CLIMATE FORWARD

Avoided Wildfire Emissions Forecast Methodology Version 1.0

Workgroup Meeting 2

March 10, 2022

Housekeeping

CLIMATE FORWARD

- Workgroup members have the opportunity to actively participate during the meeting
  - Please keep yourselves muted unless / until you would like to speak
- All other attendees/observers are in listen-only mode
- Observers are free to submit questions in the GoToWebinar question box
- We will follow up via email to answer any questions not addressed during the meeting
- The slides and a recording of the presentation will be posted online

Agenda

CLIMATE FORWARD

Roll call

Overview and discussion of quantification elements

Next steps

Introductions

CLIMATE FORWARD

CLIMATE ACTION RESERVE

Jon Remucal
Marissa Schmitz
Jordan Mao

Spatial Informatics Group

Thomas Buchholz
David Saah

Dogwood Springs Forestry

John Nickerson

Coalition for the Upper South Platte

Jeff Ravage

Carbonomics

Seth Baruch

Introductions

CLIMATE FORWARD

Name (alphabetical)	Organization
Aaron Green	Colorado State Forest Service
Andrew Dunn	HQPlantations Pty Ltd
Bruce Springsteen	Placer County Air Pollution Control District
Christian Eggleton	FRST
Dan Porter	The Nature Conservancy
Ed Murphy	Sierra Pacific Industries
Elliott Vander Kolk	Sierra Nevada Conservancy
Harry Statter	Firewise Landscapes Inc / Frontline Wildfire Defense
Jens Stevens	US Forest Service

Introductions

Name (alphabetical)	Organization
John Battles	University of California, Berkeley
John Cleland	Renew West
Mark Finney	US Forest Service
Matt Hurteau	University of New Mexico
Phil Saksa	Blue Forest Conservation
Steve Eubanks	(Independent)
Tad Mason	TSS Consultants
Tadashi Moody	California Department of Forestry and Fire Protection

Funding support

CLIMATE FORWARD

Shoulders we're standing on…

SMUD

Spatial Informatics Group

California Department of Forestry & Fire Protection
CAL FIRE
SINCE 1885

Placer County
AIR POLLUTION CONTROL DISTRICT

Coalition for the Upper South Platte

Forest Service
U.S. Department of Agriculture

SIERRA PACIFIC INDUSTRIES
Growing Forests For Our Future

CLIMATE FORWARD

Today's Discussion

Methodology Components

CLIMATE FORWARD

Eligibility

- Defining the project
- Ownership
- Start Date / Crediting period (40 years)
- Project Location
- Additionality
    - Performance Standard Test
    - Legal Requirement Test
    - Enhancement Payments
- Regulatory compliance
- Permanence

Project Area

Defining GHG boundary

Quantification

- Delineating the project area
- Quantifying project emissions/removals
- Programmatic risk deduction

Monitoring / Reporting / Confirmation

- Sampling
- Confirmation field visit

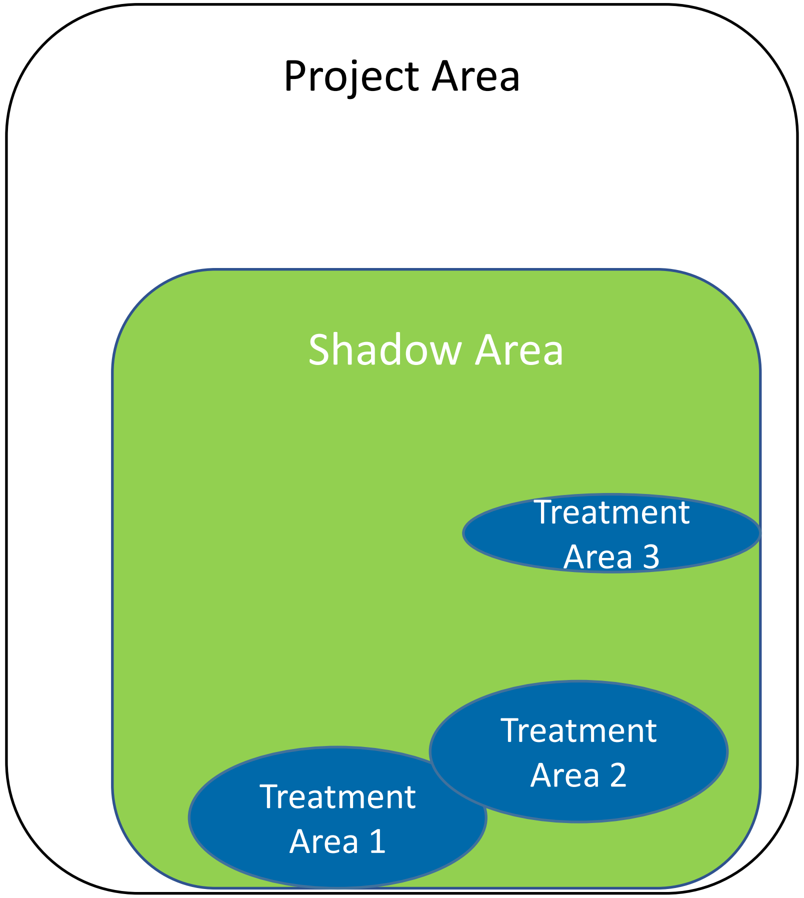
Section 4

Project Area

4 Project Area

CLIMATE FORWARD

- Project area consists of:
  - <u>Treatment areas</u> – Locations where fuel treatment activities are performed
  - <u>Non-treatment areas</u> – Locations where fuel treatments are not performed but that have the potential to have fire behavior and severity influenced by activities in treatment areas
- May comprise multiple ownerships/ownership types
- Delineated through modeling process



CLIMATE FORWARD

Section 6

Quantifying GHG Emission Reductions

Credit Calculation

CLIMATE FORWARD

$$\text{Emissions Reductions} = ([\text{Emissions}_{\text{baseline}}] - [\text{Sequestered C}_{\text{baseline}}]) - ([\text{Emissions}_{\text{project}}] - [\text{Sequestered C}_{\text{project}}])$$

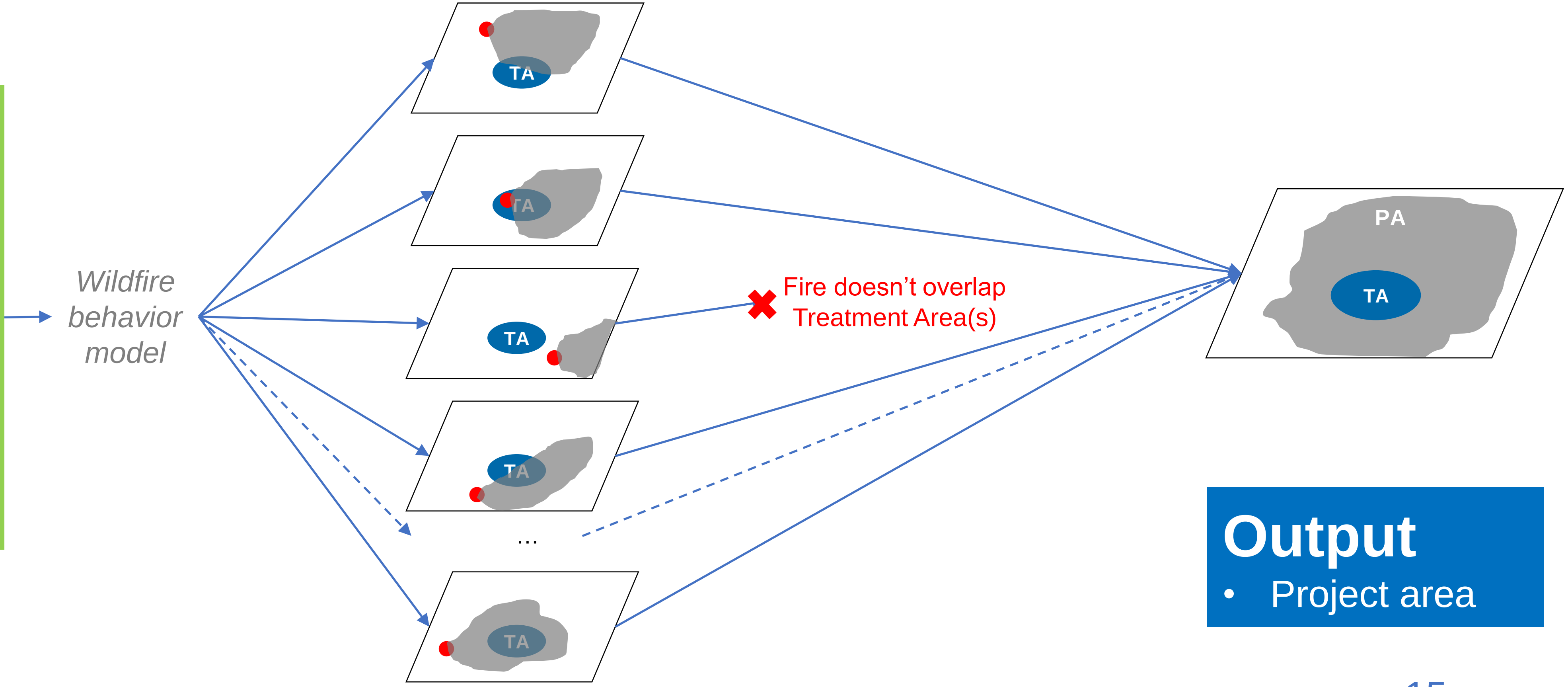
Emissions savings have to outweigh diminished C sequestration

Project Area Delineation

Define the project area by modeling fire spread from each ignition point in project vicinity, with project area determined by burned areas that overlap the project's treatment area(s).

Input

- Topography
- Weather (97th %ile)
- Tree lists
- Surface fuels (fuel models)
- Treatment areas
- Ignition points
- Fixed burn time



Output

- Project area

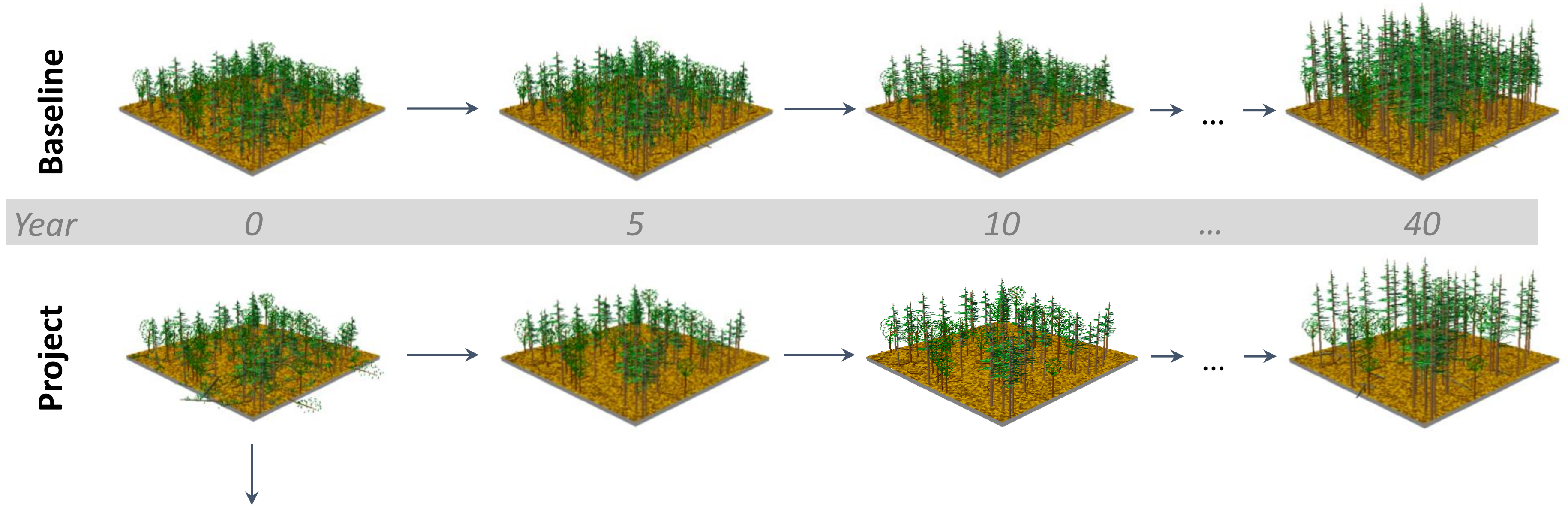
Model Forest Growth Without Fire

CLIMATE FORWARD

Model changes to tree and surface fuels data for each stand witih FFE-FVS over crediting period for baseline and project, absent wildfires and including baseline harvesting to estimate changes in forest C

Input

- Project area
- Tree lists
- Surface fuels
- Baseline harvesting
- Treatments
- Regeneration



Output

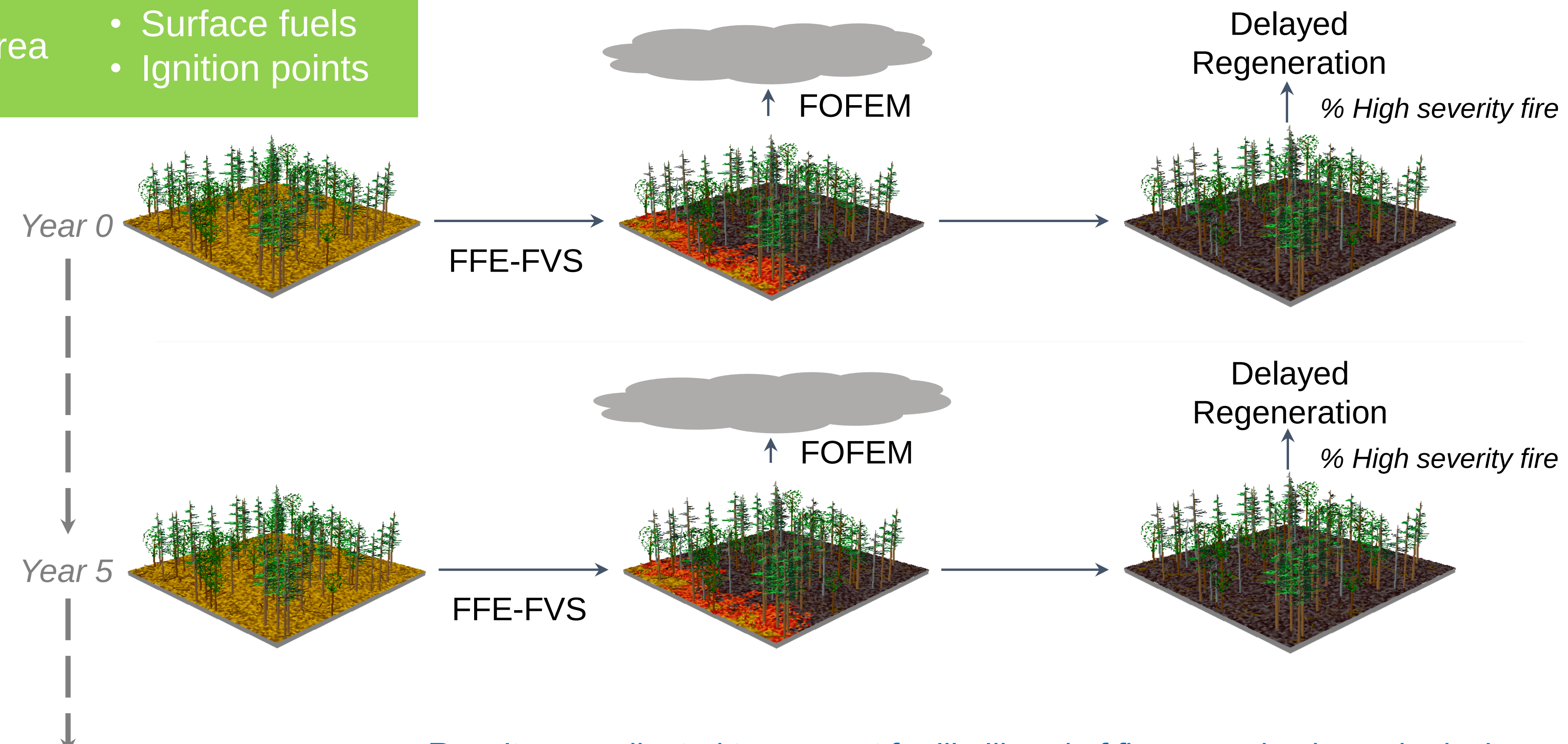
- Tree lists
- Surface fuel models
- Wood products C

Model Fire Impacts – Emissions, Regen

CLIMATE FORWARD

At each time step for the baseline and the project: Estimate GHG emissions from fires and determine resulting stand conditions

Input
- Project area
- Tree lists
- Surface fuels
- Ignition points



Output
- Tree lists
- Fuel models
- Wildfire GHG emissions
- Delayed regeneration data

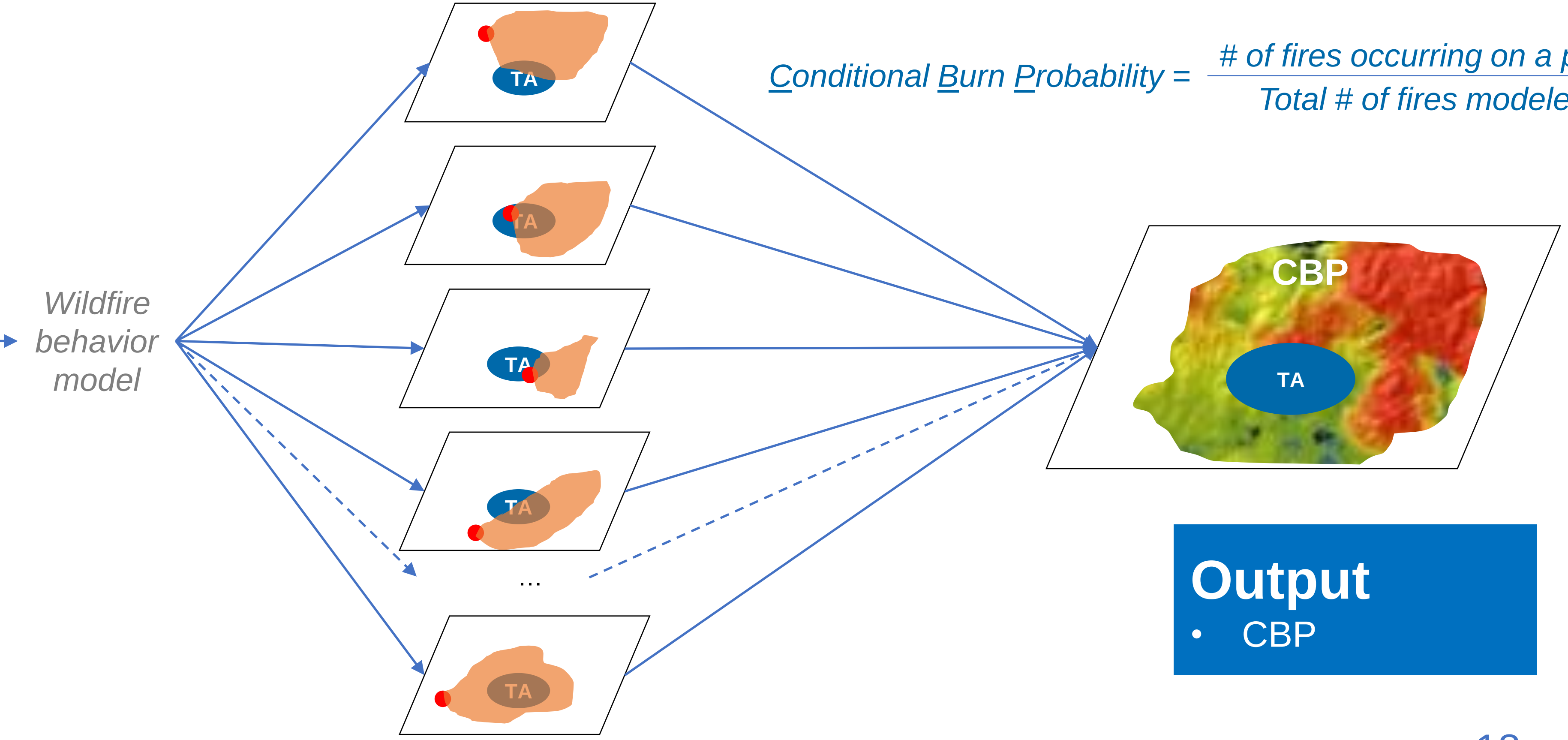
Results are adjusted to account for likelihood of fire occurring in each pixel…

Calculate Conditional Burn Probability

At each time step for the baseline and the project: Model wildfire behavior, to adjust emissions outcomes based on likelihood of individual pixels to burn from a fire starting from each ignition point

Input

- Topography
- Weather (97th %ile)
- Tree lists
- Surface fuels (fuel models)
- Treatment areas
- Ignition points
- Fixed burn time



Output

- CBP

Adjust for Annual Fire Probability

At each time step for the baseline and the project: Adjust emissions outcomes and delayed regeneration results to account for probability of fire occurring in a given year

Input
- GHG Emissions (FOFEM) adjusted by CBP
- Delayed regeneration estimates
- Fire return interval

→

[GHG Emissions] x [1/FRI]

[Delayed regeneration] x [1/FRI]

→

Output
- Probable annual emissions
- Probable delayed regeneration

6.1 - 6.7 Quantification

Accounting steps

1) Project area delineation, selection, and characterization
2) Weather data
3) **Management scenario development and fuel reduction treatment design**
4) Forest carbon (forest growth and sequestration) calculation
5) Forest removals life cycle assessment (wood products) calculation
6) Wildfire emissions calculation
7) **Delayed regeneration calculation**
8) **Fire ignition probability (fire return interval) assessment**
9) Aggregated emissions accounting

1) Project area delineation, selection, and characterization, 2) Weather data

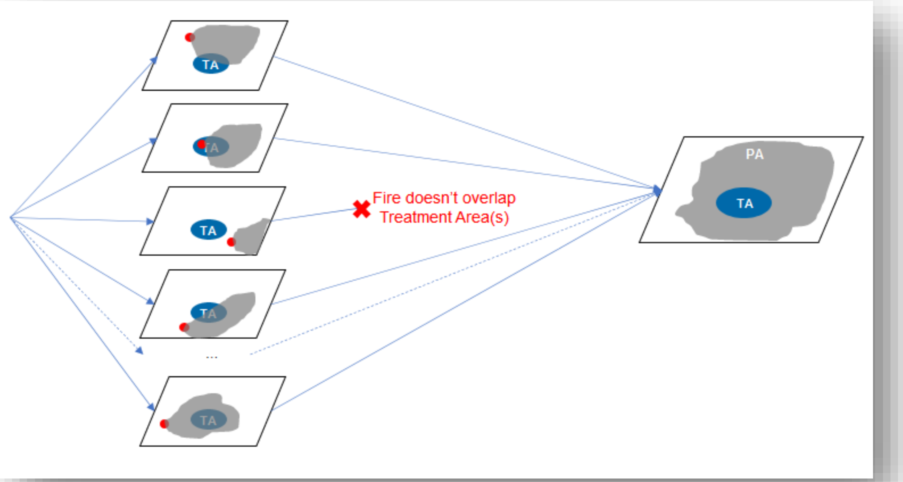
CLIMATE FORWARD

- Standardized input from Climate Forward:
  - Weather data (Two representative RAWS locations, 97th percentile, **windspeed, temperature, fuel moisture**)
  - Topographic data
  - Ignition maps (Historic ignitions from USFS)
  - Surface fuel models
- Approach:
  - Treatment polygons overlayed with ignition map
  - Add ignition points if <0.6/ha
  - Run fire spread model (8 hrs) to ignition points that impact treatment area

Example of RAWS output

Table 3: 97th percentile fire weather conditions for fire modeling.

Variable	SimFire FVS	FConstMTTValue
1-hr fuel moisture	4%	3%
10-hr fuel moisture	4%	4%
100-hour fuel moisture	5%	5%
>3"	10%	N/A
Duff	15%	N/A
Herbaceous fuel moisture	N/A	39%
Live woody fuel moisture	70%	70%
Ambient air temperature	80° F	N/A
Percentage of stand burnt	10%	N/A
Wind speed	20 mph (20 ft)	21 mph
Wind direction	N/A	Southwest (225 degrees).



CLIMATE FORWARD

3) Management scenario development

- Standardized input from Climate Forward:
  - Baseline management
- Approach:
  - Define fuel treatment spatial layers with:
  - Treatment types,
    - Locations, and
    - Timing

Treatment	Year	Entity	Activity
A	0	Federal	Remove ladder fuels & thin co-dominants
A	1	Private	Prescribed burn
B	1	Federal	Remove ladder fuels & thin co-dominants
B	3	Private	Prescribed burn
C	2	Federal	Prescribed burn
A	2	Federal	Prescribed burn
B	3	State	Prescribed burn

Example: Eve et al. 2014

Table 6-6: Common Silvicultural Options by Most Commonly Managed Forest Type

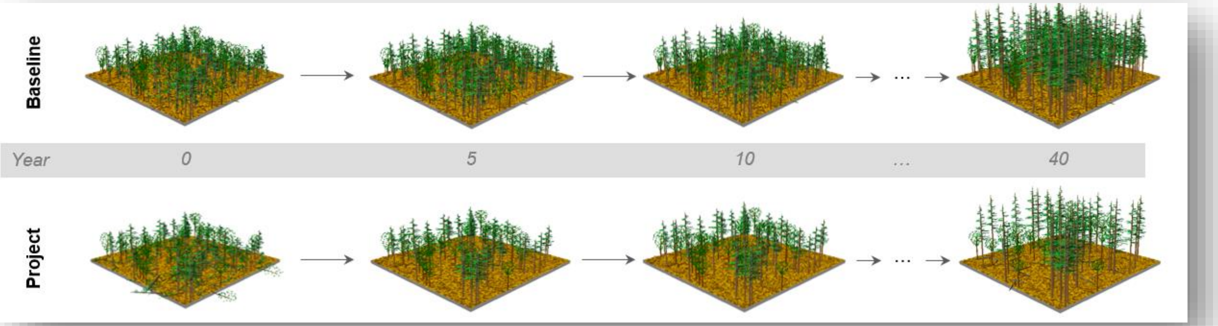
Region	Forest Type	Generalized Practice
Rocky Mountain North[g]	Ponderosa pine	Plant 400–500 trees per acre, precommercial thin to 200–300 trees per acre, commercial thin to 150–200 trees per acre at age 30–40; clearcut harvest at age 60–80
	Lodgepole pine	Site prepare to expose mineral soil seedbed, natural regeneration by seeding, precommercial thin to 200–400 trees per acre, patch clearcut harvest at age 80–100
Pacific Southwest[h]	Mixed conifer: ponderosa pine, sugar pine, Douglas fir, incense cedar, white fir, Jeffrey pine, and California black oak	Commercial thin: Starting at ages near 40 and continuing at various periodic cycles until regeneration; post-thinning stocking generally ranges between 150–250 ft^2; variable rotation length, depending on objectives
		Commercial thinning with both patch regeneration and reserved areas: Similar to above, but with higher levels of variation in post-thinning stocking levels, small patches of regeneration, primarily to increase pine species, and small areas reserved from harvest, maintaining larger/older trees providing relatively unique wildlife habitats; variable rotation length, depending on objectives
Pacific Northwest, East[i]	Douglas fir/Ponderosa pine – low intensity	Site preparation by site scarification in small spots, natural regeneration, precommercial thin at age 20–25 years to 100–250 trees per acre, patch clearcut or seed-tree harvest at age 50–70
	Douglas fir/Ponderosa pine – medium intensity (on more productive sites)	Mechanical site preparation to scarify soil and remove competing vegetation, plant with improved seedlings at approx. 400–500 per acre, precommercial thin at age 15–20, commercial thin at age 30–40, patch clearcut or seed-tree harvest at age 50–70
Pacific Northwest, West[j]	Douglas fir	Site prepare stand with pre-emergent herbicides, plant with improved seedlings at approx. 450 per acre, commercial thinning as needed at age 20–30, fertilize as needed at age 30–40, clearcut harvest at age 40–50

4) Forest carbon (forest growth and sequestration) calculation

CLIMATE FORWARD

- Standardized input from Climate Forward:
  - Tree inventory
  - (Stand data)
- Approach:
  - FVS parametrization using verifiable sources
  - FVS simulation runs (year 0 to 40 in 5-year timesteps):
    - Baseline, no wildfire
    - Project, no wildfire

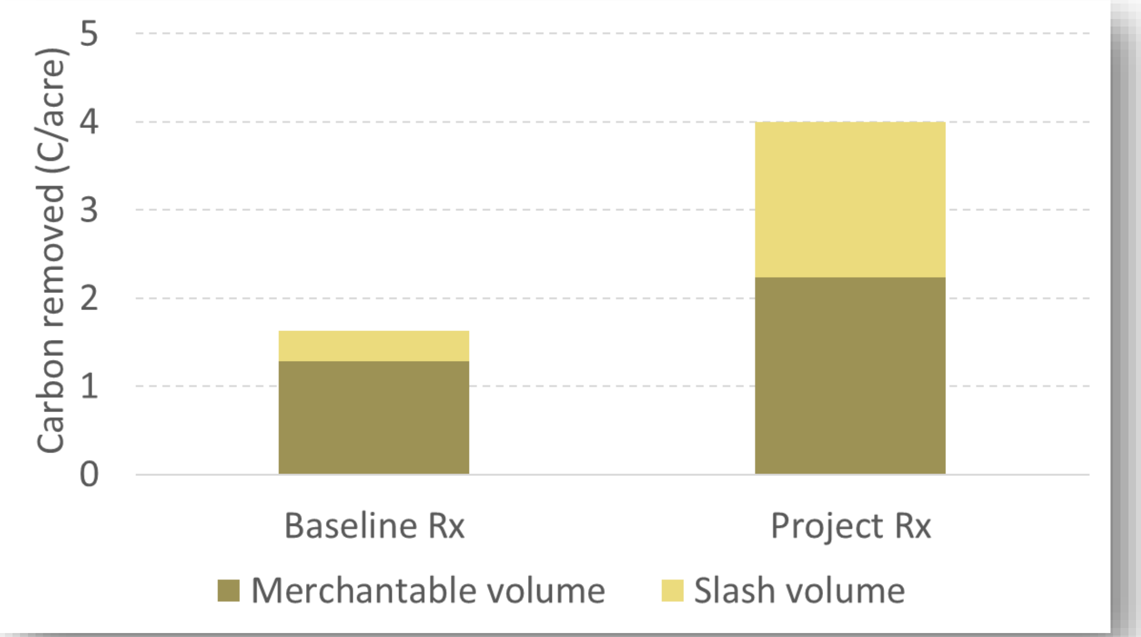
Example: TreeMap USDA



5) Forest removals life cycle assessment (wood products) calculation

CLIMATE FORWARD

- Standardized input from Climate Forward:
  - Tree inventory
  - (Stand data)
- Approach:
  - FVS simulation runs from Step 4
  - Assumptions on:
    - Harvest and transport emissions; e.g. Hennigar 2013 (Forgate); 0.4 odt metric/m3
  - No consideration of bioenergy or wood product substitution effects



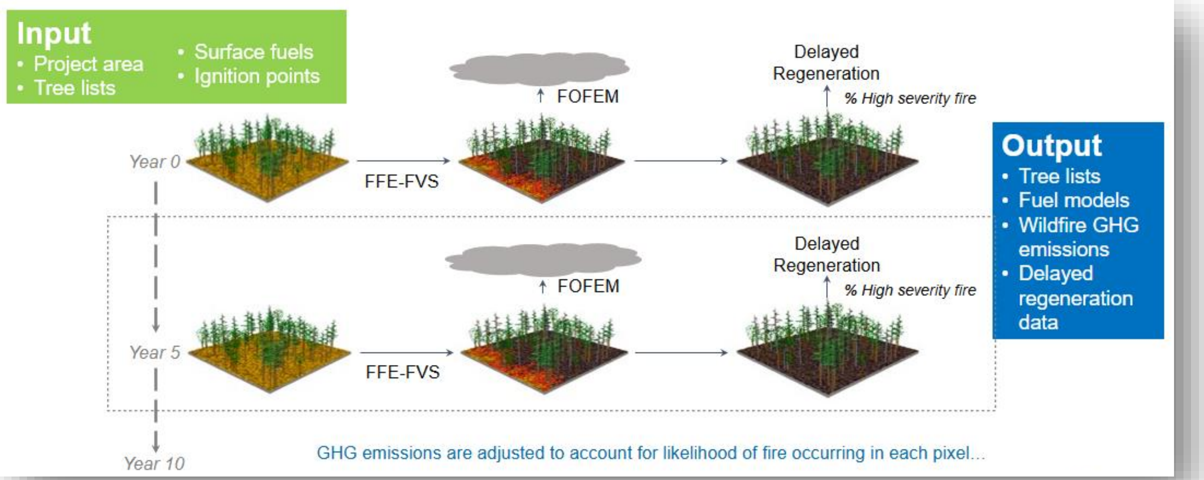
6) Wildfire emissions calculation – Direct emissions

CLIMATE FORWARD

- Standardized input from Climate Forward:
  - Surface fuel models
- Approach:
  - FVS-FFE simulation runs (year 0 to 40 in 5-year timesteps):
    - Baseline with periodic wildfire (0, 5, …, 40)
    - Project with periodic wildfire (0, 5, …, 40)
  - Crosswalk FVS-FFE into FOFEM for non-CO_2 GHG emissions

Table 6.2 Non-CO_2 GHG emissions GWPs for conversion to CO_2e

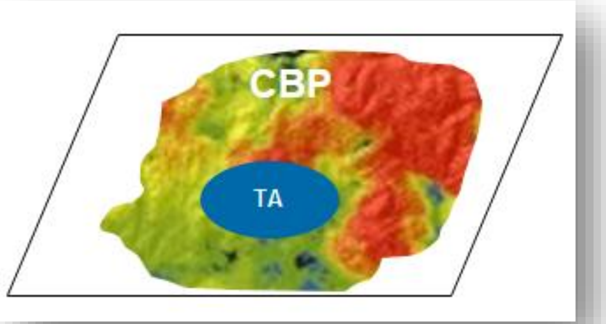
GHG	GWP Factor[11]
CH_4	25
NOx	-8.2
CO	1.0
PM2.5	9
NMOC	5

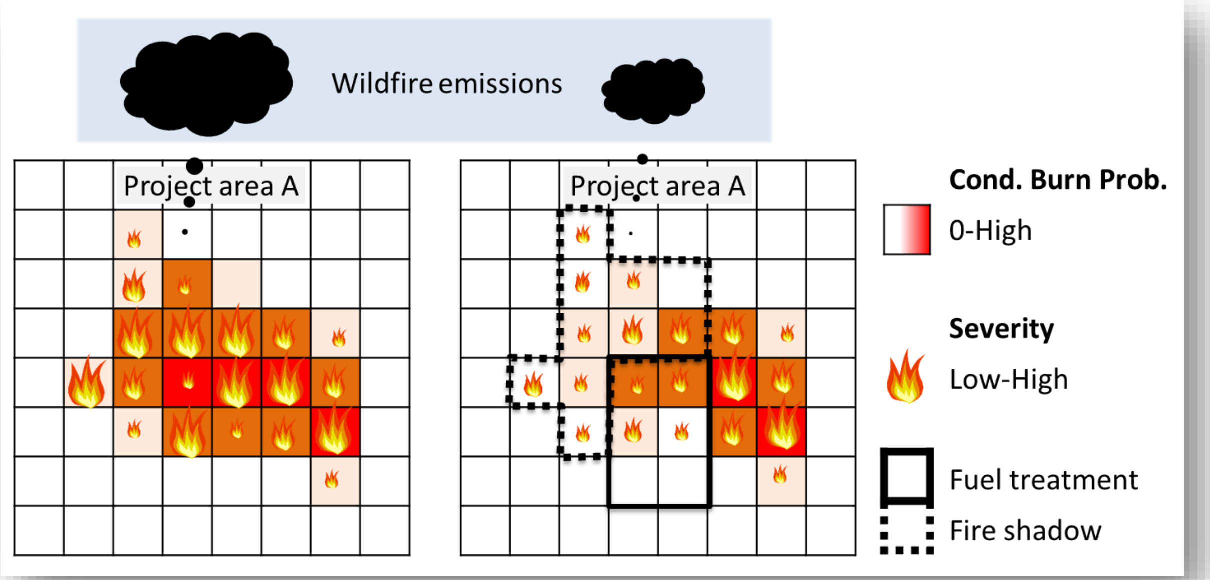


6) Wildfire emissions calculation – Indirect emissions

CLIMATE FORWARD

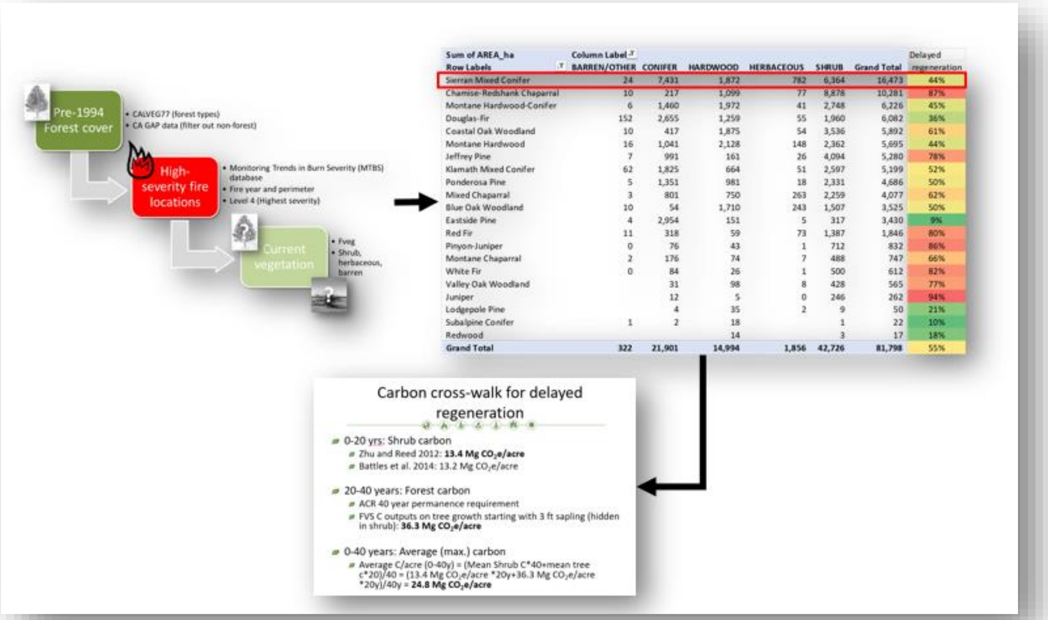
- Standardized input from Climate Forward:
  - N/A
- Approach:
  - Fire spread model with 8-hr runs
  - Determine Conditional Burn Probability (CBP) for each stand in Baseline and Project
  - Where CBP_P/CBP_{BSL} ratio <1, multiply wildfire emissions for that stand with CBP delta (CBP_{BSL}-CBP_P)





7) Delayed regeneration calculation

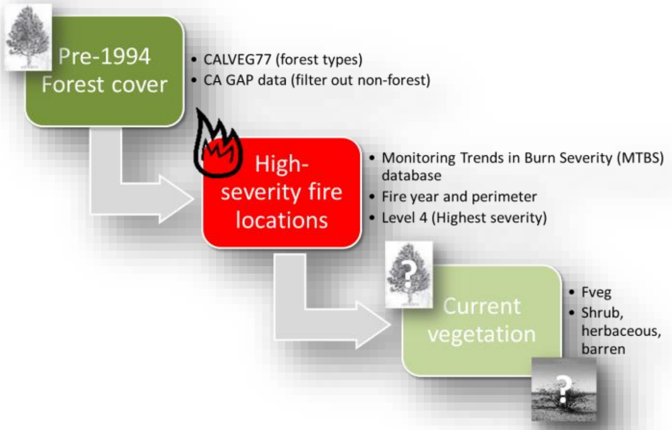
- Standardized input from Climate Forward:
  - Percentage of acreage affected by delayed regeneration by forest type and ecoregion (P_{DR})
  - Carbon crosswalk for forgone sequestration (C_{DR})
- Approach:
  - Calculate area that burnt with flame length >4' for each:
    - Baseline and project
    - Time step
    - Forest type
  - Multiply delta (acreage BSL minus Project) with P_{DR} and C_{DR}



Sum of AREA_ha / Row Labels	Column Label: BARREN/OTHER	CONIFER	HARDWOOD	HERBACEOUS	SHRUB	Grand Total	Delayed regeneration
Sierran Mixed Conifer	24	7,431	1,872	782	6,364	16,473	44%
Chamise-Redshank Chaparral	10	217	1,099	77	8,878	10,281	87%
Montane Hardwood-Conifer	6	1,460	1,972	41	2,748	6,226	45%
Douglas-Fir	152	2,655	1,259	55	1,960	6,082	36%
Coastal Oak Woodland	10	417	1,875	54	3,536	5,892	61%
Montane Hardwood	16	1,041	2,128	148	2,362	5,695	44%
Jeffrey Pine	7	991	161	26	4,094	5,280	78%
Klamath Mixed Conifer	62	1,825	664	51	2,597	5,199	52%
Ponderosa Pine	5	1,351	981	18	2,331	4,686	50%
Mixed Chaparral	3	801	750	263	2,259	4,077	62%
Blue Oak Woodland	10	54	1,710	243	1,507	3,525	50%
Eastside Pine	4	2,954	151	5	317	3,430	9%
Red Fir	11	318	59	73	1,387	1,846	80%
Pinyon-Juniper	0	76	43	1	712	832	86%
Montane Chaparral	2	176	74	7	488	747	66%
White Fir	0	84	26	1	500	612	82%
Valley Oak Woodland		31	98	8	428	565	77%
Juniper		12	5	0	246	262	94%
Lodgepole Pine		4	35	2	9	50	21%
Subalpine Conifer	1	2	18		1	22	10%
Redwood			14		3	17	18%
Grand Total	322	21,901	14,994	1,856	42,726	81,798	55%

7) Delayed regeneration calculation

CLIMATE FORWARD



Sum of AREA_ha / Row Labels	Column Label: BARREN/OTHER	CONIFER	HARDWOOD	HERBACEOUS	SHRUB	Grand Total	Delayed regeneration
Sierran Mixed Conifer	24	7,431	1,872	782	6,364	16,473	44%
Chamise-Redshank Chaparral	10	217	1,099	77	8,878	10,281	87%
Montane Hardwood-Conifer	6	1,460	1,972	41	2,748	6,226	45%
Douglas-Fir	152	2,655	1,259	55	1,960	6,082	36%
Coastal Oak Woodland	10	417	1,875	54	3,536	5,892	61%
Montane Hardwood	16	1,041	2,128	148	2,362	5,695	44%
Jeffrey Pine	7	991	161	26	4,094	5,280	78%
Klamath Mixed Conifer	62	1,825	664	51	2,597	5,199	52%
Ponderosa Pine	5	1,351	981	18	2,331	4,686	50%
Mixed Chaparral	3	801	750	263	2,259	4,077	62%
Blue Oak Woodland	10	54	1,710	243	1,507	3,525	50%
Eastside Pine	4	2,954	151	5	317	3,430	9%
Red Fir	11	318	59	73	1,387	1,846	80%
Pinyon-Juniper	0	76	43	1	712	832	86%
Montane Chaparral	2	176	74	7	488	747	66%
White Fir	0	84	26	1	500	612	82%
Valley Oak Woodland		31	98	8	428	565	77%
Juniper		12	5	0	246	262	94%
Lodgepole Pine		4	35	2	9	50	21%
Subalpine Conifer	1	2	18		1	22	10%
Redwood			14		3	17	18%
Grand Total	**322**	**21,901**	**14,994**	**1,856**	**42,726**	**81,798**	55%

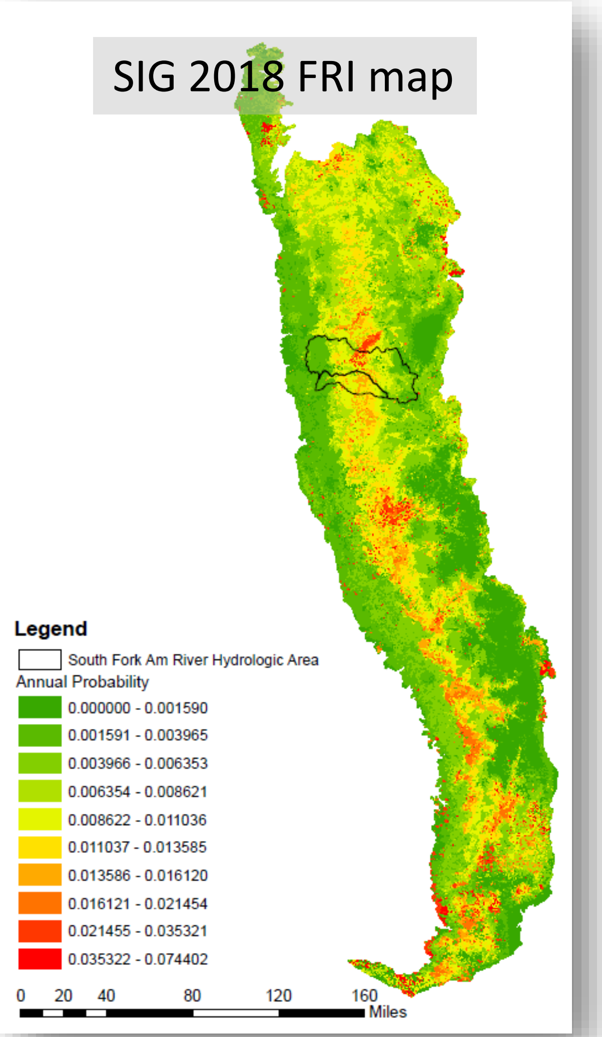
Carbon cross-walk for delayed regeneration

- 0-20 yrs: Shrub carbon
  - Zhu and Reed 2012: **13.4 Mg CO_2e/acre**
  - Battles et al. 2014: 13.2 Mg CO_2e/acre
- 20-40 years: Forest carbon
  - ACR 40 year permanence requirement
  - FVS C outputs on tree growth starting with 3 ft sapling (hidden in shrub): **36.3 Mg CO_2e/acre**
- 0-40 years: Average (max.) carbon
  - Average C/acre (0-40y) = (Mean Shrub C*40+mean tree c*20)/40 = (13.4 Mg CO_2e/acre *20y+36.3 Mg CO_2e/acre *20y)/40y = **24.8 Mg CO_2e/acre**

8) Fire ignition probability (fire return interval) assessment

CLIMATE FORWARD

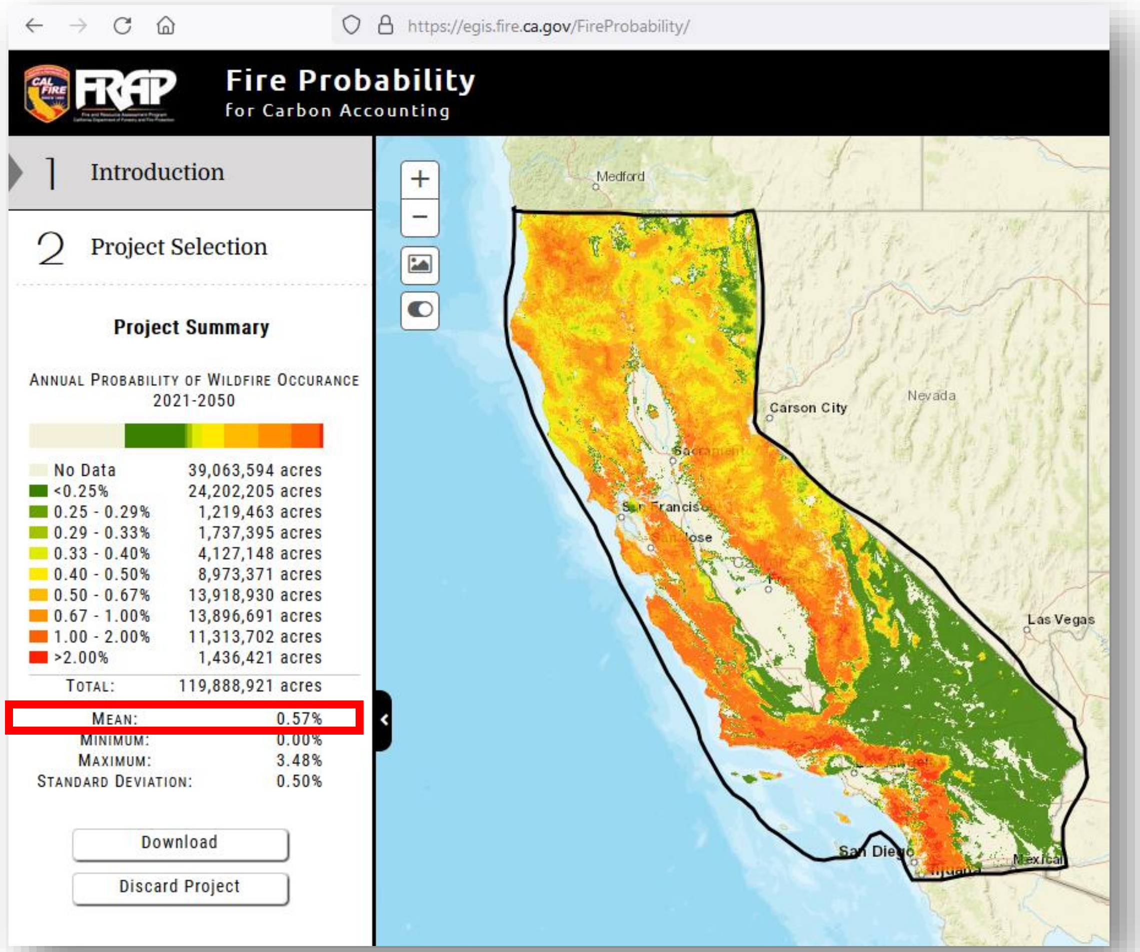
- Standardized input from Climate Forward:
  - Fire probability map
    - CAL FIRE; USFS (**relative** fire probability)
    - Updated by most recent 10y fire probability (**absolute** fire probability)
- Approach:
  - Retrieve mean fire probability for project area



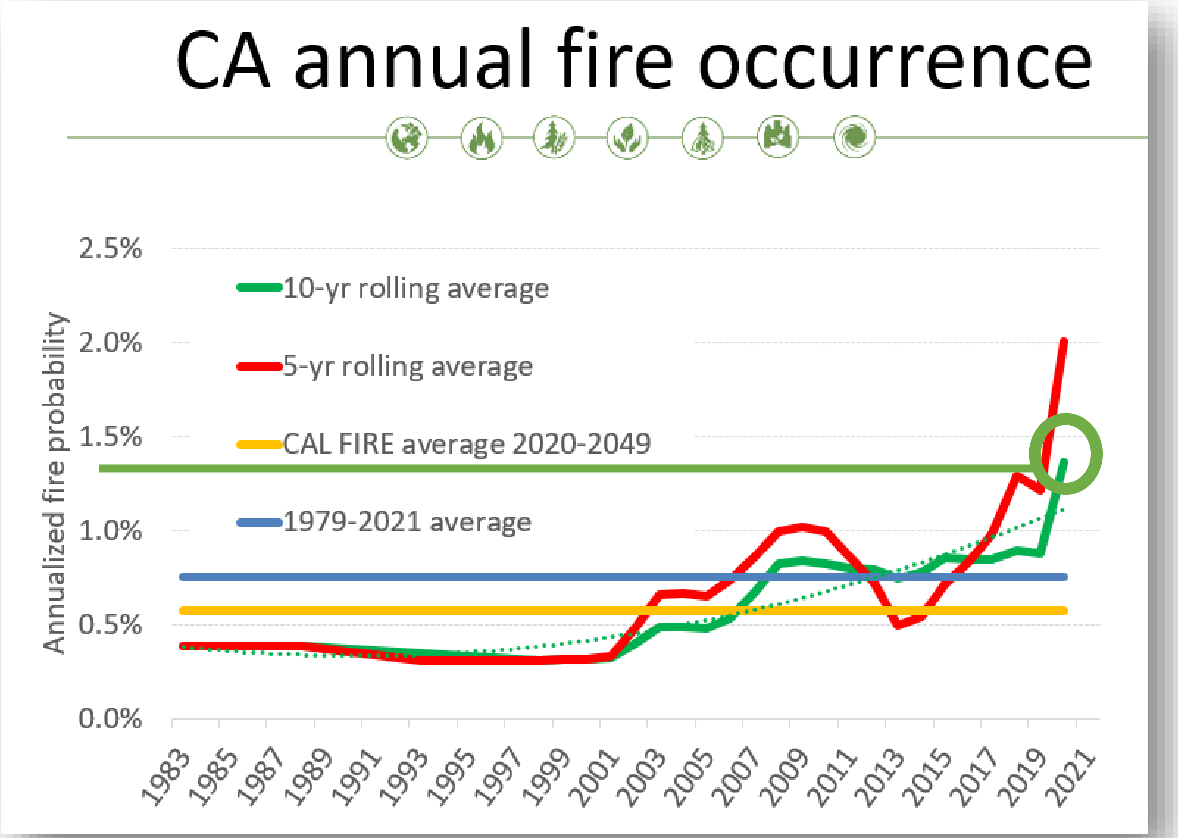
8) Fire ignition probability (fire return interval) assessment

CLIMATE FORWARD

Example: Relative fire probability



Example: Calibration factor to generate absolute fire probability



CLIMATE FORWARD

9) Aggregated emissions accounting

- Standardized input from Climate Forward:
  - Accounting template (Excel)
- Approach:
  - Insert outputs from Steps 4-8:
    - Forest carbon stocks (BSL and Project)
    - CO_2 wildfire emissions (BSL and Project)
    - Non-CO_2 wildfire emissions (BSL and Project; in CO_2e)
    - Wood products (Net)
    - Delayed regeneration (BSL and Project)
    - Fire probability

GHG offset protocol: Avoided emissions from significant wildfires

Calculation template v 8/15/2016

Example: Eldorado case study (2015-2018 QUEBROW project)

	MT CO_2e/acre fire shed								
Parameter	Time (yrs)								
	0	5	10	15	20	25	30	35	40
Baseline									
Forest stock and growth	(318.7)	(338.8)	(354.2)	(374.4)	(389.7)	(408.3)	(423.2)	(440.4)	(453.8)
Constant (annual) probability of fire		1.66%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%
Periodic (5-year) probability of fire		8.3%	8.3%	8.3%	8.3%	8.3%	8.3%	8.3%	8.3%
Wildfire		39.7	42.2	42.7	45.6	47.1	49.0	49.9	53.5
Non-CO2 GHGs		33.6	34.6	35.5	36.6	37.5	38.5	39.5	40.8
Weighted 5 year interval		6.1	6.4	6.5	6.8	7.0	7.3	7.4	7.8
Weighted cumulative		6.1	12.5	18.9	25.8	32.8	40.1	47.5	55.3
Total cumulative	(318.7)	(332.7)	(341.7)	(355.4)	(363.9)	(375.5)	(383.2)	(392.9)	(398.5)
(Fuel treatment) Project									
Forest stock and growth	(318.7)	(322.6)	(333.3)	(349.1)	(359.0)	(375.1)	(387.5)	(402.0)	(415.4)
Wildfire		20.8	21.9	23.7	25.2	25.5	26.6	26.8	28.4
Non-CO2 GHGs		28.7	29.1	28.9	29.1	29.7	30.2	30.5	32.3
Weighted 5 yr interval		4.1	4.2	4.4	4.5	4.6	4.7	4.8	5.0
Weighted cumulative		4.1	8.3	12.7	17.2	21.8	26.5	31.3	36.3
Net slash removed (zero for Climate Forward)		2.96				0.54			
Net slash diverted to bioenergy LCA		(1.1)	(1.1)	(1.1)	(1.1)	(1.3)	(1.3)	(1.3)	(1.3)
Net merchantable removed		2.55				0.22			
Wood products produced		(1.72)	-	-	-	(0.15)	-	-	-
Wood products in use or landfill (%)		43%	43%	43%	43%	43%	43%	43%	43%
Harv. & trsp. incl. presc. burn emissions		0.1	-	-	-	0.0	-	-	-
Wood products LCA		(1.0)	(1.0)	(1.0)	(1.0)	(1.1)	(1.1)	(1.1)	(1.1)
Net mill waste fate		(0.8)	-	-	-	(0.1)	-	-	-
Mill waste bioenergy LCA (zero for Climate Forward)		(0.2)	(0.2)	(0.2)	(0.2)	(0.3)	(0.3)	(0.3)	(0.3)
Mill waste fate non-bioenergy in-use (%)	100%	40%	10%	5%	0%	0%	0%	0%	0%
Mill wastefate non-bioenergy LCA		(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)
Net wood product substitution LCA		(1.8)	(1.8)	(1.8)	(1.8)	(2.0)	(2.0)	(2.0)	(2.0)
Avoided vegetation type conversion									
Vegetation type conversion baseline (%)		29%	32%	32%	34%	33%	35%	34%	36%
Vegetation type conversion project (%)		20%	25%	25%	27%	23%	30%	27%	27%
Weighted 5 yr interval LCA		(2.5)	(2.6)	(2.5)	(2.8)	(3.8)	(2.7)	(3.3)	(4.0)
Cumulative LCA		(2.5)	(5.1)	(7.6)	(10.3)	(14.1)	(16.8)	(20.1)	(24.1)
Total cumulative (pre risk deduction)	(318.7)	(325.2)	(334.3)	(348.2)	(356.4)	(372.2)	(382.5)	(395.6)	(408.0)
Net cumulative (pre risk deduction)	-	7.5	7.4	7.2	7.5	3.3	0.7	(2.7)	(9.5)
Net periodic (pre risk deduction)	-	7.52	(0.07)	(0.27)	0.37	(4.22)	(2.64)	(3.36)	(6.81)

GHG offset protocol: Avoided emissions from significant wildfires

Calculation template v 8/15/2016

Example: Eldorado case study (2015-2018 QUEBROW project)

CLIMATE FORWARD

Parameter	MT CO_2e/acre fire shed — Time (yrs) 0	5	10	15	20	25	30	35	40
Baseline									
Forest stock and growth	(318.7)	(338.8)	(354.2)	(374.4)	(389.7)	(408.3)	(423.2)	(440.4)	(453.8)
Constant (annual) probability of fire		1.66%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%	1.7%
Periodic (5-year) probability of fire		8.3%	8.3%	8.3%	8.3%	8.3%	8.3%	8.3%	8.3%
Wildfire		39.7	42.2	42.7	45.6	47.1	49.0	49.9	53.5
Non-CO2 GHGs		33.6	34.6	35.5	36.6	37.5	38.5	39.5	40.8
Weighted 5 year interval		6.1	6.4	6.5	6.8	7.0	7.3	7.4	7.8
Weighted cumulative		6.1	12.5	18.9	25.8	32.8	40.1	47.5	55.3
Total cumulative	(318.7)	(332.7)	(341.7)	(355.4)	(363.9)	(375.5)	(383.2)	(392.9)	(398.5)
(Fuel treatment) Project									
Forest stock and growth	(318.7)	(322.6)	(333.3)	(349.1)	(359.0)	(375.1)	(387.5)	(402.0)	(415.4)
Wildfire		20.8	21.9	23.7	25.2	25.5	26.6	26.8	28.4
Non-CO2 GHGs		28.7	29.1	28.9	29.1	29.7	30.2	30.5	32.3
Weighted 5 yr interval		4.1	4.2	4.4	4.5	4.6	4.7	4.8	5.0
Weighted cumulative		4.1	8.3	12.7	17.2	21.8	26.5	31.3	36.3
Net slash removed (zero for Climate Forward)		2.96				0.54			
Net slash diverted to bioenergy LCA		(1.1)	(1.1)	(1.1)	(1.1)	(1.3)	(1.3)	(1.3)	(1.3)
Net merchantable removed		2.55				0.22			
Wood products produced		(1.72)	-	-	-	(0.15)	-	-	-
Wood products in use or landfill (%)		43%	43%	43%	43%	43%	43%	43%	43%
Harv. & trsp. incl. presc. burn emissions		0.1	-	-	-	0.0	-	-	-
Wood products LCA		(1.0)	(1.0)	(1.0)	(1.0)	(1.1)	(1.1)	(1.1)	(1.1)
Net mill waste fate		(0.8)	-	-	-	(0.1)	-	-	-
Mill waste bioenergy LCA (zero for Climate Forward)		(0.2)	(0.2)	(0.2)	(0.2)	(0.3)	(0.3)	(0.3)	(0.3)
Mill waste fate non-bioenergy in-use (%)	100%	40%	10%	5%	0%	0%	0%	0%	0%
Mill wastefate non-bioenergy LCA		(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)	(0.1)
Net wood product substitution LCA		(1.8)	(1.8)	(1.8)	(1.8)	(2.0)	(2.0)	(2.0)	(2.0)
Delayed regeneration									
Delayed regeneration baseline (%)		29%	32%	32%	34%	33%	35%	34%	36%
Delayed regeneration project (%)		20%	25%	25%	27%	23%	30%	27%	27%
Weighted 5 yr interval LCA		(2.5)	(2.6)	(2.5)	(2.8)	(3.8)	(2.7)	(3.3)	(4.0)
Cumulative LCA		(2.5)	(5.1)	(7.6)	(10.3)	(14.1)	(16.8)	(20.1)	(24.1)
Total cumulative (pre risk deduction)	(318.7)	(325.2)	(334.3)	(348.2)	(356.4)	(372.2)	(382.5)	(395.6)	(408.0)
Net cumulative (pre risk deduction)	-	7.5	7.4	7.2	7.5	3.3	0.7	(2.7)	(9.5)
Net periodic (pre risk deduction)	-	7.52	(0.07)	(0.27)	0.37	(4.22)	(2.64)	(3.36)	(6.81)

Large delta BSL vs. Project

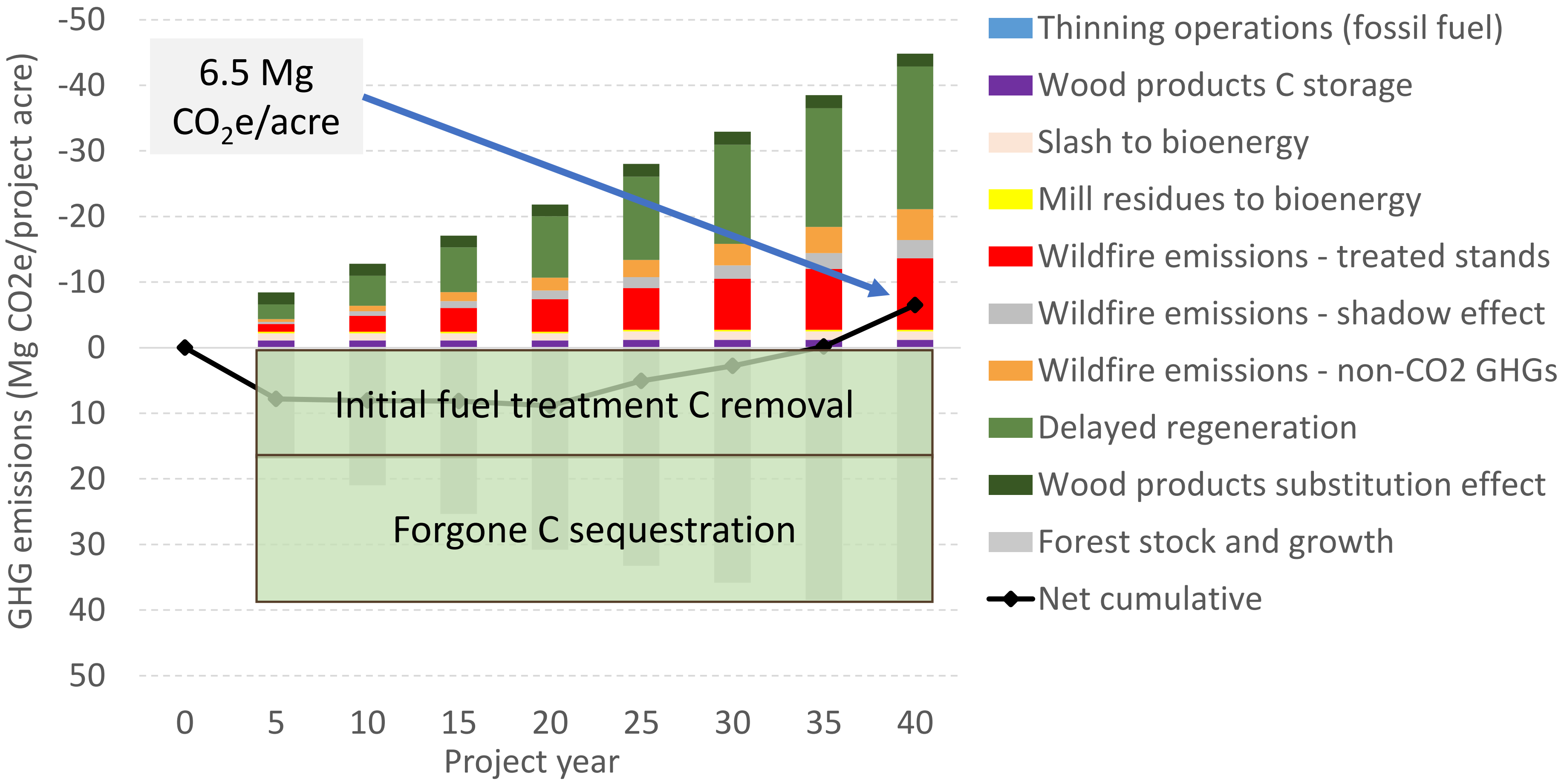
Limited additional timber production

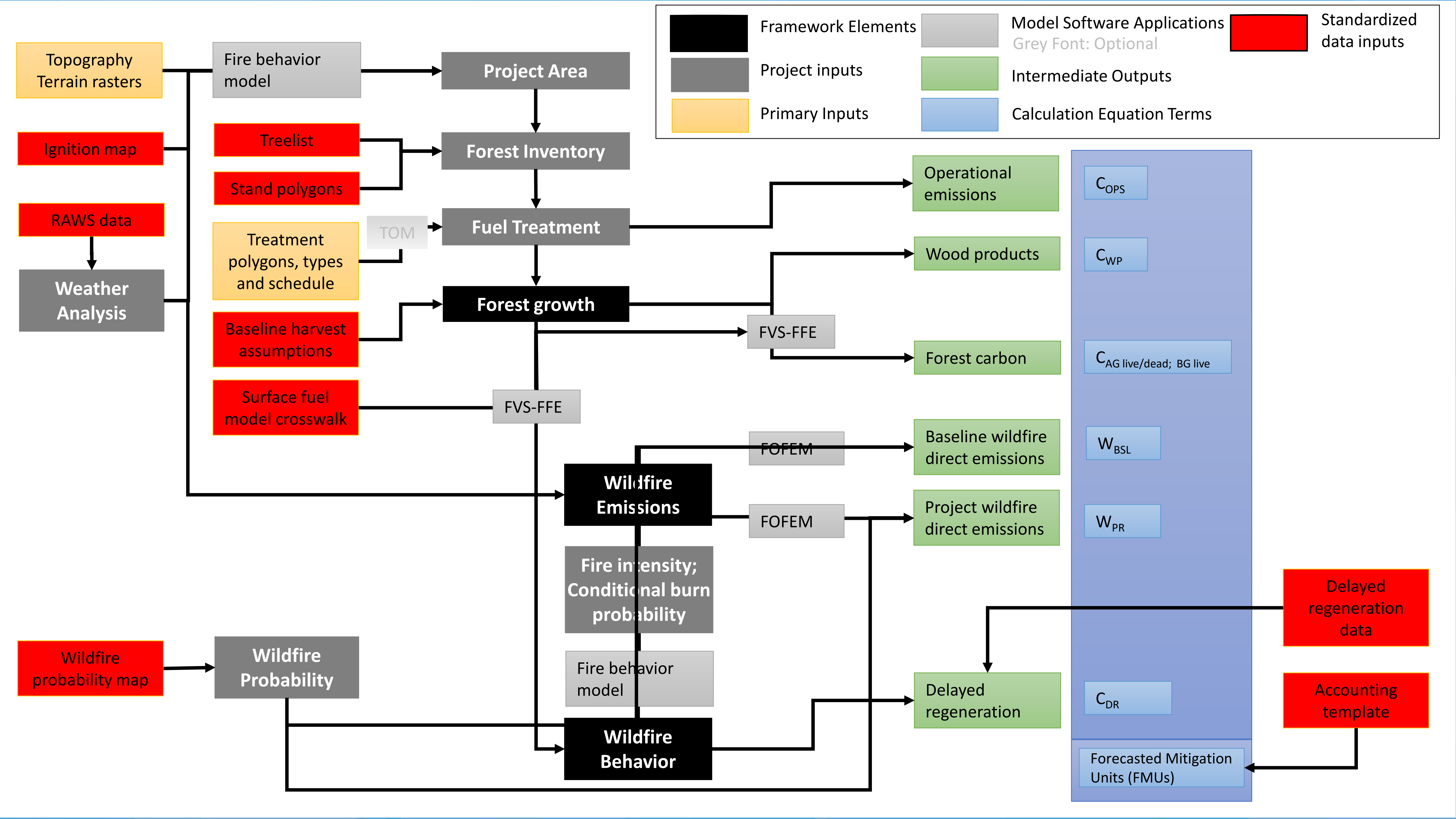
Large delta BSL vs. Project

Net GHG benefits over time

Eldorado case study: Accumulated C fluxes

CLIMATE FORWARD



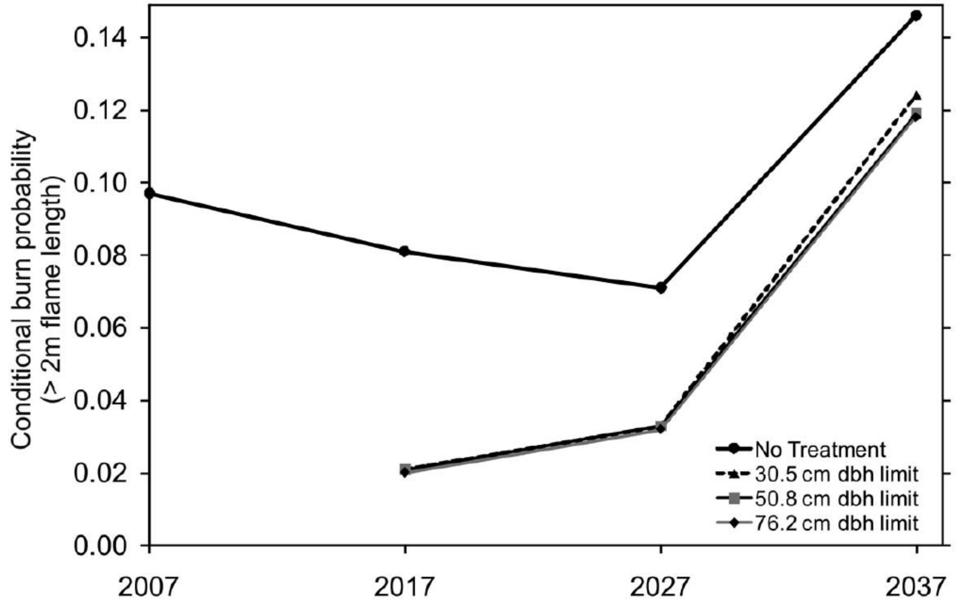


Framework Elements
Project inputs
Primary Inputs
Model Software Applications
Grey Font: Optional
Intermediate Outputs
Calculation Equation Terms
Standardized data inputs
Topography Terrain rasters
Fire behavior model
Project Area
Ignition map
Treelist
Stand polygons
Forest Inventory
RAWS data
TOM
Fuel Treatment
Treatment polygons, types and schedule
Weather Analysis
Forest growth
Baseline harvest assumptions
FVS-FFE
Surface fuel model crosswalk
FVS-FFE
Operational emissions
Wood products
Forest carbon
Baseline wildfire direct emissions
Project wildfire direct emissions
Delayed regeneration
FOFEM
FOFEM
Wildfire Emissions
Fire intensity; Conditional burn probability
Fire behavior model
Wildfire Behavior
Wildfire probability map
Wildfire Probability
C_{OPS}
C_{WP}
$C_{AG\ live/dead;\ BG\ live}$
W_{BSL}
W_{PR}
C_{DR}
Forecasted Mitigation Units (FMUs)
Delayed regeneration data
Accounting template

6.8 Performance Decline

CLIMATE FORWARD

Fuel treatments have limited efficacy periods—accounted for in project modeling



10% programmatic ex ante risk discount is applied to all projects to address:

- Goal of crediting on conservative basis
- Uncertainty associated with estimating future climate benefits from treatments today
- Uncertainty associated with probabilistic occurrence of future wildfires

Section 7 / Section 9

Monitoring / Confirmation

Photo Plots

CLIMATE FORWARD

Photo plots must show that data being used by the models are representative of actual conditions on the project site

Plot attribute	Project proponent	Confirmation body
Location	Georeferenced datapoints; plots stratified by treatment type	Confirm location, statistics
# of plots	Based on treatment size	Confirm plot number in accordance with procedures
Imaging	360 degree fisheye **pre-** and **post-**treatment	Confirm image match
Image interpretation	• Dominant overstory and understory vegetation specie(s) • Fire behavior fuel model choice • Canopy base height estimate • Canopy height estimate • Overstory closure estimate	Confirm choice (random selection of 20% of plots; 90% match for each metric)

7.1 Monitoring / 9.4 Confirmation

Plot attribute	Project proponent	Confirmation body
Vegetation	Species (overstory and understory)	Review random selection of 20% of plots ≥90% match for each metric
Fire behavior fuel model	Selection from Scott and Burgan (GTR-153)	
Canopy base height	In feet, to nearest 5’	
Canopy height	In feet, to nearest 10’	
Overstory canopy closure	Assign to closure class (0-25%, 25-50%, 50-75%, 75-100%)*	

* Can also use remote sensing-based assessment, with confirmation body estimate within 10% of project proponent estimate

If 90% match not achieved:

- Perform on-the-ground adjustments to the treatment area(s)
- Adjust data inputs for modeling to reflect pre-treatment conditions
- Adjust data inputs for modeling inputs to reflect post-treatment conditions

Next Steps

Focal Areas for Feedback

- Crediting period length
- Enhancement payments and additionality
- Weather data
- Baseline harvest scenarios
- Model parameterization and assumptions
  - Standardized vs. site-specific
  - Are standardized parameters and assumptions conservative and/or reasonable?
- Fuel model assignments
- Regeneration models
- Programmatic discount
- Tolerances for confirmation of photo plots

Logistics

CLIMATE FORWARD

- Next meeting TBD (within the next three weeks)
- Focus will be in-depth discussion of specific non-quantification topics identified by drafting group, plus any additional topics raised by workgroup members or remaining from today's meeting
- After third workgroup meeting, submit comments/feedback within two weeks
- Reach out any time to discuss methodology topics or process
- Reserve staff and drafting group will determine if additional workgroup meetings are desired, otherwise will produce draft for public comment

Questions or Comments?

Contact Information

Jon Remucal
Associate Director of Nature-Based Solutions
(213) 542-0280
jremucal@climateactionreserve.org