

**When fire burns through heavy brush and snags of a recent fire:
Fire Behavior on the 2012 Chips Fire**



Chips fire burning intensely upslope and along Indian Springs ridge in the area previously burned in the 2000 Storrie fire.

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Due to factors including climate change, land management practices and the associated shifts in fuels and fire regimes, in the future firefighters may more frequently encounter fires which burn in the footprints of previous fires. In general in the Western U.S., large fires have become more common in the past couple decades, and high severity fire effects are becoming more common in some areas. In many instances, these recent, large fire areas may leave heavy fuel loadings consisting of snags, large downed logs, shrubs and/or young tree regeneration. When these heavy shrub/snag/log fuels occur on steep slopes, firefighters are confronted not only with fire intensities that can preclude direct attack, but also with the safety hazards of falling and rolling snags, logs and debris that are compounded by steep slopes. This case study explores the fuels, fire behavior and resistance to control found in the early weeks of the Chips fire in an effort to inform planning and actions taken on future fires burning in the footprint of previous fires with heavy shrub, snag and log fuels in steep terrain.

The Chips fire started July 29, 2012 in the Feather River Canyon on steep slopes that burned twelve years earlier in the Storrie fire and again four years ago in the Belden fire. During initial actions the fire remained small due to slow to moderate rates of spread within the footprints of the recent Storrie and Belden fires despite the steep and difficult to access terrain. Firefighter efforts of the were another key element of keeping the fire to a minimum size through this period, but they were unable to contain its perimeter due to factors such as spotting, fire creeping under logs after aerial retardant application, and alignment with steep slopes.

The suppression actions held the fire on the ridge above Indian Creek for a while, before the fire burned into an area of high density snags, down logs and shrubs. The fire quickly increased in intensity, and due to unsafe fireline conditions the fire crews retreated to safer locations. The fire progressed down the slopes of Indian Creek canyon, and on August 2, the fire spotted 1.5 to 2 miles into the North Fork of the Feather River canyon. Fire intensity increased on multiple segments of the fire because burning material rolled down steep slopes into unburned fuel, and then fire ran rapidly back uphill. On multiple days, the fire continued to make substantial runs and increase in size.



Left photo - Initial spread of fire in the steep, difficult to access terrain of the Feather River Canyon, burning through the 2008 Belden and overlapping the 2000 Storrie Fire footprints.

Right photo - Fire activity during the first days of the fire as it moved along the ridge and began to slop over into the Indian Creek drainage.

The Chips fire burned 75,431 acres of the Plumas and Lassen National Forests before being contained on August 31, 2012. The fire was very resistant to control, in part because of the steep terrain, lack of accessibility, and very low fuel moisture, but also because of extensive areas of decadent shrubs, snags and logs, a fuel type resultant from the previous fires.

At lower and middle elevations in the Sierra Nevada, fires burning within the perimeter of previous fires have occurred under similar circumstances to the Chips fire, where dead and down woody material and vegetation regrowth supported fire spread. An example of this influence on fire spread is documented by the National Park Service on the 2009 Big Meadow fire that overlapped the 1990 A-Rock fire in Yosemite near the community of Foresta. The A-Rock fire converted the existing mixed conifer forest to an area dominated by a chaparral plant community with scattered patches of trees. Similar fire

activity was documented on the 2004 Mineral and Armstrong fires in Calaveras County, CA, where these fires overlapped the 1992 (Old) Gulch fire.

The heavy brush, snag and large downed woody fuels in portions of the Chips fire which had burned at high to moderate intensity during the 2000 Storrie fire lead set the stage for very high fire intensities. The most representative fuel model for the fuels within the footprint of the Storrie fire is Timber Litter 7, 'large downed logs and heavy forest litter,' however, no exact fuel models or means to model fire behavior are readily available for fires burning through areas with extensive snags. Natural snag fall rates and high winds the previous winter contributed to tops breaking off many snags and adding to surface fuels. Thousand hour surface fuel loading was measured at 214 tons/acre in a stand exam plot with heavy fuel loading prior to the fire. Shrub fuel loading ranged from 3 to 10 tons/acre in stand exam plots with heavy loading. In some cases the brush was over five feet tall.

Steep topography and dry weather 'sealed the deal,' allowing the Chips fire to burn readily. The Chips fire burned in elevations ranging between 2200 to 6400 feet initially in the North Fork of the Feather River Canyon, spreading in multiple drainages and along steep slopes. Most slopes were greater than 55% and some were even greater than 70%. These steep slopes made access difficult, increased fire behavior, and set the stage for safety difficulties with rolling snags, logs and debris for firefighters on the ground. The year preceding the Chips fire was a low precipitation year. To make matters worse, much of the precipitation which did occur fell as rain rather than snow, which is not the norm for the Sierra Nevada. When the moisture comes as rain rather than snow, it runs off or evaporates faster, leading to drier soils and surface fuels. The 1000 hour moisture was below 10% at the time of the fire, and oven-dried samples of live Manzanita leaves were at 100% moisture, both of which are very low.

Fire behavior on the Chips when the fire was moving through previous fire footprints was possibly more intense than has been recorded yet in surface fire behavior. The ERC was above 97th the percentile, and the Haines index was between 5 and 6 during the initial weeks of the Chips fire. The Chips fire spread slowly under the smoky inversion layer, and spotted long distances and consumed greater acreages when the inversion layer cleared. Quantitative estimates of fireline intensities were calculated using fuel loading data and estimates of fuel consumption. Although only based on two plots representative of 'worst case scenario' fuel loadings and several estimated factors, these calculated fireline intensities ranged up to 16,638 Btu/ft/s, which is higher than some previously published fireline intensity values. For instance, Andrews and Rothermel interpreted fireline intensities greater than 1,000 Btu/ft/s as "*crowning, spotting, and major fire runs are probable, control efforts at the head of the fire are ineffective.*"

The resistance to control on the Chips fire was exceedingly high due to both the difficulty of installing control line as well as fire behavior. The first three to four days the Chips fire burned through steep country where fireline would have been difficult to construct in flat terrain given the same heavy fuels. Snags, heavy brush and large downed logs made

fireline construction labor intensive and fuels rollout thwarted many efforts. For several days, the relative humidity was in the single digits and made most fuelbeds receptive to spotting. For many days during the fire, rates of spread and fireline intensities were higher than those where direct attack is a recommended strategy.



Paired photos from a fixed point in overlapping area of the Chips and Storrie fires taken in 2011 and 2012.

Risk management on the Chips fire was complicated as the fire became established and burned with high intensity through heavy fuels in steep terrain. Several injuries per day were occurring from rolling material and the difficult terrain where crews worked. After multiple shifts of not meeting incident objectives, coupled with the injury rate, the Incident Command Team (IMT) had to make the decision to change tactics and reengage where conditions and the likelihood of success were more favorable.

In summary, the high fire intensities and resistance to control encountered during the Chips fire were due to steep topographic features together with hot, dry weather and heavy fuel loadings which firefighters are possibly more likely to see in the future. Firefighters and IMTs should take special note when they engage on fires which are burning in the footprint of previous fires. Fires burning in these situations have a higher likelihood of exhibiting: high fire intensities, high resistance to control, as well as many safety concerns relating to snags, rolling material and steep terrain.

Future research efforts leading to the development of a decision tool for fire managers to use in these situations to aid with risk management could be useful.

(Summary and full reports available at: [\(LLC or AMSET website?\)](#))