Assessing Suitable Areas For Fire Mitigation In Yosemite National Park

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Question

Where should fire mitigation strategies be targeted within Yosemite National Park based on recurring burn areas and land cover data?

Backround

For much of its history, Yosemite National Park (YNP) practiced complete suppression of wildfires. In recent decades this has created an excess buildup of fuels which has led to increased wildfire frequency and intensity. From 2012 to 2022 over 830,000 acres burnt within the park. To bring these numbers down and combat unnaturally large and intense wildfires YNP is using mitigation techniques like prescribed burning and forest mastication. In this study, we attempt to determine where fire mitigation is most suitable based on Fire Recurrence Intervals (FRI) from historical fire data in YNP reaching back to the early 1900s. We will use a combination of fire perimeters, local FRIs, land cover, and elevation data to find the most suitable locations for fire mitigation.

Methods / Data

To begin, we found fire perimeter, land cover, elevation, and Minimum Essential Points (MEP) data on both the USGS and National Park Service online databases. We used ArcGIS Pro software to clean, wrangle, and analyze our data. The initial cleaning and wrangling of our dataset can be found in the Workflow section.

After we completed this initial step, we reclassified 6 raster datasets to into 3 classes each because that was the minimum amount of classes out of our Final Raster Layers. The Reclassified Raster Layers were then ready to be weighted. For our land cover, aspect, and slope classification, we used literature from journal articles and fire mitigation guides (McDaniel et al., 2020; Zhai et al., 2023; NWCG, n.d.). To reclassify our time since the last fire raster we used the average (Fig. 1) and median FRI for all overlapping fires in YNP. For our average FRI per land cover type to classify which were more susceptible to fire by the time of the FRI.

Our weighting scheme had two main components; accessibility (Slope and Trails) and fire susceptibility (Land Cover, Time Since, FRI, and Aspect). We decided that the weights for Map 1 can be found in Fig. 2. The weights for Map 2 were the same as Map 1, but the Roads and Trails criterion was not included and the Slope criterion was weighted 20%.

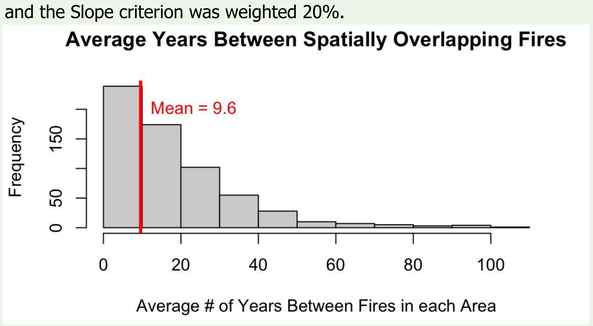
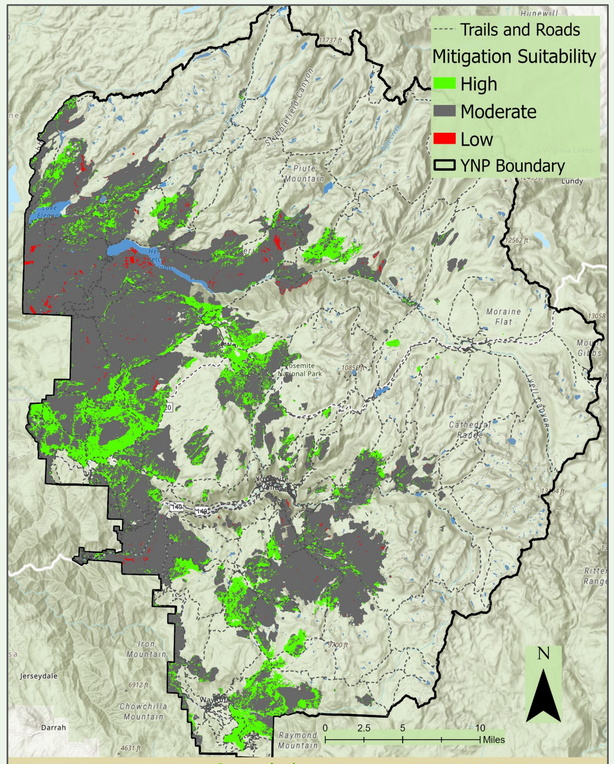


Figure 1: Visualization of years between fires in each overlap.

Rasters	%
landcoverfinal	10
TimeSince	30
MeanFRI	25
YNP_aspect	15
Reclass_Slop1	10
Reclass_trai2	10

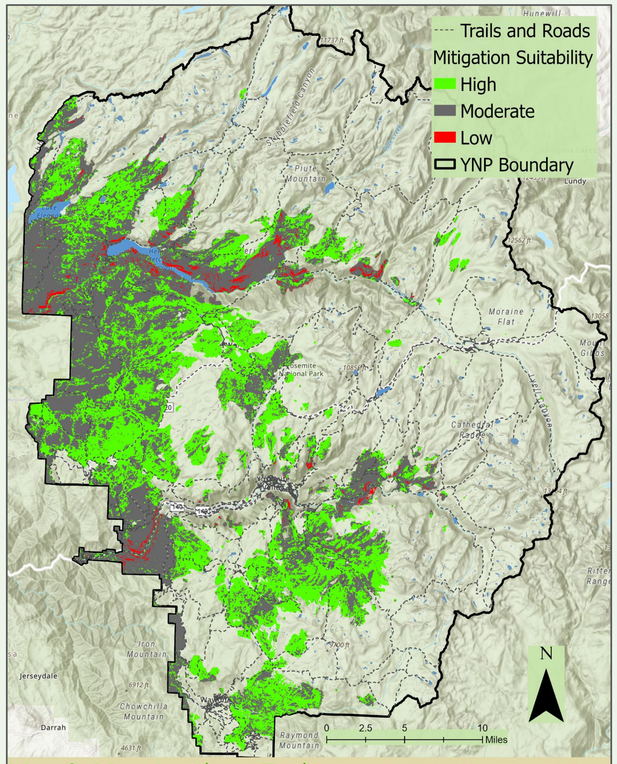
Figure 2: Weights for the Weighted overlay in Map 1.

Results



Map 1: Mitigation Suitability in Yosemite National Park

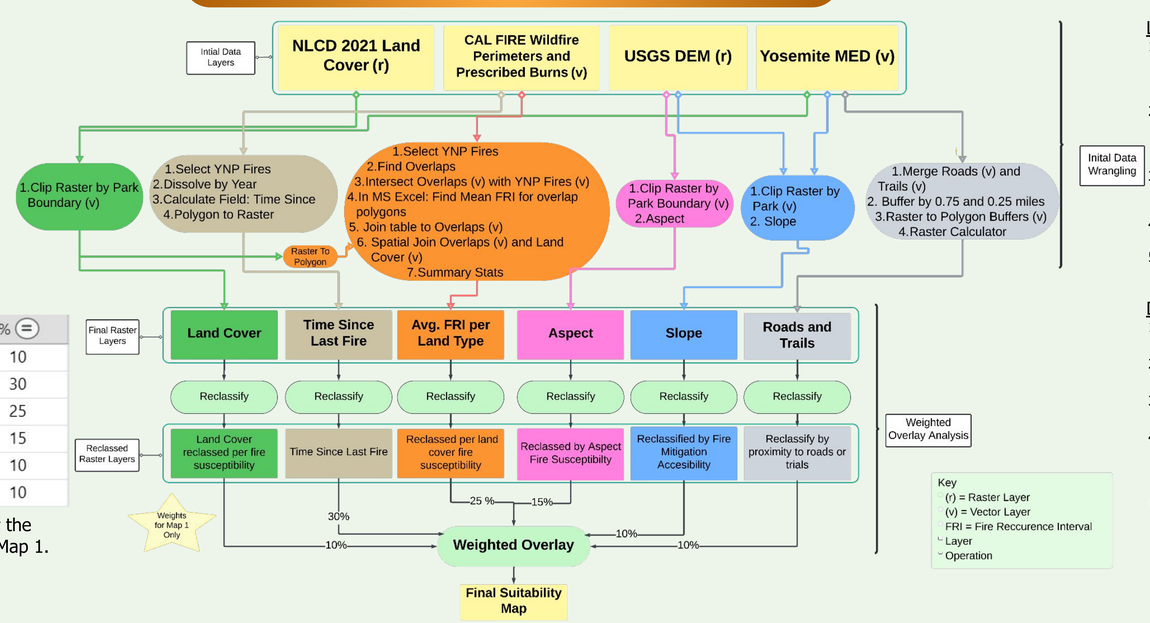
Esri, NASA, NGA, USGS, Mono County, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of



Map 2: Map 1 without Trails and Roads in Analysis

Esri, CGIAR, USGS, Mono County, California State Parks, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, Bureau of

Workflow



Discussion / Conclusion

According to our results in Map 1, ~20 % of the study area is highly suitable for wildfire mitigation techniques. Our less accessible analysis in Map 2 showed that ~47% of the study area is highly suitable. This means there are many places in YNP that mitigation techniques could reduce wildfire susceptibility, but accessibility by trail or road reduces the overall suitability by ~27%. A possible solution to this could be the consideration of implementing more air support and delivery in these mitigation techniques. For example, firefighting crews can be delivered almost anywhere within the park by air, regardless of trail accessibility.

A few notes to keep in mind with this analysis: These maps only show areas that have burned in the past. They are not total fire susceptibility maps, but instead are maps that show where wildfire mitigation techniques should be employed *based on* fire recurrence intervals. An issue we ran into while classifying was whether or not to consider steeper slopes as less or more suitable. Steeper slopes are worse for accessibility but are more susceptible to wildfire (Butler et al., 2007; NWCG, n.d.). After consideration, we decided to classify slope as an accessibility criterion because we already had 4 susceptibility criteria. A final consideration is that this map is useful for only one fire season at a time. As new fire perimeters appear and the time since the last fire increases or is changed, the analysis will be incorrect. A way to address this limitation would be to automate the analysis so that it updates as new data becomes available over time.

This unique analysis provides for a reliable baseline recommendation to target fire mitigation in the areas of High Mitigation Suitability, though these results could be improved by implementing additional more specific measures. Potential further considerations could include air humidity, wind, and seasonal data, along with a consideration of the park's ability to fund said mitigation techniques at any given time.

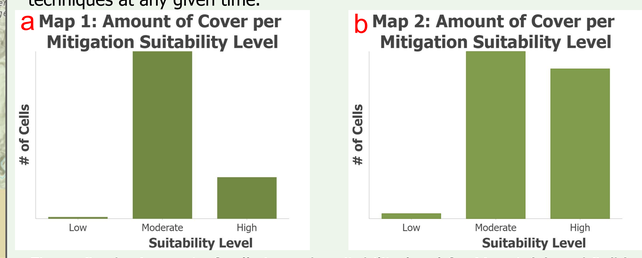


Figure 2a, b: Amount of cells in each suitability level for Map 1 (a) and 2 (b).

References

Literature Citations:

1. Addington, R. N., Tavernia, B. G., Caggiano, M. D., Thompson, M. P., Lawhon, J. D., & Sanderson, J. S. (2020). Identifying opportunities for the use of broadcast prescribed fire on Colorado's Front Range. Forest Ecology and Management, 458, 117655. -https://doi.org/10.1016/j.foreco.2019.117655
2. Butler, B.W.; Anderson, W.R.; Catchpole, E.A. 2007. Influence of slope on fire spread rate. In: Butler, Bret W.; Cook, Wayne, comps. The fire environment--innovations, management, and policy; conference proceedings. 26-30 March 2007; Destin, FL. Proceedings RMRS-P-46CD. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. CD-ROM. p. 75-82
3. McDaniel, J., Jain, T., Heffernan, C., Saralecos, A., & Kinyon, R. (2020). Is mastication right for your site? Science-based decision trees for forest managers. Science You Can Use Bulletin, Issue 45. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 10 P.
4. Module 2: Principles of Wildland Fire Behavior. (n.d.). National Wildfire Coordinating Group https://training.nwcg.gov/classes/S190/508Files/071231_s190_m2_508.pdf
5. Zhai, J., Ning, Z., Dahal, R., & Yang, S. (2023). Wildfire Susceptibility of Land Use and Topographic Features in the Western United States: Implications for the Landscape Management. Forests, 14 (4), 807. https://doi.org/10.3390/f14040807

Data Citations:

1. *Base data - Yosemite National Park Med*. ArcGIS Hub. (n.d.). https://hub.arcgis.com/maps/0c1bebf618d0425ba3181a5b0fcac821/about
2. Fire perimeters | cal fire. (n.d.). Retrieved June 1, 2024, from https://www.fire.ca.gov/what-we-do/fire-resource-assessment-program/fire-perimeters
3. *USGS National Land Cover Database CA land cover raster*. Arcgis.com. (n.d.). https://www.arcgis.com/home/item.html?id=8e336f9a4a644db3b8627f07a7e19d97
4. U.S. Geological Survey, 2014, Shuttle Radar Topography Mission 1 Arc-Second Global: SRTM1N37W120V3, https://earthexplorer.usgs.gov/

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