An FIA test-bed for understanding fuel treatment cost-effectiveness: policy relevant application of forest inventory science

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PNW-RMA Client Meeting

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Take-aways

- BioSum now available for prospective analysis of management in forested landscapes over decades
  - Translate FIA data to and builds on FVS
  - Estimate treatment cost, wood delivery cost, yield, value
  - Rate & rank alternatives, explore trade-offs
- Treatments can increase fire resistance on most acres
  - Heavier thins ~equally effective and likelier to self-pay
    - and leave less live C to become dead C in a fire
  - <$600/ac subsidy → 50% more self-paying acres
  - Species composition affects treatment success

BioSum – Bioregional Inventory Originated Simulation Under Management: a new kind of inventory analysis

- Leveraging, quality-assured, representative forest sample …

Example	FIA Analyses
State reports	Estimate & report status and change
Spatial models and maps	Build/validate remote sensing models
Mortality rate analysis, fire effects and recovery, climate adaptation	Test policy relevant research hypotheses
BioSum	**Prospective management and policy scenarios, over time**

Today's BioSum example: JFSP-funded Cost-effectiveness of fuel treatments

- Describing and controlling forest fire hazard is complex
  - Diverse goals (firefighter & public safety, emissions, economic impact, stand resistance & resilience, WUI protection)
  - Stand vs landscape hazard (consider stand level or spatial contagion aspects?)
  - Fire effects=f(weather!, terrain, fuels)
  - Typically focus on fuels, because *potentially* controllable
- Planners, managers and policy-makers curious about
  - What is effective treatment?
  - And is it cost-effective (are savings greater than costs)?

Defining effective tricky, even at stand level

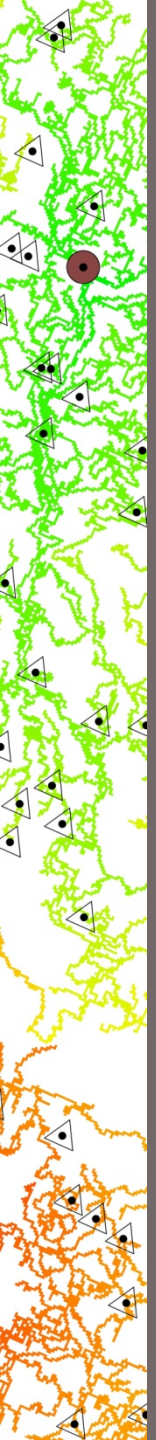
- Many goals, many metrics that matter
  - What is hazard threshold for each metric?
  - How much change (absolute or in %) = improvement?
  - Will improvement be sustained, relative to no action?
- Effect & net cost driven by treatment design, e.g.,
  - Degree of density reduction
  - Size of trees removed
  - Residue handling/surface fuels
  - Harvest system
  - Site factors (access, slope, haul distance, tree species)

BioSum Analysis Framework:

Builds on FIA's representative sample of all forest

- Inventory-originated, stand projection model-assisted, simulation and COMPARISON among outcomes of multiple, alternative, <u>multi-decade</u> forest management sequences *with respect to*
  1. Stand attributes (e.g., structure & composition)
  2. Resistance and Resilience to stressors like fire,
  3. Climate benefits (sequestration, products storage, substitution),
  4. Feedstock delivered to existing/planned wood processing facilities,
  5. Revenues & costs associated with management, and
  6. Policy constraints (diameter caps, subsidies, Rx fire limits, …)
- Supports sifting through effects & costs of alternatives

BioSum Model Framework



Roads, facilities, plots

GIS travel times

Representative landscape sample

FIA Plot Data

Devise treatments, simulate outcomes & growth

FVS

Simulate treatment costs

OpCost

CHOOSE BEST; SUMMARIZE

Core Analysis

All FVS outputs

FVS CUTLISTS

Processor

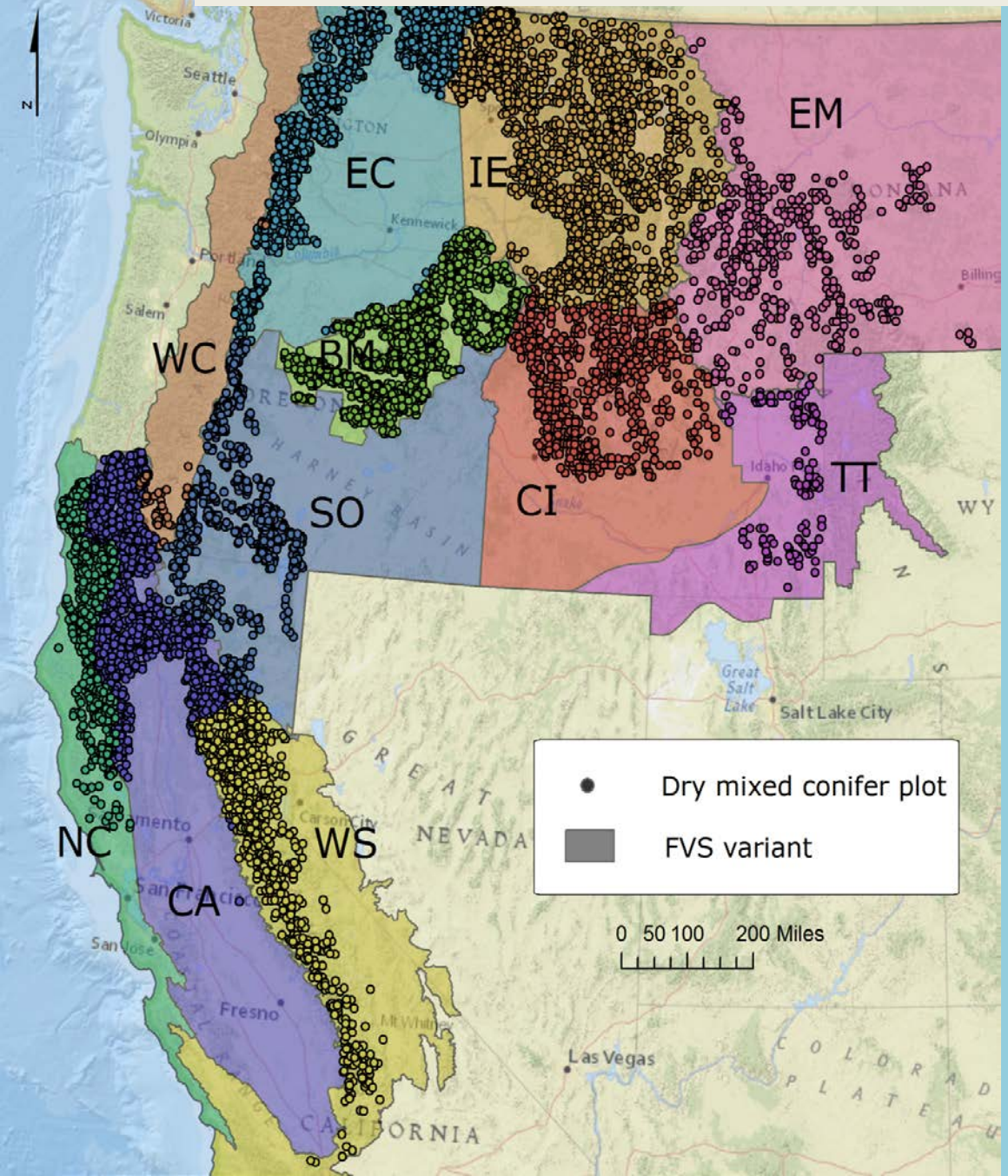
Effectiveness Criteria

For single or many cycles; relative to pre-treatment or Grow Only…

Calculate volume & Value of products,

1. Acres treated, acres by status
2. Effectiveness/Resilience achieved
3. Treatment longevity
4. Treatment cost & revenue
5. Amount/kind of HWP to each facility
6. Co-benefits such as habitat, climate benefits, forest health, …

Fuel treatment testbed: Dry Mixed Conifer Forest



- 6422 full & partial plots
- 25 million acres
- 256K measured trees
- 23 FIA forest types
- 11 FVS variants
- 9 treatments
- 4 ten-year cycles
- 283 roundwood sites
- 58 bioenergy sites
- 50 GB of project data
  - Not counting GIS

Treatments responsive to stand structure

- "Improvement Cuts" to perpetuate multi-story
- "Commercial Thins" on single story
- Rx's & priorities elicited via manager interviews
  - Prioritized cutting low vigor trees
  - Prioritized cutting fire vulnerable species first
  - Whole tree harvest to minimize residues
  - Pile & burn slash when > 15 tons/acre
- REPUTEd regen to account for ladder fuel resurgence

Rx parameters address density, size, understory

- Treatment objective: enhance stand's fire resistance

Treatment	Residual stand density target	Max DBH	Min DBH	Understory target TPA
6 improvement cuts	80 to 100 ft^2	19-32", none	5-7"	0 to 222
3 commercial thins	150 ft^2	None	7"	50
	70-90 TPA	None	5-7"	20
Grow Only	Grow Only (reference outcome)			

- Evaluate outcomes at year 1 and over 4 decades
- Grow-only case useful for comparing to treatments

4 Components of fire resistance

Survival Score	Volume share predicted to survive **6-8'** flame
0	< 0.02
1	0.02 to 0.30
2	0.30 to 0.60
3	> 0.60

Resistant BA Score	BA Share in Resistant Species > 5" DBH
0	< 0.25
1	0.25 – 0.50
2	0.50 – 0.75
3	> 0.75

CBH Score	Canopy Base Height, ft
0	< 7
1	7 to 20
2	20 to 30
3	> 30

CBD Score	Canopy Bulk Density, kg/m^3
0	> 0.15
1	0.1 to 0.15
2	0.05 to 0.1
3	< 0.05

- Fire Resistance Score (FRS)= ∑ of 4 subscores (0-12)
  - Calculated before and after treatment at each FVS cycle

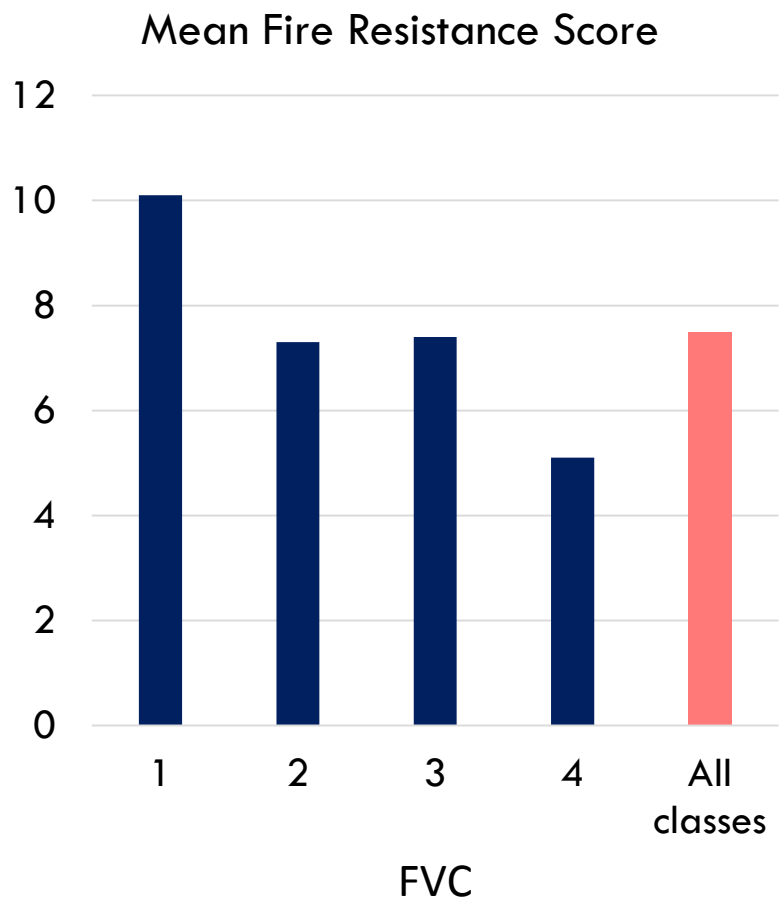
Evaluating effectiveness & best

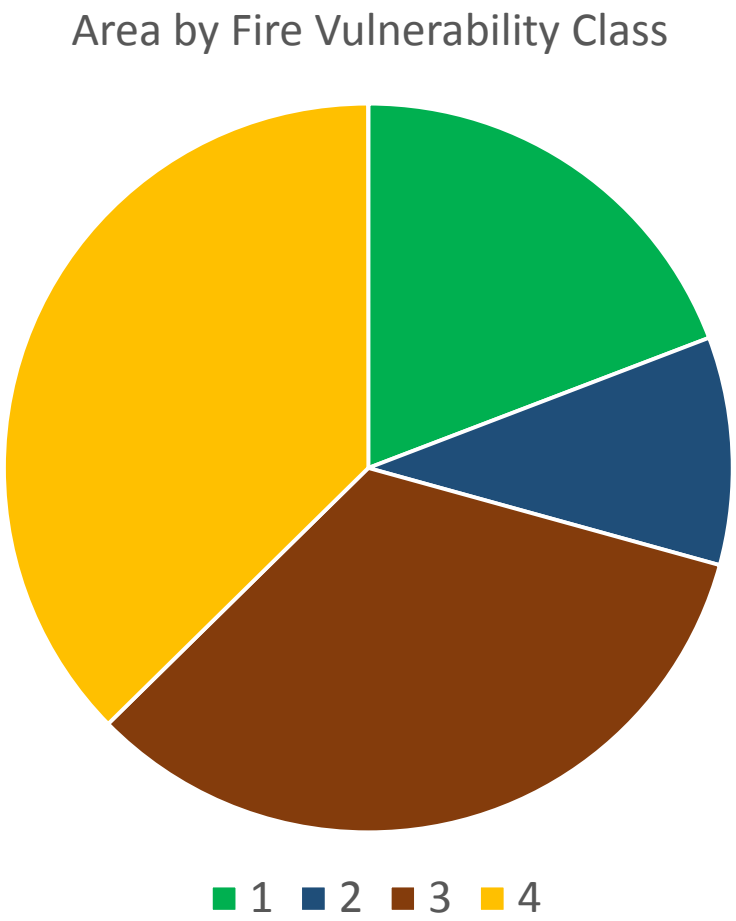
- Score difference = treated FRS – grow-only FRS
  - Immediate: at year 1 (“Y1”)
  - Future: at year 31 (“Y31”)
  - Long-term: **M**ean **S**core difference over 4 cycles (“MS”)
- If score difference > 0, then <u>effective</u>
  - maximum score difference → “<u>Best</u>”

Fire Vulnerability Class (FVC) Before Management

FVC #	Resistant BA Score	FRS
1	3 ≥75% fire resistant spp.	≥ 9
2	3 ≥75% fire resistant spp.	< 9
3	1 or 2 25-75% fire resistant spp.	All values
4	0 < 25% fire resistant spp.	All values

Most of these 25 million acres of single & multi-storied stands are vulnerable

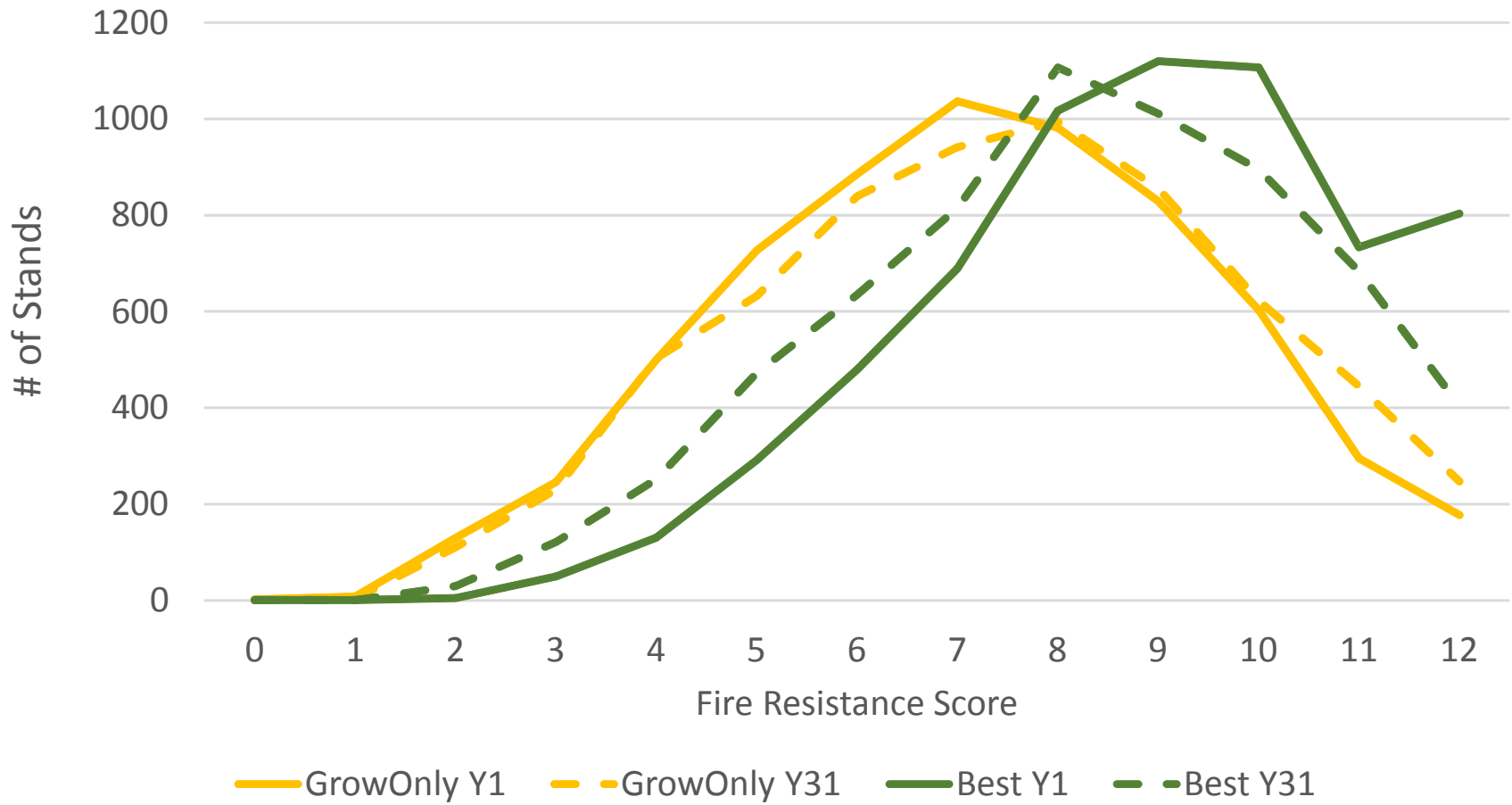




Fire resistance mean score improved most with lower residual over/understory

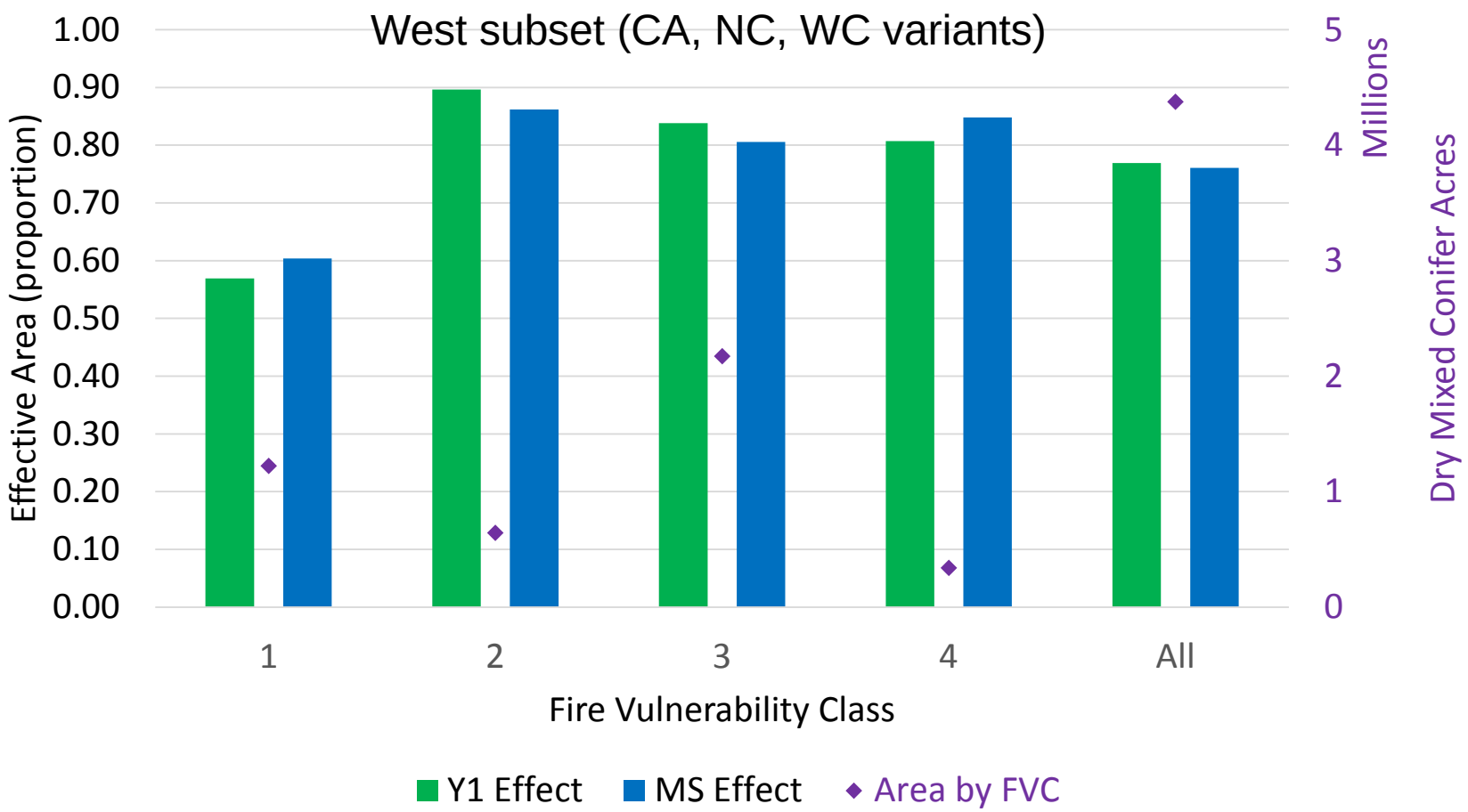
Rx No. DBH max	Resid. BA ft^2 or TPA	Under-story TPA	Net Revenue	Mean Score Change	Percent of Acres
Improvement cuts on 6.9 million multi-story acres					
Rx1: 21”	100 BA	150	111	1.2	6%
Rx2: 21”	80 BA	0	-427	1.7	63%
Rx3: 19”	80 BA	222	121	1.2	5%
Rx4: 32”	85 BA	222	939	1.2	3%
Rx8: NA	100 BA	150	1,614	1.2	5%
Rx9: NA	80 BA	0	319	1.7	57%
Commercial thins on 13.7 million single-story acres					
Rx5: NA	150 BA	50	-573	1.2	18%
Rx6: NA	90 tpa	20	770	1.7	58%
Rx7: NA	194 tpa	0	-986	1.3	17%

Treatment effect is clear, long-lasting

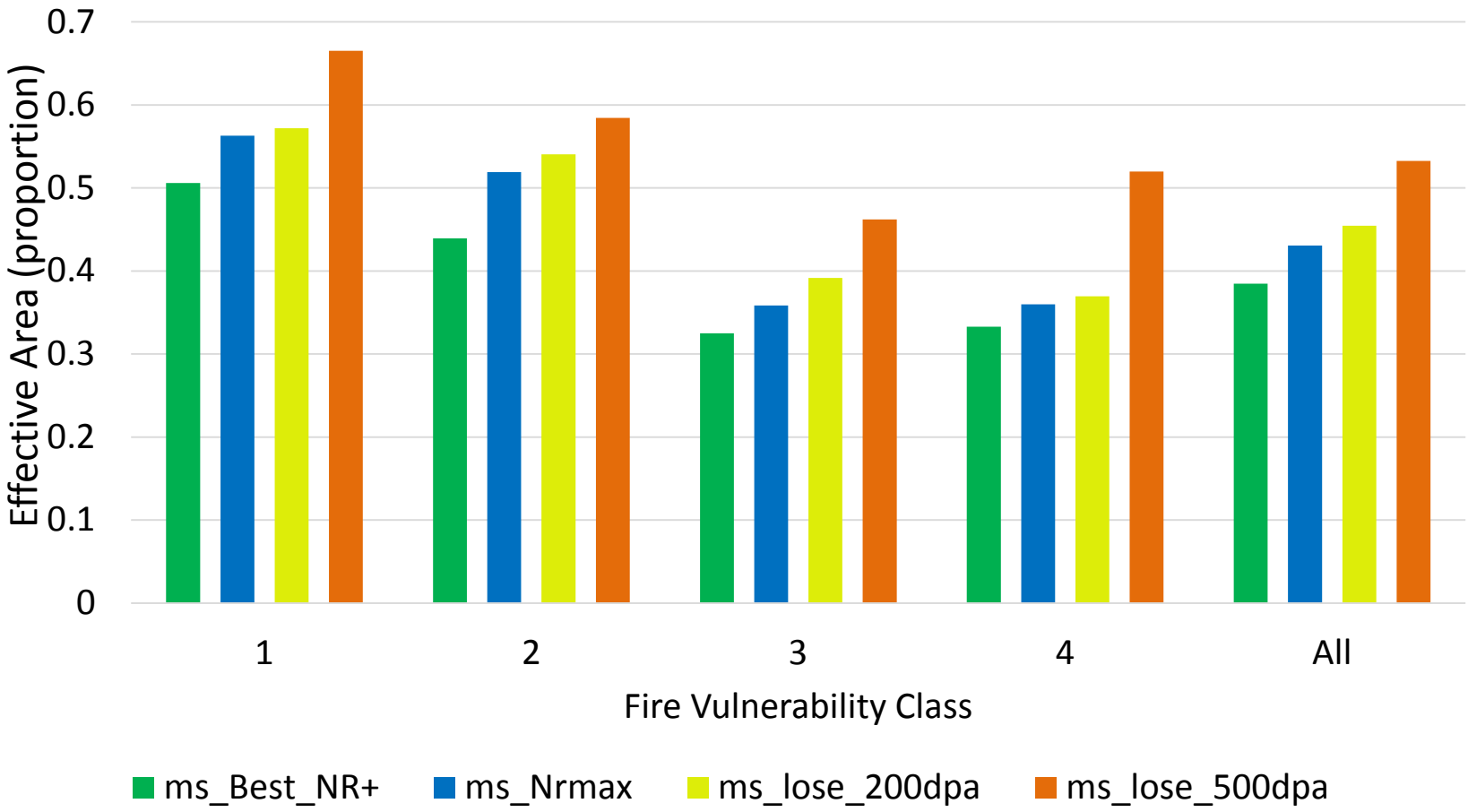


Most acres have effective treatments

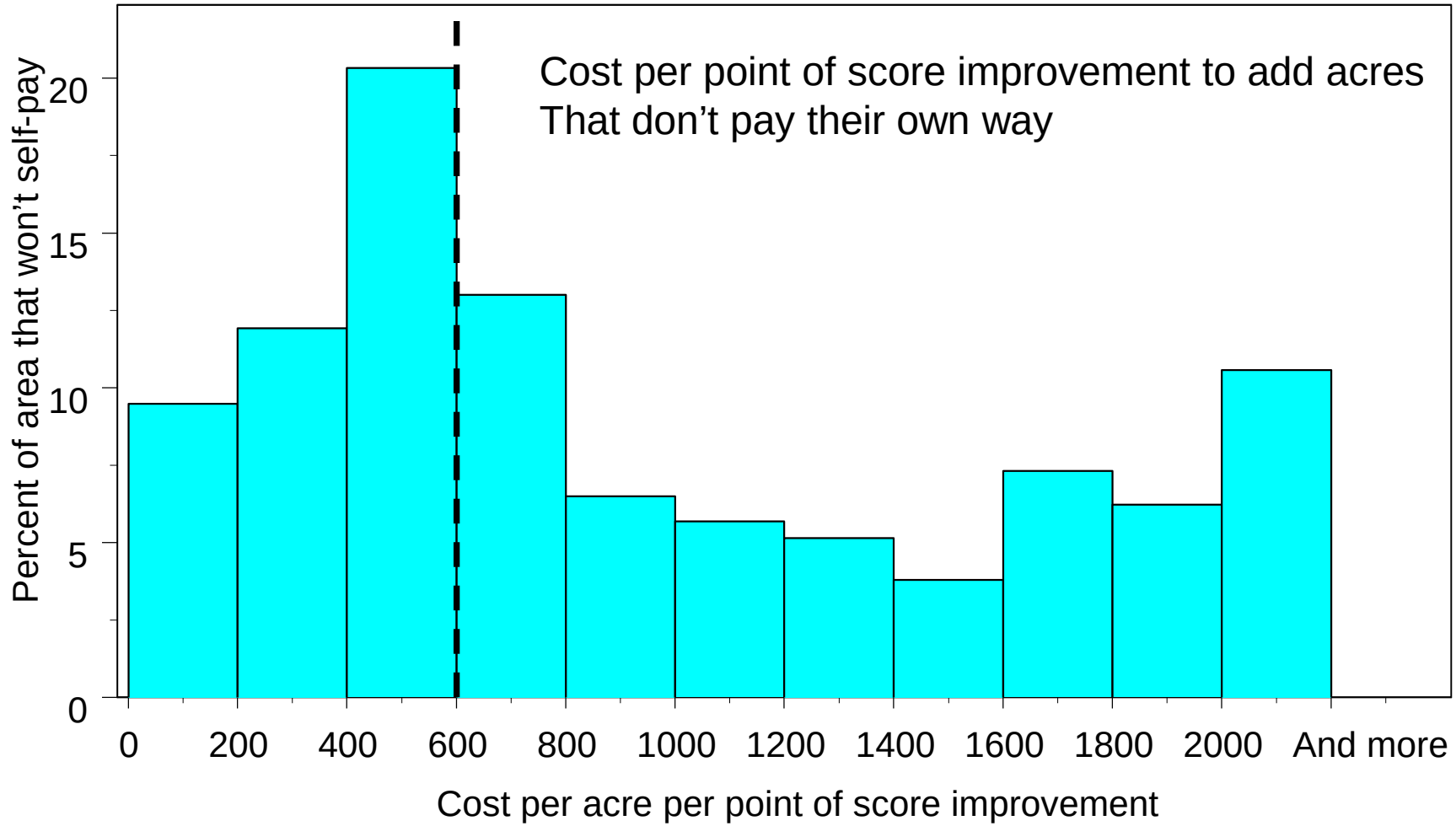
Over a third have >1 effective option



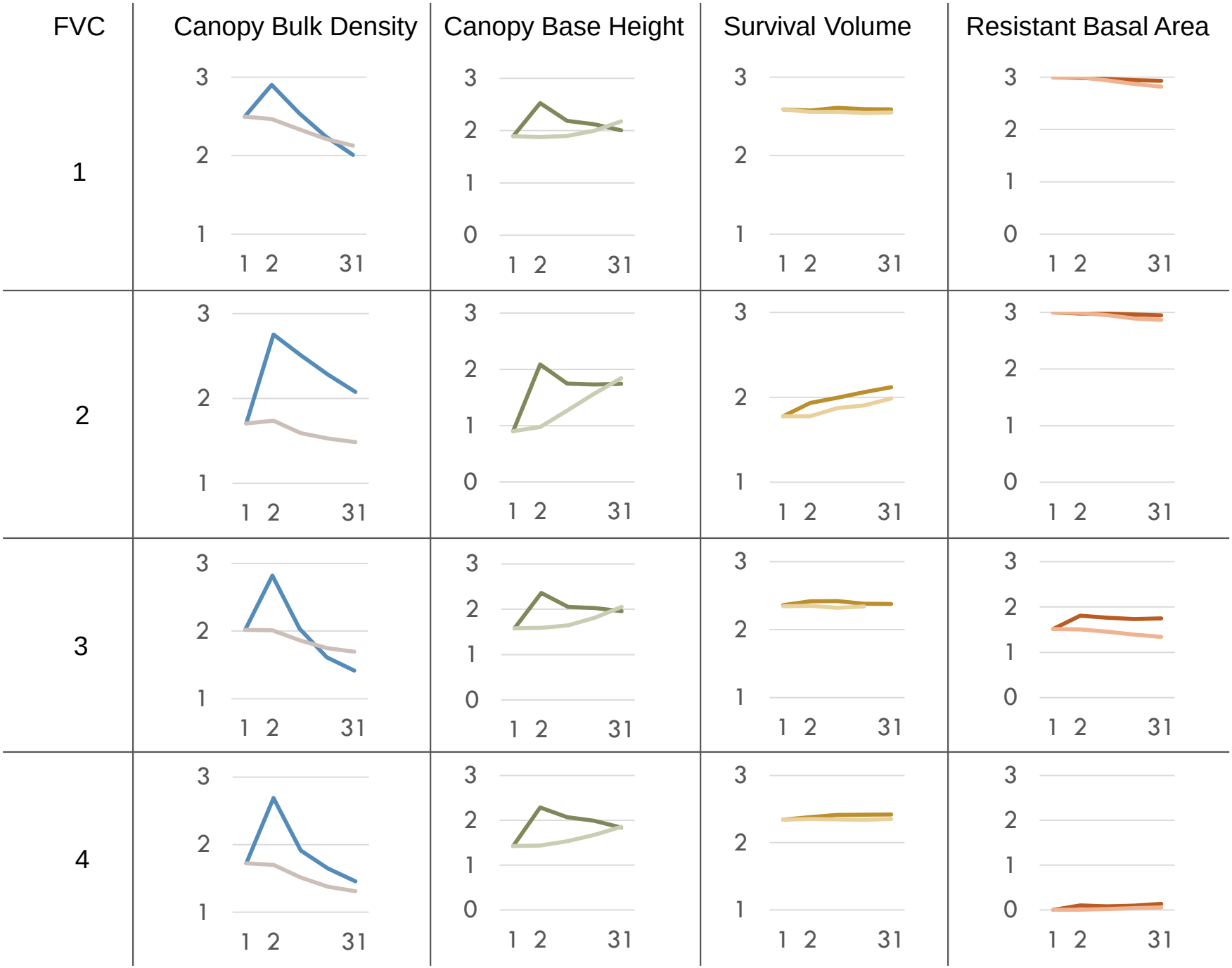
<½ of treatable acres self-pay, but for these, "cost" is negative, so cost-effective undefined!



$600 subsidy ↑ treatment from 42 → 64% of treatable area



Subscore Outcomes for Rx 2 Improvement Cut on Multi-story Stands



Conclusions

- BioSum tool eases exploration of treatment economics
- A successful treatment can be devised for most acres
  - But can be self-paying on less than half of those
  - Subsidies could increase area treated substantially
  - Some improvement in fire resistance lasts for decades
- Canopy base height and bulk density are most easily modified; resistant species basal area not so much
- Percent mortality volume hard to affect, but volume killed by fire reduced by moving wood to products

Gratitude to many!

- BioSum development funded by

PNW RMA & FSD Programs	Oregon Dept. of Forestry
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- Intellectual contributions from:

R. Jamie Barbour	Larry Potts	Benktesh Sharma
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Glenn Christensen	Conor Bell	Rob Keefe
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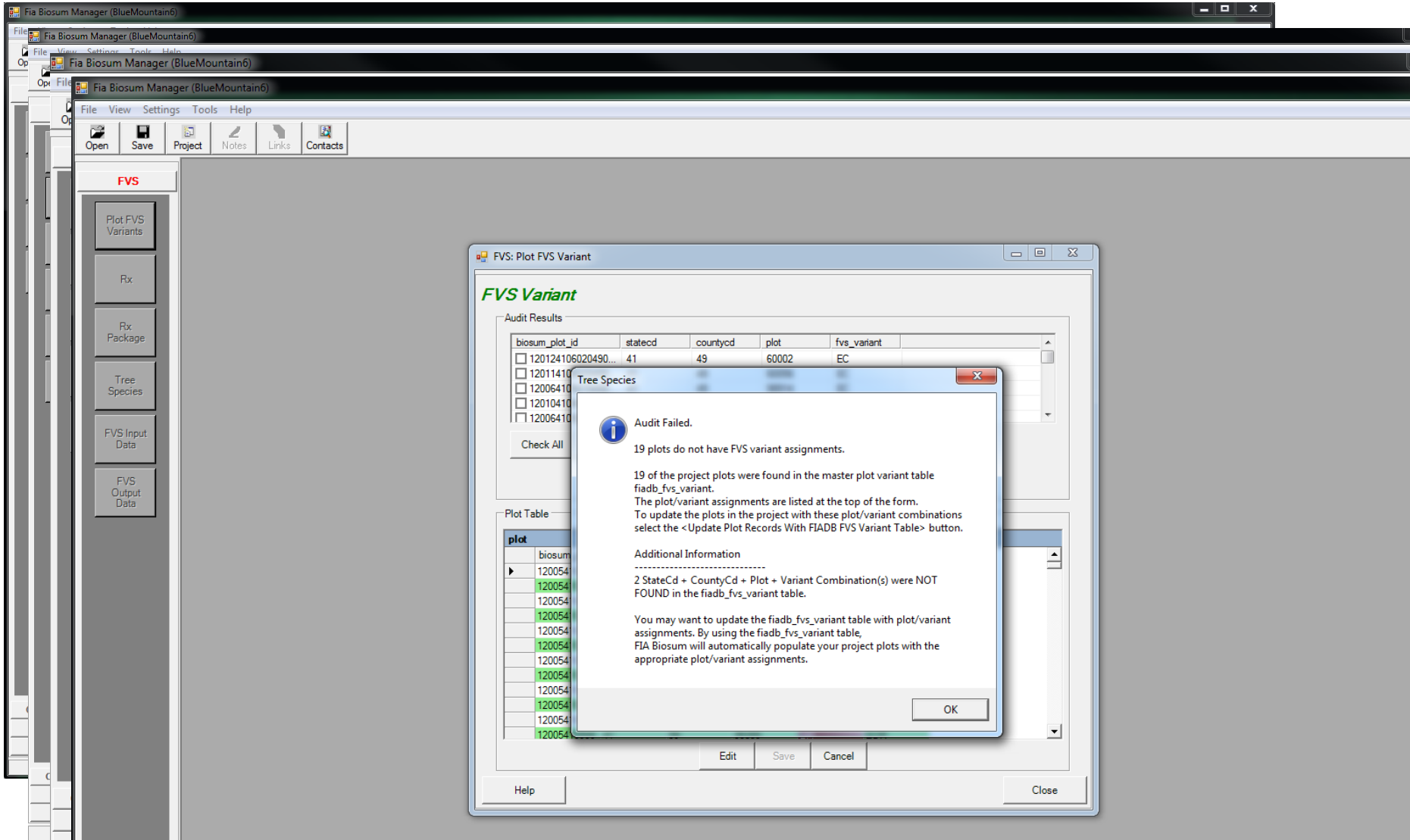
Roger Fight	Demetrios Gatziolis	Tina Mozelewski
Carlin Starrs		

- Software and docs at http://www.biosum.info

BioSum software available now!