Background

In an on-going effort to identify and share science relevant to the Sierra Nevada Region and the Watershed Improvement Program (WIP), Sierra Nevada Conservancy (SNC) staff has been tracking, monitoring, and reporting on relevant research, studies, and reports with potential implications for WIP-policy activity.

Current Status

Historically, forest ecosystem services produced in the Sierra Nevada – water, carbon, and air – have been generally been taken for granted in the policy arena. Today, unhealthy conditions, drought, and climate change are stressing forest ecosystems and those ecosystem services are instead contributing to our environmental problems. As a result, there is a growing recognition of the need to actively manage Sierra Nevada ecosystems not only to ensure continued availability of the services, but to reduce environmental impacts from degraded systems.

Below is a summary of some key research results that can help inform ongoing policy discussions.

Policy Background: Air Quality – Greenhouse Gasses (GHGs)

According to existing laws, prescribed and managed fires are counted by regional Air Boards and the federal EPA as contributors to air pollution and are therefore subject to regulation and penalties. Wildfires that are actively under suppression are not counted. Wildfires typically burn in the late summer when air quality conditions can be already poor and therefore wildfire emissions can compound air quality problems. The result can lead to unhealthy air quality days for local and regional populations, which are then erased from the official air quality records despite the impacts that these fires can have on public health.

New data suggests that all smoke is not equal. Not only can the timing of prescribed and managed fires be scheduled to avoid times when air quality is already bad, but the research below describes how, on a per-acre-burned basis, prescribed and managed fires may release much less carbon and GHGs than an out-of-control wildfire burning at high severity. The subsequent article describes health implications as they relate to particulate matter emissions. The implication is that using prescribed and managed fires during appropriate times can mitigate future emissions of GHGs and particulate matter from forest fires. SNC partner and collaborator Sierra Forest Legacy has a webpage dedicated to this issue if you would like to learn more.

Relevant Research

Impacts of Fire Management on Aboveground Tree Carbon Stocks in Yosemite and Sequoia & Kings Canyon National Parks
By John Matchett, James Lutz, et al. – 2014 – National Park Service

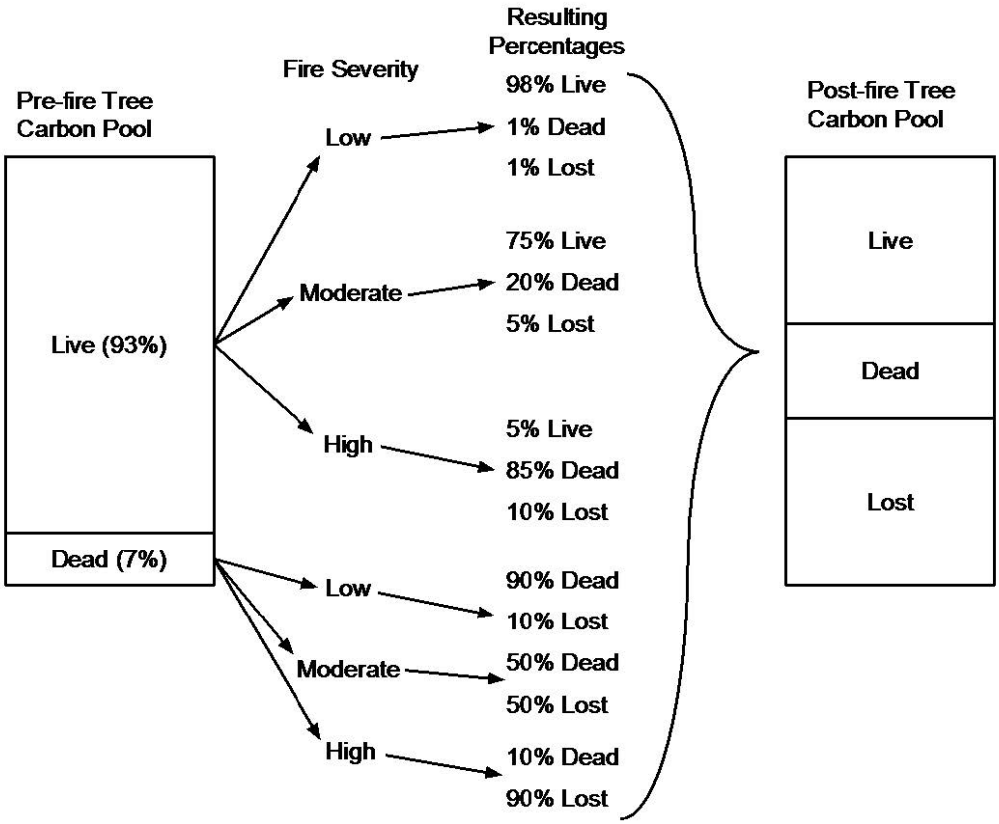
The authors performed an intensive analysis on carbon stocks in southern Sierra Nevada National Park forests and examined how recent fires may have impacted those carbon stocks. One critical distinction the authors note between their study area and forests

elsewhere in the Sierra Nevada is that the forests they analyzed have an extensive fire history and as a result recent fires have predominately been of low- or moderate-intensity. As a result, with the exception of red fir forests, they did not find that low to moderate fires significantly affected carbon levels on most of the forests they studied.

The authors developed Figure 1 below to show how carbon in forests can be impacted by different severities of fire and why the carbon stocks in their study forests showed little impact from low- and moderate-severity fires, especially the live trees. Interestingly, even though the high-severity fire kills 95 percent of the live trees, only 10 percent of live-tree carbon is actually emitted in the fire event itself ("Lost"), leaving 85 percent of that carbon now in the dead pool. This is because regardless of how severe a fire is, fires emit carbon from consumed leaves, needles, branches, and dead material and will not have any significant immediate impact on the carbon stored in tree trunks. Typically a low- or moderate-severity fire will not affect the carbon stored in canopy branches and leaves, but a high-severity fire would. While a high-severity fire will not immediately lead to emissions from the carbon stored in the tree trunks, the fire kills the tree and puts that carbon at risk. Once a tree dies, it slowly decays and its carbon is released to both the soil and the atmosphere. Therefore, the severity of the fire has a direct impact on the quantity of both immediate and long-term releases of GHGs from the burned area.

Based on the figure below, immediate event emissions from a low-severity fire represent only about two percent of the total carbon on the landscape and results in almost no additional dead trees. This is in stark contrast to high-severity fire, which leads to the emission of about 15 percent of a forest's carbon during the wildfire event and an additional 85 percent of the live carbon pool now dead and decaying. Given the quantities of carbon stored in the forest landscape and the scale of recent megafires, the 15 percent emitted to the atmosphere adds up to hard-to-comprehend amounts. The authors state *the immediate emissions from large wildfires can approach magnitudes equivalent to total annual emissions from medium to large cities, leading to the perception that such fires are significant threats to landscape carbon sequestration capacity. Even though this view only accounts for immediate and short-term fire effects, it still leads to the possibility that using fire as a management tool may be significantly limited if regulations restricting wildfire carbon emissions are implemented. However, if limitations on fire use result in further accumulation of surface and ladder fuels that increase the potential for high-severity fire and thus unstable carbon stocks, such regulations may be counterproductive for long-term carbon management*.

Figure 1



MATCHETT, LUTZ, ET AL. – 2015

Policy Background: Air Quality – Particulate Matter 2.5 (PM2.5)

When fire burns through a forest, it consumes organic matter and releases smoke to the atmosphere. According to the EPA, *smoke is composed primarily of carbon dioxide, water vapor, carbon monoxide, particulate matter (PM), hydrocarbons and other organic chemicals, nitrogen oxides, trace minerals and several thousand other compounds*. Particulate Matter 2.5 (PM2.5) is a focus of current policy discussions, including its impact on public health and as a greenhouse gas. The California Air Resources Board (CARB) has recently released for public review and comment a concept paper for a Short-Lived Climate Pollutant Reduction Strategy. CARB defines a Short-Lived Climate Pollutant as methane, black carbon (PM2.5), fluorinated gasses, and tropospheric ozone. According to CARB, *broad action to reduce short-lived climate pollutants can cut global warming in half by 2050 and save an estimated 2.4 million lives annually, by 2030*. They continue, *black carbon warms the atmosphere by absorbing solar radiation, influences cloud formation, and darkens the surface of snow and ice, which accelerates heat absorption and melting*. CARB's 2012 Black Carbon Emission Inventory found that 52 percent of California's black carbon emissions come from wildfire (does not include

agricultural burning). In 2013, 66 percent came from wildfire, which, while not explicitly stated, likely demonstrates the impacts of events such as the Rim Fire. The concept paper identifies the need to *prioritize areas where the use of prescribed fire will have the greatest reduction in wildfire risk, and associated net back carbon impacts*.

Relevant Research

Wildland Fire Management and Air Quality in the southern Sierra Nevada: Using the Lion Fire as a case study with a multi-year perspective on PM2.5 Impacts and Fire Policy
By: Don Schweizer and Ricardo Cisneros – 2014

Research conducted by Schweizer and Cisneros demonstrates how managed and prescribed fire can not only reduce fire-related health impacts to area populations compared to megafires, but that prescribed/managed fires likely release less black carbon per acre burned (as described in the previous article). *In addition to fire size, fuel loading, fire intensity, and fuel consumption at a minimum need to be understood to accurately assess emissions*.

Comparing the managed Lion Fire of 2011 to the wildfire McNally Fire of 2002, the Lion Fire had little to no effect on the regional air quality while the McNally Fire had significant impacts due to the size of the area burned each day, the amount of fuel burning, and that it occurred during a time when air quality in the area was already an issue. Based on their findings the authors warn that *the backlog of fuels created through years of fire suppression has likely created an emissions deficit that will be confronted in the near future by an increasing population*. However, their findings suggest that *management of naturally occurring fires during advantageous meteorological and ecological conditions should be prioritized to limit future air quality impacts*. Because managed/prescribed fires occur at times when overall air quality is relatively good, their acres burned per day are relatively small, and their typically low-to-moderate intensity consumes less fuel as demonstrated by Matchett et al., there is *the potential for mitigating future impacts from a larger more intense fire using managed fire*. These two studies demonstrate how prescribed and managed fires can be used to mitigate two of CARB's primary concerns: reducing black carbon emissions from California's largest emission source (wildfire) and reducing regional health impacts from PM2.5.

Policy Background: Water Quantity and Forest Management GHGs

In our fourth year of drought, Proposition 1 Water Bond projects are beginning to get underway in an attempt to create more resilient water storage to buffer CA inhabitants against future drought. At the same time, Greenhouse Gas Reduction Fund (GGRF) projects are being developed to reduce emissions, and sequester and secure carbon from the atmosphere. Better understanding the various benefits resulting from healthy forests, regardless of funding source, will inform decisions regarding the investment of these funds. The summary below describes a recent effort looking at these issues.

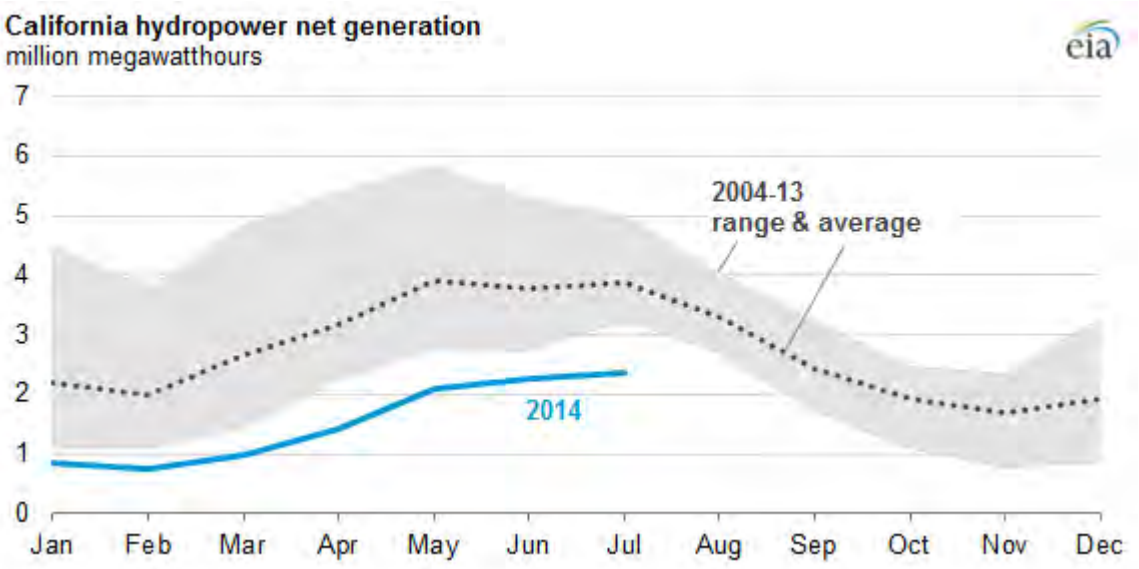
Relevant Research

Estimating the Water Supply Benefits from Forest Restoration in the Northern Sierra Nevada
By: Kristen Podolak, David Edelson, et al. – 2015 – The Nature Conservancy

The paper by Podolak et al. suggests that fuel reduction treatments could both increase available water as well as reduce greenhouse gas emissions. In many small-scale studies, selective removal of trees has led to an increase in the water yield from that watershed. The authors used the results of those studies and applied them to potential ecological restoration treatment activities in the north central watersheds of the Sierra Nevada (Battle Creek to Mokelumne River). The treatment activities were drawn from USFS data on current and potential project areas. Rather than focusing on maximizing potential water yield, the authors instead focused on treatment activities that would restore the ecological function of the forests and would increase resiliency against high-severity fire, with water yield as a side benefit that may help to pay for the treatment activities. The authors used the USFS treatable acres data to calculate the acreage necessary to reach the 20-30 percent of the landscape treated necessary to reduce overall fire threat within a watershed.

Based on their assumptions, the authors theorize an upper end of a six percent increase in water yield from their study watersheds, which in the case of the Feather River watershed would equate to an additional 285,000 acre feet of water available for downstream water use. Note that an acre foot of water provides enough water to meet the needs of approximately 10 people per year, so the potential increase in the Feather River watershed water supply could provide water to over two million Californians in a year. The authors conclude that for watersheds with existing hydropower facilities the cost of the forest restoration activities can almost be entirely paid for by the revenue from the power generated from the additional water. The authors did not extrapolate out their findings to the current drought conditions or to greenhouse gas emissions, but the drought led to roughly a 50 percent decline in hydropower production in the state from 2011 - 2014 (see Figure 2 below). The resulting energy deficit was in part filled by natural gas energy, which therefore increased California's emissions of GHGs. While observational research on the impact of treatments on water yield are still gathering data, the TNC study demonstrates the significant potential benefits that reducing the fire risk in the Sierra Nevada will have on seemingly unconnected ecosystem services – water and energy production.

Figure 2



U.S. ENERGY INFORMATION ADMINISTRATION

Next Steps

Staff will continue to track, monitor, and report on important scientific developments as they occur. Specific attention will be paid to opportunities to provide input on partner agency efforts including:

- Air Resources Board draft short-lived climate change pollutant strategy and their strategies to achieve the greenhouse gas reduction goals by 2030 set forth by Governor Brown; and
- CAL FIRE/FRAP grant guidelines for projects funded through the Greenhouse Gas Reduction Fund and how forest treatments are counted towards carbon sequestration and storage is still under development.

Recommendation

This is an informational item only; no formal action is needed by the Board at this time, although Boardmembers are encouraged to share their thoughts and comments.