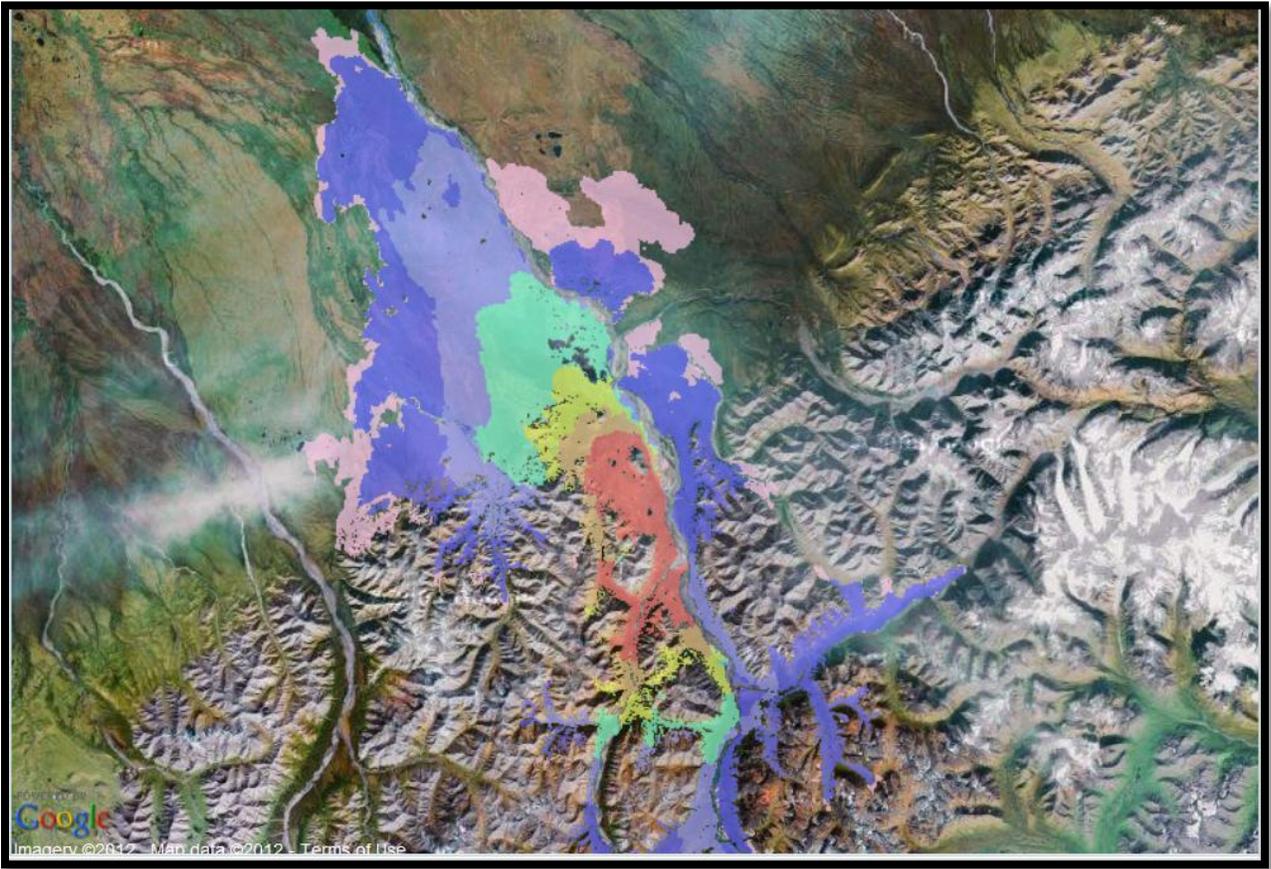


# FSPro Analysis in Alaska

## A User's Guide



Turquoise Lake Fire, 2009

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## A. Introduction

FSPro (Fire Spread Probability) is a fire modeling system that calculates the probability of fire spread from a fire perimeter or ignition point for a specified time period. Combining landscape data layers (crown base height, crown bulk density, etc.), current weather forecasts, historical weather scenarios, fuel moisture classifications, fire history, and wind speed and direction, FSPro can produce fire probability projections for 7 to 10 days and perhaps as far out as 30 days. The model is designed for situations when managers don't have a high level of confidence in weather projections, or for periods when long-term weather projections aren't available. The system starts with current weather forecasts and integrates historical data from a nearby weather station with similar topography to create many different weather scenarios. The fire spread is simulated using each of the potential weather scenarios.

This document is intended to be a user's guide for FSPro analysis in Alaska. It is not intended to be a cookbook of ingredients to be added to FSPro but rather, a starting point for analysis. This summary includes working guidelines and calibration techniques used in Alaska from 2008 through 2011 along with information gathered from the [Help Menu in WFDSS](#), materials from [S-495](#), documents written by analysts for Alaska, and published papers.

New users need to identify their current role in the Wildland Fire Decision Support System (WFDSS). Users with Fire Behavior Specialist or Super Analyst roles are the only users who can run an FSPro Analysis. The Super Analyst role is for users who provide coaching and training to other analysts. Requests for the Fire Behavior Specialist role can be made from the **My Home/User Role** tab in WFDSS. Each agency determines the training and qualifications necessary to have the Fire Behavior Specialist role.

FSPro is a useful model for answering long-term fire spread questions. The model estimates the probability that a fire may impact a point of concern over a specified period of time based on historical weather. Confidence in forecasted weather beyond three days is low. However, FSPro generates hundreds of potential wind and weather scenarios and incorporates this information in hundreds of individual fires simulations. Long-term analyses using FSPro based on probability outcomes lend themselves to dealing with uncertainty in the weather, risk-based assessments, and strategic decision-making.

The underlying fire behavior equations in FSPro include surface fire spread ([Rothermel 1972](#)), crown fire initiation and spread ([Rothermel 1991](#), [Van Wagner 1977](#)), dead fuel moisture (NFDRS algorithms), and spotting ([Albini 1979](#)). Using these equations, the crown fire simulation method used in FSPro is called the surface-fire control method ([Finney 1998](#)). This uses Van Wagner's ([1993](#)) fire modeling system where progress toward active crowning is a function of the surface fire spread rate and canopy bulk density. However, this method requires a more extreme fire environment to sustain active crowning and predicts a lower rate of spread when it does predict active or passive crowning compared to the crown-fire control method ([Scott and Reinhardt, 2001](#)) which is available in both Near- Term (NTFB) and Short-

Term Fire Behavior (STFB) modeling in WFDSS. The same limitations and assumptions associated with these models hold true for FSPPro.

Several terms used throughout this paper are defined below:

- Fire Simulation – FSPPro simulates the fire spread for an individual fire.
- Ensemble – FSPPro simulates fire spread for a fire, the number of simulations is defined by the user input of *Number of Fires* for one landscape.
- Weather Scenario – the combined weather forecast and time series generated weather used for each ensemble built from one or two Remote Automated Weather Stations (RAWS).

In the FSPPro model, there are two major components that drive fire spread probability outcomes. The first is fire growth simulations and the second is generation of artificial weather scenarios.

### **Fire Growth Simulations:**

Daily simulated fire spread is calculated using the minimum travel time algorithm (FlamMap/Minimum Travel Time) ([Finney, 2002](#)). This algorithm simulates fire growth by calculating the time required for fire to travel from the ignition source to nodes or points on a regular lattice covering the landscape. The travel time technique seeks the shortest straight-line travel paths among nodes of the lattice. Fire spread rate and intensity are recorded at each node to allow analysis of fire behavior patterns within the burned area. The fire growth simulation pre-calculates fire behavior for the entire landscape under all combinations of moisture and wind speed and direction. The fire behavior calculations yield spread and intensity values for surface fires, crown fires, and spotting distances from torching trees. Only the fire behavior characteristics essential for fire growth and intensity are stored for each combination of weather and wind. These include the elliptical fire dimensions, direction of maximum spread, maximum fire line intensity, and maximum spotting distance and direction ([Finney, 2011](#)).

### **Generation of Artificial Weather Scenarios:**

The artificial weather scenarios include fuel moistures, wind speed and wind direction. The fuel moisture scenarios are generated to capture the relationship of daily fuel moistures percentage using the Energy Release Component (ERC) index, seasonal trends throughout a given year, and variation among seasons.

This is accomplished through the use of RAWS historic weather data as archived in the Weather Information Management System (WIMS). For each FSPPro ensemble, the actual ERC value at the start of the analysis period is used to generate possible ERC series that reflect the potential trend over the user specified analysis period. The season-end date is defined as the minimum ERC value below which fires will not burn. The daily ERC values generated in the artificial weather scenarios are then translated into a fuel moisture percentages lookup table and can be re-defined by the user in the *ERC Classes* tab to reflect local conditions more adequately. Winds are also generated from a time-series analysis. Wind speed and direction are assumed to be random from day to day and are uncorrelated with fuel moisture. A probability

distribution of historical wind speed and direction is generated based on the user defined RAWS for wind. Daily values are used from the ERC and winds distributions for each artificial weather scenario ([Finney, 2011](#)).

FSPro generates all of the possible weather and wind scenarios by generating FlamMap fire behavior grids from the wind inputs combined with the fuel moisture inputs from each ERC bin for the entire **Landscape Extent**. For each pixel in the landscape, fire behavior characteristics (fire dimensions, maximum spread direction, maximum intensity, and maximum spotting distance and direction) are stored for all fuel moisture and wind speed and direction combinations. Then FSPro takes the daily ERC generated in the artificial weather scenarios and connects it to the “matching” fuel moisture condition in the fire growth simulations. The fire behavior associated with that particular fuel moisture condition is used to run a Minimum Travel Time (MTT) algorithm to determine the probability of fire spread for each pixel. FSPro repeats this process for all the simulations in the fire ensemble as defined by the user in *Number of Fires*. Therefore, if the user has specified 1000 fires for the analysis, FSPro will create 1000 artificial weather scenarios and determine the probability of fire spread given the stored fire behavior characteristics.

### Assumptions and Limitations of FSPro

Some additional assumptions and limitations of FSPro include the following:

- FSPro results assume no suppression action (other than the inclusion of barriers to simulate effective fireline construction).
- Limited fine-scale temporal variability in weather. This means that the weather is constant for the entire day (i.e., 1 ERC value and related fuel moistures, 1 wind speed and wind direction).
- The peak burning period is assumed because the ERC, fuel moisture, and wind are obtained at that time.
- There is no correction of fuel moisture for elevation, aspect, or shading.
- The FSPro model uses 100% for foliar moisture content. This value cannot be edited.
- Winds and fuel moistures are independent.
- No climate change prediction is available (assumes historic climate).
- The extremely rare event may or may not be represented by the simulation.
- FSPro results show probability contours, **not** daily progression perimeters. (The resulting burn probability maps are easily misinterpreted as a fire progression, such as in FARSITE).
- Model output is contingent on model input and modeler expertise. FSPro can only be as accurate as the input data. The following two data sources should be critiqued:
  - *Landscape*: Needs to be up-to-date (often the landscape will need to be edited to provide realistic modeling results). Use of the **Landscape Editor** may be needed ([Stratton, 2009](#)).
  - *RAWS*: One or two can be selected and need to be representative of the analysis area for both ERC and wind values.

Cruz and Alexander (2010) state that the crown fire rate of spread model (Rothermel 1991) used in conjunction with the transition to crown fire model (Van Wagner 1977) as embedded in FlamMap, has shown a significant under prediction bias when used in assessing potential crown fire behavior in conifer forests of western North America. They determined that the principal sources of this under prediction bias include incompatible model linkages, use of surface and crown fire rate of spread models that have an inherent under prediction bias, and reduction in crown fire rate of spread based on the use of unsubstantiated crown fraction burned functions. This should be considered when making Landscape Edits as described in the **Landscape Editor** section.

### **Input Recommendation Summaries**

The following summaries were used to develop initial recommendations for inputs into FSPro for fire modeling in Alaska. Each paper addresses different fire and weather scenarios and modelers using these documents should evaluate the type of conditions their fire is burning under before selecting these input recommendations. Remember that these are initial input recommendations and modelers should use these with caution, taking care to calibrate their model outputs appropriately with actual observations. Also, modelers have different approaches and opinions between modelers may actually contradict one another. The best inputs are the ones that produce the most realistic results. It is also important that different Landscape Data Sources were used across the years and edits or approaches that were appropriate for one Landscape may not be appropriate using a different one.

#### *Average to Below Average Seasons*

*Summaries:*

[Draft WFDSS/FSPro Walk-Through Guide for Alaska, Pat Stephen and Brian Sorbel, July 22, 2008.](#) This paper should be used as input recommendations for an **average, to below average fire season.**

*Season Description:*

The 2008 fire season was characterized by relatively cool, wet weather. Fire activity was extremely minimal with the second lowest acreage burned since 1985. An upper level trough settled over Alaska for much of the summer which kept statewide conditions cool and damp. 2008 was the wettest year in Fairbanks since 1990 with the last freeze date of May 30th, nearly two weeks later than average. Anchorage was cool with June and July 2-3 degrees colder than average. Flooding occurred in the Interior during the last week of July and the first week of August. ([Predictive Services, 2008](#)).

## *Warm, Dry, and Extended Fire Seasons*

### *Summaries:*

[\*Fire Modeling in Alaska during an extended dry fire season, 2009, Thoughts from a Long Term Analyst\*](#), Laurie Kurth, August 11, 2009. This paper should be used to obtain input recommendations for a **late, extended fire season**.

[\*FSPro Calibration on the Zitziana Fire \(Interior Alaska\), Rick Stratton, July 27, 2009\*](#). This paper should be used to obtain input recommendations for **warm, dry conditions in the Interior**.

[\*FSPro Calibration on the Shantatilik Creek Fire \(Kenai Peninsula\), Rick Stratton, July 20, 2009\*](#). This paper should be used to obtain input recommendations for **warm, dry conditions in South Central**.

### *Season Description:*

The 2009 fire season was characterized by one long period of hot, dry weather in July that was conducive to multiple fire ignitions and large fire spread and also warm, dry weather in the Interior through the middle of September. The total acres burned were 2,951,593 from 527 fires with the majority of fire starts in May and July and the majority of the acres burned in July and August. This was the third largest fire season in the last decade as measured by acres burned and the fourth largest fire season on record measured by number of fire ignitions. ([Predictive Services, 2009](#)).

## *Early, Pre-Green Up Fire Seasons*

### *Summaries:*

[\*Conducting FSPro and STFB analyses in Alaska, Rules, Guidelines, Hints and General Information 2010 \(pre-green up and initial greenup conditions\)\*](#), Laurie Kurth, Tami Parkinson, Morgan Pence, Tonja Opperman, John Barborinas, Mary Taber, Mitch Burgard, Rich McCrea, Brian Sorbel, Brenda Wilmore, and Brett Fay, June 12, 2010. This paper should be used to obtain input recommendations for an **early, pre-green up fire season**.

### *Season Description:*

The 2010 fire season was characterized by drought conditions from the previous fall, an early snowmelt, and warm, dry conditions through the end of May. Weather moderated through the remainder of the season with the exception of the Yukon Flats area where it continued to be warm and dry into September. A unique aspect of the 2010 season was the large number of hold-over fires from the previous summer which provided ignition sources for large fire spread earlier in the season than is normal. ([Predictive Services, 2010](#)).

## B. Requesting an FSPro Analysis

Once a fire (Incident) has been created in WFDSS ([2011 Standardization of WFDSS for Alaska](#)), an analysis request can be made. Currently, this can be accomplished in two ways: 1) Fire Behavior Request or 2) Create Analysis.

### **Fire Behavior Request:**

If you would like someone else to complete the analysis, request the analysis from the *Information* tab by clicking the *Fire Behavior Request* on the left hand menu.

### **Desired Date/Time:**

Select a date and time by which you would like the analysis completed.

### **Fire Behavior Needs:**

Select Long Term Behavior (>6 days).

### **Rationale for Request:**

Describe the question you are attempting to answer. Include specific areas of concern (e.g. cabin 4 miles NE of fire perimeter).

### **Contact Information:**

This may be used to contact you when an analysis is complete. It may be beneficial to add the protection FMO or jurisdictional agency personnel. If someone is available to provide observed fire behavior information to the analyst, this is a good place to put that contact information.

Once a request has been placed, a Fire Behavior Specialist or Super Analyst can accept that request. In Alaska, the State Strategic Planner is the focal point for finding Fire Behavior Specialists to complete analysis requests ([2011 Alaska Interagency Protocols for Fire Behavior Requests in WFDSS, draft, 2011](#)).

### **Create Analysis:**

Alternatively, if you intend to complete the analysis yourself, select the fire in the *Incident List* and then click *View Analysis*. From the **Analysis Screen** (Figure 1), select *Create Analysis*. Ensure you have selected the type of fire behavior model you would like to run.

 **Wildland Fire Decision Support System** National Preparedness Level: **1**  
 Incident: FAF-0010 / 2011-AKFAS-000010

**My Home** | **Incidents** | **Analyses** | **Intelligence** | **Data Management** | **Administration**

*There are no analyses that satisfy the filter.*

**Analysis List Filter**

Filters  
 Analyses for FAF-0010 Define Temporary Filter Edit Filter List

**Analysis List**

**New Analysis**

FSPRO  RAVAR  Basic  STFB  NTFB Create Analysis for Incident FAF-0010

[Generate KMZ for Completed Analyses](#) [Set Analysis List Preferences](#)

View Information View Results View Report Set Priority...

 Incident / Analysis Name	Type	Geographic Area	Status	Owner	Analyst	Requested (CST)	Completed (CST)
Page 0 of 0 Rows per Page: 15 <span>Accept</span> <span>Copy...</span> <span>Terminate...</span> <span>Delete...</span>							

View Information View Results View Report Set Priority...

Figure 1: Create Analysis Screen

## C. Running an FSPRO Analysis

### FSPRO Information

Wildland Fire Decision Support System

National Preparedness Level: 3  
Incident: 264 Little Creek / 2011-AKTAD-000264

My Home Incidents **Analyses** Intelligence Data Management Administration

Analysis List  
Results  
♦ **FSPRO Information**  
ERC Classes  
ERC Stream  
Winds  
Analysis Map  
Landscape Editor  
Landscape  
View Landscape  
Shape Upload  
Report  
Notes  
Contact Information  
Analysis Privileges  
RAWS KMZ  
Incident Information  
National ERC-G  
Fire Related Links

### General FSPRO Information

**General FSPRO Input Parameters**

Analysis Name  
Cal1 Default

\*Number of Fires: 256   \*Number of Days: 7   \*Analysis Start: 06/02/2011

**Analysis Shape Files**

\*Ignition File: 06/02/2011

Barriers File:   Fill Barrier  Do NOT Fill

**Run FSPRO Status**

ERC Classes need to be saved  
An ERC Stream needs to be saved  
A wind matrix needs to be saved  
A landscape file needs to be created

Save   Run FSPRO

Figure 2: General FSPRO Information Screen

#### Analysis Name:

The analysis name will be automatically prefaced by the Incident Name. Rename the analysis to differentiate between prior and subsequent model runs for the selected incident. Also, keep in mind that the analysis may be accessed by multiple users so indicate if this is a calibration run or a final analysis. For example, naming your analysis of the 123 Sample Fire as Calibration1 will result in an analysis name that is displayed in the *Analysis List* as 123 Sample/Calibration1. Naming conventions become very important when running multiple analyses on a fire. Database managers prefer you do not use underscores in the names.

#### Number of Fires:

The number of fires used for an ensemble should be based on the purpose of the analysis (a calibration or a final analysis), time requirements for an output, the fire size, and the current fire activity. Using a low number of fires for the final run to develop a probability output will result in lower reliability and may fail to adequately represent rare events. Finney et al (2011) found that when the number of fires increased the variability became more stable and rare

weather events were captured better when the number of simulated fires increased from 256 to 4000.

Remember, there is a balance between processing time and adequate number of fire simulations. What is the purpose of the analysis? If it is a calibration run, set the number of fires low (recommendation is 200-500 fires). If it is a final analysis, set the number of fires high (recommendation is 1000-4000 fires) and look at other methods to reduce processing time if necessary.

If processing time is a concern, for example if there are a large number of analyses already in the National queue, it is suggested that the resolution of the landscape could be increased. This may reduce the accuracy of the analysis (see *Resolution* description in the **Landscape** section). Another solution to managing a long processing time is to run the analysis late in the day when there are typically fewer analyses in the queue or if the analysis is for a large fire, model only the active part of the fire rather than the entire perimeter.

#### **Number of Days:**

This is the number of days fire spread will be modeled for each simulation. This should be driven by the question you are investigating. For example, if your question is "*What is the probability that this fire will impact a specified point of concern in 7 days,*" the number of days should be seven. As you increase the number of days, each fire will have a greater potential to spread across the landscape and the extent of your landscape should be reviewed. Remember, when interpreting results for long time periods (e.g. 30 days), you cannot say whether the fire impacts the point of concern after 1 day or after 30 days; you can only say it will/won't impact in the next 30 days.

#### **Analysis Start:**

The analysis start is the date of the beginning of the simulation period. This field will be auto-filled if another analysis was copied so be sure the correct date is entered. Also, if the fire started in the evening of the date you set the analysis to start, the model will spread the fire for the length of the designated burn period even though actual growth may not have begun until the following day's burning period. Consider, for fires that start late in the day, setting the analysis start date for the following day.

#### **Ignition File:**

A polygon, buffered point, or line can be used as an ignition file. An ignition file can be added by drawing, copying or uploading. There can be only one ignition file for each analysis but it can contain multiple ignitions. Use the **Analysis Map** to draw an ignition file using the polygon tool, line tool, or point tool (Figure 3). Refer to the **Shape Upload** and **Landscape Mask** sections for information on how to upload and copy files. Remember the acreage of the ignition file will be included in your final fire size outcomes in the 80-100% probability.

### Barriers File:

A polygon or buffered line that represents an obstruction to fire spread can be used as a barrier file. A barrier file can be added the same way as an ignition file. Again, only one per analysis but one barrier file can contain multiple barriers that are not necessarily continuous. Also, barriers are impermeable to surface fire spread, but not spotting. The *Fill Barrier* radial button will fill the interior of the barrier shape(s) with unburnable fuels (this is the default). If selected, the *Do Not Fill* radial button will allow burnable fuels within the barrier shape(s). Barrier files may include fuels treatments, firelines, or natural barriers that are not depicted in the landscape data. Typically the *Fill Barrier* button is appropriate for most barriers.

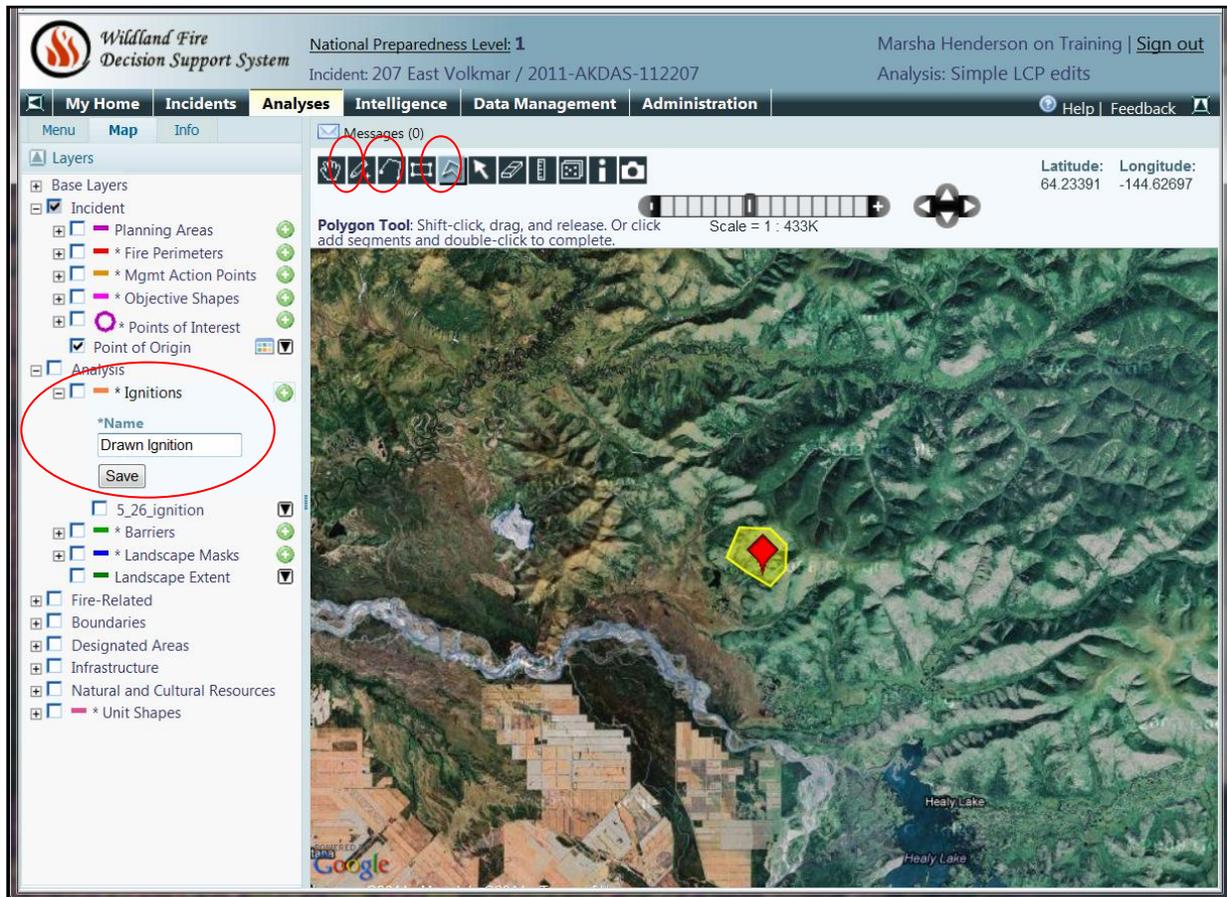


Figure 3: Draw ignition in the Analysis Map screen

## ERC Classes

### Weather Station Selection (ERC)

Data from one Remote Automated Weather Station (RAWS) is used in FSPRO to provide historic weather. The ERC, a number related to the available energy (BTU) per unit area (square foot) within the flaming front at the head of a fire, is used as an index to fuel moisture. Manual or automated stations can be used for calculating the ERC classes as long as the weather is archived into WIMS on a daily basis. The station selection is critical and the closest station is not always the best station. There are multiple ways to evaluate the weather data available in WIMS. The **Weather Analysis Buttons** at the bottom of the **ERC Classes Screen** can be helpful and are covered in detail in the **Weather Analysis Button** section.

Since Alaska uses the Canadian Forest Fire Danger Rating System (CFFDRS) and FSPRO uses the National Fire Danger Rating System (NFDRS), there is concern that the historic ERC's (which are a product of the NFDRS) that FSPRO uses to determine spread are not appropriate in Alaska. Eric Miller ([2009](#)) found that ERC underestimated BUI (Build Up Index) by an average of 23.5 percentile points during the analysis period for the Lake Minchumina RAWS. ERC's tend to reach their maxima earlier in the season than BUI's and decline earlier in the season. Figure 4 shows another example of the ERC percentiles as compared to BUI percentiles as calculated in FireFamily Plus for the Wien Lake RAWS from 1980 through 2010.

There are several potential ways to address the possible discrepancy of the ERC values and the actual drying of fuels in Alaska. The best way to address this concern is to examine the historic ERC trend for the time period of your analysis and compare it to the historic BUI trend. If you believe the current ERC is not capturing the actual burning conditions, evaluate whether to change the ERC bins to accommodate this potential fire spread (discussed in the *Add Row* section below).

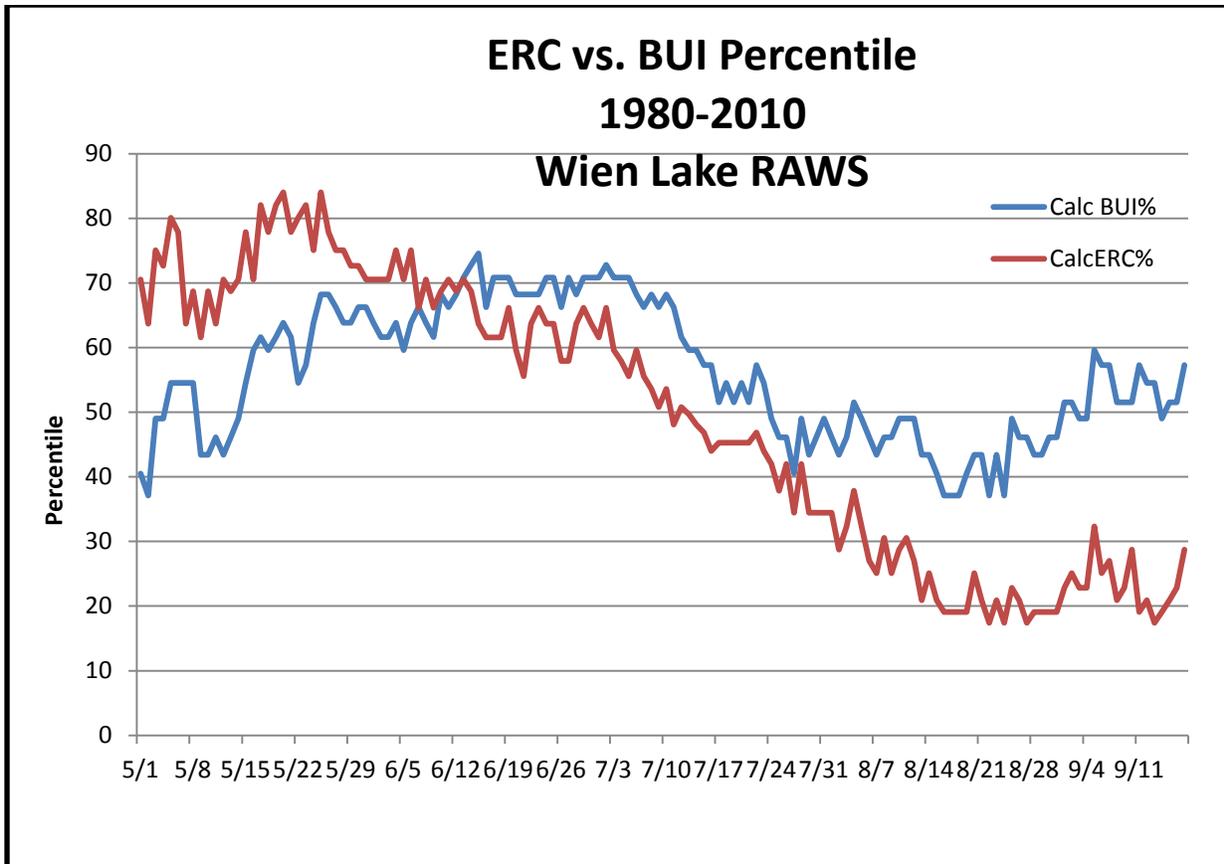


Figure 4: Wien Lake RAWS BUI versus ERC 1980-2010 using data from FireFamily Plus

**Wildland Fire Decision Support System** National Preparedness Level: 1  
 Incident: 288 Gilahina / 2011-AKCRS-114288  
 Marsha Henderson on Production | Sign out  
 Analysis: 6/1/11, 7d TU4-5 = SH5, 99 = TU

My Home Incidents **Analyses** Intelligence Data Management Administration

Analysis List Results FSPRO Information **ERC Classes** ERC Stream Winds Analysis Map Landscape Editor Landscape View Landscape Shape Upload Report Notes Contact Information Analysis Privileges RAWs KMZ Incident Information National ERC-G Fire Related Links

### ERC Classes

**Station Information**

\*Station ID: 500957 - MAY CREEK(27.6 miles) [Fire Danger Rating Graph](#)

\*Green Up Month/Day: 04/24 \*Grass Type: P : Perennial \*Climate Class: 2 : Subhumid \*Slope Class: 2: 26 - 40%

Latitude: 61.34753 Longitude: 142.70576 Elevation: 1,545 feet Aspect: West Avg Precipitation: 12.00 inches Pos on Slope: Valley Bottom / Flat Forecast Zone: 7 Station Type: 4 - NFDRS Satellite

**Date Filter** \*Start Year: 1993 to 2011 and \*Start Month/Day: 01/01 to \*End Month/Day: 12/31

**ERC Correlation Parameters** \*Max Lag: 30 \*Max Degree of Fit: 9

Generate ERC Classes

%ile	Min ERC	Max ERC	1 Hour FM	10 Hour FM	100 Hour FM	Herb FM	Woody FM	Burn Period	Spot Prob	Delay
97	57	67	4.5	5.3	8.1	30.0	50.0	660	0.25	0
90	52	57	5.0	6.3	8.8	35.0	55.0	600	0.20	0
80	47	52	5.3	6.5	9.7	40.0	60.0	540	0.15	0
69	43	47	6.1	7.3	10.8	45.0	65.0	480	0.10	0
59	39	43	6.6	8.0	11.6	50.0	70.0	420	0.05	0

Add Row Delete Row Delete All Rows Recalculate Fuel Moistures

Save Download FWX... View Percentiles... Generate ERC Time Series... Season Ending Graph...

Figure 5: ERC Classes Screen

### Station Information

### ERC Classes

**Station Information**

\*Station ID: 500957 - MAY CREEK(27.6 miles) [Fire Danger Rating Graph](#)

Figure 6: Station Information

### Station ID:

The WIMS identification number and the name of the weather station are displayed in the Station ID field. Select the most appropriate station from the drop down list. Currently, there is no option to “add stations” to this list. The list is generated by including all stations outward from the fire ignition point in a diameter increasing by 1 degree latitude incrementally until 15 stations are found. If the weather data has not been archived into WIMS for the previous three days or if less than ten years of data exists, the station will not be available from the dropdown list. The stations in this list may be different than the dropdown list for the wind station due to the different requirements (described in the **Weather Station Selection (Winds)** section).

### Fire Danger Rating Graph:

For the years selected, this produces a graph of ERC-G (the ERC for NFDRS fuel model G which has been suggested as a reasonably universal fuel model for the U.S.) including the average, maximum, minimum, and current year. This will provide a snapshot of the current ERC as related to the maxima, minima, and average values (Figure 7). However, this is not a good way to evaluate the quality of the data. Refer to the *Download FWX* description in the **Weather Analysis Buttons** section on how to review weather data quality. It would also be valuable to compare the current BUI percentiles with the current ERCs as depicted in the Fire Danger Rating Graph for the year in order to evaluate whether the ERC is providing a reasonable indicator of the condition of the fuels. The BUI values are available in FireFamily Plus (example in Figure 8).

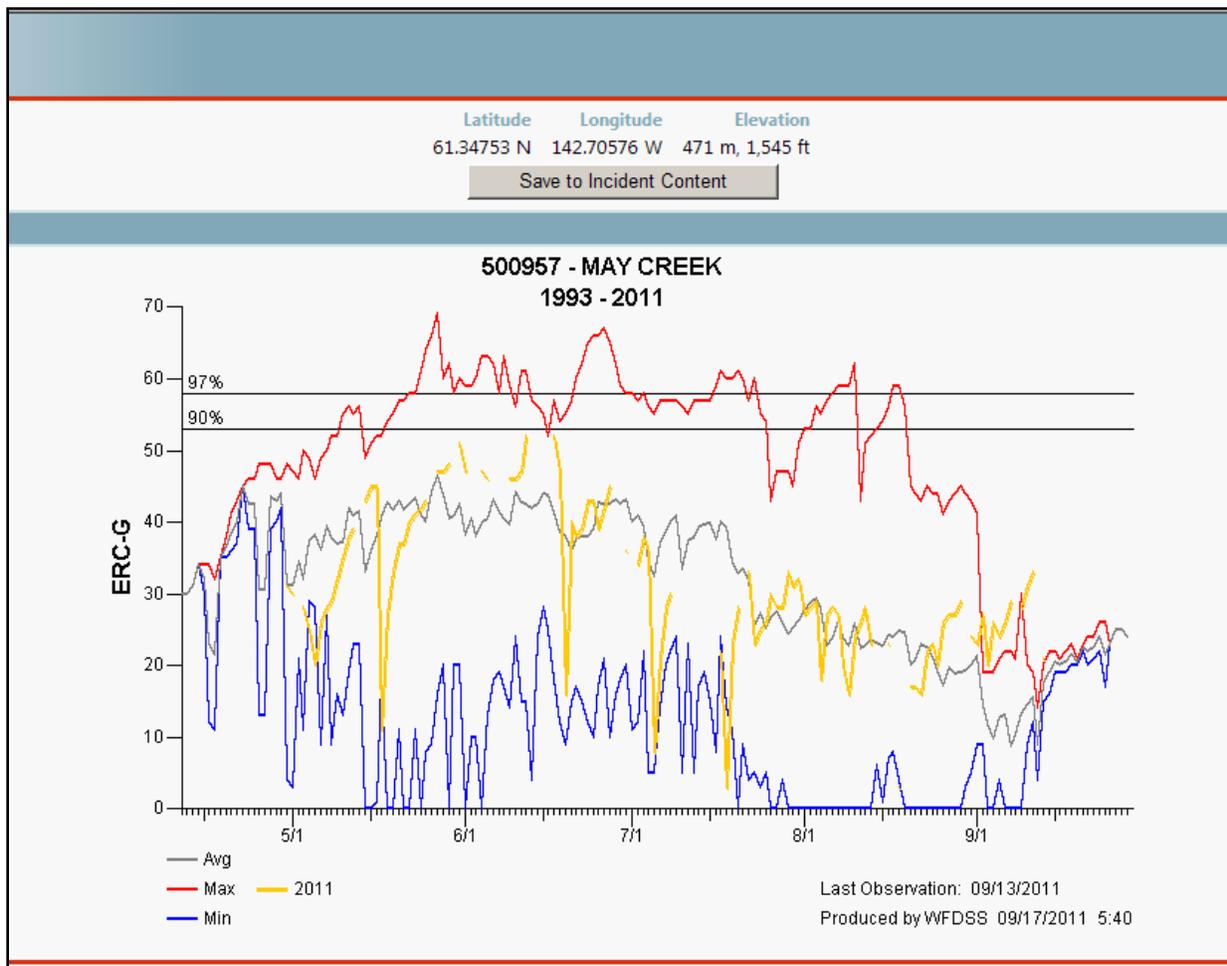


Figure 7: Sample Fire Danger Rating Graph for the May Creek RAWS from FSPRO

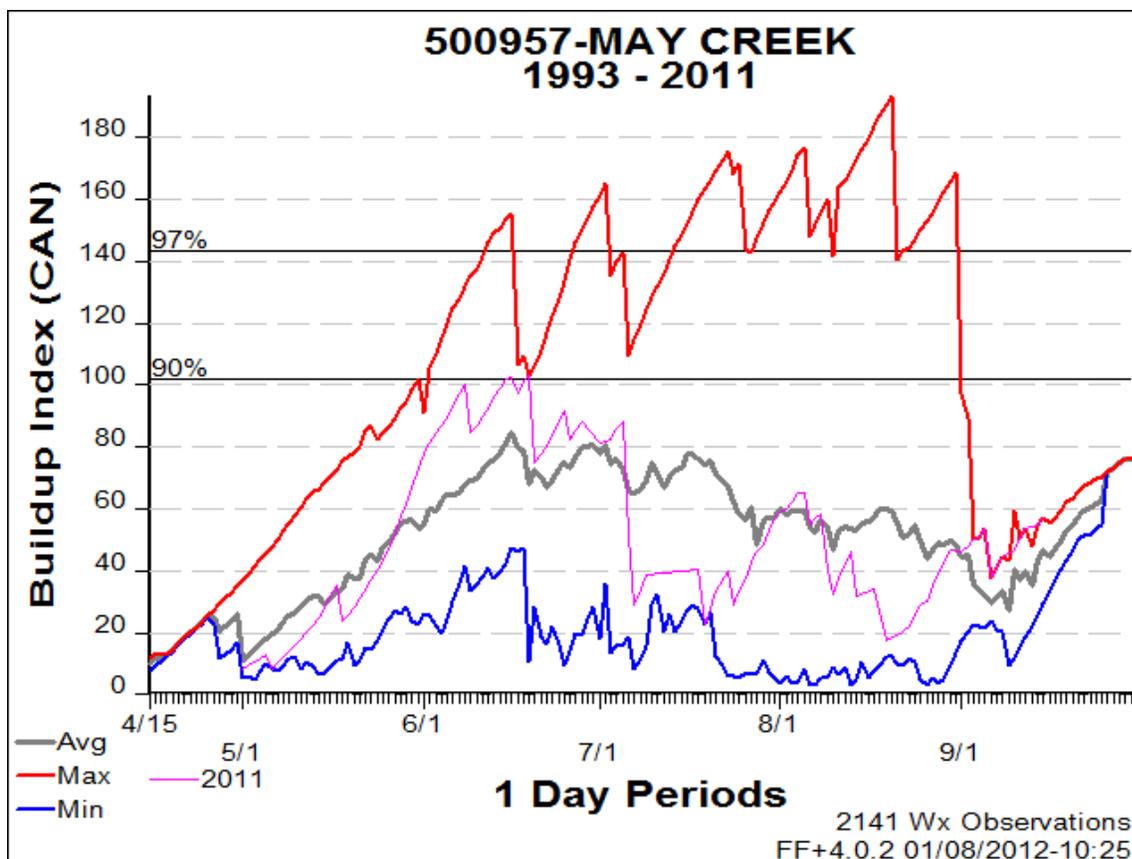


Figure 8: BUI graph for May Creek RAWs 1993-2011 from FireFamily Plus

As part of the station selection process, the fields shown below (Figure 9) are set by the WIMS interface. You can change these fields but they primarily drive the live fuel moisture calculations which you are probably going to change anyway. Making changes to these fields in FSPRO does not change the WIMS data. If you believe the WIMS data should be changed contact the station owner or Predictive Services. Definitions of these fields are provided below. For a better understanding of how these inputs work, read [Chapter 6 of the WIMS User's Guide](#).

*Green Up Month/Day 05/15		*Grass Type P : Perennial		*Climate Class 2 : Subhumid		*Slope Class 1 : 0 - 25%	
Latitude	Longitude	Elevation	Aspect	Avg Precipitation	Pos on Slope	Forecast Zone	Station Type
64.24	145.27	1,520 feet	South	12.00 inches	Valley Bottom / Flat	1	4 - NFDERS Satellite

Figure 9: Station fields determined through WIMS

**Green Up Month/Day:**

This displays the date that the user declared "greenup" for the specific fuel model module.

**Grass Type:**

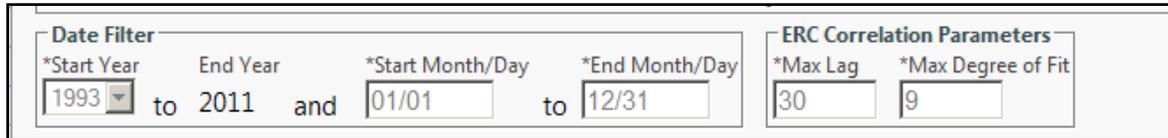
If more than half of the herbaceous plants in the represented area are annuals, designate them as "annuals"; otherwise they are "perennials".

**Climate Class:**

The length of the greenup period.

**Slope Class:**

A one-digit number representing the average slope percent in the area represented by the station.

**Date Filter**


Date Filter				ERC Correlation Parameters	
*Start Year	End Year	*Start Month/Day	*End Month/Day	*Max Lag	*Max Degree of Fit
1993	to 2011	and 01/01	to 12/31	30	9

Figure 10: Date Filter

**Start Year:**

FSPRO will preload the earliest year of data available. This may not be the best year to use. Of particular concern is the data that may be missing, specifically in some of the earlier years. One way to look at the full weather data set is to use the *Download FWX* button on the **ERC Classes** page (Figure 12) and import the file into FireFamily Plus. Ten years of data is acceptable but the more years the better as long as the data gaps are minimal and not systematic (e.g. one month is always missing).

**Start and End Month/Day:**

One concern that should be addressed if using start and end dates closely aligned with the fire season is whether there is missing data, particularly early and late in the season. Again, take a look at the weather data in FireFamily Plus before determining dates. The Analysis Start Date and Simulation Duration period must be within your selected Start and End dates. A general rule of thumb is the Start Month/Day and End Month/Day should encompass all dates for which you have data. The more data the better for generating time series.

**Max lag:**

Max lag determines the maximum number of previous days that influence the ERC on the current day. Daily ERC values are temporally "autocorrelated" with values from previous days (meaning they depend statistically on values from earlier observations) because the moisture content of dead fuels changes more slowly than changes in weather conditions. In other words, today's value is statistically correlated with yesterday's value as well as the day before, etc., but it is less correlated with values further away from the current day. The rates that fuel moistures change in response to changes in weather conditions is called a "timelag" and is longer in larger diameter dead woody fuels and deeper duff layers. The default value of 30 is a reasonable value in many fuel types, especially where larger woody fuels and duff layers contribute to fire behavior. If you do not want the correlation to go back 30 days from the start date of the analysis, you can change the number of Max lag days. The recommendation is to leave this at the default value unless you are modeling an early season fire where the RAWS

does not have complete data. You may then want to decrease the lag so the ERC is not correlating with zeros.

**Max Degree of Fit:**

This determines the detail required to achieve an adequate statistical curve-fit of the seasonal trends in ERC. ERC trends throughout a calendar year typically show one or more major peaks and troughs corresponding to dry and wet periods. A larger value in this field allow a curve-fitting procedure to better represent peaks and troughs that occur on increasingly shorter time periods. An adequate range of Max Degree of Fit is 8 to 11, the WFDSS default is 9. The recommendation is to leave this at the default value.

**Generate ERC Classes**

%ile	Min ERC	Max ERC	1 Hour FM	10 Hour FM	100 Hour FM	Herb FM	Woody FM	Burn Period	Spot Prob	Delay
97	63	70	4.5	5.8	6.3	30.0	50.0	660	0.25	0
89	56	63	5.3	6.6	7.4	35.0	55.0	600	0.20	0
79	49	56	5.8	6.7	8.8	40.0	60.0	540	0.15	0
68	42	49	6.7	7.3	10.1	45.0	65.0	480	0.10	0
59	38	42	7.4	8.3	11.4	50.0	70.0	420	0.05	0

Figure 11: Generate ERC Classes Screen

Once the Generate ERC Classes button is selected, the system will populate five ERC bins built from the RAWs selected. These bins are editable as described below. FSPRO automatically sets the lowest ERC percentile class to 59. There is no fire spread on days that the ERC value is less than the lowest percentile class listed. It is important to understand what the ERC bins are doing and how they affect the analysis. The ERC bin is selected by the forecasted ERC if a forecast is used (see **ERC Stream** section) or by generating an artificial weather scenario. The actual ERC value is fairly meaningless except that it defines which bin to use for each day of the simulation and therefore models fire spread using specific fuel moistures, length of burn period, and spotting probability. Therefore, it is critical that the values for fuel moisture, burn period, and spotting probability are reasonable for the fire activity expected at the different percentile levels. Also, remember that FSPRO has no spatial or temporal adjustment of dead fuel moistures and all the fuel moistures are the same for all the fuel models present and remain constant for each day of any simulation period.

**Percentile:**

A percentile is the value below which a certain percent of observations fall. Therefore the 97th percentile is the bin below which 97% of the historic ERCs fall.

**Min ERC:**

The lower end of the bracket for ERC.

**Max ERC:**

The upper end of the bracket for ERC.

**1 Hour FM:**

The one hour time-lag fuel moisture. The calculations for creating the dead fuel moistures are considered valid and changes to these values should be done only due to specific knowledge, i.e. direct measurements from the field.

**10 Hour FM:**

The 10 hour time-lag fuel moisture. Changes would only be recommended due to direct measurements from the field.

**100 Hour FM:**

The 100 hour time-lag fuel moisture. This may also be a rough estimate of the average moisture content of the forest floor from 3/4 inch to 4 inches below the surface which would be related to DMC. Changes would only be recommended due to direct measurements from the field.

**Herb FM and Woody FM:**

Live fuel moisture content is calculated using information from the weather station selected based on the standard NFDRS algorithms as used in WIMS and FireFamily Plus. The live fuel moisture calculations are the weakest model in the NFDRS system and these values ***should usually be changed***. There are several ways to determine the actual live moistures:

1. Field sampled data (currently little data available).
2. The Wildland Fire Assessment System (WFAS) greenness maps (not specifically examined for validity in Alaska).
3. Curing as described in Table 1([Scott and Burgan, 2005](#)) or the Compare Models spreadsheet developed by Scott.
4. Rough estimates based on plant phenology ([410-1 Fireline Handbook Appendix B](#)).
5. Using BehavePlus to evaluate how rate of spread changes with live herbaceous moisture particularly for the dynamic fuel models.

Seventeen of the 40 Scott and Burgan fuel models are dynamic. Whenever dynamic fuel models exist in the landscape, some portion of their live herbaceous fuel load will be transferred to the 1 hour dead category when the live herbaceous fuel moisture is less than 120%. Because of this, the corresponding fire behavior can be significantly affected by the load shift between live and dead fuels. In some cases, very small changes in the live fuel moisture content elicit large changes in predicted fire behavior. The grass fuel models showed the highest sensitivity to live fuel moisture changes because they have the most live herbaceous fuel loads. The distribution of fuel loading as determined by live fuel moisture determines the live fuel moisture of extinction and the effective wind speed limit. As live fuel moisture decreases below the live fuel

moisture of extinction, an abrupt change in the predicted fire behavior may occur because both the live and dead fuels are adding to the combustion process resulting in an increase in reaction intensity, eliminating the need for the wind limit which results in an increase of the effective wind speed ([Jolly, 2007](#)). In a dynamic fuel model, live herbaceous load is transferred to dead load as a function of the live herbaceous moisture content. The dynamic fuel model process is described by Burgan ([1979](#)) with summarized methods outlined below:

- If live herbaceous moisture content is 120% or higher, the herbaceous fuels are green and all herbaceous load stays in the live category at the given moisture content.
- If live herbaceous moisture content is 30% or lower, the herbaceous fuels are considered fully cured, and all herbaceous load is transferred to dead herbaceous.
- If live herbaceous moisture content is between 30 and 120%, then part of the herbaceous load is transferred to dead. For example, if live herbaceous fuel moisture content is 75% (halfway between 30 and 120%), then half of the herbaceous is transferred to dead herbaceous, the remainder stay in the live herbaceous class.

If an analysis is copied and the new analysis is later in the season, pay particular attention to whether the live fuel moistures should be changed as it is later in the season.

**Table 1: Live herbaceous moisture content estimated by level of curing ([Scott and Burgan, 2005](#))**

	<b>Level of Curing</b>	<b>Live herbaceous moisture content</b>
<b>Uncured</b>	0%	120% or more
<b>One-quarter</b>	25%	98%
<b>One-third</b>	33%	90%
<b>One-half</b>	50%	75%
<b>Two-thirds</b>	66%	60%
<b>Three-quarters</b>	75%	53%
<b>Fully cured</b>	100%	30% or less

**Burn Period:**

Burn Period is the number of minutes per day that the fire is actively spreading. Although we typically define our burn period in Alaska as the number of daylight hours, limit this to the active burning period.

**Spot Probability:**

The spotting probability determines the percentage of embers that are ignited if they land on receptive fuels (M. Burgard, pers comm.). Each of these embers will be used as new point ignitions in the simulation. Large numbers here can dramatically slow processing time. Spotting only occurs when passive or active crown fire is modeled. The Crown Fraction Burned (CFB) and Canopy Cover are used to determine the number of torching trees. More embers will be lofted at finer landscape resolutions. Maximum ember distance and azimuth are calculated using canopy cover, crown fraction burned, elevation, and all available wind information. User-set spotting probability determines which predicted crown fire cells (and associated nodes) will loft an ember. Those nodes generate a single ember with random distance from zero to the

maximum for that node. Embers landing on unburnable or already burned substrate do not ignite. Embers landing on burnable substrate always ignite ([Finney, 2002](#)).

The spotting model in FSPro is different than in Farsite/Near-Term Fire Behavior (NTFB) and you will probably want to set spotting probability higher in FSPro than for Farsite/Near-Term Fire Behavior (NTFB) tools. The Short-Term Fire Behavior (STFB) model in WFDSS uses the same spotting methods as FSPro ([Opperman, 2010](#)). Foliar moisture content cannot be altered and is defaulted to 100%.

**Delay:**

The amount of time (in minutes) that passes between a spot landing and fire spread occurring. The default is zero and the recommendation would be to use this default.

**Add Row:**

In order to allow fire spread when ERC's are lower than the lowest ERC bin generated additional rows can be added. This allows you to populate fuel moisture conditions, burn period length, and spotting probability for times of the year when ERC's are historically low but fire continues to spread. This may be a way to deal with the ERC down trend in the latter part of the fire season when BUI's are continuing to trend up.

**Delete Row:**

In order to eliminate fire spread at lower ERC's, rows can be deleted. Remember, FSPro will not model fire spread for ERC's below the lowest bin.

**Delete All Rows:**

If you want to start with your own percentiles, delete all rows and then add one row at a time to build custom ERC bins.

**Recalculate Fuel Moistures:**

If a row is added, fuel moistures can be calculated using this button. Those fields can then be edited as needed.

**Weather Analysis Buttons**

%ile	Min ERC	Max ERC	1 Hour FM	10 Hour FM	100 Hour FM	Herb FM	Woody FM	Burn Period	Spot Prob	Delay
97	57	67	4.5	5.3	8.1	30.0	50.0	660	0.25	0
90	52	57	5.0	6.3	8.8	35.0	55.0	600	0.20	0
80	47	52	5.3	6.5	9.7	40.0	60.0	540	0.15	0
69	43	47	6.1	7.3	10.8	45.0	65.0	480	0.10	0
59	39	43	6.6	8.0	11.6	50.0	70.0	420	0.05	0

Buttons: Add Row, Delete Row, Delete All Rows, Recalculate Fuel Moistures

Buttons: Save, Download FWX..., View Percentiles..., Generate ERC Time Series..., Season Ending Graph...

Figure 12: Weather analysis buttons on the ERC Classes Screen

**Download FWX:**

The FWX file is the raw data file (NFDRS 1972 Format) for the RAWS station selected. This data includes only the 1300 hour weather observations. This data can be saved to your hard drive and then examined in FireFamily Plus. This is a simple way to download the years of weather data for the selected station including the current year.

**View Percentiles:**

This displays a table of the ERC percentiles for the selected station for identified years and start/stop dates (Figure 13). This provides the list of 1 hour, 10 hour, 100 hour, 1000 hour, herbaceous, and woody fuel moistures calculated for each percentile. Percentile ranking is based on the historic ERCs for the dates during the years selected in the Date Filter. Repeated ERC values indicate that this ERC occurred more than 1 percent of the days. Fuel moistures are the average fuel moisture for days with the corresponding ERC.

ERC Percentiles							
Station ID: 500743 From: 2000 to 2011 and 1/1 to 12/31							
%	ERC	1 Hour	10 Hour	100 Hour	1000 Hour	Herb	Woody
100	70.0	4.14	4.53	6.10	10.24	58.59	78.19
99	66.0	4.71	6.80	6.19	10.39	61.27	80.17
98	64.0	4.32	5.37	6.45	11.18	57.06	80.73
97	63.0	4.54	6.74	6.64	11.09	58.46	82.87
96	62.0	5.35	6.13	7.28	11.05	66.79	81.66
95	60.0	5.71	7.56	7.01	11.26	61.22	82.47
94	60.0	5.71	7.56	7.01	11.26	61.22	82.47
93	58.0	4.95	5.86	7.44	11.88	75.90	89.46
92	58.0	4.95	5.86	7.44	11.88	75.90	89.46
91	57.0	5.01	6.33	7.55	12.48	54.17	83.57
90	56.0	6.69	7.76	8.01	11.85	58.83	90.15
89	56.0	6.69	7.76	8.01	11.85	58.83	90.15
88	55.0	4.92	6.07	8.12	12.83	65.26	91.47
87	54.0	5.75	6.96	8.86	12.59	50.53	86.77
86	53.0	6.43	7.17	9.00	12.36	79.98	93.86
85	53.0	6.43	7.17	9.00	12.36	79.98	93.86
84	52.0	4.86	5.99	8.55	13.78	53.43	87.37
83	51.0	6.62	7.33	8.97	13.28	55.23	83.22
82	50.0	6.21	7.03	9.23	13.56	58.67	95.56
81	50.0	6.21	7.03	9.23	13.56	58.67	95.56
80	49.0	6.43	6.90	9.22	13.90	50.03	88.05
79	49.0	6.43	6.90	9.22	13.90	50.03	88.05
78	47.0	7.17	7.34	9.77	13.93	60.44	93.40
77	47.0	7.17	7.34	9.77	13.93	60.44	93.40
76	46.0	6.29	6.70	9.60	14.95	47.44	96.21

Figure 13: View Percentiles Example

**Generate ERC Time Series:**

FSPRO uses a statistically generated ERC time series for each simulation, based on the historic ERCs for the chosen weather station. This graph displays the mean, maximum, and minimum generated ERCs, as well as the current year's observed ERCs to date and the historic mean ERC (Figure 14). This graph is different from the Fire Danger Rating graph which does not show data from the time series analysis. When using forecasted weather, the time series uses the forecast ERC and wind speed for each of the specified number of days. Days following the forecast period (or, if a forecast is not used, then instead of the forecast period) vary for each randomly generated simulation, but they are based on the range and frequency of historic observations. The variation in ERC generated through the time series, in combination with the variation in winds, makes FSPRO a probabilistic model. Each time you click ERC Time Series Graph, you

generate a new graph based on a new collection of time series. When you compare graphs, you see variation in the red and blue lines, because they represent a single point, however, the average line should remain relatively stable. This demonstrates that there is variation in the individual time series, but the average is consistent. The time series graph for the actual analysis is not available (for analyses in review or completed status).

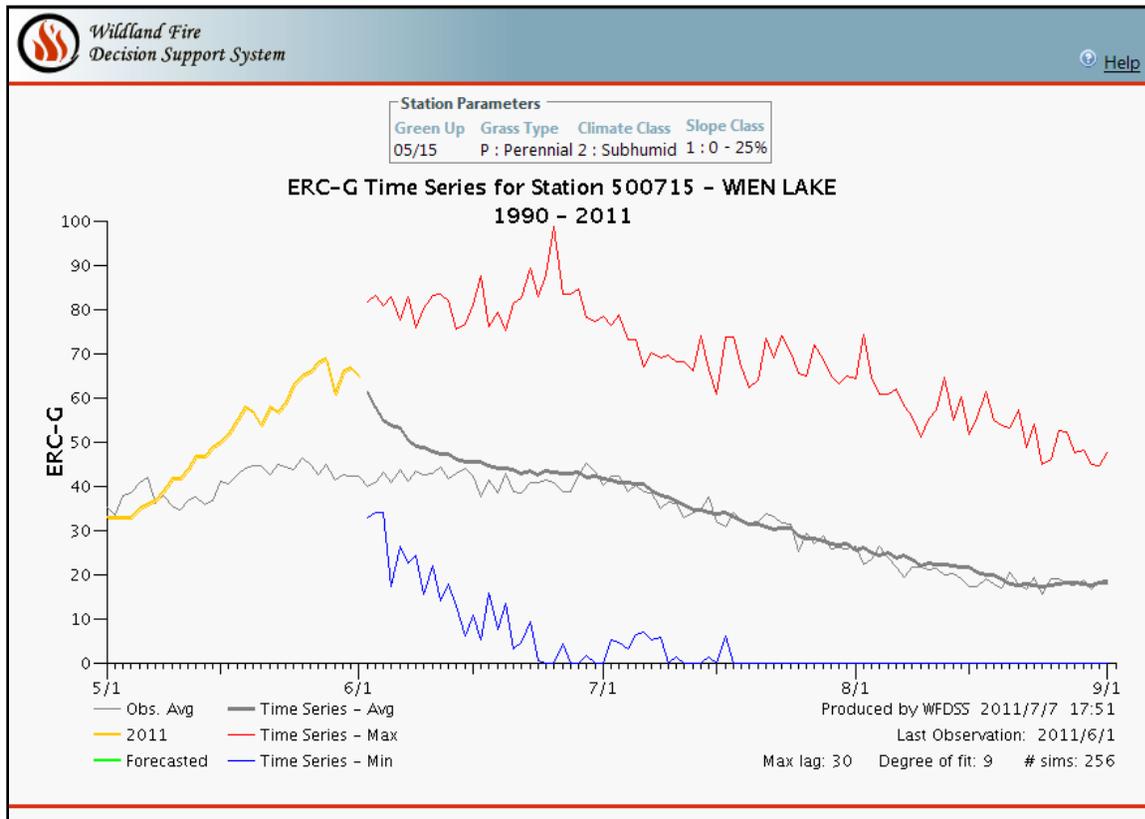


Figure 14: Time Series for Wien Lake RAWs - Start/End Dates May 1 to Sept.1 from FSPPro

### Season Ending Graph:

This graph shows the percent season ending event as defined by the ERC using the time series for the selected station and identified years (Figure 15). It uses the next lowest ERC below your lowest ERC bin as the season-ending ERC. For example, if the lowest ERC bin uses a minimum of 45, the season ending graph will calculate the percent chance of reaching an ERC of 44 by date. The maximum, minimum, and average time series generated ERC's are overlaid on this graph. This demonstrates why it is critical to select data years for the weather station that has good data through the end of your analysis period. An Alaskan workgroup drafted a document that suggests using a combination of precipitation amounts, precipitation duration, and mean relative humidity to determine season-ending and fire-slowing events ([Fire Ending Event Workshop, draft, 2008](#)). These recommendations have not been extensively tested but you may want to refer to this document and compare the FSPPro generated season-ending event with the parameters defined in this paper.



Station Parameters

Green Up 05/15 Grass Type P: Perennial 2: Subhumid Climate Class 1: 0 - 25% Slope Class

Season Ending Graph for Station 500715 - WIEN LAKE  
1980 - 2011

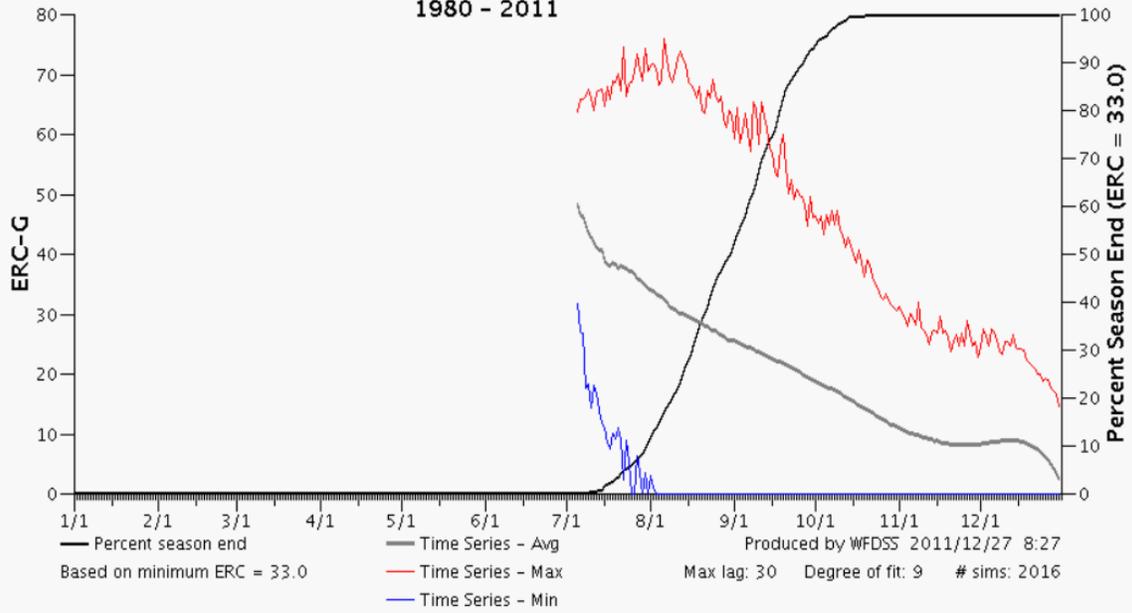


Figure 15: Season Ending Graph for Wien Lake RAWs

## ERC Bin Recommendations for Alaska

Below are a few suggested starting points for populating the ERC bins. It is recommended that you let FSPRO calculate the dead fuel moistures.

### **Average to below average fire season:**

([P. Stephens, B. Sorbel, 2008](#)). The live fuel moisture values shown below ([Table 2](#)) are based on the idea that Alaskan brush species have volatile chemicals that can cause them to burn actively, even when the calculated live fuel moistures are not very low. The burn period values are for the longer potential burning period of the Alaska fire season. The spotting probability was determined after calibrating several fires from the 2008 fire season. These moisture values should be used as a starting point for an **average to below average fire season**.

Table 2: Recommended ERC bins for an average to below average fire season

%ile	Herb FM	Woody FM	Burn Period	Spot Prob
97	30	50	600	0.2
90	60	55	600	0.2
79	90	70	480	0.15
69	110	100	360	0.1
60	115	110	240	0.02
50	120	120	120	0.02

### **Warm, dry, and extended fire season:**

([Kurth, 2009](#)). With a **warm, dry, and extended season** into July and August, the recommendation was to offset the downward trend of the time-series generated ERC's by using lower live fuel moistures, longer burn periods, and higher spotting probability than the default ([Table 3](#)). Additional ERC bins could also be added to allow fire spread at lower ERC levels. This paper suggests that live fuel moistures would be considered cured this late in a dry season and would not fluctuate much even at lower ERC levels.

Table 3: Recommended ERC bins for a warm, dry, extended season

%ile	Herb FM	Woody FM	Burn Period	Spot Prob
97	30	50	720	0.3
90	32	55	720	0.3
79	34	60	600	0.25
69	36	65	600	0.25
60	38	70	540	0.20
50	40	75	540	0.20

**Pre-green up conditions:**

([Kurth et al, 2010](#)). This summary is a compilation of ideas from several analysts who used FSPRO during the 2010 fire season. This fire season was characterized by an early spring season with numerous holdover fires and dry conditions resulting in large fire growth in May and June. The live fuel moistures recommended here are for **pre-green up conditions**. Both [Table 4](#) and [Table 5](#) were used by analysts during this season. [Table 5](#) uses slightly higher live fuel moistures but longer burn periods and slightly higher spotting probability in the lower bins. These tables demonstrate two ways to accomplish similar outputs.

[Table 4: Recommended ERC bins for an early, pre-green up season](#)

<b>%ile</b>	<b>Herb FM</b>	<b>Woody FM</b>	<b>Burn Period</b>	<b>Spot Prob</b>
97	65	85	600	0.25
90	75	92	540	0.2
79	78	96	480	0.15
69	79	99	420	0.10
60	81	101	360	0.05
50	85	112	300	0.01

[Table 5: Alternative ERC bins for early, pre-green up season](#)

<b>%ile</b>	<b>Herb FM</b>	<b>Woody FM</b>	<b>Burn Period</b>	<b>Spot Prob</b>
97	70	74	660	0.25
90	77	85	600	0.2
79	78	94	540	0.15
69	83	99	480	0.10
60	85	102	420	0.05

**June fire in Southcentral:**

The ERC bins used in the calibration of the Zitziana Fire ([Stratton, 2009](#)) increased the burn periods and spotting was increased even in the lower bins and an additional bin was added to allow fire spread even during ERC dips ([Table 6](#)). The spotting was increased to simulate the group torching of black spruce. These moisture values could be used as a starting point for a **June fire in Southcentral**.

[Table 6: Recommended ERC bins for a June SouthCentral Fire](#)

<b>%ile</b>	<b>Herb FM</b>	<b>Woody FM</b>	<b>Burn Period</b>	<b>Spot Prob</b>
97	40	80	600	0.30
90	50	90	540	0.30
79	90	100	480	0.25
69	100	110	360	0.20
60	110	120	240	0.20
50	130	130	180	0.15

In general, recommendations from modeling experts have been to decrease both the herb and woody live fuel moistures, greatly increase the burn periods (particularly in the higher bins), and increase the spotting probability.

## ERC Stream

**Wildland Fire Decision Support System** National Preparedness Level: 1  
 Incident: 288 Gilahina / 2011-AKCRS-114288  
 Marsha Henderson on Production | Sign out  
 Analysis: 6/1/11, 7d TU4-5 = SH5, 99 = TU1

My Home Incidents **Analyses** Intelligence Data Management Administration

Analysis List Results FSPRO Information ERC Classes **ERC Stream** Winds Analysis Map Landscape Editor Landscape View Landscape Shape Upload Report Notes Contact Information Analysis Privileges RAWS KMZ Incident Information National ERC-G Fire Related Links

### ERC Stream

Date	Avg ERC	Std Dev	Current ERC
05/31/2011	39.93	10.92	51
06/01/2011	41.44	11.44	-1
06/02/2011	37.50	15.75	-1
06/03/2011	39.81	13.00	-1
06/04/2011	37.64	13.14	-1
06/05/2011	39.60	14.86	-1
06/06/2011	40.13	13.13	-1
06/07/2011	42.82	9.84	-1
06/08/2011	41.18	10.62	-1
06/09/2011	40.13	12.71	-1
06/10/2011	39.53	13.63	-1
06/11/2011	43.88	8.75	-1
06/12/2011	42.59	12.82	-1
06/13/2011	42.00	11.62	-1
06/14/2011	41.73	12.78	-1
06/15/2011	42.53	9.34	-1
06/16/2011	43.87	6.99	-1
06/17/2011	43.56	7.81	-1
06/18/2011	41.24	11.44	-1

### Weather Forecast

In order for Weather Forecast entries to be valid, the first forecast date must be the same as the analysis start date.  
 \*Analysis Start Date: 06/01/2011

Date	ERC	Speed	Direction
06/01/2011	50	10	45
06/02/2011	48	5	320

Add Row Delete Row Delete All

### National Digital Forecast Database

Get NDFD Forecasts Days: 3

Save Stream and Forecasts

Figure 16: ERC Stream Screen

## ERC Stream

The ERC Stream is listed for the time period that was specified in the *ERC Classes'* date filter. The average ERC is listed for each day, as well as the standard deviation (a measure of dispersion or how widely spread the values are from the mean) and the current ERC. The value in the current ERC column will show a -1 when there is no ERC value from the RAWs.

The ERC stream should list ERC average values up to the simulation start day and then -1 values should be shown thereafter. If no weather forecast is input, FSPRO will use weather and winds from the WFDSS-generated time series that utilized historic weather (see the **Generate Times Series Graph** section). If you are working on a fire that has already occurred, the ERC stream will show actual known ERC values. However, FSPRO will not use them but will instead develop the artificial weather as if the fire were happening now (unless a forecast is used).

## Weather Forecast

Using a weather forecast is optional. When forecast confidence is high, using forecasts is reasonable, but a general rule of thumb is to use no more than 33% of the analysis period as a forecast ([Wildland Fire Management RD&A, 2011](#)). It is important to remember how the forecast works in FSPRO. When a forecast is used, it "locks" the ERC bin and wind bin and will be used for each of the designated days for every fire simulated in the FSPRO analysis. In other words, if you are doing a 7 day run with 1000 fires and day 1 uses a forecast, FSPRO will use that forecast ERC for the first day of all 1000 runs. Therefore, the forecast should be used only when there is a high degree of confidence in the forecast.

Determining the forecast ERC can be accomplished in several ways:

- Use the National Digital Forecast Database (NDFD) (see below).
- Talk with Predictive Services for a recommendation.
- Examine the previous days' ERC and depending on precipitation amounts in the previous 24 hours, adjust the ERC up or down accordingly.

The National Digital Forecast Database is currently unavailable in Alaska. The expectation is for it to be available as point source data by the beginning of the 2012 fire season.

# Winds

## Weather Station Selection (Winds)

Remote Automated Weather Stations (RAWS) are used in FSPro to provide historic winds. Only automated stations can be used for calculating winds as long as the weather is archived into WIMS on a daily basis. Station selection is critical and the closest station is not always the best station. Unlike the ERC weather station, ten years of wind data is not required. Therefore, it is important to evaluate your selection as to whether there is an adequate number of years of data. This does **not** have to be the same station used for ERC. The most important considerations for selecting a weather station that generates a wind matrix are 1) do the wind direction and speed reflect realistic conditions for your fire; 2) does the time filter encompass enough data to represent realistic wind conditions for your fire; and 3) does the topographic station location sample winds that are realistic for your fire.

After a weather station is selected, click on the *Generate Wind Matrix* button (Figure 17). The values in the wind distribution matrix are grouped into categories by wind speed and cardinal directions. This format can be thought of as a tabular wind rose. Remember, FSPro does not use gridded winds so topography will not be used to modify wind speed or direction across the landscape.

**Wildland Fire Decision Support System** National Preparedness Level: 1  
 Incident: 288 Gilahina / 2011-AKCRS-114288 Marsha Henderson on  
 Analysis: 6/1/11, 7d TU

My Home Incidents **Analyses** Intelligence Data Management Administration

**FSPro Winds**

**Station Information**  
 \*Station ID: 500957 - MAY CREEK(27.6 miles)  
 Latitude: 61.347534 Longitude: 142.705759 Elevation: 1,545 feet Aspect: West Pos on Slope: Valley Bottom / Flat Forecast Zone: 7 Station Type: 4 - NFDPS Satellite

**Time Filter**  
 \*Start Year: 2000 to \*End Year: 2011 and \*Start Month/Day: 05/17 to \*End Month/Day: 06/20 and \*Start Hour: 12 to \*End Hour: 20

**Weighted Winds**  
 \*Calm Weight: 4.55 \*Calm Threshold: 1 \*Winds Type: Both Total Weight: 102.12 **Generate Wind Matrix**

Speed	45	90	135	180	225	270	315	360
5	2.59	2.62	2.24	3.13	8.18	11.74	6.67	3.52
10	3.29	1.42	1.36	2.08	7.24	12.16	5.73	3.95
15	1.27	0.33	0.43	1.29	3.71	5.91	2.06	1.24
20	0.85	0.09	0.13	0.20	0.38	0.23	0.13	0.42
25	0.35	0.03	0.00	0.01	0.00	0.01	0.00	0.28
30	0.16	0.01	0.00	0.01	0.00	0.00	0.00	0.03
35	0.06	0.00	0.00	0.00	0.00	0.01	0.00	0.01
40	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Add Row Delete Row Delete All Rows Wind Rose... Download Winds...  
 Recalculate Winds Distribution

Figure 17: FSPro Winds Screen

## Station Information

### Station ID:

Select the most appropriate station from the drop down list. Currently, there is no option to “add stations” to this list. The list is generated by including all stations outward from the fire ignition point in a diameter increasing by 1 degree latitude incrementally until 15 stations are found. In order for a station to be considered for the list, it must be a cataloged NFDRS weather station, be active and collecting data in WIMS, and have hourly wind information for both the ten-minute average winds and gusts. In all cases, wind speeds of 90 mph are filtered out and not used when developing the winds distribution tables and wind roses.

See the **ERC Station Information** section for a description of the other fields associated with the Station ID.

### Start/End Year:

The more years of data the better; however it is important to ensure the years used are not missing data. Review of the actual wind data for an individual station must be determined outside of WFDSS. Using FireFamily Plus to review the dates and years of data collection is recommended (See *Download Winds* explanation in the **Wind Analysis Buttons** section).

### Start/End Month/Day:

A recommended window is six to eight weeks around the analysis. Make sure the *End Month/Day* is beyond the *Number of Days* for your analysis ([Kurth et al., 2010](#)). These dates are important to capture the historic winds that may affect your fire. In Figure 18 below, the annual filter is changed from May-August to January-December. Notice that the predominate wind direction using the entire year of data is very different from the fire season winds. It is important to narrow the dates to capture only the historic wind speeds and directions that will likely influence your fire.

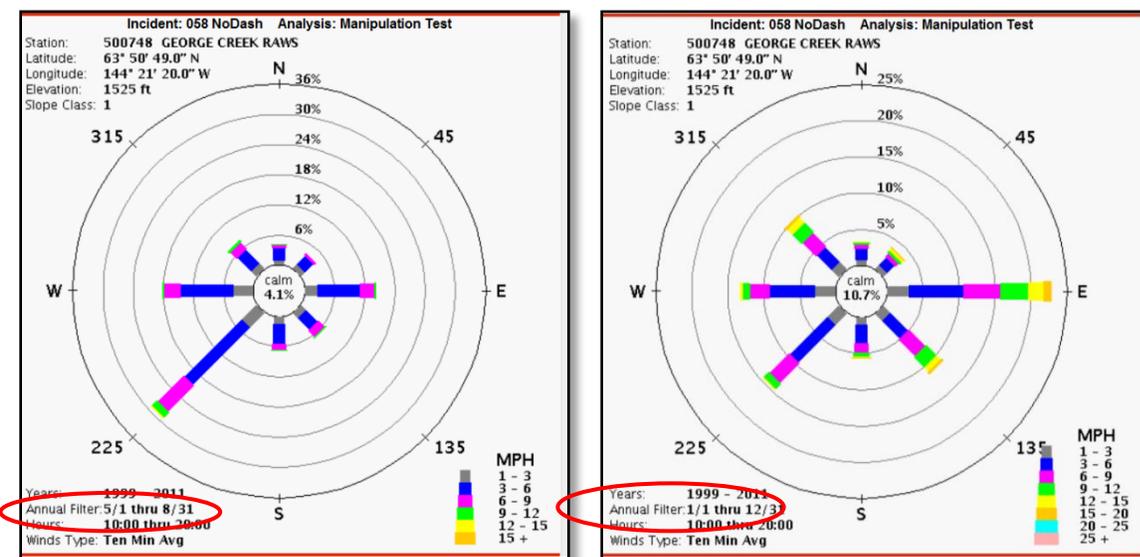


Figure 18: Example showing change in predominant wind direction and speed based on change of Start/End Month/Day

**Start/End Hour:**

This is dependent on the hours in which you are seeing fire spread. A place to start is between 1000 and 2000. If there is active night fire spread occurring, consider extending the End Hour ([Kurth et al., 2010](#)).

**Weighted Winds****Calm Weight:**

This does not need to be modified unless you change the values in the wind matrix.

**Calm Threshold:**

This does not need to be modified unless you change the values in the wind matrix.

**Winds Type:**

Ten-minute average winds and gusts are used when *Both* is selected. In mild years, consider using the ten-minute average, otherwise use *Both*. Because the wind speeds are so high when selecting only Gusts, this option is not recommended except under the most extreme conditions. If you are unsure which wind to select, run two separate scenarios, one with the ten-minute average and one using Both ([Stratton, 2009](#)). In the calibration work done in 2008 for the Herron Fire in Denali National Park, the recommendation in black spruce fuel types was to use "Both" rather than "10 Minute Averages" ([Stephen & Sorbel, 2008](#)).

**Wind Analysis Buttons****Wind Rose:**

A graphical representation of wind direction and wind speed. This is a quick way to see the effect the date filters have on the wind.

**Download Winds:**

Before the analysis is run or accepted, only the Fire Behavior Analysts can download the historical record of wind data for the selected RAWS. For accepted analyses, all users can download winds. A subset of the historical wind data, based on the user-defined *Start/End Time*, populates the wind matrix. However, the downloadable wind data provide all the historical data available for the RAWS including the average and maximum gust wind speeds, and the average and maximum gust wind directions. The file downloads as a Comma Separated Values (.csv) file, and opens with Excel.

## Analysis Map

See the *Landscape Extent* description in the **Landscape** section for direction on how to define the Landscape Extent from the *Analysis Map* page. Remember that the *Analysis Map* page only shows the landscape data source without modifications, even if you have already edited the landscape (Figure 19). This is a good place to make sure that your fire perimeters, ignitions, barriers, and masks are appropriate for this analysis. This is also the only place to ensure the proper data source was selected by using the identify tool (  ), clicking on the map, and then checking the Source listed to the left.

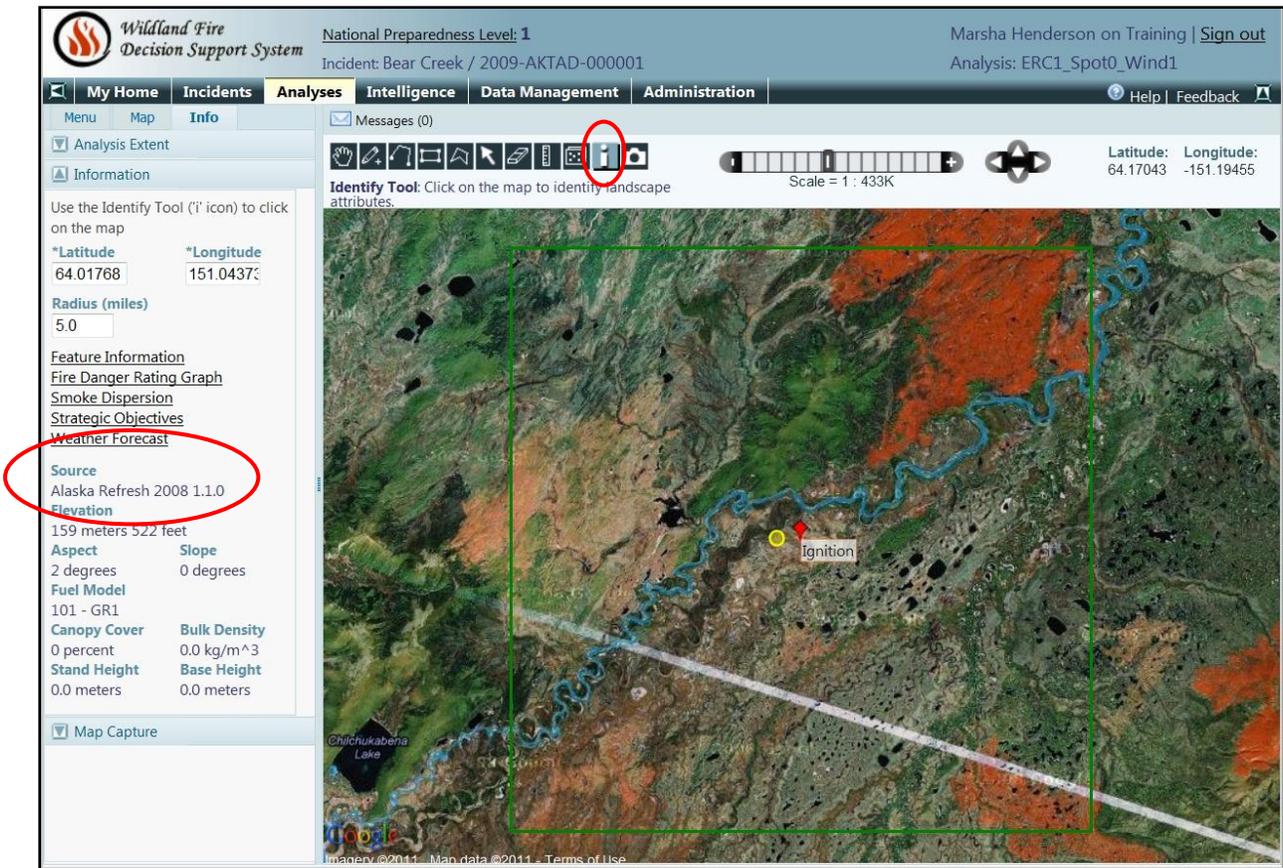


Figure 19: Analysis Map Screen

The landscape data, from LANDFIRE, includes eight variables. These are described below (Table 7).

Table 7: Landscape Data Variables

Variable	Range	Units	Description
Elevation	Open-ended	Meters	Land height above mean sea level
Aspect	0-360	Degrees	The azimuth of the sloped surfaces across a landscape
Slope	0-90	Degrees	The change of elevation over a specific area
Fuel Model	91-204		See Fuel Model section
Canopy Cover (CC)	0-100	%	The percent cover of the tree canopy in a stand. Specifically, the vertical projection of the tree canopy onto an imaginary horizontal surface representing the ground's surface. Provides information for calculating wind reduction factors to reduce 20 foot wind speeds to mid-flame height wind speeds.
Canopy Bulk Density (CBD)	Open-ended	Kg/m <sup>3</sup>	The density of available canopy fuel in a stand. Defined as the mass of available canopy fuel per canopy volume unit. Provides information to determine spread rate of crown fires.
Stand Height (SH)	Open-ended	Meters	The average height of the top of the vegetated canopy. Provides information to calculate wind reductions and ember production during spotting.
Canopy Base Height (CBH)	Open-ended	Meters	The average height from the ground to a forest stand's canopy bottom. Specifically, it is the lowest height in a stand at which there is a sufficient amount of forest canopy fuel to propagate fire vertically into the canopy. Provides information with surface fire intensity and foliar moisture content to determine crown fire transition.

## Landscape Editor

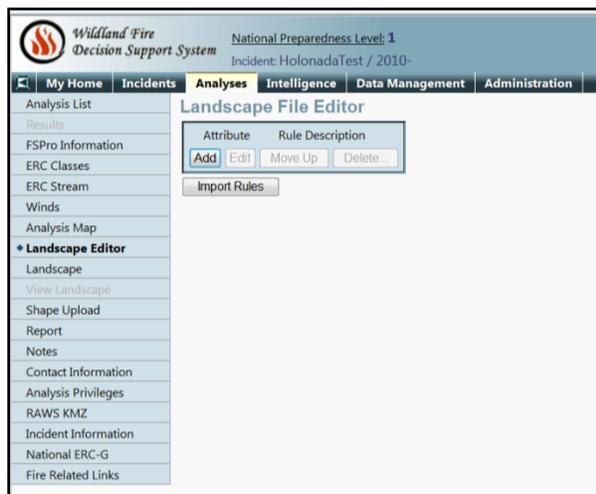


Figure 20: Landscape Editor Screen

The fuel model as well as the canopy characteristics (canopy base height, canopy bulk density, canopy cover, and stand height) can be edited for the landscape in the Landscape Editor screen.

There are three primary reasons to consider editing the landscape.

1. There are errors in the data source.
  - Check that data theme values are within normal ranges, both biologically and physically. For example, canopy cover values should not exceed 100%.
  - Ensure that ranges of values for data themes are valid and consistent for the local area (Reference Table 7).
  - Ensure that relationships between data themes are valid. For example, if there is a value for canopy cover in a given cell then the corresponding values for other canopy characteristics should also be populated (e.g., canopy base height, stand height, and canopy bulk density).

There are several ways to confirm that your fuel models are reasonable.

- Talk with someone knowledgeable who has been on the ground and is familiar with the fuels and the typical fire behavior in the area.
- Overlay a fuel model image in Google Earth ([Stratton, 2012](#)).
- Test the landscape using Short-Term Fire Behavior (STFB) to ensure crown fire is being modeled appropriately.

2. There has been a recent disturbance on the landscape that is not modeled in the data source.

Refresh 2008 LANDFIRE data should be capturing fire scars up through 2008. However, all fire scars and in particular fire scars from the last decade should be examined carefully. Currently, the 1999 fires are missing from the Refresh 2008 data source. LANDFIRE plans to fix this

omission but if your analysis will potentially involve an area burned in 1999, ensure the fix has occurred and edit as necessary.

3. LANDFIRE data values are most appropriate when using the Scott and Reinhardt crown fire method. However, FSPRO uses the crown fire method developed by Finney. This means that a more extreme fire environment is necessary to sustain active crowning and lower spread rates are predicted with active or passive crowning. Therefore, canopy characteristics and/or fuel model assignments may need to be edited including increasing canopy bulk density (CBD) and decreasing canopy base height (CBH).

In order to determine if there are errors in the data source or if recent disturbances have the appropriate fuel and canopy characteristics, refer to the **Landscape Critique** description in the **Landscape** section. Landscape masks are a useful tool when editing data sources and a detailed explanation of their use is found at the end of this **Landscape Editor** section.

### **Import Landscape Editor Rules**

If you are working with other analysts to create a set of landscape editor rules or you would like to just edit a set of rules from a different analysis, use the Import Rules feature. By selecting this button, you can select another FSPRO analysis and import the Landscape Editor Rules. Remember that landscape editor rules are applied from the top to the bottom of the list so move the rules up or down the list for your specific analysis and edit specific rules as needed.

## Add Landscape Editor Rules

**Wildland Fire Decision Support System** National Preparedness Level: 1  
 Incident: 207 East Volkmar / 2011-AKDas-112207  
 Marsha Henderson on Training | Sign out  
 Analysis: Simple LCP edits

My Home Incidents **Analyses** Intelligence Data Management Administration Help Feedback

Landscape File Editor > Add Landscape Editor Rule

### Add Landscape Editor Rule

**Target Attribute**

Attribute to Change: **Canopy Base Height** New Attribute Value:  Conversion Factor:

**Rule Conditions**

	Minimum	Maximum
Elevation (meters)	<input type="text"/>	<input type="text"/>
Aspect (degrees)	<input type="text"/>	<input type="text"/>
Slope (degrees)	<input type="text"/>	<input type="text"/>
Stand Height (meters)	<input type="text"/>	<input type="text"/>
Canopy Base Height (meters)	<input type="text"/>	<input type="text"/>
Canopy Bulk Density (kg/m <sup>3</sup> )	<input type="text"/>	<input type="text"/>
Canopy Cover (percent)	<input type="text"/>	<input type="text"/>

- Enter both a minimum and maximum value to specify an attribute value range.
- Enter only a minimum value to apply this rule to attribute values greater than or equal to the specified minimum.
- Enter only a maximum value to apply this rule to attribute values less than or equal to the specified maximum.
- Enter neither a minimum or a maximum value if the attribute is not required.
- Select any number of fuel models by pressing Ctrl + left mouse click.
- Select one or more shape masks to limit the rule to the intersection of the shapes with the landscape file.

**Fuel Models**

91 - Urban / Developed  
 92 - Snow / Ice  
 93 - Agricultural  
 98 - Water  
 99 - Bare Ground  
 101 - Short, Sparse Dry Climate Grass

**Limit Rule by Shape Mask**

Big\_Swede

Save Return

Figure 21: Add Landscape Editor Rules

### Landscape Edits to Change Fuels Due to Recent Disturbances

Several people have used landscape edits to change fuels to model fires not captured in the LANDFIRE data source. If you have no field validation of fuels within burn scars and you think the burn scars are going to affect predicted fire behavior, you may want to start with the edits shown below. However, use these rules as guidelines as they were calibrated to specific fire behavior during the 2010 fire season. Each example shows a table of recommendations and then an example of how those edits would look in the Landscape Editor.

Recommendation 1: [Kurth et al, 2010](#)

Table 8: Landscape edits to incorporate fire scars based on time since fire

Time Since Fire	Current Fuel Model	Change Fuel Model To:	Comments
6-10 years	147 - 189 below 200 meters (elevation)	147	This will retain all the grass models and most of the shrub models that existed pre-burn.
6-10 years	142-189 above 200 meters (elevation)	142	This will retain all the grass models and a few lower load shrub models that existed pre-burn.
6-10 years	All	Set Canopy Cover to 0	This will cause the model to ignore canopy in the fire behavior calculations. Therefore, there is no need to change CBD and CBH.
4-5 years	161-189	161	This will retain all the grass and shrub models that existed pre-burn.
1-3 years	161-189	181	This will retain all the grass and shrub models that existed pre-burn.
1-5 years	161-189	Set: SH = 5 CBH = 0.3 CC = 35	This will set the canopy characteristics to more closely model FM 161 and 181.

Figure 23 is an example of how some of the fire scars edit listed above (Table 8) would be displayed in the Landscape Editor.

Attribute	Rule Description
Fuel Model	If (Fuel Model is 142, 143, 144, 145, 146, 147, 148, 149, 161, 162, 163, 164, 165, 181, 183, 184, 185, 186, 187, 188, 189) AND (Elevation >=200) AND (LCP intersects fires from 2000-2004) Set Fuel Model to 142
Fuel Model	Else If (Fuel Model is 147, 148, 149, 161, 162, 163, 164, 165, 181, 183, 184, 185, 186, 187, 188, 189) AND (Elevation <199) AND (LCP intersects fires from 2000-2004) Set Fuel Model to 147
Fuel Model	Else If (Fuel Model is 161, 162, 163, 164, 165, 181, 183, 184, 185, 186, 187, 188, 189) AND (LCP intersects fires from 2005-2006) Set Fuel Model to 161
Fuel Model	Else If (Fuel Model is 161, 162, 163, 164, 165, 181, 183, 184, 185, 186, 187, 188, 189) AND (LCP intersects fires from 2007-2009) Set Fuel Model to 181
Fuel Model	Else if (Fuel Model is 164) set Fuel Model to 145
Stand Height	If (Fuel Model is 161, 162, 163, 164, 165, 181, 183, 184, 185, 186, 187, 188, 189) AND (LCP intersects fires from 2005-2009) Set Stand Height to 5.0
Canopy Base Height	If (Fuel Model is 161, 162, 163, 164, 165, 181, 183, 184, 185, 186, 187, 188, 189) and (LCP intersects fire from 2005-2009) Set Canopy Base Height to .2
Canopy Base Height	Else if Multiply Canopy Base Height by .6106
Canopy Bulk Density	If (Fuel Model is 161, 162, 163, 164, 165, 181, 183, 184, 185, 186, 187, 188,

<b>Canopy Bulk Density</b>	189) and (LCP intersects fire from 2005-2009) set Canopy Bulk Density to .3 Else if (Fuel Model is 161, 162, 163, 164, 165, 181, 183, 184, 185, 186, 187, 188, 189) set Canopy Bulk Density to .3
<b>Canopy Cover</b>	If (LCP intersects fires from 2000-2004) Set Canopy Cover to 0
<b>Canopy Cover</b>	Else If (Fuel Model is 161, 162, 163, 164, 165, 181, 183, 184, 185, 186, 187, 188, 189) and (LCP intersects fires from 2005-2009) set canopy cover to 35
<b>Canopy Cover</b>	Else if (Canopy Cover is between 25 and 45) Multiply Canopy Cover by .85
<b>Canopy Cover</b>	Else if (Canopy Cover >= 46) Multiply by .7

Figure 22: Landscape edits to incorporate fire scars as shown in the Landscape Editor

#### Recommendation 2: [Stratton, 2009](#)

These recommendations are based not just on the number of years since the fire but also the actual fire behavior observed. You should routinely confirm the modeled fire behavior with reality regardless of what edits you make to the landscape.

Table 9: Landscape edits for fire scars using time since fire and observed fire behavior (Zitziana Fire)

Time Since Fire	Change Fuel Model To:	Observed Fire Behavior
1-2 years	181	Negligible
3 or more years	161	Low - fire creeping, inconsistent spread, low flame length
3 or more years	142	Low-moderate - higher rate of spread and flame length than 161
FM 164 in all fires	Set Canopy Cover to 10	

Figure 23 is an example of the Landscape Editor using the some of the guidelines shown in Table 9.

Attribute	Rule Description
Fuel Model	If (Fuel Model is 101, 102, 103, 104, 105, 106, 107, 108, 109, 121, 122, 123, 124, 141, 142, 143, 144, 145, 146, 147, 148, 149, 161, 162, 163, 164, 165, 181, 182, 183, 184, 185, 186, 187, 188, 189, 201, 202, 203 or 204) AND (LCP intersects Burn_00 OR 2002_burn) Set Fuel Model to 142

Figure 23: Fire scar landscape edits based on time since fire and observed fire behavior as shown in the Landscape Editor.

### Landscape Edits to Create a More Extreme Fire Environment

In order to model crown fire appropriately during warm, dry seasons, several users have experimented with **changing timber fuel models to shrub models to increase the rate of spread** (Table 10) ([Kurth et al, 2010](#)) or **changing canopy characteristics** (Table 11) ([Kurth et al, 2010](#)) and Table 12 ([Stratton, 2009](#)).

Table 10: Landscape edits for converting timber models to shrub models based on crown fire activity

Observed Fire Behavior	Current Fuel Model	Change Fuel Model To:
Little or no crown fire in black spruce	All	No change
Crown fire in black spruce	164	145
Crown fire in most forest with understory	161-165	145

In the more **active fire behavior conditions**, additional landscape edits are recommended as shown in Table 11 and Figure 24 ([Kurth et al, 2010](#)).

Table 11: Landscape edits for timber models in active fire behavior conditions.

Landscape Feature	Specific Condition	Landscape Edit
Crown Bulk Density	FM 161-189	Set to 0.3
Crown Base Height	All	Multiply by 0.6
Canopy Cover	CC is between 25 and 45	Multiply by 0.85
Canopy Cover	CC is equal to or greater than 46	Multiply by 0.7

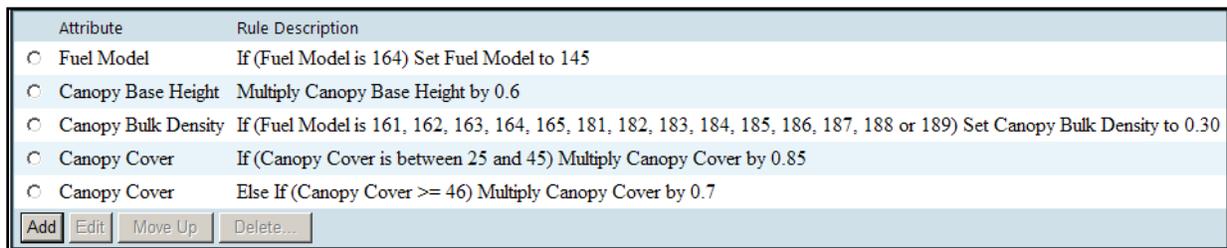


Figure 24: Landscape edits for timber models with active fire behavior as seen in Landscape Editor

An FSPro analysis was completed on the 2007 Mooseheart Fire in which landscape edits included changing the canopy characteristics of fuel model 164 by reducing CBH to 0.1 and increasing CBD to 0.4 but this did not result in the fire spread seen on the Mooseheart Fire. Fuel model 164 was then changed to 145 which resulted in spread probabilities more closely matching actual fire spread ([Ziel, 2008](#)). The fuel moisture conditions at the time of the Mooseheart Fire closely matched those of the 2009 season. Remember this analysis was completed using a different landscape data source than is currently available.

An FSPro analysis was completed on the 2009 Zitziana Fire in which the timber fuel models were not changed to shrub models. Instead, the canopy characteristics were changed to allow for more crown fire and greater rates of spread ([Stratton, 2009](#)). These edits are described in [Table 12](#). Remember this analysis was completed using National LANDFIRE not Refresh 2008 so examine these edits carefully before using them.

Table 12: Landscape edits for timber models

Landscape Feature	Specific Condition	Landscape Edit
Crown Bulk Density	FM 164	Set to 0.25
Crown Base Height	FM 164	Set to 0.1
Canopy Cover	CC is between 50 and 100	Multiply by 0.75
Canopy Cover	CC is equal to or greater than 46 and FM 164	Multiply by 0.7

Figure 25 shows an example in the Landscape Editor of the Table 12 edits:

Attribute	Rule Description
Fuel Model	If (LCP intersects 2008_Blind_Luck) Set Fuel Model to 181
Fuel Model	Else If (LCP intersects mooseheart_2007) Set Fuel Model to 181
Fuel Model	Else If (LCP intersects cosnariver_bitzshtini_bearpawmtn_2005) Set Fuel Model to 161
Fuel Model	Else If (LCP intersects johnhansen_1k_ck_gekakmina) Set Fuel Model to 161
Fuel Model	Else If (LCP intersects zitziana_bearpawmtn_2000) Set Fuel Model to 161
Canopy Base Height	If (Fuel Model is 164) Set Canopy Base Height to 0.1
Canopy Bulk Density	If (Fuel Model is 164) Set Canopy Bulk Density to 0.25
Canopy Cover	If (Canopy Cover is between 50 and 100) Multiply Canopy Cover by 0.75
Canopy Cover	Else If (Fuel Model is 164) AND (LCP intersects blind_luck; cosnariver_bitzshtini_bearpawmtn_2005; johnhansen_1k_ck_gekakmina; mooseheart_2007 OR zitziana_bearpawmtn_2000) Set Canopy Cover to 10

Figure 25: Landscape edits for timber models as appears in Landscape Editor

Remember, there may be other specific edits needed for your Landscape extent due to other disturbances (i.e., beetle-killed areas) or from errors in the LANDFIRE data source. Perform a landscape (LCP) critique before you begin making edits and after you have made edits to ensure those edits were applied as you envisioned.

### Landscape Mask

A Landscape Mask can be added to the analysis to change fuel characteristics in a defined area of the landscape. A Landscape Mask is typically used to create a polygon for a fire scar. There are two ways to acquire fire perimeters: 1) copy perimeters from WFDSS for perimeters from 2000-2010 (see below); or 2) download perimeters from the AICC website ([Sorbel, 2010](#)).

### Copying fire perimeters from WFDSS for use as Landscape Masks:

1. Open the *Analysis Map* and turn on the *AK Fires 2000-2010* layer under *Fire Related*.
2. Select the identify tool from the menu of tools.
3. Click on the historic fire you wish to download.
4. From the *Info* list on the left, select *Feature Information* (Figure 27).
5. Make sure the incident of interest is listed (Figure 28).

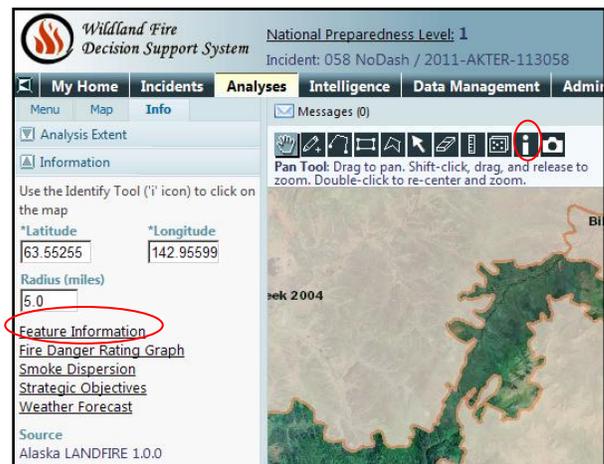


Figure 27: Analysis map showing historic fire selection.

There are two ways to use the perimeters (Figure 28).

1. Click the down arrow next to the incident name and the perimeter can be saved to the hard drive.
2. Click the papers next to the incident name and the perimeter can be copied directly into FSPro as a Landscape Mask (or Barriers, Management Action Points, etc).

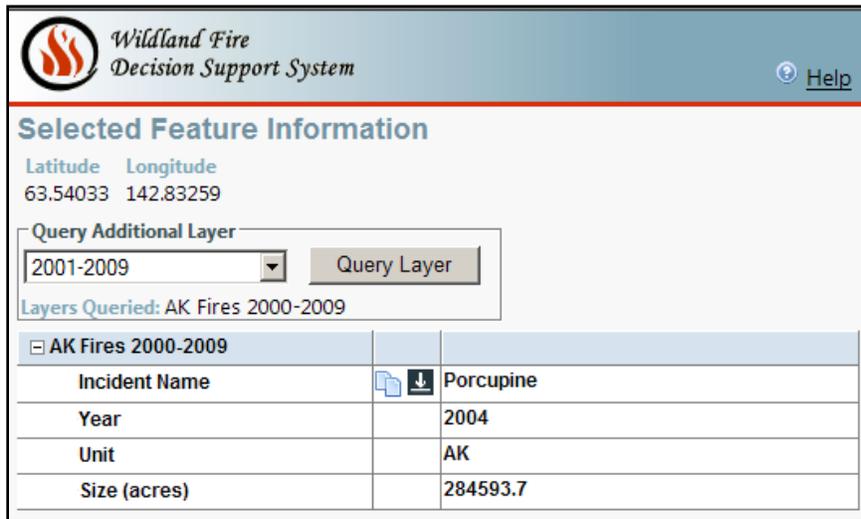


Figure 28: Selected Feature Information screen

Reference the [The Use of Masks to Make Changes to the WFDSS Alaska 2009 LCP](#), Rick Stratton, July 2009 for more information on how to use masks and how to apply edit rules.

#### Landscape Editor Rules Using Landscape Masks:

1. The rule highest on the list of rules takes precedent over any changes below it. Therefore, once an attribute (fuel model or canopy characteristics) is changed for a single pixel it is not available for subsequent change in a rule later down on the list.
2. Always put landscape edits that involve masks at the top of the list of edits.
3. If you want to change fuel models or canopy characteristics outside of masked areas only (i.e., retain values inside the masked areas and make adjustments outside of them), you need to be sure to use the logic method that WFDSS applies to the landscape rules. ***In order to retain values inside of a mask while making changes outside of a mask, you must create two rules.*** The first rule will retain the masked area's values and the second rule will change everything outside of the masked area. For example, to retain canopy characteristic values inside of the masked areas, multiply those by a value of 1. The subsequent rule will not be applied to the area inside the mask because the first rule takes precedent. To retain fuel model values inside of the masked areas, set the fuel model to equal the fuel model (e.g., fuel model 145 = fuel model 145 where intersects Shape/Mask) and then the subsequent rule will not be applied inside the mask because the first rule will take precedent.

## Landscape

The screenshot shows the 'Landscape File' configuration interface. At the top, it displays the system logo, 'National Preparedness Level: 1', and the user 'Marsha Henderson on Pro'. The incident details are 'Incident: 288 Gilahina / 2011-AKCRS-114288' and the analysis date is '6/1/11, 7d TU4-5'. The navigation menu includes 'My Home', 'Incidents', 'Analyses', 'Intelligence', 'Data Management', and 'Administration'. The 'Analyses' section is active, showing a list of analysis options on the left, including 'Landscape Editor' and 'Landscape'. The main content area is titled 'Landscape File (LCP file generated from 'Alaska LANDFIRE 1.0.0')' and contains the following fields:

- Incident Latitude: 61.44278, Incident Longitude: 143.51472
- Landscape Extent** section:
  - \*Top Latitude: 61.725 (Degrees: 61, Min: 43, Sec: 30.0)
  - \*Left Longitude: 144.1049 (Degrees: 144, Min: 6, Sec: 17.6) or \*Right Longitude: 142.8635 (Degrees: 142, Min: 51, Sec: 48.6)
  - \*Bottom Latitude: 61.2953 (Degrees: 61, Min: 17, Sec: 43.1)
- \*Resolution: 90
- Landscape Data Source** (radio buttons):
  - Alaska LANDFIRE 1.0.0
  - Alaska Refresh 2008 1.1.0
  - CA Landscape 2010
  - Hawaii Refresh 2008 1.1.0
  - LANDFIRE National 1.0.0
  - LANDFIRE Refresh 2008 1.1.0
- Fuel Model** (radio buttons):
  - 40
  - 13

At the bottom, there are five buttons: 'Save', 'Create LCP File', 'Upload LCP File', 'Download LCP File', and 'Generate LCP Critique'.

Figure 29: Landscape Screen

### Landscape extent:

The landscape extent defines the area to which the outputs will be limited.

- It is important to understand that FSPRO runs MTT on all the cells within the landscape extent before it calculates the probability of spread. In other words, if the extent is large, even if the resulting FSPRO output is small, it will still require a long processing time.
- The extent should encompass all the potential fire spread for the analysis being conducted, otherwise low or rare events will not be shown as the analysis will be limited by the landscape.
- The landscape extent is different than the planning area.

There are two ways to define the landscape extent. The first is by typing in the latitude and longitude of the extent (Figure 29). The negative sign on the longitude is assumed and does not need to be typed. The second way is from the *Analysis Map* page (Figure 30). Draw a box using the "Draw a rectangular extent" tool from the toolbar. After drawing the rectangle on the map, the latitude and longitude that define the box will appear to the left. Click *Save* to accept this as the landscape extent.

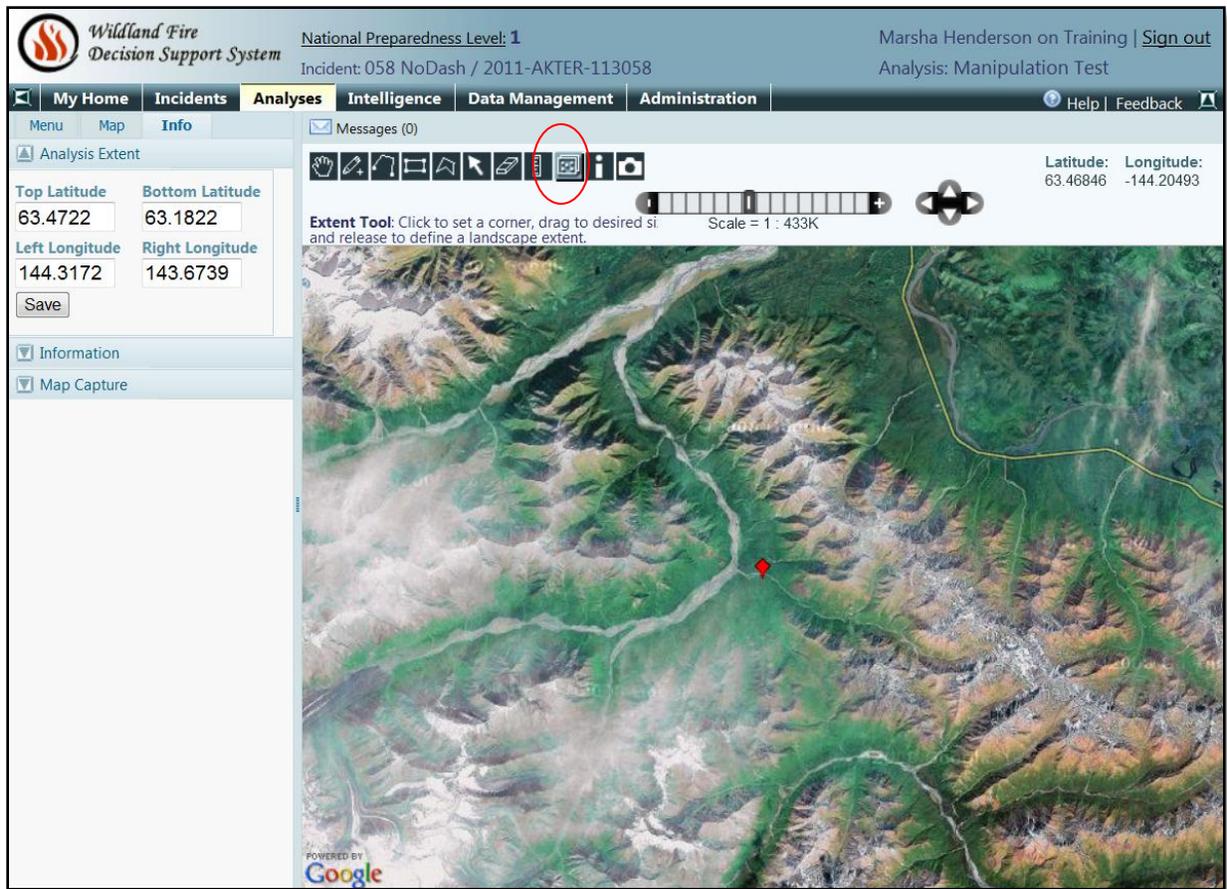


Figure 30: Landscape extent defined from the Analysis Map

### Landscape Data Source:

The landscapes (LCPs) available in WFDSS are regional to national scale data sets. Consequently, it is unlikely the fuels and canopy characteristics will truly reflect the area for a particular incident. ([Wildland Fire Management RD&A, 2011](#)).

There are currently two data sources for Alaska landscapes. Alaska LANDFIRE 1.0.0, released in 2010, uses imagery from 1999-2003 and will not have fire scars or other disturbance from 2001 through the current year. If this data source is used, some editing or masking of the landscape is likely needed to appropriately model the fuels within these fire scars.

The second data source is Alaska Refresh 2008 1.1.0. Alaska Refresh maps probable fuel types for fire scars through 2008 (with the exception of 1999 fires). After review of the Alaska Refresh data source at the 2011 Alaska LANDFIRE Fuels Calibration Workshop, it was recommended for use in WFDSS ([Alaska LANDFIRE Fuels Calibration Workshop, 2011](#)).

The data source is selected on the *Information* tab of the *Incident*. This selection will appear on the *Landscape* page in *Analyses* tab. It can also be selected or changed from the **Landscape** page. There was a bug in the system that would not change the actual data source used from the **Landscape** page. The bug was fixed but it doesn't hurt to check that the proper data source

is being used. The only definitive way to ensure the proper data source is being used is to open the *Analysis Map* (See **Analysis Map** section). This will provide a list of the data variables of the pixel on the left of the screen which includes Source.

### **Resolution:**

The resolution is the cell size of the landscape data that will be analyzed. This will also determine the output cell size. The minimum resolution is 30 meters which is dictated by the resolution of the LANDFIRE landscape files. The default is 90 meters. Using coarser resolution will decrease processing time. Pay particular attention to this when modeling large fires. However, making the resolution coarser could have an adverse effect on modeling results by over or under-emphasizing fuels or fire travel pathways relevant to fire spread. For example, if there is a barrier to fire spread (e.g., a river) and the resolution is coarse enough that these non-burnable cells are not depicted on the landscape, they will not be used in the analysis and fire spread may be modeled where it is not practical. This is particularly important where fuels are highly variable ([Wildland Fire Management RD&A, 2011](#)). The maximum size of the landscape file for FSPRO is 2.5 million cells.

### **Fuel Model:**

A fuel model is a set of fuel bed inputs needed by a particular fire behavior or fire effects model. You can select either Anderson's 13 fuel models or Scott and Burgan's 40 fuel models. Both of these fire behavior fuel models are used in Rothermel's ([1972](#)) surface fire spread model. The original 13 fire behavior fuel models are "for the severe period of the fire season when wildfires pose greater control problems..." ([Anderson 1982](#)). The new 40 fuel models were designed to do the following:

- Improve the accuracy of fire behavior predictions outside of the severe period of the fire season.
- Increase the number of fuel models applicable in high-humidity areas.
- Increase the number of fuel models for forest litter and litter with grass or shrub understory. Predicted surface fire behavior drives crown fire models ([Alexander 1988](#); [Van Wagner 1977](#)), so increased precision in surface fire intensity prediction will lead to increased precision in crown fire behavior prediction and hazard assessment.
- Increase the ability to simulate changes in fire behavior as a result of fuel treatment by offering more fuel model choices, especially in timber-dominated fuel beds. ([Scott and Burgan, 2005](#))

The 40 Fire Behavior Fuel Models that have an herbaceous component are dynamic (see *Live Fuel Moisture* description in the **Weather Station Selection** section).

Alaska has developed an excellent resource that cross-walks Alaska vegetation types to both the 13 and 40 fuel models ([Fuel Model Guide to Alaska Vegetation, 2008](#)). This is only a guide but by selecting the 53 fuel models, you may have a wider range of appropriate fuel models and have some guidance on whether those fuel models are accurately modeling fire behavior.

### **Create LCP File:**

Before creating the LCP file, a landscape extent must be defined, the landscape parameters (resolution, data source, and fuel type) must be defined, and landscape editor rules must be completed if desired. Remember that a LCP file must be re-generated anytime new landscape editor rules or LCP parameters are changed.

### **Upload LCP File:**

A LCP file can be uploaded if desired. However, this is a project that requires significant GIS skills not least of which are the challenges associated with projections. WFDSS uses a custom Albers projection for the landscape extent that can result in the uploaded LCP to appear in a different location despite using the correct PRJ file. It would be a rare instance when uploading a custom Alaska LCP file would be preferred over using the LCP generated by WFDSS.

### **Download LCP File:**

The LCP file may be downloaded for use in other programs such as ArcGIS, FlamMap, or FARSITE. However, remember that these LCP's are downloaded in a custom Albers conic projection which may be problematic if vector files will be used. To mitigate this problem, use the LANDFIRE Data Access Tool (LFDAT) to dismantle the LCP into individual raster maps and re-project them with the projection file that was downloaded with the LCP (<http://www.landfire.gov/datatool.php>). Alternatively, re-project the vector files using the projection file that was downloaded with the LCP.

## **Landscape Critique**

### **LCP Critique:**

LCP Critique will generate a pdf summary of the landscape, the first page is shown in Figure 31. You must first generate an *LCP Critique* then wait a few moments and refresh the screen. You can then download the LCP Critique. Using this critique, review the landscape themes to ensure they are within reasonable ranges and review the maps to see if there is missing information. Remember that an aspect of -1 indicates flat while an aspect of ND means no data. The first part of the Critique, as shown in Figure 31, provides some information on the landscape size and location. WFDSS centers the landscape and then builds a localized projection. Therefore, the UTM coordinates will be meaningless except to show the size (in meters) of the landscape. The latitude that is shown is what is used to calculate daylight length. Download the landscape critique prior to making any edits through the **Landscape Editor**. Then, after edits are completed, download the landscape critique again to ensure the edits were applied as you intended.

FlamMap Landscape File Critique			
Landscape File: c:\wfdss\temp_training\flammap\375604.lcp			
Latitude:	64	Cell Resolution Y:	90.00
Cell Resolution X:	90.00	Num Cells North:	359
Num Cells East:	358	UTM East:	16184.0000
UTM North:	16199.0000	UTM West:	-16036.0000
UTM South:	-16111.0000		
Themes Present			
Theme	Units	Range	
Elevation	Meters	320 - 987	
Slope	Degrees	0 - 35	
Aspect	Degrees	0 - 359	
Fuels	Class	93 - 189	
Canopy Cover	Percent	0 - 64	
Stand Height	Meters*10	0 - 100	
Canopy Base Height	Meters*10	0 - 35	
Canopy Bulk Density	kg/m <sup>3</sup> *100	0 - 80	

Figure 31: Sample LCP Critique

Table 13 includes some considerations specific to the fuel model and associated canopy characteristics ([Stratton, 2006](#) and [Stratton, 2009](#)):

Table 13: Data Considerations

Data Theme	Considerations
Fuel Model	Observed fire behavior versus modeled fire behavior
	Fuel model given elevation and aspect
	Fuel treatments/Bug kill/Old fires
	Look for unnatural patterns - i.e. straight lines(identified as a potential between LANDFIRE mapping units)
	Are the values of the 40 fuel models between 91 and 204?
Canopy Cover	Circular fire growth could mean canopy cover too high
	Does the Canopy cover (CC) exceed 75%? Canopy cover rarely exceeds 70% even in so-called closed-canopy forests ( <a href="#">Scott and Reinhardt, 2005</a> ). Canopy cover is different than crown closure. Canopy cover refers to the horizontal proportion of the ground covered by tree crowns (i.e., bird’s eye view looking down). If excessive CC values exist within the modeling domain, rate of spread may be reduced due to increases in fuel moisture and lower wind speeds (sheltering effect of the tree overstory).
	If CC is 0 then models will ignore all other canopy characteristics and no crown fire activity will be calculated
Stand Height	If SH is too low, the wind reduction factor will not calculate mid-flame wind speed accurately
	Are the values of Stand Height (SH) consistent with your knowledge of the area? Remember the values are in meters and multiplied by 10 (multiply by .3281 to calculate feet) when viewed in LCP Critique. The stereo photo series for quantifying natural fuels ( <a href="#">Ottmar et al, 1998</a> ) is a useful resource for canopy characteristics.

Canopy Base Height	<p>Rule of thumb: FL of 50% of CBH needed for transition to crown fire</p> <p>Are the values of Canopy Base Height (CBH) consistent with your knowledge of the area? Remember the values are in meters and multiplied by 10 (multiply by .3281 to calculate feet) when viewed in LCP Critique. Pay particular attention to the CBH values. If the values are too high, particularly when coupled with a modest fuel model (e.g., fuel model 183), crown fire will seldom initiate.</p>
Canopy Bulk Density	<p>Are the values of Canopy Bulk Density (CBD) consistent with your knowledge of the area? Remember the values are in kilograms per cubic meter and multiplied by 100 (divide by 100 to obtain kg/m<sup>3</sup>) when viewed in LCP Critique. This value is canopy bulk density, the entire volume of a stand not the volume immediately around the tree canopy (<a href="#">Cruz and others, 2003</a>). Remember that the crown fire simulation method used in FSPro is based on Finney's model (<a href="#">1998</a>). This method uses Van Wagner's (<a href="#">1993</a>) fire modeling system using U.S. fire models and progress toward active crowning is a function of the surface fire spread rate and canopy bulk density. However, this method requires a more extreme fire environment to sustain active crowning and predicts a lower spread rate when predicting active or passive crowning compared to the crown-fire control method (<a href="#">Scott and Reinhardt, 2001</a>). Therefore, CBD may need to be adjusted.</p>

Below is a list of items to guide your review of the critique ([Stratton, 2009](#)).

1. Check the latitude (degrees) and ensure the value is approximately in the center of your LCP. The models use latitude to calculate daylight length.
2. Check the cell resolution.
3. Familiarize yourself with the units of each theme. Verify they are the same as shown in [Table 7](#).
4. Carefully look at the range of values for each theme and answer the following questions:
  - a. Is the maximum elevation consistent with the highest peak in the area?
  - b. Does the slope exceed 90 degrees?
  - c. Are the values of the 40 fuel models between 91 and 204?
5. Maps of each of the themes are contained in the critique and are provided for a quick visual evaluation. Look at each layer to see if the values are distributed appropriately across the landscape.
6. Review the histograms (Theme Value Distributions) (Figure 32). Start with the individual theme histograms on page one. Does the distribution look reasonable? Compare the class proportions relative to one another. What fuel models are most frequent on the landscape? Is this consistent with what you have observed? Are there any fuel models not represented that should be? If your area contains mostly grasses and shrubs, you should have a high proportion of zero values for CC, SH, CBH, and CBD. Also, study the

histograms specific to each fuel model - does the fuel model distribution make sense at a given elevation, slope, or aspect?

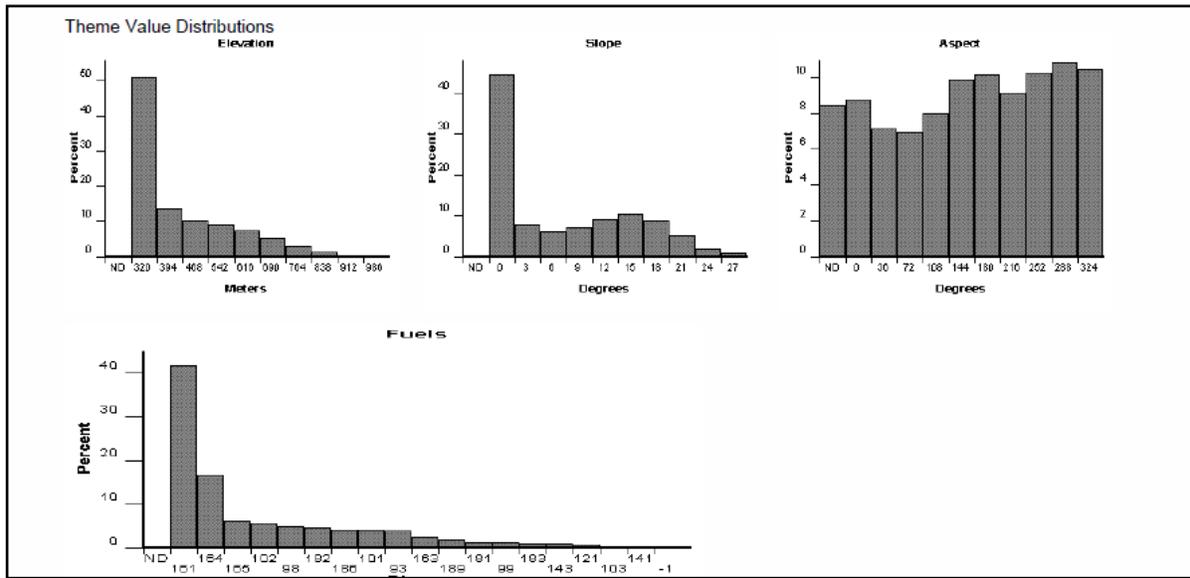


Figure 32: Theme Value distribution histograms

## View Landscape

Once you have created a landscape file for an analysis, you should always view it and verify that the editor rules you applied to the landscape are working correctly. You can see your modifications to the landscape only from the **View Landscape** page by using the *Identify* tool or by downloading a landscape critique. Using the *Identify* tool from the **Analysis Results** page or the **Analysis Map** page displays only the unmodified data of whatever landscape data source you selected.

## Shape Upload

Wildland Fire Decision Support System

National Preparedness Level: 1

Marsha Henderson on Production | Sign out

Incident: 271 Hastings Fire / 2011-AKFAS-111271

Analysis: 6.11.2000 21day 3K 90m chat.b 6.14.line 15

My Home Incidents **Analyses** Intelligence Data Management Administration

Help Feedback

### Upload Shape File

Select a zipped shape file and click the 'Upload' button to load your shape.

\*Shape Label  \*Shape Type **Fire Perimeter**

#### Fire Perimeter Input Parameters

\*Effective Date  Effective Time (hh:mm)

Comments

#### \*Source Types

- Drawn / Ground
- Drawn / Air
- Drawn / Satellite
- GPS / Ground
- GPS / Air
- Infrared
- Other
- Unknown

File to Upload

Figure 33: Upload Shape File Screen

When managing incidents, you might need to upload shapes and other files that support the analysis and decision-making process. All shapes loaded into WFDSS require a projection file. WFDSS stores all shapes in the government standard NAD83 GCS. If you upload a shape as a NAD83 GCS, it will not need to be reprojected. If you upload a shape with a different projection, WFDSS will automatically reproject it to NAD83 GCS. The shape file with associated projection file must be zipped to be uploaded.

The following shapes can be uploaded to WFDSS:

- *Fire Perimeters*: Perimeters can be loaded for viewing purposes and are helpful when developing analysis and documentation.
- *Analysis Ignition*: Ignition shape files can be a fire perimeter, portions of a fire perimeter, or hotspot information gathered from infrared data, MODIS, or some other source.
- *Barriers*: Barriers to surface fire spread are useful for decision-making and fire modeling. Examples include bodies of water, rock and ice, prescribed burns, old fire lines, or fuel treatments.
- *Landscape Mask*: Landscape masks are polygons that analysts use to change fuel characteristics in a defined geographic area. Analysts use these masks to make modeled fires more representative of observed fire behavior, or to incorporate changes to the landscape since it was last modeled (recent fire activity, beetle kill, blow-down, etc.).
- *Management Action Points*: These are useful for developing and evaluating a course of action and creating analyses for an incident. Management Action Points (M.A.P.s) are clearly specified incident conditions that, if reached, prompt a predefined modification

to existing fire management actions, or trigger the implementation of new strategies and/or tactics.

- *Objective Shapes*: These help to spatially represent incident objectives and are useful for developing and evaluating a course of action. Multiple objectives can be associated with a single shape, and multiple shapes can be associated with a particular objective.

# Report

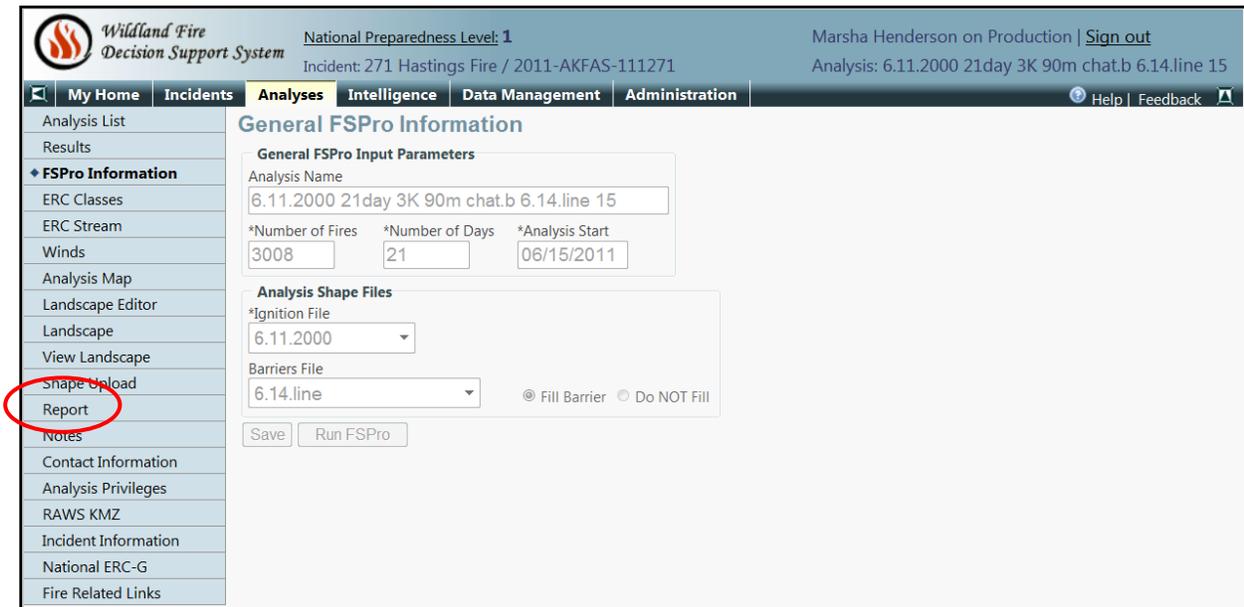


Figure 34: Report Screen

## Incident Information:

Incident information provides a summary of the basic incident information.

## Analysis Information:

Analysis information provides a summary of the analysis data including notes, general information, contacts for the analysis, and the history of the analysis (date and time assigned, Queued, Available for Review, etc).

## FSPPro Results:

Figure 35 shows the average size fire produced across all the fire simulations for this analysis. It also provides the largest fire acreage and a breakdown of percentiles.

The histogram in Figure 36 provides additional information. Each bar represents the number of fires for the acres range shown on the X axis. The first bar in this example shows 220 fires burned from 2800 to 3200 acres. Since 256 fires were used in the analysis, 86% of the fires were in this range. Both the table and the histogram can also be viewed from the **Results** section on the **Analyses** tab.

FSPPro Fire Sizes	
FIRE SIZE	ACRES
Average Size	3,153
90th Percentile	3,315
70th Percentile	3,040
50th Percentile	3,040
30th Percentile	3,040
10th Percentile	3,040
Largest Fire	7,035

Figure 35: Fire size output

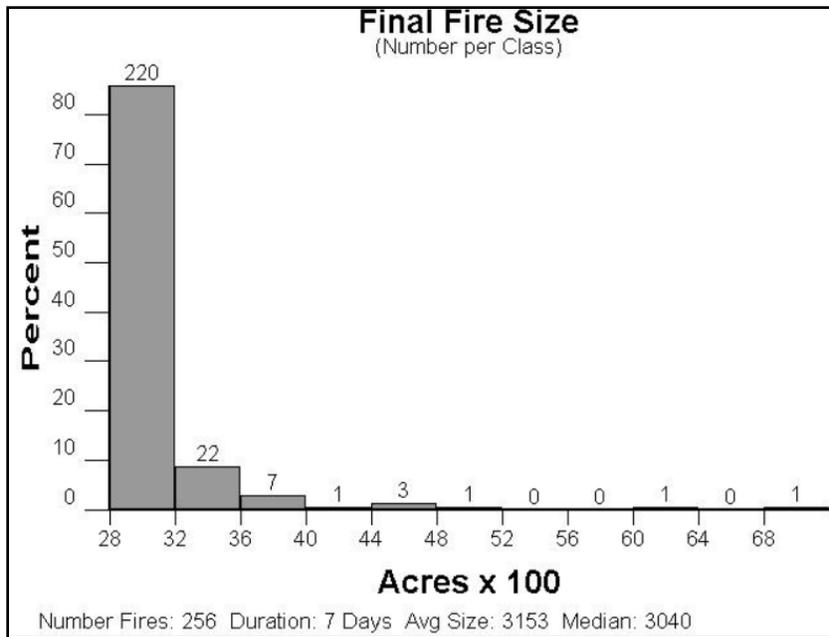


Figure 36: Fire size histogram

**FSPro ERC Classes:**

This provides a summary of the ERC station information and the ERC classes used for this analysis. This summary also includes the same ERC Percentiles list available from the **ERC Class** page.

**FSPro ERC Stream:**

This stream provides a list (by day) for the entire year of the analysis that displays the average ERC, standard deviation, and actual recorded ERC up to the analysis start date. This section also summarizes any weather forecast used in the analysis.

**FSPro Winds:**

This provides a summary of the weather station used for winds, any filters used in the analysis, the winds matrix, and wind rose (including any applied filters).

**FSPro Landscape:**

This provides a summary of the landscape information and the landscape editor rules used in the analysis.

**Values at Risk:**

This field shows a summary of values that currently exist in the WFSS database and are organized by fire spread probability class.

## Notes

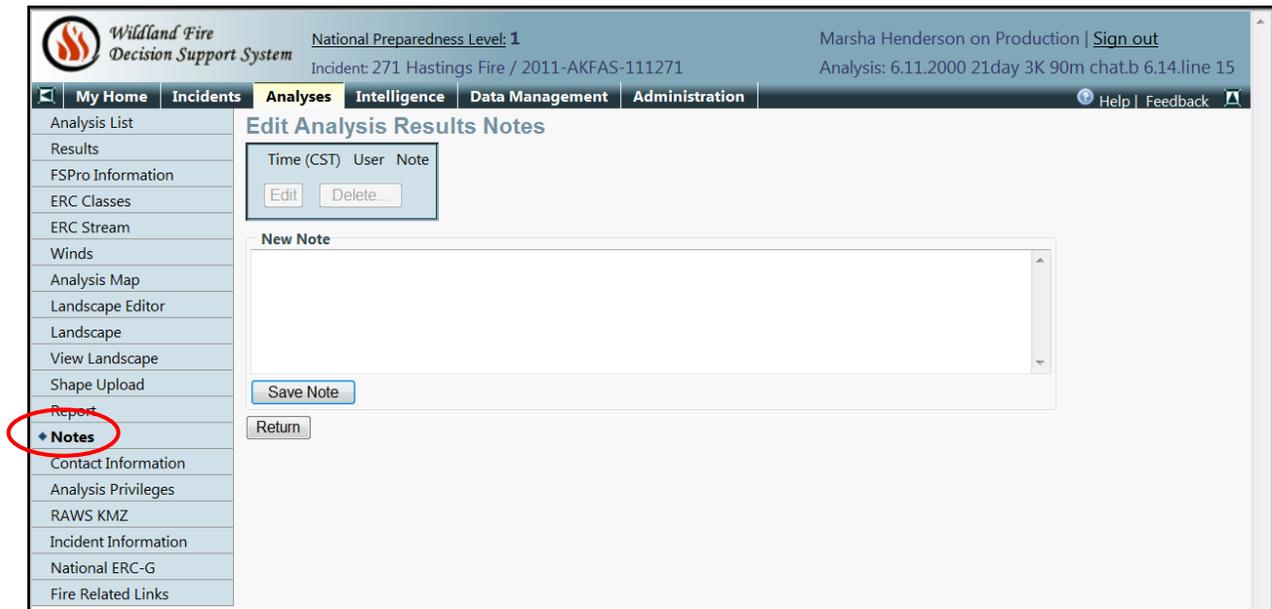


Figure 37: Notes Screen

Notes can be added to the analysis on each screen of the analysis at any time. WFSS will attach the notes to the appropriate section of the final report. These notes are important because they allow other analysts or managers to understand the thought process that led you to certain decisions. For example, if the default weather station is not used for either ERC or winds, describe the reasons for using a different station. One **critical note** to make is to indicate whether your analysis is a calibration, a test, or the final run.

[Standardized Analysis Annotations in WFSS](#) provides detailed examples of notes you should consider making for each of your analyses.

## Contact Information

The screenshot shows the Wildland Fire Decision Support System interface. At the top, it displays the system name, incident details (271 Hastings Fire / 2011-AKFAS-111271), and user information (Marsha Henderson on Production). The navigation menu on the left includes options like 'My Home', 'Incidents', 'Analyses', and 'Contact Information', which is circled in red. The main content area is titled 'Edit Contact Information' and contains a form with fields for Position, Name, Phone Number, and E-mail Address. Below the form is a table of 'Incident Contact Information' with columns for User Name, E-mail Address, Phone Number, Geographic Area, Agency, Unit, and Responsibilities.

User Name	E-mail Address	Phone Number	Geographic Area	Agency	Unit	Responsibilities
Allen, Rob	Rob.Allen@blm.gov	907-356-5540	Alaska	BLM		Editor
DeFries, Tamala	tdefries@blm.gov	907-356-5875	Alaska	BLM	AKMID	Editor
Eliot, Mark	mark.eliot@alaska.gov	907-451-2670	Alaska	State	AKNRS	Editor, Approver
Proulx, Jeanne	jeanne.proulx@alaska.gov	907-451-2722	Alaska	Other		Editor, Reviewer
Pyne, kathryn	kathryn.pyne@alaska.gov	907-451-2601	Alaska	State	AKFAS	Owner, Reviewer

Figure 38: Contact Information Screen

There may be other people involved in this analysis (e.g. FMO's or other analysts) that should be contacted when an analysis is complete. You can select who has editing and viewing privileges of the analysis before it has been accepted. This can be particularly helpful if you are working with another analyst.

## D. Conclusion

This guide is intended to provide both a starting point for FSPRO analyses in Alaska and a refresher for experienced users when beginning a new analysis on an Alaskan fire. This guide should in no way replace information received from experienced fire personnel in the field.

This guide is also not intended to be static (hence the footnote: Version 1). Ideally, as additional knowledge is gained on modeling fire behavior in Alaska, it will be added in subsequent versions of this document.

There have been several examples of reasonable results from FSPRO analyses (Eagle Trail Fire, 2009; East Volkmar Fire, 2011; and Hastings Fire, 2011) which would suggest that FSPRO can be a valuable tool in strategic decision-making in Alaska.

Finally, this document provides you with some guidance in utilizing FSPRO with Alaska data. It is up to you to verify the results for use in strategic decisions on wildfires in Alaska.

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Additional Tools:

Scott, J.H. Compare Models  
[http://www.frames.gov/documents/alaska/docs/Scott\\_CompareModels.xls](http://www.frames.gov/documents/alaska/docs/Scott_CompareModels.xls)