Retrospective fire modeling to quantify the cumulative effects of suppression

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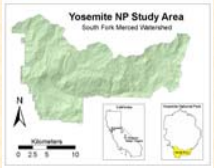
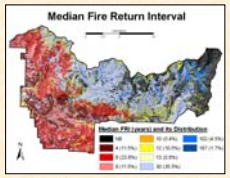
Introduction

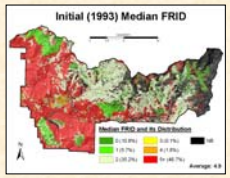
Excluding fire has untold effects on the landscape. Yosemite and Sequoia-Kings Canyon National Parks have expressed the need to understand and track these effects and thereby the consequences of fire suppression decisions. This project quantifies the impact of suppression. Our main objective is to **evaluate the cumulative effects of past fire suppression decisions** on Fire Return Interval Departure (FRID), a measure used to describe deviation from natural conditions. Lightning ignitions suppressed between 1994–2004 were retrospectively and chronologically modeled using the environmental conditions present at the time of ignition. The FRID that would have resulted had these ignitions been allowed to burn was calculated and compared to what actually resulted as a consequence of their suppression.



The 30,000 hectare South Fork Merced watershed in Yosemite NP



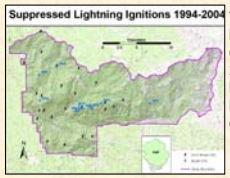
The median time interval between two successive fire events. Based on vegetation classification.



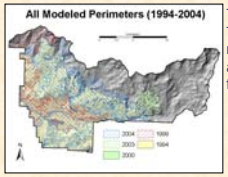
The number of Fire Return Intervals missed.

Methods

- Identify suppressed lightning ignitions for analysis.
- Develop surface fuel model data using Scott and Burgan's Comprehensive Set of Fire Behavior Fuel Models which allows for more finely detailed fuel description (vs. the 13 NFFL Fuel Models) and dynamic fuel models.
- Determine where lightning-ignited fires would have spread had they not been suppressed using FARSITE fire spread modeling and actual weather conditions.

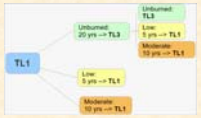


Ten of the 34 suppressed lightning ignitions that occurred between 1994 and 2004 were selected as having been likely to spread had they been given the chance.

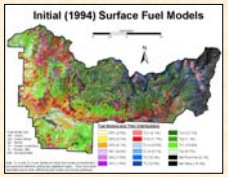


The resultant modeled fire perimeters. Two of the 10 selected ignitions were not modeled because they fell on areas whose fuels had not recovered from a previously modeled fire.

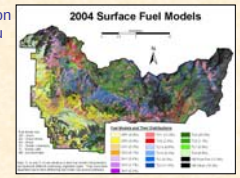
- Fuel conditions were updated between modeled fires using a fuel succession model developed in cooperation with local scientists and fire staff. Succession rules are based on vegetation type and fire severity



Two examples of fuel succession crosswalks - Timber Litter 1 (left) and Timber Understory 1 (right). Unburned, low, moderate and high refer to fire severity. The number of years refers to recovery time from a post-fire non-burnable state to the subsequent fuel model. More traditional fuel consumption/ succession models (e.g. FOFEM and FVS-FFE) weren't used because of a lack of input data and the need to model annual dynamics.

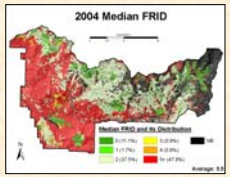


After each year (1994-2004) fuels were updated using this succession model before simulating the next years' fires. In these two maps you see the surface fuels as they appeared at the start of the 1994 (left) and 2004 (right) simulation years. Other Farsite inputs (e.g canopy cover, crown base height etc.) were updated in a similar, if more simplistic manner.

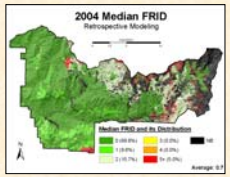


Results

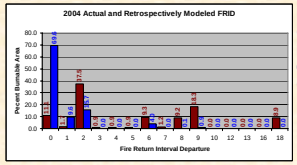
We found that the cumulative impacts of suppression on Fire Return Interval Departure (FRID) are substantial:



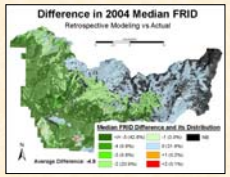
2004 FRID from actual fire history. Nearly 50% of the burnable area falls into the extreme departure (5+) category.



2004 FRID from retrospective modeling and actual fire history where it was applicable. Average FRID for the area has fallen from 5.5 to 0.7.



Distribution of actual (maroon) and retrospectively calculated FRID (blue).

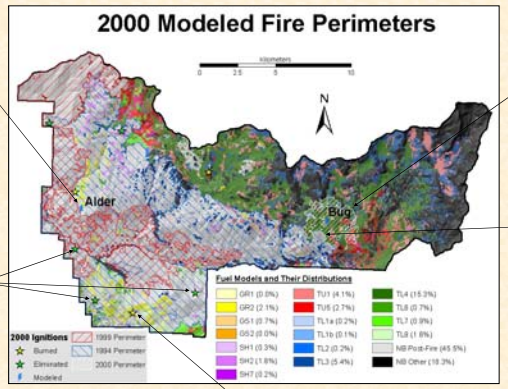


The difference or reduction in FRID resulting from the retrospectively modeled fires. FRID was reduced by 5 or more in ~43% of the burnable area, by 2 in ~ 21% of the area and didn't change in ~31%.

We also demonstrated that past fires have a huge impact on if, how and where future fires burn:

The simulated spread of the 2000 Alder ignition was limited to ~7 ha because it occurred in an area of isolated fuels that resulted from the 1994 modeled fires.

Some initial attack efforts would not have been necessary if previous lightning-ignited wildfires had been allowed to burn. Here we see ignitions that fall on non-burnable areas created by earlier fires.



Modeling suggests that the 2000 Bug ignition would have grown to ~725 ha.

1994 fires would have impacted Bug's spread, halting its expansion to the southwest.

Other suppressed wildfire ignitions would fall in areas of isolated or sparse fuels if prior fires had been allowed to burn.

Discussion

This study demonstrates and quantifies the ecological and managerial benefits of fire. The cumulative reduction in FRID from 1994 to 2004 we calculated is one way to quantify the ecological benefits of not suppressing lightning ignitions. Other benefits are realized through future reductions in the number of ignitions requiring initial attack and the creation of natural fire breaks. There are a number of risks and limitations to allowing these ignitions to burn, including escape from park boundaries and threats to other valuable resources. These risks are well known and studied. Our purpose was to demonstrate that along with potential risk comes potential benefit. Our next step is to perform the same analysis on the much larger Kaweah watershed in Sequoia-Kings Canyon NP. We will develop a guidebook so fire management staff can update the cumulative analysis on their own and continue to measure the impact of suppression on both fire ecology and management.

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