CLIMATE FORWARD

Avoided Wildfire Emissions Forecast Methodology Version 1.0

Public Comment Webinar

July 7, 2022

A program of the CLIMATE ACTION RESERVE

Housekeeping

CLIMATE FORWARD

- All attendees are in listen-only mode
- Questions may be submitted via the Q&A dialog
- Zoom technical issues addressed via chat dialog
- 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

Introduction to Climate Action Reserve, Climate Forward, and methodology development team

Overview of methodology

Next Steps

Q & A

Climate Action Reserve

CLIMATE FORWARD

Regulatory-quality standard setting and credit generation

Publicly accessible web-based system

Comprehensive protocol development process

Working to ensure integrity, transparency, and financial value in the North American carbon market

CLIMATE FORWARD

Climate Forward accelerates action on climate change by encouraging investment in projects that mitigate future greenhouse gas emissions

A program of the CLIMATE ACTION RESERVE

Climate Forward:
a carbon project registry

CLIMATE FORWARD

Issues Forecasted Mitigation Units (FMUs) to projects that follow Reserve-approved methodologies

- Follows ISO 14064-2 and GHG Protocol for Project Accounting Standards
- Credits typically issued about one year after project implementation, for the forecasted climate benefit over the project’s lifetime
- No long-term, ongoing monitoring, reporting and verification requirements

Expands the scope and scale of carbon project types

- Enormous potential for diverse, creative climate solutions

Tracks FMUs ownership and project activities in a publicly accessible database

- A registry of forward-looking GHG reductions to balance against forward-looking GHG impacts

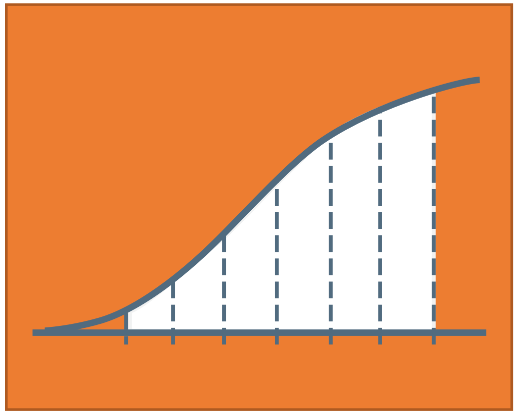
Accelerating Climate Mitigation: CLIMATE FORWARD

CLIMATE FORWARD

Offsets

Climate Reserve Tonnes

1 CRT = 1 tCO_2e of achieved reductions



Issued for achieved GHG reductions

Used to mitigate any emissions

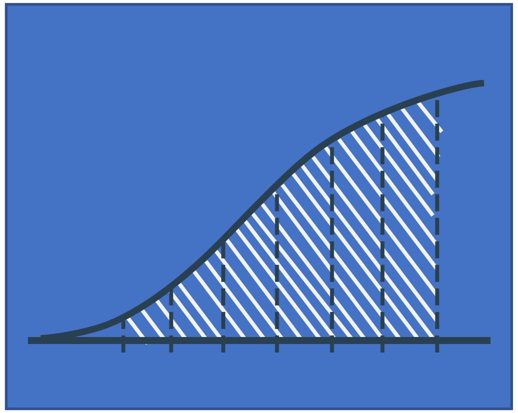
Protocols available for projects in North America

Reserve develops protocols for the offsets it issues

FMUs

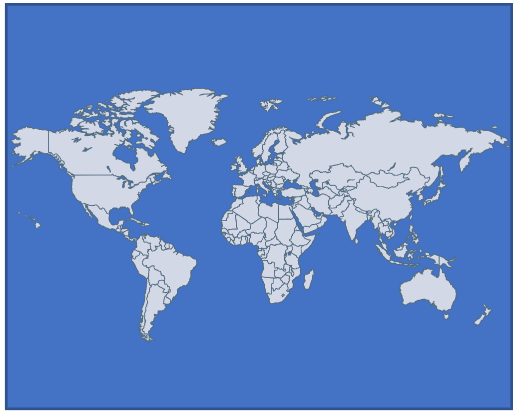
Forecasted Mitigation Units

1 FMU = 1 tCO_2e of anticipated reductions

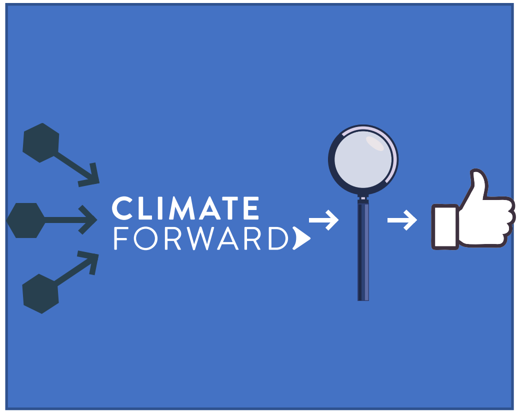


Issued for **forecasted** GHG reductions

Used to mitigate anticipated emissions



Projects may be located anywhere in the world



External parties may submit forecast methodologies

tCO_2e = tonne of carbon dioxide equivalent

Introductions

CLIMATE ACTION RESERVE

Spatial Informatics Group

Dogwood Springs Forestry

Coalition for the Upper South Platte

Carbonomics®

Methodology Development Process

CLIMATE FORWARD

1. Methodology drafting (ongoing)
2. Kick-off meeting (Oct '21)
3. Work-group formation (end of '21)
4. Work-group process, (3 meetings in early '22)
5. Public comment (30-day)
6. Final revisions and consideration for methodology approval

Methodology overview → Quantification approach → Eligibility, monitoring and confirmation

Workgroup Members (Organizations)

CLIMATE FORWARD

Blue Forest Conservation	Sierra Nevada Conservancy
California Department of Forestry and Fire Protection	Sierra Pacific Industries
Colorado State Forest Service	The Nature Conservancy
FRST	TSS Consultants
Firewise Landscapes Inc / Frontline Wildfire Defense	US Forest Service
HQPlantations Pty Ltd	University of California, Berkeley
Placer County Air Pollution Control District	University of New Mexico
Renew West	

Funding support

CALIFORNIA DEPARTMENT OF FORESTRY & FIRE PROTECTION
CAL FIRE
SINCE 1885

Coalition for the UPPER SOUTH PLATTE

element MARKETS

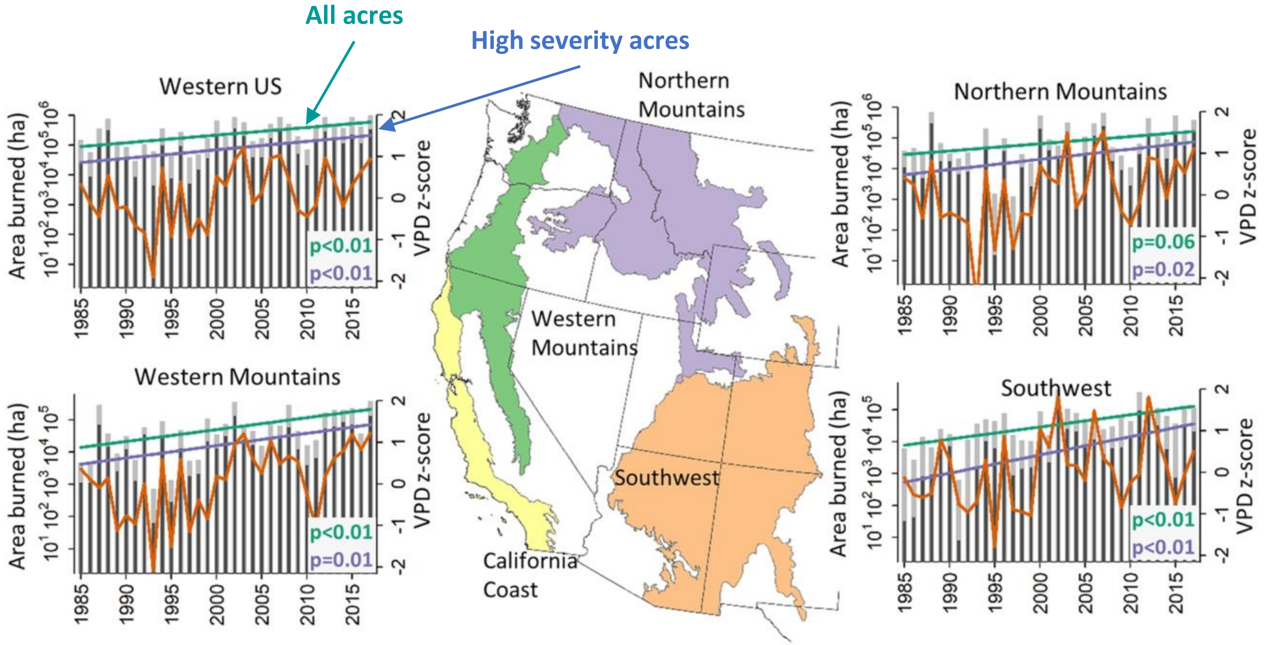
COCO

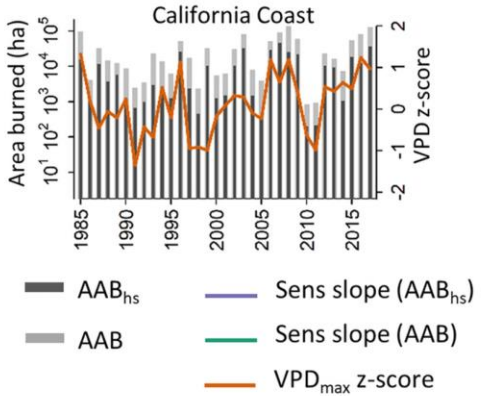
Shoulders we're standing on…

Why address wildfire emissions?

CLIMATE FORWARD

Loyalton Fire, Calpine, CA, August 2020 By Duncan Kennedy:





Correlation (Pearson's r) between AAB_{hs} and AAB and the three climate variables ($p \leq 0.01$ for all relationships; Table S3). Arrows indicate that the climate variable has experienced a statistically significant increase from 1985-2017 (Table S5).

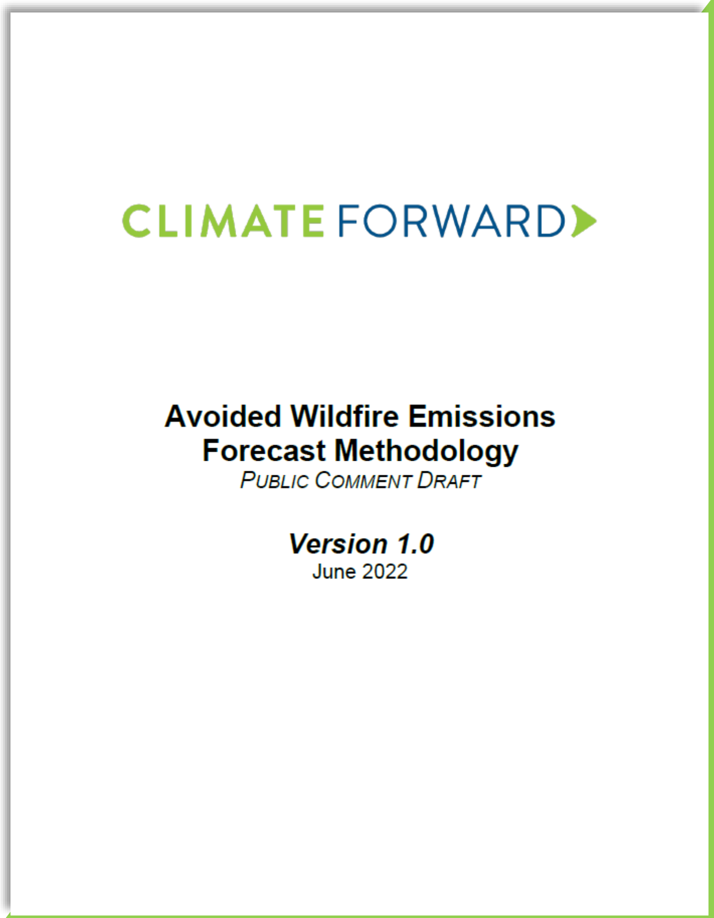
	AAB_{hs}			AAB		
Ecoregion	VPD_{max}	T_{max}	CWD	VPD_{max}	T_{max}	CWD
California Coast	0.67 ↑	0.58	0.69	0.70	0.62	0.69
Western Mountains	0.74 ↑	0.70 ↑	0.71	0.73	0.67	0.70
Northern Mountains	0.90 ↑	0.89 ↑	0.88	0.89	0.90	0.86
Southwest	0.59	0.40	0.64 ↑	0.55	0.41	0.56
Western US	0.83 ↑	0.79 ↑	0.74	0.80	0.73	0.69

Parks, S. A., & Abatzoglou, J. T. (2020). Warmer and drier fire seasons contribute to increases in area burned at high severity in western US forests from 1985 to 2017. *Geophysical Research Letters*, *47*(22).

Methodology Overview

Methodology introduction

CLIMATE FORWARD


CLIMATE FORWARD

Avoided Wildfire Emissions Forecast Methodology

Public Comment Draft

Version 1.0

June 2022

Accounts for emissions reductions associated with **fuel treatment activities that modify the behavior of wildfires, reducing their severity and extent**

Establishes eligibility rules, methods to calculate expected GHG emissions reductions, and procedures for reporting project information to the Reserve

Provides guidance for **independent confirmation** by a Reserve-approved confirmation body selected by the project proponent

Methodology Components

CLIMATE FORWARD

Project Definition

Eligibility

- Project Location
- Start Date / Crediting period
- Additionality
  - Performance Standard Test
  - Legal Requirement Test
  - Enhancement Payments
- Environmental/Social Safeguards
- Regulatory compliance
- Ownership & Double-Counting

Project Area Definition

Defining GHG Boundary

Quantification

- Delineating the project area
- Quantifying project emissions reduction
- Programmatic risk deduction

Monitoring / Reporting / Confirmation

- Sampling
- Confirmation field visit

Section 2

The GHG Reduction Project

2.1 Project Definition

Activity or set of activities that result in reduced wildfire emissions from forestlands relative to business-as-usual

Fuel treatments

- Mastication
- Broadcast / prescribed / cultural burns
- Thinning (e.g., thinning from below, crown thinning, selection cut), resulting in:
  - Increased quadratic mean diameter
  - Minimum basal area of 50 ft^2
- Pruning
- Mechanical removal of surface fuels

2.2 Project Proponent

CLIMATE FORWARD

Who can be issued FMUs?

Project proponent:

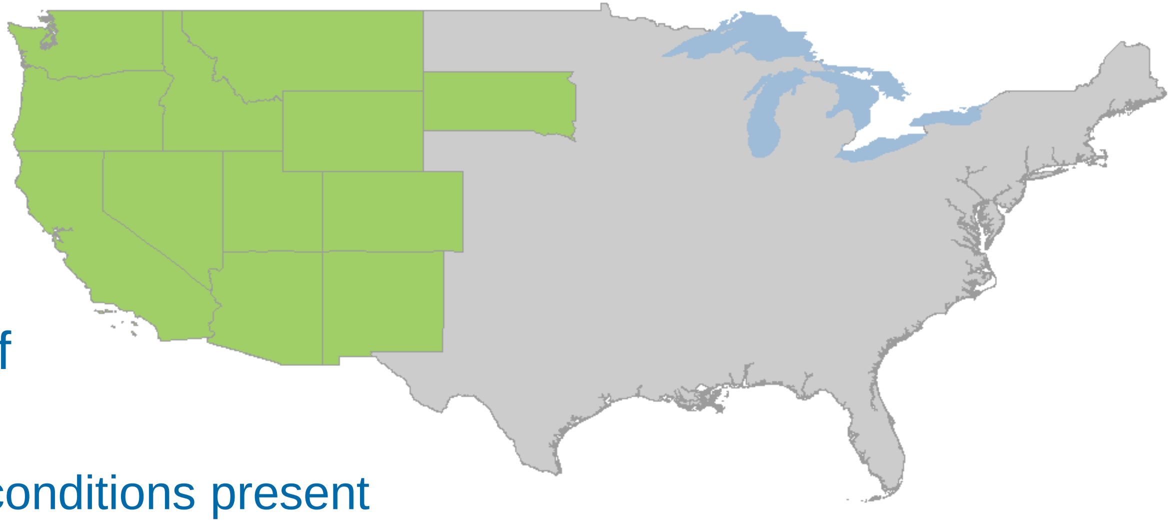
- Entity that:
  - Has a Climate Forward registry account
  - Submits the project to the registry
  - Is responsible for reporting and confirmation
- Generally is the entity responsible for:
  - Organizing
  - Planning
  - Implementing or overseeing the implementation
- Not required to be underlying landowner of treatment areas
  - Must have written agreements with landowners whose lands are being treated
- Can aggregate treatments across ownerships, including across ownership types

Section 3

Eligibility

3.1 Location

CLIMATE FORWARD



- Western U.S.
- Limited based on data availability
- Private or public lands
- May be on locations where prior AWE projects took place (subject to quantification of net climate benefits)
  - New AWE project on same location uses fuel conditions present at the time it is initiated, including as impacted by previous projects
  - Altered conditions from prior treatments (and other activities/disturbances within the project area) are part of the baseline for new projects
- May be on locations where other C projects exist (e.g., stacked with an IFM project), but need to seek Reserve approval and guidance to prevent double-counting

3.2 Start Date & Crediting Period

CLIMATE FORWARD

Project start date

- Date that fuel treatment activities are first initiated
- May be up to 12 months prior to release of final methodology

Project listing deadline

- Submitted for listing within 1 year of the project start date
- If start date is prior to release of the methodology, may be submitted up to 1 year after the methodology release date

Crediting period

- Length of time over which forecasted GHG reductions are recognized for crediting
- 40 years

3.3 Additionality

Projects must yield surplus GHG removals “additional” to what would have occurred in the absence of the project

Performance standard

- Given the generally low prevalence of fuel treatments and the financial challenges associated with them, project activities are additional to the extent they reduce GHG emissions below what would have occurred under the baseline.

Legal requirement test

- Project activities must not be legally required
- Project proponent signs Attestation of Legal Additionality

3.3 Additionality

CLIMATE FORWARD

Enhancement payment stacking

- Submitting a project based on a practice that is also funded by the government or other parties via grants, subsidies, payments, etc., on the same land.
  - Examples: California Climate Investment funds, Natural Resources Conservation Service grants
  - Would practice have still happened in the absence of carbon project revenues?
  - If project has all fuel treatment costs fully covered by a grant or subsidy, it would have taken place even if a carbon project wasn't being registered → likely not considered additional
- Projects are allowed to receiving enhancement payments up to 85% of the cost of fuel treatments
  - **If payments received >85%, seek Reserve guidance as soon as possible—may still be allowed**
- BUT if payments based on quantified climate benefits generated ($/tCO2e), then possibly:
  - Considered non-additional, or
  - Require quantification adjustments

3.4 Environmental & Social Safeguards

CLIMATE FORWARD

Existing laws/regulations provide basic environmental and social safeguards

Project proponents must:

- Report on potential adverse impacts to environmental and social issues, including air and water quality, endangered species, environmental justice.
- Coordinate with relevant local resource agencies and fire planning entities
    - Provide fuels management plan for minimum of 5 years from project start date
    - Obtain approval from majority of relevant resources/planning entities
    - Intent:
        - Promote aggregation/cooperation among smaller projects and prevent competition to be “first in”
        - Allow projects at scale → benefits of the whole greater than the sum of its parts

3.5 Regulatory Compliance

- Project must be in compliance with all relevant legal requirements
- Sign an Attestation of Regulatory Compliance
- Provide an assessment of the risk of future non-compliance during the crediting period and identify how such risks will be reduced or mitigated

3.6 Ownership & Double-Counting

CLIMATE FORWARD

Ownership

- Credits issued to project proponent based on implementation of fuel treatments and their influence on future fire behavior and GHG emissions
  - Direct effects (from impacts on fire behavior within fuel treatment sites)
  - Indirect effects (from impacts on fire behavior flowing from fuel treatments sites onto non-treated sites within the project area, i.e., shadow areas)

Double-counting

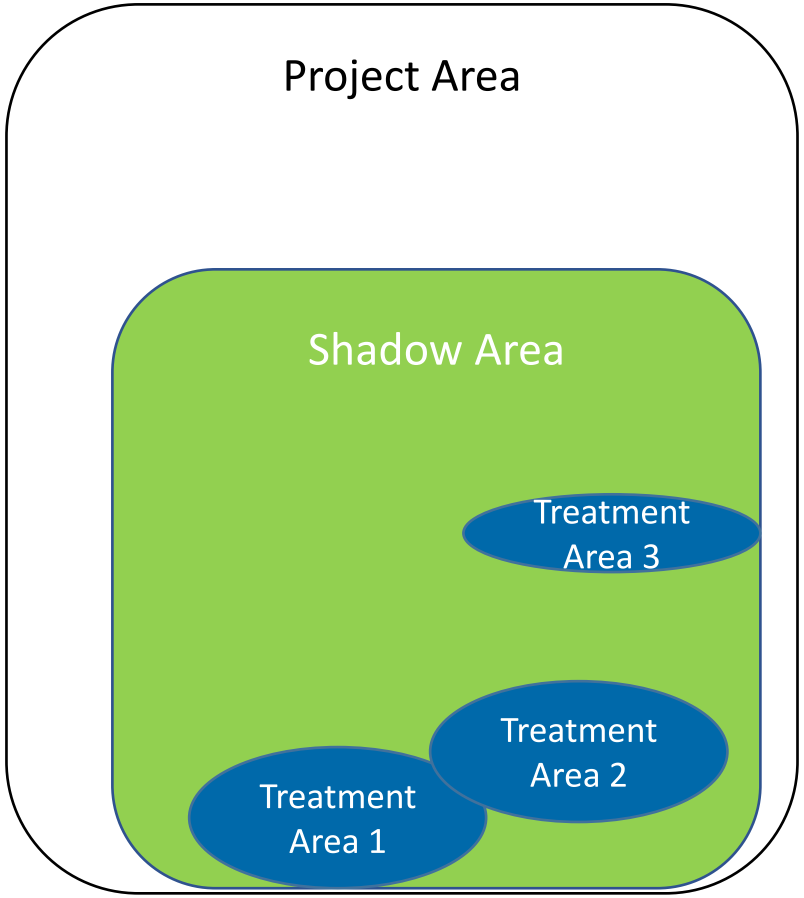
- Avoid crediting for same GHG benefits recognized under another project
- Stacking projects may be allowed where no double-counting would occur
  - Example: AWE project stacking with an Improved Forest Management (IFM) project
  - AWE project must omit harvested wood products from fuel treatment activities since they would also be counted under the IFM project

Section 4

Project Area

4 Project Area

- 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



Section 5

GHG Assessment Boundary

5 GHG Assessment Boundary

CLIMATE FORWARD

Included pools:

- Standing live and dead trees
- Shrubs and herbaceous understory
- Lying dead wood
- Litter and duff
- Harvested wood products in use and in landfills (as long as not stacked with another project that accounts for it)
- Biomass combustion emissions (from prescribed burns and wildfires)
- Mobile combustion emissions (heavy machinery use for fuel treatments)

Section 6

Quantifying GHG Emission Reductions

Credit Calculation

Emissions Reductions =

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

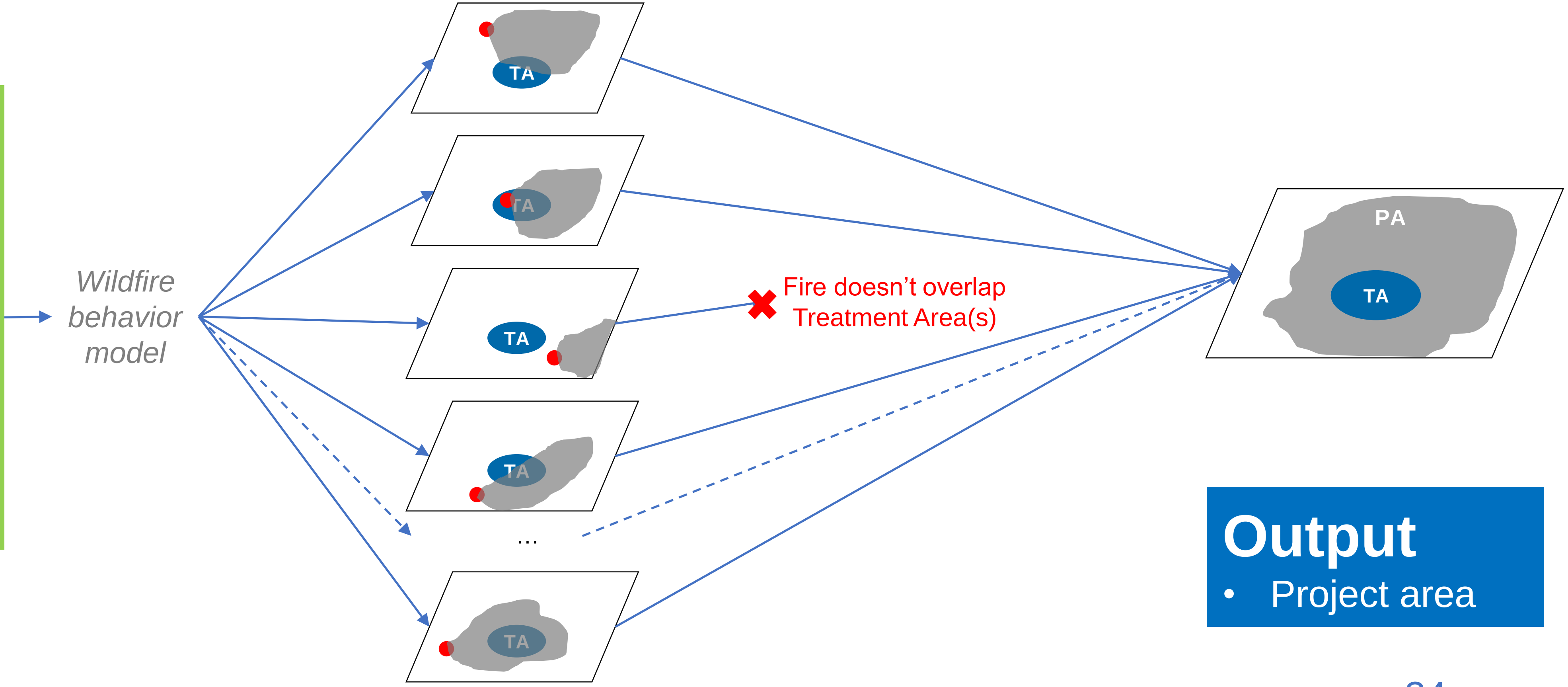
Emissions savings > Diminished C sequestration

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

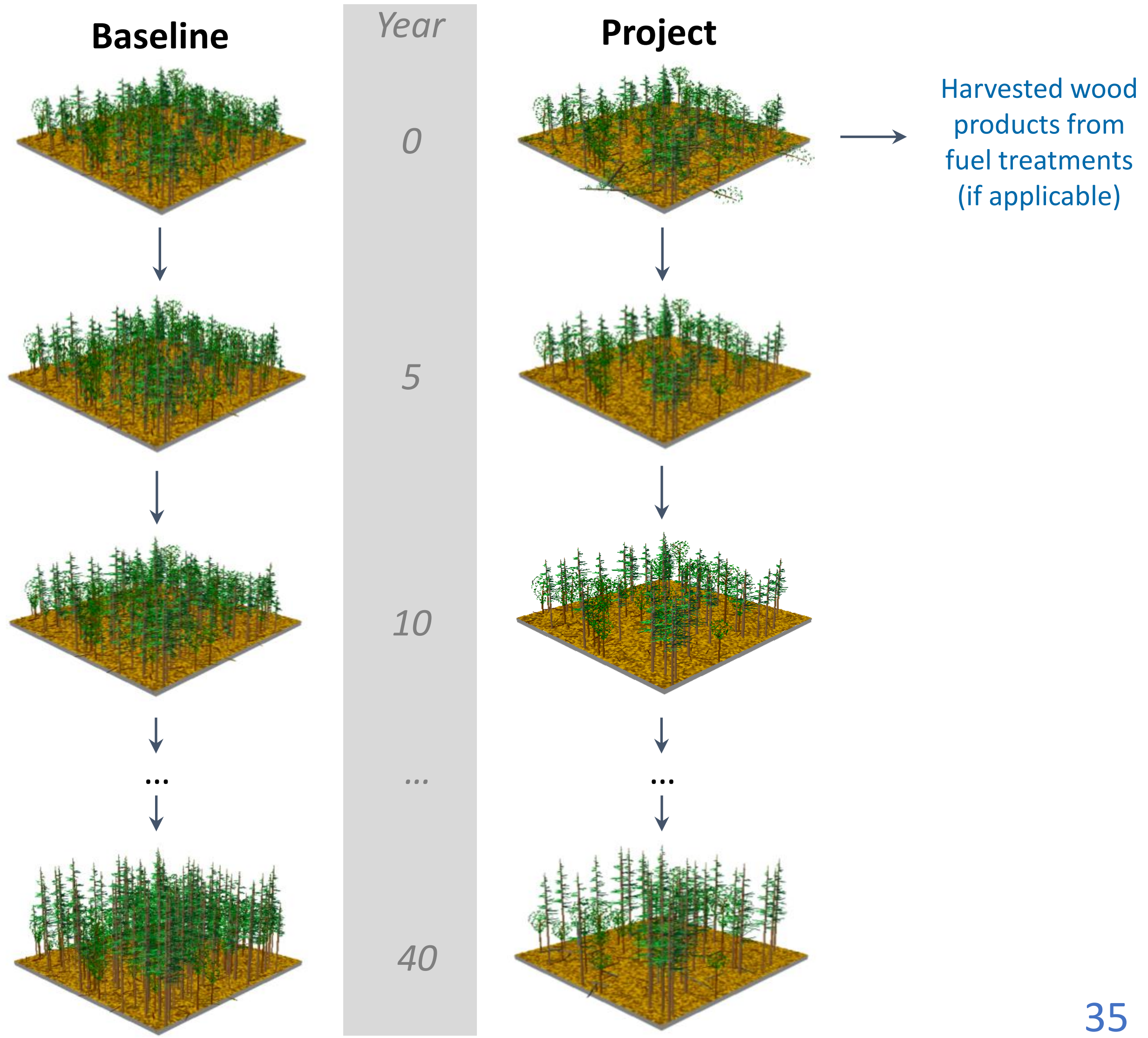
Model Forest Growth Without Fire

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 backround harvesting to estimate changes in forest C

Input
- Project area
- Tree lists
- Surface fuels
- Background harvesting
- Fuel treatments
- Regeneration

Output
- Tree lists
- Surface fuel models
- Wood products C

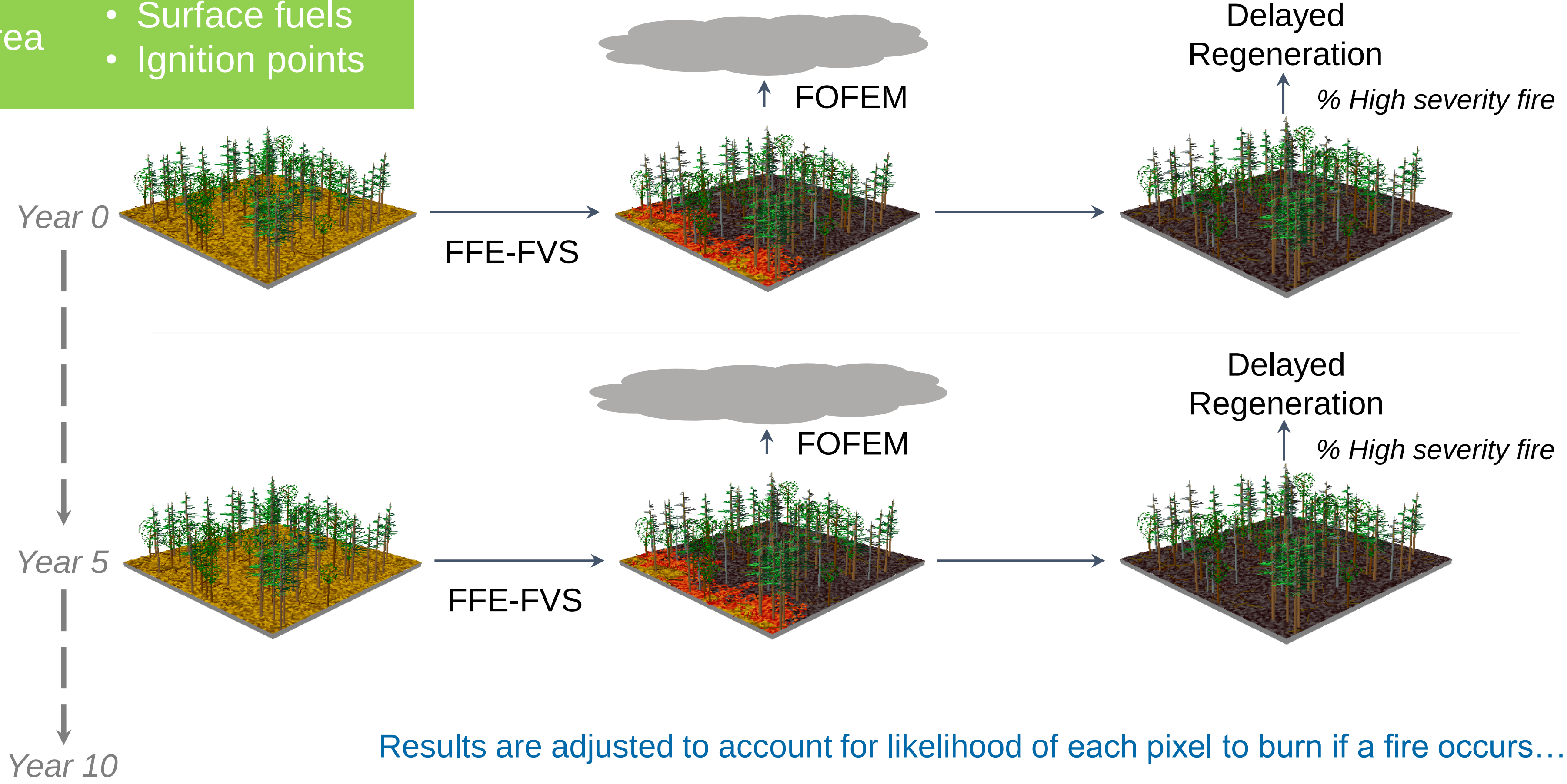


Model Fire Impacts – Emissions, Regen

CLIMATE FORWARD

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

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



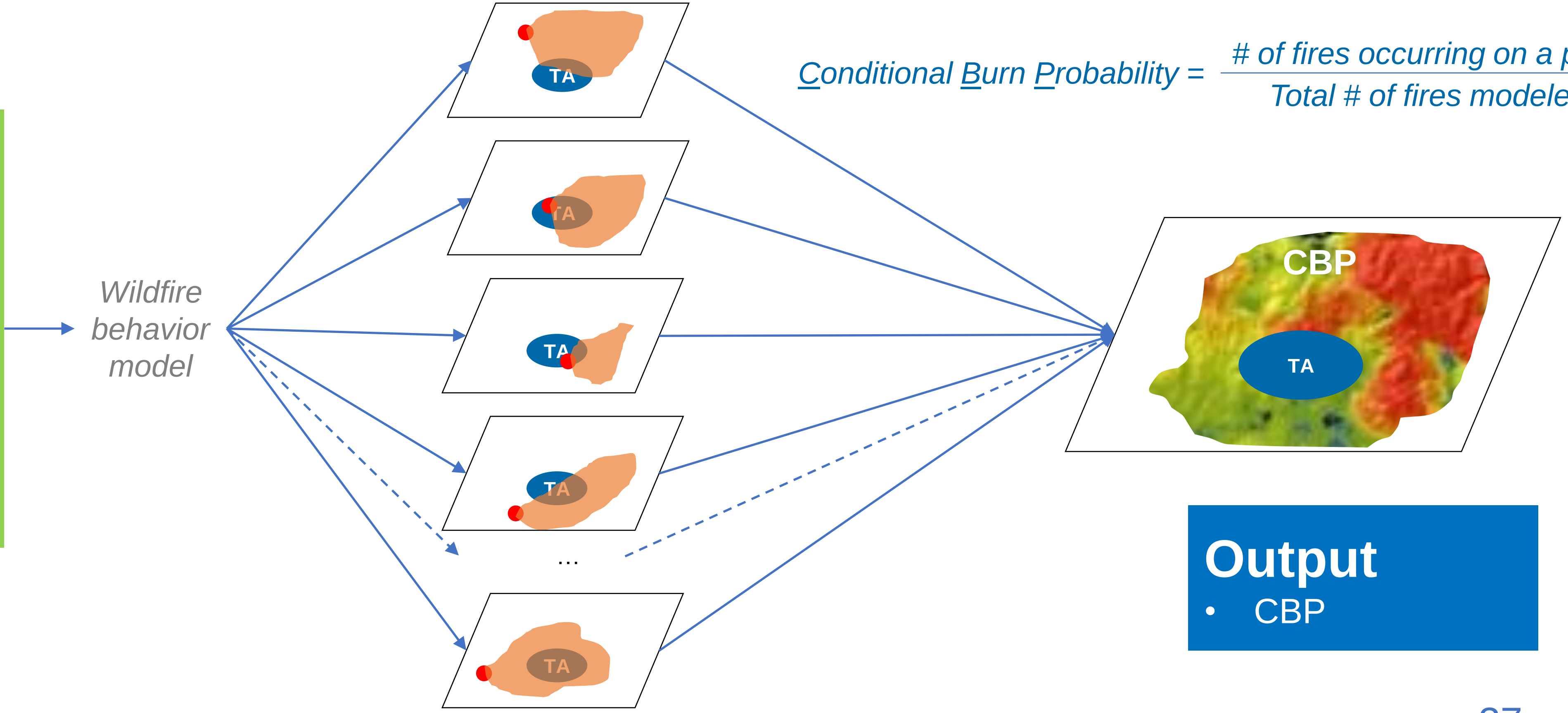
Output
- Tree lists
- Fuel models
- Wildfire GHG emissions
- Delayed regeneration data

Results are adjusted to account for likelihood of each pixel to burn if a fire occurs…

Calculate Conditional Burn Probability

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

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



Conditional Burn Probability = $\dfrac{\textit{\# of fires occurring on a pixel}}{\textit{Total \# of fires modeled}}$

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 adjusted by CBP
- Delayed regeneration estimates
- Fire return interval

→ [% Annual Fire Risk] →

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

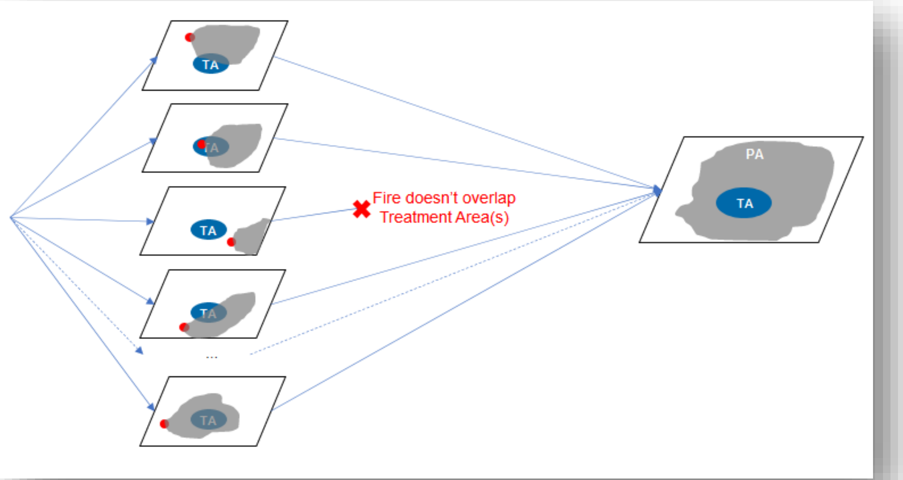
CLIMATE FORWARD

- 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).



3) Management scenario development

- Standardized input from Climate Forward:
  - Background forest 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

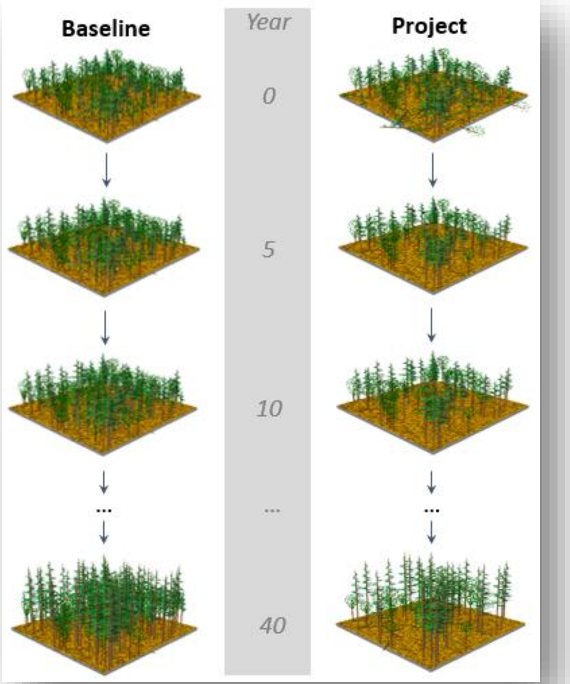
Region	Forest Type	Generalized Practice
Rocky Mountain North[g]	Ponderosa pine	Plant 400–500 trees per acre, precommercial thin to 200–300 trees per acre, commercial thin to 150–200 trees per acre at age 30–40; clearcut harvest at age 60–80
	Lodgepole pine	Site prepare to expose mineral soil seedbed, 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
  - Regeneration assumptions

Example: TreeMap USDA

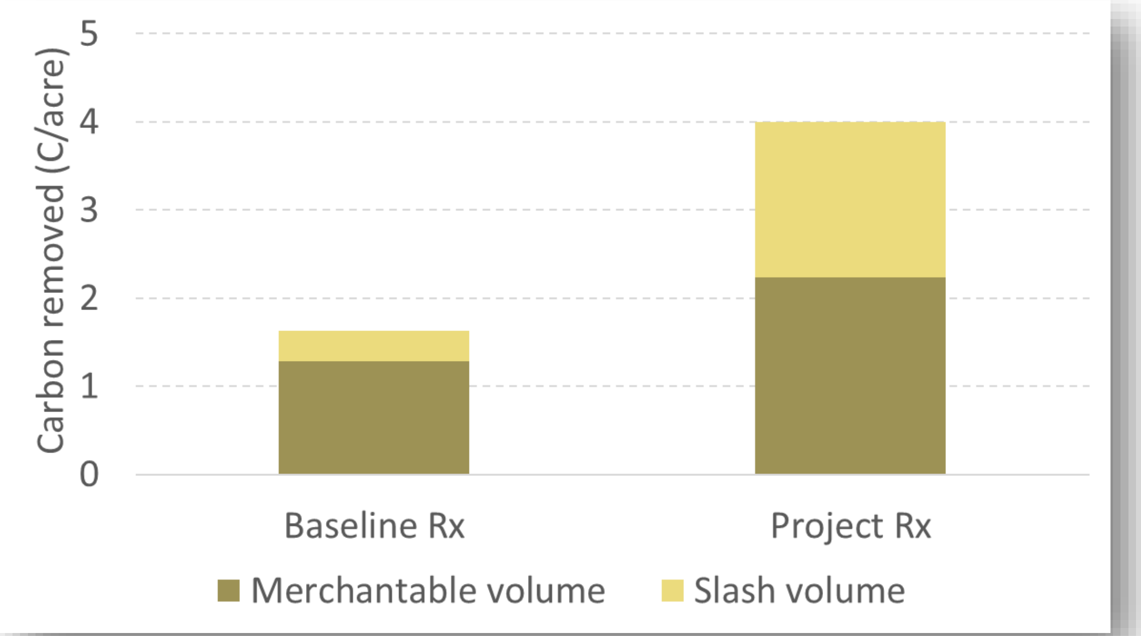


- Approach:
  - FVS parametrization using verifiable sources
  - FVS simulation runs (year 0 to 40 in 5-year timesteps):
    - Baseline, no wildfire
    - Project, no wildfire

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

CLIMATE FORWARD

- Standardized input from Climate Forward:
  - Tree inventory
- 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



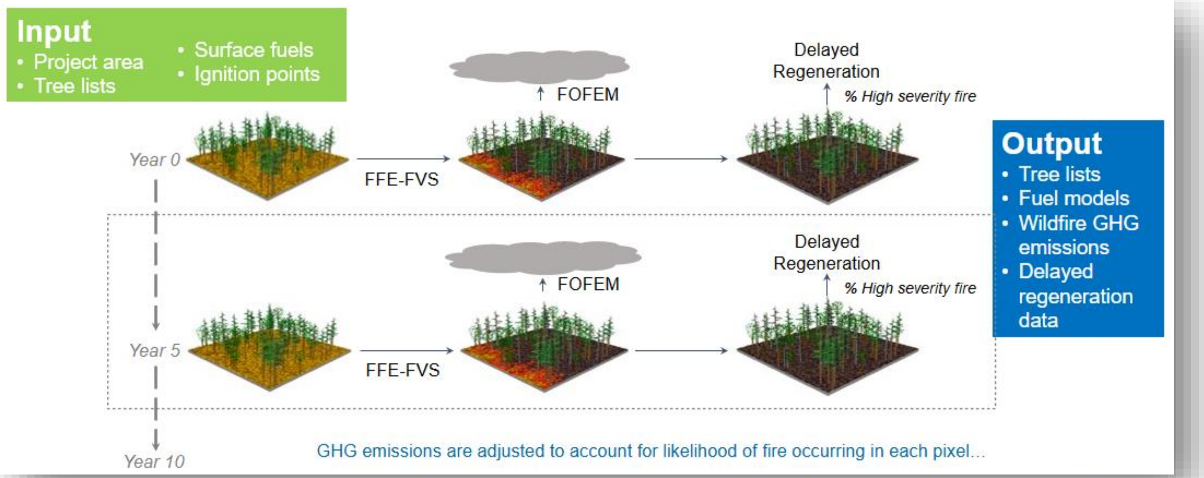
6) Wildfire emissions calculation – Direct emissions

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

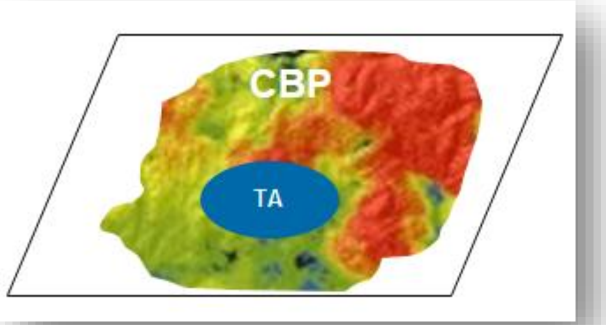
GHG	GWP Factor[11]
CH_4	25
NOx	-8.2
CO	1.0
PM2.5	9
NMOC	5

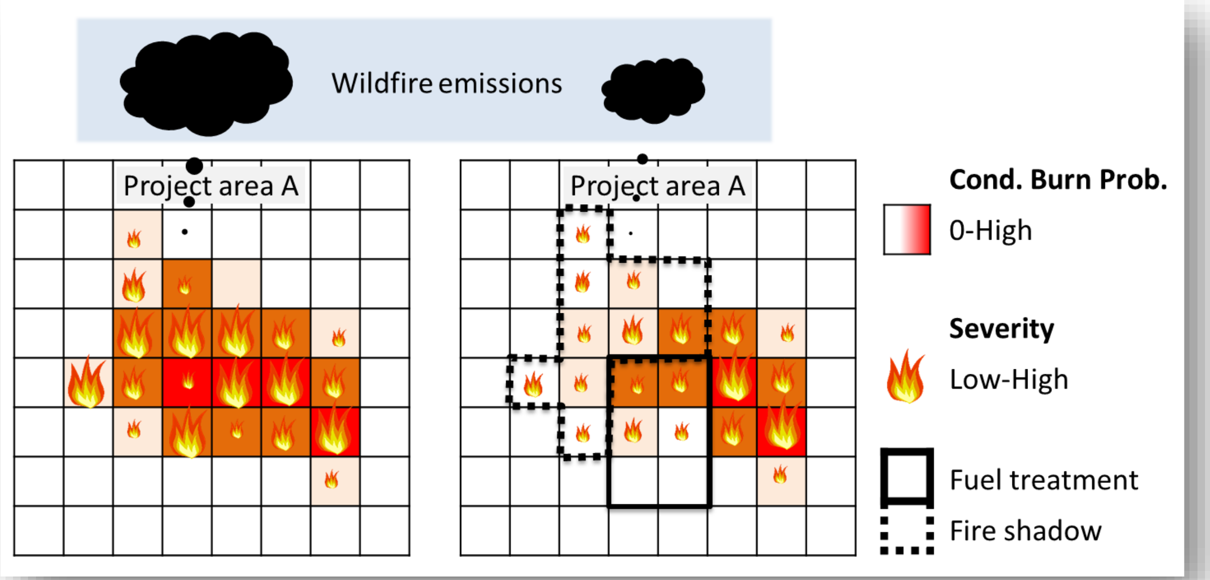


6) Wildfire emissions calculation – Indirect emissions

CLIMATE FORWARD

- Standardized input from Climate Forward:
  - Approved fire behavior models
- 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)

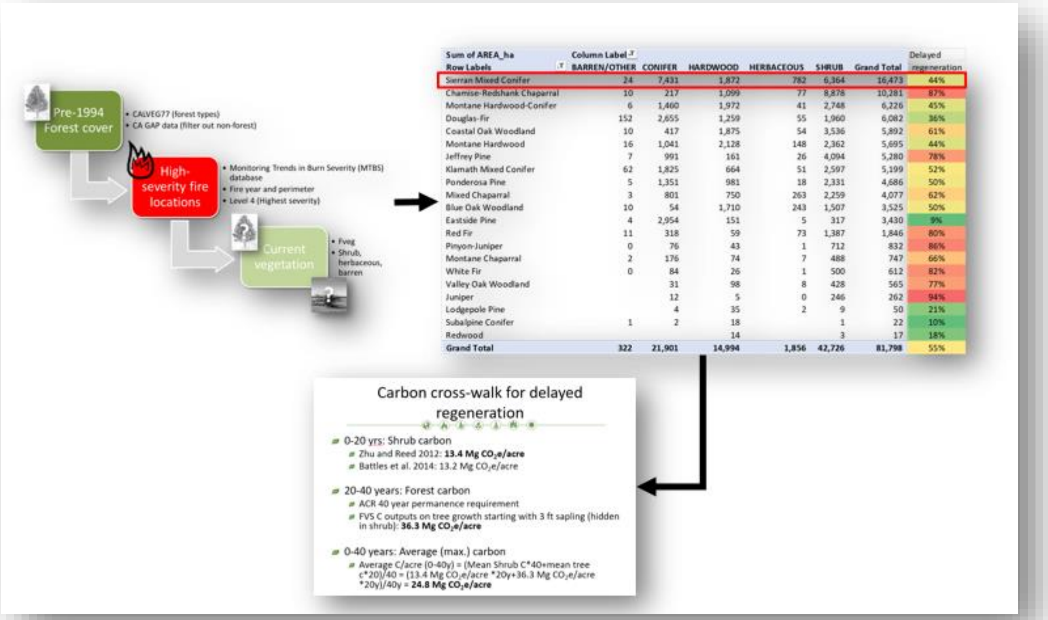




7) Delayed regeneration calculation

CLIMATE FORWARD

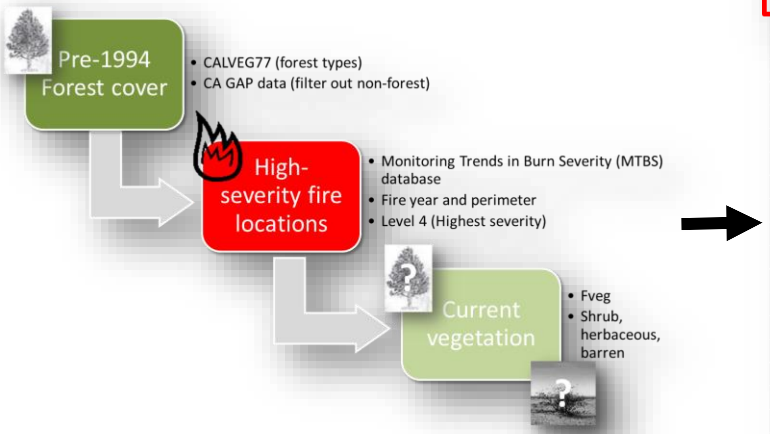
- Standardized input from Climate Forward:
  - Percentage of acreage affected by delayed regeneration by forest type and ecoregion (P_{DR})
  - Carbon crosswalk for forgone sequestration (C_{DR})
- Approach:
  - Calculate area that burnt with flame length >4’ for each:
    - Baseline and project
    - 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%

CLIMATE FORWARD

7) Delayed regeneration calculation



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%

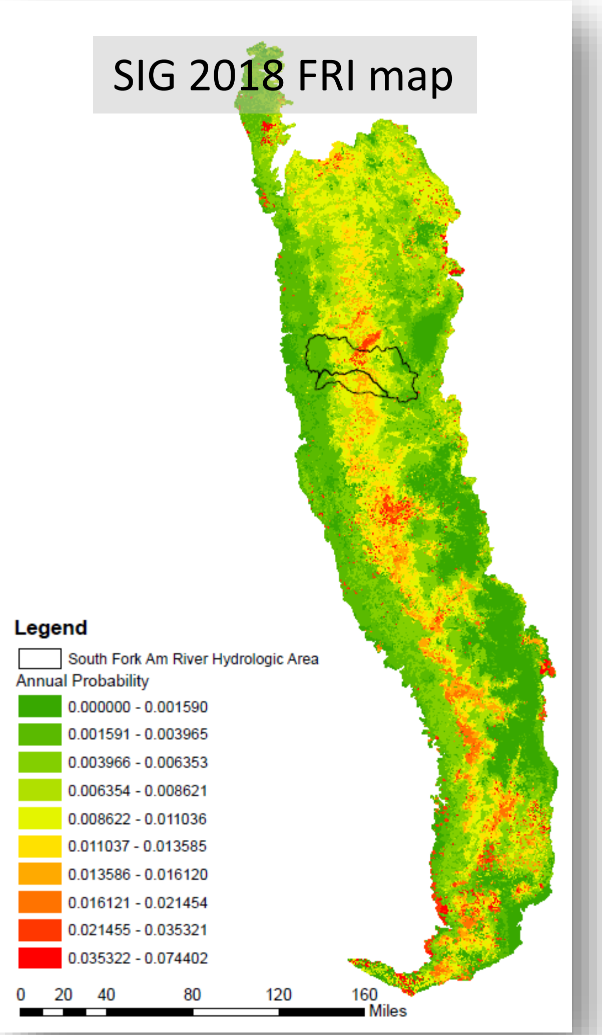
Carbon cross-walk for delayed regeneration

- 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

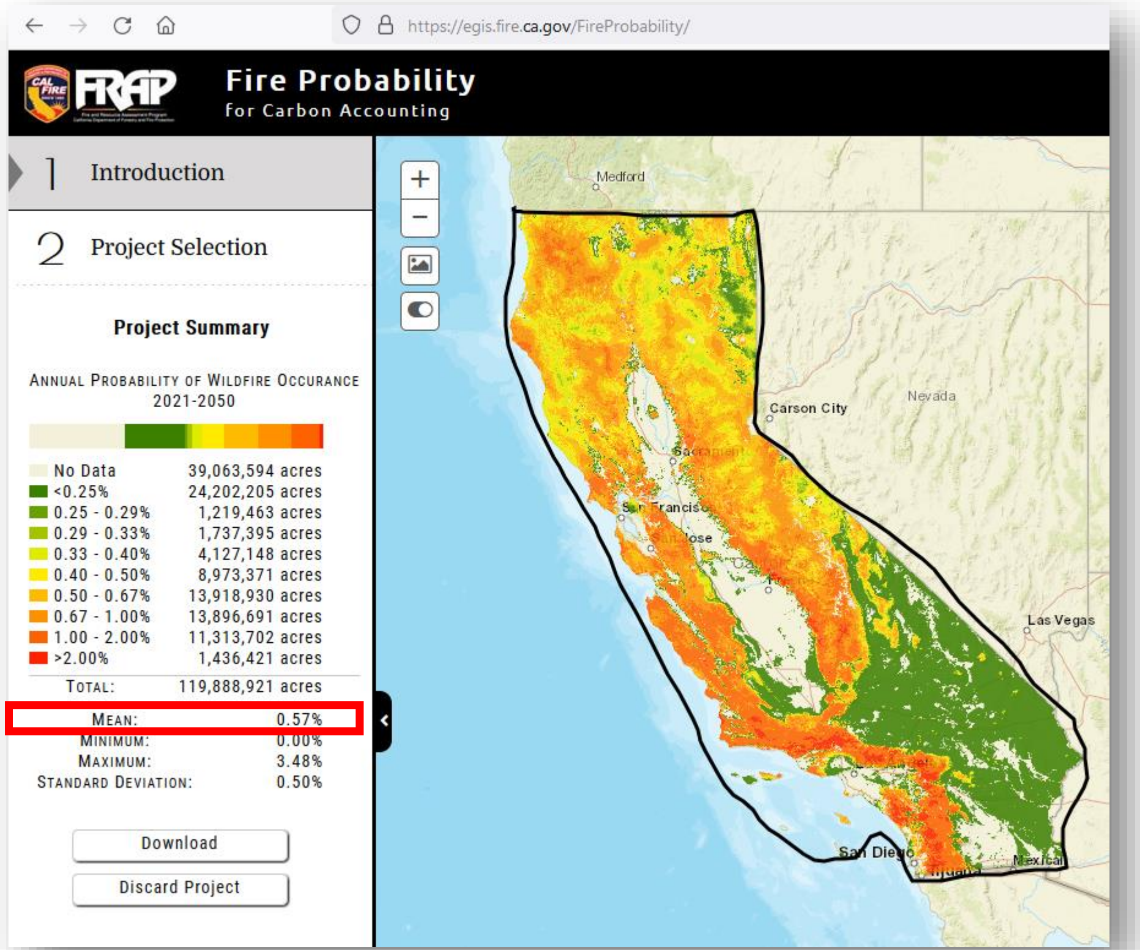
- Standardized input from Climate Forward:
  - Fire probability map
    - CAL FIRE; USFS (**relative** fire probability)
    - Updated by most recent 10y fire probability (**absolute** fire probability)
- Approach:
  - Retrieve mean fire probability for project area



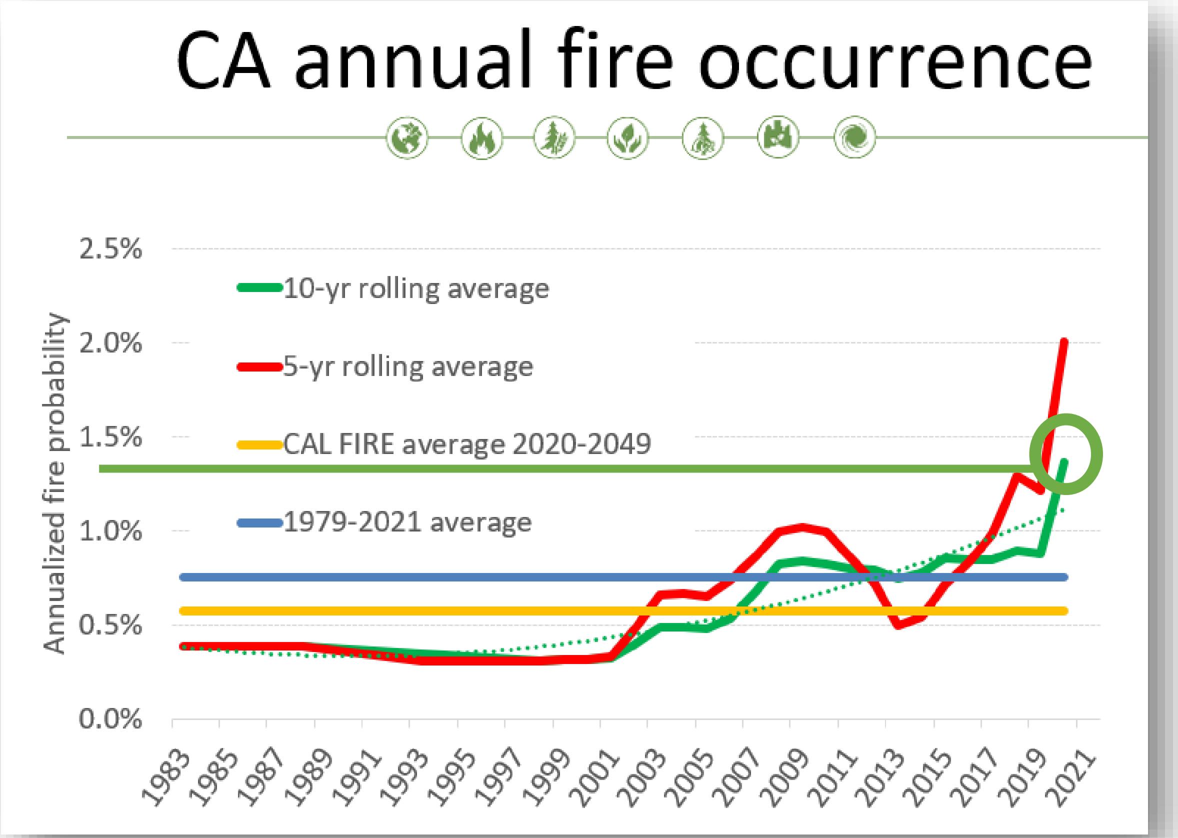
8) Fire ignition probability (fire return interval) assessment

CLIMATE FORWARD

Example: Relative fire probability



Example: Calibration factor to generate absolute fire probability



9) Aggregated emissions accounting

CLIMATE FORWARD

- 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)

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)
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)

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)
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

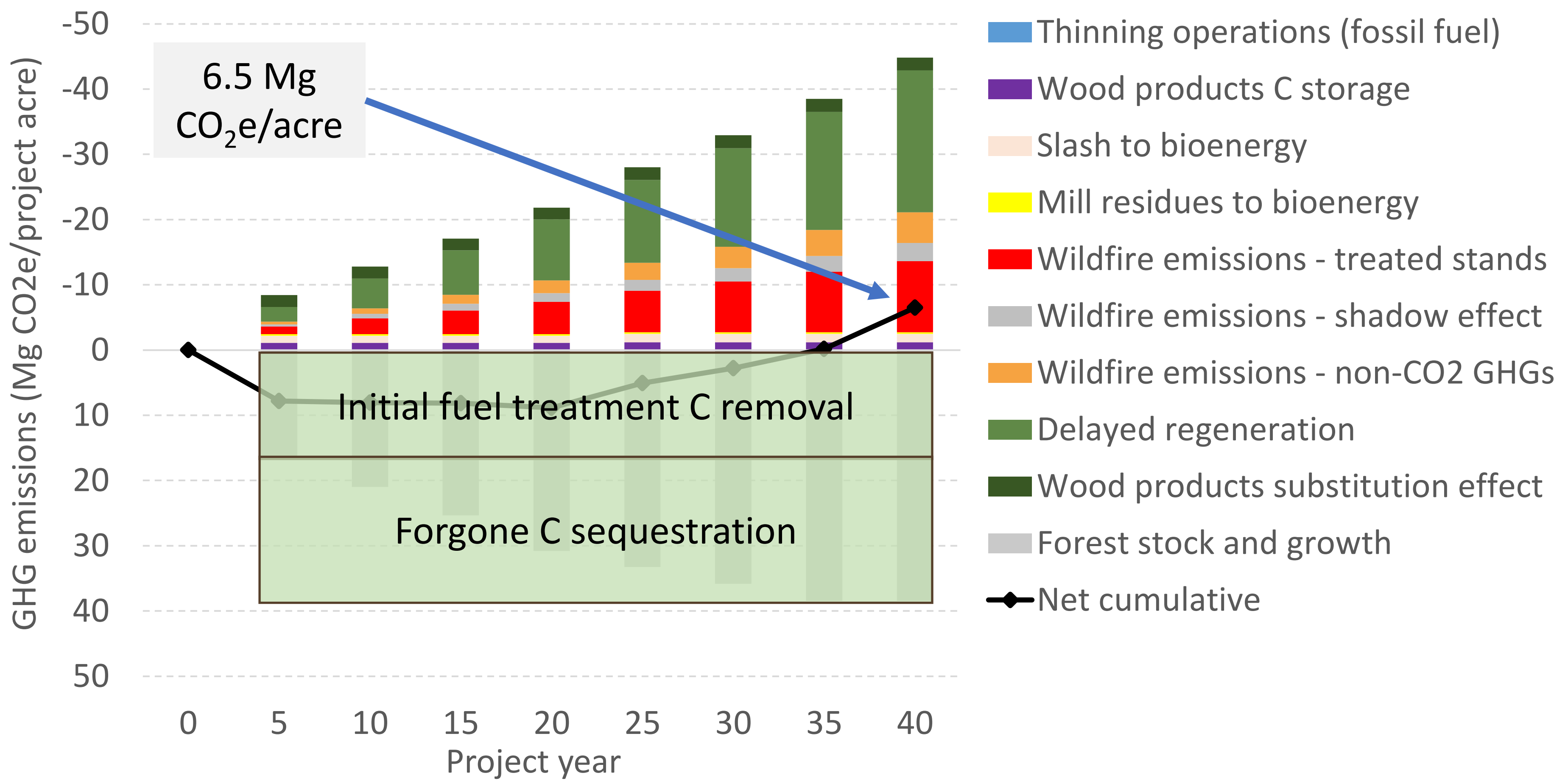
Limited additional timber production

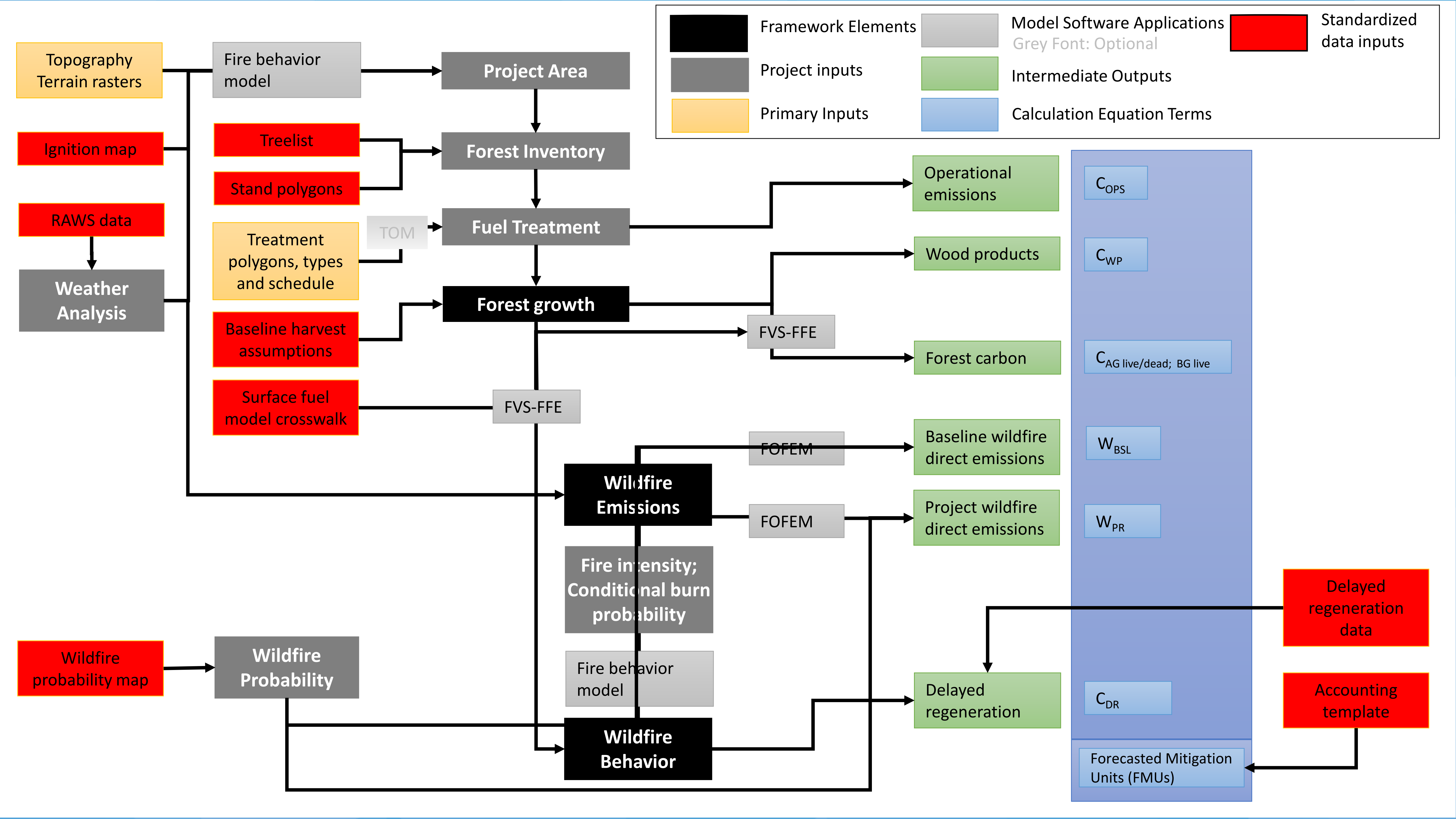
Large delta BSL vs. Project

Net GHG benefits over time

CLIMATE FORWARD

Eldorado case study: Accumulated C fluxes





Framework Elements
Project inputs
Primary Inputs
Model Software Applications
Grey Font: Optional
Intermediate Outputs
Calculation Equation Terms
Standardized data inputs
Topography Terrain rasters
Ignition map
RAWS data
Weather Analysis
Fire behavior model
Treelist
Stand polygons
Treatment polygons, types and schedule
TOM
Baseline harvest assumptions
Surface fuel model crosswalk
Project Area
Forest Inventory
Fuel Treatment
Forest growth
FVS-FFE
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

Standardized data

CLIMATE FORWARD

Tool or dataset	Description	Relevance for the methodology
Ignitions	Ignition points have to be derived from USFS Spatial wildfire occurrence data for the United States (https://www-fs-usda-gov/rds/archive/Catalog/RDS-2013-0009.5)	Required to model wildfire behavior and determine the size of the project area depending on average wildfire size. See section methodology section 6.1.4 and 6.2.3
Tree inventory	The latest iteration of the TreeMap dataset provided by USFS has to be used as the underlying tree list (https://www-fs-usda-gov/rmrs/tools/treemap-tree-level-model-conterminous-us-forests)	Provides a tree-level model of conterminous U.S. forests at a 30m resolution. TreeMap data has to be updated by the project proponent to reflect the project's starting year. Any disturbances that occurred on the project area between the TreeMap vintage year and the project start date has to be fully captured (harvests, wildfire, fuel treatments, etc.)
Weather	Weather data has to be derived from RAWS (https://raws.dri.edu/)	Needed to identify the project area and simulate stand-level wildfire impacts and wildfire behavior/spread. The project proponent has to use at least a 10-year average besides the requirements specified in the methodology section 6.2.2.
Surface fuel models	TBA	TBA
Regeneration assumptions	TBA	TBA
Fire probability map	TBA	TBA
Delayed regeneration data	TBA	TBA
Background management	TBA	TBA
List of approved fire behavior models	TBA	TBA
Topographic data	The topographic data provided by Landfire (https://landfire.gov/topographic.php) is recommended to derive project-relevant topographic data. A maximum pixel size of 30 m x 30 m is required.	Relevant input for establishing the project area (methodology section 6.1.2) and for fire behavior modeling. Growth and yield modeling can be done aspatially and does not require topographic input.

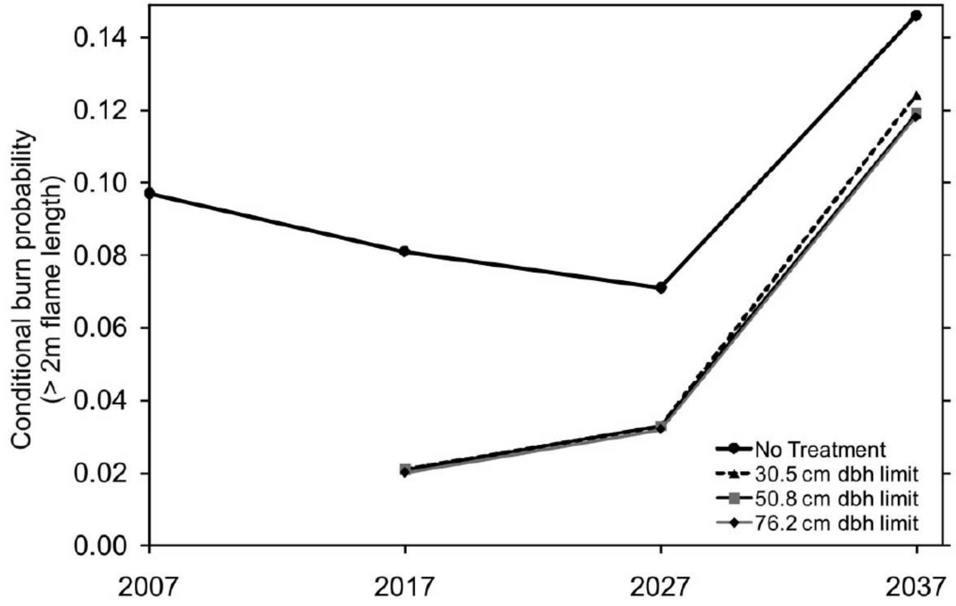
6.8 Performance Decline

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

No requirement for ongoing management to achieve forecasted benefits from project activities

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
  - Probabilistic occurrence of future wildfires



Sections 7 / 8 / 9

Monitoring / Reporting / Confirmation

8.1 Project Submittal Documentation

CLIMATE FORWARD

LISTING:

- Project Submission form
- KML (map) file of treatment areas

CONFIRMATION:

- Signed Attestation of Title form
- Signed Attestation of Legal Additionality form
- Signed Attestation of Regulatory Compliance form
- Project Implementation Report (PIR)
- KML (map) file of project area
- Confirmation Report, and Confirmation Statement
- From Confirmation Body: confirmation plan, sampling plan, and list of findings (not made public)

9 Confirmation

CLIMATE FORWARD

Confirmation process may commence once project is listed and project activities are completed

Desktop review to evaluate PIR and companion documents

- Eligibility requirements
- Modeling and FMU quantification
- Photo plot interpretations

Site visit to confirm project activities

- Project area
- Treatment area boundaries
- Post-treatment conditions

7.1 Photo Plots

CLIMATE FORWARD

Photo plots used to show:

- Data being used by the models are representative of actual conditions on the project site
- QMD has increased following fuel treatments based on thinnings

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

CLIMATE FORWARD

Plot attribute	Project proponent	Confirmation body
Vegetation	Dominant vegetation types (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

Confirmation Body also reviews whether stands where thinnings occur have >50 ft^2 in basal area, either based on professional judgement or conducting random samples.

Next Steps

Public Comment Period

Deadline for comments:

Monday, July 25, 2022

Documents available for comment

- Avoided Wildfire Emissions Forecast Methodology V1.0
- Repository of standardized data/assumptions for use by projects

Submit written comments to

info@climateforward.org

Questions or Comments?

Contact Information

Jon Remucal

Associate Director of Nature-Based Solutions

(213) 542-0280

jremucal@climateactionreserve.org