Forest fuels & fire behavior reading group

Organizers:
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Topic and scope

Main guiding question: **How do fuels affect fire behavior?** We will stick to the topic of fuels to explore fire behavior models, so we'll emphasize how models are driven by fuels (as opposed to how they work in general).

1. *How do fuels affect fire behavior in a given site?*
    a. How do we simulate fire behavior through time with fuel accumulation and different treatment (prescribed fire, wildfire, thinning, etc)?
    b. How do we understand **which** fuels (e.g., litter & duff vs. grass vs. live/dead shrubs vs. fine woody surface fuels vs. CWD rotten/sound vs. live/dead ladder fuels) and **what fraction** of each:
        i. Are consumed during fire under different conditions
        ii. Contribute to fire intensity/severity
2. *What are the different types of fire simulation models, how do they account for fuels, and where is there lacking information?*
    a. Models to examine
        i. FVS
        ii. BEHAVE/BehavePlus
        iii. Fuels Management Analyst (FMAPlus)
        iv. NEXUS
        v. FARSITE (for fire spread)
        vi. FlamMap (maps of potential fire behavior that feed into FARSITE)
        vii. FFI?
    b. How do these models account for fuel contribution to modeled fire behavior?
    c. How do they account for changes in fuels over time (if at all)?

Logistics

- Each week we will discuss 2-4 papers (depending on length).
    - The larger number of papers reflects the fact that we are focusing specifically on fuels and fire behavior, and non-fuels sections can often be skimmed.
- For each paper, we will have someone sign up to summarize it in 5 minutes (tops!) to kick off the discussion. Participants will therefore likely end up summarizing more than one paper throughout the quarter. We'll distribute this evenly among participants.

- All participants (except summarizers) are required to prepare (and email to the organizers in advance) two discussion/clarification questions on the week's readings.
- Readings are largely predetermined (see schedule below), with the last two weeks left open to accommodate additional papers we learn of during the quarter.
- If a participant knows of good papers we've missed and should add (or preselected papers we should exclude), the organizers would love to hear about them (at least 1 week before the day it is set to be discussed) and will do their best to adjust the schedule to accommodate them.

Weekly schedule

Week 1: Intro/overview
- [Overview of fire and fuel modeling options] McHugh 2006. Considerations in the use of models available for fuel treatment analysis
- [Comparison/validation/critique of multiple fire behavior modeling platforms] Cruz and Alexander 2009. Assessing crown fire potential in coniferous forests of western North America: a critique of current approaches and recent simulation studies
- Finney, M. A. 1999 Mechanistic modeling of landscape fire patterns
- **Optional:** NWCG Wildland Fire Decision Support Tools

Week 2: Empirical fuel measurements (with some modeling applications)
- Vaillant et al. 2009 Effect of Fuel Treatments on Fuels and Potential Fire Behavior in California, USA, National Forests (empirical data + NEXUS modeling)
- Cansler et al 2019. Fuel dynamics after reintroduced fire in an old-growth Sierra Nevada mixed conifer forest

Week 3: Empirical fuel measurements cont. (focus on FBAT reports)
- Derek's correspondence with FBAT regarding options for quantifying shrub fuel loads and consumption during fire
- [FBAT report on fire and fuel dynamics in Rim Fire] Ewell et al. 2015. 2013 Rim Fire Stanislaus National Forest and Yosemite National Park Fire Behavior Assessment Team Summary Report [Includes an appendix comparing results of alternative fuel quantification systems]
- [FBAT report on first order fire effects in Caples Fire] Dailey et al. 2020. 2019 Caples Fire First Order Fire Effects. PDF will be sent out.
- **Optional:** [Two papers applying FBAT's method of calculating standing fuel biomass based on plot measurements] [Skim and focus on fuel/biomass methods]:
  - Miesel et al. 2018. Quantifying Changes in Total and Pyrogenic Carbon Stocks Across Fire Severity Gradients Using Active Wildfire Incidents
  - Reiner et al. 2009. Mastication and prescribed fire impacts on fuels in a 25-year old ponderosa pine plantation, southern Sierra Nevada

Week 4: Fuel consumption (empirical with some links to modeling)

- Lydersen et al. 2014. Using field data to assess model predictions of surface and ground fuel consumption by wildfire in coniferous forests of California [Uses FOFEM fire model]
- Levine et al. 2020. Forest stand and site characteristics influence fuel consumption in repeat prescribed burns
- Lutz et al 2017. SHRUB COMMUNITIES, SPATIAL PATTERNS, AND SHRUB-MEDIATED TREE MORTALITY FOLLOWING REINTRODUCED FIRE IN YOSEMITE NATIONAL PARK, CALIFORNIA, USA

Week 5: The concept of "fuel models"

- Hall and Burke 2006. Considerations for characterizing fuels as inputs for fire behavior models (uses empirical data + NEXUS fire model)
- [Traditional standard fuel models. **Focus on intro; skim the rest**] Scott and Burgan 2005. Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model (includes application to the BEHAVE fire model)
- Noonan-Wright et al. 2014. The Effectiveness and Limitations of Fuel Modeling Using the Fire and Fuels Extension to the Forest Vegetation Simulator

Week 6: Fuels in FVS

- Noonan-Wright et al. 2014 (above) if not covered in previous week.
- [Overview of FFE in FVS] Rebain et al. 2010. The Fire and Fuels Extension to the Forest Vegetation Simulator: Updated Model Documentation
- [Application of FVS to model fire behavior in plots where fuels are empirically measured] Vaillant et al. 2013. Effectiveness and longevity of fuel treatments in coniferous forests across California

Week 7: BEHAVE/BehavePlus

- [Overview of BehavePlus] Andrews 2012. Current status and future needs of the BehavePlus Fire Modeling System
- [Description of BEHAVE fuels module, and photo series for shrub bulk density] Burgan and Rothermel 1984. BEHAVE: Fire Behavior Prediction and Fuel Modeling FUEL Subsystem [Skim, with a focus on how fuels are input as fuel models vs. directly. Is BEHAVE more flexible in accepting fuels directly vs. as a "fuel model"?]
- [Application of BEHAVE in oak savanna fuel conditions] Grabner 2001. Fuel model selection for BEHAVE in midwestern oak savannas
- [Application of BEHAVE using input fuel parameter values] Dimitrakopoulos 2002. Mediterranean fuel models and potential fire behaviour in Greece

Week 8: FMAPlus

- Kobziar et al. 2009. [The efficacy of fire and fuels reduction treatments in a Sierra Nevada pine plantation](#) [modeled fire behavior and empirical fuel consumption and fire intensity monitoring]
- Stephens and Moghaddas 2005. [Experimental fuel treatment impacts on forest structure, potential fire behavior, and predicted tree mortality in a California mixed conifer forest](#) [fire behavior is purely modeled]
- **Optional, lower priority:** Vaillant et al. 2009. [Effectiveness of prescribed fire as a fuel treatment in Californian coniferous forests](#) [fire behavior is purely modeled]

Week 9: Flammap / Farsite

- [Overview of FlamMap] Finney, M. A. 2006 [An overview of FlamMap fire modeling capabilities](#)
- [Overview of Farsite - **Skim and focus on fire behavior models and simulation sections**] Finney, M. A. 1995 [FARSITE: A fire area simulator for fire managers.](#)
- [Application of Farsite to assess effectiveness of landscape fuel treatments, with an emphasis on methodology] Stratton, R. D. 2004 [Assessing the effectiveness of landscape fuel treatments on fire growth and behavior](#)
- **Optional:** [Application of Farsite across various fuels treatments] Cochrane et al. 2011. [Estimation of wildfire size and risk changes due to fuels treatments](#)

Week 10: Debrief and revisit driving questions.