SSGIC
Wildland Fire Susceptibility Index (WFSI) Process Development
Contractor – Don Carlton, Fire Program Solutions, LLC
April 7, 2002 – Porterville, CA

Meeting Notes

Objective

Don Carlton was contracted to assist the SSGIC in developing processes to implement the WFSI model over the SSGIC analysis area. The model integrates the "Risk" of fire ignition with a "Hazard" rating that describes fire behavior. Risk is predicted by the FOA (Fire Occurrence Areas) analysis and hazard from FlamMap Rate of Spread (ROS) outputs. To implement the model, regression equations need to be developed which relate the FlamMap ROS output to a Final Fire Size (FFS). The purpose of this meeting was to develop these equations. Two sources of data were utilized including NFMAS Suppression Table 1 in the IIAA module for contained fires and fire progression maps for actual, escaped fires. This meeting was a follow up of the Feb. 27, 2002 meeting. The specific goals of this meeting were to:

- Allow subject matter experts to collaboratively review the IIAA data as a source for the ROS vs. FFS relationship at low ROS's.
- Review fire progression maps for actual, escaped fires to extract data points relating ROS to FFS at high ROS's.
- Develop the regression equations relating ROS to FFS.
- Identify an appropriate maximum fire size to prevent the model from predicting unrealistic fire sizes at high ROS's.

Participants

Don Carlton, dcarlton1@aol.com, Contractor from Fire Program Solutions, LLC
Corky Conover, corky_conover@nps.gov, Sequoia & Kings Canyon National Parks
Aaron Gelobter, agelobter@fs.fed.us, Sequoia National Forest
Tony Sarzotti, asarzotti@ca.blm.gov, Bakersfield Bureau of Land Management
Diane Travis, dsutphentravis@fs.fed.us, Sequoia National Forest
Anne Birkholz, anne_birkholz@nps.gov, SSGIC

Review of IIAA Data

Three agency datasets of NFMAS Suppression Table 1 data from the IIAA module were available. The Bakersfield BLM District data included two Fire Management Zones (FMZ) identified as B5 (grass/shrub) and B3 (high elevation Pinyon/Juniper). The Sequoia National Forest data included three FMZ's identified as 01 (grass/shrub), 02 (mixed conifer), and 03 (mixed conifer). The third dataset was developed jointly by the Sequoia National Forest and Sequoia & Kings Canyon National Parks for the Hume Lake area. It was identified as J4 and characterized as high elevation.

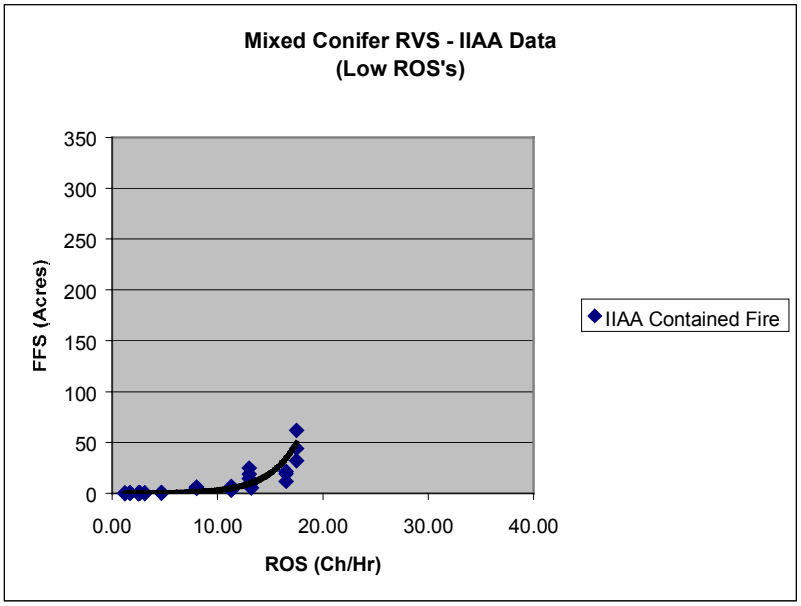
Comparison of these data relating ROS to FFS supported the conclusion that sufficient variation existed between the FMZ's to justify more than a single regression equation to relate ROS to FFS. Subsequent review of the escaped fire data below confirmed this conclusion. The decision was made to proceed to develop three regression equations representing three ROS vs. FFS (RVS) relationships.

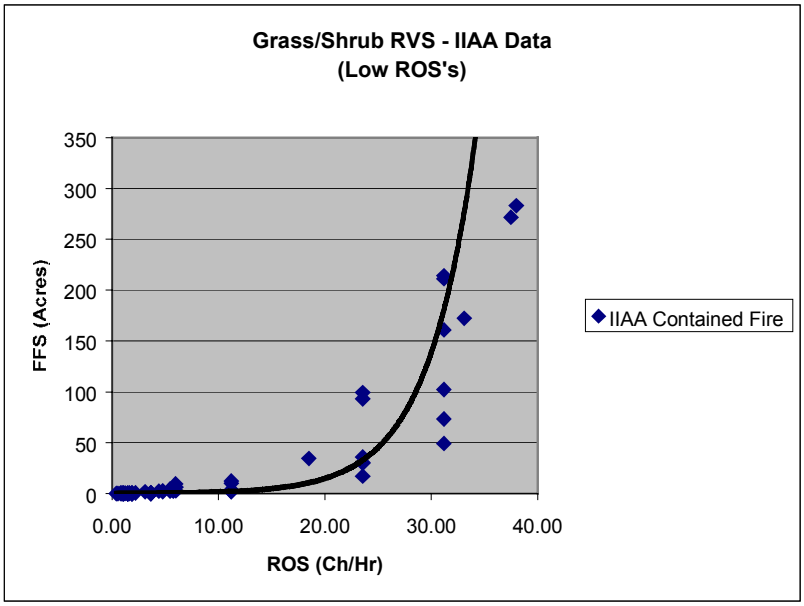
The table below summarizes these RVS's.

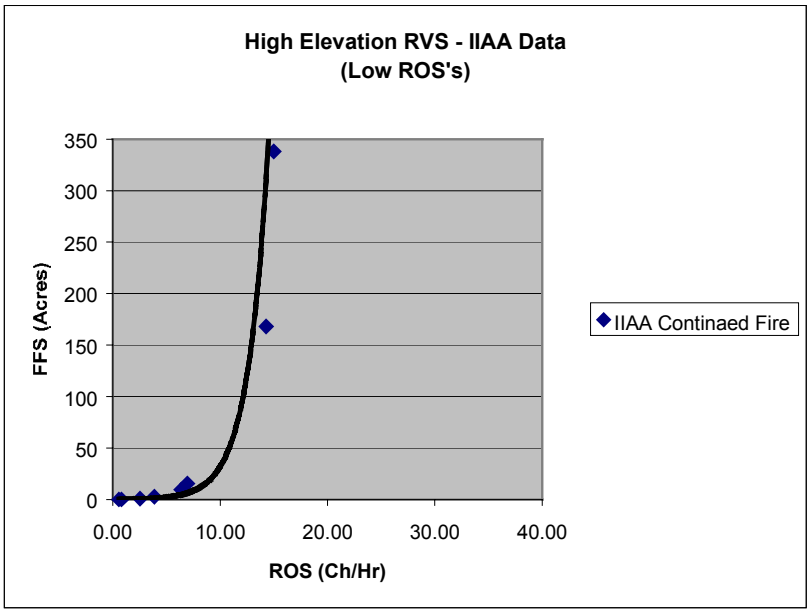
RVS Description	Definition	Contributing FMZ's
High Elevation	Elevation 6,000+ ft ***	NPS/FS J4
Grass Shrub	Below 6,000 ft elevation *** Fuel models 1,2,3,4,5,6,15*, and 28**	BLM B3, BLM B5, and FS 01
Mixed Conifer	Below 6,000 ft elevation *** Fuel models 8,9,10,11,12, and 13	FS 02 and FS 03

* Fuel model 15 characterizes high elevation, desert fuels
** Fuel model 28 characterizes structural, urban fires
*** Addendum – Definition of High Elevation RVS later modified to > 7,500 feet based on subsequent analysis and subject matter expert opinion.

The driving issue for defining the High Elevation RVS was limited access by fire fighters to these areas. Fuel type was the driving issue defining the lower elevation RVS's. Graphs showing the IIAA datasets for each RVS follow:







Review of Fire Progression Maps

Fire progression maps were available for 9 escaped fires to develop the ROS to FFS relationship at high ROS's. Discussion for each centered on the best interpretation of the maps themselves based personal knowledge of the fires regarding issues such as topography, weather conditions, effective hours of burn time between recorded perimeters, fuels, resources available, operational strategies implemented, etc. This knowledge was essential to refine the interpretation of the maps. It was also utilized to determine which fires were representative of each RVS to subsequently include in the regression equations. Data were discarded from the King, Manter, Coffee, Stormy, and Highway fires based on expert knowledge for a variety of reasons. There were no fires whose data adequately represented the Mixed Conifer RVS. The table below summarizes utilized data.

RVS	Fire	Agency	Date	ROS (ch/hr)	FFS
Grass/Shrub	Kaweah	NPS/CDF/BLM	8/13/96	15.06	
			8/14/96	49.24	
			Average	33.29	4898
Grass/Shrub	Buckeye	NPS	10/16/88	52.53	
			10/16/88	30.30	
			Average	37.71	3075
Grass/Shrub	Jack's Creek	BLM	8/9/97	54	
			8/10/97	32	
			Average	41.78	5693
High Elevation	Choke	NPS/FS	8/6/97	20.48	
			8/7/97	13.81	
			8/8/98	17.86	
			Average	17.38	3926

Regression Equations
Once the data points contributing to each regression equation were identified, Don Carlton fit a variety of equation forms to the points using Prism software and participants evaluated them and selected a "best fit". The selected equations are double quadratic of the form:

$$Y = E + A * X^B + C * X^D$$

The table below contains the coefficient values for each RVS.

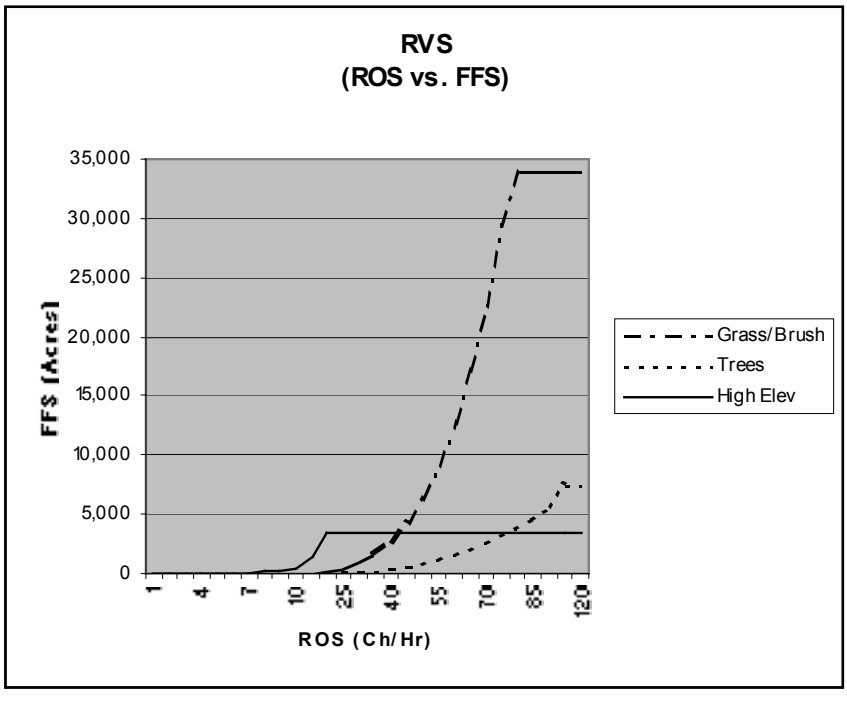
Coefficient	Grass/Shrub RVS	Mixed Conifer RVS	High Elevation RVS
A	0.02339	-0.01128	0.0268
B	3.607	3.013	3.771
C	-0.02237	0.01626	0.0268
D	3.561	3.041	3.771
E	0.1	0.1	0

A constant of 0.1 acres (coefficient E) was added to the FFS for the Grass/Shrub and Mixed Conifer regression equations to correct predicted FFS's of 0 for small ROS's. This was unnecessary for the High Elevation RVS. All equations were forced through the origin at 0,0.

Maximum Fire Size
A maximum fire size for each RVS was determined from NFMAS data and group discussion. This is necessary to prevent the model from predicting exceedingly large fires at high ROS's. The maximum fire sizes are:

High Elevation – 3,500 acres
Mixed Conifer – 7,500 acres
Grass/Shrub – 34,000 acres

The final regression equations are shown in the chart and table below.



Tabular View of Predicted FFS (Acres) for each Regression Equation

ROS (ch/hr)	Grass/Shrub RVS	Mixed Conifer RVS	High Elevation RVS
1	0.1	0.1	0.1
2	0.1	0.1	0.7
3	0.2	0.3	3
4	0.5	0.5	10
5	1	0.8	23
6	1	1	46
7	3	2	82
8	5	3	136
9	8	4	212
10	13	6	316
15	63	22	1,459
20	192	53	3,500
25	452	106	3,500
30	906	186	3,500
35	1,631	300	3,500
40	2,709	453	3,500
45	4,238	652	3,500
50	6,319	902	3,500
55	9,066	1,211	3,500
60	12,602	1,584	3,500
65	17,056	2,028	3,500
70	22,566	2,549	3,500
75	29,281	3,154	3,500
80	34,000	3,849	3,500
85	34,000	4,641	3,500
90	34,000	5,536	3,500
100	34,000	7,500	3,500
120	34,000	7,500	3,500

Summary

Regression equations relating ROS to FFS were developed to implement the WFSI model for the SSGIC. Evaluation of the data supported the decision to identify three ROS vs. FFS (RVS) strata and an equation was developed for each. The three RVS's were High Elevation, Grass/Shrub, and Mixed Conifer. In evaluating the equations, it is important to recognize that the purpose of the WFSI is not to predict actual FFS's, but to ordinate them across the landscape.