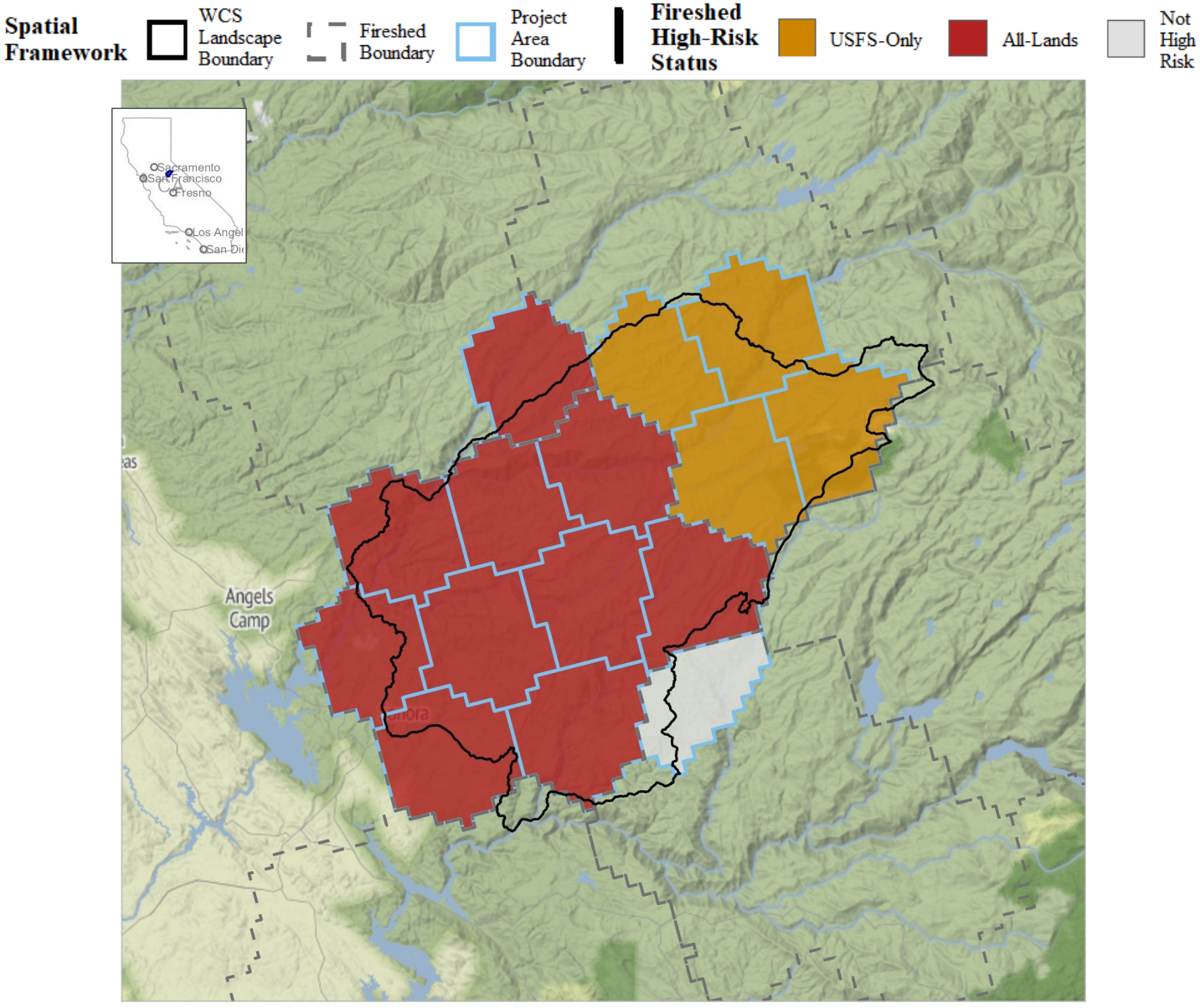
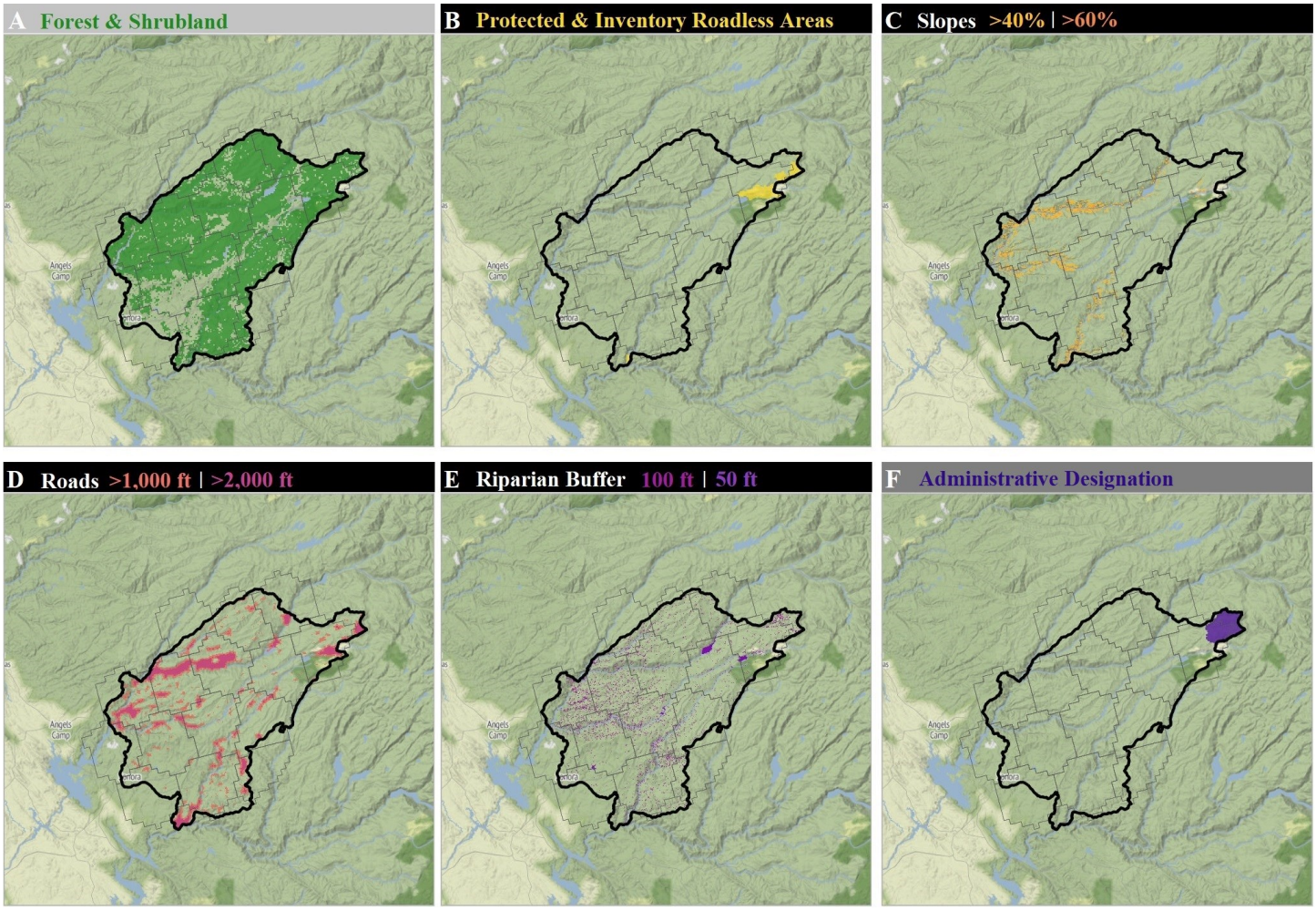
Influence of Physical and Policy Constraints to Mechanical Fuel Operations on the Stanislau Wildfire Crisis Strategy Landscape

The Stanislau landscape identified in the U.S. Department of Agriculture, Forest Service's Wildfire Crisis Strategy (WCS), located in California covers 305,000 acres. This analysis evaluates how legal classifications, slope restrictions, road infrastructure, riparian buffers, and administrative land designations impact the proportion of the landscape available for mechanical operations. Under the status quo approach, ~27% of the landscape is too steep for traditional mechanical operations. Allowing for steep slope operations reduces this impact to only constrain ~11% of the landscape, leaving riparian buffers as the most constraining feature. Expanding the use of temporary roads, greater skidding distances, and steep slope operations increases the largest patch of low mechanical constraint from 20% to 80% of the landscape.



The above map shows the WCS landscape (black outline), along with the firesheds (gray dashed outline; Ager et al. (2021)) that are ~250,000 acres in size and contain ~10 nested fireshed project areas (light blue outline) that are ~25,000 acres in size and are used for planning and conducting vegetation management projects. In the map, fireshed project areas are shaded by risk to communities and infrastructure of the parent fireshed with the shaded firesheds representing those with the 5% highest risk nationally. Of the 14 high-risk fireshed project areas in the landscape, 4 are managed by the Forest Service (shaded orange) and 10 have diverse ownerships (shaded red).

Constraints tested for mechanical operability



The above maps show the layered operational constraints were considered in order to quantify the amount of land available for mechanical forest health and risk reduction fuel treatments. The map identifies (A) forest and shrubland vegetation, (B) protected and inventoried roadless areas, (C) areas exceeding either 40% or 60% slopes, (D) areas greater than either 1,000 ft or 2,000 ft from existing roads, (E) areas within either 100 ft or 50 ft riparian buffers, and (F) areas with administrative designations (e.g., sensitive species habitat, conservation areas).

In the Stanislau landscape, this analysis (A) identified 287k acres of forest and shrubland representing the total land available for treatment given no constraints, (B) identified 8k acres of protected and inventoried roadless areas (IRA), (C) classified 80k acres as >40% slope terrain and 32k acres as >60% slopes, (D) determined 69k acres were >1,000 ft and 23k acres were >2,000 ft from existing roads to represent possible equipment haul distance, (E) identified 135k acres as within 100 ft and 98k acres within 50 ft riparian buffers, (F) and identified 9k acres within administrative boundaries.

A hierarchy of constraints was used to determine whether mechanical equipment was allowed and operationally feasible for this analysis. Spatial constraints were overlaid from L1 through L5 to determine what land is mechanically available or constrained and by what factor.

The below table shows the three scenarios developed to represent a gradient in funding, policy, and management options based on the constraining factors to mechanical operability (e.g., slope, road access, riparian buffers, and administrative designation).

Layer	Constraint Type	Scenario 1	Scenario 2	Scenario 3
L0:	NLCD Cover Type	Forest or Shrubland	Forest or Shrubland	Forest or Shrubland
L1:	Protected or IRA Status	Not Protected	Not Protected	Not Protected
L2:	Slope	<40%	<60%	<60%
L3:	Distance to Nearest Road	<1,000 ft	<2,000 ft	<2,000 ft
L4:	Riparian Buffer	>100 ft	>100 ft	>50 ft
L5:	Administrative Designation	No Designation	No Designation	No Designation

Importance of each constraint on mechanical operations

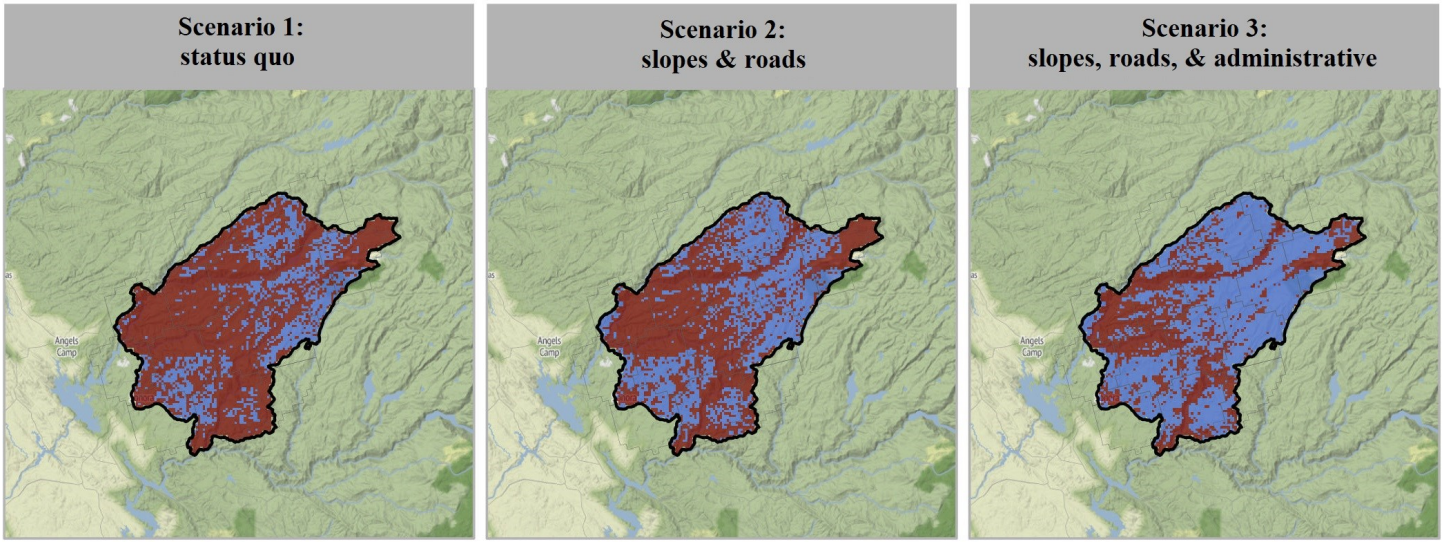
The below table details the percentage reduction from different types of constraints on mechanical treatment based on the three scenarios of operational constraints detailed above on the Stanislau landscape.

Scenario	Forest & Shrub (acres)	Forest & Shrub (%)	Protected & IRA	Slope Steepness	Road Distance	Riparian Buffer	Administrative	Mechanically Available (acres)	Mechanically Available (%)
Scenario 1: status quo	116k	94.3%	-2.9%	-26.7%	-10.6%	-24.7%	-0.6%	40k	34.5%
Scenario 2: slopes & roads	116k	94.3%	-2.9%	-10.7%	-3.9%	-35.8%	-0.8%	53k	46.0%
Scenario 3: slopes, roads, & administrative	116k	94.3%	-2.9%	-10.7%	-3.9%	-26.1%	0.0%	66k	56.5%

In the Stanislau landscape, this analysis identified 35% as mechanically available under the status quo (scenario 1), 46% when increasing slope and road access (scenario 2), and 57% under increased slope and road access and relaxed constraints to mechanical operations in administratively designated areas (scenario 3). In scenario 1 steep slopes constrain mechanical operations on 27% of the landscape, with this shifting to riparian buffers being the most constraining feature in scenario 2.

Landscape classified as available or constrained to mechanical operations

Available | **Constrained**



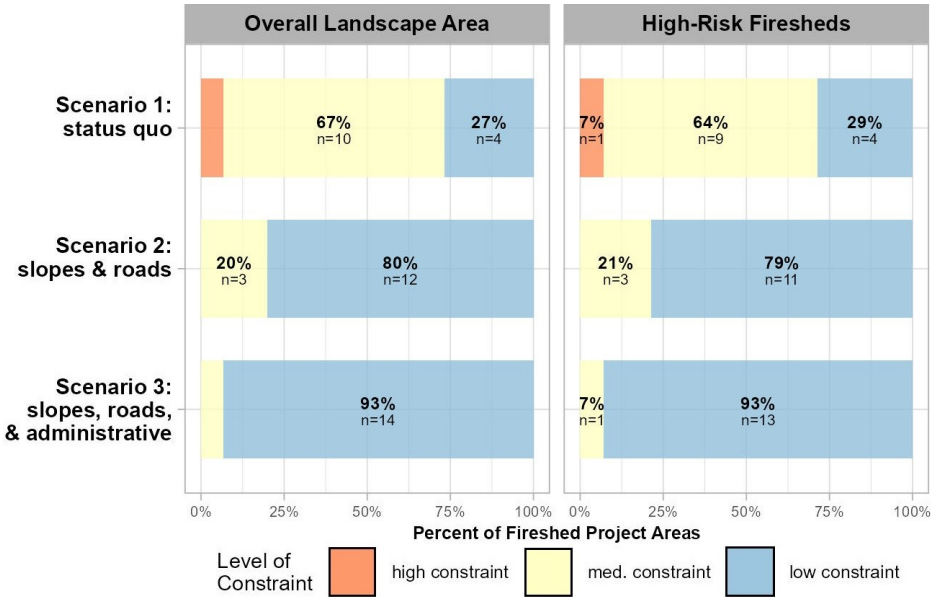
The above maps show how the overlapping spatial constraints were used to classify pixels within the landscape as either available (blue) or constrained (red) for mechanical operations.

Classification of fireshed project areas based on level of mechanical constraint

After identifying the area available for mechanical operations, we used the fireshed project areas to characterize the spatial arrangement of mechanically available land. We chose levels of mechanical constraint to classify fireshed project areas based on WCS objectives and science showing that fuels treatments are more effective as the percentage of the landscape treated progressively increases. After classifying each fireshed project area, we calculated the proportion of fireshed project areas by constraint class both within the overall landscape area and within high-risk firesheds only.

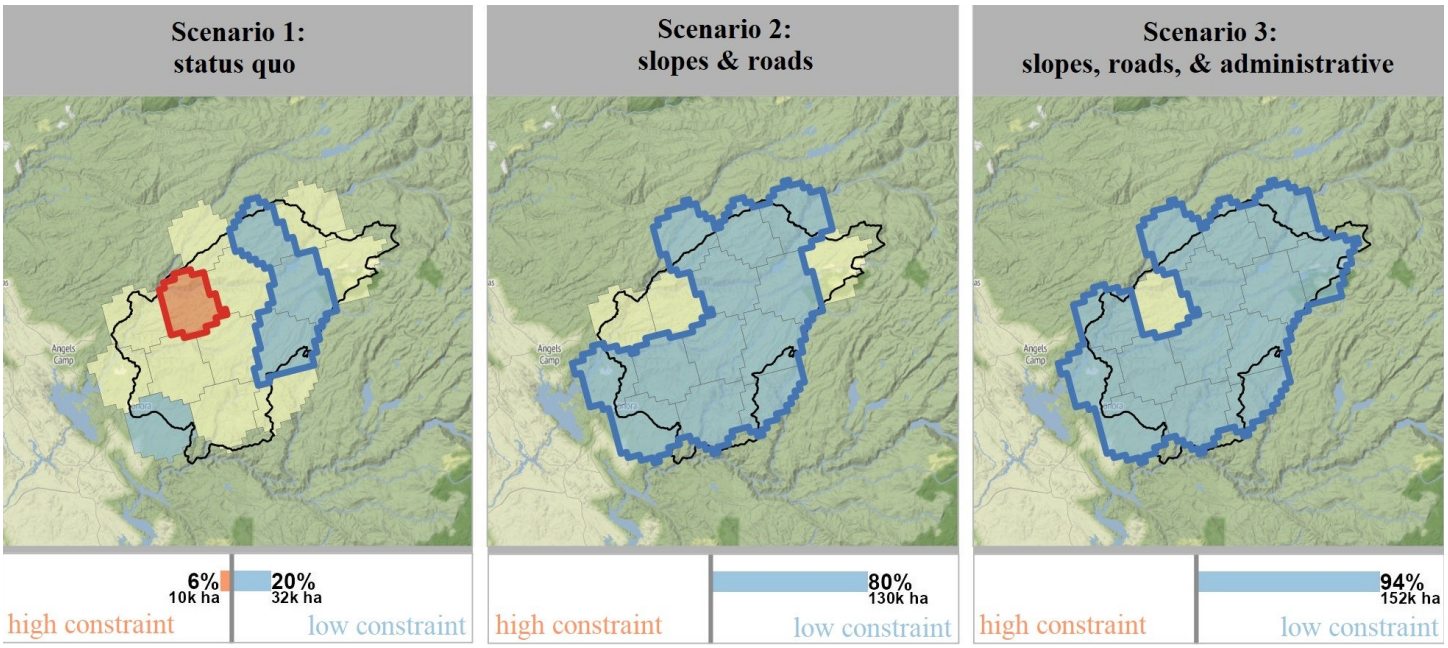
Fireshed project areas of ~25,000 acres in size represent the geographic unit at which vegetation and fuel management projects are planned. The below table and figure define the three classes of mechanical constraint intensity and the proportion of project area in each class under the three scenarios.

Level of Constraint	Mechanically Constrained Area	Mechanically Available Area
High Constraint	81-100%	0-19%
Medium Constraint	60-80%	20-40%
Low Constraint	0-59%	41-100%



Spatial arrangement of mechanically available land

The fireshed project areas were then mapped and shaded by level of constraint. We selected the largest patch of interconnected fireshed project areas by constraint class and calculated the percent of the area of the overall landscape comprised by this patch (i.e., largest patch index). Comparison is made between the largest patch of project areas classified as high constraint (100% to 81% constrained; 0% to 19% available for mechanical treatment) and the largest patch of project areas classified as low constraint (0% to 59% constrained; 41% to 100% available). Extensive patches with little mechanical constraint represent opportunities for land managers to design plans that incorporate the principles of effective landscape-scale fuel treatments.

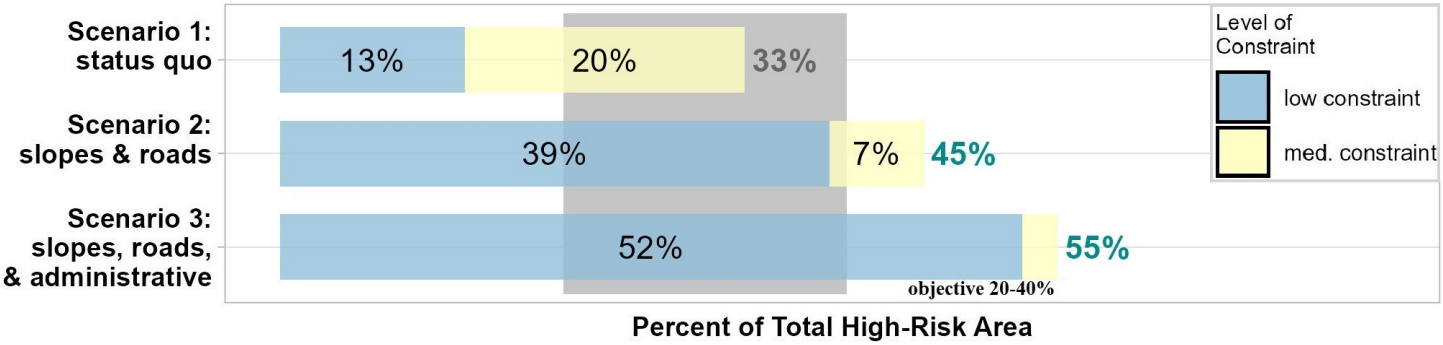


The above maps show the largest patch of high constraint (red) and low constraint (blue) fireshed project areas under the three scenarios.

On the Stanislau landscape, the proportion of total area composed of the largest patch of low mechanical constraint project areas was 20% under the status quo (scenario 1), 80% when increasing slope and road access (scenario 2), and 94% under increased slope and road access and relaxed constraints to mechanical operations in administratively designated areas (scenario 3). Conversely, on this priority landscape, the proportion of total landscape area composed of the largest patch of high mechanical constraint project areas was 6% under scenario 1, 0% under scenario 2, and 0% under scenario 3.

Mechanically available acres to meet treatment area objective of 20% to 40%

To assess the 20% to 40% objective, the amount of mechanically available area within low and medium constraint high-risk fireshed planning areas was aggregated and compared against the total area of high-risk fireshed planning areas.



The above figure shows the percent of total area within high-risk firesheds where there exists the ability to create effective, extensive fuels treatments by mechanical methods alone (low constraint areas: 0% to 59% constrained; 41% to 100% available for mechanical treatment) or in combination with managed fire (medium constraint areas: 60% to 80% constrained; 20% to 40% available). The gray area in the plot represents the WCS objective of treating 20% to 40% of high-risk fireshed acreage. The combined low and medium constraint acreage in Scenario 1 (33%, gray) met the objective, while low constraint acres in Scenarios 2 and 3 (45%, 55%, turquoise) can meet the objective.

On the Stanislau landscape, there is sufficient mechanically available acreage to meet the 20% minimum target of high-risk acreage by pooling low and medium constraint areas under the status quo (scenario 1). Increasing slope and road access under scenario 2 opens sufficient acreage such that over 20% of high-risk area is mechanically available in lightly constraint project areas to meet the WCS treatment objective. Expanding mechanical access to riparian areas and within administratively designated areas are pathways to enhance flexibility to meet additional management objectives.

Work based on:

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Chad Hoffman is a Professor of Fire Science at Colorado State University who investigates the interactions of fuels with fire behavior and effects at fine-scales to improve fire risk assessment and prescribed fire planning.

References:

Ager, A., Day, M., Ringo, C. et al. 2021. Development and Application of the Fireshed Registry. USDA Forest Service, Rocky Mountain Research Station, General Technical Report, RMRS-GTR-425, 47 p. Fort Collins, CO. https://research.fs.usda.gov/treesearch/62641