Middle Fork Risk Assessment

Summary

- Dead fuel moistures are very low with downed logs consuming completely and allowing spread via cigarette burning.
- Fire spread by spotting has been the other primary spread mechanism and is expected to continue.
- Three to five additional offshore flow episodes are expected over the remainder of September and into October; it is unclear if any episodes will strengthen into an East wind event.
- The remainder of September has an 11% chance each day for a large growth event while October has less than 2% chance. The remainder of September is likely to have multi-day episodes, while October usually has single day episodes and only in the first half of the month.
- The remainder of September has a 9-11% chance each day of poor humidity recovery at night ($\leq$ 30%); October has a 2-5% chance, most likely in the first week.
- Additional Haines Index 6 days are not expected before season end, but cannot be ruled out entirely.
- The remainder of September has a 2-6% chance each day of a fire-slowing event; this probability increases to 4-8% each day in October. September fire slowing events are likely to be single day events, with a greater chance that the event will exceed 0.25 inches than be smaller. October fire slowing events tend to be multi-day events with daily precipitation more likely to be less than 0.25 inches, but cumulative precipitation likely to exceed 0.50 inches.
- FSPro results likely over-estimate fire spread potential to the south, west and east to some degree, with the possible exception of in Red Blanket Creek canyon and may well underestimate fire spread potential to the north and northeast.
- FlamMap simulations suggest rapid fire spread to the north and northeast is more likely than rapid spread in any other direction.
- FARSITE results suggest that spread by spotting will tend to “pull” the fire to the northeast

Current Trends

Fire Weather

Maximum temperatures have been running above seasonal average since September 4. Minimum relative humidity has been running below seasonal average since September 1 and reached the single digits on September 11 and 12. Skies have been clear, although smoky conditions tend to prevail on the west or east sides of the fire, depending on the dominant wind direction above the ridgetops on any given day. Surface winds have been the typical diurnal winds. Ridgetop winds have been variable, but predominantly east and west. East winds occur as weak to moderate thermal troughs, promoting offshore flow, and then shift to west as the thermal trough moves to the east of the Cascades and permits onshore flow.

The only inversions have been the typical nighttime variety that breaks around 1000-1100. However, transport winds have not been developing until around 1300-1500, depending on the strength of the westerlies, so little mixing and clearing tends to occur before mid-afternoon. Stable layers have been forming daily at the 7000-8500 ft level, limiting mixing as well. Fire activity would increase when the level of the stable layer formed much higher. The Haines Index has been running at 4 and 5 with a dry but relatively stable atmosphere. However, the September 14-19 period saw increasing instability, culminating on September 19 with a Haines Index 6 day combined with very high temperatures, low relative humidity both day and night, and critically low fuel moistures (figure 1).

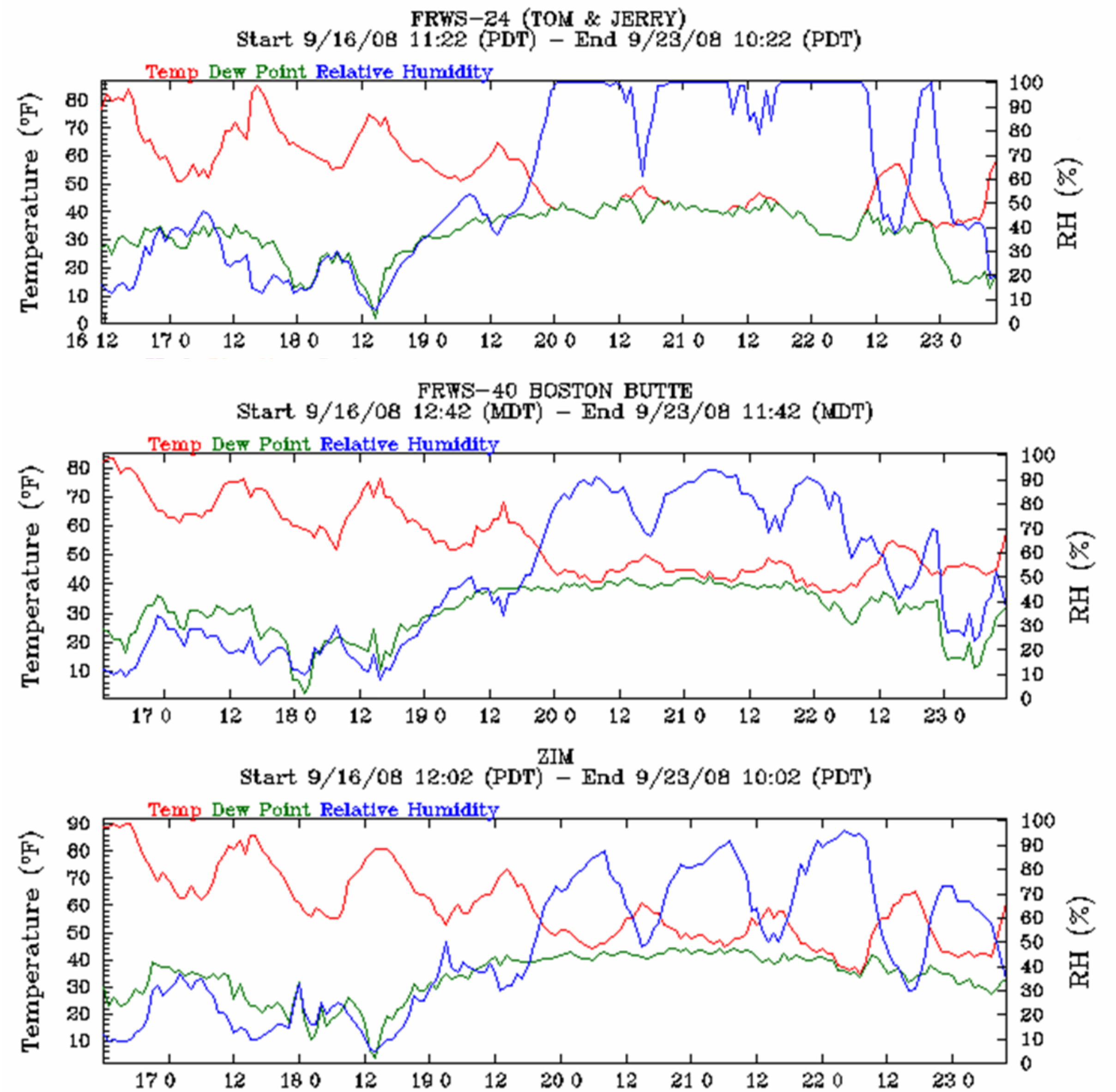


Figure 1. Temperatures reached maximums and relative humidity minimums 9/16-18; then a weak front dropped temperatures and increased relative humidity, greatly moderating fire behavior.

Conditions are expected to be warmer and wetter than average in the September 29-October 7 period. A stronger cold front with rain may move over the fire area sometime between September 29 and October 2.

Fire Behavior

Fire behavior has been very mixed. The surface fire typically has had 1-2 foot flame lengths and daily spread rates of 10-15 chains per day on the fire as a whole. Some flanks are spreading at only 2 chains per day on average. Cigarette burning through downed logs has been a primary spread mechanism, particularly above the canyon rims. In these cases, the duff is completely consumed within 1-1.5 feet of the logs with no consumption beyond that distance. Brushy areas are underburning, if they carry fire at all. Meadows above 6000 feet elevation remain green and have not carried fire.

Group-torching has been occurring regularly throughout the day, sometimes carrying into the early evening. When conditions are suitable, usually set up by a combination of atmospheric instability, steep slopes and wind, short to extended crowning runs occur. The largest such run was on September 8, when just under 800 acres burned in the afternoon with a crown fire. Conditions on that day were a combination of steep slope, south aspect, atmospheric instability to 15,000 feet, easterly winds, and low relative humidity. Crowning runs typically occur between 1200 and 1800, although a few runs have occurred earlier and later in the day, with flame lengths of 150-200 feet. Torching and crowning activity has produced numerous spot fires with spotting distances typically 0.25-0.5 miles but spotting to 1 mile has not been uncommon.

Beginning on September 14, fire behavior began to pick up, peaking on September 18. The fire made runs to the east, south and north on various days, becoming established in Crater Lake National Park and on the Winema National Forest on September 17. Even during the major runs, the fire did not spread as a crown fire. Instead, it "hopscotched" by sending out many embers, that started many spot fires that burned together and into the main fire before repeating. The duration of each cycle is not well known, but multiple such cycles occurred on September 16, 17 and 18. Fire behavior moderated on September 19-21 with the passage of a weak front that brought clouds, lower temperatures, and higher relatively humidity, but no rain. A warming and drying trend began on September 22.

If the extended forecast is correct and the implications are a return to more typical fall weather patterns, fire behavior will tend to "yo-yo" through early October. Warming, drying and offshore flow will tend to accompany rebuilding of high pressure, and promote an increase in flame lengths, torching and spotting. During these periods, the fire may increase by several hundred acres at the peak. Weak to moderate fronts or troughs will bring cooling, moistening conditions with some rain possible every 3-5 days keeping fire behavior limited to smoldering, slow spread and cigarette burning. The strength of these weather features will determine how much fire behavior increases and decreases.

I attempted to bracket the possible trajectory for fall by comparing past years' ERC tracks with this year's track and locating years that were relatively similar to 2008 thus far (figure 2). I did this analysis only for Zim RAWS.

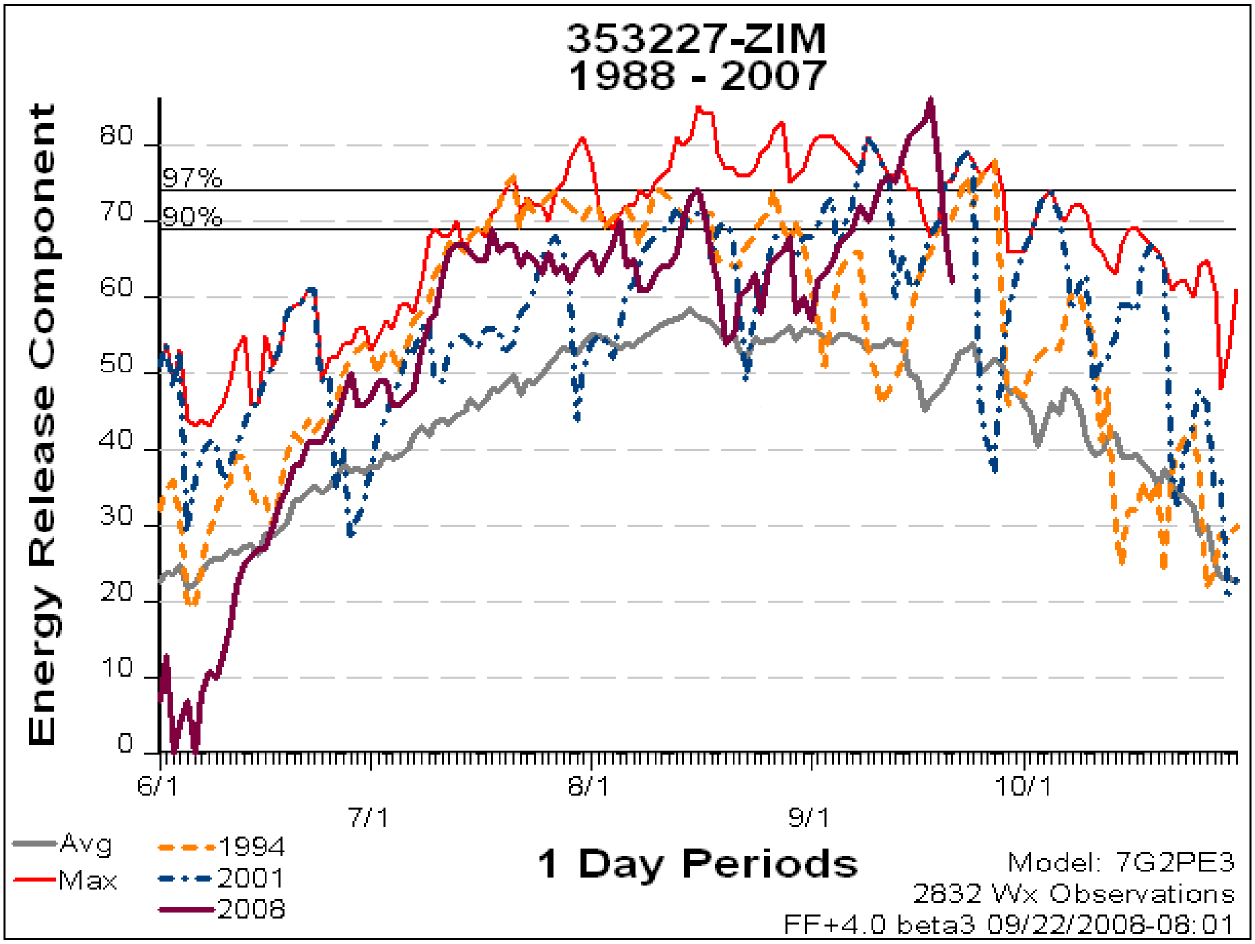


Figure 2. Fire season ended about 2 weeks earlier in 1994 than in 2001

The ERC track for 1994 shows higher than average ERC in September punctuated by precipitation events and relatively slow recovery to near previous levels. Overall, however, the ERC began to drop relatively quickly through October with fire season ending around October 10. The ERC track for 2001 also shows a higher than average ERC in September punctuated by precipitation events. However, recovery to previous levels was much quicker, continuing to set new highs into mid-October, and ERC dropped more slowly through October. Fire season ended around October 21 that year. The 8- to 14-day forecast suggests that this fire season may end later than in 1994, but earlier than in 2001.

Drought and Fuel Dryness

The Drought Monitor for September 16 indicates this part of Oregon remains abnormally dry with moderate drought established in extreme southwest Oregon. The forecast for October is uncertain, however, with equal changes for above average, average and below average temperatures and precipitation.

Live woody fuel moisture calculated using the National Fire Danger Rating System (NFDRS) equations indicate that woody fuel moistures reached the minimum allowed in mid-July. However, shrubs are not carrying fire, suggesting that live woody fuel moistures remain above 100%. The NFDRS equations essentially cured the live herbaceous fuels at the same time. Herbaceous fuels above 6000 ft remain uncured. The latest Departure from Greenness maps indicate this part of Oregon is of average greenness, a further indication that the calculated live fuel moistures are too low.

- Thousand-hour fuel moistures dropped below seasonal average on June 22 and remained below this average since, although above the minimums recorded. Given that these fuels are consuming completely, the NFDRS 1000-hour moistures are likely representative of actual conditions.
- Hundred-hour fuel moistures dropped below seasonal average on June 11, returned to near seasonal average by July 28, and began dropping sharply on September 1.
- Both 1000-hour and 100-hour fuel moistures set new minimums in the September 14-19 period at both Zim and Mt. Stella RAWS.
- Calculated 100-hour fuel moistures have since recovered to near seasonal averages while 1000-hour fuel moistures have increased only slightly.

Weather Event Probabilities

This analysis used data from both Zim (station 353227) and Mt. Stella (station 353209) remote automated weather stations (RAWS). Mt. Stella is located about 12 miles northwest of the fire area at 4715 feet elevation. Zim is located about 5 miles west of the fire area at 4106 feet elevation. Chiloquin RAWS (station 353310) is located approximately 13 miles east of the fire at 4517 feet elevation, but was not considered representative of weather conditions on the fire at this time. All weather events analyzed used data from 1988 through 2007 (20 years) and cover September 22 through October 31. Table 1 summarizes the probabilities of the events analyzed where occurrence data is available.

Strong Winds

Southwest Oregon often has offshore flow in the fall due to the formation of thermal troughs along the coast of northern California. These troughs move up the coast and eventually come onshore and cross over the Cascades, allowing the return of onshore flow. If the pressure gradient between Spokane, Washington and North Bend, Oregon exceeds 15 mbar, the offshore flow can strengthen into a foehn wind. Although still called an East wind, this wind is actually more likely to be out of the northeast instead of east.

Most thermal troughs in fall are weak to moderate. The offshore flow brings warming and drying conditions, accelerating fuel drying and contributing to fire spread rates and the incidence of torching, crowning and spotting. Onshore flow brings cooler, moister conditions, generally slowing fire spread and moderating fire behavior. Three to five additional multi-day episodes of offshore flow are expected between mid-September and mid-October, although it is less clear if any of these episodes will strengthen into an East wind.

Thunderstorm downdrafts can be very problematic for fire spread and fire behavior, but are extremely rare in fall. Dry cold fronts may also occur in fall, but are much rarer than in summer. The prefrontal, southwesterly winds tend to be warm and dry, while the post-frontal northwesterly winds tend to be cool and moist in fall. Cold front winds are more problematic west of the Cascades than east at this time of year. Marine push winds east of the Cascades have not been identified as a potential problem this far south in the Cascade range.

High Temperature-Low RH

High temperatures and low relative humidity can also result in significant periods of spread. Often this acceleration in fire behavior occurs when the daytime high exceeds the 90^{th}

percentile and daytime relative humidity drops below the 10th percentile value. At Zim RAWS, these values are 89° and 14% relative humidity and at Mt. Stella, they are 87° and 15% relative humidity. However, since observed fire behavior has been relatively active when relative humidity drops below 20%, this value was also used in the analysis. September events tend to be 1-3 day events while October events tend to be single day. However, up to 5-day events have occurred at least once in October.

Poor Humidity Recovery

Poor humidity recovery at night can also contribute to fire spread and fire behavior the following day. The critical value for fire spread is considered 30%. Both the remainder of September and October tend to have only single day periods of poor humidity recovery.

Haines Index

A Haines Index 5 is frequently associated with offshore flow, such that additional multi-day episodes remain probable through the end of September, but only single day events are likely in October. Using the Haines Index climatology website (http://35.8.15.88/maps), one more day of Haines 6 is possible in the remainder of September, with an estimated probability of <10%. A Haines 6 in October is highly unlikely. Haines Index 5 days are likely in September with a probability ranging from near 100% for a single day event to 25% for a 3-day event. In October, the probability ranges from near 100% for a single day event to 10% for a 3-day event.

Fire Slowing Events

A common definition for a fire-slowing event is 0.10-0.25 inches of rain over a single day period, which is assumed to slow fire spread for 1-3 days. A larger event – 0.25-0.50 inches – over the same period is assumed to slow fire spread for 4-6 days. Late September may see one such event, with the larger event more likely. These larger September events tend to be closer to 0.25 inches than 0.50 inches. October tends to see multiple events, with the smaller event actually a multi-day event of up to 0.25 inches that cumulatively tends to exceed 0.50 inches. Historical records from National Weather Service cooperator station at Prospect (figure 3) indicate the September event tends to occur late in the second week or early in the third week with a decrease in probability after that.

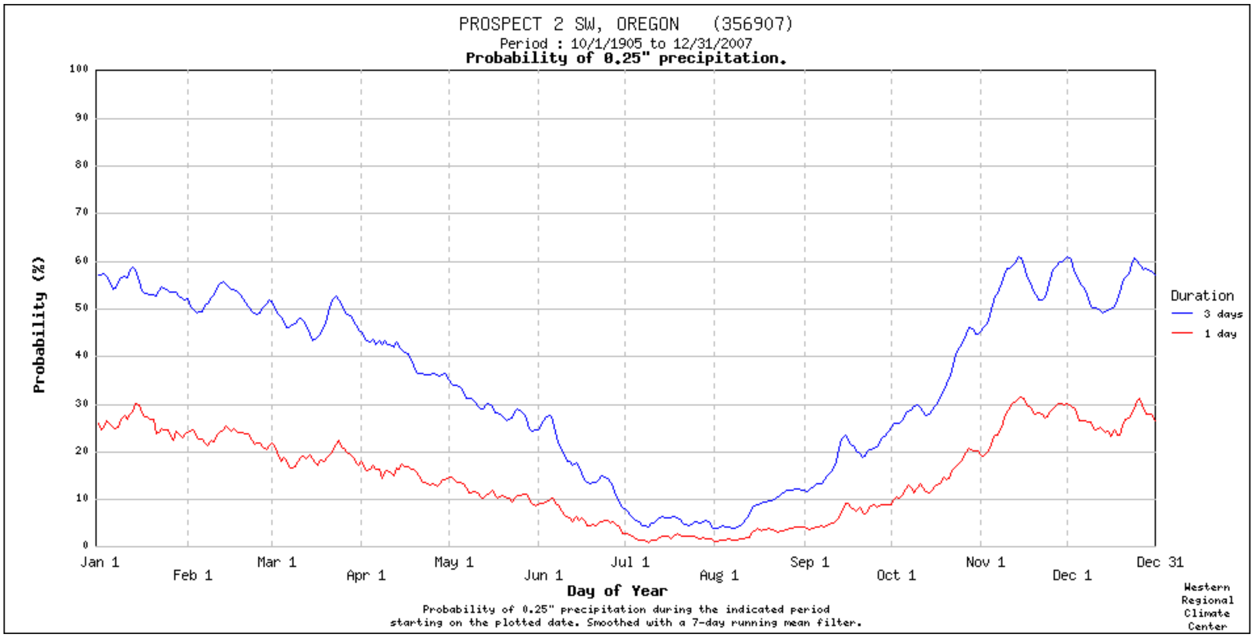


Figure 3. The data from Prospect indicates an event is most likely around mid-September, with increasing chances for rain in October.

Table 1. Daily and annual probabilities for fire growing and fire slowing weather events at Zim and Mt. Stella RAWS for September 22 through October 31.

Weather Event	Month	Zim RAWS		Mt. Stella	
		Daily Probability	**Annual Probability[1]**	**Daily Probability**	**Annual Probability**
Max Temp ≥ 90^{th} percentile, Min RH ≤ 10^{th} percentile	Sep	5-6%	30%	7%	25%
	Oct	1%	10%	<1%	5%
Max Temp ≥ 90^{th} percentile, Min RH ≤ 20%	Sep	11%	35%	7%	25%
	Oct	2%	15%	<1%	5%
Max RH ≤ 30%	Sep	9%	40%	10%	50%
	Oct	2-3%	30%	5%	45%
1 day rain 0.10-0.25 inches	Sep	1-2%	15%	2%	10%
	Oct	4-5%	55%	5-6%	85%
1 day rain 0.25-0.50 inches	Sep	6%	25%	5-6%	40%
	Oct	5%	70%	7-8%	90%

[1]Percent of years in which at least one event occurred

Season End

Predictive Services at the Northwest Coordination Center has created a season-end product based on the 7-day significant fire potential product. Season-end is defined as the beginning of the period when fuel conditions remain in the "green" with only scattered days at higher dryness and no triggers for either significant growth on an existing large fire or the development of a large fire. According to this product, the median season-end date is September 26 and the 90th percentile date is October 3 for Predictive Services Area W4. However, these dates do not make sense to local fire management personnel based on many years of collective experience in southwest Oregon.

Season-end is commonly defined as the point when ERC drops below the 70th percentile and does not recover. This definition often is not strongly associated with a particular precipitation event. Since Mt. Stella and Zim RAWS have proven to be most representative of the weather seen on the Middle Fork Fire, I estimated season-end for both stations using data from 1988 through 2007. In some years, ERC never reached the 70th percentile; those years were not included in the analysis. I used Fire Family Plus 4.0 Beta 3 to identify the season end date for each year and then constructed a waiting time distribution curve in RERAP 7.03. Mt. Stella's data produces season end dates 2 days later than Zim even though it is 600 feet higher in elevation than Zim (table 2, figure 4).

Table 2. Season ending dates for Zim and Mt. Stella RAWS based on ERC values.

Percentile	**Zim**	**Mt. Stella**
50th	Oct. 7	Oct. 9
60th	Oct. 11	Oct. 13
80th	Oct. 19	Oct. 21
90th	Oct. 24	Oct. 27

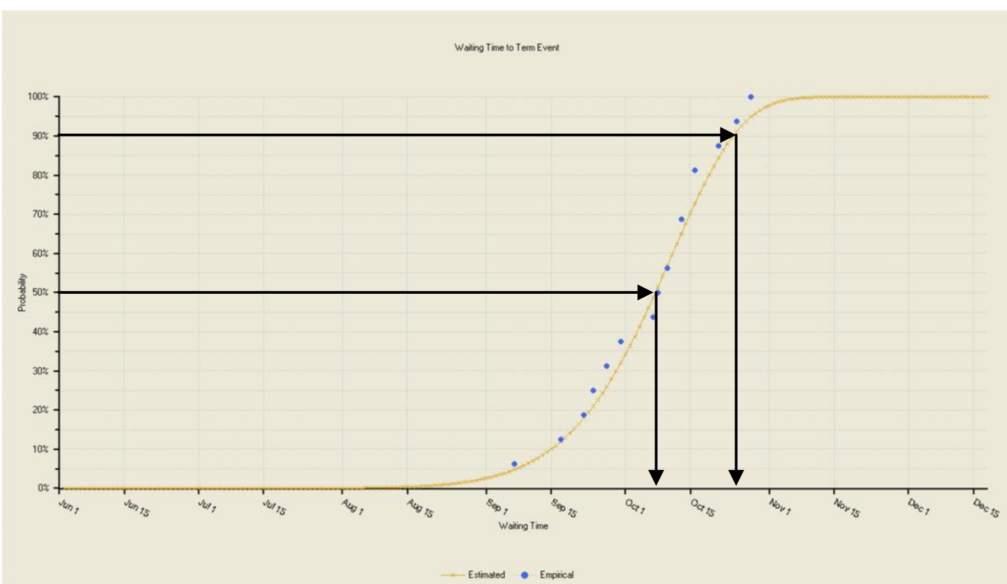


Figure 4. Data from Zim RAWS indicates fire season is most likely to end sometime between October 7 and October 24.

FSPro

In order to have some idea of the values potentially threatened by the fire between the present and season-end, I conducted a 30-day FSPro analysis. I used Zim RAWS data for the weather and Mt. Stella RAWS for winds. Mt. Stella has a greater frequency of winds from a wider variety of directions. Because no fire behavior processors can model fire spread and fire behavior under an unstable atmosphere, modelers are forced to try to use winds as a surrogate. With a few exceptions, winds have had little influence on fire behavior with atmospheric instability, slope, aspect and fuel arrangement much more important. Since Mt. Stella's higher frequency winds are from a greater variety of directions than Zim, I thought it might better represent the possible fire spread directions better than Zim. The drawback is that spread distances will still be underestimated under greater atmospheric instability.

I also changed fuel characteristics in an effort to obtain higher rates-of-spread. I changed fuel models 185 (high load conifer litter), 186 (moderate load broadleaf litter) and 187 (large downed logs) to model 165 (very high load, dry climate timber-shrub). I also increased canopy bulk density to 0.40 kg m^{-3} in all locations where it was lower in order to increase the incidence of torching and active crown fire as a surrogate for spread under unstable atmosphere.

FSPro results assume that the entire fire perimeter is active and that any potential natural barriers and suppression efforts are ineffective. FSPro outputs can be thought of as very densely packed RERAP lines, with the probability of fire reaching certain distances at the end of 30-days instead of season end. As with RERAP, FSPro creates artificial seasons, in this case 1028 seasons, and then spreads the fire based on the fuel moistures estimated for each day's ERC value in the artificial season. Although the process allows the modeler to use forecast ERC values for the first 1-10 days of the simulation, I was unable to use this feature for the 3-day forecast I had intended to use.

Unlike RERAP, FSPro does not spread the fire in straight lines. Instead, it uses the minimum travel time algorithms from FlamMap to identify the fastest pathways and spreads the fire down those pathways for the duration of each artificial season.

FSPro results do not depict the potential fire size or shape nor do they indicate when the fire may reach a given location. For example, the fire may spread to a given spot within the first three days of the simulation and then stop, or reach that location quickly and then advance very slowly after that. The reverse is also true, where the fire could initially move slowly and then very rapidly near the end of the simulated season. The various boundaries represent the percent of simulations in which an individual pixel burned.

The 30-day FSPro output likely underestimates fire spread probability if one or more periods of higher atmospheric instability coupled with high temperatures and low relative humidity, including poor humidity recovery at night occurs (figure 5). The data from both Zim and Stella RAWS indicate that at least one such event should be expected before season end. However, it is unlikely that more than three such events would occur.

How well the results match the real potential to the east is difficult to determine. Movement to the east generally pushes the fire into drier conditions, but also downhill. However, a strong front with high pre-frontal winds might push the fire in that direction. Movement to the northeast would be more likely than movement due east. Given the fire's behavior to date, the FSPro probabilities to the south may be the most accurate. Within the Middle Fork canyon where no suppression actions have been taken, the fire has moved slowly even under the severe burning conditions that occurred on September 16-18. Given the change in sun angle and the canyon's north-south orientation, it seems more likely now that the fire will not reach the Seven Lakes Basin as this canyon may receive too little direct solar energy to support major fire spread.

Further spread to the west, with the possible exception of in Red Blanket Creek canyon is unlikely. Suppression efforts have held even through the severe fire weather period; it seems unlikely that weather and fuel conditions as well as sufficient available fuel remains to allow the fire to regain sufficient energy to jump existing firelines and resume spreading. Red Blanket Creek canyon remains more vulnerable as firelines have not been in place as long, and the canyon's orientation promotes daytime heating and enforces down-canyon winds under offshore flow conditions. Spread northward towards Highway 62 seems very likely, this area is relatively flat and exposed to midday and afternoon sun. Under greater instability, particularly if multiple periods occur, the fire may reach the highway in at least one location. The finger of higher probability down Onion Creek should probably be shifted further east and point more north. Onion Creek itself is also oriented north-south near the current location of the fire and would have the same issues with heating as Middle Fork canyon.

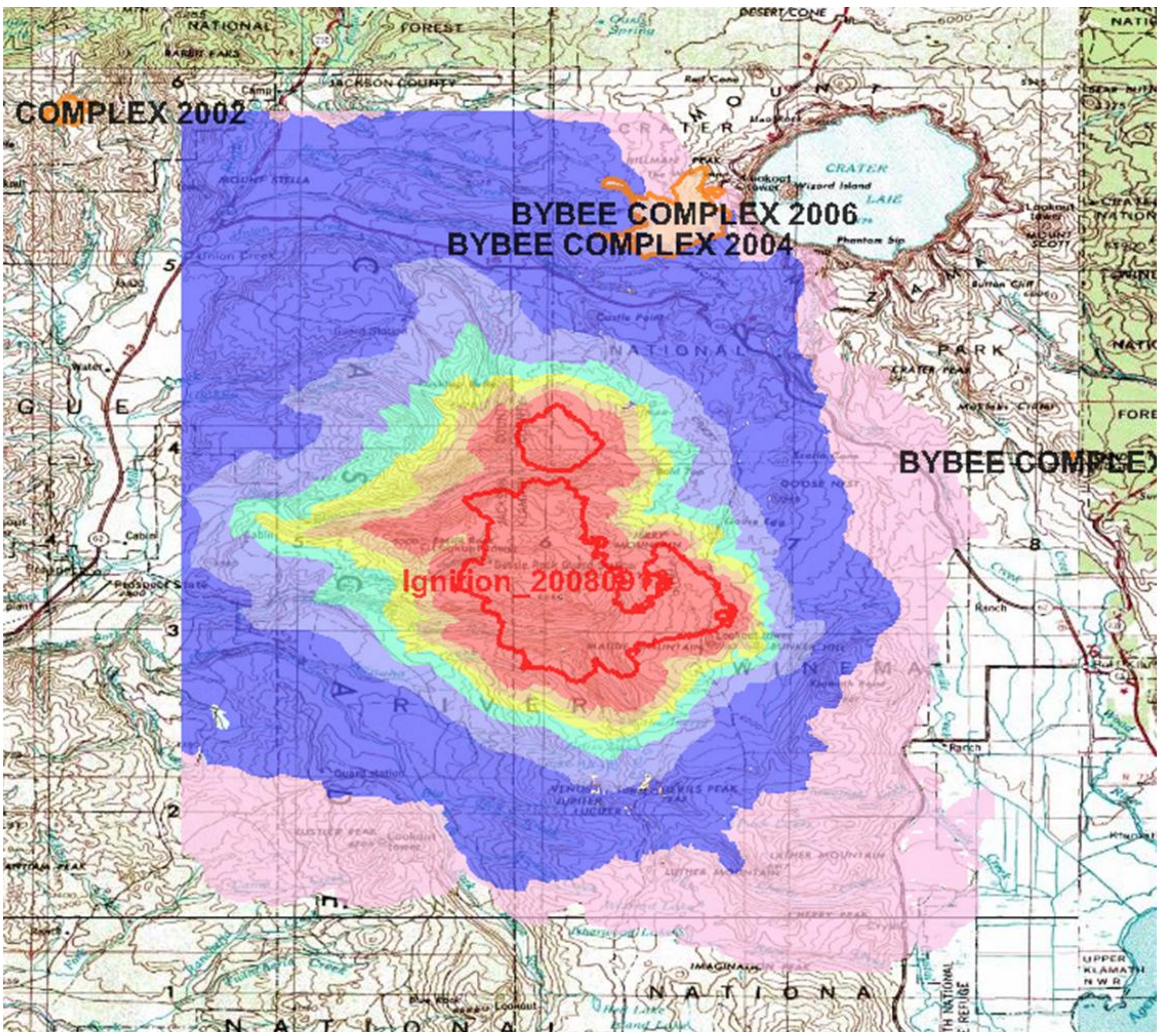
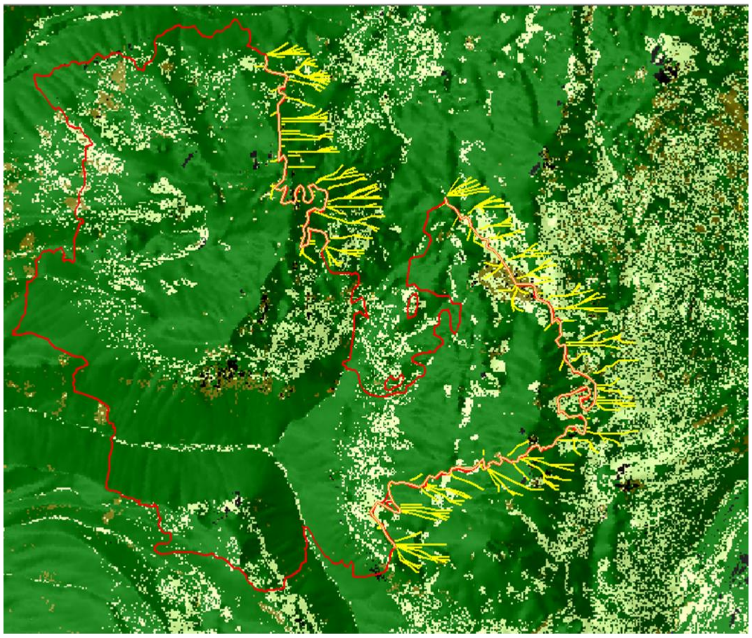


Figure 5. Assuming one or more days of high spread will occur before season end, the fire is likely to reach into the 20-40% boundary in one or more locations.

FlamMap

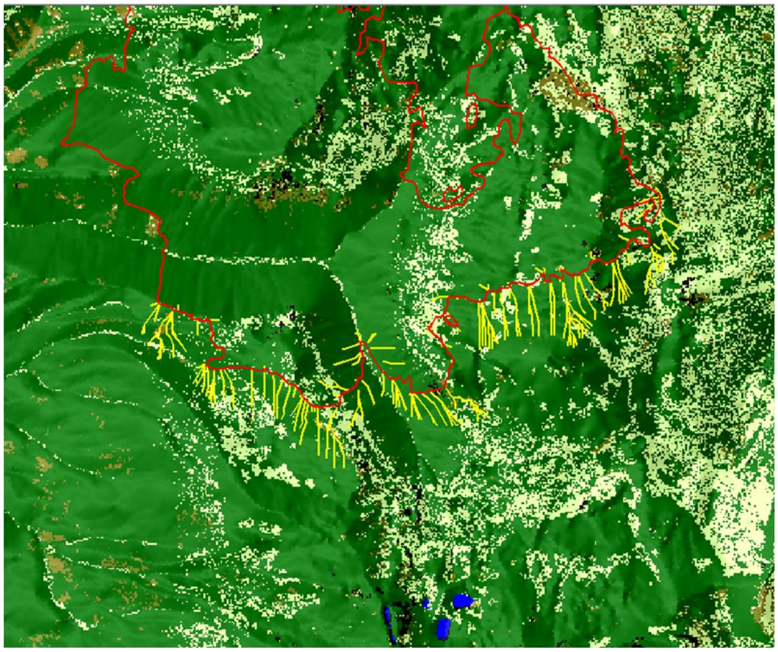
In order to identify potential weak spots around the fire, I conducted several minimum travel time analyses in FlamMap version 3.0. I used the same landscape file as was used for the FSPro run. I created ignition files for the various directions using the infrared perimeter from September 18. I created gridded wind files using WindNinja version 0.910 Beta; all winds were 25 mph at 20 feet above forest vegetation. Wind directions used were north, northeast, east, south, southwest, and west. Fuels were conditioned using hourly weather data from Zim RAWS for September 11 at 1200 to September 19 at 1200. All runs were for 600 minutes (10 hours) in order to obtain flow paths of sufficient length to determine probable weak points and spread directions.

West Winds



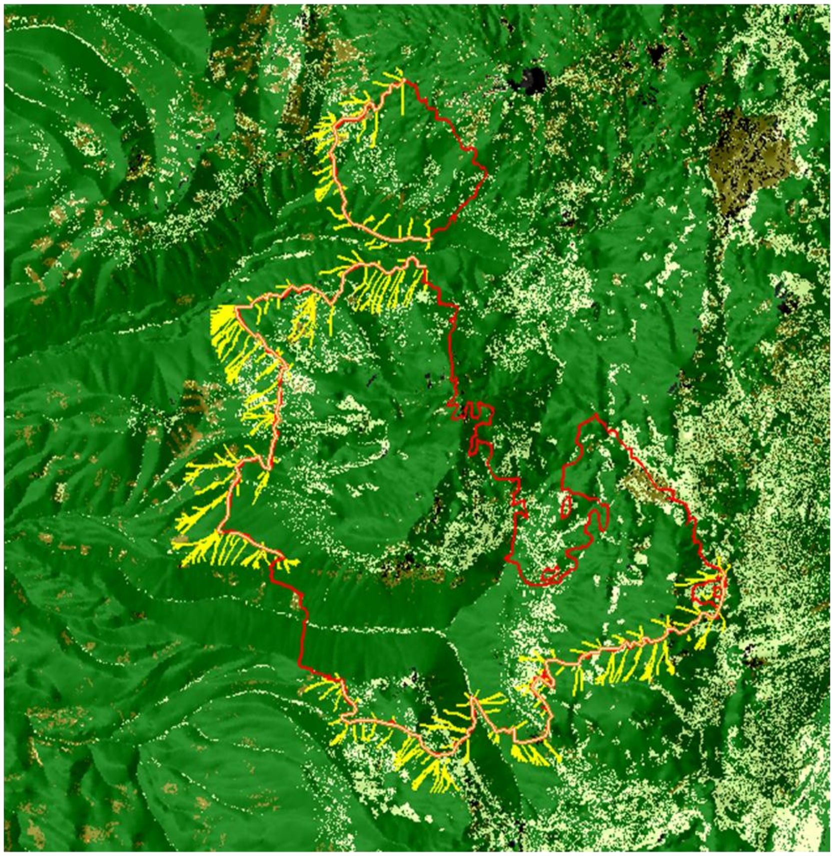
Fire spread to the east is slow, with no particular locations standing out as at particular risk. Fuel model 161 (low load, dry climate timber-grass-shrub) dominates the landscape east of the Cascade crest in the LANDFIRE data set. Fire spreads very slowly through this fuel model. I do not know how well this represents the real fuels and the real potential in this direction.

North Winds



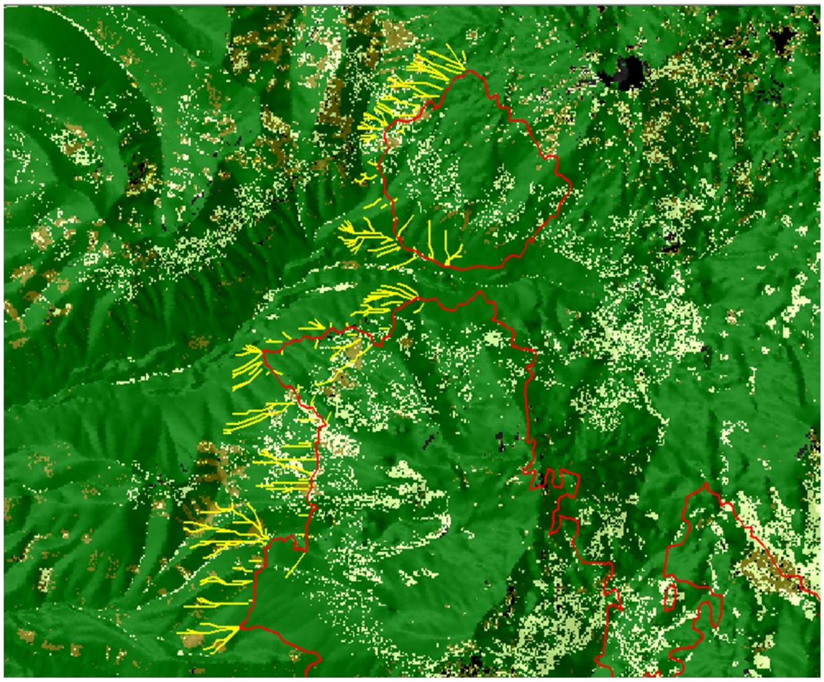
The fire spreads as slowly to the south as to the east, with no clear weak points identified. Given that the fire has spread slowly in this direction, this run may well represent the true potential.

Northeast Winds



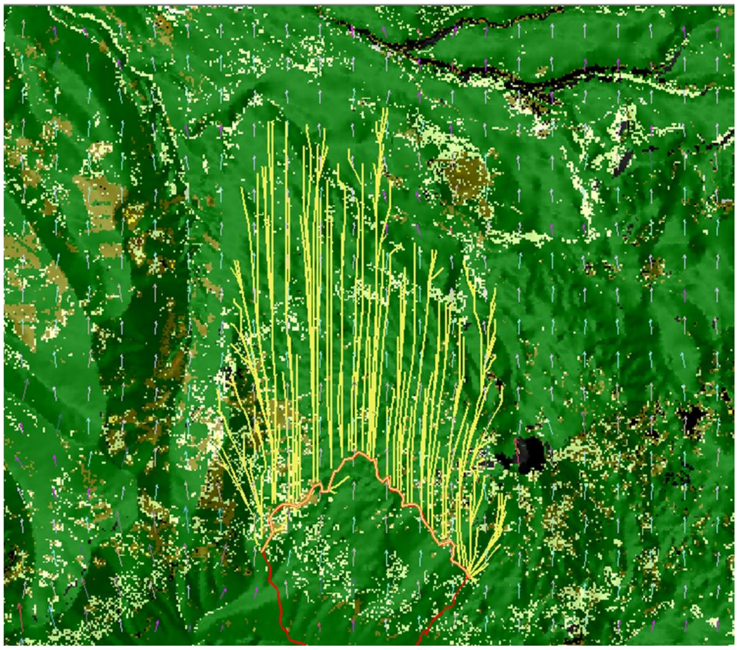
As with the west and north winds, the fire spreads slowly with no particular weak points indicated. However, given the spread history to date, this run probably underestimates the fire potential in Red Blanket Creek. This drainage is more aligned with the northeast winds with potential to funnel and increase wind speeds. This situation is an example of where the more simplified nature of WindNinja may result in an underestimation of potential wind speeds.

East Winds



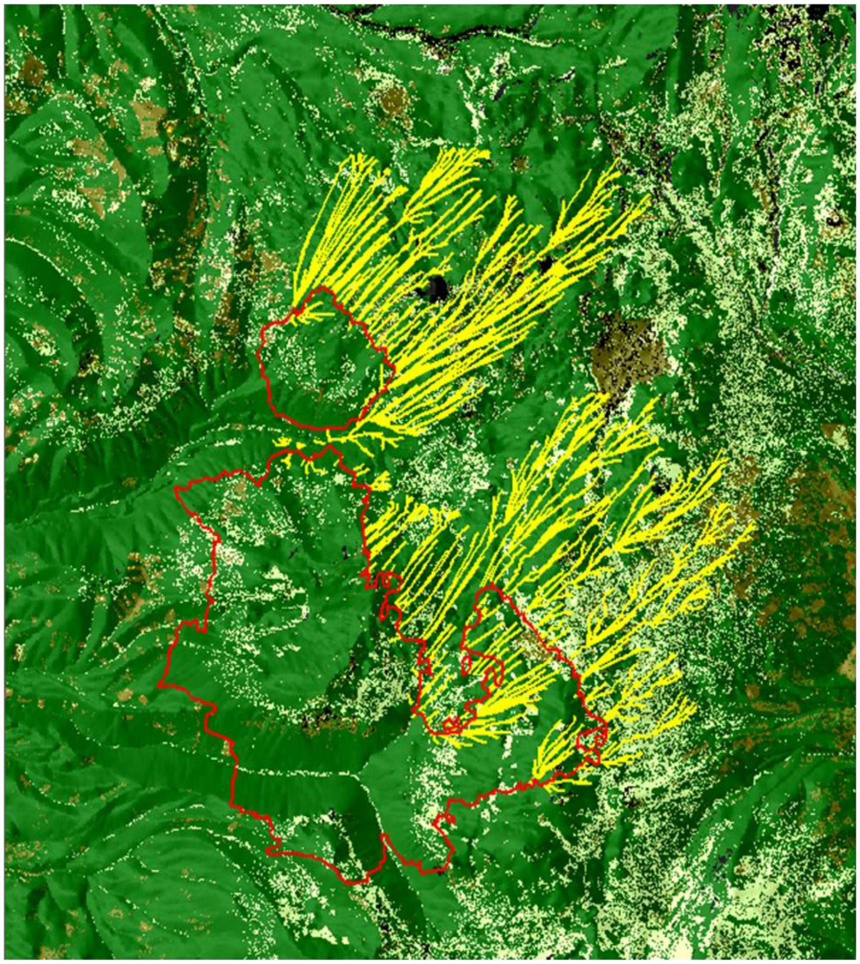
This run may also underestimate the potential spread down Red Blanket Creek, but does a better job of highlighting the potential. Further south, the fire shows some fairly significant potential in association with the various tributaries to Bessie Creek. This section of line has held through the last period of severe fire weather, so this potential is likely over-estimated.

South Winds



The fire moves very definitely to the north under strong south winds. The spot fire is located on a rolling plateau that is more fully exposed to the winds. This run suggests the fire has a higher probability of reaching Highway 62 and Castle Creek. Since the fire moved predominantly north since it burned out of Middle Fork canyon near Kerby Peak, these results have higher certainty of representing the fire potential under more severe conditions.

Southwest Winds



The southwest, pre-frontal winds also indicate potential for significant spread to the northeast. One factor the model cannot do is model the interaction between fires. More than likely the large spot fire north of Red Blanket Creek and the main fire would draw together and burn out the area between the two sets of flow paths.

In summary, the FlamMap runs indicate the greatest potential for spread lies to the north and northeast with little potential to the east, south, southwest and west. Spread potential down Red Blanket Creek is probably underestimated, but spread potential to the south and west south of Red Blanket Creek is likely reasonable.

FARSITE

FARSITE version 4.1.054 was used simulate fire spread for the September 24-29 period. This period is expected to be relatively warm and dry before the next significant chance of rain in the September 30-October 2 period. Dennis Gettman, IMET, provided wind and weather files for input. Fuels were conditioned from September 21 to September 24 at 1000. Fire spread covered September 24 at 1000 through September 29 at 1900. Spotting with growth from spot fires and crowning were enabled. Spread was calculated every three hours and spotting percentage set at 3%. One run uses no burn period, while the other run uses a 1300-1700 burn period (figure 6).

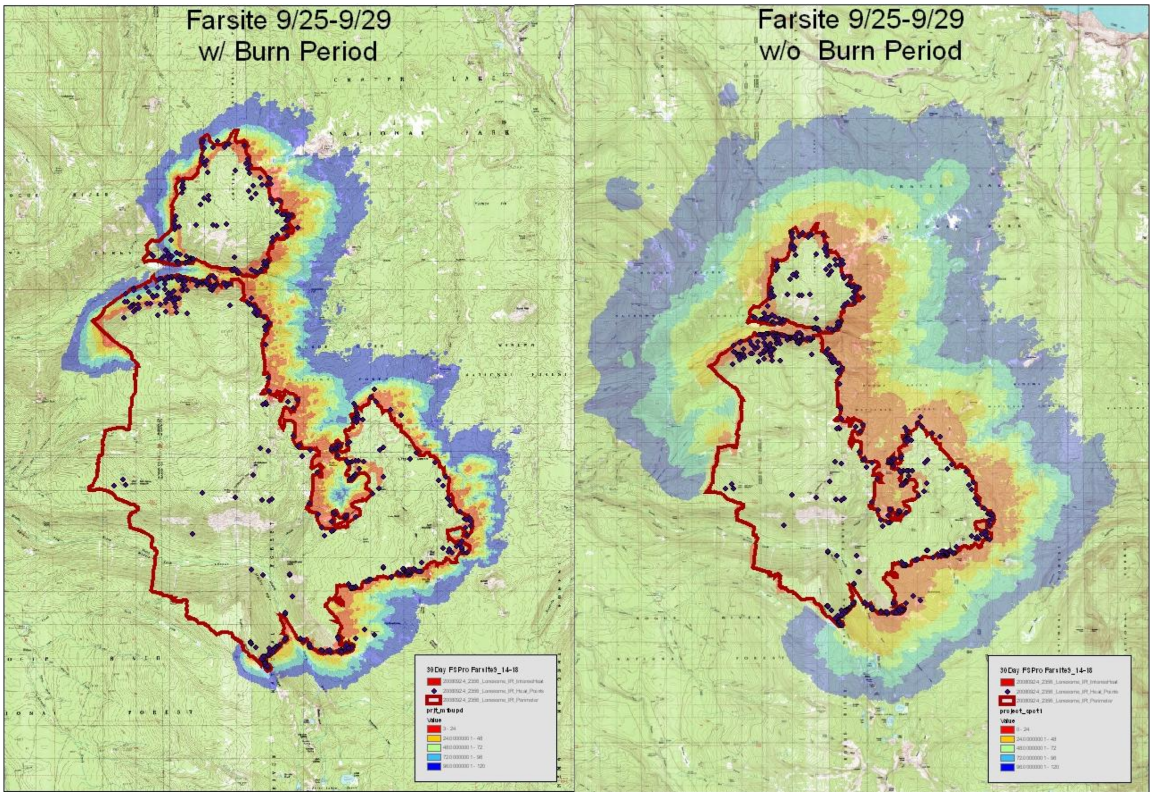


Figure 6. Using a burn period reflective of the actual time when the fire is active significantly reduces the distance the fire spreads to about 1/3 to ½ that of the run where the fire spreads for 24 hours a day.

Enabling spot fire growth results a spread direction primarily to the northeast under the forecast weather. Given that this fire has spread primarily by spotting, this direction is probably representative of fire potential. With 24-hour spread, the fire reaches Highway 62 and the Mazama Campground area late on September 28 or early in September 29. That outcome would represent a worse-case scenario. The more likely outcome is the run using a 4-hour burn period. Fire could approach the eastern edge of the wilderness boundary by the end of the burn period on September 29. Spotting remains a primary spread mechanism.

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