Spatial Informatics Group

Evaluating Greenhouse Gas Emissions for Fuel Treatment Projects

Tadashi Moody
David Saah, Ph.D.
John Gunn, Ph.D.

April 3, 2015

Greenhouse Gas Reduction Fund (GGRF)

- CAL FIRE delivering GGRF funds through grants, cost share agreements, technical assistance, research and projects.

- Goal: to ensure California's forests continue to be significant carbon storage "sinks" and to reduce or avoid GHG emissions due to pest damage, wildfires, and loss of forest tree cover from development to non-forest uses.

- CAL FIRE Programs:
  - Fuels Reduction
  - Urban and Community Forestry
  - Reforestation Services
  - Forest Legacy
  - Pest Control
  - Forest Practice
  - Demonstration State Forest Research

GGRF - Fuel Reduction Program

- Projects that treat (selectively remove) hazardous wildfire fuels and vegetation.
- Projects must be designed to meet GGRF objectives:
  - Stabilize or increase carbon sequestration in trees retained on the project site
  - Reduce wildfire hazard to decrease wildfire emissions
  - Utilize biomass to offset use of fossil fuels
  - Use solid wood materials to offset emissions resulting from removal of vegetation

Methods for Estimating GHG Emissions for Fuel Reductions Projects

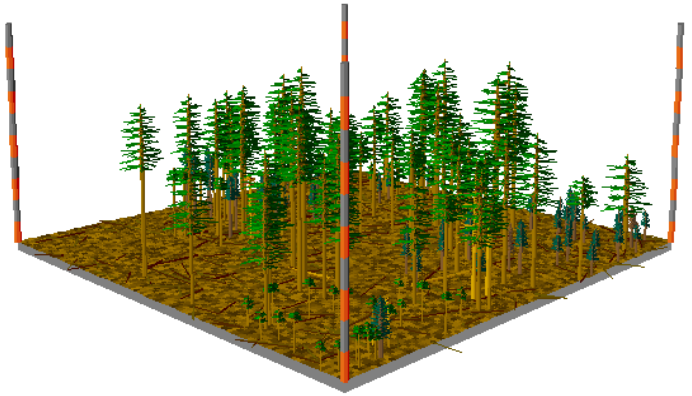
- Fuel reduction projects unique
  - Initial removal of biomass
  - Avoided emissions
  - Stochastic nature of fire occurrence and severity
- No approved accounting methodologies within protocols to draw from.
- Can draw from elements of other methodologies
  - Improved Forest Management
  - Afforestation/Reforestation
  - Avoided Conversion

Fuel Reduction GHG Evaluation - Elements

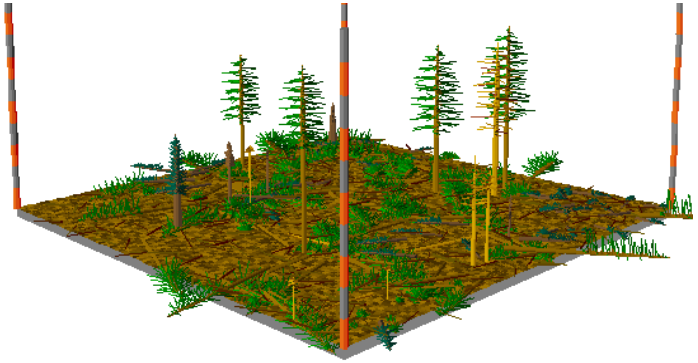
- SEQUESTRATION
- REMOVED CARBON LCA
- WILDFIRE EMISSIONS
- TX EFFECTS ON WILDFIRE
- ADDITIONAL CONSIDERATIONS
- CARBON ACCOUNTING

SEQUESTRATION

- Baseline scenario
  - Without project (business as usual)
- Project scenario
  - With fuel treatments (carbon removal)

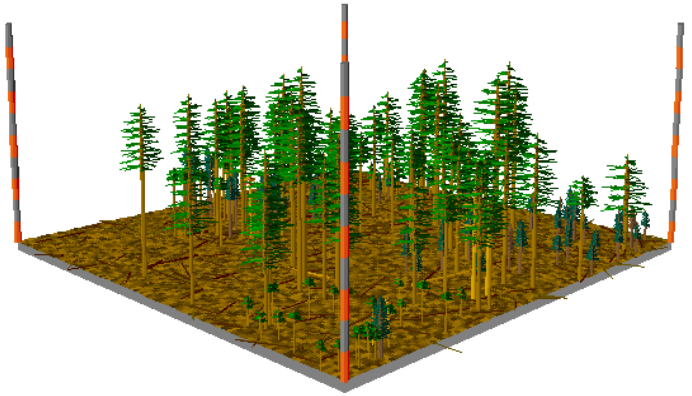


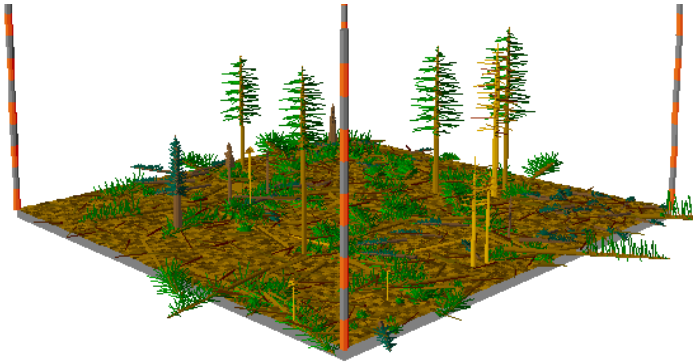
- What is the effect of removing biomass from the forest on it's sequestration and total storage over time?



SEQUESTRATION

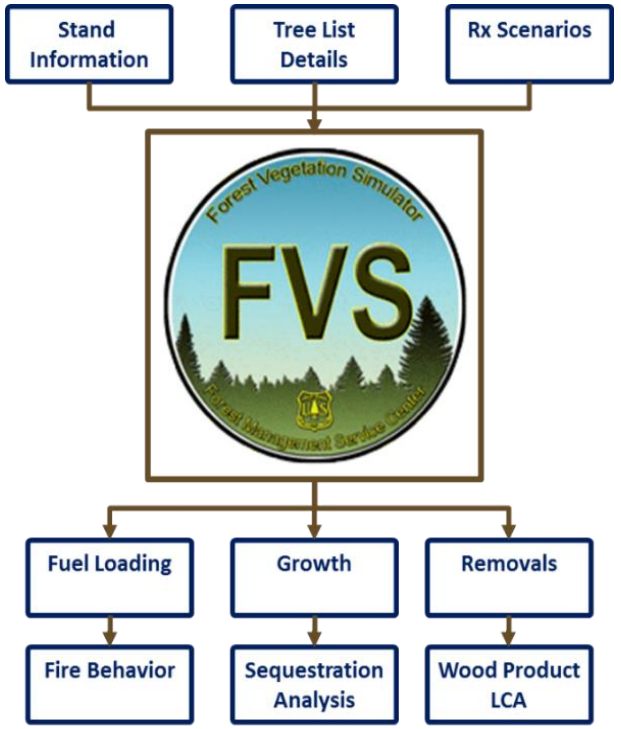
- Options
  - Carbon Online Estimator (COLE)
  - Forest Vegetation Simulator
- FVS: A relatively complete package
- FVS Minimum Requirements
  - Stand Information
  - Plot Information
  - Data Sources
    - Stand Examinations
    - FIA



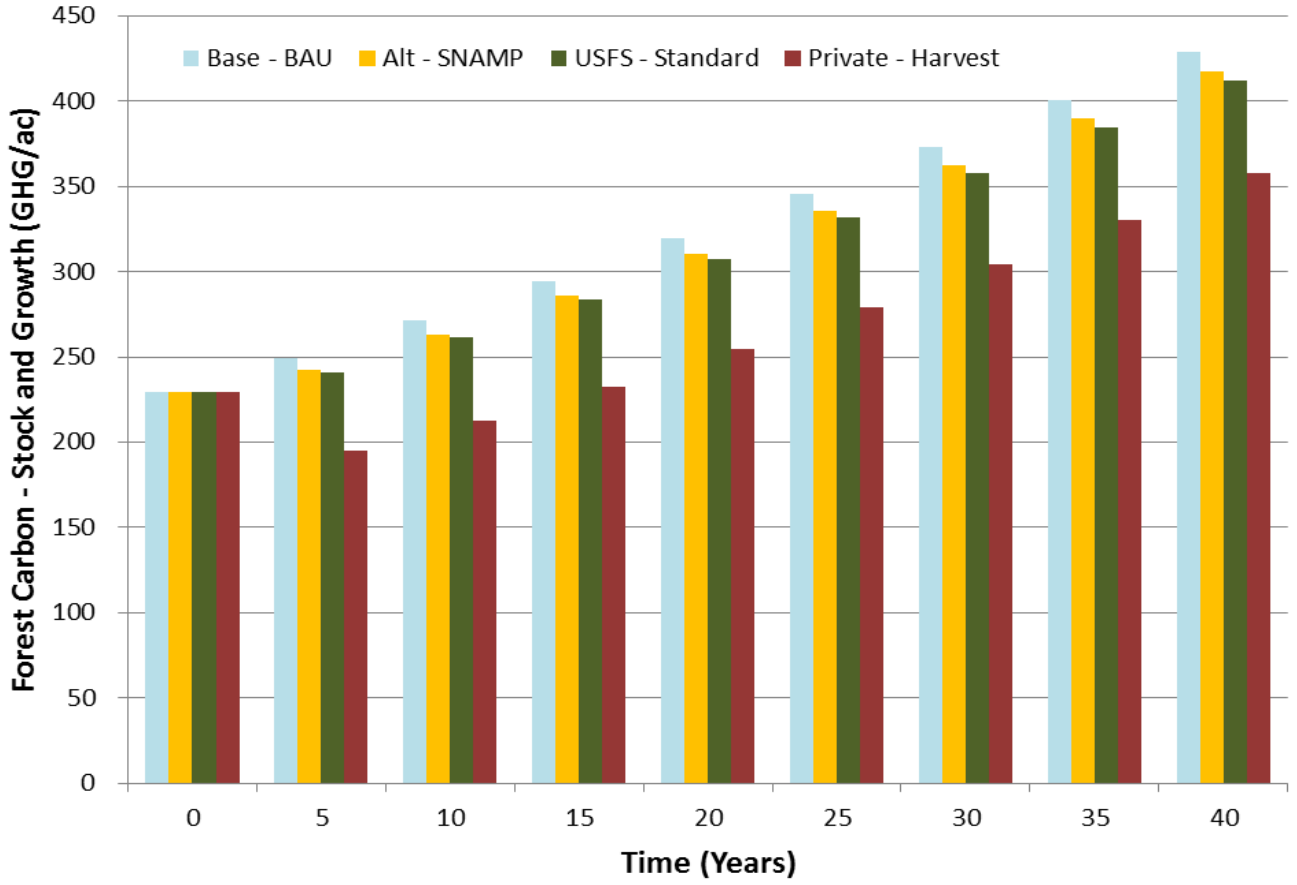


SEQUESTRATION

- FVS – Model forest fuel treatments and track C
  - Thinning, Rx fire, mastication, pile burning
- Project Boundaries (Carbon Pools)
  - FVS "Total Stand Carbon"
    - AG live, AG standing dead, AG dead/down, BG live/dead, forest floor, shrub/herb
  - Soil C only if significant disturbance (e.g. site prep)



SEQUESTRATION



WILDFIRE EMISSIONS

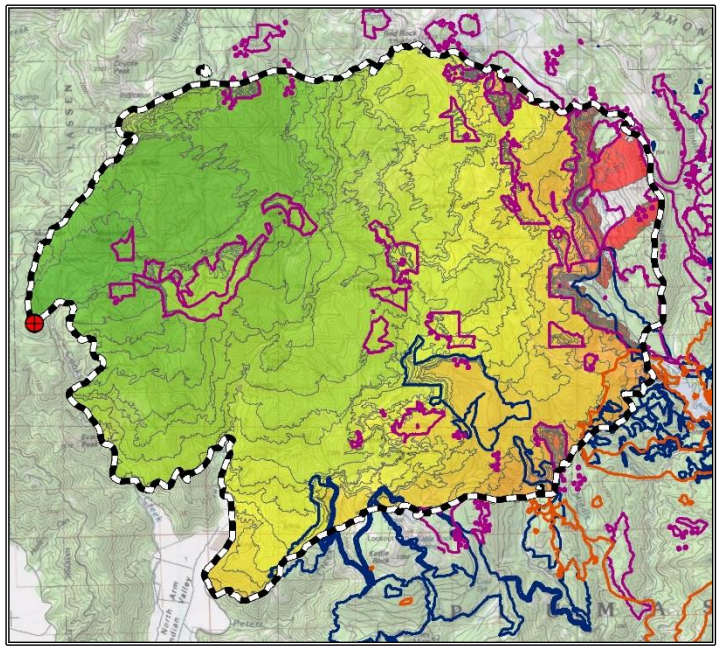
- What are the expected "direct" emissions – i.e. emissions expected from each acre of land, without accounting for effects of fire spread or behavior?
- Emissions for treated areas vs untreated areas
- Options
  - First Order Fire Effects Model
  - FVS
  - CONSUME (FFT)

WILDFIRE EMISSIONS

- Model expected emissions for severe fire on baseline and project landscapes
- FVS: Fire and Fuels Extension, Carbon Extension
- Perform prescribed fire under severe conditions at time of interest
  - Track “Carbon Released by Fire”

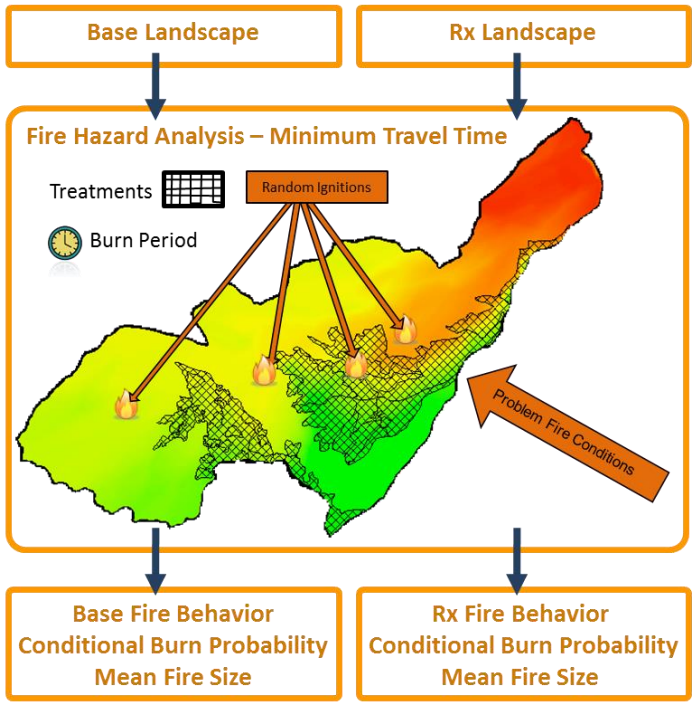
WILDFIRE BEHAVIOR

- What effects will the treatments have on fire behavior?
  - Fire size
  - Fire intensity/severity
- Options
  - Flammap/Farsite
  - FVS + Flammap
  - Local/Expert knowledge
- Expectations
  - Reduced fire size?
  - Effect reduced over time without maintenance
  - Reduced fire severity?



WILDFIRE BEHAVIOR

- Simulating treatment effects in Flammap
  - Use Minimum Travel Time algorithm to burn baseline and project landscapes
  - Large number of randomly located ignitions (1000+)
  - Calculate changes in fire behavior (size)



CARBON REMOVAL LCA

- ARB Forest Projects Protocol – Appendix C
- Consider:
  - Merchantable and non-merchantable removals (FVS)
  - Mill efficiencies
  - Biomass energy production
- FVS output – Carbon report

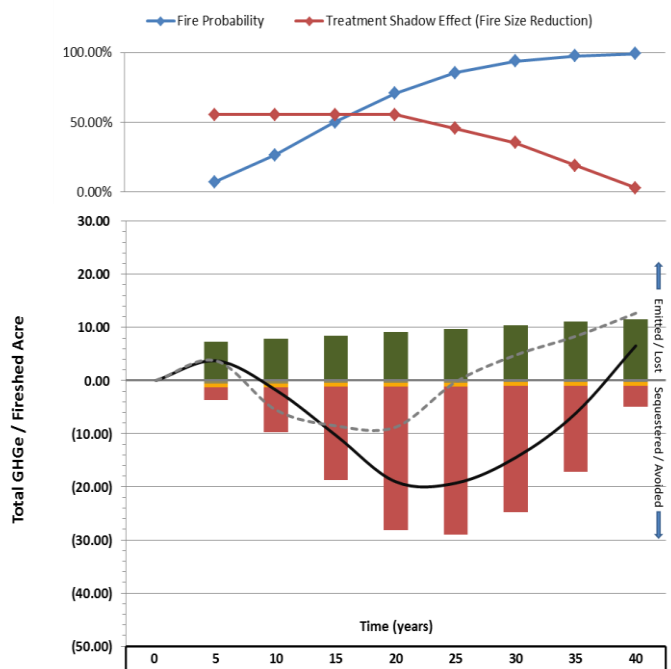
ADDITIONAL CONSIDERATIONS

- Probability of fire occurrence
  - Assume fire will occur (vs.)
  - What is the actual probability of fire occurring on a given acre?
  - Probability of high vs. low severity fire?
  - Climate change?

- Avoided vegetation type conversion (redirection)
  - Decomposition of residual standing dead forest

CARBON ACCOUNTING

- Biomass/Carbon equations built into FVS –or-
- Calculate C per tree using ARB Forest Project Protocols
- Convert C units to proper units
  - Mg/Ac CO2
- Baseline
  - Forest Carbon
  - Wildfire Emissions
- Project
  - Forest Carbon
  - Wildfire emissions
  - Wood removals
- Baseline – Project = GHG Benefit or Liability



	0	5	10	15	20	25	30	35	40
Wildfire	-	(2.29)	(8.48)	(17.63)	(27.02)	(27.98)	(23.77)	(16.17)	(4.02)
Biomass Energy	-	(0.68)	(0.68)	(0.68)	(0.68)	(0.68)	(0.68)	(0.68)	(0.68)
Wood Products	-	(0.63)	(0.53)	(0.47)	(0.42)	(0.39)	(0.36)	(0.33)	(0.31)
Forest Carbon	-	7.34	7.90	8.48	9.09	9.75	10.33	11.05	11.55
Accumulated	-	3.73	(1.79)	(10.30)	(19.05)	(19.29)	(14.49)	(6.14)	6.54
Net	-	3.73	(5.52)	(8.52)	(8.74)	(0.25)	4.81	8.34	12.68

Example Project

Example Project

- FVS PROCESS

  DATA PREPARATION

  SEQUESTRATION
  - Use Carbon Extension (“FVS_Carbon and “Harv_Carbon” reports
  - Grow baseline landscape
  - Grow project landscape, treating at appropriate time

  WILDFIRE EMISSIONS
  - Run same simulations as above, but burn landscapes at appropriate time
  - Can burn landscape at each timestep to track treatment efficacy over time

Example Project

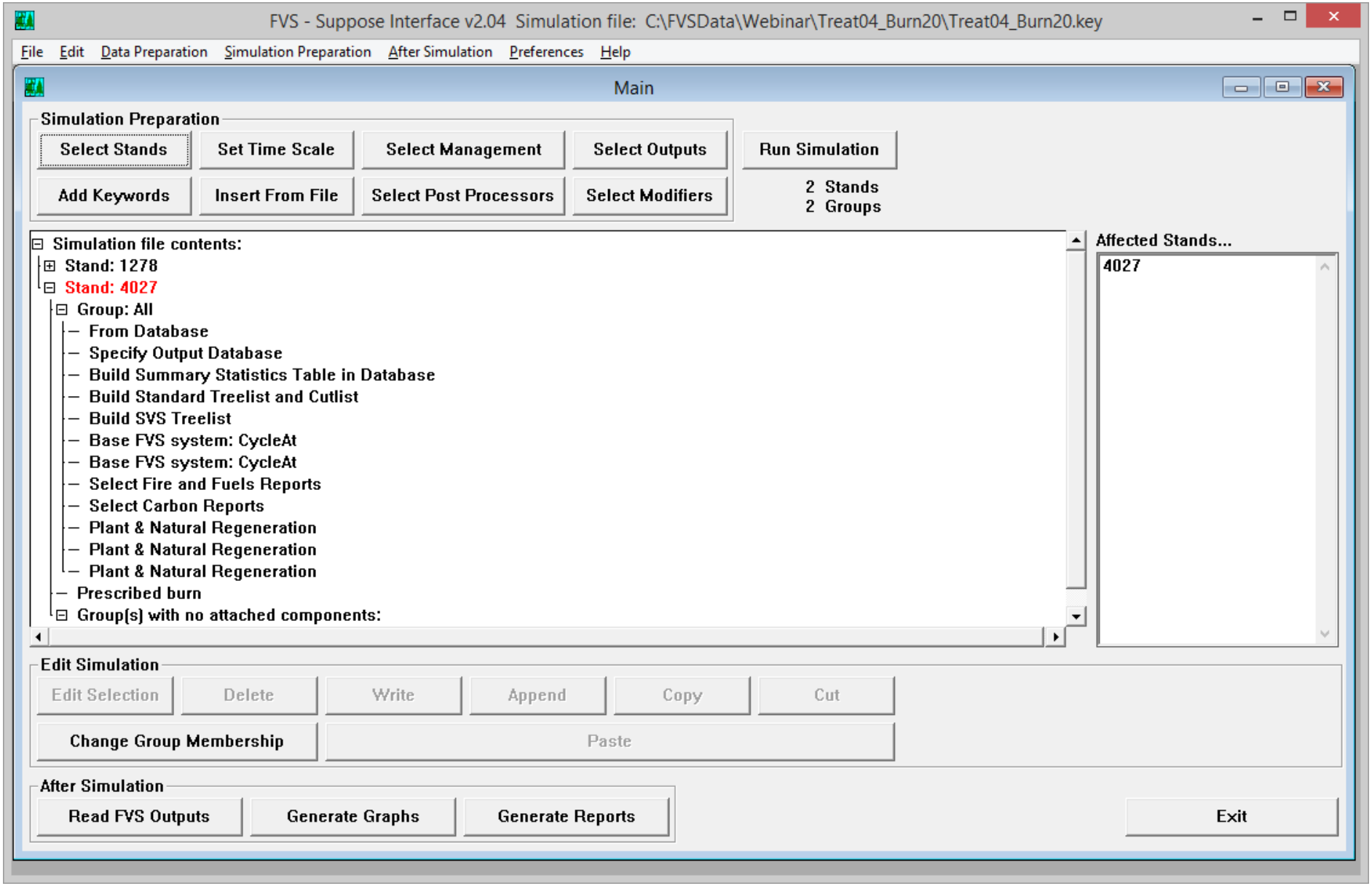
WILDFIRE BEHAVIOR

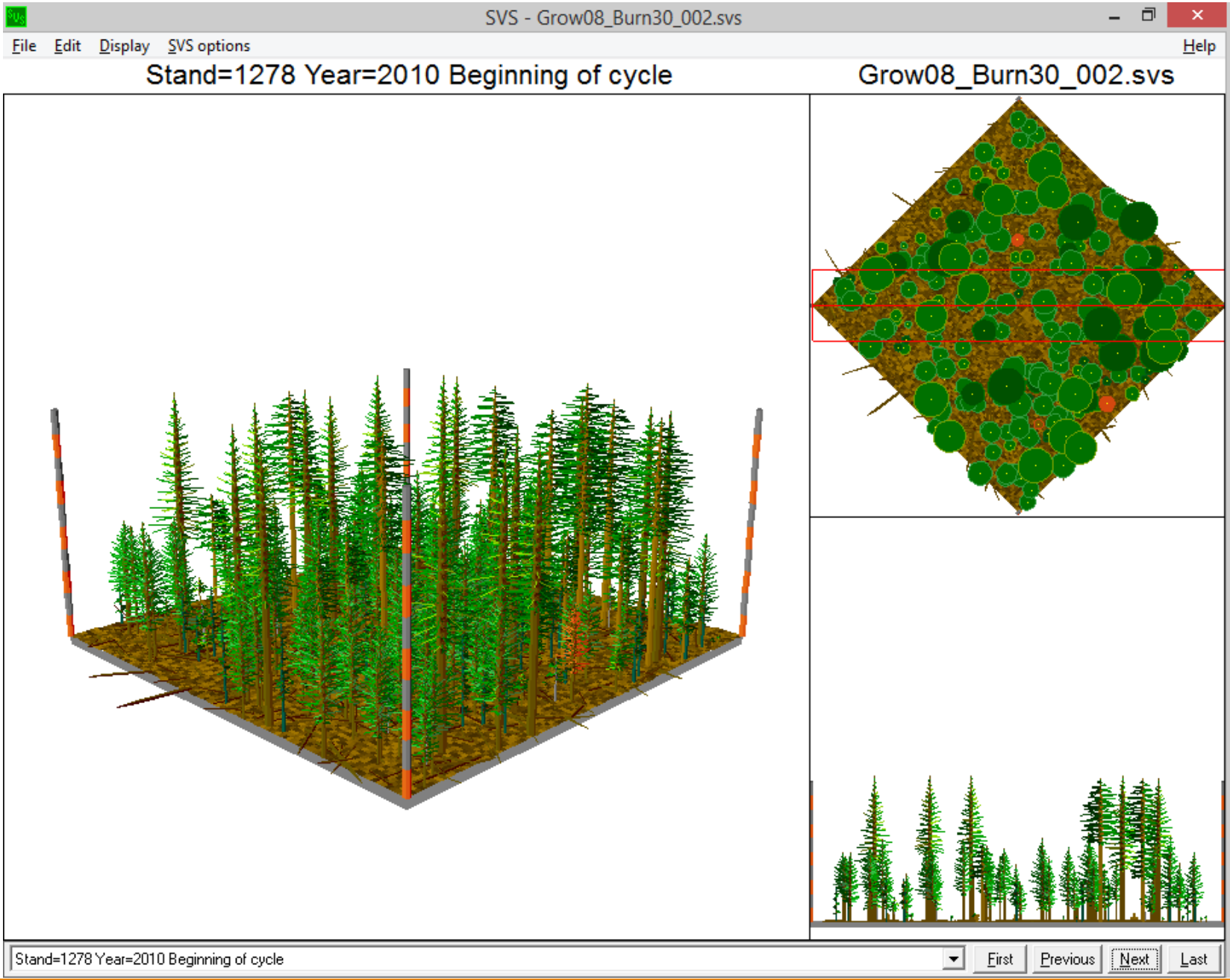
- Simulate treatment in Flammap
- Estimate fire size reduction

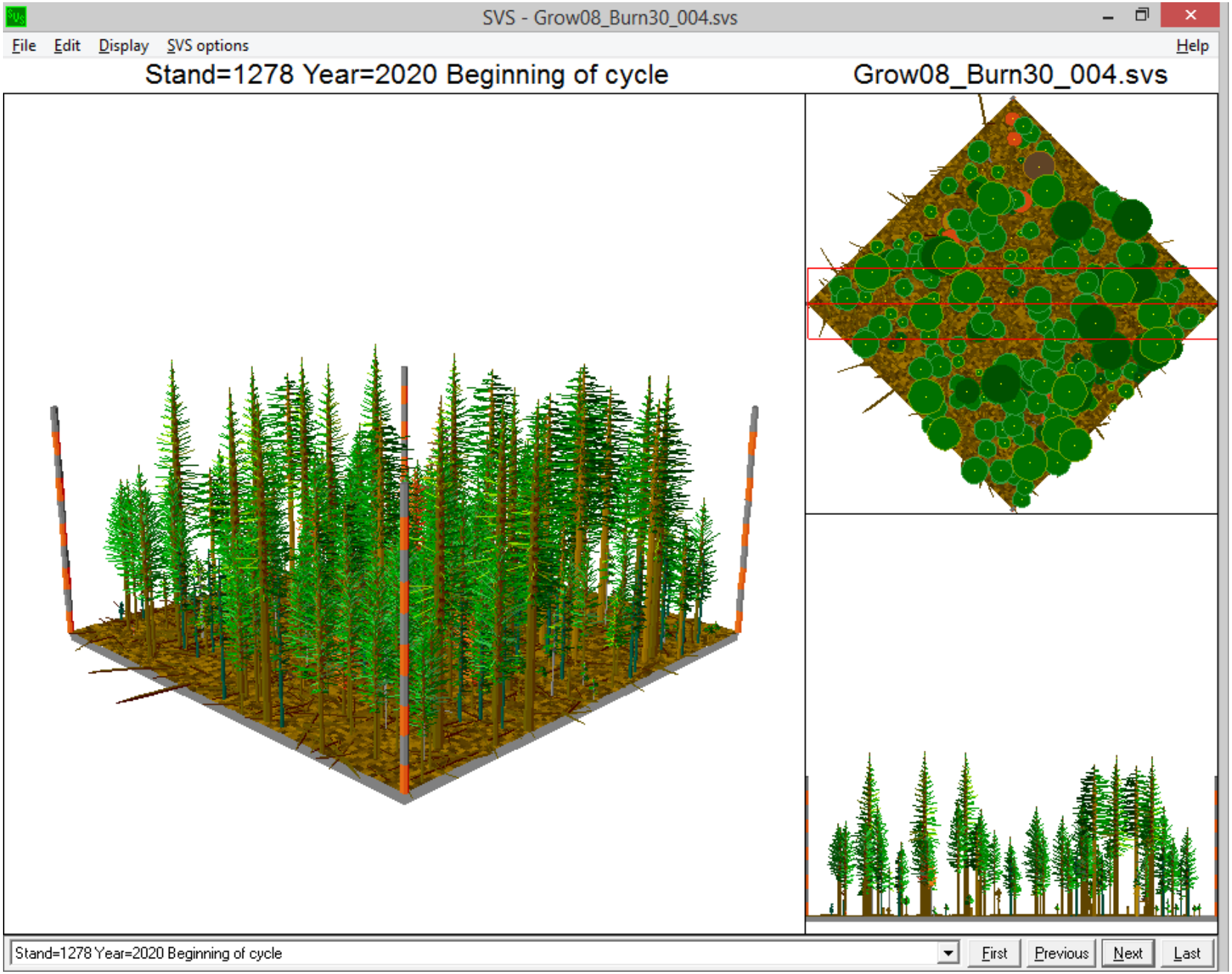
REMOVED CARBON LCA

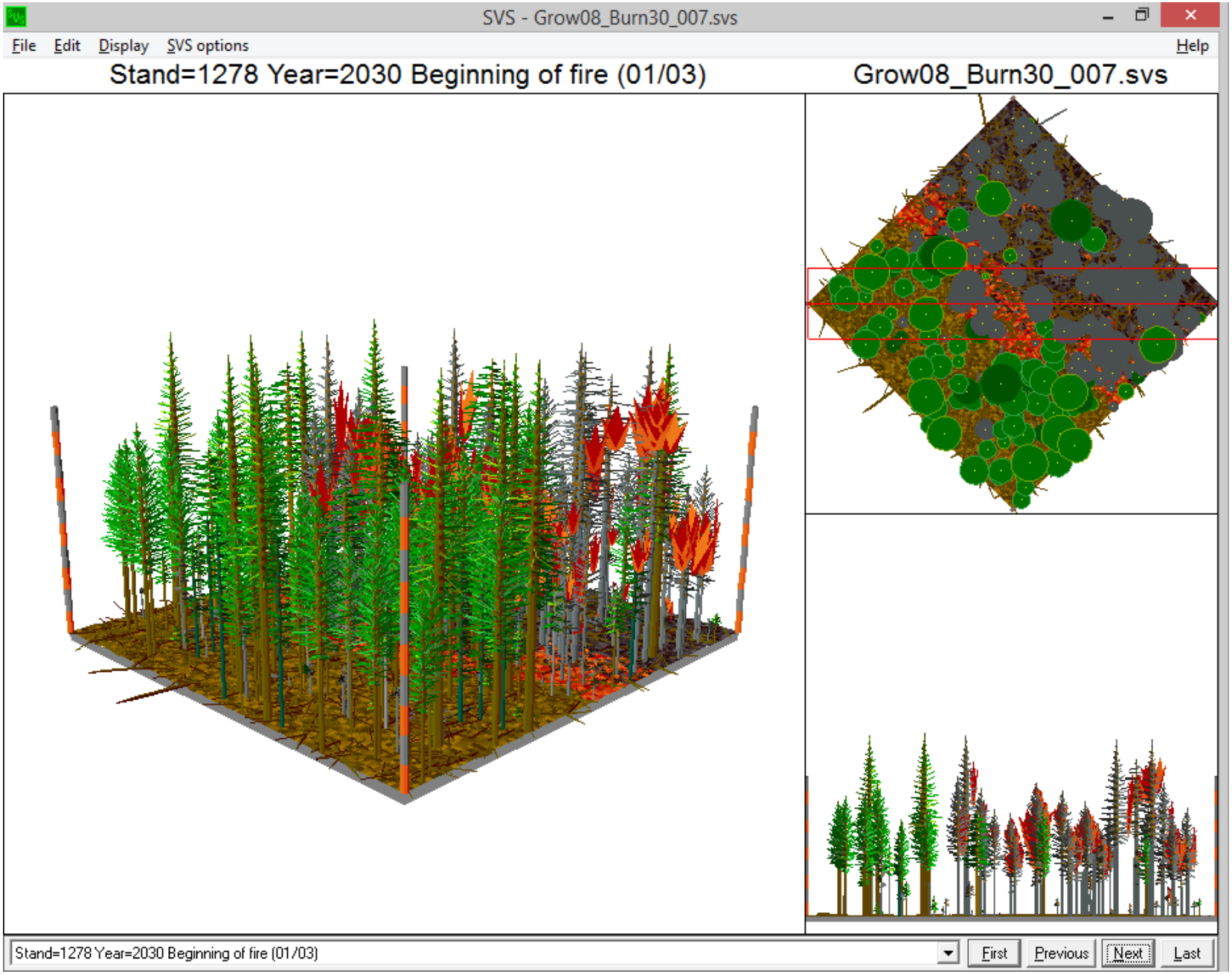
- Calculate harvested carbon in FVS
- Determine fate of harvested carbon using local knowledge, ARB protocols.

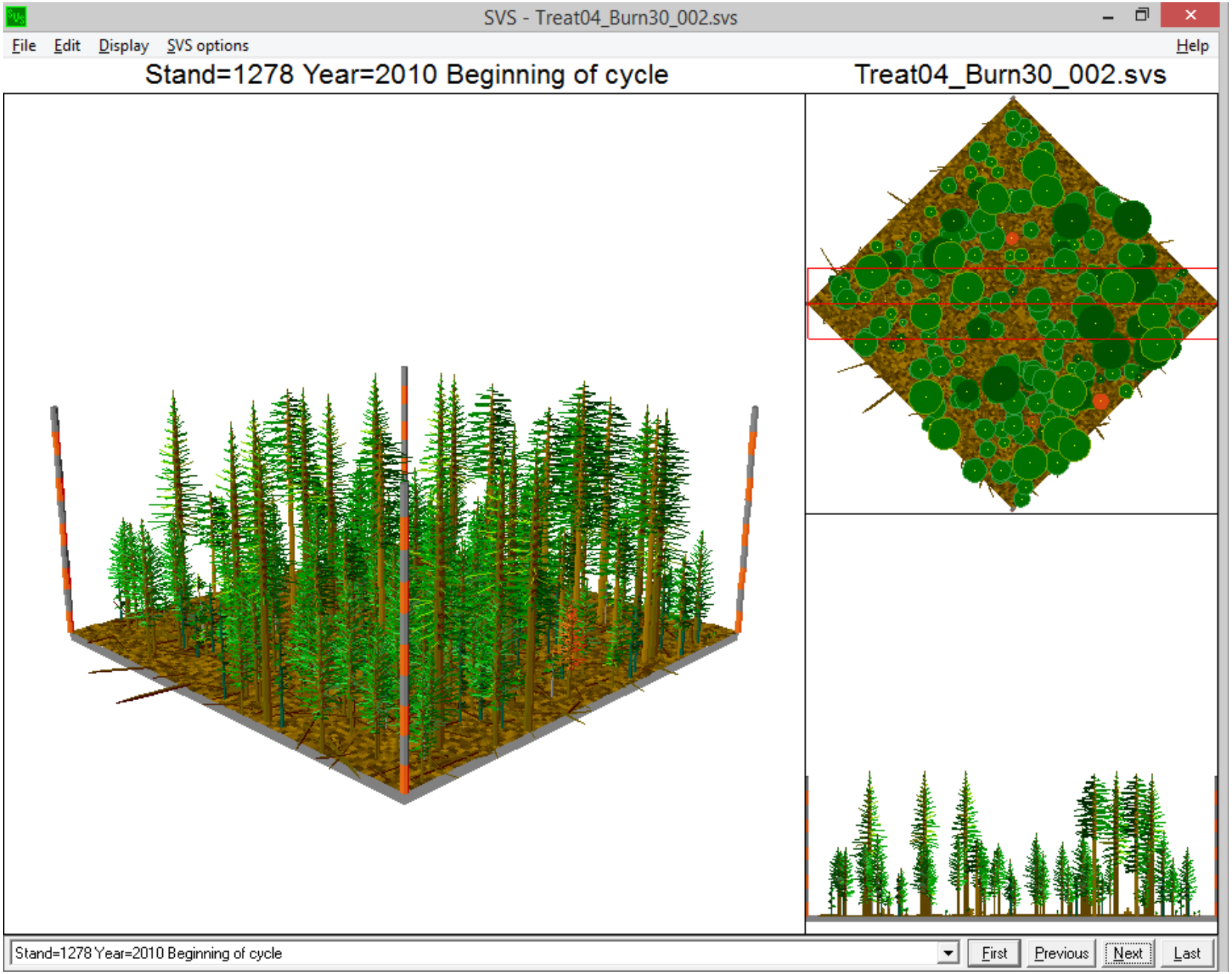
CARBON ACCOUNTING

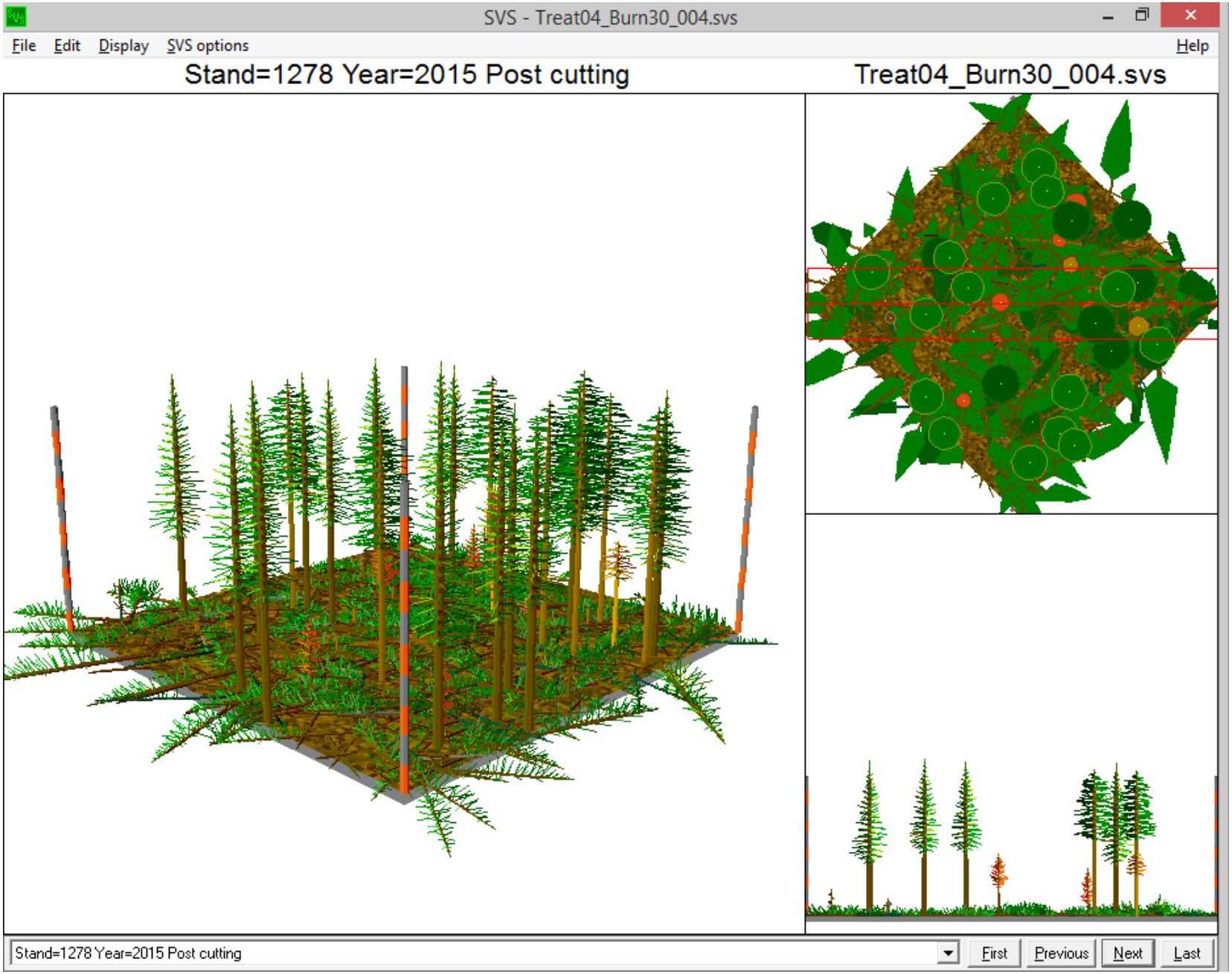

FVS - Suppose Interface v2.04 Simulation file: C:\FVSData\Webinar\Treat04_Burn20\Treat04_Burn20.key
File Edit Data Preparation Simulation Preparation After Simulation Preferences Help
Main
Simulation Preparation
Select Stands
Set Time Scale
Select Management
Select Outputs
Run Simulation
Add Keywords
Insert From File
Select Post Processors
Select Modifiers
2 Stands
2 Groups
Simulation file contents:
Stand: 1278
Stand: 4027
Group: All
From Database
Specify Output Database
Build Summary Statistics Table in Database
Build Standard Treelist and Cutlist
Build SVS Treelist
Base FVS system: CycleAt
Base FVS system: CycleAt
Select Fire and Fuels Reports
Select Carbon Reports
Plant & Natural Regeneration
Plant & Natural Regeneration
Plant & Natural Regeneration
Prescribed burn
Group(s) with no attached components:
Affected Stands...
4027
Edit Simulation
Edit Selection
Delete
Write
Append
Copy
Cut
Change Group Membership
Paste
After Simulation
Read FVS Outputs
Generate Graphs
Generate Reports
Exit

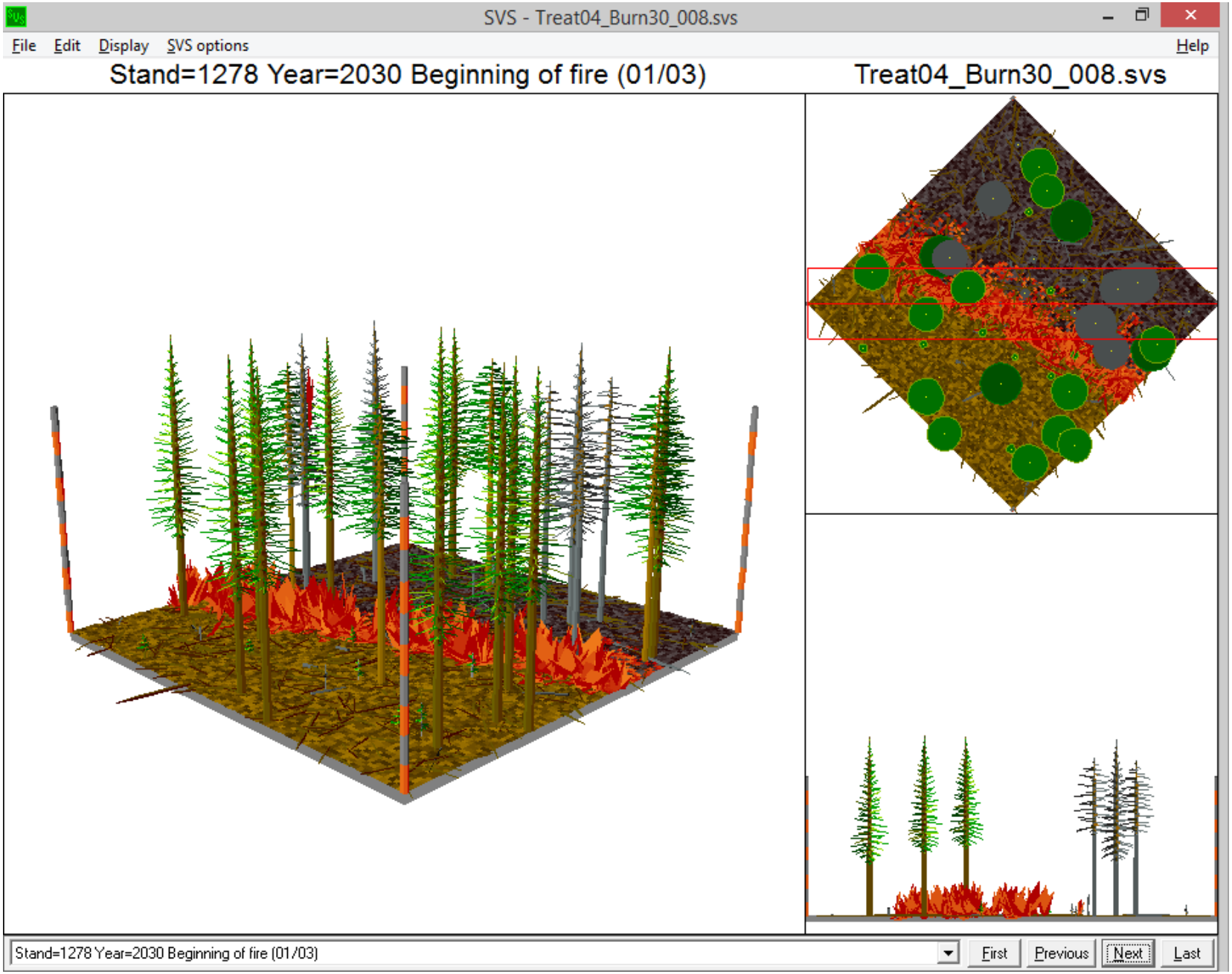

SVS - Grow08_Burn30_002.svs
File
Edit
Display
SVS options
Help
Stand=1278 Year=2010 Beginning of cycle
Grow08_Burn30_002.svs
Stand=1278 Year=2010 Beginning of cycle
First
Previous
Next
Last


SVS - Grow08_Burn30_004.svs
File
Edit
Display
SVS options
Help
Stand=1278 Year=2020 Beginning of cycle
Grow08_Burn30_004.svs
Stand=1278 Year=2020 Beginning of cycle
First
Previous
Next
Last


SVS - Grow08_Burn30_007.svs
File Edit Display SVS options Help
Stand=1278 Year=2030 Beginning of fire (01/03)
Grow08_Burn30_007.svs
Stand=1278 Year=2030 Beginning of fire (01/03)
First Previous Next Last


SVS - Treat04_Burn30_002.svs
File
Edit
Display
SVS options
Help
Stand=1278 Year=2010 Beginning of cycle
Treat04_Burn30_002.svs
Stand=1278 Year=2010 Beginning of cycle
First
Previous
Next
Last


SVS - Treat04_Burn30_004.svs
File
Edit
Display
SVS options
Help
Stand=1278 Year=2015 Post cutting
Treat04_Burn30_004.svs
Stand=1278 Year=2015 Post cutting
First
Previous
Next
Last


SVS - Treat04_Burn30_008.svs
File
Edit
Display
SVS options
Help
Stand=1278 Year=2030 Beginning of fire (01/03)
Treat04_Burn30_008.svs
Stand=1278 Year=2030 Beginning of fire (01/03)
First
Previous
Next
Last

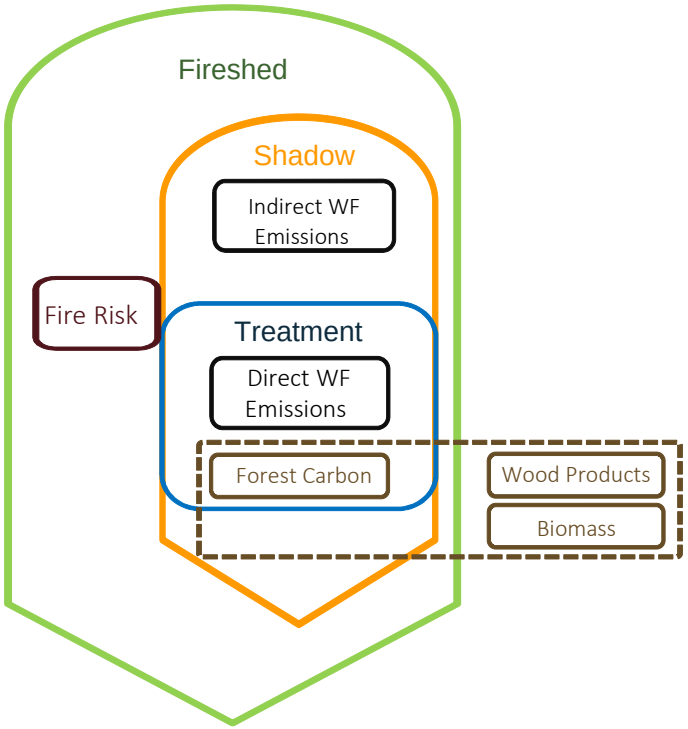
	2010	2020	2030	2040	2050
Baseline					
Stand Carbon	-52.95	-68.86	-86.82	-104.76	-122.01
Potential Emissions	8.66	10.24	12.03	13.06	13.90
Project					
Stand Carbon	-52.95	-63.53	-78.98	-94.81	-110.40
Potential Emissions	8.66	9.19	10.39	11.13	12.32
Fire Behavior Benefit		-5.12	-5.42	-5.22	-4.86
Merch Carbon Stored		-5.40	-4.80	-4.31	-3.91

PROJECT EFFECTS	2010	2020	2030	2040	2050
Sequestration		5.33	7.84	9.95	11.62
Emissions		-1.05	-1.64	-1.93	-1.58
Fire Behavior		-5.12	-5.42	-5.22	-4.86
Products and Utilization		-5.40	-4.80	-4.31	-3.91
Net		**-6.25**	**-4.01**	**-1.52**	**1.26**

*Units are Mg/Ac Carbon, in terms of emissions. Positive values represent carbon emitted or lost, negative values are sequestered carbon or avoided emissions.

Advanced Methodology

- Saah D, Robards T, Moody T, O'Neil-Dunne J, Moritz M, Hurteau M and Moghaddas J. (2012). *Developing an Analytical Framework for Quantifying Greenhouse Gas Emission Reductions from Forest Fuel Treatment Projects in Placer County, California.* Final Report submitted to: United States Forest Service, Pacific Southwest Research Station.



Resources

- Forest Vegetation Simulator – Download, training, manuals and more:
  - http://www.fs.fed.us/fmsc/fvs/
- Dixon, G.E. 2014. Essential FVS: User's guide to the Forest Vegetation Simulator. USDA Forest Service.
  - http://www.fs.fed.us/fmsc/ftp/fvs/docs/gtr/EssentialFVS.pdf
- Hoover, C. M., & Rebain, S. A. (2011). Forest carbon estimation using the Forest Vegetation Simulator: Seven things you need to know. USDA Forest Service GTR-NRS-77
  - http://www.nrs.fs.fed.us/pubs/gtr/gtr_nrs77.pdf
- First Order Fire Effects Model
  - http://www.firelab.org/project/fofem
- Carbon Online Estimator (COLE)
  - http://www.ncasi2.org/COLE/
- CONSUME
  - http://www.fs.fed.us/pnw/fera/research/smoke/consume/index.shtml
- Flammap
  - http://www.firelab.org/project/flammap

Questions and Discussion

Tadashi Moody
tmoody@sig-gis.com
(510) 301-0030

David Saah, Ph.D.
dsaah@sig-gis.com
(510) 301-0030

John Gunn, Ph.D.
jgunn@sig-nal.org
(207) 212-7723