Long-Term Assessment
Battle Creek Complex
21 July 2007

Summary

The long-term risk assessment includes these primary findings:

- August through October are expected to be warmer and drier than average. Drought conditions are expected to develop or intensify in the general area of the fire.
- Large spread events may occur when temperature is $\geq 90^{\circ}$ and relative humidity is $\leq 11\%$ at Snake River Remote Automated Weather Station (RAWS) (station 101109). These conditions are likely in the remainder of July and in August and tend to occur over 1-4 day periods. These conditions are unlikely after early September.
- August could see 3-6 cold front passages and September could see 3-4. Cold front passage in August, with the possibly exception of the third week of August, and in early September are likely to be dry cold fronts.
- There is little chance of enough precipitation to slow fire spread in the remainder of July, however a precipitation event is highly likely in August and again in September. National Weather Service cooperative station histories indicate the August event is most likely in the third week (so-called August Singularity)
- Fire season is most likely to end by mid-October.
- Chance of reaching Imnaha – 80-100% in the absence of successful suppression efforts
- Chance of reaching Imnaha River Woods – 40-80% in the absence of successful suppression efforts.
- Chance of the two fires burning together – 20-40% in the absence of successful suppression effort.
- The 40-100% probability perimeter includes 105 building clusters worth an estimated $15.5 million, 11.9 miles of power lines, approximately 28 other landmarks and features, 27 miles of steelhead habitat, 38 miles of Chinook salmon habitat, 29,281 acres of lynx habitat, and 4,163 acres of threatened and endangered plant species habitat.

Introduction

The Battle Creek Complex started in the Hells Canyon National Recreation Area from a lightning storm on July 13, along with several other fires in the geographic area. The exact number of starts has been difficult to determine due to the fuel types involved, but at least 3 fires started in Oregon on the Wallowa-Whitman National Forest and one in Idaho on the Payette National Forest. Three of the fires are located in Hells Canyon and the fourth is located on Grizzly Ridge near the Imnaha River. A type I Incident Management Team (IMT) was ordered for the fire (Hoff) but the number of new starts and emerging large fires across the western United States limited the number of firefighting resources that could be assigned to the fire. Consequently, the IMT and the Forest decided to focus on point protection in Hells Canyon and take advantage of fuel breaks to contain the Grizzly Ridge fire.

Both the Team and the Forest recognized the potential for a long duration event and increased risk of fire movement towards points of concern along the Imnaha River later in the summer. After consulting with the Regional Office, the team requested a long-term assessment with an emphasis on FSPro and RAVAR outputs to examine the risks to private residences and developments along the Imnaha River by examining:

- Short-term potential of the fire in the absence of any action,
- Probabilities of critical spread events,
- Probabilities of fire slowing events, and
- Timing of season end.

Most of our analysis is based on weather data from Snake River RAWS for the years 1987 through 2006 with some additional wind and freeze analysis using Harl Butte RAWS (station 351502). This period provides 20 years worth of largely complete data at Snake River and 16 years at Harl Butte, and excludes the cooler, moister period that preceded a global climatic shift that occurred in the mid-1980s.

Fuels

Grass fuels dominate throughout the Battle Creek Complex up to 5000-5500 ft. elevation. North-facing draws tend to contain mixed conifer forest with grassy and shrubby understories while south-facing draws tend to contain shrub fuels. The grass is cured below about 5000 ft elevation as of July 19. Forbs begin to dominate the herbaceous fuels above 5000 ft, limiting fire spread potential. Grass production has been higher than average in the previous two years (2005 and 2006 growing seasons). Where grazing has been limited or has not occurred and where no fires have occurred in the past two years, grass fuels were assumed to be relatively high and continuous, primarily within the NRA. Private lands along the Imnaha River are grazed or are irrigated hayfields, where fire spread is either lower or less likely. All other fuels below about 5000 feet are also carrying fire readily, including both dead and, to a lesser degree, live fuels. Snowpacks were well below average this past winter and what snow was present melted several weeks early. Thus dead and downed woody fuels are dry and receptive, able to carry fire into higher elevations via cigarette burning and spotting. Live fuels, particularly conifer crowns appear to be still above the critical moisture threshold as crowning runs tend to require a significant and sustained heat pulse.

Although last fall was quite wet, 2007 has been drier than average. Seasonal ERC values at Snake River have largely been above seasonal norms and have been setting new high ERC values since late June. Crown fire behavior has been limited to group torching and short crowning runs, primarily in late afternoon and early evening when conditions are the warmest and driest or when crowns are rapidly heated during uphill runs in steep, narrow draws. Fire fighters have reported active burning from 1000 to 0400 most days. As of July 21, the fire has received no moisture, although brief showers fell in the general area on July 19.

Seasonal Severity

Seasonal severity is based on various indicators of drought and fuel dryness that influence the probability that fires will start, grow and exhibit extreme fire behavior such as crowning and medium- to long-range spotting. The Drought Monitor integrates several different measures of short- and long-term drought such as stream and reservoir levels, soil moisture, snowpack, precipitation, and professional judgment by regional climatologists. According to the July 17 Drought Monitor (figure 1), this portion of the Pacific Northwest is on the border between moderate and severe drought. The latest Drought Outlook,

constructed in mid-July, indicates that drought conditions are expected to intensify in the Hells Canyon Area.

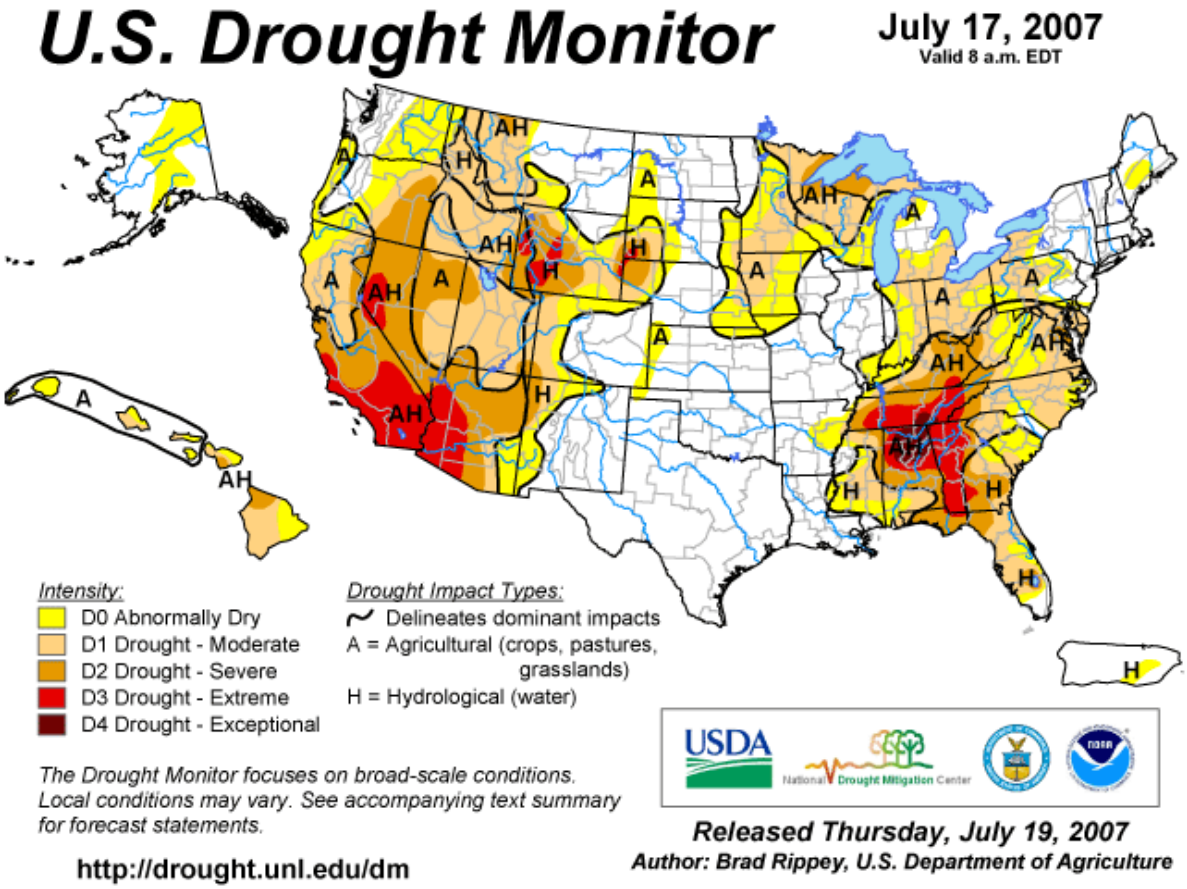

Figure 1. The Hells Canyon area is currently experiencing moderate to severe drought with these conditions expected to intensify.

Energy release component is a measure of the potential energy available to a fire and serves to indicate longer-term fuel dryness, particularly of large fuels and live fuels. This year, ERC has been largely trending above seasonal averages at Snake River with new seasonal highs periodically set since late May (figure 2).

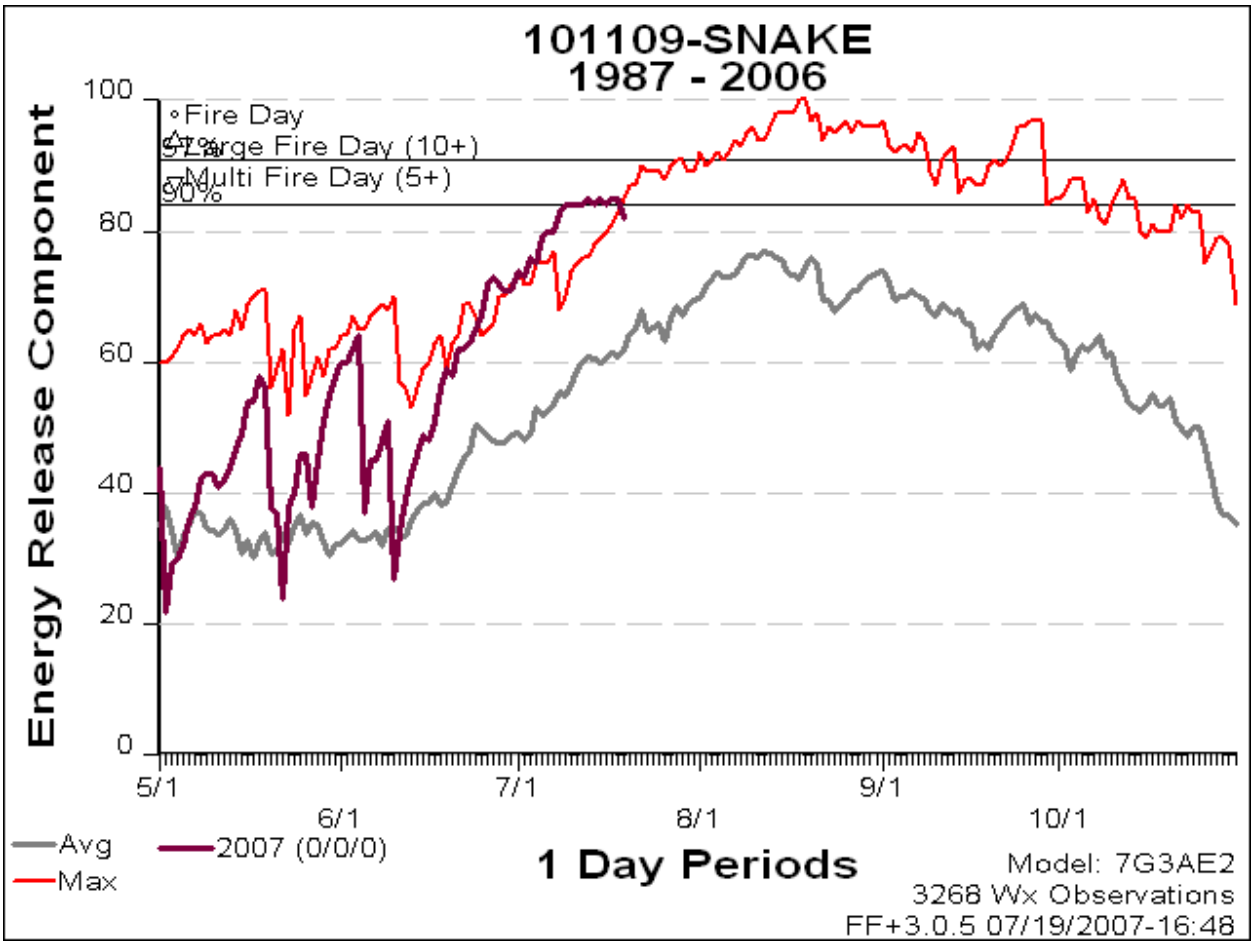

Figure 2. The drop in ERC below the 90th percentile on July 19 was likely due to overcast conditions and brief, light showers in northeast Oregon, which brought lower temperatures and higher relative humidities.

Both the 30-day outlook for August and 90-day outlook for August through October call for above average temperatures and below average precipitation. Precipitation amounts are lowest in August in much of the interior West and this area is no exception. This forecast suggests that ERC will continue to trend well above seasonal averages for the remainder of the fire season.

Critical Events

A long-duration fire faces several potentially critical events – periods of large spread, rain sufficient to slow fire spread for a few days, the possibility of a hard freeze that dries fuels and the end of the season.

Large Spread Events

Wind Events. High winds can arise from cold front passage or thunderstorm downdrafts. Thunderstorm winds are difficult to detect in both hourly and daily wind observations. Lightning Activity Level could provide some indication of the frequency and intensity of thunderstorms, but this data is not available. Since Snake River RAWS is largely sheltered from frontal winds, we used Harl Butte RAWS to look for cold front passage winds in August and September. The criteria used were southwesterly winds of at least 15 mph during a 24-hour period in August and between 1000 through 1900 in September. Cold front passage at

night in August is likely to result in significant spread due to the dry conditions. However, temperatures and relative humidity at night in September are different enough that cold front passage at night is much less likely to result in significant spread.

We used 10-minute average wind speeds in this analysis. Ten-minute average wind speeds tend to hide very strong gusts (table 1) and this gustiness tends to cause more problems for firefighters than steady winds.

Table 1. Average and probable maximum gusts associated with 10-minute average wind speeds from RAWS and 1-minute average wind speeds from using belt weather kits. Reprinted in part from Crosby and Chandler, 2004, Fire Management Today 64(1): 53-55.

10-minute Avg. (mph)	**1-minute Avg. (mph)**	**Average Gust (mph)**	**Maximum Gust (mph)**
5	9	15	18
10	14	22	26
15	20	29	33
20	25	35	40
25	30	41	47
30	35	47	54

Southerly winds are strongest during cold front passage at Harl Butte (figure 3), with strong winds tracking around to the northwest as is typical during frontal passage. In August, winds greater than 15 mph occur 20% of the time, on average over a 24-hour period. These winds are present 11% of the time between 1000 and 2400. These data translate into 3-6 cold front passages in August. These are more likely to be dry cold fronts with possibly one wet cold front around the third week of August. September experiences 3-4 cold front passages on average. Fronts in early September are likely to be dry, but fronts in late September could be wet.

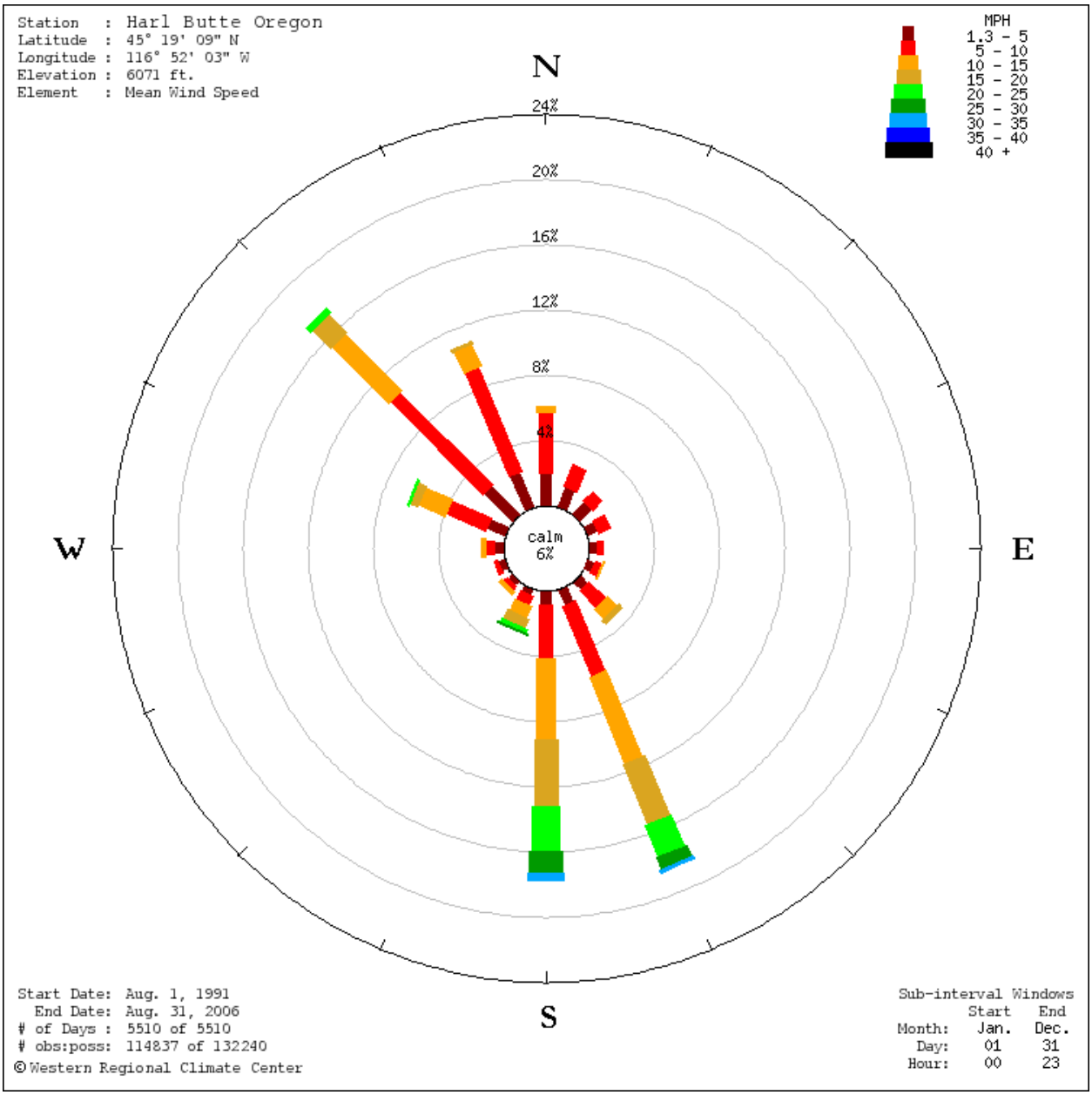

Figure 3. Cold fronts winds are strongest out of the south at Snake River RAWS and next strongest out of the northwest.

High Temperature and Low Relative Humidity. Large spread events can also occur when temperatures are high and relative humidity is low. To identify the number of days that temperatures and relative humidity may drive fire behavior, we used the Event Locator tool in Fire Family Plus to find days at Snake River RAWS where maximum temperature was above the 90th percentile and relative humidity was below the 10th percentile.

The 90th percentile maximum temperature at Snake River is 90° and the 10th percentile minimum relative humidity is 11%. Snake River records suggest that up to 6 periods of critical temperatures and relative humidity could be expected on average, with 2 periods in the remainder of July and 4 periods in August. Each period of critical temperature and

relative humidity may last from 1-4 days in the remainder of July and 1-6 days in August. The frequency of these events has increased since 2000, consistent with the beginning of a West-wide warmer and drier period, which some climatologists consider as the beginning of a prolonged drought.

Fire Slowing Events

Precipitation events that serve to slow the fire spread for a few days are as important as those events that cause significant spread. The Wallowa-Whitman identified two types of fire slowing events, although the larger event is also often associated with effective season end when it comes later in the fire season:

- 0.15-0.25 inches – slow for 1-3 days
- 0.25-0.50 inches: - slow for 3-6 days

We used the Event Locator tool in Fire Family Plus to find the likelihood of each type of event between July 20 and October 15 over one-day and three-day periods. There was little difference in the results between a one-day and three-day analysis for the smaller event. Any fire slowing event is unlikely in the remainder of July. Both August and September should see at least one event, with the larger event more likely. Precipitation probability graphs for NWS cooperator stations in the area indicate the August event is most likely during the third week of August (figure 4). This event is commonly known as the August singularity as conditions usually turn dry again afterwards.

Table 3. Expected number of fire-slowing events after July 20 by type based on data from Snake River RAWS.

	1-3 days Slowing	3-6 days Slowing
July 20-31	1 every 5 years	1 every 5 years
August	1 every other year	1
September	1 every other year	1 every other year
October 1-15	1 every other year	1 every other year

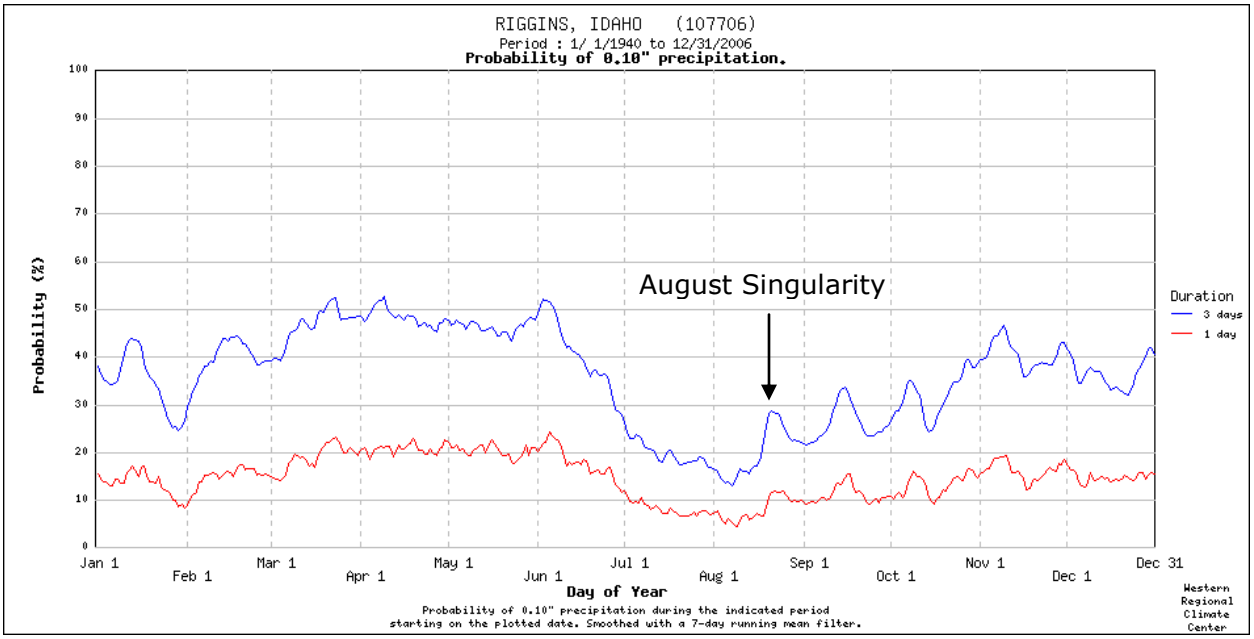

Figure 4. The chance of any precipitation is minimal in early to mid-August, but a precipitation event occurs with some regularity in both late August and mid-September.

Season End

Season end is often associated with a precipitation event on the Wallowa-Whitman, but there is little consistency in the nature of that event and some seasons end without a precipitation event. We compared two definitions for season end:

1. the point late in the season when ERC drops below the 75th percentile and
2. A precipitation event of at least 0.15 inches over a single day.

Both approaches contain some ambiguity since ERC can drop below the 75th percentile but climb above that level several days to a couple of weeks later. It's not always true that the precipitation event used truly ends the season. To avoid "false positives" we selected the later date for both criteria in years when multiple dates were present. The purpose of the season end event in this type of assessment is to determine when critical spread events (100 acres or more) are unlikely either on new starts or on going fires. Fires can still start and spread after this type of event.

At Snake River RAWS there was little difference in the season-end date between the two criteria through September. In October, however, the two curves start to display more separation with the ERC-based curve tending to indicate much later dates. These results suggest that using a precipitation-based definition may be appropriate in average or wetter than average years, while using an ERC-based approach may be more appropriate in drier years, such as 2007. Accordingly, we selected the ERC-based curve (figure 5).

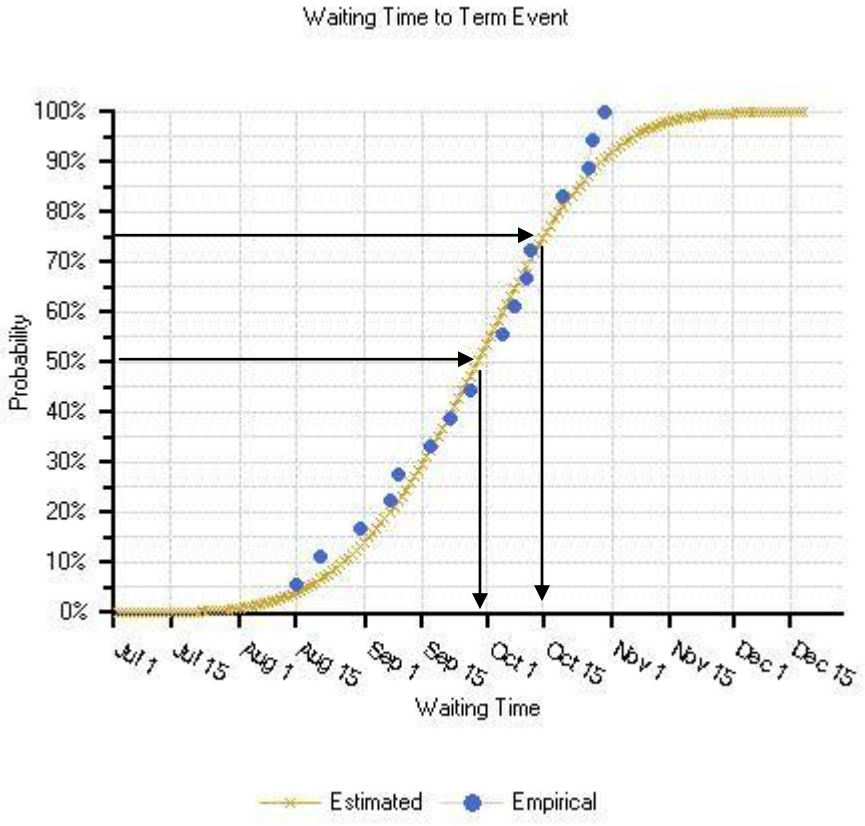

Figure 5. Seventy-five percent of the time, the season ends by mid-October while 50% of the time it ends by September 29, using ERC as the basis.

Along with changing temperatures and relative humidity, changing sun angles and day lengths contribute to the decay and eventual end of potential for large fire growth. Between August 15 and October 15, the maximum sun angle declines by 22.6°, rising only to 35.8° above the horizon on October 15. This drop in angle reduces the sun's effectiveness in preheating fuels through radiant energy. The day length reduces by slightly over 3 hours in that same period with most of the loss (113 minutes) in the evening. By October 15, sunrise is at approximately 0621 and sunset at approximately 1719. The primary burning period drops from approximately 12 or more hours currently to about 3-4 hours by mid-October.

In addition to reduced solar heating of fuels and reduced burning periods, small rain events begin to have a significant impact on fire spread potential on the lower 1/3 of slopes and north and east aspects. North aspects in particular that receive a wetting rain after about September 15 are unlikely to dry sufficiently to carry fire except on the upper 1/3 of the slope. South and west aspects at the bottom of very narrow drainages may be similarly affected.

Hard Freeze

In this location, hard freezes may become important at the higher elevations. If a hard freeze occurs before the season end, fire fighters may have to content with freeze-dried fuels, which are difficult to represent in fire behavior models. We constructed a term file of hard freeze dates using Harl Butte RAWS and compared those results to the season-end

date at Snake River RAWS. Anytime temperatures drop below 32°F, vegetation experiences some level of damage, although it takes several hours at 32°F for significant damage to occur. At 28°F, significant damage occurs in minutes. If conditions are dry during such a freezing period, the vegetation essentially freeze-dries and becomes available as fuel. This condition is particularly important in shrub fuels that normally contribute little to fire spread.

Based on this comparison, in September and early October, the season end is more likely to come before the hard freeze. By mid-October, however, the season-end curve and the hard freeze curve cross each other such that a hard freeze is more likely to occur before the season end by at least a few days. Harl Butte frequently receives shots of moisture of 0.25 inches beginning in late July, which could lessen the probability of freeze-dried fuels in some years.

FSPro/RAVAR

Inputs

We used weather data from Snake River RAWS for 1987 through 2006 to estimate Energy Release Component (ERC) values, fuel moistures and winds. The ERC percentiles were calculated on the basis of June 1 to October 31. Wind data is based on hourly observations from July 1 through July 31 at 1000 through 2300.

After examining the landscape file we made several changes to the fuel models, canopy closures, canopy bulk densities and canopy base heights to better represent actual conditions. A continuing problem with LANDFIRE-based data layers is the canopy fuels. Because of the methodology used, LANDFIRE-based data layers usually over-estimate canopy closure and under-estimates canopy bulk density. Canopy base heights are also frequently incorrect, with base heights more often set too high rather than too low. Stand heights may also be incorrect, although this error is less critical to estimating crown fire behavior than the other canopy measures.

Changes made to fuel models address actual conditions include:

- Fuel model 102 (low load, dry climate grass) changed to fuel model 105 (low load, humid climate grass) below 5500 ft elevation to represent 2 years of high grass production and observed spread rates.
- Fuel model 102 changed to fuel model 101 (short, sparse dry climate grass) above 5500 ft elevation to represent forb domination of openings and reduced spread potential.
- Fuel model 122 (moderate load, dry climate grass-shrub) changed to fuel model 105 below 5500 ft elevation to represent 2 years of high grass production, lower level of shrubs than included in model 122 and observed spread rates.
- Fuel model 122 to fuel model 101 above 5500 ft to represent forb dominated openings and reduced spread potential.
- Fuel model 184 (small downed logs) to 165 (very high load, dry climate timber shrub) to better represent the fuel complex present.
- Fuel model 161 (low load, dry climate timber-grass-shrub) to fuel model 165 on north aspects to better represent the fuel complex present on northerly aspects in draws.
- Fuel model 161 to fuel model 144 (load low, humid climate timber-shrub) to better represent the fuel complex on southerly aspects in draws.

- Fuel model 183 (moderate load conifer litter) to fuel model 165 below 5000 ft to better represent observed spread rates in timber stringers in lower elevation settings.
- Fuel model 188 (long needle litter) to fuel model 163 (moderate load, humid climate timber-grass) to better represent potential spread rates at higher elevations.

In addition to the fuel model changes, we modified canopy characteristics for the two dominant forest models, 163 and 165:

Fuel Model	Aspect	Canopy Closure	Canopy Bulk Density	Canopy Base Height
165	315-360 (NW-N)	50%	0.2 kg/m^3	1 m
165	0-45 (N-NE)	50%	0.2 kg/m^3	1 m
165	46-314 (E,S,W)	30%	0.1 kg/m^3	2 m
163	All	50%	0.2 kg/m^3	2 m

We used Behave Plus to check these values. Results indicated we could expect frequent torching and active crown fire on north aspects in fuel model 165, frequent torching on all other aspects in fuel model 165 and occasional group torching and short crowning runs in fuel model 163 (interpretation of actual BEHAVE outputs estimating surface fire behavior and crown fire potential on flat ground with a 10 mph 20-ft wind speed). We considered this fire behavior to be a realistic representation of the potential under current stand conditions and current and expected burning conditions.

The fire perimeter used as the ignition file was a rough "sketch" based on the approximate perimeter as of the morning of July 19. Due to limitations in creating shapefiles to use as ignition files, the sketch was conducted on a 250K resolution map in order to include the entire boundary of the Battle Creek Fire. The roughness of this sketch could affect the outcome of the runs. Fire was spread for 14 days using 3000 Monte Carlo simulations of fire spread. The resulting polygons represent the probabilities of the individual pixels burning. Spread resolution was set at 150 m due to the large landscape involved, which speeds processing of the analysis but results in "cruder" polygon boundaries.

We created barrier files along the Snake River for the Battle Creek Fire, and along the Imnaha River from the confluence with Horse Creek south to near the town of Imnaha and south along Horse Creek to near Imbler Gulch for the Grizzly Fire. No fires have been known to spot across the Snake River in Hells Canyon. The barriers for the Grizzly Fire represent successful suppression activity on that portion of the fire.

As with other fire behavior processors, FSPro has limitations on how well it represents different types of spread. For example, it cannot model spread by rolling debris. Backing spread into the wind tends to be underestimated, particularly at higher wind speeds. FSPro does include spotting, using similar algorithms as in FARSITE. Spotting probabilities are automatically set very low to avoid over-predicting spread by spotting.

Results

Fire spread probabilities represent the potential location of the fires in the absence of successful suppression action. Acreage amounts associated with the map do not represent potential fire size; instead they tally the number of acres within a given probability area.

Battle Creek Fire:

Probability Boundary	Geographic References
80-100%	Buck Creek to the south and Yreka Creek to the north. Fire spread east is constrained above 5500 ft elevation by fuel models and to west by barrier along the Snake River
60-80%	Doyle Creek to the south and Cove Creek to the north. Reaches the Imnaha River between Neil Creek and just north of Grizzly Creek and the middle 1/3 of Freezeout Creek.
40-60%	Spring Creek to the south near the boundary between the Wallowa-Whitman National Forest and lands managed by Vale BLM. Cougar Creek to the north. West of Imnaha River between Line Creek and Pallette Ranch. Up the east side of the Imnaha River to near Blackmore Creek.

The Battle Creek Fire reached the 80-100% probability boundary to the south on July 20. A quick updated FSPro analysis was conducted on the fire perimeter as of the morning of July 20. This update indicates a 60-80% probability that this fire will reach the 2005 Tryon Creek burn to the north and the 2006 Foster Gulch burn to the south in the absence of successful suppression.

Grizzly Fire:

Probability Boundary	Geographic References
80-100%	Fire spreads around the barrier at Imbler Gulch and just north of Imnaha. Lightning Creek to the east. South to near Fivemile Viewpoint. Crosses the Imnaha River at the south end of the barrier and includes the town of Imnaha
60-80%	North up Lightning Creek to near the confluence with Sleepy Creek. East to the head of Rhodes Creek. South along both sides of the Imnaha River to Thorn Creek. West into Brushy, Trail and Camp Creeks.
40-60%	Further north up Lightning Creek to the east of Horse Creek and to near Bens Creek west of the Imnaha River. East to Cow Creek. South along both sides of the Imnaha River to Double Creek. Further west up Big Sheep, Brushy, Trail and Camp Creeks.

Chance of reaching Imnaha – 80-100% in the absence of successful suppression efforts

Chance of reaching Imnaha River Woods – 40-80% in the absence of successful suppression efforts.

Chance of the two fires burning together – 20-40% in the absence of successful suppression effort.

RAVAR

Two tiers of RAVAR analysis were conducted on this complex at the Missoula Fire Sciences Laboratory (attached). Tier one analysis concerns primary assets, such as homes, campgrounds, and other structures. Building clusters may consist of a single or multiple structures. The presence of infrastructure, such as powerlines, and other human-made features, such as mines, are noted but not valued. All structures receive the same valuation regardless of structure type. The following assets are contained within the 40-100% probability boundaries:

- 105 building clusters with an estimated value of $15.5 million
- 11.9 miles of power transmission lines
- 2 lookouts (Hat Point and McGraw)
- 8 campgrounds or other recreation sites
- 2 cabins (Wilson and Marks)
- 3 current or historical schools (Bridge, Freezeout and Park)
- 2 trailheads (Freezeout and Warnock Corral)
- Memaloose Guard Station and helibase
- Hells Canyon Visitor Center and Launch (listed as Hells Canyon Creek Forest Service Station)
- Imnaha Grange
- Haas Horse Troughs, 2 additional helipads, Warnock Corral, Brockman Ranch, Parliament, and Winsor Place.

Tier two analysis concerns natural resources of regional significance. The following resources are contained within the 40-100% probability boundaries:

- 27 miles of steelhead habitat
- 38 miles of Chinook salmon habitat
- 29,281 acres of lynx habitat
- 4,164 acres of threatened and endangered plant species habitat

The amount of T&E plant species habitat is likely over-estimated since some areas appear to be sections that contain habitat without specifics. The data available did not include information on which plant species are potentially affected in which areas.

Louisa Evers – Team Leader, Long-Term Analyst, State Office-Regional Office

Jenny Reinheardt – Eagle Cap Ranger District Fuels Specialist