2018 Ferguson Fire

Fire Behavior Assessment Team (FBAT), US Forest Service

Figure 1. Looking North from Devil (Signal) Peak (7079 ft elevation) on 7/22/18, 1100.

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Introduction

The Ferguson Fire started on the evening of July 13th in the Sierra National Forest in the Merced River canyon from a vehicle contacting roadside vegetation, and grew to over 9,000 acres by the morning of July 16th. The Ferguson Fire area is largely grass and shrub fuels at lower elevations and timber/grass/shrub fuels at higher elevations including tree mortality fuels. The Energy Release Component[1] (ERC) early in the fire was slightly below the 80th percentile and began a sharp climb toward the higher percentiles typically found August through mid-September. Long lasting daily inversions were common during this fire (at the time of this report, 7/31) and fire growth was generally moderate and steady. Faster rates of spread were found in the grass and brush at lower elevations on the fire, namely the fire spread clocked at 90 chains/hr (using drone imagery) on 7/21 in Ned Gulch, as the fire spread up the Merced canyon walls and sub-gulches on a south/southwest aspect onto the Stanislaus NF. See fire vicinity maps (figure 10 &11 at end of report).

Fire Behavior Assessment Team (FBAT) goals for the 2018 season are related to capacity. The FBAT program is in a position where full fuels/fire behavior plot installation methods will probably not be feasible in 2018, largely due to lack of funding to support pre-season training or preparedness for the season. FBAT goals for 2018 are to 1) collect more data on fire behavior in red phase tree mortality to expand the 2016/17 dataset for stronger analysis, 2) beta-test terrestrial scanning Lidar (TLS) methods pre- and post-fire to assist in getting Lidar technology on a trajectory to provide fuels and consumption data operationally, and 3) support IMT and/or fire host unit(s) with specific goals as feasible.

[1] ERCs were computed from El Portal RAWS at 2080 ft elevation, 20 years of data, fuel model G [heavy dead and downed closed canopy conifer]). ERCs are a fire behavior index related to available energy (fuels) at the head of the fire used to track seasonal trends.

Tree Mortality & Fire Behavior Observations

Going into the Ferguson Fire, FBAT was aware that much of the mortality on the Sierra NF might be grey phase, however, we attempted to find opportunities to meet our primary goal for 2018. Across various portions of the south and eastern flanks of the Ferguson Fire, FBAT found approximately 5% of dead trees in the 'old red' phase (only a portion of dead needles remaining) and about 40% of stands in the 'grey phase' (needles gone, with all size branches still remaining). Scattered old phase mortality (snags with few branches remaining) was also found.

Methods used to collect fire behavior observations in red phase tree mortality included standard Field Observer methods of weather, fuels and fire behavior, as well time-lapse cameras to obtain observations for more locations and longer time periods than field observation. Although time-lapse video did not always capture as much readily-quantifiable fire behavior as hoped, it did show daily inversion, smoke and general fire behavior patterns. All field-observed fire behavior was backing fire in brush and largely grey phase tree mortality with short uphill runs in brush fuels. General observations from time-lapse were 1) fire behavior was very dampened when the inversion or smoke layer was present, and 2) grey phase mortality burned with higher surface fire intensity and longevity than areas that did not have high loadings of 100-, and 1000-hour surface fuels. (time-lapse weblink: https://www.fs.fed.us/adaptivemanagement/amset_videos.php)

Specific fire behavior observations from time-lapse:

- Footman Ridge July 22 (0900-1022): 3 chains/hours backing downhill and against a 1-4 mph south and southwest wind (75-82° F RH 54-48%; note - weather measured with a Kestral positioned in full sun).
- Henness Ridge July 27 (2023-2057): two lines of flanking fire pulled together and then moved uphill approximately 5 chains in 34 minutes (9 ch/hr) with surface fire and torching (figure 2).

Figure 2. Time-lapse image from Henness Ridge on July 27, during 2000 hour

Tree mortality fuels in the western southern/central Sierra Nevada range are phasing from standing dead trees, to falling or rotting-in-place older dead trees, which creates a variety of difficulties for land and fire management. The high density of dead trees requires more effort and exposure during incident management, and after snags near containment lines are felled, the resultant large-diameter fuels added to the surface can increase the complexity of burning or holding operations. As the density of dead trees increases, so does the exposure of firefighters to hazard trees. On upper Henness Ridge at the time-lapse location, we heard 11 snags fall in the upper Zip Creek drainage from 0900-0945 on 7/29 with only an intermittent 2 mph wind felt at the ridge. There were reports on the Ferguson Fire of snags becoming fire-weakened enough to fall only 30 minutes after fire was in the area. The hotshot community recognizes that we don't have experience in the kinds of tree mortality conditions present today. *The wicked problem of managing fires in heavy tree mortality while keeping firefighters and public safe requires commitment and flexibility, and continuous learning and improvement.* We must plan for the complexity of multi-layered and multi-year effects from large-scale tree mortality outbreaks in future land management and forest restoration efforts, with firefighter and public exposure included.

Lidar Connections to Fire Management

California needs to improve estimates of biomass consumed and carbon released by wildfires, as well as fuel loadings across the landscape. In order work towards mapping and monitoring these biophysical characteristics and dynamics, FBAT collaborated with the Global Environmental Analysis and Remote Sensing Laboratory (GEARS) lab at the University of Nevada Reno (Director, Jonathan Greenberg), the USFS PSW Region Remote Sensing Lab (Program Manager, Carlos Ramirez), the University of Maryland, College Park, and NASA Goddard Space Flight Center. Accurate identification of fuels - including crown bulk density, height, and ladder fuels – are essential inputs to fire behavior and air quality models. Lidar data holds promise for measuring these characteristics.

FBAT staff were given permission to lead two terrestrial laser scanner (TLS) and vegetation plot crewmembers within the planned controlled area of the growing Ferguson Fire (figure 3). Six TLS plots were established east of Devil's Peak July 21-22 (figure 7). Additionally, the NASA JPL successfully obtained airborne Lidar with little smoke degradation for the same area sampled with TLS, which greatly improves the data utility.

Figure 3. Crew members setting up the TLS scanner at a plot on the Ferguson Fire.

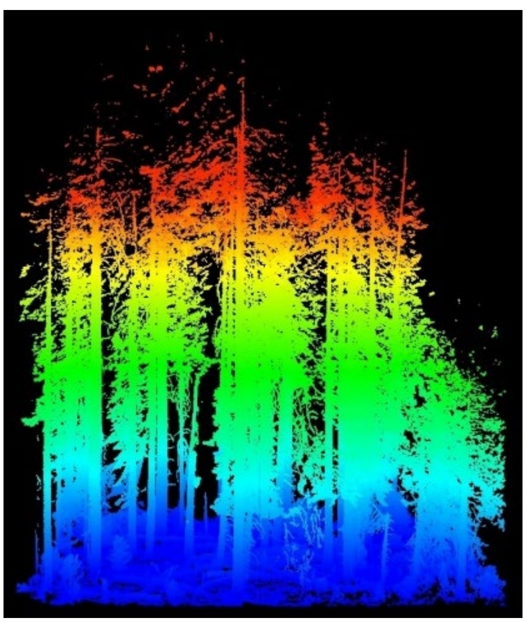


Figure 4. Visualization of plot 405 from a horizontal position, with the colors representing height above terrain.

The current state of TLS science requires significant pre- and post-processing of data in order to obtain stand characteristics and estimates of fuels (figure 4). Extracting tree-level metrics automatically is currently being operationalized. Methods of converting Lidar data into surface fuel loading data are currently being developed and refined. GEARS-RSL-UMD-NASA are looking to develop workflows for rapid processing of the Lidar data to produce near-real time outputs that can be used for fire behavior modeling and other aspects of incident support.

More information about how lidar data can help fire modeling was recently covered in a popular magazine: https://www.wired.com/story/how-supercomputers-can-help-fix-our-wildfire-problem/?mbid=social_fb_onsiteshare&fbclid=IwAR1m9iC1r-GaCm5HycccOo4Y24IXrKXejzhMOBUUhZt1BEIgG5t9G8_N9ok

The Lidar images included here (figures 4 to 6) show samples of the types of fuel characteristics that can be extracted from Lidar data including vegetation height above terrain, ladder fuels, and density. The ladder fuels are depicted in a visualization of a 'slice' from 0.5 to 3 meters of TLS data from the plot (figure 5). The "rings" are the cross sections of standing trees (DBH can be measured from this view). Note that all of the plots measured on the Ferguson Fire had a significant number of downed trees. The gap fraction analysis visualization (figure 6) shows 'voxels,' or 3-D boxes of vegetation density. The yellower the voxel, the higher the gap fraction, so denser vegetation is seen in greener colors. Ultimately this type of analysis will allow biomass estimation.

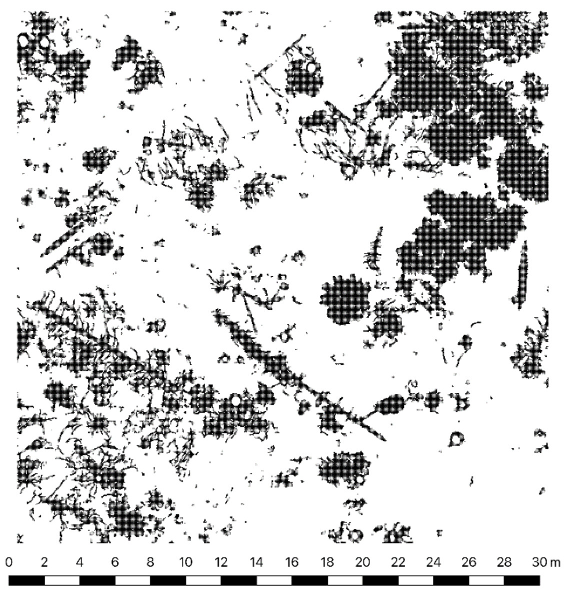
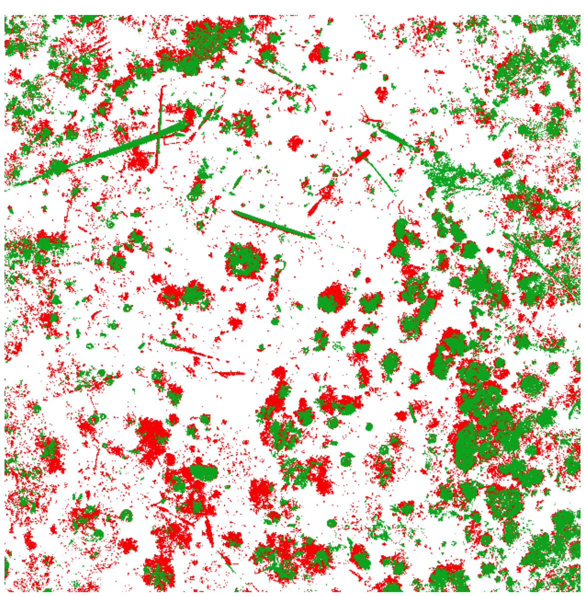


Figure 5. 'Slice' from 0.5m to 3m (ladder fuel range) visualization of TLS data from plot 405.



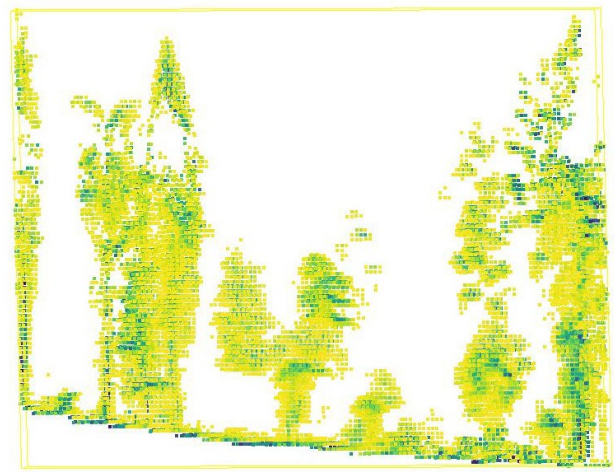


Figure 6. Gap fraction analysis visualization of plot 404 using 50 cm voxels.

The post-fire image of plot 406 was created from TLS data (figure 7) shows the fuel consumption. Fuels that survived the fire are shown in green, and red depicts the loss between pre- and post-fire. This type of data shows consumption of fuels per each fuel particle across the whole plot, compared to current fuel sampling methods, in which only a portion of the plot area is sampled for fuels characteristics.

A video 'fly-through' of plot 405 **before** the fire passed through can be viewed at:
https://youtu.be/dnuGwGYVu4U
A video 'fly-through' of a plot **after** the fire passed through can be viewed at:
https://www.youtube.com/watch?v=GnK1WEBBjBY

These are highly reccommended video, and shows the live vegetion and dead fuels from multiple perspectives.

Figure 7, image at left. 'Slice' of TLS data at plot 406 showing green is fuel or vegetation that survived the fire, and red is consumed.

Paired Photos at plot 405 (figure 8) also show some consumption and fire effects, which the TLS data can better estimate and quantify. More photos are available upon request.

Figure 8. Before and after the Ferguson Fire passed through plot 405.

Safety

Dead trees (snags) and driving on poorly maintained, dirt cloud-choked roads were the biggest risk categories for firefighters and researchers to engage in and near the Ferguson fire area both during and after the fire passed through. Our grieving hearts and our situational awareness was extremely heighten after the deaths of 2 firefighters during the active parts of the Ferguson Fire. We are reminded daily that capturing wildfire data is not worth unnecessary risks. FBAT had to slow down on meeting our pre- and post-fire data goals to mitigate these safety risks, including postponing plot re-visits until some windy days had gone by, posting snag spotter person on every plot, practicing plot-specific snag escape protocol, requesting help of falling teams to assess and clear roads of fallen trees when the suppression objectives were met in those divisions, and delaying re-capturing post-fire data at plot 405. Figure 9 was a snag area in plot 405 that has been assessed a few times, and only after additional wind events going into October did a small field crew visit the plot during a no wind period, with snag safety spotters on site.

Figure 9, image on the left. Some of the snag trees that survived early fall winds into October on plot 405.

Fuel Moistures

Fuel moisture, or the amount of live or dead fuel that is easily available to burn based on seasonal conditions, serves a function in fire spread and fire behavior modeling and predictions. The IMT was interested in how the recent fire footprints on the Stanislaus NF might be affecting fire spread to the north side of the fire. FBAT staff helped collect fuel moisture samples on the shrubs that have resprouted inside the 2013 Rim fire footprint, as a calibration tool for fire modeling or strategic burning operations. Yosemite NP staff did a similar task for the area in the Merced Grove, outside and east of the Rim fire footprint (figure 10). The summary table shows that the live shrub foliar moisture is not at critical levels yet, and field observations were able to note that the shrub fuels mostly consisted of new moist vine-like material and lacked dead, decadent woody material typical of older shrubs. Note fire- and bug/drought-killed snags were common both as standing and fallen woody fuels.

Fire Name	Sample Location	Date Sampled	Elev.	Slope %	Aspect	Sample Type	Fuel Moisture %	notes
Ferguson Fire area, inside 2013 Rim Fire footprint	N of Merced Grove Parking Lot	7/29/2018	5960	~15	SSW	whitethorn, Ceanothus cordulatus	138-139	evergreen shrub, inside Rim's moderate severity veg. category
	N of Merced Grove Parking Lot	7/29/2018	5960	~15	SSW	greenleaf manzanita, Arctostaphylos patula	150-159	evergreen shrub, inside Rim's moderate severity veg. category
	N of 5 Corners, S of Golden Arrow Rd, above where 1S12 intersects with 1S75	7/29/2018	4090	~15	SW	deerbrush, Ceanothus integerrimus	112-128	deciduous shrub, inside Rim's higher severity veg. category
	N of 5 Corners, upper 1/3 of Big Creek Basin, higher up 1S12 Rd than above sample	7/30/2018	4840	~15	SW	deerbrush, Ceanothus integerrimus	130-146	deciduous shrub, inside Rim's moderate to high severity veg. category

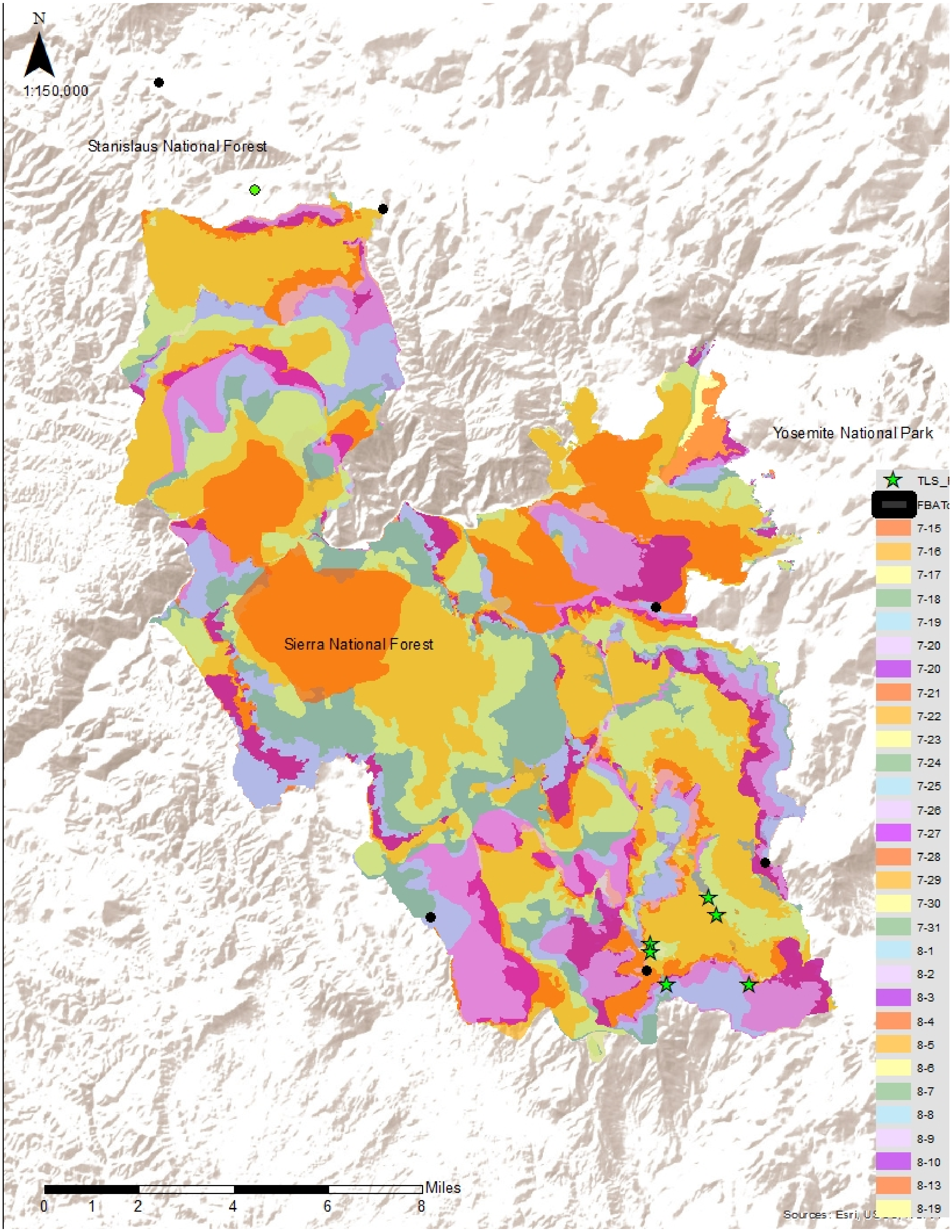


Figure 10. Ferguson Fire progression as of late August and vicinity area with FBAT time-lapse and fuel moisture sites (black and green dots) and field Lidar (TLS) locations (green stars)

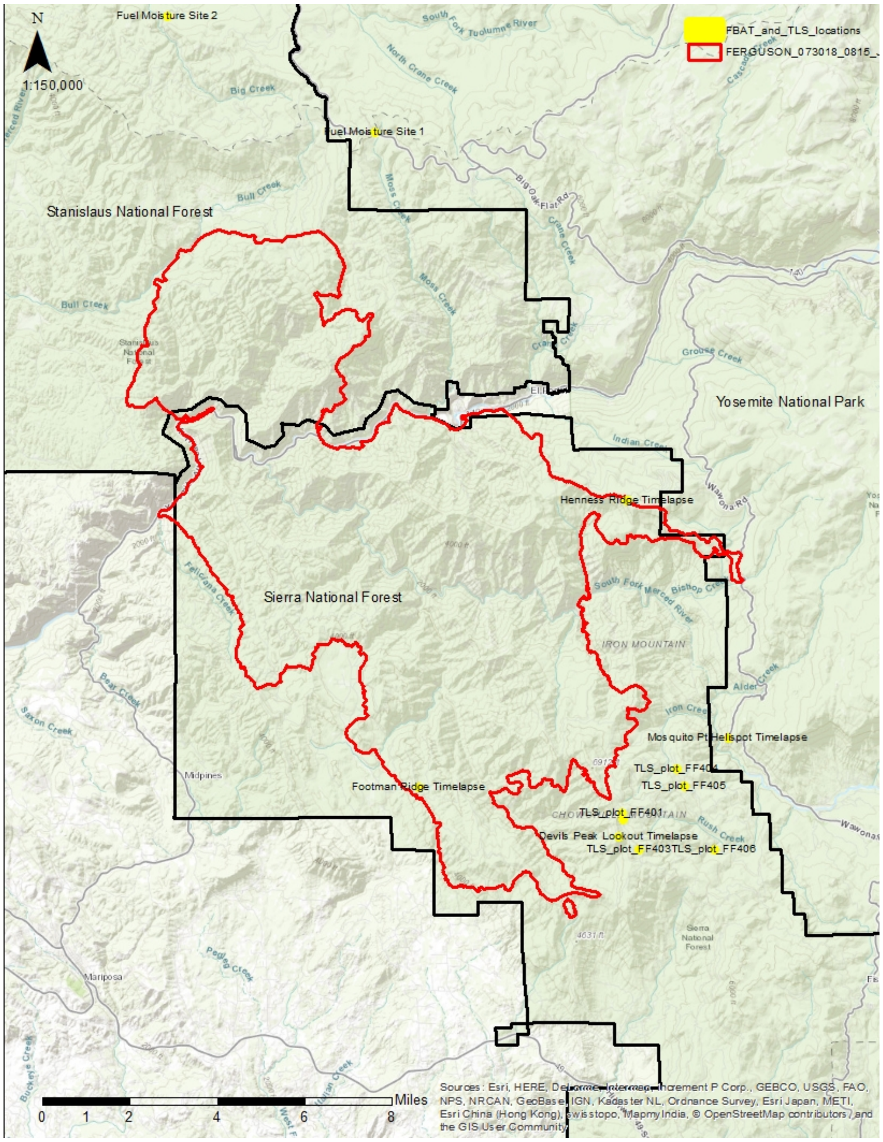


Figure 11. Ferguson Fire (based on 7-30-18 am perimeter) and vicinity with FBAT time-lapse and field Lidar (TLS) locations, most which had not burned as of this date.

Acknowledgements

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TLS field crew: Rodney Hart and Laura Wade; **TLS Visualizations/Analysis**: Zhengyang Hou (University of Nevada, Reno) and Steven Hancock (University of Maryland, College Park); **TLS Funding**: NASA Carbon Monitoring System: Continuing Prototype Product Development, Research, and Scoping, “Three dimensional change detection of aboveground biomass”. 2017. J.A. Greenberg, J. Armston, L. Duncanson, S. Hancock, T. Painter, S. Conway, and C. Ramirez.

Fuel moisture assistance: Michael Brockman, Ron Plummer, Garrett Dickman