Effects of Forest Management & Wood Utilization on Carbon Sequestration & Storage in California

Kendall DeLyser
Director, Climate Science, American Forests

Nadia Tase
Climate Change & Forest Inventory,
Fire and Resource Assessment Program , CAL FIRE

California Board of Forestry and Fire Protection Meeting

June 19, 2024

Agenda

- Project background and California context
- Scenario development overview
- Results summary and key takeaways for climate-smart forestry in California
- Q&A

Modeling state & regional climate-smart forestry

American Forests™ NIACS Northern Institute of Applied Climate Science

Forest Carbon and Climate Program
Department of Forestry
MICHIGAN STATE UNIVERSITY

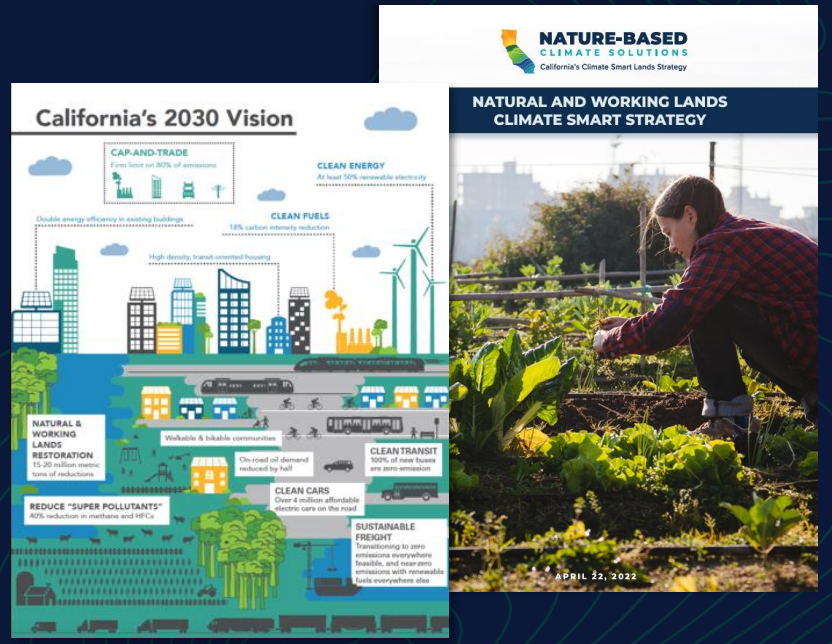
FOREST SERVICE US DEPARTMENT OF AGRICULTURE

Canada
Natural Resources Canada
Canadian Forest Service

✓Partners in 7 US states (MD, PA, MN, MI, WI, OR, & CA)

Objectives:

- Model carbon impacts of forest management and wood utilization scenarios
  - Ecosystem + wood products + substitution (+ economics)
- Understand climate mitigation potential of scenarios & identify climate-smart forestry practices
- Integrate carbon in forest management and planning
- Integrate forests as natural climate solutions in state climate planning and funding

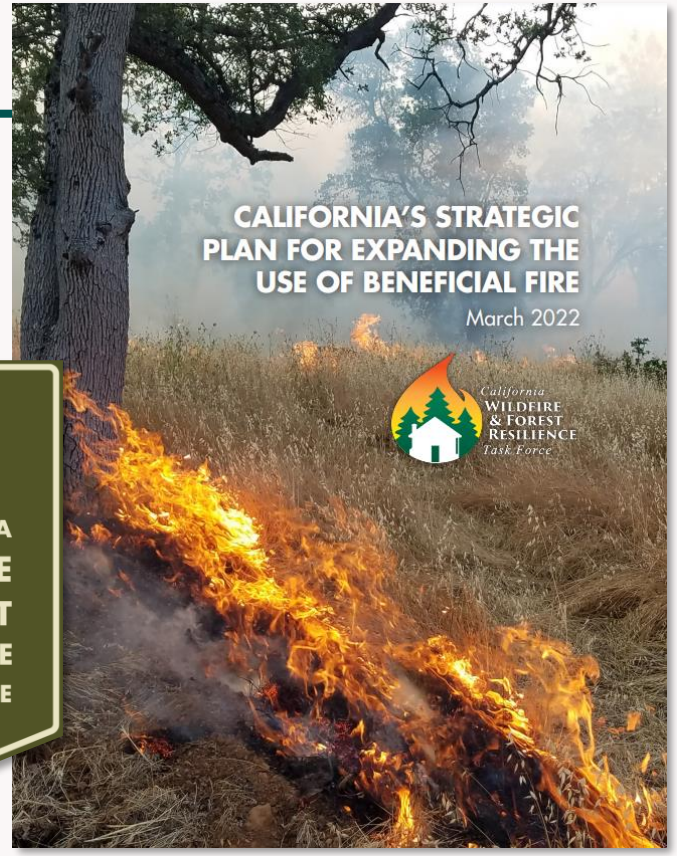


American Forests

Modeling state & regional climate-smart forestry

California context:

- Task Force Wildfire and Forest Resilience Action Plan
- One Million Acre Strategy
- Reforestation Strategy Working Group
- CARB 2022 Scoping Plan Update
- CNRA 2024 Nature-Based Solutions Climate Targets



CALIFORNIA WILDFIRE & FOREST RESILIENCE TASK FORCE

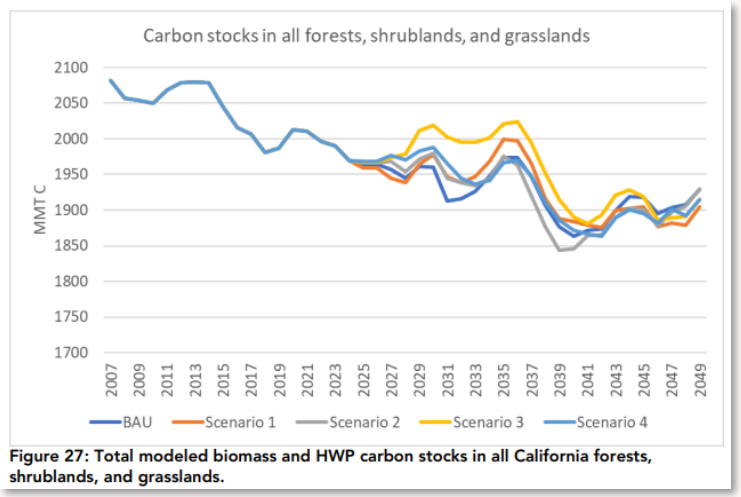


Figure 27: Total modeled biomass and HWP carbon stocks in all California forests, shrublands, and grasslands.

American Forests

Scenario data & development

MODELED SCENARIOS

- Business-as-usual (BAU)
- Climate-adjusted BAU*^

MANAGEMENT SCENARIOS

- Post-fire landscape restoration*^
- Fire resilience treatments
- Expand fire resilience treatments to mature and old-growth forest*^
- Forest conservation^
- Silvopasture^
- Extended rotations^
- Altered rotations

WOOD UTILIZATION SCENARIOS

- Long-lived wood products*^†
- Transportation fuels*^†
- Biochar*^†

PORTFOLIOS (include marked scenarios)

- *Ramp up implementation
- ^Max NCS action by 2045
- †Innovative wood utilization

CLIMATE ADJUSTMENTS TO BAU

PRODUCTIVITY DECLINES

- Climate-Adapted Seed Tool

MORE FREQUENT AND MORE SEVERE NATURAL DISTURBANCE

- Westerling et al. 2018 (4th California Climate Assessment)
- Anderegg et al. 2022

POST-FIRE REGENERATION FAILURE

- Davis et al. 2023

FIRE RESILIENCE NEEDS ASSESSMENT

- Pyrologix wildfire hazard potential 2021 (WHP)

BAU ACTIVITIES & DATA

STARTING INVENTORY & GROWTH DATA

- USFS FIA database up through 2021

LAND-USE CHANGE

- NLCD time-series comparison, 2001-2019

FOREST MANAGEMENT (2000-2021)

- USFS activities database (FACTS)
- Timber harvesting plans (THP)
- Non-industrial timber management plans (NITMP)
- VTP treatment polygons
- LANDFIRE Historic Disturbance dataset

NATURAL DISTURBANCE (2000-2021)

- Monitoring Trends in Burn Severity (MTBS)
- USFS Rapid Assessment of Post-Fire Vegetation Condition (RAVG)
- USFS Insect & Disease Surveys (IDS)
- LANDFIRE Historic Disturbance dataset

WOOD UTILIZATION & TRADE (1952-2021)

- University of Montana Bureau of Business and Economic Research (BBER)
- US International Trade Commission
- IPCC/FAO

Fire Resilience Needs Assessment

Table 1. Acres in need of fire resilience treatments, separated by ownership and ecoregion.

	Ownership								Total Acres
Ecoregion	USFS	BLM	NPS	Other federal	State/ local	Tribal	Private industrial	Private	
North Coast	7,576	28,151	4,464	677	29,536	6,679	109,836	180,332	**367,252**
Klamath/Interior Coast Ranges	2,199,309	130,277	258	6,704	26,333	49,510	448,847	816,548	**3,677,785**
Sierra/Cascades	2,730,737	183,784	207,660	15,255	67,368	13,101	847,648	1,059,147	**5,124,701**
Eastside	371,568	125,067	-	605	3,390	1,534	72,196	113,632	**687,992**
Central Coast and Interior Ranges	170,612	40,144	8,300	29,937	58,186	-	1,587	380,593	**689,359**
Central Valley	-	111	-	10	59	7	-	3,891	**4,079**
Deserts, South Coast and Mountains	487,733	23,192	415	3,639	44,386	25,947	-	96,596	**681,907**
Total Acres	5,967,535	530,725	221,097	56,828	229,257	96,778	1,480,115	2,650,739	11,233,075

Wildfire Hazard Potential (WHP)
↓
Forest Type
↓
Ecoregion
↓
Forest Ownership
↓
Productivity Class
↓
Slope Class (<30%, 30-49%, 50-69%, 70+%)
↓
Wilderness and Other Reserved Lands
↓
Road Accessibility (within 1000 feet of a road)
↓
Utility Corridors (within 200 feet of transmission lines)
↓
Wildland-Urban Interface (WUI)
↓
State Responsibility Areas (SRAs)
↓
Critical Wildlife Habitat
↓
Acres in need of resilience treatments *to reduce WHP*

After applying filters, only **7.3 million acres** of forest are likely to be eligible for resilience treatments; includes pushing slope limits, increasing removal intensity, treating w/in wildlife habitat in some cases.

Treated at a steady rate over 10 years, this equates to an average of **735,000 acres per year**

CALIFORNIA ECOSYSTEM CARBON MODELING SCENARIOS

American Forests™

Scenario	Average Area 2022-2031	Difference from CBAU	Model Change from CBAU
Landscape restoration	246,917 ac/yr	Increase salvage and reforestation within 3-5 years of high-severity fire	+171,961 ac/yr
		Increase site prep and reforestation rates to address current reforestation needs within 10 years	+134,880 ac/yr from 2022-2031
Fire resilience treatments	821,719 ac/yr	Increase hazardous fuels thinning to address current resilience treatment needs within 10 years	+523,438 ac/yr (mechanical thin) from 2022-2031 +65,490 ac/yr (hand thin)
		Increase prescribed fire to address current resilience treatment needs within 10 years	+229,405 ac/yr (burn only) +54,576 ac/yr (pileburn 5 years after hand thin) +104,689 ac/yr (broadcast burn 10-30 years after mechanical thin)
		Decrease wildfire severity in response to treatments	206,153 ac/yr of high-> moderate severity wildfire 180,043 ac/yr moderate->low severity wildfire
Expand fire resilience to mature and old-growth forests	821,719 ac/yr	Increase resilience in mature stands within 10 years	Increase age cap for resilience mechanical thin to make mature acres eligible (~+99,873 ac/yr eligible)
		Increase resilience in old-growth stands within 10 years	Remove age cap for hand thin/pile burn to make OG acres eligible (~+72,004 ac/yr eligible)
Forest conservation	13,186 ac/yr	Reduce permanent forest loss rate until equal to forest gain rate in 2045	+2,298 ac/yr additional forest conservation from 2022-2045
Silvopasture	9,512 ac/yr	Increase silvopasture implementation by 2045	+9,512 ac/yr from 2022-2045
Extended Rotations	114,864 ac/yr	Extend rotations on all lands	50 years->80 years minimum harvest age
Altered Rotations	114,864 ac/yr	Extend rotations on public lands, shorten rotations on private lands	50 years->80 years minimum harvest age on public lands 50 years->40 years minimum harvest age on private lands

Potential Wood Utilization Strategies

CALIFORNIA HARVESTED WOOD PRODUCT CARBON MODELING SCENARIOS	
Scenario	Difference from CBAU
Create more long-lived wood products	Allocate additional harvested material from resilience thinning eligible for lumber to mass timber
Use woody biomass for transportation fuels	Allocate additional harvested material in slash category from resilience thinning to produce transportation fuels (renewable diesel and aviation gas), after current bioenergy capacity has been fully met
Create more biochar	Allocate additional harvested material in slash category from resilience thinning to create biochar
Innovative wood products	Allocate additional harvested material from resilience thinning into mass timber, transportation fuels, and biochar

- Need alternative use for additional material produced from large-scale resilience treatments (approx. 5x more than CBAU at peak)
- Product categories are representative of various potential wood utilization strategies with different uses and half-lives

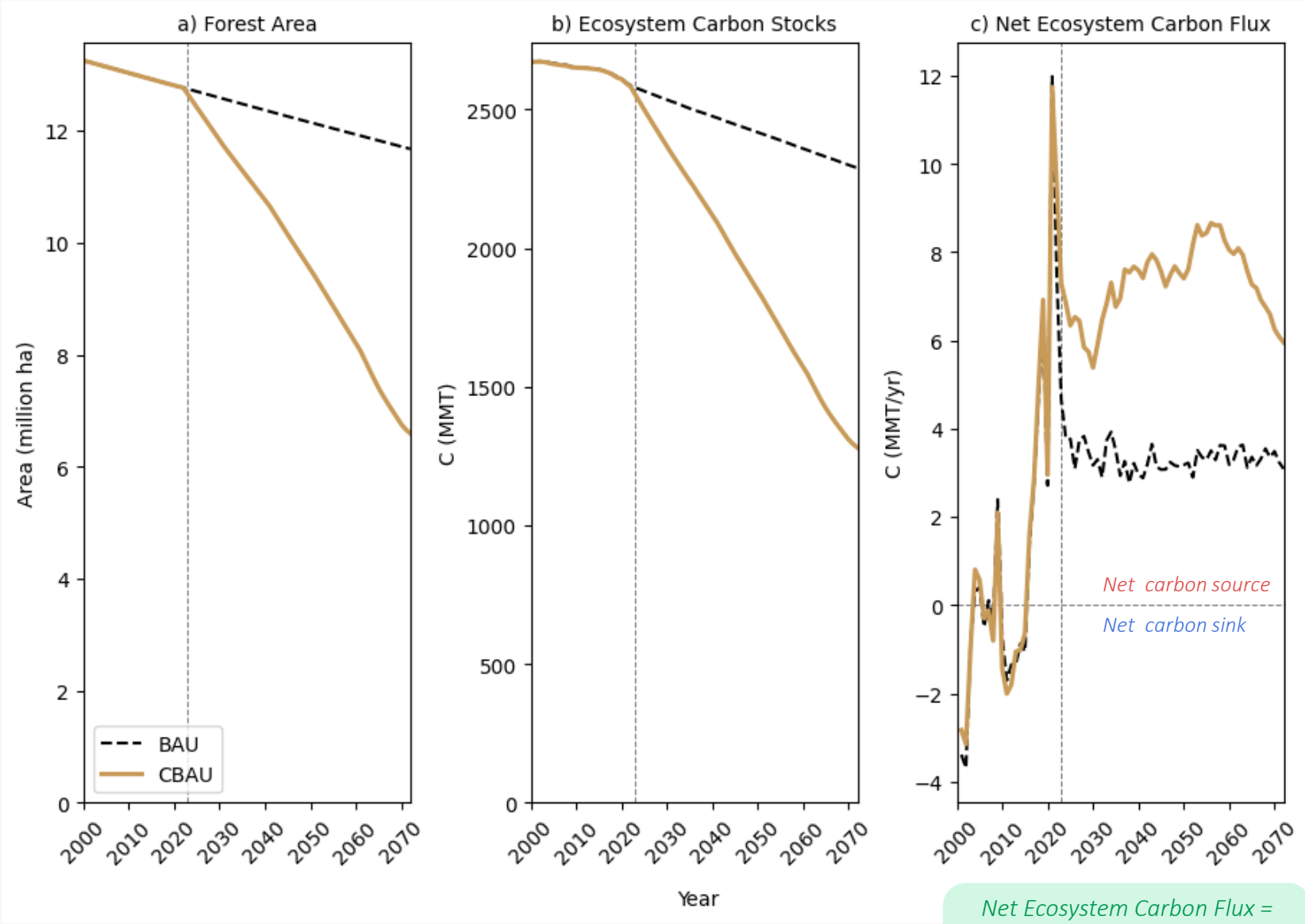
CNRA NATURE-BASED SOLUTIONS CLIMATE TARGETS COMPARISON (acres/year)

CNRA Category	CNRA Target			CBM Target		
	2030	2038	2045	2030	2038	2045
Afforestation • Oak woodland reestablishment	52,900	52,900	52,900	9,125 (silvopasture)	9,125 (silvopasture)	9,125 (silvopasture)
Conservation • **Conserve OG**, conserve conifer, riparian, and oak woodland forests	55,100	55,100	55,100	34,268	8,843	7,466
Restoration • **Post-high severity fire reforestation and restoration**, restore oak woodlands including enhancing riparian zones	322,100	462,100	322,100	299,321	171,960	171,960
Beneficial Fire • **Rx burn, cultural burn, planned managed fire**, planned trt burned in wildfire	800,000	1,200,000	1,500,000	622,539 (309,030 Rx, 313,509 mngd)	718,747 (413,718 Rx, 305,029 mngd)	784,882 (413,718 Rx, 371,164 mngd)
Other Fuel Reduction Activities • **Thinning**, invasive species removal, grazing, **mechanical trts, uneven-aged harvest**	700,000	800,000	1,000,000	794,265	270,827	270,827
Working Forest Conservation • **Extend rotations**, shift intensity of harvest, restore/conserve wildlife habitat	165,200	165,200	165,200	114,864	114,864	114,864
Decrease Conversion • **Decrease illegal conversion** and forest degradation by:	-20%	-50%	-90%	-34%	-65%	-92%
Shift to Low/Moderate Severity Fire • **Through beneficial fire and other fuel reduction activities, shift the proportion of statewide high severity wildfire to low or moderate severity wildfire** so that:	75% of wildfire is low/mod severity	83% of wildfire is low/mod severity	90% of wildfire is low/mod severity	82%	82%	82%

Bolded items are included in CBM modeling effort

Influence of future climate

- An average of **82%** of forest will fail to regenerate after high-severity wildfire
- Significant loss of forest area: **-48%** from 2022-2071
- Decline in carbon stocks: **-50%** from 2022-2071
- Forest ecosystem became a net carbon source in 2015 with high insect mortality events
- Higher carbon emissions: **+49%** over BAU values



Net Ecosystem Carbon Flux = Growth – Decomposition – Disturbance emissions – Harvest transfers

Influence of forest age

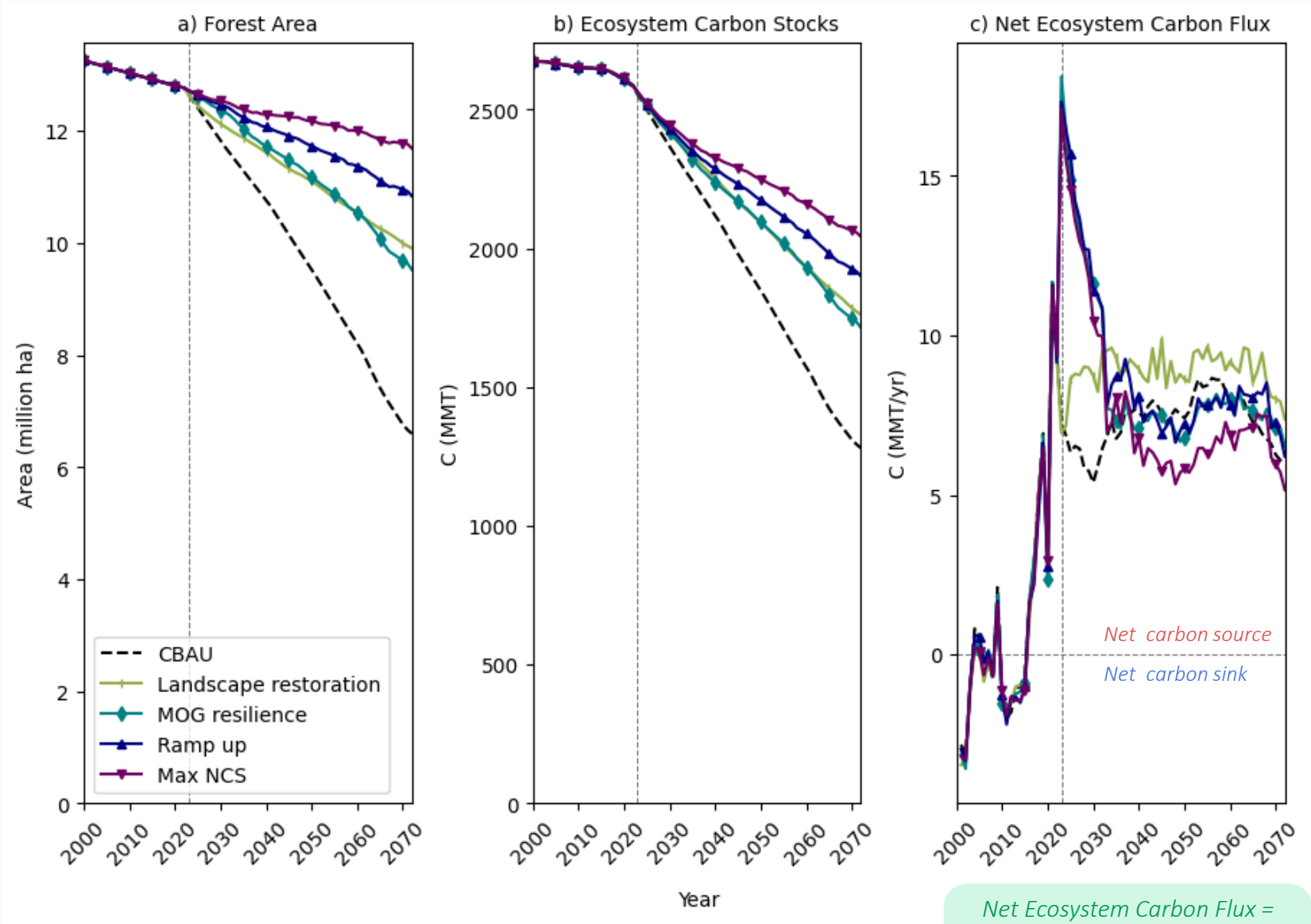
- Future climate drives stand age down with more disturbance and high regeneration failure (stands stay age 0)
- Landscape restoration and resilience treatments help more forest survive, so stand age increases with time

FOREST AGE AND TREATMENT COMPLETION RATE

Ecosystem Scenario	Time Period	Average Forest Age	Treatment Completion
BAU	2022-2031	135	95.56%
	2062-2071	152	95.74%
CBAU*^	2022-2031	132	95.12%
	2062-2071	108	93.87%
Landscape restoration*^	2022-2031	131	95%
	2062-2071	128	94.65%
Fire resilience treatments	2022-2031	136	95.21%
	2062-2071	144	93.92%
Expand fire resilience to mature and old-growth forest*^	2022-2031	136	95.24%
	2062-2071	144	93.99%
*Ramp Up Implementation	2022-2031	135	94.68%
	2062-2071	149	93.68%
^Max NCS Action by 2045	2022-2031	134	94.53%
	2062-2071	148	93.14%

Forest ecosystem trends

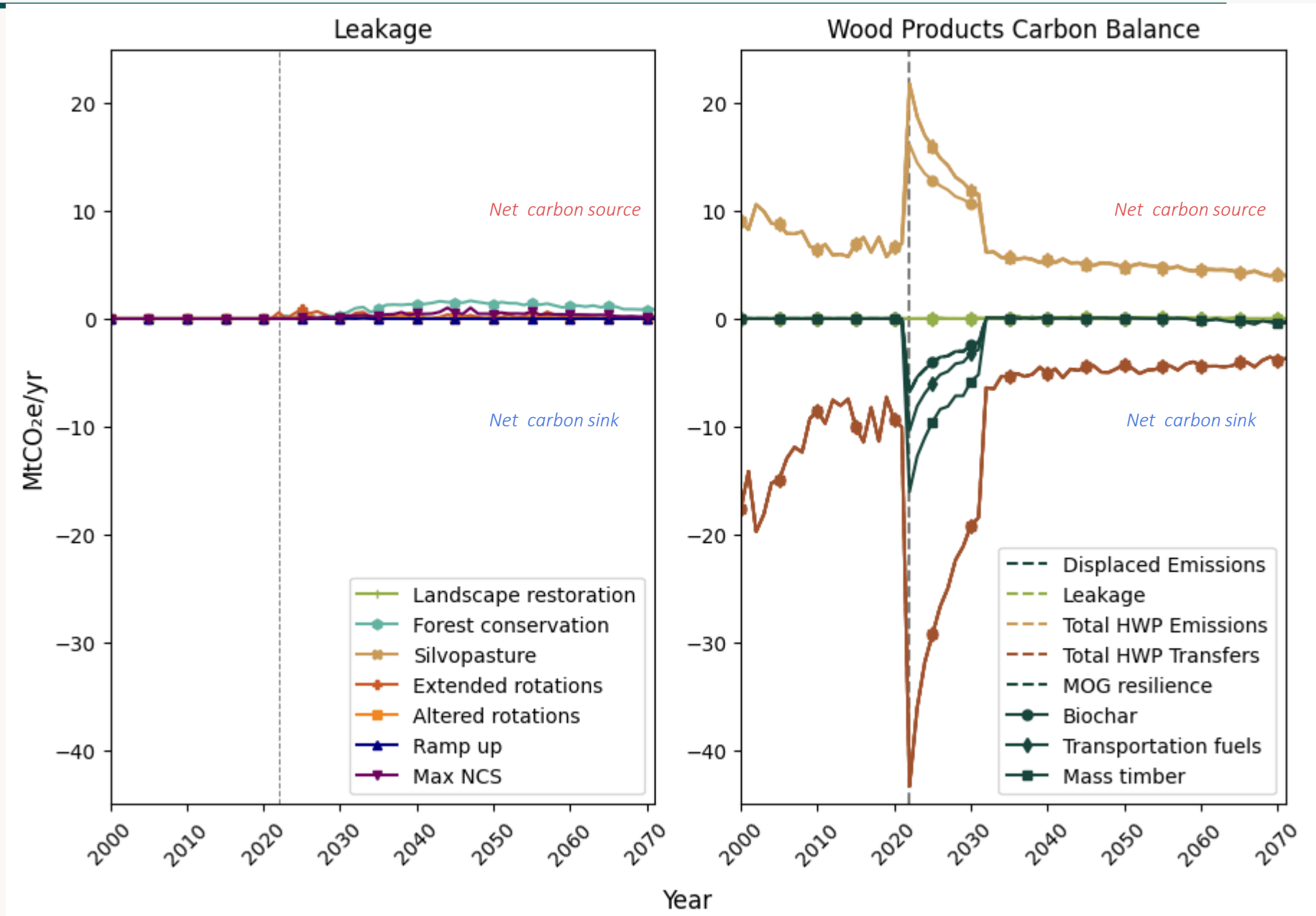
- Max NCS scenario best conserves overall forest area: **-8%** from 2022-2071 (40% better than CBAU)
- Max NCS scenario minimizes carbon stock losses: **-20%** from 2022-2071 (30% better than CBAU)
- Ecosystem carbon flux magnitude is driven by decomposition, natural disturbance, and wood product transfers



Net Ecosystem Carbon Flux = Growth – Decomposition – Disturbance emissions – Harvest transfers

Wood products dynamics

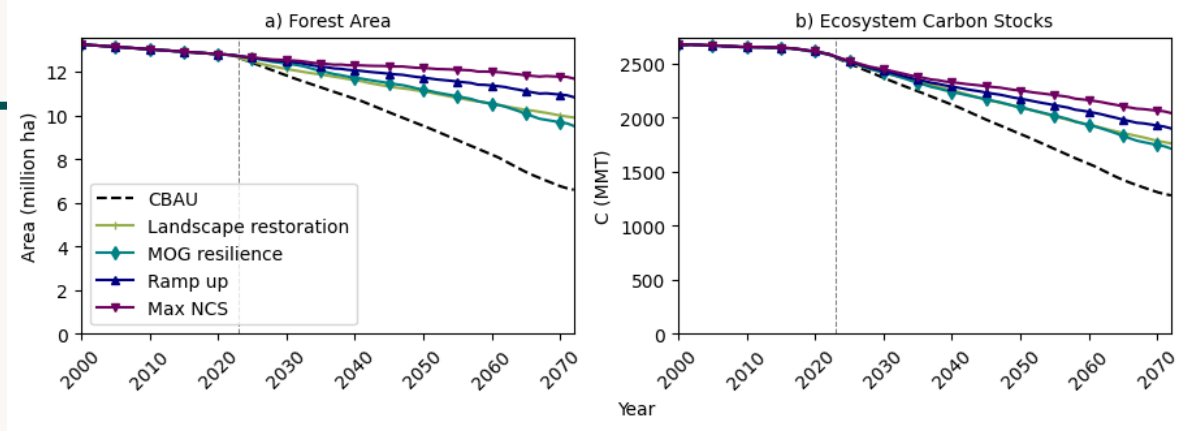
- Wood use drives HWP carbon balance
- Displaced emissions (substitution benefits) contribute **+10-66%** of HWP net carbon sink
- Product use and half-life impact emissions
- Leakage reduces HWP net carbon sink by **0.3-6%**

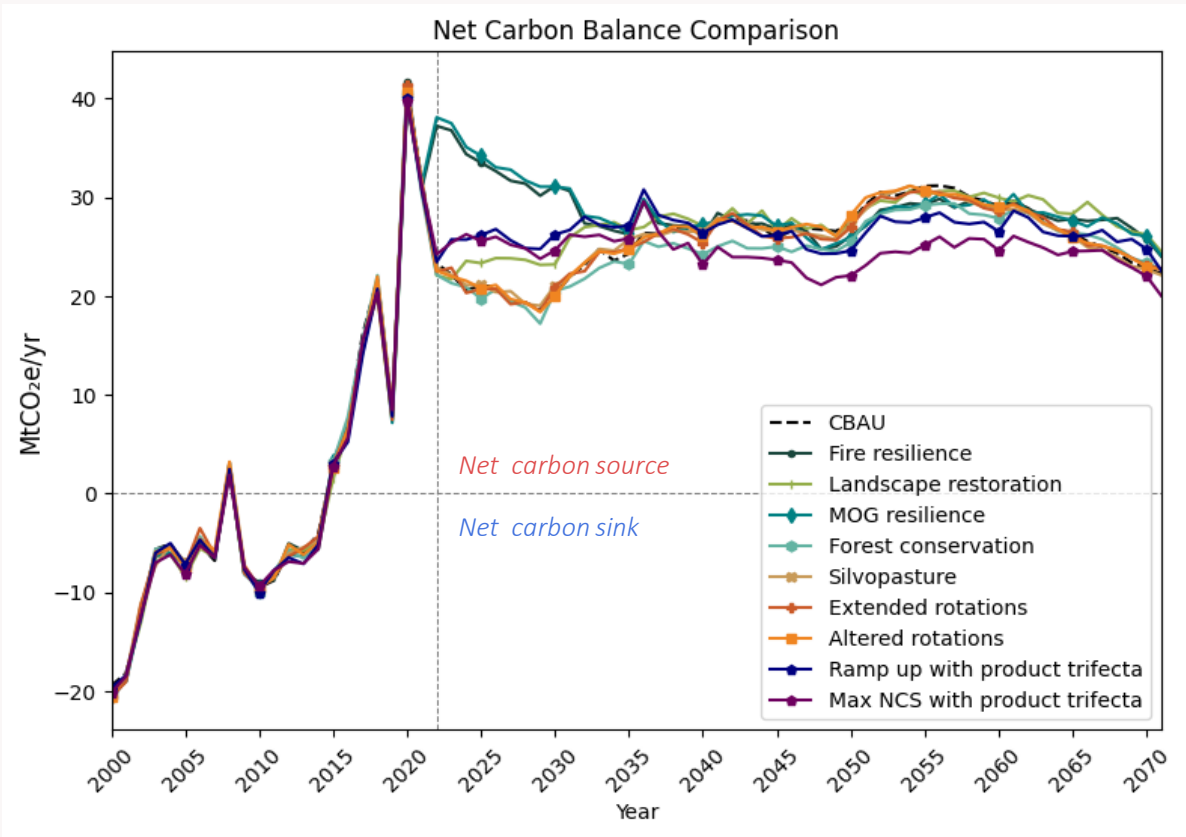


American Forests

Net carbon balance

- Net carbon balance is fairly consistent across scenarios, with variability at different times
- Resilience and landscape restoration strategies show higher early removals from treatments
- Scenarios that do not address wildfire impacts have later but more sustained carbon emissions from wildfire and post-fire regeneration failure
- Carbon flux is just one metric of forest ecosystem health to consider





Net Carbon Balance = Net Ecosystem Carbon Flux + HWP Transfers + HWP Emissions + Leakage + Substitution Benefits

Climate-smart forestry in California

Scenario	CALIFORNIA	
	Annual net carbon balance/ha rank	
	2030s	2050s
CBAU	4	12
Landscape restoration*^	9	7
Fire resilience treatments	10	5
Expand fire resilience to mature and old-growth forest*^	11	6
Forest conservation^	1	8
Silvopasture^	7	9
Extended rotations^	3	10
Altered rotations	5	11
*Ramp up implementation	12	4
+ innovative wood utilization	8	3
^Max NCS Action by 2045	6	2
+ innovative wood utilization	2	1

Less carbon than CBAU — CBAU — More carbon than CBAU

Annual net carbon balance includes net ecosystem sequestration in the forest, transfers to HWP, emissions from wood products in use and in landfills, substitution benefits in years where harvest is different than BAU, and leakage in years where harvest is less than BAU.

American Forests · NIACS · USFS

Forest Carbon and Climate Program
Department of Forestry
MICHIGAN STATE UNIVERSITY

Effects of Forest Management & Wood Utilization on Carbon Sequestration & Storage in California

Major finding:

Climate-smart forestry can increase the net forest carbon sink per hectare by **25%** and overall by **11%** in California by 2045.

Source: DeLyser et al. 2024 (forthcoming)

Key takeaways

1. Forests are a net carbon source in the future (consistent with CARB projections).
2. Addressing post-fire regen failure is critical to maintain forest area and carbon stocks and decrease future emissions – and there is an opportunity to affect future wildfire trends.
3. A portfolio of climate-smart strategies leads to smaller forest area and carbon losses, including upfront landscape-scale restoration & wood utilization.
4. Stand age increases with restoration actions, including in mature and old-growth forest.
5. Wood utilization is necessary to increase forest sector sink strength associated with landscape-scale restoration.
6. Scale of opportunity and timing of action drive carbon trajectories.

Key areas of uncertainty & gaps

UNCERTAINTY

- Global emissions pathway and future climate conditions
- Treatment effectiveness
- Simulation of uneven-aged management dynamics
- Actual extent and impact of future harvest and natural disturbance
- Post-fire regeneration dynamics
- HWP utilization pathways realized
- Leakage/substitution assumptions
- Landfill decomposition assumptions

GAPS

- Structure/composition – species preference cutting assumptions, ICO stand structure
- Diameter limits
- Forest type transitions
- Periodic future harvest for maintenance resilience treatments in addition to Rx fire

Next Steps

- Final written report to be delivered to CALFIRE
- Socio-economic analysis (CALFIRE)
- Peer-reviewed publication(s) to follow

- Additional state outreach and engagement
- Future projects extending from this work?

American Forests™

Questions?

Kendall DeLyser – Director, Climate Science

kdelyser@americanforests.org

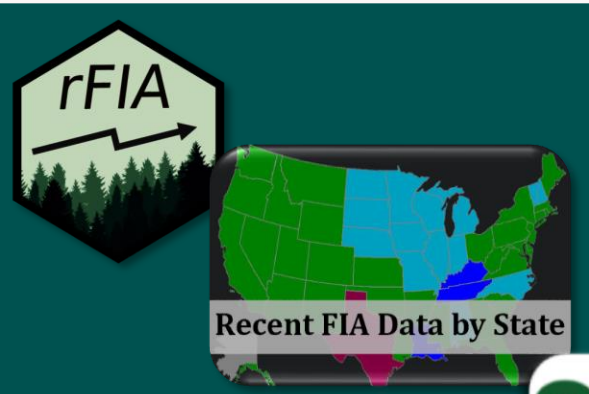
Nadia Tase – Climate Change & Forest Inventory

nadia.tase@fire.ca.gov

Appendix

The CBM-CFS3

Carbon Budget Model of the Canadian Forest Sector



Parameterized with FIA data to ensure accuracy for US forests and conditions

CBM CFS 3

- Model of forest ecosystem carbon dynamics at various levels:

  stand → operational → state → regional → national

- Links to associated ANSE Framework for Harvested Wood Products, which we use to build custom HWP models
- Model is spatially referenced – not tied to specific locations, but can reference types of forest stands using *classifiers* (e.g. forest type, ownership, site class)
- Model is not predictive – requires user-determined inputs for future natural disturbance, climate change, etc

Business-as-Usual (BAU)

Land-Use Change

- NLCD time-series comparison, 2001-2019

Current Management Practices

- GIS data from:
  - USFS activities database (FACTS)
  - Timber harvesting plans (THP)
  - Non-industrial timber management plans (NITMP)
  - CAL FIRE Treatment polygons
  - LANDFIRE Historic Disturbance dataset
- Overlay with classifiers to find area by forest type, owner, etc.

California business-as-usual (BAU) parameters (average ha/yr, 2000-2021)

Event	Practice	Biomass Impact	Total	*USFS*	*Other Federal*	*State/ Local*	*Private/ Tribal*
Land-use change	Forest loss	-	-24,381	*-12,814*	*-2,437*	*-286*	*-8,844*
	Forest gain	-	2,068	*298*	*51*	*51*	*1,669*
	NET TREND	-	**-22,314**	*-12,517*	*-2,387*	*-235*	*-7,175*
Forest management	High harvest	90% cut, 85% removed	10,638	*1,542*	*7*	*5*	*9,084*
	Intermediate harvest	50% cut, 45% removed	14,399	*1,244*	*18*	*74*	*13,064*
	Group selection	50% cut, 45% removed	21,447	*452*	*7*	*376*	*20,613*
	Commercial thin	30% cut, 25% removed	16,638	*10,566*	*14*	*18*	*6,040*
	Hazardous fuels thin	30% cut, no removal	3,943	*2,666*	*53*	*135*	*1,088*
	Precommercial thin	10% cut, no removal	16,032	*11,092*	*7*	*30*	*4,093*
	Rx fire	5% burned	10,137	*4,909*	*420*	*317*	*2,083*
	Pile burn	50-90% consumption of pile	8,241	-	-	-	-
	Salvage	90% cut, 90% removed	11,985	*1,852*	-	*4*	*10,128*
	MANAGEMENT TOTAL	-	**113,461**	*35,133*	*526*	*960*	*66,193*

BAU/CBAU

Natural Disturbances

- Historic data from:
  - Monitoring Trends in Burn Severity (MTBS)
  - USFS Rapid Assessment of Post-Fire Vegetation Condition (RAVG)
  - USFS Insect & Disease Surveys (IDS)
- Future projections from:
  - Westerling et al. 2018 (4th California Climate Assessment; wildfire projections)
  - Anderegg et al. 2022 (insect/disease, abiotic projections)

Additional CBAU assumptions

- Future productivity: average -27.34% from 2020-2100 (Climate-Adapted Seed Tool)
- Post-fire regeneration: average 82.2% acres will fail to regenerate after high-severity fire (Davis et al. 2023)

Natural Disturbance (annual average ha/yr, 2022-2071)

Parameter		BAU	CBAU	Difference
Wildfire	High Severity	57,805	151,685	87,416
	Moderate Severity	55,759	143,298	79,898
	Low Severity	69,700	69,699	-
Insects	High, Mort	1,965	3,544	1,471
	Mod, Mort	318,398	584,282	255,006
	Low, Mort	76,982	134,387	55,350
	High, Defol	3,405	3,404	-
	Mod, Defol	643	643	-
	Low, Defol	6,078	6,078	-
Disease	High, Mort	39	38	-
	Mod, Mort	18,024	22,919	4,863
	Low, Mort	1,892	1,823	(69)
	High, No Mort	1,863	1,863	-
	Mod, No Mort	2,115	2,115	-
	Low, No Mort	4,423		-
Abiotics	High, Mort	406	474	48
	Mod, Mort	3,952	4,157	183
	Low, Mort	12	13	-
	High, No Mort	3,545	3,545	-
	Mod, No Mort	731	731	-
	Low, No Mort	3,127	3,127	-

CALIFORNIA EXPANDED FIRE RESILIENCE TREATMENT PARAMETERS (1 of 2)

Forest Type Group	Ownership	Ecoregion	Slope Class	Stand Age	Productivity	Reserve Status	Critical Habitat Status	Thinning	Rx Fire
California mixed conifer, Douglas-fir, Ponderosa pine	USFS, Other Federal, State/Local	All	All	All	All	**Reserve**	All	-	Every 20 years
			0-49%	**<189 years (CMC) <180 years (DF) <142 years (PP)**	Productive	Not reserve	All	Mechanical thin (40% biomass cut, 35% removed)	Follow up every 15 years
				<256 years (CMC) <260 years (DF) <200 years (PP)	Not Productive	Not reserve	All	Mechanical thin (40% biomass cut, 35% removed)	Follow up every 15 years
			50-69%	**<189 years (CMC) <180 years (DF) <142 years (PP)**	Productive	Not reserve	All	Hand thin (5% biomass cut); repeat on 15-year cycle	Follow up pile burn 5 years later; repeat on 15-year cycle
				<256years (CMC) <260 years (DF) <200 years (PP)	Not Productive	Not reserve	All	Hand thin (5% biomass cut); repeat on 15-year cycle	Follow up pile burn 5 years later; repeat on 15-year cycle
	NPS	All	All	All	**All**	All	All	-	Every 20 years
	Private, Private industrial	All	0-49%	**<189 years (CMC) <180 years (DF) <142 years (PP)**	Productive	All	All	Mechanical thin (40% biomass reduction)	Follow up every 15 years
				<256years (CMC) <260 years (DF) <200 years (PP)	Not Productive	All	All	Mechanical thin (40% biomass reduction)	Follow up every 15 years
			50-69%	All	**All**	All	All	-	-
Western oak (Oak woodlands)	All	All	All	All	All	All	**Critical habitat**	-	-
	USFS, Other Federal, State/Local, Tribal	All	0-49%	All	**All**	**Reserve**	Not critical habitat	-	Every 10 years
			0-49%	All	All	Not reserve	Not critical habitat	Mechanical thin (20% biomass cut, 15% removed)	Follow up every 10 years
			50-69%	All	All	Not reserve	Not critical habitat	-	-
	NPS	All	0-49%	All	All	All	Not critical habitat	-	Every 10 years
			50-69%	All	All	All	Not critical habitat	-	-
	Private, Private industrial	All	All	All	All	All	Not critical habitat	-	-

CALIFORNIA EXPANDED FIRE RESILIENCE TREATMENT PARAMETERS (2 of 2)

Forest Type Group	Ownership	Ecoregion	Slope Class	Stand Age	Productivity	Reserve Status	Critical Habitat Status	Thinning	Rx Fire
Redwood (Coast Redwood)	All	North Coast, Central Coast & Interior Ranges	All	All		All	**Critical habitat**	-	-
			0-49%	**<150 years**	Productive	All	Not critical habitat	Mechanical thin (40% biomass cut, 35% removed)	Follow up every 30 years
				<200 years	Not Productive	All	Not critical habitat	Mechanical thin (40% biomass cut, 35% removed)	Follow up every 30 years
			50-69%	**<150 years**	Productive	All	Not critical habitat	-	Every 30 years
				<200 years	Not Productive	All	Not critical habitat	-	Every 30 years
Redwood (Giant Sequoia)	All	Sierra/Cascades, Klamath/Interior Coast Ranges	All	All	All	All	**Critical habitat**	-	-
			All	All	All	All	Not critical habitat	-	Every 30 years
Fir/spruce/mtn hemlock, Lodgepole pine, Western white pine	All	All	All	All	All	**Critical habitat**	-		
	USFS, Other federal, State/local, Tribal, Private, Private industrial	All	All	All	All	**Reserve**	Not critical habitat	-	-
			0-49%	**<150 years <151 years (FSM)**	Productive	Not reserve	Not critical habitat	Mechanical thin (40% biomass cut, 35% removed)	
				<200 years <247 years (FSM)	Not Productive	Not reserve	Not critical habitat	Mechanical thin (40% biomass cut, 35% removed)	
			50-69%	All		Not reserve	Not critical habitat	-	-
Pinyon/juniper, Tanoak/laurel	All	All	All	All	All	All	**Critical habitat**	-	-
				All	All	All	Not critical habitat	Hand thin (5% biomass cut); repeat on 15-year cycle	Follow up pile burn 5 years later; repeat on 15-year cycle
Hemlock/Sitka spruce, Other Western SW, Elm/ash/ cottonwood, Aspen/birch, Other HW, Woodland HW	All	All	All	All	All	All	**Critical habitat**	-	-
						All	Not critical habitat	-	-

Scenario combos and abbreviations

- Scenarios in **green** use current HWP assumptions only
- Scenarios in **brown** include innovative wood product(s) use
- Scenarios marked with * are part of the Ramp Up portfolio
- Scenarios marked with ^ are part of the Max NCS Action portfolio

California ecosystem + HWP carbon modeling scenarios

Abbreviation	Ecosystem Scenario	HWP Scenario
LR	Landscape restoration*^	BAU
FR	Fire resilience treatments	BAU
FR Biochar		Biochar
FR Transport		Transportation Fuels
FR MT		Mass Timber
MR	Expand fire resilience to mature and old-growth forest*^	BAU
MR Biochar		Biochar
MR Transport		Transportation Fuels
MR MT		Mass Timber
FC	Forest conservation^	BAU
SV	Silvopasture^	BAU
ER	Extended Rotations^	BAU
AR	Altered Rotations	BAU
RU	Ramp Up Implementation (* scenarios)	BAU
RU Products		Product Trifecta
NCS	Max Natural Climate Solutions Action by 2045 (^ scenarios)	BAU
NCS Products		Product Trifecta

American Forests

Carbon Modeling Portfolios

- All alternative scenarios on previous slide are run alone
- Create portfolios to represent simultaneous and comprehensive state action on climate-smart forestry

California ecosystem and wood product carbon modeling portfolios

Portfolio	Component scenarios	
Ramp Up Implementation	Ecosystem	CBAU* + Landscape restoration + Expanded fire resilience to include mature and old-growth
	Wood Products	Biochar + transportation fuels + long-lived products
Max Natural Climate Solutions Action by 2045	Ecosystem	CBAU* + Landscape restoration + Expanded fire resilience to include mature and old-growth + Forest conservation + Silvopasture + Extended rotations
	Wood Products	Biochar + transportation fuels + long-lived products

* Includes CBAU management and natural disturbances not affected by other component scenarios