Mustang Fire
Salmon-Challis National Forest
Long-term Assessment and Implementation Plan

August 7, 2012

Table of Contents

Long-term Assessment Team:

Bret Ruby – Team Lead (Strategic Operations Planner)

Bart Singley – Operations

Louisa Evers – Long Term Analyst (LTAN)

Rita Chandler – LTAN (t)

Brian Maier – Geo-Spatial Analyst (GSAN)

Erik Spillman – Field Observor (FOBS)

Dean Warner – Fire Behavior Analyst (FBAN)

Executive Summary

The 2012 season for the fire area started with slightly below normal snowpack and near normal total precipitation. Fire indices from the Skull Gulch RAWS station have been showing a drier than normal fire season since early June.

Fire growth in this area is usually associated with hot, dry, unstable atmosphere coupled with light winds, temperatures $\geq 79^{o}$, relative humidity $\leq 13\%$, and ERC ≥ 77 at Skull Gulch. Haines climatology indicates August should experience at least one day of Haines 6 and 1-2 days of Haines 5 or 6.

Fire spread simulations indicate that Mustang, Cayuse Point, and Broomtail have a high probability of burning together in the next 14 days should suppression efforts be ineffective. These analyses also indicate a high probability the fire(s) will cut off access to Long Tom Lookout and establish in the heads of Colson, Corn, and Swamp Creeks. Should that occur, the options for direct attack in the area of the 123 Road will largely depend on spotting. Options for large fire operations in this area are limited due to the extreme nature of the terrain and the fuel conditions. The next opportunity south of the 123 Road for large scale fire operations is along the Salmon River Road.

Near-term analysis indicates Filly Fire will burn towards Gattin Ranch should this fire become active. Roan Fire is likely to continue spreading through the 2000 Filly Burn but stay west of Horse Creek over the next 3 days.

An analysis of spot fire spread along the Salmon River indicates that the resulting fires could spread laterally as much as 6 miles in three days, when pushed by 15 mph winds. The area around the mouth of Colson Creek appears to be especially vulnerable to fires burning under west or northwest winds from spot fires igniting and establishing to the west of that location.

Historic data suggests the fire season will not end until late September or early October. However, most growth events of 1000 acres or more typically occur in August, with only a few such events in early September.

Introduction

The Mustang, Broomtail, Roan, Filly and Cayuse Point Fires were ignited by lightning on July 28, 2012 in the Horse Creek drainage of the Salmon-Challis National Forest. Mustang Fire was discovered on July 30th at 1015 and rapellers began initial attack at 1205. However, an increase in fire behavior and related safety concerns caused the rapellers to disengage from the fire at about 1330. The strategy then shifted to point protection to protect Gattin Ranch and Long Tom Lookout. The remaining four fires were discovered between 1453 on July 30 and 1850 on August 1. An IMT3 took over the management of the Mustang Fire along with the other four fires in the area on August 1 at 2012.

The fires are located within the Frank Church River of No Return Wilderness near the border with Montana and the Bitterroot National Forest. This area of the wilderness is characterized by subalpine fir, Engelmann spruce, and lodgepole pine with an understory of beargrass and grouse whortleberry. Older lodgepole pine stands contain standing dead and recent dead trees in patches of varying size due to past insect infestations. Numerous large fires that burned in the past 27 years have created partial barriers to fire spread on the north, west and east of the current fire area. The fuels within these burns vary dramatically depending on the year the fires burned. Upper slopes have reproduction of varying densities and age while the lower slopes (towards the Salmon River) are dominated by brush and grass.

A Long Term Assessment Team was ordered by the Forest on August 1 to complete a Long-term Assessment for Mustang, Broomtail, Roan, Filly and Cayuse Point Fires added as they were discovered. The full team arrived late on August 2 and began work on August 3.

Objectives

The following objectives were given to the team by the Forest FMO during the in-brief on August 1st.

1) Do your part to provide for public and firefighter safety by recommending appropriate actions and strategies, implementing LCES appropriate for your assignment, and managing fatigue within your team.
2) Develop a long term assessment of the fires listed above including a projection of fire growth, risk assessment, estimate of costs, and recommendations for future actions and their associated triggers.
3) Base your recommendations on my priorities for firefighter and public safety, managing costs appropriate to the values at risk, reducing the risk of fire spreading to private land and Forest Service infrastructure, and evaluating opportunities to safely engage the fire as it moves into more accessible terrain.
4) Work with the IMT and the local unit to help provide for protection of values indicated in the current WFDSS decision.

Key Questions:

- What is the threat to the Gattin Ranch and the Long Tom Lookout?
- What are the containment options to the South of the fires?
- How would fires likely spread laterally on the mid to lower slopes in the Salmon River Canyon?

Risk Assessment Considerations

- Private lands at Gattin Ranch
- Long Tom Lookout
- Colson Creek Road

Management Action Points (Mitigation Actions)

Three "Management Action Points" or "Prospects" were identified as strategies for the management of the Mustang group of fires. Each MAP includes an objective that describes the general strategy analyzed for each MAP, the activities to be implemented, the probabilities of success of the actions, the resources needed to implement the action, the cost and the consequences of not implementing the action.

Management Action Point Descriptions

MAP 1 – examines the options and potential impacts of indirect fireline construction and burn-out operations along existing roads and dozer lines from the 1985 Butte Burn along Long Tom Ridge. The majority of exposure hours displayed for this MAP are rated as **high risk**.

MAP 2 – examines the options and potential impacts of indirect line construction and burn-out operations along the Salmon River corridor on FS Road 030. Exposure hours for firefighters and the public will increase dramatically due to the expected long duration of the effort. As the fire increases in size and intensity, smoke concentrations in the Salmon River canyon may well reach unhealthy levels for a prolonged period.

MAP 3 – is already complete and includes structure protection for the Long Tom Lookout and Gattin Ranch.

Management Action Point Details

MAP #	Objectives/Conditions	Action/ Probability of Success	Resources Needed/ Cost	End Date
MAP 1	**Objective: Objective: Indirect line construction and burnout along FS Road 123 (Long Tom Ridge) south from the 2011 Saddle Complex.** **Condition: Previous indirect line construction from the 1985 Butte Fire should help expedite implementation.**	**Decision Point:** Due to the very hazardous terrain on the Mustang and adjacent fires, lack of escape routes and safety zones puts firefighters in extreme exposure to perform direct attack on the fires safely. . **Action:** Utilize previous work completed from the 1985 Butte Fire to construct indirect line from the 2011 Saddle Butte Fire southwest along Long Tom Ridge to the end of the FS Road 123. Use of modern equipment, crews and engines will be assessed for 14 days. **Probability of Success:** 60%	Resources needs for Indirect Attack 14 day assessment for MAP 1. Type 1 Crews (4) Type 2 IA Crews (2) Type 2 Crews (2) Fellers (7) Engines (5) Dozers (2) Type 1 Helicopters (2) Type 3 Helicopters (1) Line Overhead (20) Camp Overhead (20) **Total Cost: $ 2,147,432.00** **Total Exposure Hours: 46,256**	

Consequences of not implementing:

The Mustang, Broomtail and Cayuse fires will likely spot and burn across the FS Road 123 to the south towards the Salmon River and FS Road 030. Fire may threaten the Long Tom Lookout, the Colson Road and numerous private inholdings along private land adjacent to the Salmon River including the Seeks Out Adventure LLC located two miles from the Mustang fire.

Smoke impacts to the Salmon River Valley can be expected.

When fire behavior and fire weather indicate fire activity will threaten MAP 1, MAP 2 should be considered.

MAP 2	**Objective: Provide for point protection for structures south of FS Road 123. Structure Protection Plan will need to implemented along the Salmon River corridor and possible burnout around structures along FS Road 030 will need to be considered.** **Condition: Fire has compromised the FS Road 123. Opportunities to pick up spots in old burned area may be a possibility; however any fire west of the Colson Road may burn aggressively due to topography and high volume of burnable fuels.**	**Decision Point: Long Tom Ridge has been compromised by fire activity. Rates of spread will vary due to areas which are involved. Areas west of the Colson Road may prove to be some of the most difficult due to lack of previous fire activity in the area.** **Overall Decision Point: Contain fire to minimize acres burned.** **Action: Once structures in the river bottom have been prepped and triaged, burnout opportunities may begin bringing fire down the mountain to square the fire off as it burns towards the Salmon River. Many hazards will occur as more fire is put on the ground i.e. rolling rocks and logs. Over 30 miles of road may be impacted.** **Probability of Success:** 75 %	Resources needed for this option include: **21 Day Assessment** Type 1 Crews (6) Type 2 IA Crews (4) Type 3 Engines (4) Type 6 Engines (3) Falling Teams (3) Fixed Wing ATGS Platform (1) Type 1 Helicopters (3) Type 3 Helicopter (1) Misc. Overhead (30) Camp Overhead (20) **Cost: $ 2,272,430.00** **Total Exposure Hours: 89,670**	
Consequences of not implementing: Not implementing MAP 2 will allow the fire to spread in its natural progression. Fire spread to the east may be slowed due to the 1985 Butte Fire; however, there is a good grass component that will move the fire. As the fire increases in size and intensity there will be more volume of smoke dispersal into the air shed.				

MAP 3

Local Type 3 Organization has already implemented structure protection at the Gattin Ranch and the Long Tom Lookout complete on August 4th, 2102.

See Appendix F for cost details

Fire Behavior

Topography

The Mustang, Cayuse Point, Broomtail, Roan, and Filly fires are clustered in the middle portion of the Horse Creek drainage, in steep, dissected terrain. These fires generally started near the ridgetops on southerly and westerly aspects near or above 2000 m (~6500 ft) in elevation. Roan and Filly are within the main Horse Creek drainage. Broomtail lies in the headwaters area of Little Broomtail Creek. Mustang lies along the ridge dividing Mustang and Little Broomtail Creeks. Cayuse Point lies just south of its namesake Cayuse Point in an unnamed tributary to Little Broomtail Creek.

Weather

The Salmon-Challis National Forest has a semi-arid continental climate with most precipitation falling in the winter as snow. Salmon, Idaho, which mirrors the typical pattern in the area, averages just under 9 inches of precipitation annually with August the driest month and July the warmest, although these two months are very similar. The Salmon River exerts a strong influence on local weather, particularly winds. The lowest elevations along the river and its tributaries are quite warm and dry, but the steep terrain also provides for a steep gradient in terms of temperature and precipitation. Higher elevation valleys, such as around Gattin Ranch, tend to pool cool air, creating frost pockets that can reach freezing temperatures in any month of the year.

The fire area occurs in fire weather zone ID475 and predictive services area EB02. The National Weather Service office in Pocatello, Idaho, located at http://www.wrh.noaa.gov/pih/, provides fire weather and spot forecasting services. Fire weather and fire business outlooks are provided by the Eastern Great Basin Coordination Center at http://gacc.nifc.gov/egbc/. To support this assessment, we used Skull Gulch Remote Area Weather Station (RAWS) for weather analyses and Red Rock Peak RAWS for winds in FSPro analyses (table 1). We evaluated use of Hells Half Acre, but decided the weather at this station had too many missing observations and was not as representative of the conditions in the fire area as Skull Gulch. However, data for 1992 and 1993 at Skull Gulch is highly suspect for relative humidity.

Table 1. RAWS sites used in assessment.

STATION	RAWS NUMBER	ELEVATION	DISTANCE
Skull Gulch	101311	5878 ft	6.5 mi S
Red Rock Peak	101316	7910 ft	32 mi S
Hells Half Acre	101019	8100 ft	15.5 mi N

At Skull Gulch RAWS between June 1 and October 31, maximum temperature peaks in late July and early August in the upper 80s, slowly declining to the 50s by late October. Maximum temperatures in the 90s and low 100s have been recorded well into September. Minimum temperatures typically peak at near 60ºF, declining to the upper 30s by late October, but minimum temperatures in the 30s can occur in late August through September. Daytime relative humidity typically bottoms out in the teens during August while nighttime humidity recovery also reaches its lowest points in the 50s. Single digit relative humidity has been recorded in every month of the fire season. Ten-minute average wind speeds at 20 ft above the ground are generally light at around 5 mph but wind speeds of 10-20 mph can occur with about equal frequency throughout the analysis period.

All five fires originated in a lightning storm on July 28, but were discovered over a 3-day period, beginning on July 30 (figure 1). After the storm, temperatures increased and relative humidity

decreased for the first two days, followed by a 4-day period when temperatures decreased and relative humidity increased as a low pressure system worked its way through the area. By August 4, the low pressure system was far enough east to lose any influence and high pressure began to dominate, increasing temperatures and lowering relative humidity. However, fire activity was dampened at least somewhat by drift smoke from the Halstead Fire to the south-southwest. Winds through this entire period remained light and variable (figure 2).

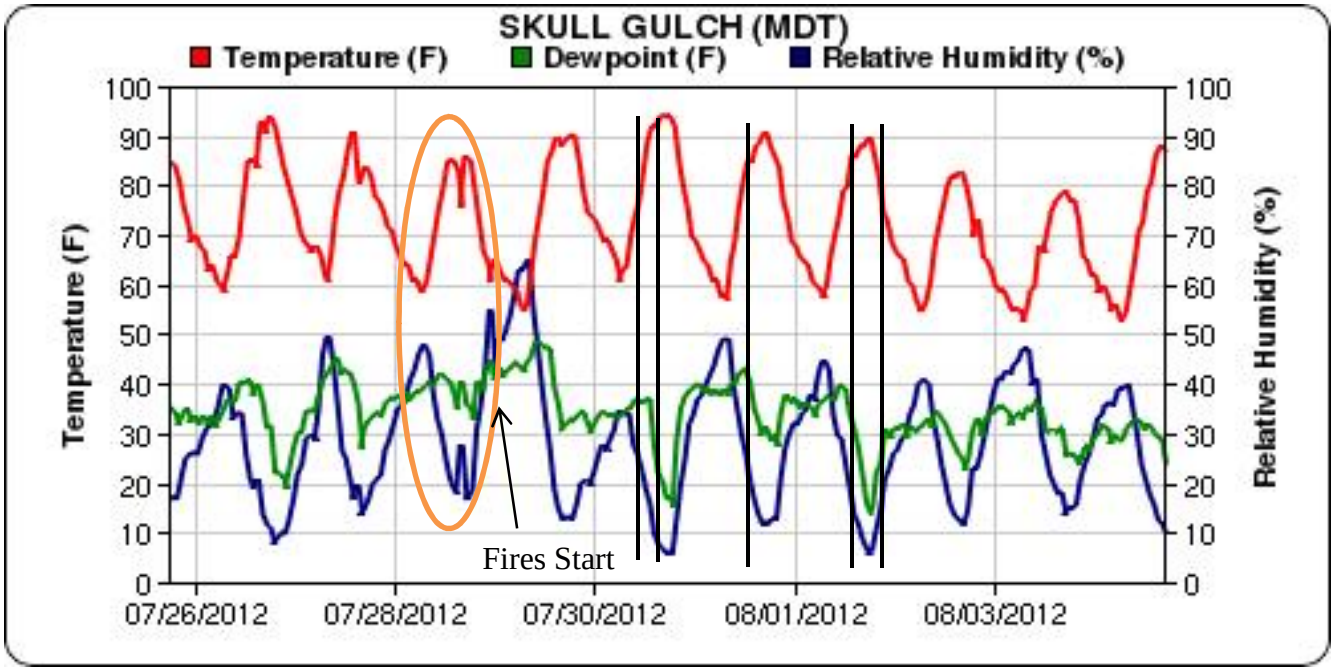


Figure 1. The fires began on July 28 and were discovered July 30 through August 1. The vertical black lines represent the approximate discovery times for each fire. The order of fire discovery was Mustang (7/30 @ 1015), Roan (7/30 @ 1453), Broomtail (7/31 @ 1234), Cayuse Point (8/1 @ 1314), and Filly (8/1 @ 1850).

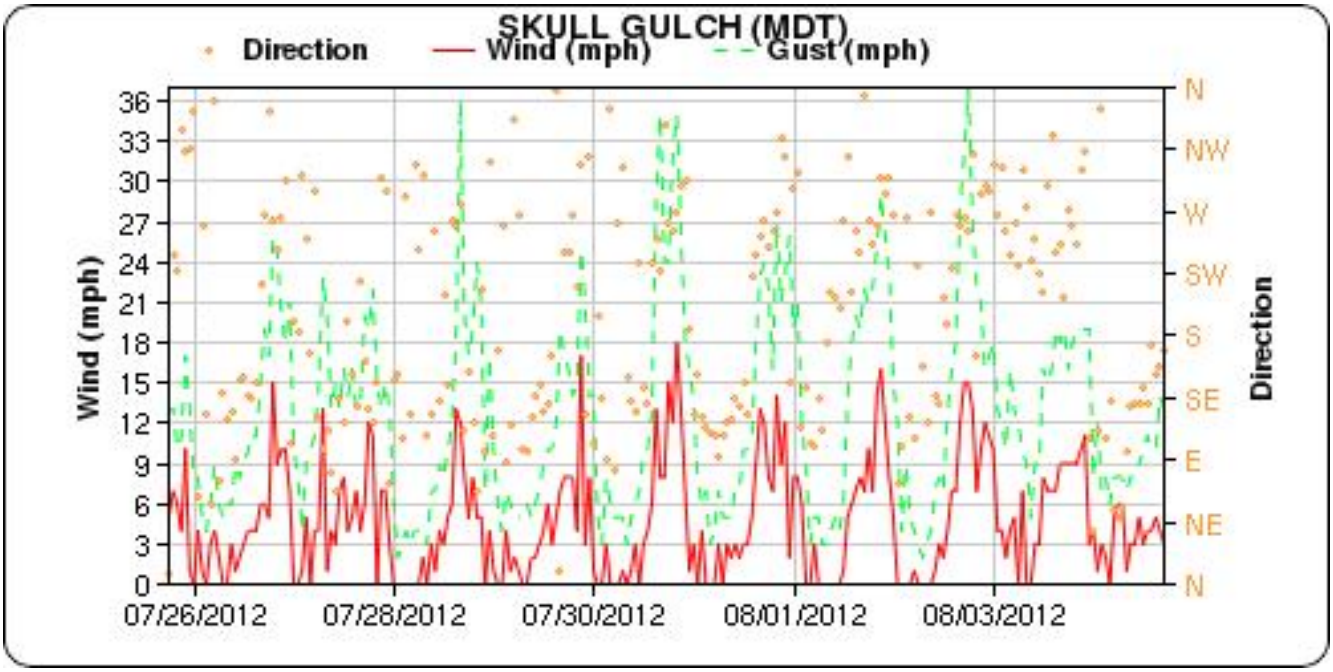


Figure 2. Wind speed and direction for the two-week period indicate that typical diurnal winds were predominant.

Over the next seven days (August 4-10) fuels in EB02 are rated as very dry. A lightning event is forecast for Monday, August 6, which may bring additional fire starts to the area, but little moisture is currently expected. Lower temperatures and higher relative humidity may dampen fire spread temporarily, but a quick return to hot, dry conditions should increase expected fire behavior on current fires, if actions taken to date are ineffective, as well as allow for active behavior on any new starts, especially those occurring where recent bark beetle activity has been high. The next surge of moisture is expected the following weekend (August 11-13).

Fuels

Fire Vicinity

Fuels within the fire area consist of a mix of old and relatively young lodgepole pine and subalpine fir stands intermingled with sagebrush-dominated openings and a mix of shrubs, beargrass, and conifer reproduction in recent burns. The fires are burning primarily in older stands of lodgepole intermixed with subalpine fir and Engelmann spruce. Bark beetle activity has been relatively minor in the immediate vicinity of the fires. What activity has occurred has primarily progressed to the gray stage. The main carriers of the fires are surface litter and downed logs. Trees have a relatively high lichen load that promotes occasional torching and short crowning runs. Shrub, graminoid, and beargrass moistures are apparently relatively high, dampening fire spread. Cayuse Point Fire is located adjacent to the 2002 Little Horse Burn; fire spread into this burn area has been minimal. Roan Fire started within the perimeter of the 2000 Filly Burn. Older burns, such as the 1961 Corn Lake Burn, consist of relatively dense, young lodgepole pine with light surface fuels and few or no snags.

Surrounding Area

Fuels on the lower south facing slopes of the Salmon River are covered by continuous short grass with scattered shrubs in some places. Mid-slope and riparian areas are grass-litter understory in open stands of ponderosa pine and Douglas-fir. Higher elevations are represented with a mix of conifer stands with more continuous canopy. The immediate vicinity of the fires is mixed mosaic of age classes resulting from several large fires. Older fires like Butte and Corn Lake have areas of tightly spaced 10-20 foot tall stands of lodgepole pine. Shiny-leaf ceanothus interspersed with pockets of ninebark dominate the dryer south facing sites. Depending on the age of the fire scar, snags can be numerous and many have fallen, contributing to a significant down woody fuel component. Non-fire influenced stands most often contain a significant amount of bug kill, ranging from 20 to 60 percent mortality.

Four fuel moisture samples were taken directly from the fire area then processed to determine percent fuel moisture (table 2).

Table 2. Calculated fuel moistures from vicinity of Broomtail Fire.

Fuel Sample Species/Type	% Moisture
Lodgepole pine	120
Subalpine fir	100
Huckleberry	300
Litter/Duff	12

These moisture calculations tend to validate current fire behavior. When unstable air dominates the fire environment or when wind and slope align, fire movement is generally associated with aerial or ladder fuels. When conditions limit air movement the fire is forced to the ground where moistures are higher in the herbs and grasses. The litter/duff sample was a deep cross section sample and thus

heavily compacted therefore it is more likely to resemble a 100 or 1000 hr fuel sample rather than a fine dead fuel sample. Three fuel models best characterize the area in proximity to the Salmon River Canyon, while four fuel models characterize the area around the fires (table 3 and figure 3). Fuel model TL9 best represents particular situations in both general locations.

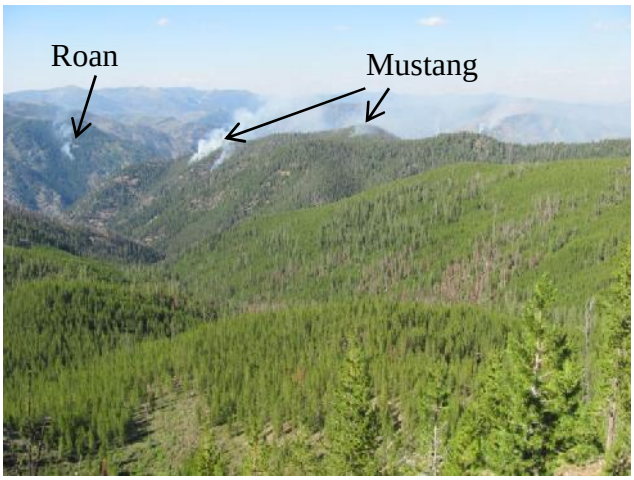
Table 3. Dominant fuel models in the fire area and the Salmon River canyon.

FM 13	FM 40	Description	Application
1	GR4	Short Grass	Grass with scattered brush and ponderosa pine
2	GR4	Grass w/ litter under story	Timber, grass, and understory
5	SH7	Short Brush	Post 1985 burn with 3 to 4-foot brush, primarily ceanothus or Timber and brush
6	SH7	Dormant Brush	Post 1985 burn 3 to 4-foot brush, primarily ceanothus
9	TL9	Long-needle pine	Timber litter ponderosa pine or Timber and brush intermix post-1985 burn
10	TU5	Mixed Conifer	Timber and brush intermix post-1985 burn

Ceanothus brush with heavy snag component.

Bug kill example

Ridge top open stand w/ green bear grass.



Mixed fuel mosaic (Mustang and Roan Fires in background).

Fire induced dense reproduction – 123 road.

Dense multistory/species stand near ridgeline

Figure 2. Photos representative of fuels within the general area of the fires. Ceanothus brushfields are dominant in the stand-replacement portions of burns from 1985 to present. Young, dense lodgepole pine stands are dominant in burns prior to 1985.

Fire Behavior

Observed Fire Behavior

General fire activity observed on 8/3 and 8/4 was smoldering and creeping with short uphill runs where rolling debris was able to ignite receptive fuels below. The uphill runs exhibited occasional single tree torching where wind and slope aligned (east aspect with west wind). 100- and 1000-hr fuels were completely consuming but not significantly contributing to fire growth. Bug kill trees were not specifically observed torching but they are most likely significant contributors to fire behavior, especially in torching form. Wind and temperature steadily increased throughout the day, peaking at 1900 defining the main burn period from 1500 to 1900

Other first-hand accounts reported abrupt increases in fire activity before the normal burn period. Specifically, On August 1st, the Mustang Fire made short crowning fire runs around 1300 on a north aspect with little wind. Abundant bug kill and a heavy lichen load along with steep slopes are most likely contributors to this fire behavior

Table 4. Fire growth between August 1 and August 5 for each fire.

Fire	August 1	August 2	August 3	August 4	August 5
Mustang	181 ac	232 ac	257 ac	290 ac	344 ac
Cayuse Point	3 ac	85 ac	92 ac	110 ac	135 ac
Roan	Spot	1 ac	6 ac	8 ac	25 ac
Filly	1 ac	1 ac	1 ac	1 ac	1 ac
Broomtail	1 ac	1 ac	1 ac	1 ac	245 ac

All fires except Filly have grown between their discovery dates and August 5, although at different times and rates (table 4). Although Mustang is the largest fire in the group its ridge-top location has limited fire growth to downhill backing. Besides the August 1st event, the greatest fire activity was observed where slope and wind align, mainly on the west side. Cayuse Point Fire was more active on 8/3 with good wind and slope alignment but due to the proximity of young fire scars and sparse fuels active it was much less active on 8/4. Roan Fire was observed smoldering and appeared hung-up in a rock slope with sparse fuels. Unlike Mustang and Cayuse, it has abundant uphill fuel with no visible fire scars in the immediate vicinity. Filly and Broomtail received suppression efforts in the form of helicopter bucket drops. Due to lack of fire activity Filly is suspected of being out. Broomtail, however, continued to smolder and spread rapidly on August 5. Instability on August 5 contributed to the activity on Broomtail and was likely a factor in the appearance of another fire within the 1985 Butte Burn.

Behave Plus Runs and Outputs

Behave Plus was used to simulate a run from the Mustang fire to the 123 road. Inputs assumed dry fuel conditions in timber litter and timber with brush fuel models, 15 mph wind speed, and 85 degrees. Outputs resulted with a rate of spread of 12 ch/h, flame length of 8 feet, torching likely at 38 ch/hr, ¼ mile spotting distance, and safety zone size of 2/10 of an acre.

At 38 chains per hour the Mustang Fire would only need run for less than fours to reach Road 123, which is well within the burn period of one operational period. However, the Behave Plus relies heavily on wind to predict spotting distance. As discussed in the Large Growth Events below, large fire days in this area largely depend on instability, therefore we cannot rely solely on wind to predict large fire runs.

The predicted safety zone size is based on 8 foot flame lengths instead of torching tree flame lengths. This is likely not enough space for a safety zone, especially for an area that is historically known for fatalities and deployments. Use IRPG page 7 instead – for instance, 20 foot flame lengths will require ½ acre for a 3 person engine crew.

Seasonal Severity Indicators

Energy Release Component

Energy Release Component (ERC) using Fuel Model G is a measure of the long-term dead and live fuel dryness, therefore a good indicator of fire season severity. According to data from Skull Gulch RAWS, the 2012 season has been drier than average with ERC well above seasonal averages. To evaluate how the season may develop further, we compared each year's ERC trace against 2012 to date to locate years with a similar pattern. We ignored 1992 and 1993 as a check of the actual data indicates significant errors in relative humidity (observation time, maximum and minimum) and possibility in observation time temperature, which affects the ERC calculations. The two closest analog years are 2001 and 2007 (figure 3). In 2001, the basic pattern through August and September was a moisture event followed by a slow return to above-average values in August and a rapid return in September. In 2007, ERCs remained well above average until mid-August. Afterwards, periodic small shots of moisture would depress ERC to near average conditions followed by a quick return to above average conditions. Each recovery would not be as high as the previous recovery through September. The 2007 season effectively ended in late September whereas the 2001 season persisted into early October.

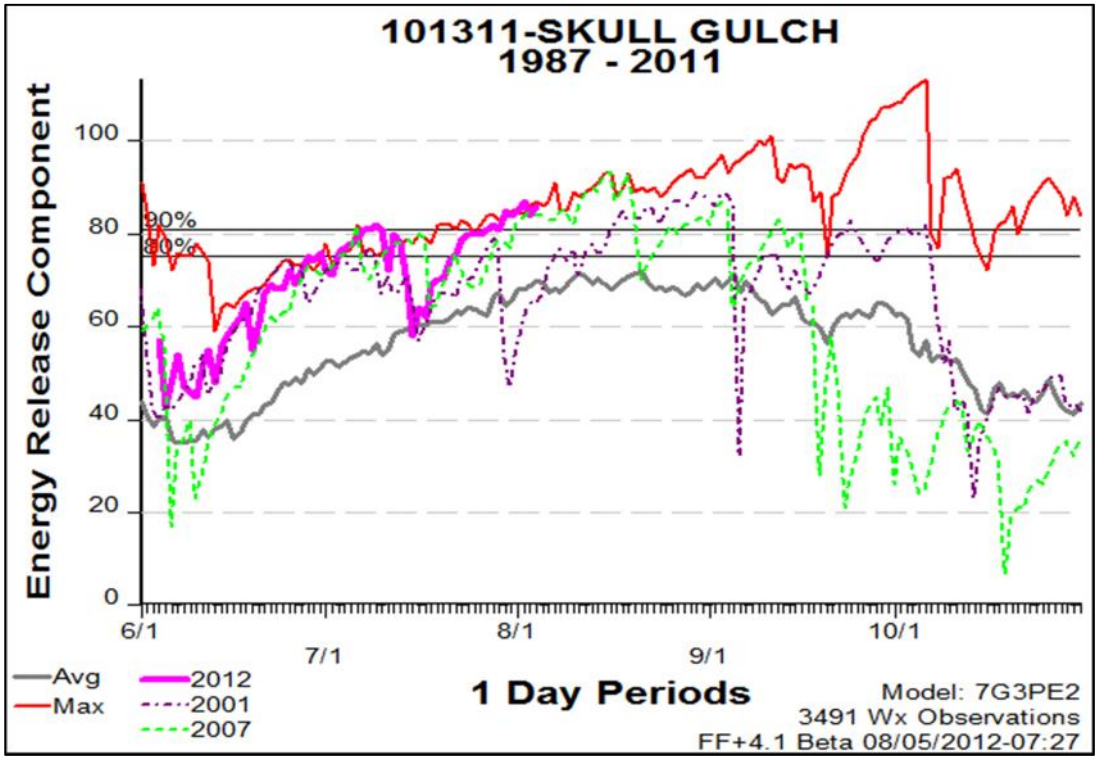


Figure 4. Although Skull Gulch ERC typically peaks in mid-August, 2012 has been well above seasonal averages since early June. Two years that started similarly to 2012 were 2001 and 2007. High maximum values in late September and early October are from 1993, which has highly suspect data.

Large Fuel Moisture

The 7-day large fire potential calculations are based on ERC and 100-hour fuel moisture as these two measures of seasonal severity are the most highly correlated with fire business levels. Skull Gulch 100-hour fuel moistures have been tracking below seasonal averages (figure 4). 1000-hour fuel moistures have been displaying the same trend. Fire behavior observations indicate that the large fuels are helping to carry the fires.

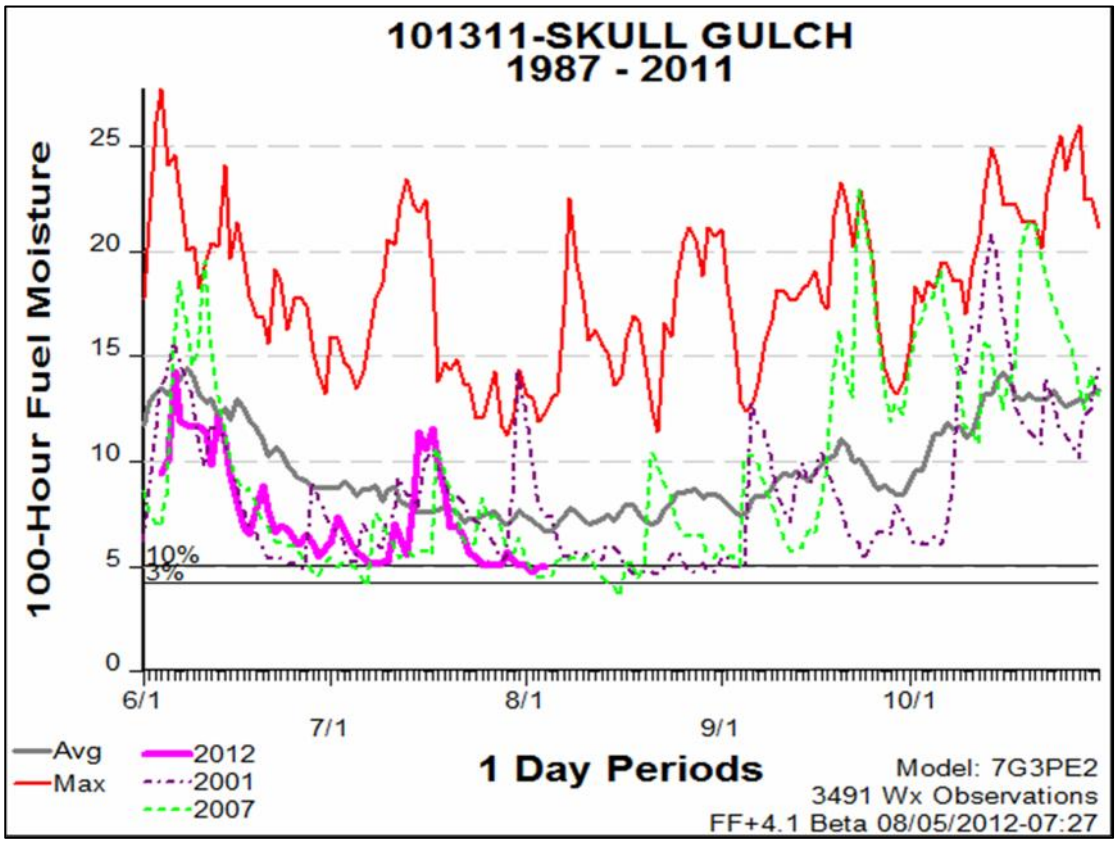


Figure 5: As with ERC, 100-hour fuel moistures at Skull Gulch have been trending drier than average. 2001 and 2007 are included as comparison years.

Long Term Outlook

The long term outlook and seasonal severity prognosis is based on weather records at the template Remote Area Weather Stations, as well as several sources of climatological information including but not limited to the Climate Prediction Center, the Western Regional Climate Center, Natural Resources Conservation Service, and the National Climate Data Center. We also used several evaluation tools including Fire Family Plus, Fire Spread Probability (FS Pro), Near-Term and Short-Term analyses in the Wildland Fire Decision Support System (WFDSS), and FlamMap.

Long Range Forecast

The potential for significant fire activity is expected to remain above average in the central Idaho mountains through September. The central Idaho mountains are rated as abnormally dry in the July 31 Drought Monitor, although drought is not expected to develop through October (figure 5). Over the mid-term, temperatures are expected to be above average and precipitation below average through mid-August (figures 6 & 7). Temperatures are expected to be above average through August with

equal chances for above average, average, or below average precipitation (figure 8). Trends are too uncertain to know to project probable temperatures and precipitation through October (figure 9).

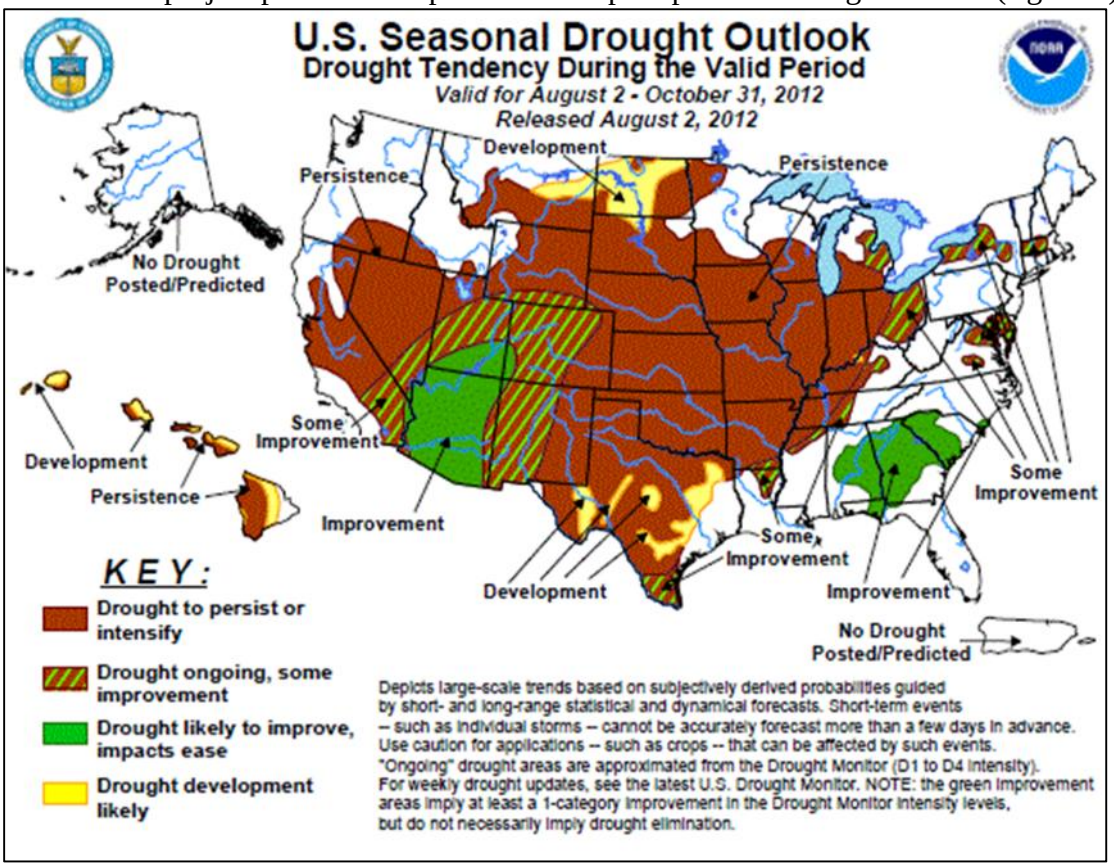


Figure 6. Drought conditions are not expected to develop over the central Idaho mountains through October.

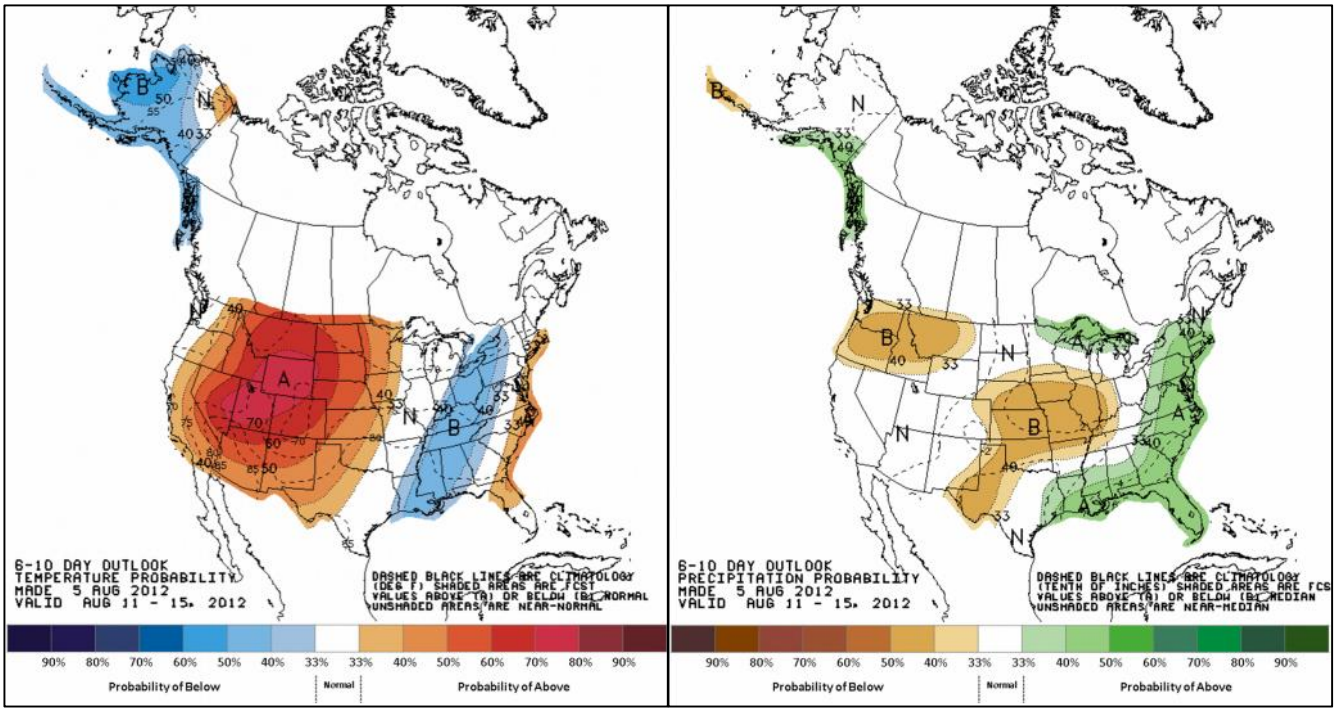


Figure 7. The central Idaho mountains are expected to be warmer and drier than average through August 15.

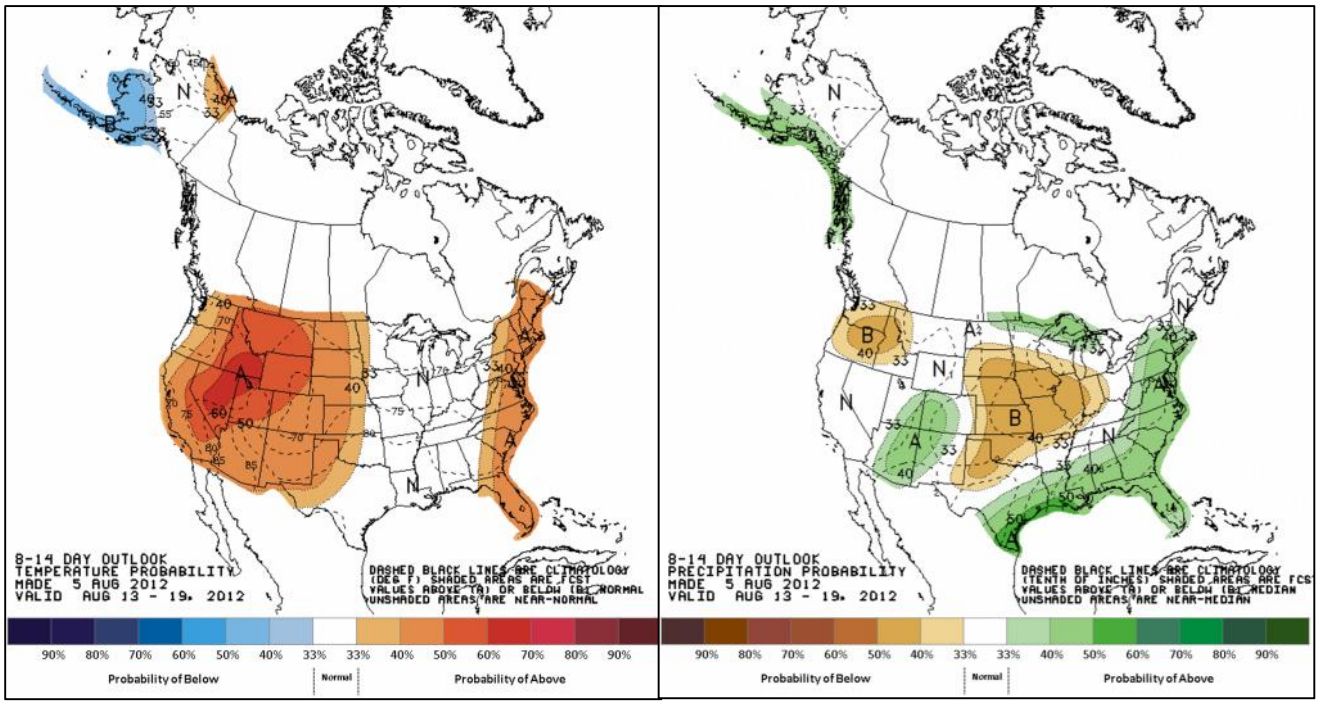


Figure 8. The 8-14 day outlook is very similar to the 6-10 day outlook for central Idaho.

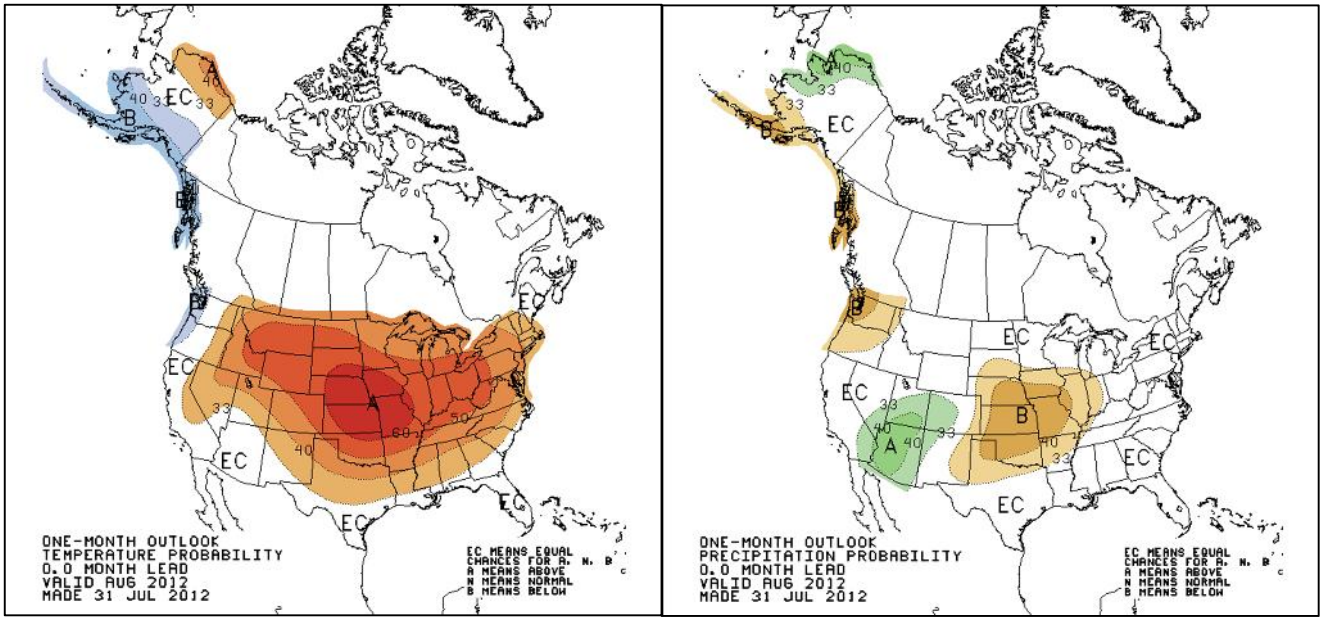


Figure 9. August is expected to be warmer than average in Idaho but has equal chances for above average, average, and below average precipitation.

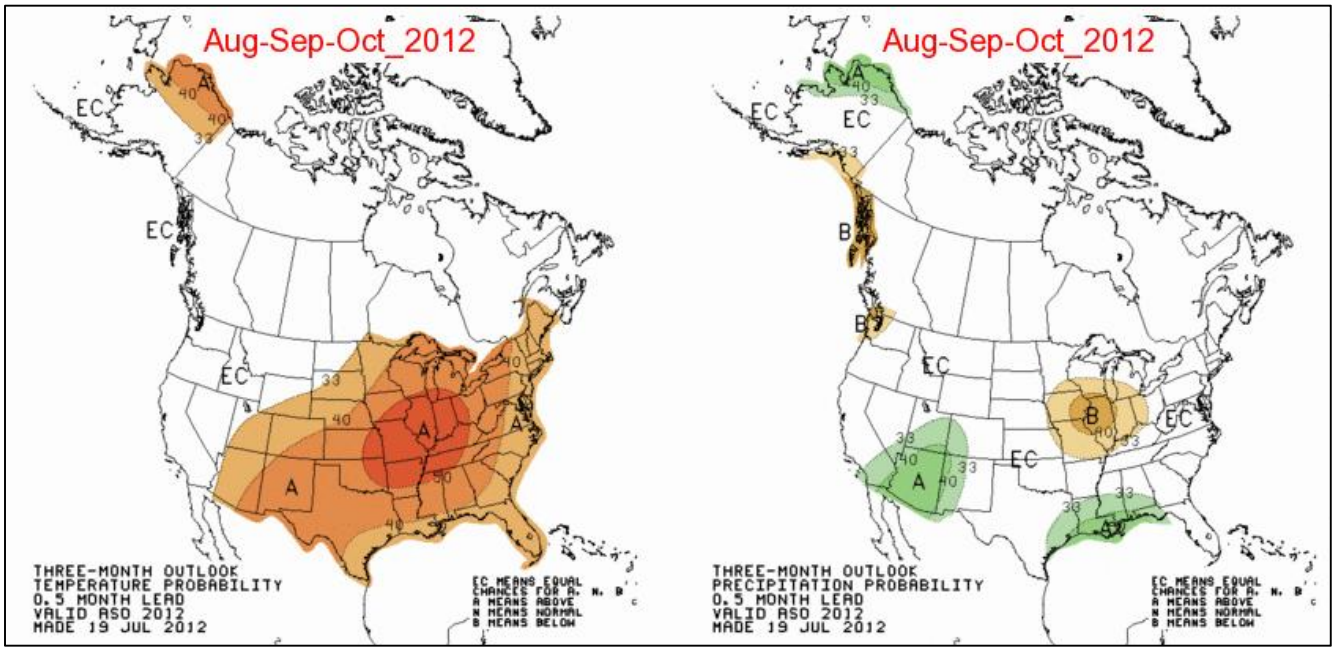


Figure 10. Central Idaho has equal chances for above average, average, and below average temperatures and precipitation through October.

Season Slowing Events

Typical summers include periods of little to no fire growth, often as a result of precipitation that temporarily slows fires. Such events may help contain fires within a given perimeter or can upset burnout operations intended to secure fire line as well as place crews at risk of stranding in remote areas with limited access. We used Fire Family Plus to search for key precipitation events that may slow or temporarily halt fire spread, using at least three event types (table 5). The first event type is the same event used on the Saddle Fire long-term assessment – at least 0.2 inches of precipitation over a 2-day period. Such an event is expected to slow or halt fire spread for at least 3 days. The second event type was 0.1-0.24 inches of precipitation over a 1-day period. This event type is expected to slow or halt fire spread for 1-3 days. The third event type was 0.25-0.49 inches of precipitation over a 1-day period, expected to slow or halt fire spread for 3-5 days.

Table 5. Probability and number of precipitation events expected to slow or temporarily halt fire spread in August, September, and October using data from Skull Gulch RAWS (1987-2011). The total number of events in the period of record are listed in parentheses.

At least 1 event	Number of Days of Slowing	August	September	October
0.2+ in over 2 days	3+	40% (10)	56% (14)	68% (17)
0.1-0.24 in over 1 day	1-3	72% (18)	56% (14)	72% (18)
0.25-0.49 in over 1 day	3-5	16% (4)	28% (7)	36% (9)
2 or more events				
0.2+ in over 2 days	3+	24% (6)	28% (7)	36% (9)
0.1-0.24 in over 1 day	1-3	28% (7)	16% (4)	40% (10)
0.25-0.49 in over 1 day	3-5	4% (1)	12% (3)	12% (3)

Since the fire area is approximately 1000 ft higher in elevation, the probability of these events may be somewhat higher. A given rain event may not have recorded enough precipitation at the elevation of

Skull Gulch to reach the criteria used, but could have done so at the elevation of the fires. While some August events occurred early in the month, more events occurred in the 3rd week. September and October events did not show a clear pattern in timing.

Season Ending Events

The potential length of the fire season is important to operational and other management decisions, as the number of burn days left in the season have a direct effect on the likelihood that a free-burning fire will reach any point of concern. However, determining when the season effectively ends can be tricky. In the mountains of the Intermountain West, season end is often associated with a precipitation event, but there is no consistency to the size and duration of that event, both from place to place and from year to year.

In addition to precipitation, other factors play a role in season end, such as temperature and relative humidity, day length, and sun angle. In early August, the burn period can begin mid-morning, end near sunset on very warm and dry days, and extend well into the night in thermal belts. Between August 3 and September 15 at the latitude of Salmon, Idaho, the day shortens by 2 hours 5 minutes and the maximum sun angle declines by 15º. These changes reduce the potential burn period and are enough to affect the probability that the lower 1/3 of slopes will carry fire, especially on northerly and easterly aspects. These slope positions are also less likely to dry out sufficiently to carry fire should a precipitation event, even a relatively small one, occur around mid-September. By October 15, day length will have shortened another 1 hour 34 minutes and maximum sun angle another 12º, tending to limit the main burn period to just a few hours in the afternoon. Throughout this period, maximum and minimum temperature are decreasing and maximum relative humidity in particular is increasing. The energy input needed to promote fire spread and extreme fire behavior continues to increase.

Energy release component effectively integrates all these factors associated with season end. We developed season ending dates based on 24 years of data from Skull Gulch RAWS and analyzed them using the Term module in Fire Family Plus. We discarded 1993 due to the suspect data and 1990 never reached the 70th percentile ERC. We defined season end as the point at which ERC drops below the 70th percentile value (69 at Skull Gulch) and does not recover above it. Since the Saddle long-term assessment used the 80th percentile value, we also analyzed that, compared the two results, and found no difference between the two. Key season ending dates and probabilities are (figure 10):

- September 27 – 50% chance
- October 12 – 75% chance
- October 24 – 90% chance

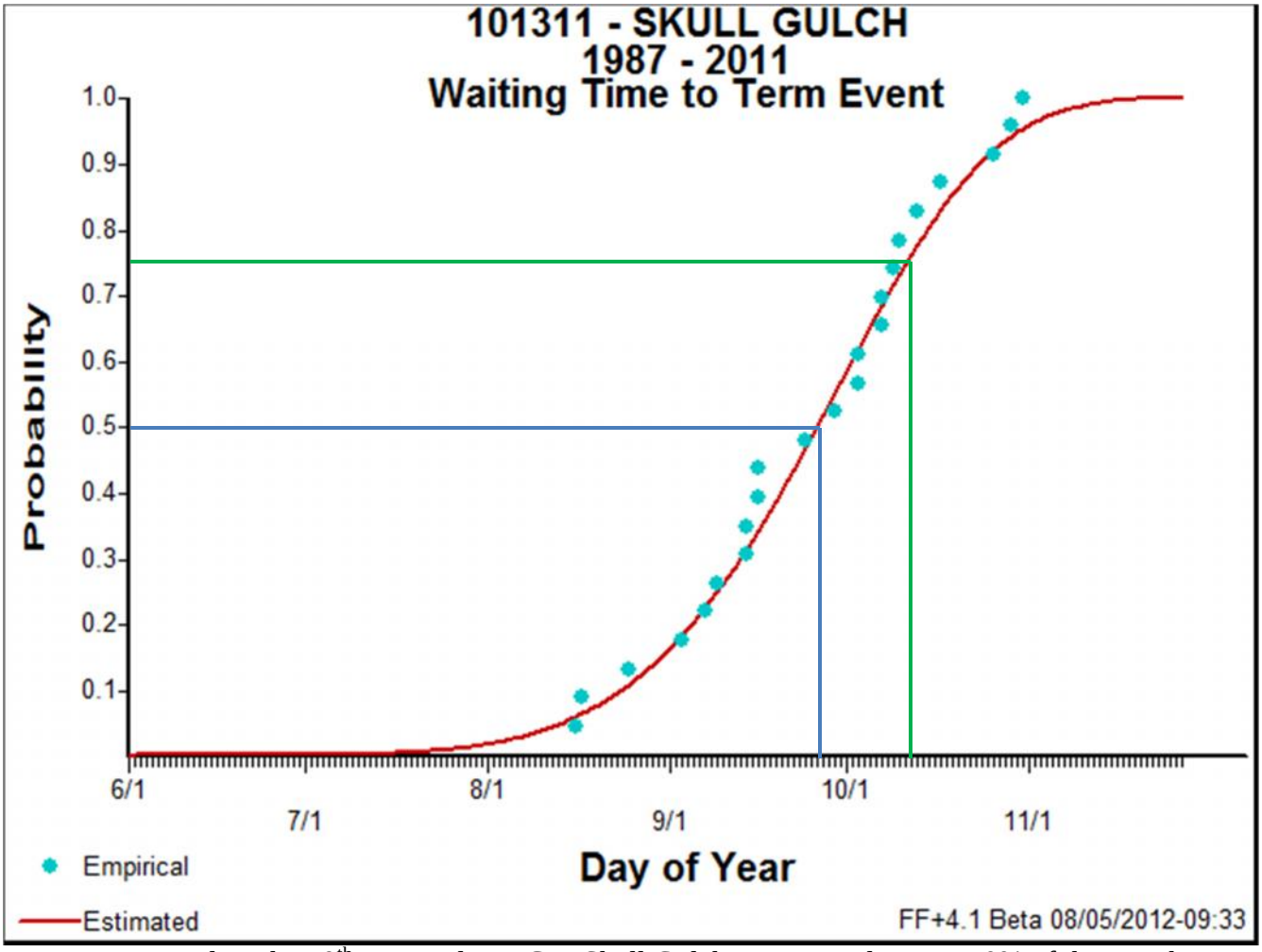


Figure 11. Based on the 70th percentile ERC at Skull Gulch, season end occurs 50% of the time by September 27 and 75% of the time by October 12.

Fire Growth Events

Large fire growth events result in the majority of acres burned but typically occur on only one or a handful of days over the life of a large fire in western coniferous forests. While strong winds can be a driver and are often reported by personnel on the fire, more events are driven by a dry, unstable atmosphere. Strong winds can develop around the fire as in-drafts to the main column, but local RAWS may only record light and variable winds. The long-term analysis conducted on the nearby Saddle Fire in 2011 lends support to this theory as 20-foot winds recorded at observation time during large growth days on both Saddle and historical fires in the area averaged only 10 mph. Only one spread event had 10-minute average wind speeds of greater than 8 mph.

No surface weather measures record atmospheric conditions, but experience suggests certain surface observations may be correlated with such conditions. Two approaches have been used to estimate the probability of large fire growth events (Table 6). One approach uses the combination of maximum temperature greater than or equal to the 90th percentile value and minimum relative humidity less than or equal to the 10th percentile value. This approach assumes that hot, dry conditions indicate a dry, unstable atmosphere on the spread day. The second approach uses the 10th percentile maximum relative humidity recovery, under the assumption that poor humidity recovery the night before the spread day indicates a dry, unstable atmosphere. We analyzed the probability of both types of events

using data from Skull Gulch RAWS for 1987-2011 (25 years). At Skull Gulch RAWS the values associated with these criteria are:

- 90^{th} percentile maximum temperature = 87ºF
- 10^{th} percentile minimum relative humidity = 8%
- 10^{th} percentile maximum relative humidity = 30%

Table 6. Probability of large growth events for August through October using maxT-minRH and maxRH approaches and total number of events between 1987 and 2011.

MaxT-MinRH	August	September	October
At least 1 event	60% (15 events)	24% (6 events)	4% (1 event)
2+ events	36% (9 events)	16% (4 events)	0%
MaxRH			
At least 1 event	88% (22 events)	72% (18 events)	32% (8 events)
2+ events	68% (17 events)	72% (18 events)	24% (6 events)

If the maximum relative humidity approach were combined with another indicator, such as low 1000-hour timelag fuel moistures or low live fuel moistures, the probability and number of events likely would be lower. Poor humidity recovery at night tends to occur in runs of two or more days whereas the combination of high maximum temperature and low minimum relative humidity tends to be a single day event. Irrespective of these probabilities, forecast or observed temperatures and relative humidities that equal or exceed the values listed above indicate a higher potential for active fire behavior.

We also analyzed past fires to try to validate the information above. Using the Salmon-Challis fire progression layer, we identified all spread events on past fires that were at least 1000 acres in size. We then looked up the maximum temperature, maximum and minimum relative humidity, observation time wind speed, and ERC value at Skull Gulch RAWS for those spread days. We threw out spread days that lacked weather observations. Where perimeter increases included more than one spread day, we used the weather for the driest day in the spread period, assuming that most of the spread occurred on that day. This process provided us with 124 spread events to analyze. We identified the following criteria as indicators of high potential for a large spread event (figure x):

- Minimum relative humidity $\leq$ 13%
- Humidity recovery $\leq$ 50%
- Maximum temperature $\geq$ 79º
- Observation time wind speed $\leq$ 8 mph
- ERC $\geq$ 77

Humidity recovery the previous night seemed to be a poorer indicator, encompassing a wider range than the other variables analyzed (figure 12). Most large growth events occurred in August with about an equal number (and a far fewer number) in July and September. The lack of large fire growth events in September was surprising.

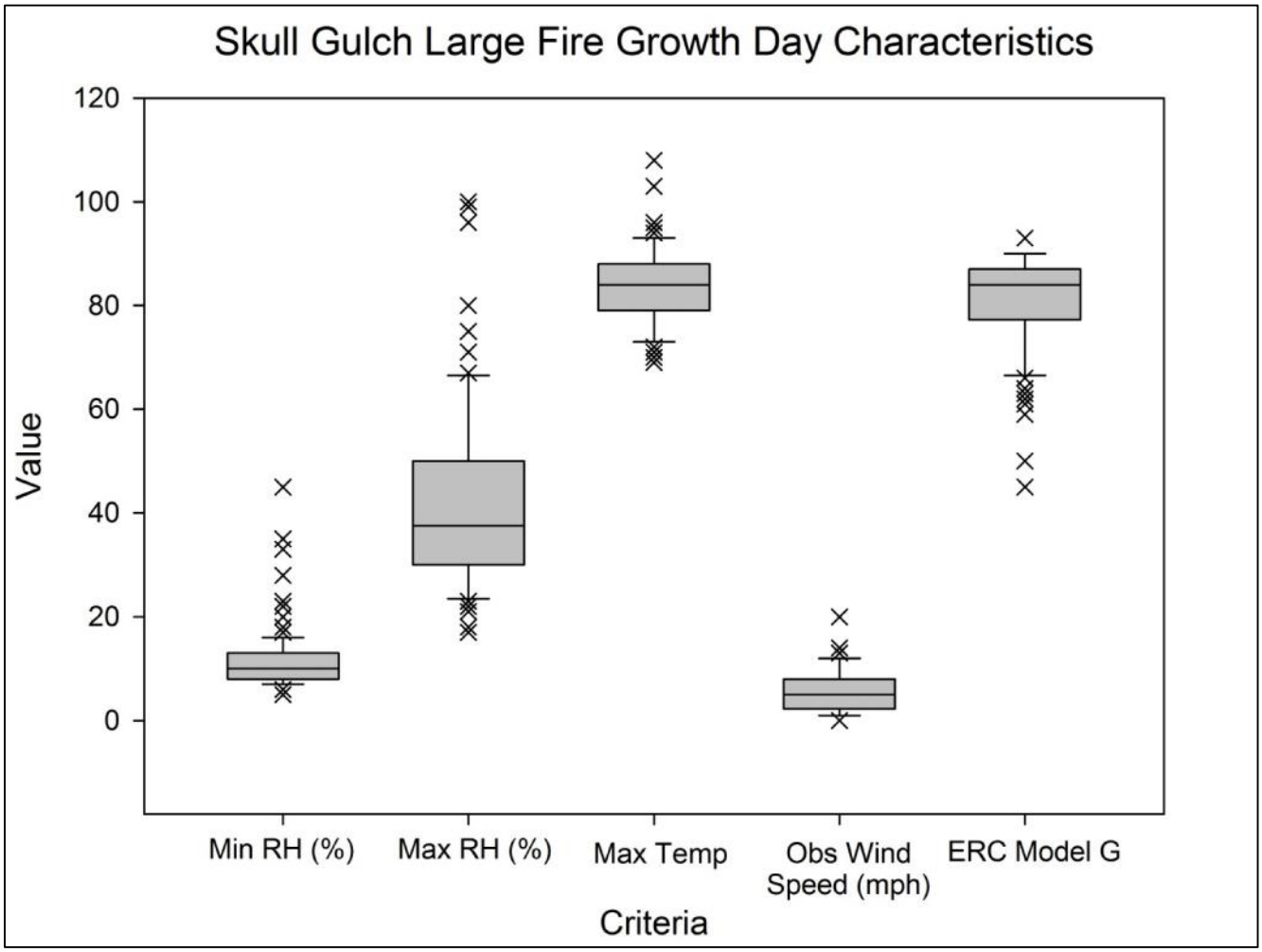


Figure 11. Characteristics of days with spread events of 1000 acres or more. The boxes enclose the 25th and 75th percentile values for the criterion with the interior line at the median value. Whiskers identify the 95th percentile range. Xs indicate upper and lower outliers, which are the equivalent of rare events.

Risk Assessment

WFDSS-FSPro – Fire Spread Probability Model

The Fire Spread Probability (FSPro) model was used to evaluate fire spread potential. FSPro is a spatial model that calculates the probability of fire spread in all directions from a current fire perimeter or ignition point. FSPro models fire spread of hundreds or thousands of weather scenarios based on local climatological records to determine the probability of a fire spreading through an area over a given time period. FSPro can be used to identify the probability that areas of concern could be impacted by fire. The outputs are helpful for developing priorities and analyzing values at risk.

FSPro Assumptions and Inputs.

All runs are for 14 days (Aug4-18) We used Skull Gulch RAWS was used for weather Red Rock Peak RAWS for the winds as it more closely represented the winds associated with the fires. LANDFIRE Refresh 2008 1.1.0b data were used for the analysis with the 40 fuel models. Primary fuel models represented in the landscape include TU5 – very high load dry climate timber shrub, which adequately

represents those areas with good reproduction and older previous fire scars; TL3 and TL8 - moderate load and long needle litter; and several grass and grass-shrub models – GR2, GS2, GR1, which mostly represent previous burn scars outside of the fire perimeter.

Aerial detection flight surveys from 2008-2011 were overlain with the landscape and masks were created for bug killed timber areas. Areas affected and mapped in 2008 and 2009 were considered 'gray stage' and a mask was created that reduces canopy cover by half to reduce sheltering within those stands. Areas affected and mapped in 2010 and 2011 were masked as 'red stage' bug kill and foliar moisture in the canopy was effectively reduced by reducing canopy base height. The ratio used to multiply the CBH mimics a reduction in foliar moisture from 100 percent to 10 percent.

The polygons were not further divided as to percent of dead trees within the perimeter. A calibration run in the near term model using the edited Landscape to simulate the spread event on August 3rd simulated actual fire spread reasonably well. Previous calibrations using the 'bug' edits on fires on the Salmon-Challis NF had proven to be very good with the Saddle fire of 2011 which utilized these same edits. These edits were based on those used to simulate fire spread on the Saddle Fire in 2011

The fire IR heat from the August 02 IR flight was used as the ignition file and no barriers were entered into the system. The model assumed no control action had been taken. Acres associated with various burn probabilities can be identified, however these are only the sum of the area within these zones and do not reflect an actual or final fire size.

Initial runs in FSPro indicated the fire spread into recent burn areas was too high based on observed fire behavior. Field observations indicated that herbaceous fuels were still green. Therefore, we increased lover herbaceous fuel moisture in FSPro to 120 in all ERC bins. Subsequent runs better represented the influence of recent burns on fire spread.

Fire Growth Projections

FSPro evaluates the likelihood that a free-burning fire reaches any given piece of ground during the assessment period. The team conducted FSPro analyses for 14 days with free burning potential on Mustang and Cayuse fires.

There were two points of concern that the local unit identified- The Gattin Ranch-private lands to the North, and Long Tom Lookout to the South.

Mustang:

The FSPro analysis for Mustang on the SW portion indicates <0.2% threat to Gattin Ranch area and a 40% probability within the 14 day period of reaching the wilderness boundary along S-SE edge near Swamp Camp and shows 0% probability of actually reaching Long Tom Lookout. (Figure 13) There is a 70% probability of the Mustang fire crossing over the BroomTail creek and overtaking the Cayuse Point fire within the 14 day analysis period. (Figure 13).

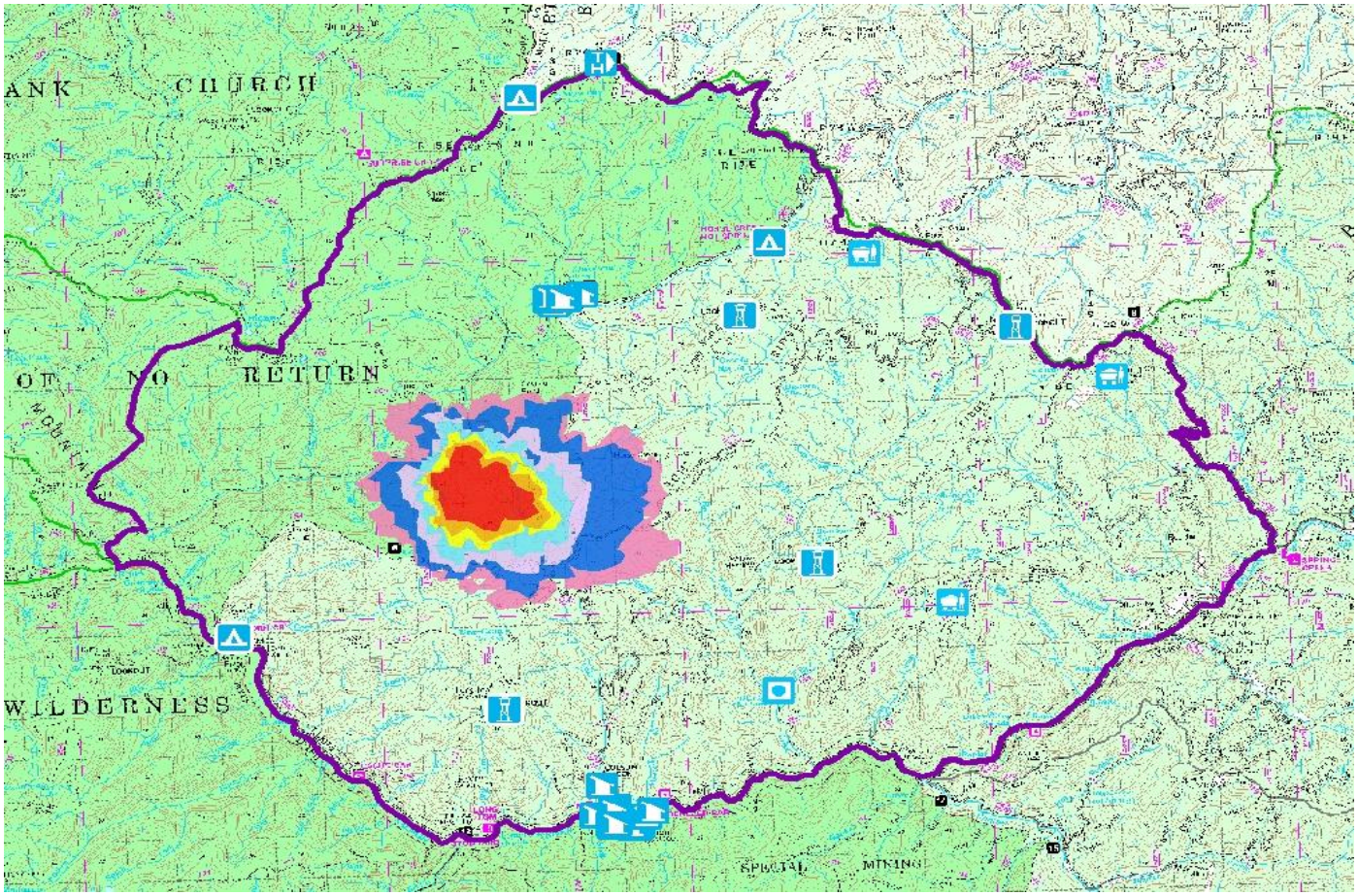


Figure 13. Fire Spread Probability (FSPro) analysis for the Mustang fire, Salmon-Challis National Forest, August 4 -August 18, 2012 with no suppression line or actions taken.

Cayuse Point:
The FSPro analysis for Cayuse on the NE portion indicates <0.2% threat to Gattin Ranch area and a 80% probability of reaching the wilderness boundary along Oreana Ridge within the 14 day analysis period (Figure 14). The 2002 Little Horse Burn interrupts and slows fire spread potential along the FS 123 road East of current fire area. (figure 14).

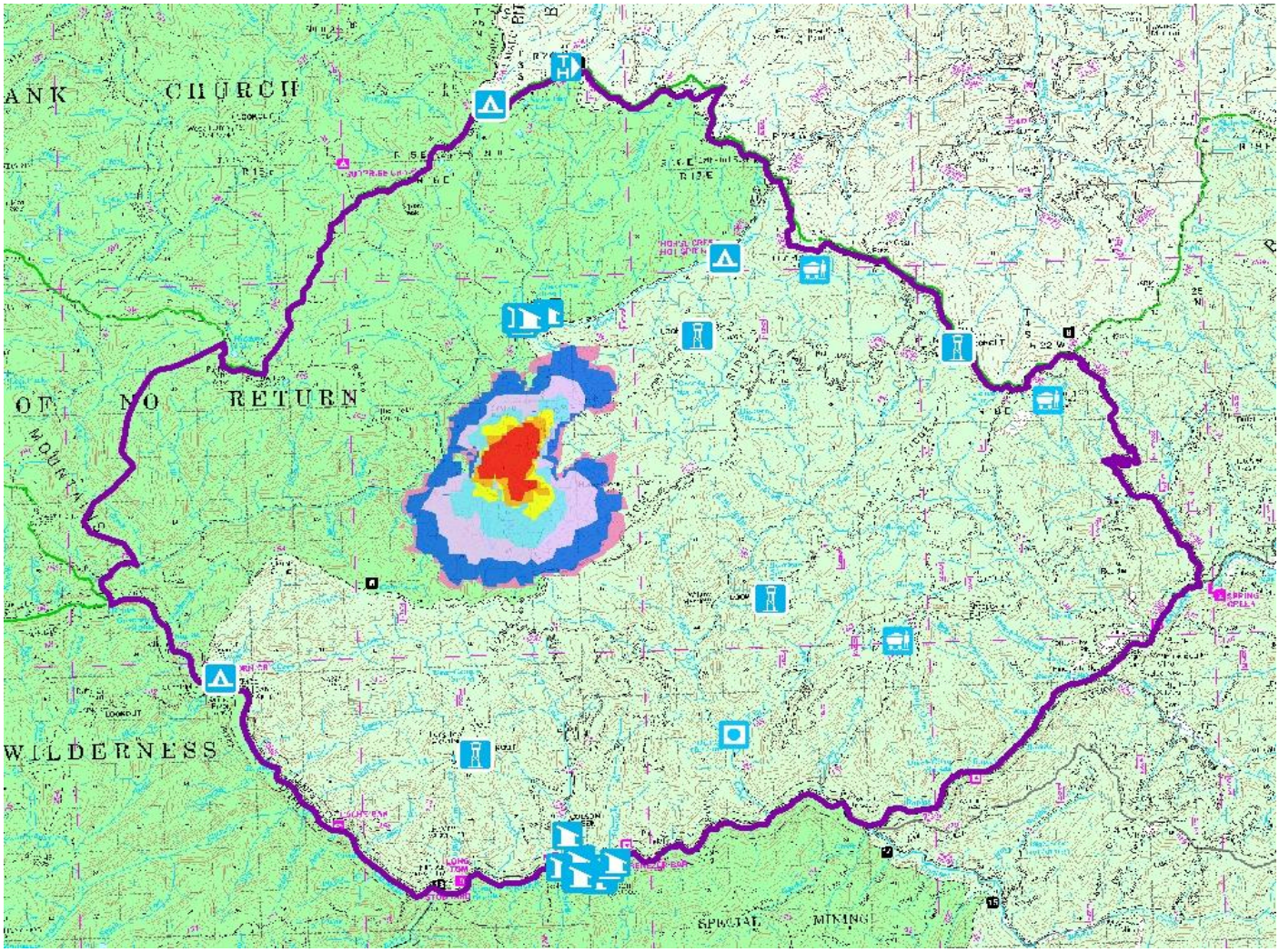


Figure 14. Fire Spread Probability (FSPro) analysis for the Cayuse fire, Salmon-Challis National Forest, August 4 -August 18, 2012 with no suppression line or actions taken.

Combined:
Given the shape of the assessments for Mustang and Cayuse, we combined the two results to better understand how these two fires might interact. (figure 15)

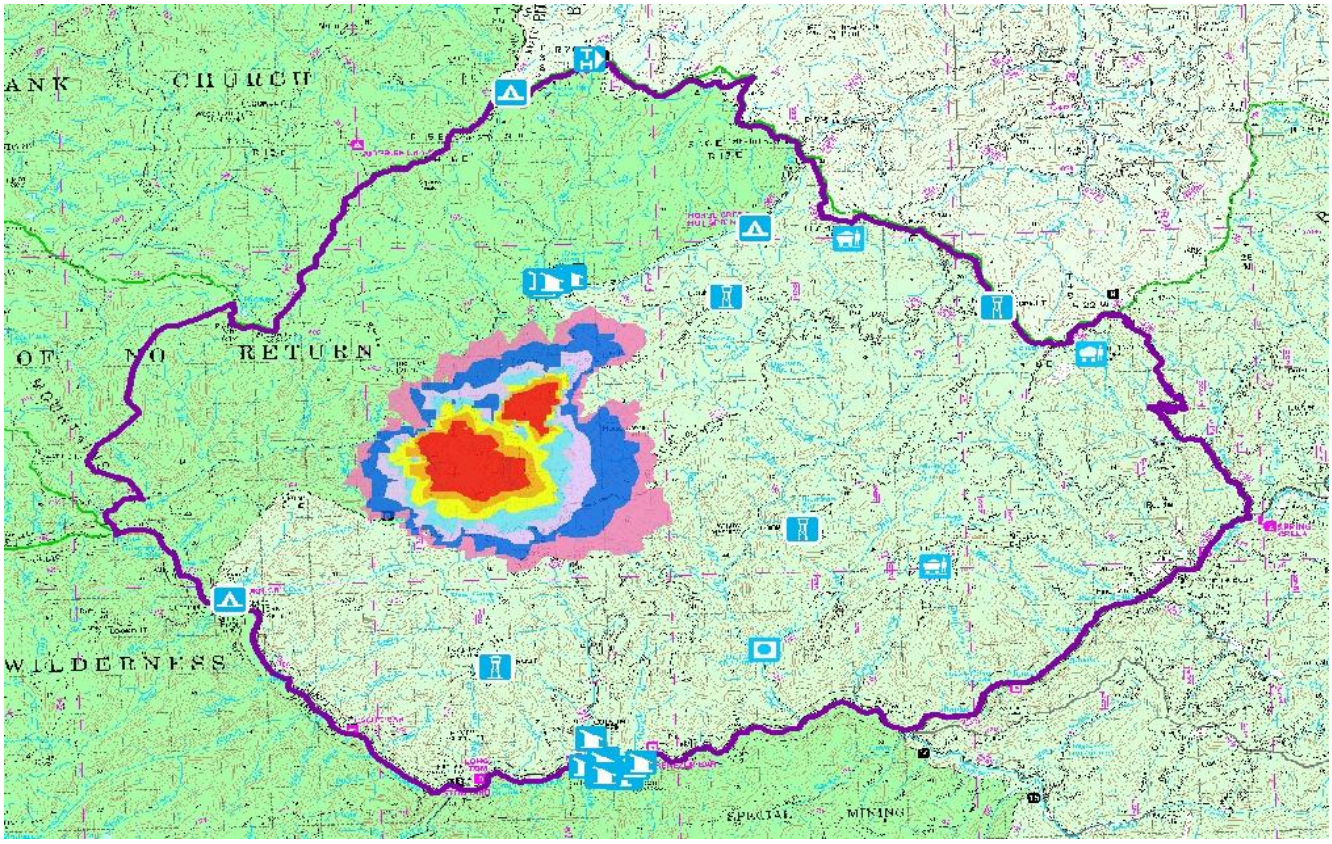


Figure 15. Fire Spread Probability (FSPro) analysis for the Mustang & Cayuse fires combine, Salmon-Challis National Forest, August 4 -August 18, 2012 with no suppression line or actions taken.

FSPro also provides a histogram of fire sizes from fire simulations. See Figure 15. Mustang used 1008 fires and the average fire size of 5,704 acres for the 14 day run, with 90% of the simulations resulting in a fire size of 9,298 acres or less. Cayuse had 1,032 fires and the average fire size of 2,207 acres for the 14 day run, with 90% of the simulations resulting in a fire size of 4,698 acres or less.

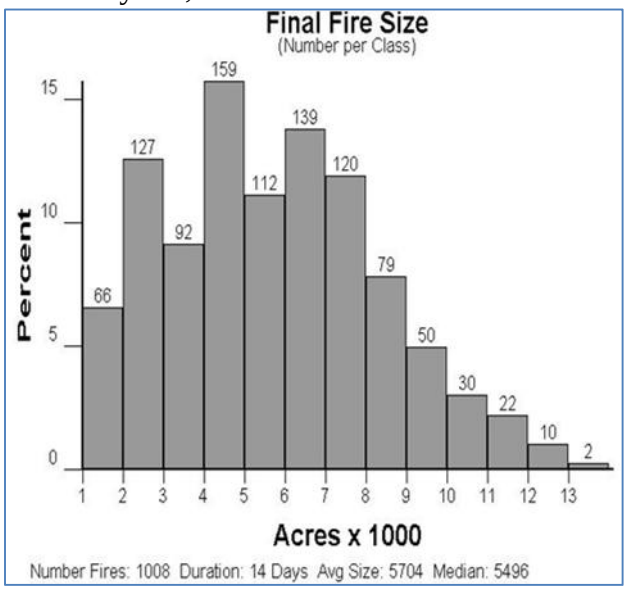


Figure 15. FSPro Histogram for Mustang fire

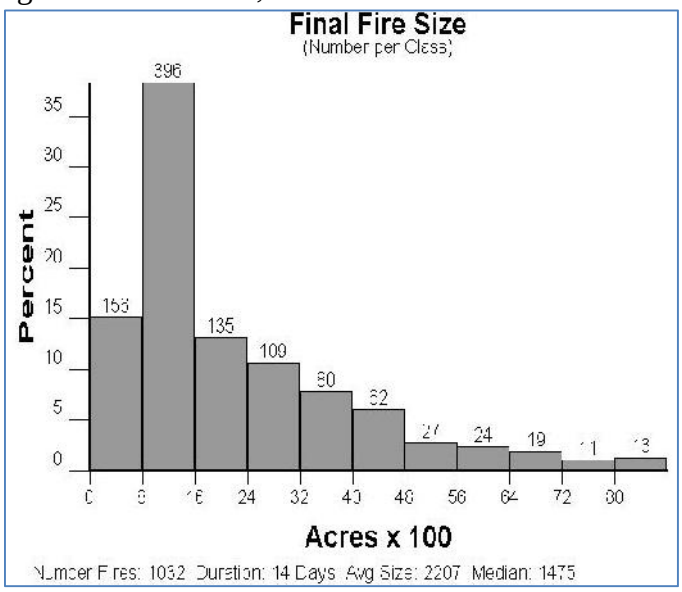


Figure 15. FSPro Histogram for Cayuse fire

WFDSS – NTFB & STFB

Near-Term Fire Behavior (NTFB)
This fire behavior model produces outputs that represent modeled growth in the form of a 'fire progression, similar to the FARSITE desktop model. Unlike Short-Term Fire Behavior, NTFB models fire behavior using inputs for weather and wind that change over the duration of the simulation. Although NTFB can model fire growth for up to seven days, it is generally most appropriate for the 'near term' of one to three days, due to unknowns in the forecast beyond that time frame. The model retrieves forecasted weather and winds for the selected time, using National Weather Service (NWS) Forecast Data for current simulations.

Short-Term Fire Behavior (STFB)
Short term fire behavior is a two-dimensional fire growth model. This web-based application calculates spread rates and maximum spread direction at each cell. Using one set of wind and fuel moisture conditions, it provides potential fire spread (arrival times and major paths) for a user-defined length of time, usually 1-3 days.

Assumptions & Inputs
Near-Term and Short-Term Fire Behavior runs were conducted for the three smaller fires within the complex, Broomtail, Roan, and Filly. Original runs done on August 3rd for the dates of August 4-6. Additional follow-up runs refreshed for August 6-8th. Three days of forecast were used for the NTFB on all three of these fires.

Broom Tail:
For potential spread based on run from August 3rd (figure 17).
From the run made on August 3rd fire major travel paths are depicted in (figure 18). The August 3rd run was conducted when Broomtail was less than 1 acre. The resultant run indicated that should the fire become active under a west wind, it would spread into the head of Swamp Cr (figure 17). Figure 18 depicts the major travel paths under a NW wind. In both simulations spotting was a significant factor in the fire spread.

Roan: (figure 19).
Refresh of the Roan NTFB shows that spread potential stays west of Horse Creek within the wilderness area for the three day burn period. This uses the 25 acre perimeter from the 0806 flight.

Filly: (figure 20).
Refresh of the Filly NTFB shows that it stays south of Gattin Ranch are of concern by 2.4 miles and south of Stud Creek. Spread potentially could reach the wilderness boundary on day 2 burn period assuming not action taken.

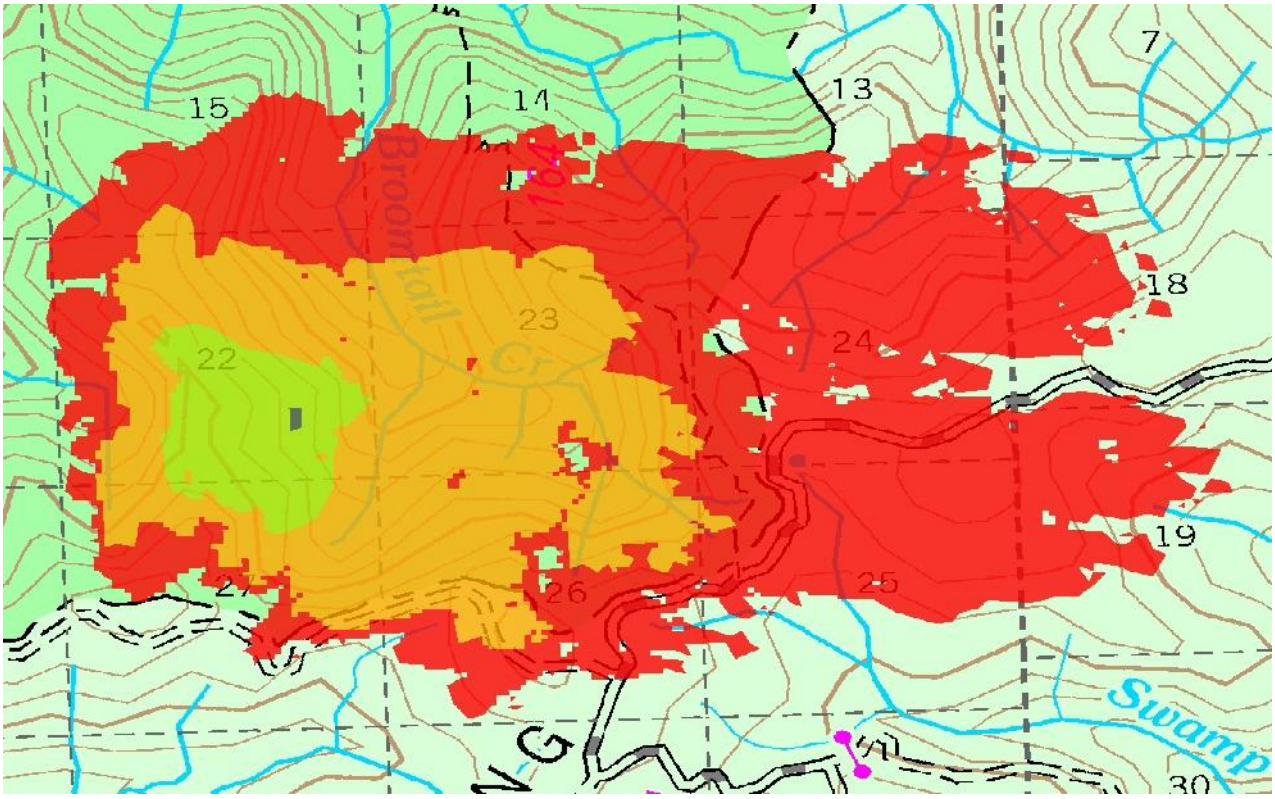


Figure 17. Near -Term Fire Behavior analysis for the Broom Tail fire, Salmon-Challis National Forest, August 4 - 6, 2012 with no suppression line or actions taken.

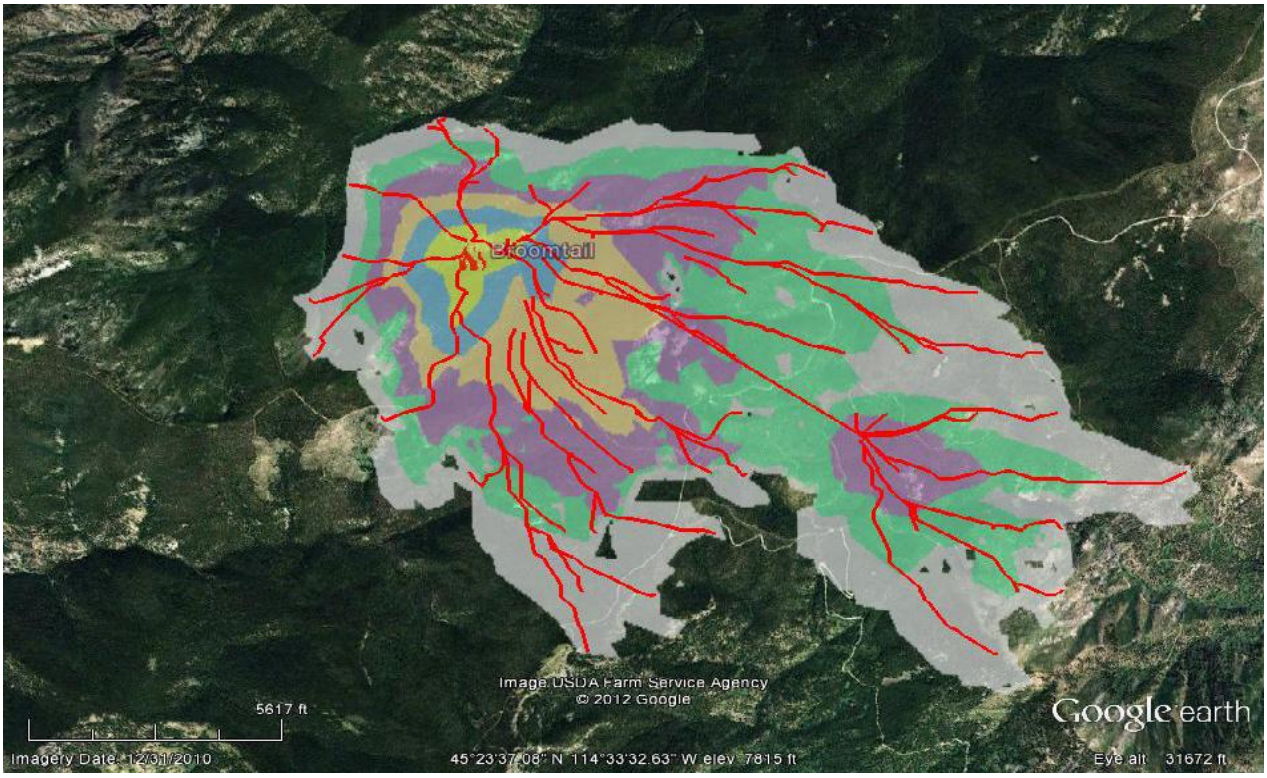


Figure 18. Short- Term Fire Behavior analysis showing major travel path for the Broom Tail fire, Salmon-Challis National Forest, August 4 - 6, 2012 with no suppression line or actions taken.

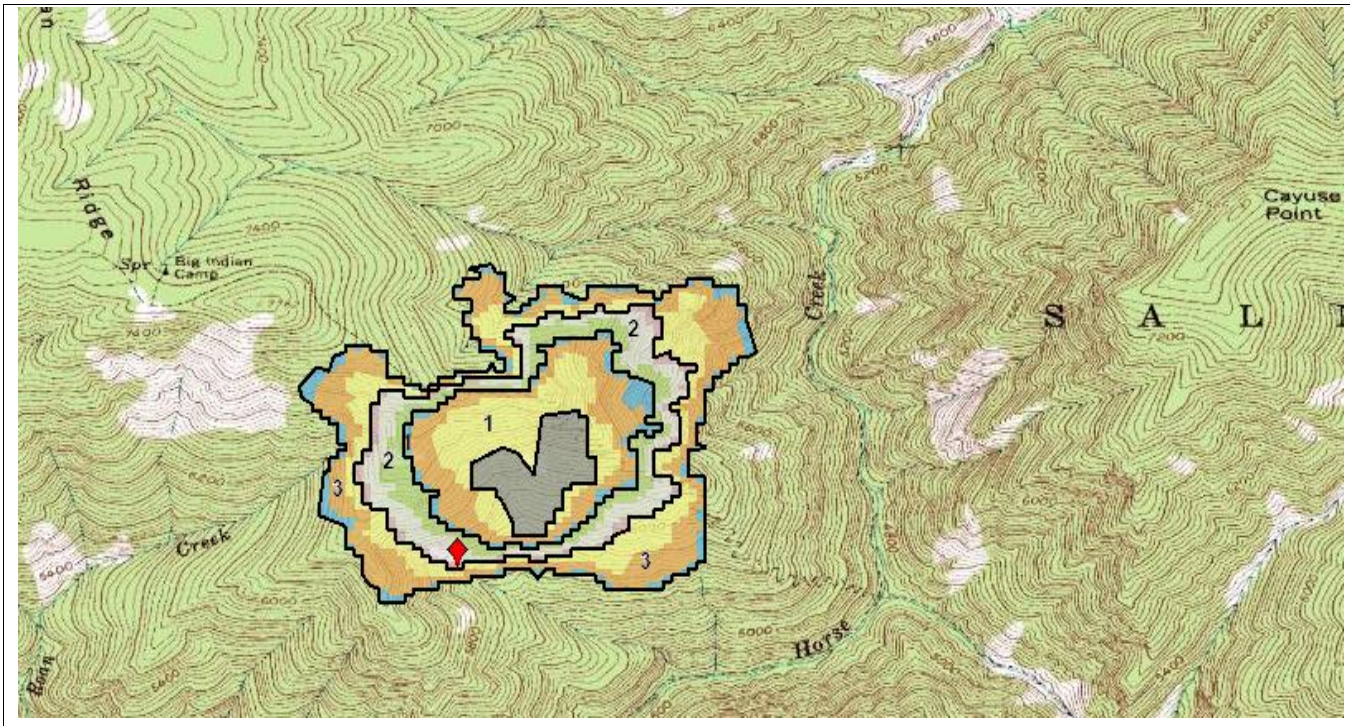


Figure 19. Near- Term Fire Behavior analysis for the Roan fire, Salmon-Challis National Forest, August 6-8, 2012 with no suppression line or actions taken. Uses IR fire perimeter from 2012_0806.

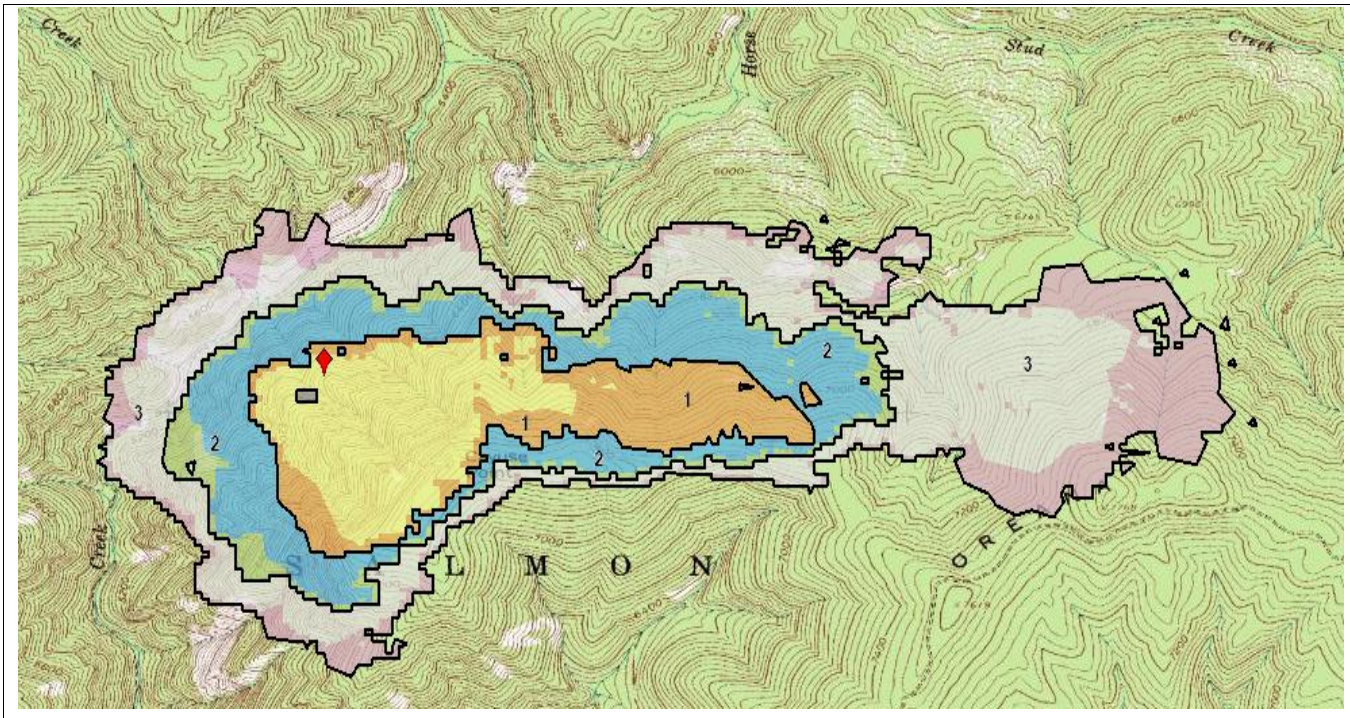


Figure 20. Near -Term Fire Behavior analysis for the Filly fire, Salmon-Challis National Forest, August 6-8, 2012 assuming no suppression actions taken.

August 6th, 2012 REFRESHED FSPro

Combination of the Mustang, Broom Tail and Cayuse Point fires into one FSPro run is prudent given that the Broom Tail fire growth increased the afternoon of August 5th . An individual run was done for the Broom Tail fire using the IR perimeter and it indicated that the 80% probability for each of these fires wanted to overlap or run together.

Assumptions and Input

The fire IR heat from August 6th flight was used as the ignition file on all three fires and no barriers were entered into the system. IR indicated acres for Mustang-347, Cayuse-136 and Broom Tail-246. The model assumed no control action had been taken.

A fourteen day run was made for the time period August 6-20, 2012 to evaluate potential fire spread probabilities. Skull Gulch RAWS used for ERC calculations and Red Rock RAWS was used for winds. All other inputs remained the same as the August 3rd runs.

Fire Growth Projections

The team conducted FSPro analyses for 14 days with free burning potential on Mustang, Cayuse Point & Broomtail fires. Two points of concern were identified by the local unit - The Gattin Ranch-private lands to the North, and Long Tom Lookout to the South.

The combine fires FSPro analysis indicates <0.2 % probability of threat to Gattin Ranch area and stays south of FS road# 065. There is 80% probability reaching the wilderness boundary along the South and SE with 60-70% probability of moving into Swamp Creek. It shows a 0% probability of actually reaching Long Tom Lookout, however it does indicate there is a .2-5% probability of coming within .8 mile of the Lookout. East side spread probability of 5-19% for reaching Horse Creek Butte and into Horse Creek (figure 21)

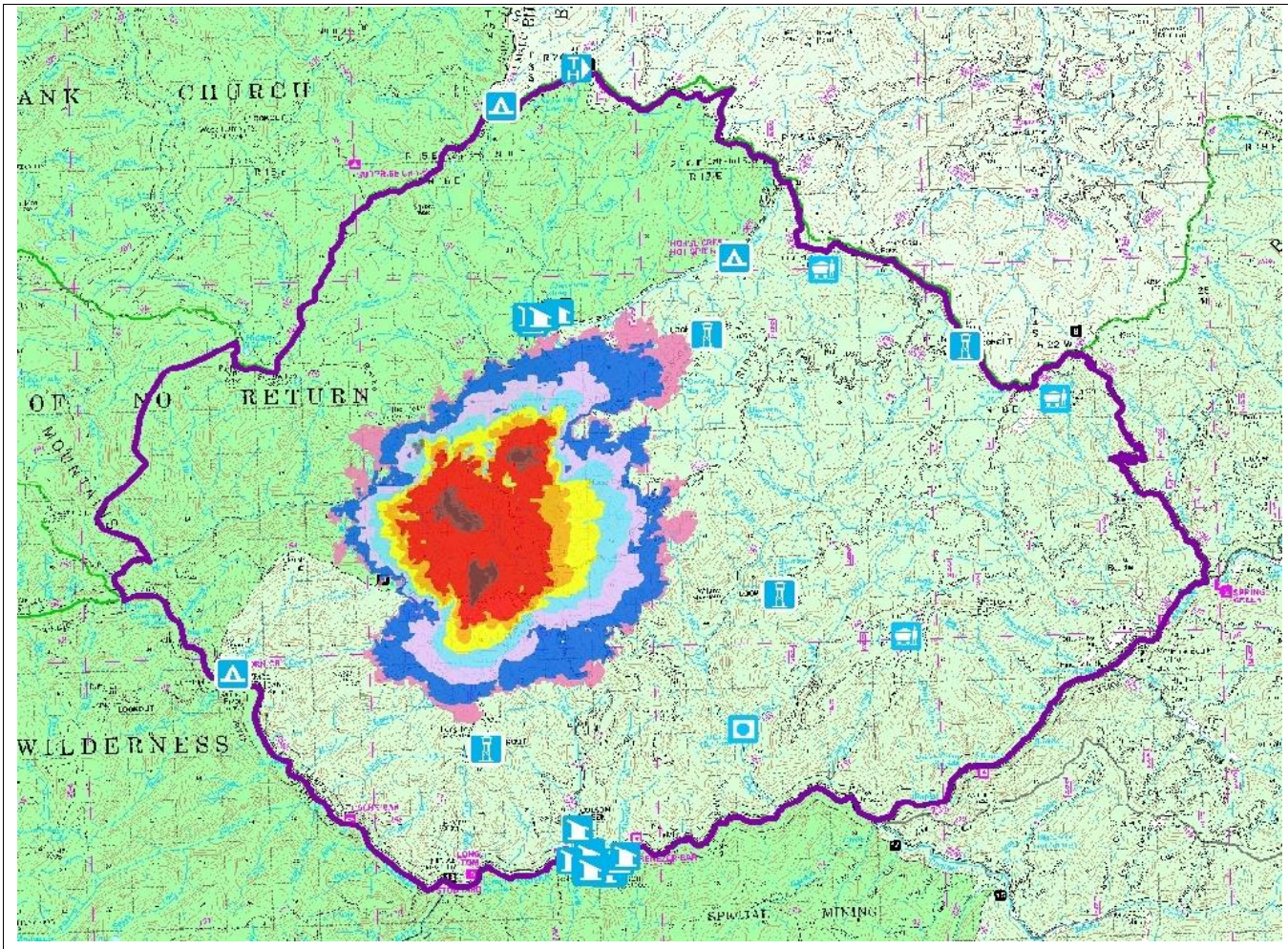


Figure 21. Fire Spread Probability (FSPro) analysis for the combine run on Mustang, Broom Tail and Cayuse Point fires, Salmon-Challis National Forest, August 6 -August 20, 2012 , assuming no suppression line or actions taken.

ASSESSMENT USING FLAMMAP

FlamMap5 is a fire behavior mapping and analysis program that computes potential fire behavior characteristics (spread rate, flame length, fireline intensity, etc.) over an entire FARSITE landscape for constant weather and fuel moisture conditions. It is not a replacement for FARSITE or a complete fire growth simulation model. There is no temporal component in FlamMap. It uses spatial information on topography and fuels to calculate fire behavior characteristics for a single set of environmental conditions.

Question:
What is the potential lateral fire movement if fire spots south outside the wilderness boundary into the Salmon River drainage?

FlamMap Assumptions and Inputs
A three day run was considered for the timeframes input into the FlamMap program. We used a 90 degree temperature with zero % cloud cover and 15mph wind. A total of four runs were made at various points North of the Salmon River. Assuming no action taken to limit fire movement.

1. Ignition point 1 on ridge between Corn Cr. and Wheat Cr. – used NW wind
2. Ignition point 2 on ridge between Cramer Cr. and Long Tom Cr. – used West & NW wind
3. Ignition point 3 mid-slope east of Owl Cr. Hot Springs – used West wind.

Answer / Outputs: (figure 22)

- **Ignition pt. 1** - Within 3 days the major path indicates the fire pushes six miles SE into the Long Tom Campground and could spot across the river.
- **Ignition pt**. **2** – Given a NW wind within 2 days the major path indicates the fire pushes into Colson Cr. and in day 3 indicates it could cross river near Ebenezer Bar area.
- **Ignition pt. 2** – Given a West wind, within 72 hours or 3 days the head of the fire pushes East 8 miles into Owl Cr.
- **Ignition pt**. 3 – With a West wind the fires major path reaches Cove Cr. Bridge area in day 2 and makes a run up Cove Cr. and East Fork of Owl Cr. Once across the river near the confluence of Panther Creek it moves up this drainage.

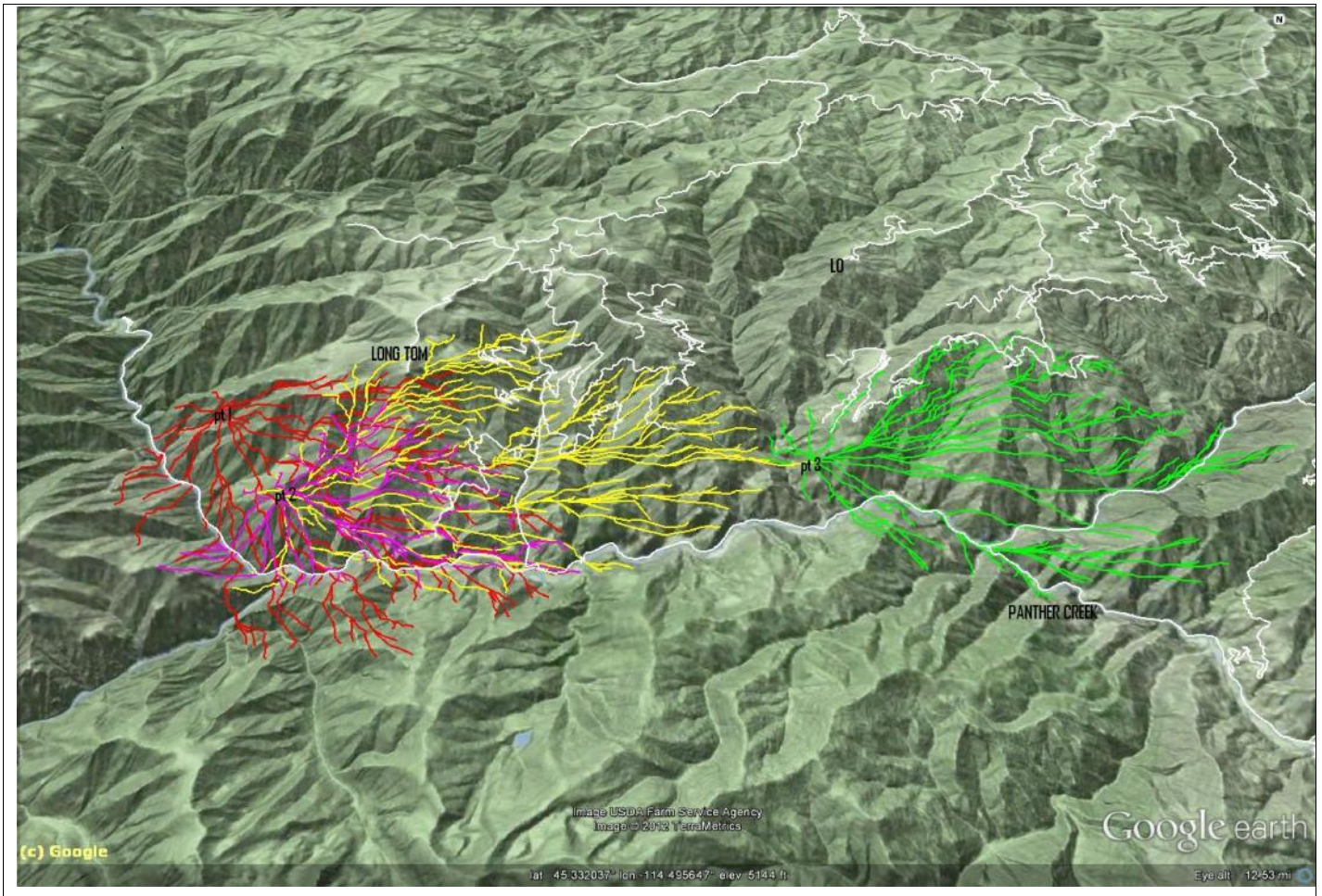


Figure 22. FlamMap Fire Behavior analysis showing major travel path for potential lateral fire growth North of Salmon River on the Salmon-Challis National Forest. August 6-8, 2012 with no suppression line or actions taken. This is the series of the four runs shown together.

Smoke Management

The Frank Church River of No Return Wilderness, where the fires are located, is Class II area while the Selway-Bitterroot Wilderness to the north is a mandatory Class I area. Idaho Department of Environmental Quality (Idaho DEQ) has not designated any smoke sensitive areas but does maintain a near real-time $PM_{2.5}$ monitor in Salmon, ID (data available at http://airquality.deq.idaho.gov/). As of the morning of August 6, the air quality was still rated as Good, but the air quality value was 50, the upper end of Good. Any further decrease in air quality would likely result in a Moderate rating, indicating the air quality may be problematic for some people that are especially sensitive to smoke.

Smoke modeling tools available through WFDSS indicate that transport winds will carry daytime smoke to the east and east-northeast into Montana over the next 5 days, potentially causing some impact to Butte, MT, a PM_{10} non-attainment area. Nighttime smoke will settle into the Salmon River drainage, potentially leading to poor air quality into the early morning hours. Smoke from the Halstead Fire is also impacting the area around the Mustang group of fires and contributing to degraded air quality in Salmon and along the Salmon River. The current estimated air quality index rating for the Salmon River in the vicinity of the fires is Moderate.
The pattern of daytime smoke ventilating into Montana or northward towards the Selway-Bitterroot Wilderness with nighttime smoke settling into the Salmon River canyon is very common in summer. Strong high pressure will reduce the amount of smoke moving out of the area and disperse that smoke over a wider area, and exacerbate air quality problems in the Salmon River canyon. Stronger shortwave pulses and cold fronts will have the opposite effect, scouring out the canyon and increasing the smoke impacts to Montana. Weaker systems may increase the amount of smoke moving into Montana but without noticeably improving air quality in the canyon.

Conclusions and Recommendations:

The Mustang, Cayuse and Broomtail fires are wilderness fires but are near the wilderness boundary. There is a high likelihood that the fires will reach the wilderness boundary and Colson Creek Road before the end of the fire season. We recommend continued implementation of a combination of indirect attack and point protection. The fire season can be expected to last another 60 days in Central Idaho. If the fires establish below the Colson Creek Road to the south, opportunities for direct attack on the fires or spots will be limited due to the extreme nature of the terrain and fuel hazards.

MAP 2, burning off of the Salmon River Road and protecting the infrastructure, residences along the road will be an option for indirect attack and point protection. With this option it will be necessary to actively manage these fires through the end of fire season.

MAP 1, depending on the nature of the fire behavior (especially spotting) occurring when the fire reaches FS Road 123, some suppression actions may be possible near the road. If the fire establishes below the road to the south suppression actions would be very hazardous due to the extreme nature of the topography and fuels.

The probability of the fires reaching Gattin Ranch is largely dependent on movement of the Filly Fire and the length of fire season. To date, water drops on the Filly Fire have been effective in minimizing this fire's spread.

Fire managers and the public will see periods of active fire growth and heavy smoke events in the Salmon River. We recommend sharing these forecasts with the public allowing them to anticipate these days of active fire growth and the smoke events in the canyon.

The fire projections will need to be refreshed after either 14 days or any significant growth events.