Spatial Informatics Group

Greenhouse Gas Reduction Fund (GGRF): California Forest Legacy

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Webinar

April 10, 2015

Forest carbon & forestry services

- Protocol development & ARB tools
- Project feasibility assessments
- Soup-to-nuts project development
  - Inventory design & onsite inventory
  - GIS & mapping
  - Growth & yield modeling
  - Harvest schedules
  - Linear optimization modeling
  - Verification guidance
  - Offset Project Data Report (OPDR)
- Forest biometrics
- Applications for GGRF
- Valuation & financial analysis – cash flow & NPV/IRR calcs

How many forest carbon projects has SIG developed?

Market/Standard	Number of projects as of 12/15/2014	Initial Credits at Registration	Annual Credits	Acres
Regulatory - Air Resources Board	6	7,460,000	350,000	455,674
Pre-compliance- Climate Action Reserve v. 3.2	6	406,815	21,100	25,988
Voluntary - Verified Carbon Standard and Plan Vivo	3	60,000	42,000	23,500
TOTAL	15	7,926,815	430,100	505,162

Conservation easement

- Conservation easements that demonstrate GHG reductions qualify for the GGRF.
- Types of easements
  - 1. Avoided Conversion
    - An easement places an encumbrance on a property to maintain it as woodlands and avoid conversion to residential development, agricultural conversion, mining, or golf course.
  - 2. Improved Forest Management (IFM)
    - Easements that dedicate a property to increased carbon retention above legal requirements via sustainable forest management or passive management.

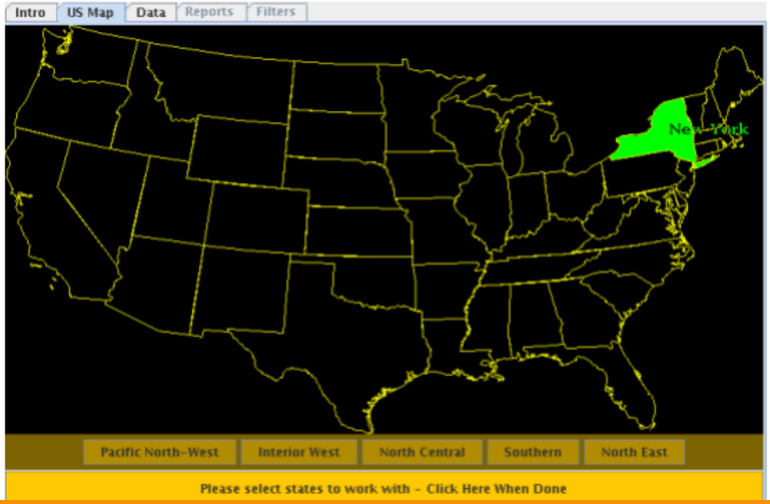
Quantifying GHG reductions

- Baseline
  - Business-as-usual scenario: What could happen if there was no easement?
  - Avoided Conversion
    - Residential development or golf course?
  - IFM
    - What is the lowest stocking a property can reach while adhering to local, state and federal forestry regulations. How much can be harvested while still meeting the requirements of the forest practice rules of California?

Where does my data come from?

Property owner has no inventory data

- Carbon On Line Estimator
- Based on FIA inventory
- May not be representative of individual's land
- Can not simulate harvesting



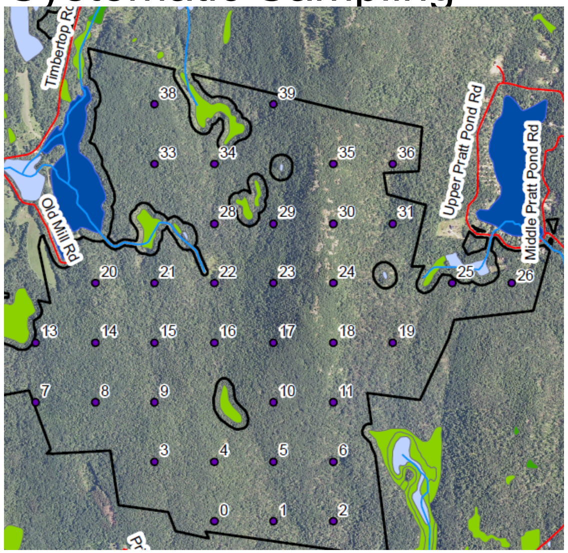
COLE carbon report

Table 1: **Carbon Stocks by Age Class for California**

Age Class	Mean volume	Live tree	Dead tree	Under story	Down dead wood	Forest floor	Soil	Total non soil
years	m^3/hectare	tonnes carbon/hectare						
0	0	0	2.55	0	15.2	33.04	49.8	50.79
5	3.97	2.44	2.55	6.77	14.24	33.04	49.8	59.04
10	21.21	11.57	2.55	4.43	14.18	33.04	49.8	65.77
15	48.83	24	2.55	3.22	14.6	33.04	49.8	77.41
20	80.58	36.21	2.55	2.64	15.08	33.04	49.8	89.52
25	111.72	46.52	2.55	2.34	15.42	33.04	49.8	99.87
30	139.67	54.56	2.55	2.16	15.56	33.04	49.8	107.86
35	163.39	60.52	2.55	2.05	15.52	33.04	49.8	113.67
40	182.81	64.81	2.55	1.98	15.34	33.04	49.8	117.72
50	210.47	69.96	2.55	1.91	14.74	33.04	49.8	122.2
60	227.12	72.44	2.55	1.87	14.02	33.04	49.8	123.92
70	236.83	73.6	2.55	1.86	13.3	33.04	49.8	124.35
80	242.39	74.14	2.55	1.85	12.65	33.04	49.8	124.23
90	245.54	74.39	2.55	1.85	12.07	33.04	49.8	123.9
100	247.32	74.51	2.55	1.85	11.57	33.04	49.8	123.52

Forest Inventory

Systematic Sampling



Plots

Carbon Pools

QA/QC

Example of treelist

Stand_ID	Plot_ID	Plot type	Species	DBH	Live/Dead	Total height	4" D.O.B.
E	45202	1	PIPO	14.38	1		0
E	45202	1	PIPO	12.88	1		0
E	45202	1	PIPO	11.38	1		0
E	45202	1	PIPO	6.78	1		0
E	45202	1	PIPO	16.48	1		0
E	45202	1	PIPO	9.28	1		0
E	45202	1	PIPO	18.07	1		0
E	45202	1	PIPO	17.48	1		0
E	45202	1	PIPO	5.58	1		0

Avoided Conversion

- Carbon accounting is 10 years
- Can get annual credits after 10 years, but majority of GHG reductions claimed within 10 years because of demonstrated conversion rate.
- (http://www.arb.ca.gov/regact/2014/capandtrade14/capandtrade14addtldoc2.pdf)

Avoided Conversion

- Based on ARB Forest Offset Protocol

- Highest and Best Use (HBU) should be conversion to agriculture, residential development, mining, golf courses etc.
- Follow guidelines in ARB's Forest Offset Protocol
  - > 40% *greater* than the value of the current forested land use; 80% reduction to avoid deduction in net GHG reduction claimed.
  - must indicate that the slope of Project Area does not exceed 40 percent.

- Where conversion to residential, commercial, or recreational land uses is anticipated, the appraisal must also describe the following information:
  - 1. The proximity of the Project Area to metropolitan areas.
  - 2. The proximity of the Project Area to grocery and fuel services and accessibility of those services.
  - 3. Population growth within 180 miles of the Project Area.

Avoided Conversion - Quantification

- Spectrum of options

- Option 1. Look-up tables and stand table
  - Less time consuming, but less accurate
  - Create harvest schedule with board feet and convert to metric tonnes carbon dioxide equivalent (MTCO_2e).

- Option 2. Growth and yield modeling
  - More time consuming, more accurate
  - Use FVS or other growth-and-yield model
  - Considers regeneration, stand density, models mortality, etc.
  - Use model's internal equations to generate CO_2e

Avoided Conversion

- Option 1. Look-up tables and stock and stand tables.
  - Create harvest schedule of board feet for project scenario and baseline (net growth is zero)
  - 10 MBF/acre

Year	MBF/acre	MBF harvested/acre	MT CO2e/acre	MTCO2e harvested/acre
1	10	1.5	48.3	-5.6
2	8.85	1.5	42.7	-5.6
3	7.7	1.5	37.2	-5.6
4	6.55	1.5	31.6	-5.6
5	5.4	1.5	26.1	-5.6
6	4.25	1.5	20.5	-5.6
7	3.1	1.5	15.0	-5.6
8	1.95	1.5	9.4	-5.6
9	0.8	1.5	3.9	-3.9
10	0.0	1.5	0	-5.0

Conversion bdft to merch cubic vol

- 10 MBF
- 1. Convert to merchantable cubic volume
- 2. 10 MBF x 222 (Doyle)=2,220 merch cubic vol.

Car multipliers to Merch cubic vol	
Green tons	31.5
MBF-Doyle	222
MBF-International 1/4"	146
MBF-Scribner ("C" or "Small")	165
MBF-Scribner ("Large" or "Long")	145
MCF-Thousand Cubic Feet	1000

Carbon in bark and round wood

- 2,220 ft^3
- 87% of volume in round wood.
- 13% of volume in bark.
  - 1,914 ft^3 in roundwood
  - 306 ft^3 in bark

Conversion volume to dry biomass

- Weight = (volume) * (specific gravity) * (density of H_2O) * (1+MCod/100).
  - Miles and Smith (2009, USDA Forest Service Research Note NRS -38).
  - Round wood: 1,914 ft3*0.40 * 62.4 lb ft3 * (1+0/100) equals 47,773.4 lb or 21.7 MT dry
  - Bark: 288.6 ft3*0.56 * 62.4 lb ft3 * (1+0/100) equals 10,084.8 lb or 4.6 MT dry
  - Total: 26.3 MT dry

Convert to CO_2e

- 26.3 MT biomass
- Convert to carbon 26.3*.5= 13.15
- Convert to metric tons carbon (MTCO2e)= 13.15 *(44/12)= 48.3 MTCO2e
  - Of the bole only!

Net GHG reductions

Year	MBF/acre	MBF harvested/acre	MT CO2e/acre	MTCO2e harvested/acre
1	10	1.5	48.3	-5.6
2	8.85	1.5	42.7	-5.6
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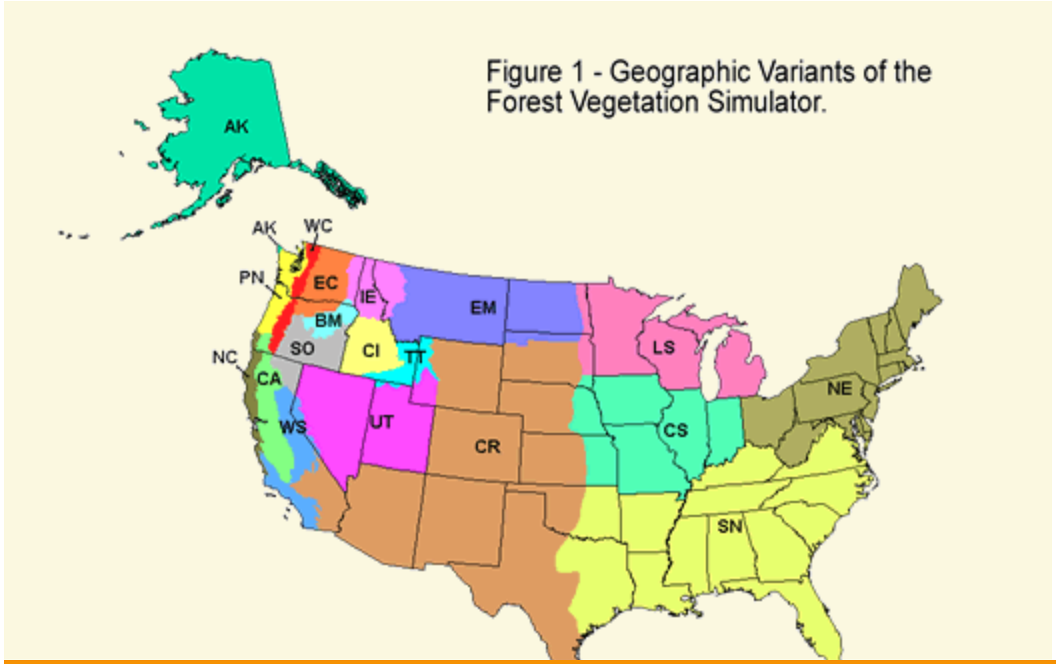
9	0.8	1.5	3.9	-3.9
10	0.0	1.5	0	-5.0
			GHG reductions	
			Add other baseline carbon pools	0.0
			Baseline harvested wood products	2.5
			Project harvested wood products	0.5
			10 year Net MT GHG reductions per acre	46.3
			1,000 acre net MT GHG reductions	46,300

Avoided Conversion

- Option 2. Growth and yield modeling
- Use FVS or other growth-and-yield model
- Using FVS as an example:



FVS

- Equations are not same as FIA equations (Hence not the same as ARB's Forest Offset Protocol)
- Carbon equations are from Jenkins (2003) and Fire and Fuels Extension
- Includes all carbon pools
- Tree Init Access Table in FVS

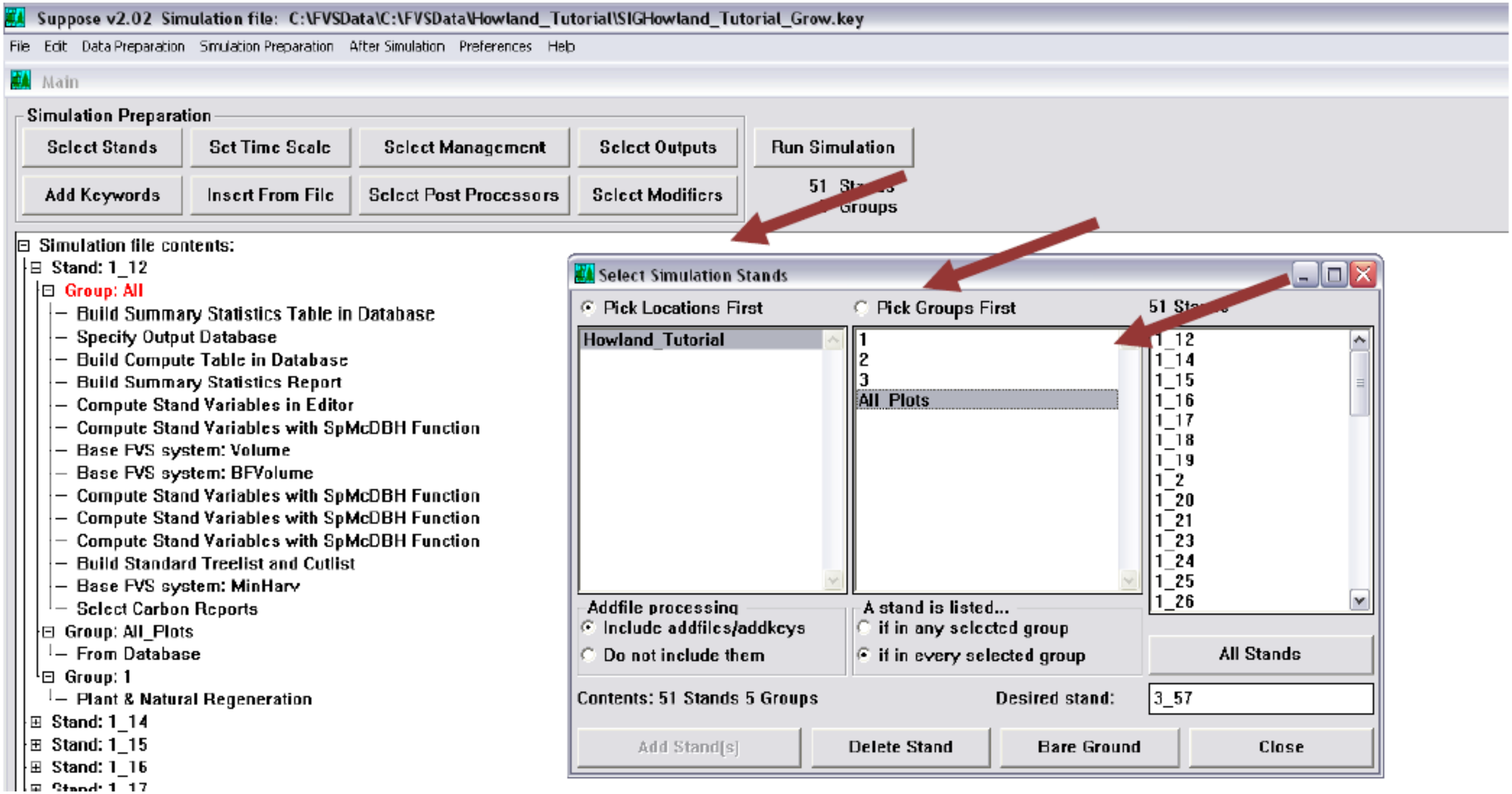
Custom

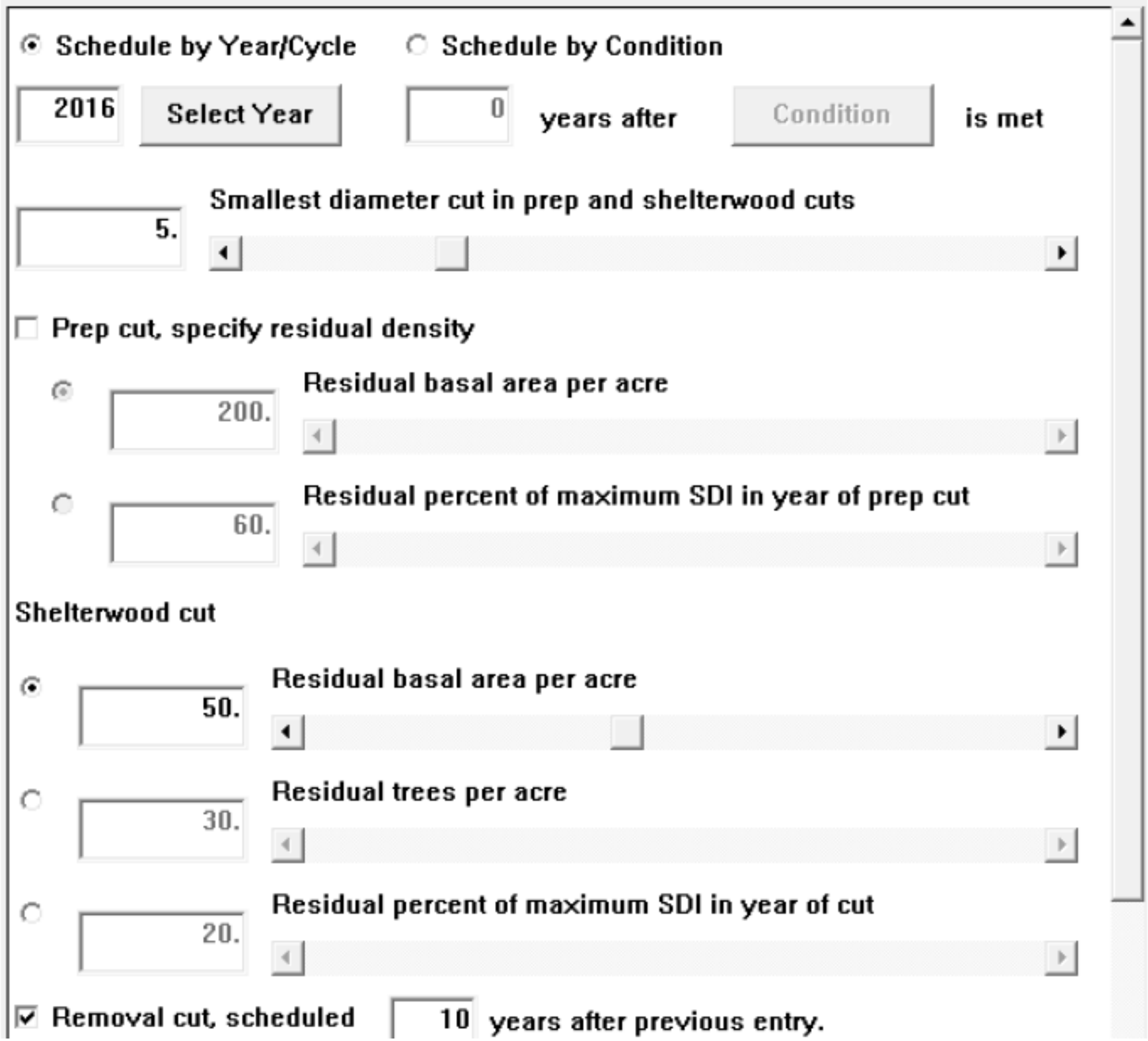
FVS Tables
- FVS_StandInit
- FVS_PlotInit
- FVS_TreeInit
- FVS_Group...

FVS Data Ent...
- Enter_Stand...
- Enter_Plot_...
- Enter_Tree_...

Edit FVS_Gro...
- Update Dat...

Stand_ID	StandPlot_ID	Plot_ID	Tree_ID	Tree_Count	History	Species	DBH	DG	Ht
7	7_1	1	8	2	1	71	12		
7	7_1	1	6	1	1	71	12		
7	7_1	1	4	1	1	71	6		
7	7_1	1	3	1	1	806	8		
7	7_1	1	7	1	1	71	10		
7	7_1	1	5	1	1	71	10		
7	7_1	1	2	1	1	71	10		
7	7_2	2	5	1	1	125	12		
7	7_2	2	3	2	1	125	12		
7	7_2	2	4	1	1	125	10		
7	7_2	2	2	2	1	125	10		
7	7_2	2	1	1	1	125	10		
7	7_3	3	4	1	1	97	12		
7	7_3	3	3	2	1	97	6		
7	7_3	3	6	1	1	125	4		
7	7_3	3	2	4	1	97	4		
7	7_3	3	7	1	1	125	10		
7	7_3	3	1	1	1	125	10		
7	7_3	3	5	1	1	97	10		
7	7_4	4	3	2	1	125	12		


Suppose v2.02 Simulation file: C:\FVSData\C:\FVSData\Howland_Tutorial\SIGHowland_Tutorial_Grow.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
Groups
Simulation file contents:
Stand: 1_12
Group: All
Build Summary Statistics Table in Database
Specify Output Database
Build Compute Table in Database
Build Summary Statistics Report
Compute Stand Variables in Editor
Compute Stand Variables with SpMcDBH Function
Base FVS system: Volume
Base FVS system: BFVolume
Compute Stand Variables with SpMcDBH Function
Compute Stand Variables with SpMcDBH Function
Compute Stand Variables with SpMcDBH Function
Build Standard Treelist and Cutlist
Base FVS system: MinHarv
Select Carbon Reports
Group: All_Plots
From Database
Group: 1
Plant & Natural Regeneration
Stand: 1_14
Stand: 1_15
Stand: 1_16
Select Simulation Stands
Pick Locations First
Pick Groups First
Howland_Tutorial
1
2
3
All_Plots
1_12
1_14
1_15
1_16
1_17
1_18
1_19
1_2
1_20
1_21
1_23
1_24
1_25
1_26
Addfile processing
Include addfiles/addkeys
Do not include them
A stand is listed...
if in any selected group
if in every selected group
All Stands
Contents: 51 Stands 5 Groups
Desired stand:
3_57
Add Stand[s]
Delete Stand
Bare Ground
Close


Schedule by Year/Cycle
Schedule by Condition
2016
Select Year
0
years after
Condition
is met
5.
Smallest diameter cut in prep and shelterwood cuts
Prep cut, specify residual density
200.
Residual basal area per acre
60.
Residual percent of maximum SDI in year of prep cut
Shelterwood cut
50.
Residual basal area per acre
30.
Residual trees per acre
20.
Residual percent of maximum SDI in year of cut
Removal cut, scheduled
10
years after previous entry.

Calculates all carbon pools automatically

Stratum	StandID	Year	Aboveground_Total_Live Carbon	Aboveground_Merch_Live Carbon	Belowground_Live Carbon	Belowground_Dead Carbon	Standing_Dead Carbon
1	1_1	2013	28	16	5	0	0
1	1_1	2018	31	18	6	0	1
1	1_1	2023	34	20	7	0	1
1	1_1	2028	37	22	7	0	2
1	1_10	2013	31	18	6	0	0
1	1_10	2018	34	20	7	0	2
1	1_10	2023	36	21	7	1	4

Improved Forest Management

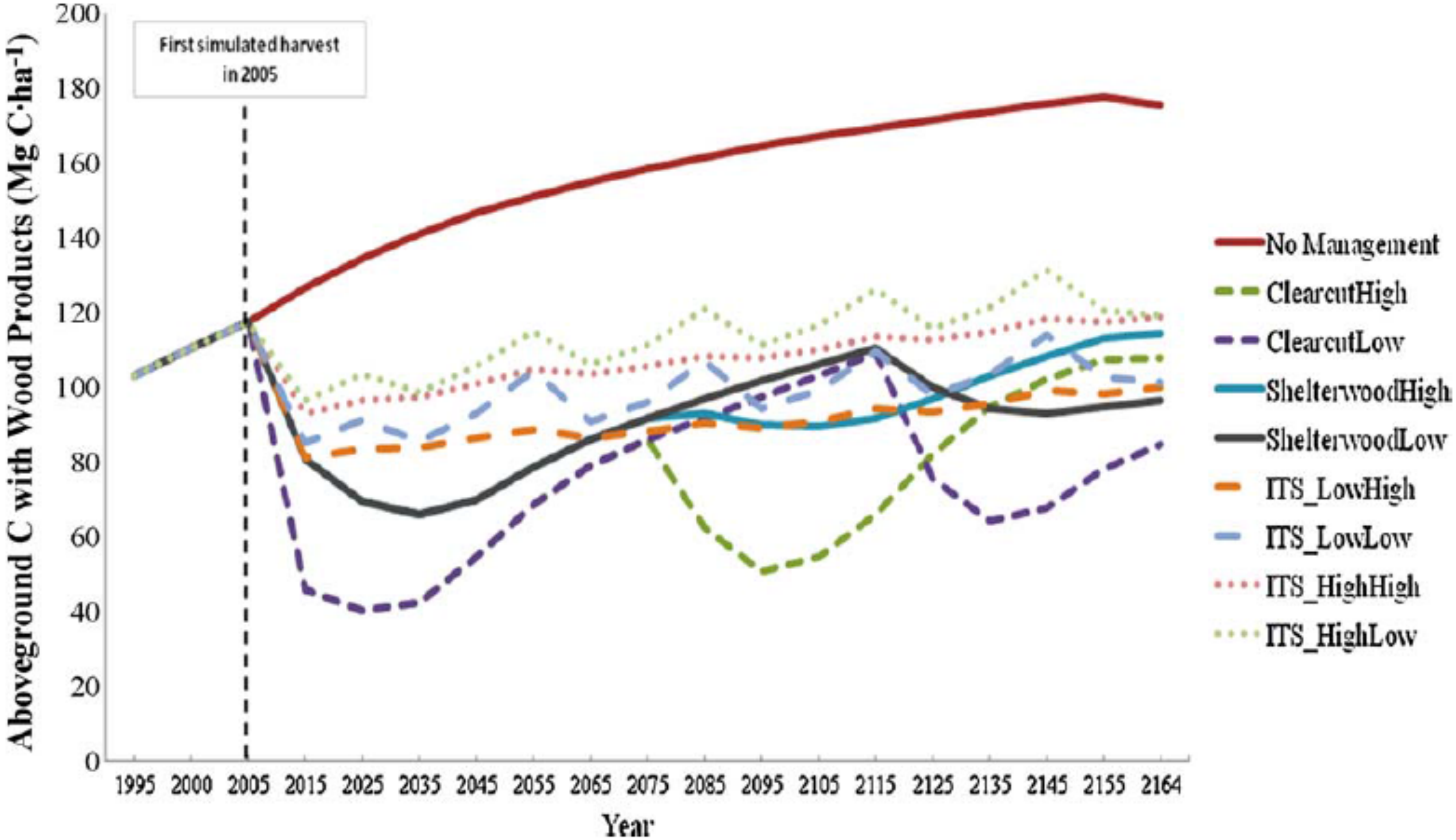
- Baseline
  - Harvest maximum volume, but in compliance with local, state, and federal laws.
  - Compliance with forest practice rules of California

- Spectrum of quantification options
  - Option 1. Look-up tables and stand stock and stand tables
    - Less time consuming, but less accurate
    - Create harvest schedule with board feet and convert to metric tonnes carbon dioxide equivalent ($MTCO_2e$).
  - Option 2. Growth and yield modeling
    - More time consuming, more accurate
    - Use FVS or other growth-and-yield model
    - Considers regeneration, stand density, models mortality, etc.
    - Use model's internal equations to generate CO_2e

Baseline- stock and stand table

Year	MBF	MBF harvested	MT CO2e	MTCO2e harvested
2015	10		48.3	
2025	13.5		65.2	
2035	9	8	43.5	-21.7
2045	12.5		60.4	
2055	7	9	33.8	-26.6
2065	10.5		50.7	
2075	2	12	9.7	-41.1
2085	5.5		26.6	
2095	-6	15	-29.0	-55.5
2105	-2.5		-12.1	
2115	1		4.8	
100 yr average	5.7	11.0	27.4	-36.2

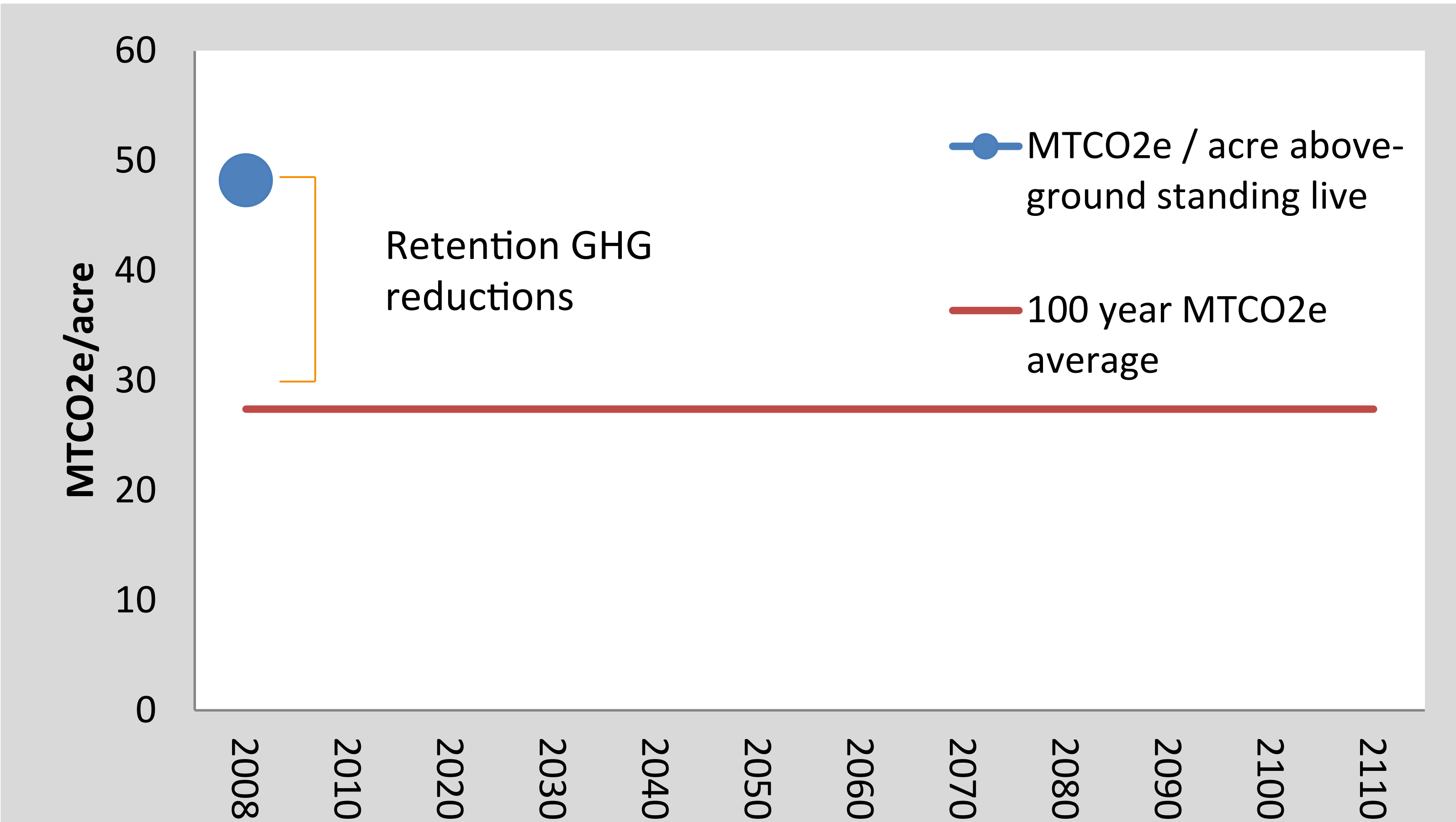
Baseline-Growth and yield modeling



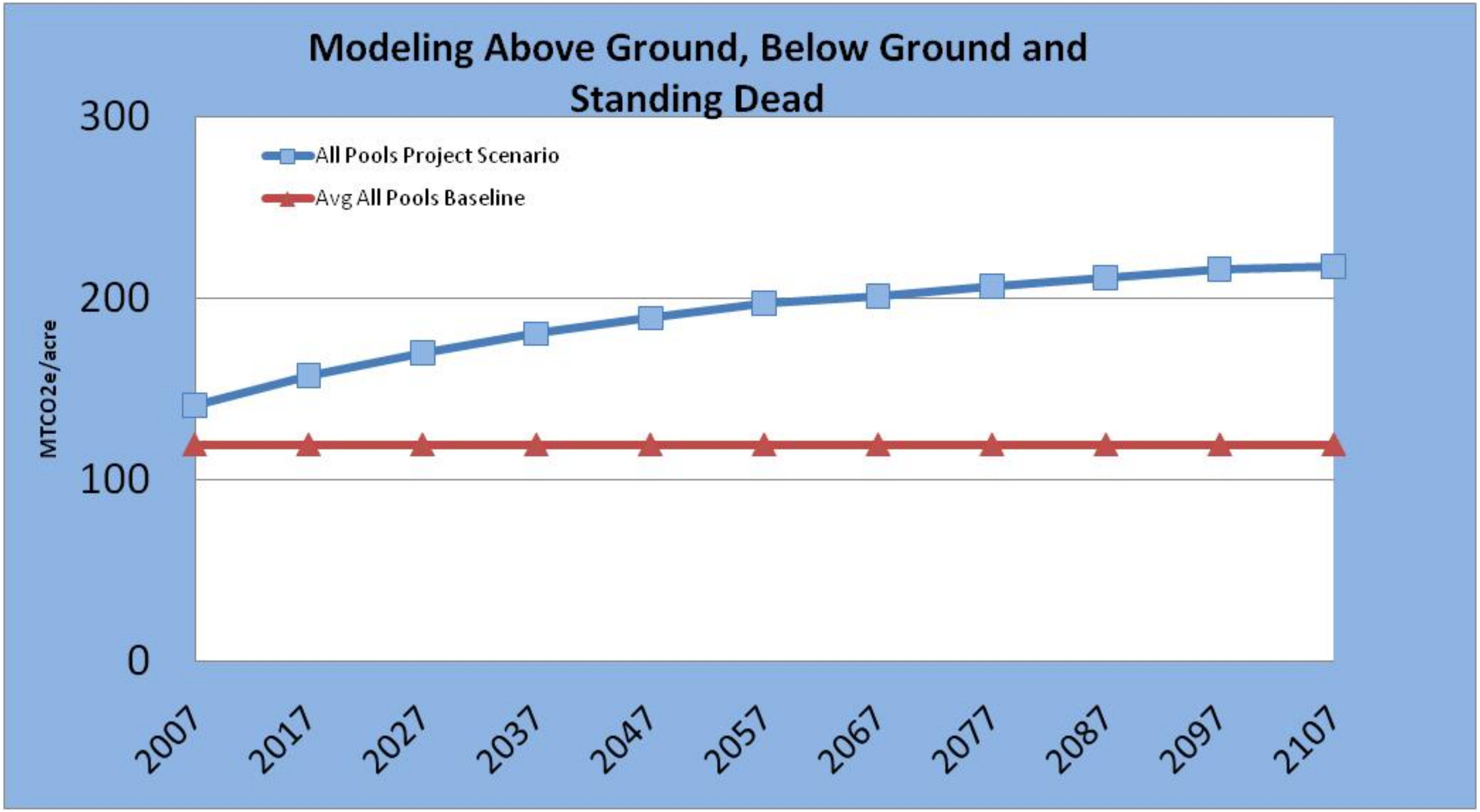
Nunery & Keeton, 2010

SIG

GHG reductions is difference between project scenario and baseline



Growth GHG reductions: Example of all required carbon pools



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Thank you!

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