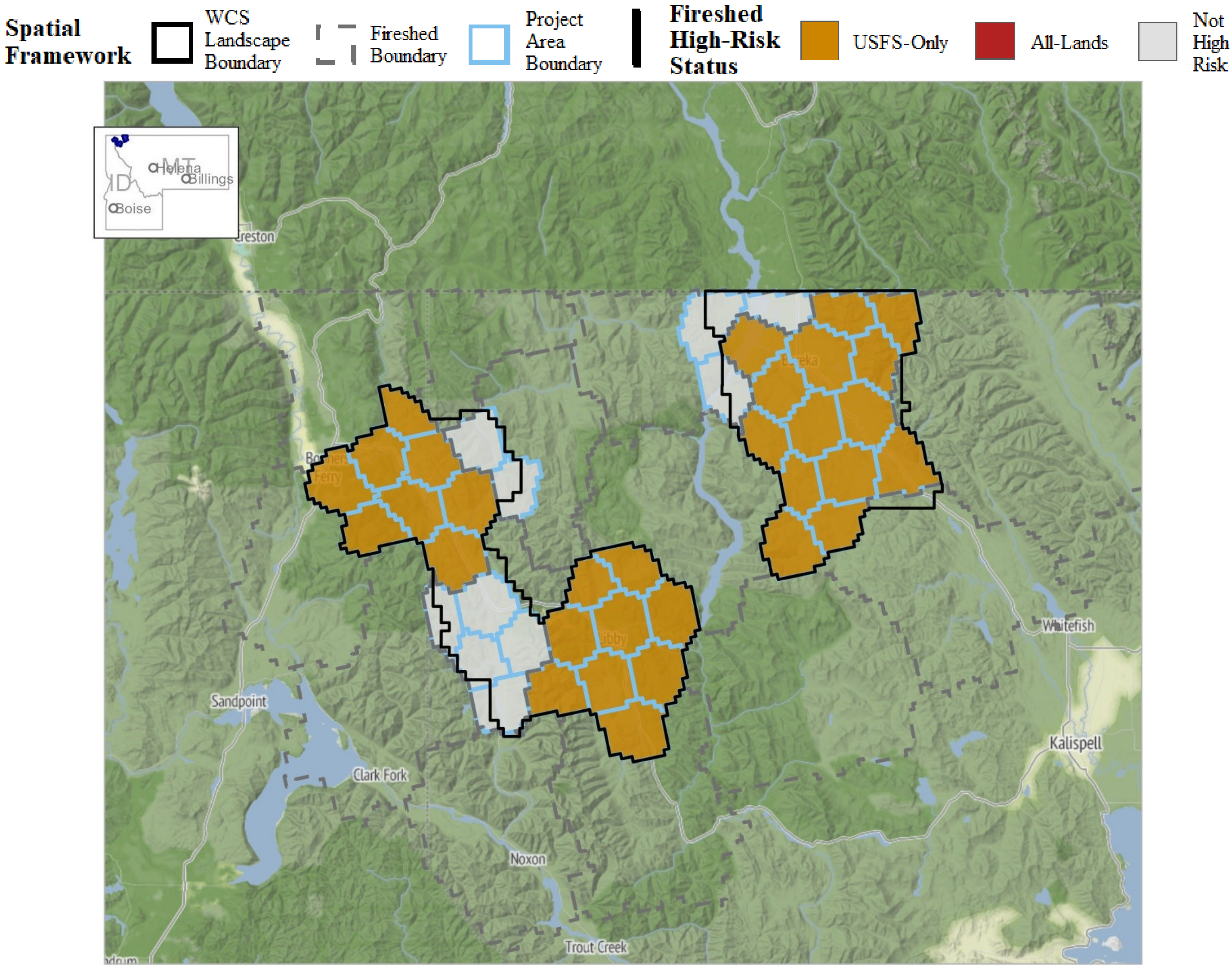
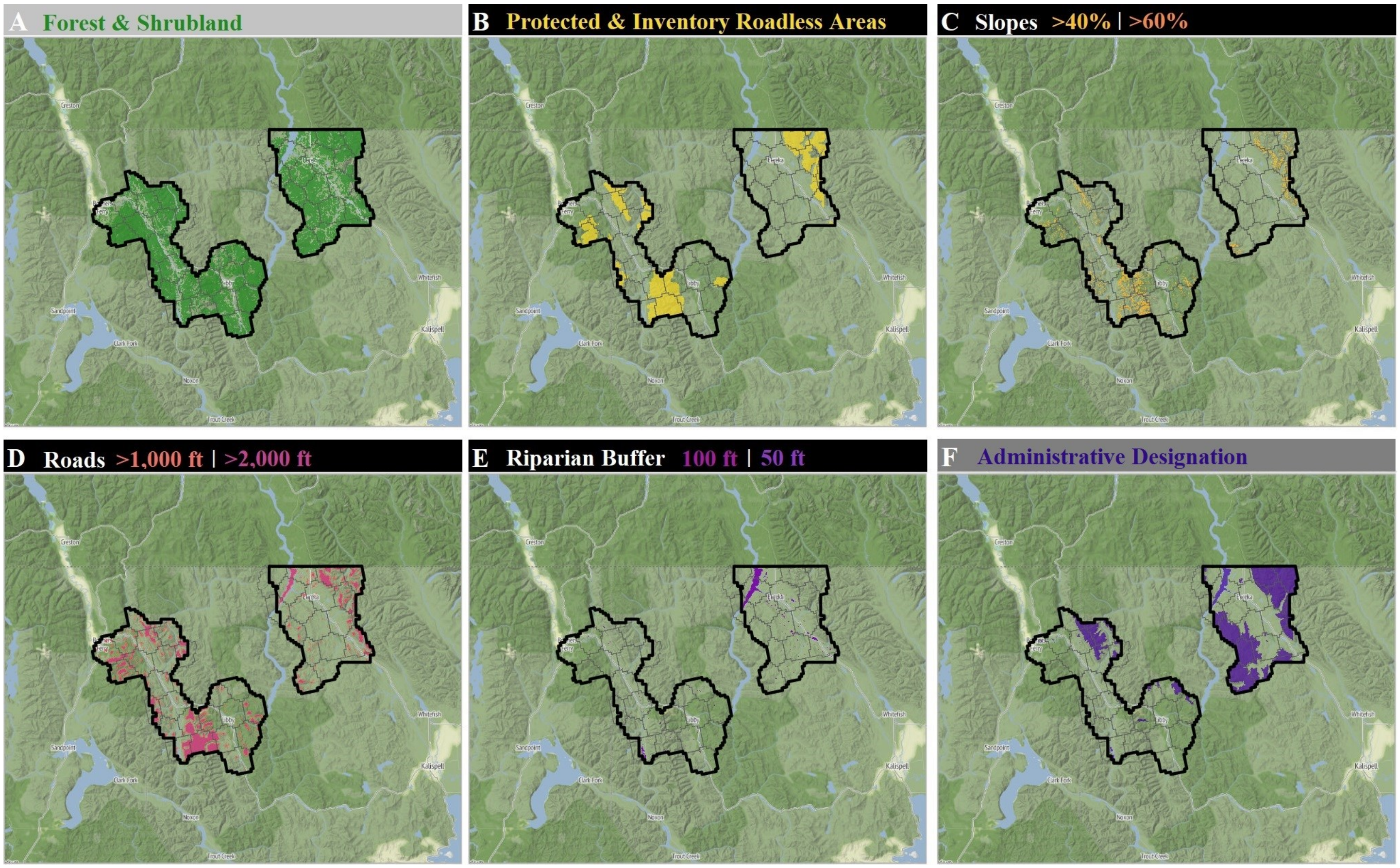
Influence of Physical and Policy Constraints to Mechanical Fuel Operations on the Kootenai Complex Wildfire Crisis Strategy Landscape

The Kootenai Complex landscape identified in the U.S. Department of Agriculture, Forest Service's Wildfire Crisis Strategy (WCS), located in Montana covers 1,009,000 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 treatment approach, more than 24% of the landscape is either too far from existing road infrastructure or too steep for mechanical operations. When allowing for greater use of temporary roads, longer skidding distances, and steep slope operations, administratively designated lands become the most constraining element at ~14%. Expanding the use of temporary roads and longer skidding distances increases the largest patch of low mechanical constraint from 18% to 25% 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 31 high-risk fireshed project areas in the landscape, all of which are managed by the Forest Service (shaded orange).

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 Kootenai Complex landscape, this analysis (A) identified 920k acres of forest and shrubland representing the total land available for treatment given no constraints, (B) identified 209k acres of protected and inventoried roadless areas (IRA), (C) classified 277k acres as >40% slope terrain and 92k acres as >60% slopes, (D) determined 262k acres were >1,000 ft and 114k acres were >2,000 ft from existing roads to represent possible equipment haul distance, (E) identified 138k acres as within 100 ft and 102k acres within 50 ft riparian buffers, (F) and identified 259k 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

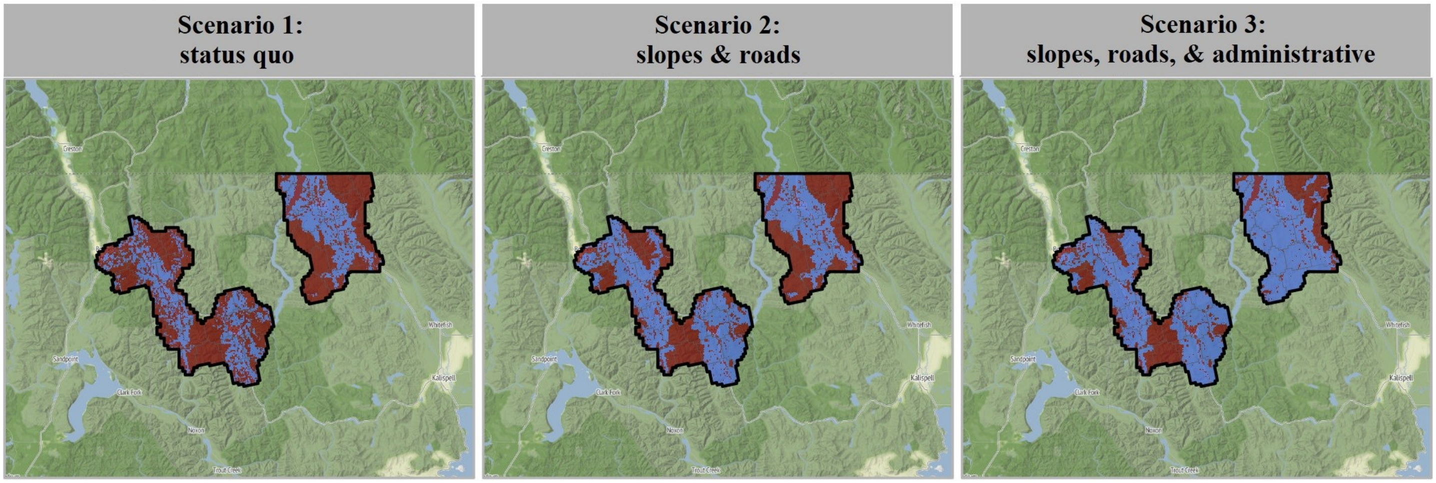
The below table details the percentage reduction from different types of constraints on mechanical treatment based on the three scenarios of operational constraints detailed above on the Kootenai Complex landscape.

Scenario	Forest & Shrub (acres)	Forest & Shrub (%)	Protected & IRA	Slope Steepness	Road Distance	Riparian Buffer	Administrative	Mechanically Available (acres)	Mechanically Available (%)
Scenario 1: status quo	327k	91.4%	-21.4%	-15.0%	-7.8%	-6.9%	-10.6%	142k	38.3%
Scenario 2: slopes & roads	327k	91.4%	-21.4%	-3.6%	-2.1%	-8.6%	-13.8%	188k	50.6%
Scenario 3: slopes, roads, & administrative	327k	91.4%	-21.4%	-3.6%	-2.1%	-6.1%	0.0%	249K	66.9%

In the Kootenai Complex landscape, this analysis identified 38% as mechanically available under the status quo (scenario 1), 51% when increasing slope and road access (scenario 2), and 67% under increased slope and road access and relaxed constraints to mechanical operations in administratively designated areas (scenario 3). In scenario 1 steep slopes are the most constraining factor, with this shifting to administrative designations under scenario 2.

Landscape classified as available or constrained to mechanical operations

Available | **Constrained**



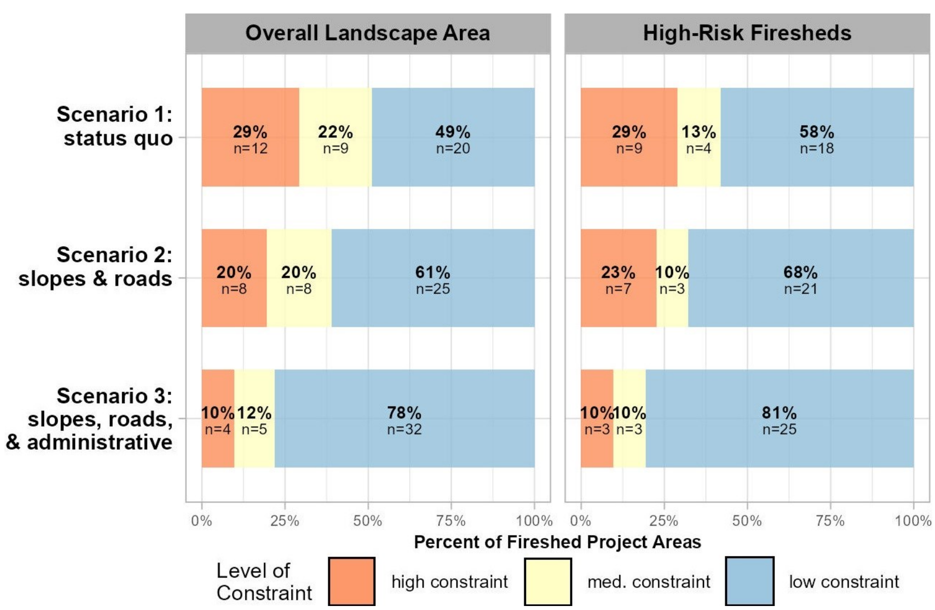
The above maps show how the overlapping spatial constraints were used to classify pixels within the landscape as either available (blue) or constrained (red) for mechanical operations.

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.

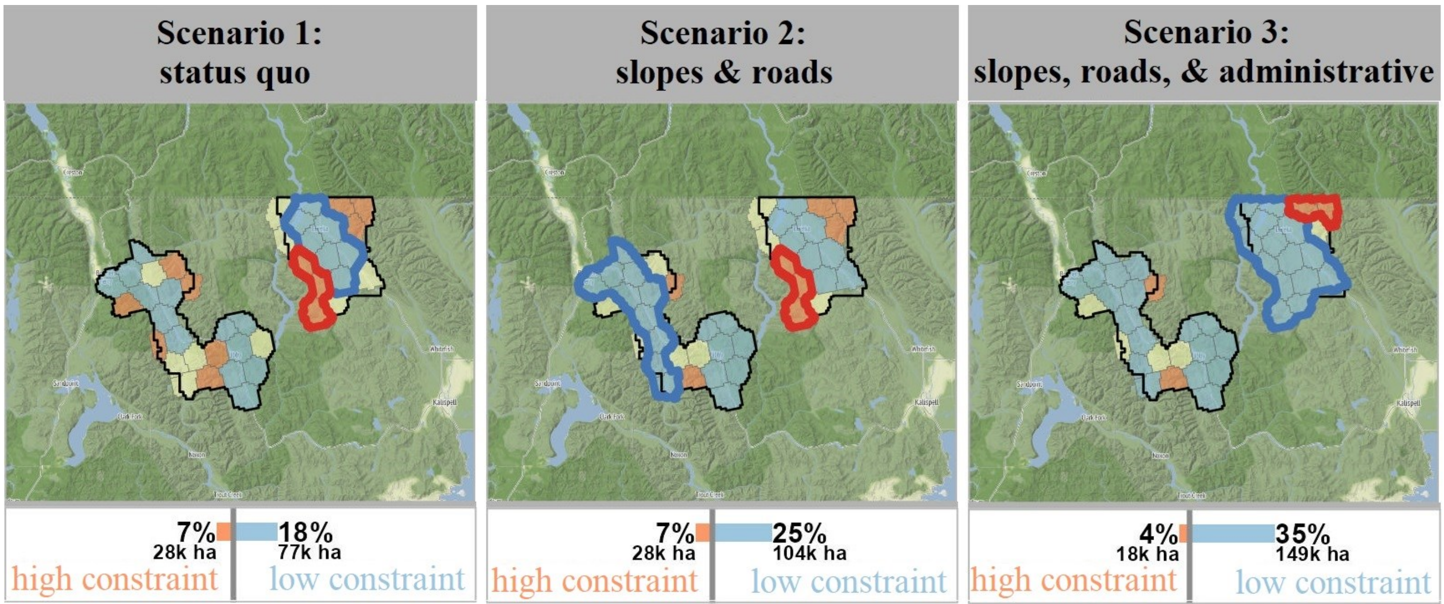
Fireshed project areas of ~25,000 acres in size represent the geographic unit at which vegetation and fuel management projects are planned. The below table and figure define the three classes of mechanical constraint intensity and the proportion of project area in each class under the three scenarios.

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

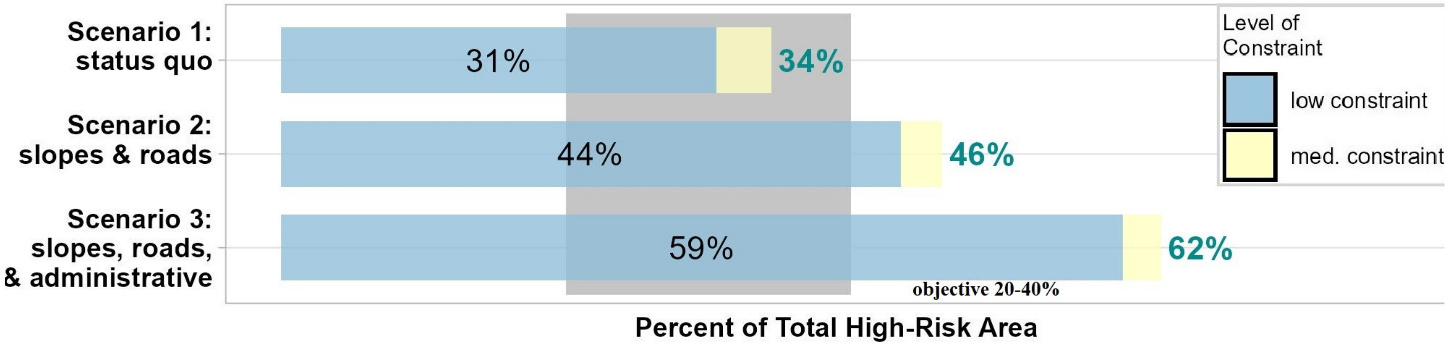


The above maps show the largest patch of high constraint (red) and low constraint (blue) fireshed project areas under the three scenarios.

On the Kootenai Complex landscape, the proportion of total area composed of the largest patch of low mechanical constraint project areas was 18% under the status quo (scenario 1), 25% when increasing slope and road access (scenario 2), and 35% 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 7% under scenario 1, 7% under scenario 2, and 4% 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 Scenarios 1, 2, and 3 (34%, 46%, 62% turquoise) can meet the objective.

On the Kootenai Complex landscape, there is sufficient mechanically available acreage to meet the 20% minimum target of high-risk with just low constraint areas under the status quo (scenario 1). Increasing slope and road access under scenario 2 significantly expands the proportion of the landscape available for mechanical operations. 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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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