-1} ($346 ha^{-1})	$264 ± $79 ac^{-1} ($653 ± $195 ha^{-1})	$474 ± $33 ac^{-1} ($1,170 ± $82 ha^{-1})	$313 ± $143 ac^{-1} ($774 ± $353 ha^{-1})
Piling	$468 ± $258 ac^{-1} ($1,155 ± $638 ha^{-1})	$350 ± $66 ac^{-1} ($865 ± $163 ha^{-1})	$868 ± $151 ac^{-1} ($2,145 ± $372 ha^{-1})	$574 ± $281 ac^{-1} ($1,417 ± $695 ha^{-1})
Burning	$78 ± $11 ac^{-1} ($235 ± $17 ha^{-1})	$56 ± $64 ac^{-1} ($138 ± $158 ha^{-1})	$323 ± $291 ac^{-1} ($799 ± $719 ha^{-1})	$162 ± $208 ac^{-1} ($399 ± $515 ha^{-1})
Total, Pile + Burn	$545 ± $247 ac^{-1} ($1,347 ± $612 ha^{-1})	$406 ± $130 ac^{-1} ($1,003 ± $320 ha^{-1})	$1,191 ± $441 ac^{-1} ($2,944 ± $1,090 ha^{-1})	$735 ± $464 ac^{-1} ($1,817 ± $1,146 ha^{-1})
Total	$615 ± $148 ac^{-1} ($1,520 ± $367 ha^{-1})	$670 ± $176 ac^{-1} ($1,656 ± $436 ha^{-1})	$1,507 ± $253 ac^{-1} ($3,724 ± $624 ha^{-1})	$970 ± $478 ac^{-1} ($2,397 ± $1,181 ha^{-1})

Results were aggregated to the state level for confidentiality purposes.

Table 3. Reported costs for hand and machine cutting, piling, and burning by state based on interviews with FMPs.