<table>
<thead>
<tr>
<th>2018-19</th>
<th><strong>Title/Presenter</strong></th>
<th><strong>View Recording</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct 4</td>
<td><strong>An update on the High-Resolution Rapid Refresh model</strong> / Joe Olson, NOAA</td>
<td>View Recording</td>
</tr>
<tr>
<td>Oct 11</td>
<td>The essential and irrepressible role of fire in western forests / Steve Arno</td>
<td>View Recording</td>
</tr>
<tr>
<td>Oct 25</td>
<td><strong>WFDSS and Relative Risk Assessment</strong> / Erin Noonan, USFS</td>
<td>View Recording</td>
</tr>
<tr>
<td>Nov 1</td>
<td><strong>Improving Parameterization of Combustion Processes in Coupled Fire-Atmosphere Models through Remote Sensing</strong> / Scott Goodrick, USFS</td>
<td>View Recording</td>
</tr>
<tr>
<td>Nov 8</td>
<td><strong>Wildland Fire Chemicals and Aerial Delivery Systems</strong> / Shirley Zylstra, NTDC</td>
<td>View Recording</td>
</tr>
<tr>
<td>Nov 15</td>
<td>High survival of small whitebark pine at alpine treeline edges – and in forest interiors – after widespread mountain pine beetle outbreaks in the US Northern Rockies / Colin Maher</td>
<td>View Recording</td>
</tr>
<tr>
<td>Nov 29</td>
<td><strong>Coldest observed temperature in CONUS at Rogers Pass</strong> / Corby Dickerson, NOAA</td>
<td>View Recording</td>
</tr>
<tr>
<td>Dec 6</td>
<td><strong>Atmospheric factors for large plumes on the Rice Ridge Fire</strong> / Ryan Leach, NOAA</td>
<td>View Recording</td>
</tr>
<tr>
<td>Dec 13</td>
<td>Human Performance &amp; Innovation and Organizational Learning RD&amp;A: The Wildland Fire Meta-Review / Sara Brown, Acting Director of the Human Performance and Innovation &amp; Organizational Learning RD&amp;A Program</td>
<td>View Recording</td>
</tr>
<tr>
<td>Feb 14</td>
<td><strong>Forest restoration in the Sierra Nevadas</strong> / Sean Jeronimo</td>
<td>View Recording</td>
</tr>
<tr>
<td>Feb 21</td>
<td><strong>Across the Great Divide: Adventures of a Retired Fire Ecologist</strong> / Laurie Kurth</td>
<td>View Recording</td>
</tr>
<tr>
<td>Date</td>
<td>Title/Presenter</td>
<td>View Recording</td>
</tr>
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<tr>
<td>Feb 28</td>
<td><strong>Lessons from Wilderness Fire: fuels and forest structure in unburned, once-burned, and twice-burned forests in the Bob Marshall Wilderness</strong> / Andrew Larson</td>
<td></td>
</tr>
<tr>
<td>Mar 7</td>
<td><strong>Consequences of climatic thresholds to fire activity and post-fire vegetation change</strong> / Phil Higuera</td>
<td></td>
</tr>
<tr>
<td>Mar 14</td>
<td><strong>The Carr Fire Vortex: A case of pyro-tornadogenesis?</strong> / Neil Lareau</td>
<td></td>
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<tr>
<td>Mar 21</td>
<td><strong>Locally Informed Land Use Planning in the Far North of Finland, Lapland</strong> / Sini Kantola</td>
<td></td>
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<tr>
<td>Mar 28</td>
<td>Cancelled ** Seminar time changed to 10:00 a.m. , Shawn Urbanski</td>
<td></td>
</tr>
<tr>
<td>Apr 4</td>
<td><strong>Advancing fire science with unprecedented forest demography data: calibrating mortality models and assessing uncertainty in satellite-derived severity</strong> / Tucker Furniss</td>
<td></td>
</tr>
<tr>
<td>Apr 11</td>
<td>&quot;<strong>The Life in Smoke</strong>&quot; thus far / Leda Kobziar</td>
<td></td>
</tr>
<tr>
<td>Apr 18</td>
<td><strong>Management of natural resources and wildfire in Morocco</strong> / Mr. Fouad Assali, Hicham Mharzialaoui, and Aadel Taaoufik</td>
<td></td>
</tr>
<tr>
<td>Apr 25</td>
<td><strong>Community Planning Assistance for Wildfires (CPAW)</strong> / Eva Karau, Kimiko Barrett, Kelly Pohl</td>
<td></td>
</tr>
<tr>
<td>May 9</td>
<td><strong>MASTIDON: a monster of a mastication project</strong> / Bob Keane, Pam Sikkink, Jim Reardon, Faith Ann Heinsch, Lisa Holsinger, Helen Smith</td>
<td></td>
</tr>
<tr>
<td>May 16</td>
<td><strong>Reducing vulnerability to increasing wildfire disasters</strong> / Crystal Kolden</td>
<td></td>
</tr>
<tr>
<td>July 1</td>
<td><strong>The Tale of Frankenlog: Real Time Monitoring of Dead Wood Moisture</strong> / Chris Woodall, project leader of the Northern Forest Science and Applications, USFS Northern Research Station</td>
<td></td>
</tr>
</tbody>
</table>
An update on the High-Resolution Rapid Refresh model

The High-Resolution Rapid Refresh (HRRR) is NOAA’s real-time operational hourly updating forecast systems run at 3-km grid spacing. The HRRR uses the Advanced Research version of the Weather Research and Forecasting (WRF-ARW) as the model component of the forecast system. During the second installment of the Wind Forecast Improvement Project (WFIP 2), the HRRR has been targeted for the improvement of low-level wind forecasts in the complex terrain within the Columbia River Basin (CRB), which requires much finer grid spacing to resolve important topographic features in/near the CRB. Therefore, this project provides a unique opportunity to test and develop the HRRR physics suite within a very high-resolution nest (\(\Delta x = 750 \text{ m}\)) over the northwestern US. Special effort is made to incorporate scale-adaptive flexibility into the HRRR physics suite, with emphasis on the representation of subgrid-scale boundary layer and orographic drag processes.

Many wind profiling and scanning instruments have been deployed in the CRB in support the WFIP 2 field project, which spanned 01 October 2015 to 31 March 2017. During the project, several forecast error modes were identified, such as: (1) too-shallow cold pools during the cool season, which can mix-out more frequently than observed and (2) the low wind speed bias in diurnal thermal trough-induced gap flows during the warm season. Development has been focused on improving these common forecast failure modes, among others, with the criteria of achieving at least neutral impacts in all other operational forecast objectives. This presentation will overview the HRRR forecast system, highlight the testing and development of various model components, and demonstrate improvements in forecast skill over original HRRR physics. Examples of case studies and retrospective periods will be presented to illustrate the improvements. Ongoing and future challenges in RAP/HRRR physics development will be touched upon.
Date: October 11, 2018
Time: 11:00 AM-12:00 PM
Where: The Fire Science Lab
5775 West U.S. HWY 10, Missoula, MT 59808.

For more information, please contact missoula_firelab_seminars@fs.fed.us or visit www.firelab.org
Spatial Differentiation of Wildfire Risk in the United States from Systematic Operational Risk Assessments – How Risk is Conceived by Land Managers

This research examines perceptions of risk by decision-makers during wildland fires using newly available data from the Wildland Fire Decision Support System (WFDSS), with an eye toward better understanding how fire managers are considering risk on the fires they manage. It explores preference for and aversion to high, moderate, and low ratings for the risk elements of value, hazard and probability that collectively constitute a measure of relative risk.

Erin Noonan,
USFS

Date: October 25, 2018
Time: 11:00 AM-12:00 PM
Where: The Fire Science Lab
5775 West U.S. HWY 10, Missoula, MT 59808.

For more information, please contact missoula_firelab_seminars@fs.fed.us or visit www.firelab.org
Improving Parameterization of Combustion Processes in Coupled Fire-Atmosphere Models through Remote Sensing

Coupled fire-atmosphere models intended to be used for landscape-scale fires (domains of hundreds of meters to 10s of kilometers), typically divide the simulation domain up into a mesh of grid cells and these grid cells typically range in size from 1-30 meters on a side. As the processes governing combustion of an individual fuel element occur on considerably smaller scales, the gridded model requires a means of describing these smaller scale, or subgrid, processes. Probability distributions are one method of describing the impact of such processes and is the approach used in the HIGRAD/FIRETEC model.

For the solid phase of combustion, the mass loss rate in the model is dominated by turbulent mixing and fraction of a cell combusting as determined by a probability density function based on a grid cell’s temperature. We employ both visible and infrared video analysis to estimate these quantities. For the turbulent mixing, optical flow techniques are used in conjunction with particle image velocimetry on the visible videos to estimate a centimeter scale flow field in the vicinity of the fire which can be used to estimate the turbulence. Mass loss rate is estimated from infrared remote sensing techniques developed first in the laboratory and later used with satellites to estimate fire radiative power and fuel consumption. Results from a set of simple idealized fuel beds are shown along with preliminary results from natural fuel beds.
Wildland Fire Chemicals and Aerial Delivery Systems.

In 2017, approximately 57.3 million gallons of retardant was loaded onto airtankers. Of that, approximately 19 million gallons were dropped onto NFS lands. The use of fire chemicals is not without controversy. This presentation will summarize the various categories of wildland fire chemicals, their characteristics, and the environmental implications of their use.

Aerial delivery systems are utilized to distribute fire chemicals, primarily retardant, on the landscape. Knowledge of drop patterns, parameters influencing those patterns, application tactics and reasons for line failure will also be discussed.
High survival of small whitebark pine at alpine treeline edges – and in forest interiors – after widespread mountain pine beetle outbreaks in the US Northern Rockies

Mountain pine beetles (*Dendroctonus ponderosae*; MPB) are causing extensive mortality of whitebark pine (*Pinus albicaulis*) throughout the species’s range. In the highest mountains where these trees grow, they reach alpine treeline – the climatic boundary where growth forms transition from trees to shrub-like krummholz. Although treeline whitebark pine exist within a landscape of widespread MPB-caused mortality, these populations appear to have survived the most recent outbreaks. This observation motivated the hypothesis that stunted treeline growth forms escape MPB attack because their stems are too small to attract beetles, and that these habitats serve as refuges for whitebark pine.

The purpose of this research was to determine if treeline ecotone populations could serve as refuges for whitebark pine from the most recent MPB outbreaks in the US Northern Rocky Mountains, and whether these populations represent the greatest potential for future whitebark pine population recovery. I surveyed mortality along 500 m transects at alpine treeline and other forest edges at 10 randomly selected sites in the US Northern Rocky Mountains. I found consistent mortality gradients at alpine treelines, but not at other edges. This supports the hypothesis that treeline habitats are refuges, and that treeline whitebark pine may avoid MPBs because of transitions in growth form. I observed limited reproductive output at alpine treelines, but these habitats may still serve as population refuges over long time periods. However, smaller surviving whitebark pine exist at greater density than dead ones (by ~200 per ha) throughout my study region, indicating a strong potential for these forests to recover from the recent MPB outbreaks in the short-term without a treeline refuge.
Coldest observed temperature in CONUS at Rogers Pass

One half mile west of Rogers Pass, and just south of the Continental Divide, a humble cabin was nestled next to a fledgling gold mine. The cabin sat within a small, ‘saucer-shaped depression’ in the landscape. It was 1954. The weather had been unrelenting: heavy, intense snow had fallen near continuously for seven days, totalling over five feet in settled depth, by 5pm on the 19th of January. And the temperature that morning had been a frigid -37°F. But, unbelievably, these measurements themselves would ultimately pale in comparison to what would occur later that night.

By morning an incredible record breaking low temperature of -70°F was observed by volunteer observers at the 4 K’s Mine near Rogers Pass. During this presentation I will share the meteorology behind this remarkable observation which for 22 years stood as the coldest temperature in the United States and still remains the coldest temperature in the contiguous states, to include Montana, of course. Furthermore I will discuss the story of these miners, the U.S. Weather Bureau’s verification of this reading, along with my investigative efforts to locate the precise location where this observation was taken. Finally, I will share our collaborative efforts with the USFS to preserve this cabin as a historic site for future public interpretation.
Two Days on the Rice Ridge Fire

Abstract: The Rice Ridge fire ultimately burned over 150,000 acres in western Montana in the summer of 2017. Two days stand out in particular, September 2\textsuperscript{nd} and 3\textsuperscript{rd}. Both days were hot, dry, and windy with Red Flag warnings issued by the local NWS office. However, on the 2\textsuperscript{nd} the fire consumed roughly 12,000 acres, whereas on the 3\textsuperscript{rd} it developed a pyrocumulus and burned almost 50,000 acres. In this talk, we will investigate the atmospheric differences between the two days that likely led to the development of a pyrocumulus and propose a technique forecasters can use to track and forecast pyrocumulus potential.
Seminar Series

Human Performance & Innovation and Organizational Learning RD&A: The Wildland Fire

Sara Brown, Acting Director of the Human Performance and Innovation & Organizational Learning RD&A Program

Date: December 13, 2018
Time: 11:00 AM-12:00 PM
Where: The Fire Science Lab
5775 West U.S. HWY 10, Missoula, MT 59808.

For more information, please contact missoula_firelab_seminars@fs.fed.us or visit www.firelab.org
Forest restoration in the Sierra Nevadas

Sean Jeronimo

Date: February 14, 2018
Time: 11:00 AM-12:00 PM
Where: The Fire Science Lab
5775 West U.S. HWY 10, Missoula, MT 59808.

For more information, please contact missoula_firelab_seminars@fs.fed.us or visit www.firelab.org
Across the Great Divide:
Adventures of a Retired Fire Ecologist

Travel with Laurie Kurth from Moscow to Vladivostok aboard the Trans Siberian Railway with a stop in Irkutsk and Lake Baikal. Laurie will share photos of the adventure from obtaining a Russian visa to sharing a train cabin with families to going to the circus on a remote island to cruising the world’s largest fresh water lake on a hydrofoil and exploring Siberia from the tracks. She will share her eye opening moments and great adventures and misadventures on this 5772 mile train ride. In addition she’ll share a few adventures of kayaking in Thailand and hiking in Argentina....with a little fire ecology thrown in.
Lessons from Wilderness Fire: fuels and forest structure in unburned, once-burned, and twice-burned forests in the Bob Marshall Wilderness

Since the early 1980s managers have allowed many lightning-ignited fires to burn with minimal interference in forests of the Bob Marshall Wilderness in northwestern Montana, USA. We used this active fire regime to investigate fire-effects and post-fire fuel loads, tree regeneration, and forest structure in mixed-conifer forest communities. Our most important finding was that surface fuel loads are maintained or increased in the years following an initial wildfire after a long fire-free period as fire killed trees and branches fall to the ground. This unsurprising result nevertheless deserves highlighting because the current conventional wisdom is that an initial fire can be thought of as a “fuel treatment.” Our most surprising finding was the unimportance of reburns as a cause of transitions to non-forest. Managers need to plan for multiple fire entries (i.e., two or more fires) if their goal is to use wildfires as surface fuel reduction treatments. Some transitions to a putative non-forest condition should be expected following both initial fires and short-interval reburns. Thus, managers may wish to incorporate this outcome into their expectations, and into their outreach and education efforts, in order to prepare policy makers and the public for forest conversion.
Consequences of climatic thresholds to fire activity and post-fire vegetation change

Ecological properties governed by threshold relationships can exhibit heightened sensitivity to climate change. This talk focuses on understanding the consequences of climate change for fire activity in select western North American ecosystems, and how changing fire activity can catalyze vegetation changes across broad regions. Specifically, the talk will present results from recent publications from the Lab and collaborators that help characterize threshold relationships between (a) climate and fire activity, and (b) climate and post-fire tree regeneration.
The Carr Fire Vortex: A case of pyro-tornadogenesis?

In this talk, radar and satellite observations are used to document the evolution of a rare, destructive, fire-generated vortex during the Carr fire on 26 July 2018 near Redding, California. The National Weather Service estimated that surface wind speeds in the vortex were in excess of 64 m/s, equivalent to an EF-3 tornado. Radar data show that the vortex formed within an antecedent region of cyclonic wind shear along the fire perimeter and immediately following rapid vertical development of the convective plume, which grew from 6 to 12 km aloft in just 15 min. The rapid plume development was linked to the release of moist instability in a pyrocumulonimbus (pyroCb). As the cloud grew, the vortex intensified and ascended, eventually reaching an altitude of 5,200 m. The role of the pyroCb in concentrating near-surface vorticity distinguishes this event from other fire-generated vortices and suggests dynamical similarities to nonmesocyclonic tornadoes.

The talk will conclude with a forward-looking examination of the application of operation radar data to track both the plume dynamics and surface fire progression of other high impact wildfires including the Camp Fire that devastated Paradise, CA in November 2018.
Locally Informed Land Use Planning in the Far North of Finland, Lapland

Sini Kantola
Geography Research Unit, University of Oulu & Natural Resources, Institute Finland (Luke)

Date: March 21, 2018
Time: 11:00 AM-12:00 PM
Where: The Fire Science Lab
5775 West U.S. HWY 10, Missoula, MT 59808.

For more information, please contact missoula_firelab_seminars@fs.fed.us or visit www.firelab.org
Seminar Series

Shawn Urbanski
Missoula Fire Lab, RMRS

Date: March 28, 2018
Time: 11:00 AM-12:00 PM
Where: The Fire Science Lab
5775 West U.S. HWY 10, Missoula, MT 59808.

For more information, please contact
missoula_firelab_seminars@fs.fed.us or visit www.firelab.org
Advancing fire science with unprecedented forest demography data: calibrating mortality models and assessing uncertainty in satellite-derived severity

Post-fire mortality models and satellite-derived severity indices are the primary methods available to assess fire effects across broad scales, and these tools are foundational to the monitoring and management of fire-prone forest ecosystems throughout the west. Despite the widespread use of these tools, however, there is a persistent need to improve their accuracy, determine their applicability in different forest types, and ensure they remain relevant under uncertain climate futures.

I evaluated the performance of mortality models within the First Order Fire Effects Model (FOFEM) software, and compared their performance to locally-parameterized models based on five different forms. I assessed model accuracy at the individual-tree, stand, and community levels, and compared stand-level accuracy across a range of spatial scales. FOFEM consistently under-predicted mortality for the three conifer species, possibly because of the timing of the fire during a severe multi-year drought. Model error was spatially correlated at small spatial scales (<2.5 ha), suggesting that mortality was mediated by spatially-structured delayed mortality processes.

I also conducted a comparison of 36 satellite-derived spectral indices using tree-based measures of fire severity and estimated uncertainty in actual fire effects. dNBR performed reliably well, but accuracy could be improved by using other indices to detect specific aspects of tree mortality (percent basal area mortality versus percent stem mortality). Relativized versions of dNBR did not consistently improve accuracy; the relativized burn ratio (RBR) was generally equivalent to dNBR, but RdNBR had consistently lower accuracy. There was a considerable amount of uncertainty at the landscape scale, with an expected range in estimated percent basal area mortality greater than 37% for half of the area burned (>50,000 ha).

This research employed both familiar and novel analytical techniques to empirically evaluate these essential fire science tools and identify ways in which they may be advanced. I used a large, intensively sampled forest demography plot to assess error across multiple spatial scales, among different tree diameter classes, and with a variety of performance metrics. The unique nature of this dataset provided a new perspective through which these tools could be evaluated, and this revealed unexpected results that contribute to both theoretical and applied aspects of fire science.
“The Life of Smoke: A New Perspective on Smoke as a Vector and Refuge for Microorganisms”

The field of aerobiology is expanding due to a recognition of the diversity of roles microbes play in both terrestrial and atmospheric ecology. Smoke from global biomass burning has had significant and widespread ecological and human health consequences, but the living component of smoke has received little attention. Microbes aerosolized and transported by wildland fire may have profound effects on atmospheric and environmental factors, acting as nuclei for ice condensation, transporting pathogens or symbionts, and otherwise influencing ecosystems and human populations downwind. The potential for smoke to aerosolize and transport viable microbes is a virtually blank piece of the microbial biogeography puzzle with far reaching implications.

Leda Kobziar
University of Idaho

Date: April 11, 2018
Time: 11:00 AM-12:00 PM
Where: The Fire Science Lab
5775 West U.S. HWY 10, Missoula, MT 59808.

For more information, please contact missoula_firelab_seminars@fs.fed.us or visit www.firelab.org
Seminar Series

Date: April 18, 2018  
Time: 11:00 AM-12:00 PM 
Where: The Fire Science Lab  
5775 West U.S. HWY 10, Missoula, MT 59808.

For more information, please contact  
missoula_firelab_seminars@fs.fed.us or visit  
www.firelab.org

Management of natural resources and wildfire in Morocco

Since 2007, the US Forest Service (USFS) has collaborated with Morocco’s High Commission on Water, Forests and Combating Desertification (HC) on several natural resource management programs. Morocco’s forest resources are threatened by reduced rainfall, increased desertification, and wildfire. Forests in northern Morocco are critical to local livelihoods and recreation for residents and international visitors. These forests are also important timber resources for the HC as all revenue generated is returned to the HC budget and to rural communities for development. Because the ecology of forested areas in Morocco’s Mediterranean landscape is extremely prone to fires, the HC requested assistance from the USFS in enhancing fire management programs to improve management of Morocco’s rapidly shrinking forested areas. This assistance has taken many forms since initiated in 2012, including: support in adapting the Incident Command System to Morocco, helping to establish standard operating procedures and fire operations guides for the National Center for Forest Climate Risk Management (CRCF) that opened in Rabat in 2016, and mentoring/shadowing on live fire incidents. In November 2018, a USFS team conducted fire modeling training in Tetouan, Morocco to begin developing estimates of fire potential in Morocco’s Rif region, where 85% of the country’s forest fires have occurred historically. A core group of officials and staff from the CRCF will be visiting the Missoula Fire Lab the week of April 15 to continue work toward implementing fire modeling in Morocco. In this seminar, they will present information about their work in natural resource management and fire management in Morocco.
Date: April 25, 2018
Time: 11:00 AM-12:00 PM
Where: The Fire Science Lab
5775 West U.S. HWY 10, Missoula,
MT 59808.

For more information, please contact
missoula_firelab_seminars@fs.fed.us or
visit www.firelab.org

Eva Karau, Kimiko Barrett, Kelly Pohl
Date: May 2, 2018
Time: 11:00 AM-12:00 PM
Where: The Fire Science Lab
5775 West U.S. HWY 10, Missoula, MT 59808.

For more information, please contact missoula_firelab_seminars@fs.fed.us or visit www.firelab.org
MASTIDON: a monster of a mastication project

Wildland fuel mastication is rapidly becoming the preferred fuel treatment for many fire hazard reduction projects, especially in areas where reducing fuels with prescribed fire is challenging. Mastication is the process of mechanically modifying the live and dead surface and canopy biomass to lower fuelbed depth and increase bulk density to reduce fire hazard. The problem is that little is known about the changes in masticated fuels as they age. In 2013, we initiated a comprehensive study called MASTIDON (MASTIcated Decomposed fuel Operational Network) to measure the diverse characteristics of masticated fuelbeds at treatment sites of different ages to evaluate effects of different aged masticated fuelbeds on fire behavior, fuel moisture dynamics, soil heating, and smoldering combustion. These investigations were then used to build fire behavior fuel models for masticated fuelbeds for use in operational fire management. This presentation presents an overall summary of the research findings for the MASTIDON project emphasizing the influence of aging on the masticated fuel characteristics and properties. In summary, we found there were minor changes in masticated fuels as they aged for their (1) physical and chemical properties, (2) rate at which they dried, (3) amount of heat they pulsed into the soil, and (4) fire behavior when burned. We also found that the method of mastication had a more pronounced effect than aging on nearly all of our 15 sites.
Reducing vulnerability to increasing wildfire disasters

Wildfire disasters are unique among natural hazards in that humans have a complex evolutionary and contemporary relationship with fire. As such, addressing this hazard requires a more nuanced approach to understanding vulnerability to wildfire across socio-ecological systems and identifying mitigation strategies. From 1980 to 2018, nearly 4,000 people died in wildfires globally, and economically disastrous wildfire events increased non-linearly due to both the top-down driver of climate change and the bottom-up drivers of land use and sociopolitical factors. Further, many wildfires have disastrous consequences beyond loss of life and property but are difficult to empirically track due to the more chronic or distributed nature of the impacts. I apply a widely-used natural hazards vulnerability framework to wildfire and demonstrate its application across spatial scales globally in order to highlight both different types of wildfire disasters and the factors that must be accounted for in developing mitigation strategies. Such an approach provides insight into both the futility of the historical ‘command-and-control’ management of wildfires and the need for transdisciplinary efforts to reduce wildfire vulnerability.
The Tale of Frankenlog: Real Time Monitoring of Dead Wood Moisture

Downed dead wood has been documented to provide a variety of benefits in forest ecosystems such as increasing forest structure, habitat for various flora and fauna, substrate for tree regeneration, and store of carbon. What has been poorly understood is the mechanisms by which dead wood alters various moisture and temperature regimes within forest ecosystems, namely across the forest floor and soil continuum. As a means to better understand the role of dead wood in various forest processes (tree regeneration or wildfire risk), we developed and applied a sensor network to a sugar maple log in a northern hardwood forest during a growing season to monitor log and soil temperature and moisture during 15-minute intervals. Initial results suggest that the temperature and moisture of dead wood is highly dynamic while interacting with the forest floor and soil so as to mitigate the periodicity of precipitation. Building off this first study, streamlined sensor networks are being deployed on numerous logs across an operational-scale adaptive silvicultural experiment in northern NH for the assessment of log and soil moisture dynamics in the context of forest management and wildfire risk.