SOFAR Red Fire GIS Analysis
Updated 5/19/20
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A goal of this exercise is to identify SOFAR areas where higher quality red fir habitat occurs near high wildfire hazard and future climate stressors. These landscapes could be considered higher-priority areas for SOFAR forest treatment projects to reduce fire risk and improve long-term wildlife habitat. Additionally, climate projections could help inform post-treatment management goals. Priority areas identified by our GIS analysis can be accuracy assessed, refined, and/or modified by FS fire managers, silviculturists, and others based on their knowledge and experience working on these landscapes.

To identify potential priority treatment areas in red fir habitat, the SOFAR Red Fir GIS analysis utilizes the following features related to red fir distribution; forest stand composition, accessibility, fire hazard, and climate vulnerability. These data layers can be stacked to examine if their interrelationships reveal potential priority project areas in SOFAR red fir habitat. Our four GIS features and rationale for employing each are described below.

1. forest stand composition -
What: This layer identifies where red fir forest stands characterized by larger diameter trees and denser canopies are distributed across our study area. We used the California Wildlife Habitat Relationships (CWHR) Red Fir (RFR) classification type to map this distribution, and selected RFR CWHR size classes 4 and 5, and RFR density classes M and D. Generally these are red fir stands of at least 40-acres (CWHR's standard minimum mapping unit) dominated by Red Fir trees greater than 11" dbh, and canopy closures >40%. In a separate GIS layer, we binned all other, smaller CWHR RFR size and density classes occurring within the study area.

Why: We identified Red Fir stands with larger trees and denser canopy closure because these areas indicate where key wildlife habitat resource values are greatest within red fir forests, and where the potential for ecologically appropriate RFR forest treatments would be most likely.

2. accessibility -
What: This layer identifies where red fir is most accessible for mechanical treatments. We constrained our definition of "accessible" to RFR areas where slopes are less than 35% , and that are less than 1000ft from roads (Forest System roads, levels 1-5).

Why: We selected out these red fir forest areas since mechanical treatments are generally limited to these topographic characteristics.

3. fire hazard -
What: This layer identifies relative fire hazard as it has been modeled across the SOFAR area. As a proxy for fire hazard, we have used fire behavior model outputs of Conditional Flame Length (CFL) from the Tahoe Central Sierra Initiative's (TCSI) fuel and fire behavior modeling. CFL is a

measure of what the central tendency of flame length would be per pixel based on models of fuelscape and weather conditions, and ignition and fire probabilities. As such, CFL can be used as an indicator of relative fire hazard (flame lengths) should a fire occur within the analysis area. The TCSI's CFL values are FSim outputs that are calibrated to a 2018 current conditions fuelscape, and are at 90m² pixel resolution.

Why: We are using this layer to identify where potential fire hazard threatens current red fir distribution within SOFAR. Larger, denser stands of red fir within or near high fire hazard areas would represent higher priority red fir treatment sites.

Why CFL?
Based on both the principles of Wildfire Simulations modeling described in *A wildfire risk assessment framework for land and resource management_GTR_315* (Scott et al., 2013), and on our Red Fir Analysis question regarding relative fire hazard to SOFAR RFR, I believe the most useful metric to assess fire hazard to SOFAR red fir available to us at this time are the FSim CFL probability outputs available from TCSI fuel and fire modeling.

CFL represents the most likely flame length at a given location if a fire occurs, based on all simulated fires. CFL is an average measure of wildfire intensity and can be a less complex metric of fire hazard than other fire behavior model outputs like Mean Fireline Intensity (MFI) [see especially GTR 315 at Chapter 3. Wildfire Simulation, pp. 16-28 for more description of CFL and MFI as measures of fire hazard].

Why the TCSI CFL dataset?
I compared the CFL modeling methodologies and outputs generated from the Northern Sierra Risk Assessment (NSRA) study (c. 2016), the TCSI fire behavior modeling (2018), and the USFS National Wildfire Risk to Communities (NWRC) dataset for California (Scott et al., 2020). I assumed NSRA methodology was the same or similar to that described in the *Southern Sierra Risk Assessment: Methods and Results* report (Scott et al., 2015), and assumed, based on (Ed Smith, TNC, pers. comm.), that the TCSI methodology was the same or similar to that described for the French Meadow project in *Potential Wildfire Behavior of Treatment Alternatives for the French Meadows/American River Headwaters Project Area* (Brough et al., 2017).

All of these datasets include CFL outputs covering the SOFAR area. Because the TCSI fuelscape is based on more current vegetation conditions (LF 1.4.0 calibrated with 2018 LiDAR) than the NSRA dataset (LF 1.1.0), and because TCSI outputs are at a higher resolution (90m² / pixel) than either NSRA or NWRC, I recommend that the TCSI CFL outputs provide our red fir analysis with the more accurate metric of fire hazard of the three available.

4. climate vulnerability -
What: The GIS analysis for this characteristic is still on-going. Our group originally used Thorne et al. climate modeling for CA, downscaled to SOFAR red fir, however these data indicate a drier future climate will be less stressful to focal red fir stands than a wetter future climate, which seems incorrect. We are currently exploring alternative means of identifying climate-driven

departure of desired red fir habitat conditions using methodology and data from the TCSI. We anticipate receiving these data in time to complete an analysis of TCSI climate datasets by June 2020.

Why: Areas where models indicate red fir will be exposed to future climate stresses (e.g., higher temperatures, less precipitation) could be areas where red fir exhibit increased mortality due to stress-induced insect and/or pathogen invasions. Treatments could be designed to reduce the risk of such future stressors. What is more, in areas modeled for high future climate stress exposure, silviculturists could plan post-treatment strategies that consider alternative regeneration scenarios based on modeled future climate conditions.