How WGB Dryness Levels (DL) were Developed in the 7-day Fire Potential Outlook:

Historically, the fire community has defined fuel dryness in terms of percentile ranks of various NFDRS fuel moisture elements. In Nevada, this usually meant 80/95th or 90/97th percentile values of either BI or ERC. Using these thresholds is a legitimate way of assessing fuel dryness, but ideally, threshold values should be chosen that actually relate to fire activity. My goal was to choose thresholds that directly relate to increased probability of large fires.

From correlation analysis between NFDRS fuel moisture elements and large fire occurrence we found that a **combination of F100 and ERC** for fuel model G (ERC-G) had the highest correlation with historical fire activity for most of our Predictive Service Areas (PSA). With this as a basis, we created a simple matrix of F100 versus ERC-G for each PSA and then partitioned the matrix into 3 separate areas. Each partition corresponded to significantly different probabilities of large fire occurrence.

1. For each PSA a matrix was developed showing ERC-G, in 5-unit increments, along the x-axis and F100, in 1-unit increments, along the y-axis. For each cell division within the matrix the total number of fire days (i.e. days with at least 1 fire reported) was recorded. We used the months of May-September for the years 1986-2004. This is referred to as our **Fire Day Matrix**. An example for Nevada PSA 6 (the Humboldt Basin) is shown below.

F100 \ ERC	<65	65	70	75	80	85	90	95	100	105	110	
2	0	0	0	0	0	0	0	1	0	2	1	4
3	0	0	0	0	0	1	1	11	16	7	0	36
4	0	0	0	2	7	12	42	31	18	0	0	112
5	0	6	5	6	10	18	23	11	4	0	0	83
6	2	5	4	5	10	13	8	0	0	0	0	47
7	5	1	3	3	7	5	1	0	0	0	0	25
8	3	3	5	8	2	1	0	0	0	0	0	22
9	4	1	4	8	1	0	0	0	0	0	0	18
10	3	2	3	3	1	0	0	0	0	0	0	12
11	2	0	3	1	0	0	0	0	0	0	0	6
>11	6	0	0	0	0	0	0	0	0	0	0	6
	25	18	27	36	38	50	75	54	38	9	1	371

We see that in our 18 year sample, there was a total of 371 fire days for the months of May through September broken down by F100 vs ERC-G combinations.

2. Next, an identical matrix was developed except instead of all fire days, <u>only large fire days</u> were included. The **Large Fire Day Matrix** for PSA 6 is shown below.

F100 \ ERC	<65	65	70	75	80	85	90	95	100	105	110	
2	0	0	0	0	0	0	0	0	0	0	0	
3	0	0	0	0	0	1	1	2	2	4	0	10
4	0	0	0	0	1	1	10	9	1	0	0	22
5	0	0	0	1	2	3	3	3	2	0	0	14
6	0	1	0	0	1	2	1	0	0	0	0	5
7	1	1	0	1	0	0	0	0	0	0	0	3
8	0	0	2	2	0	0	0	0	0	0	0	4
9	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	1	0	0	0	0	0	0	0	1
>11	0	0	0	0	0	0	0	0	0	0	0	0
	1	2	2	5	4	7	15	14	5	4	0	59

This demonstrates that of the 371 Fire Days, 59 of them were also Large Fire Days. The matrix shows their relationship to F100 and ERC-G percentile levels.

3. The next task was to partition the matrix into 3 separate divisions each showing a significantly different probability of a large fire. This is done by dividing the number of large fire day occurrences for a particular F100/ERC combination (cell) from the Large Fire Day Matrix by the number of fire day occurrences for the corresponding cell in the Fire Day Matrix. This represents the historic probability that given a fire day having a particular ERC/F100 combination, a large fire would occur. For example, when the ERC was between 80 and 84 and the F100 was 6, there were a total of 10 fire days (from the Fire Day Matrix). For that same ERC/F100 combination, of the 10 fire days, 1 of them was a large fire day (from the Large Fire Day Matrix). Dividing 1 by 10 results in a probability of 10% that given at least 1 ignition with that particular combination of ERC/F100, a large fire would result.

Once probabilities for all matrix cells are computed, the matrix can be divided into three distinct divisions, each having a significantly different conditional probability for a large fire than the other:

Dryness Level (DL)	Probability of a Large Fire, given a Fire Day	Percent of all Large Fire Days
Moist	8%	15%
Dry	17%	36%
Very Dry	22%	49%

This table shows that for our 18 year sample, given at least 1 ignition, only 8% turned into a large fire when the ERC/F100 combination fell within the Moist (green) area of our matrix. Furthermore, only 15% of all large fires occurred under Moist conditions. On the other end of the spectrum, 22% of all fire days produced a large fire when conditions were Very Dry (brown) and of all large fires, nearly half (49%) were during Very Dry conditions.

Fire Day and Large Fire Day matrices have been developed for each of our 12 PSAs and are updated every year after the previous year's fire occurrence data is available.

Operational Use of our DLs

Each day during the fire season we make a forecast of the DL for each PSA for each of the next 7 days. This is posted to the NWCC web page as part of the **7-Day Significant Fire Potential** product. The DL is portrayed as green, yellow or brown representing moist, dry or very dry conditions, respectively. The forecasts are generated by regression equations developed by the Desert Reseach Institute that use predictors derived from weather models as well as the previous day's observed NFDRS fuel moistures.

Thoughts Regarding Fuel Dryness

High values of ERC and low 100-hour fuel moistures are well correlated with fire activity in Nevada. Their relationship to large fire occurrence is even better when used together. This makes some sense: by including F100, we are essentially adding more weight to lighter fuels than what would be present by using ERC by itself. **The ERC is a composite of fuel moisture from all size classes of fuel, both living and dead, but is heavily weighted toward fuel moistures of large fuels (F1000)** and hence is a relatively conservative measure, acting more slowly to daily fluctuations in air mass moisture. On the other hand, **F100 is much more responsive to daily moisture fluctuations. By using both measures together a better representation of both the longer term moisture levels (ERC) and the more volatile daily moisture levels (F100) is achieved.**

Another very important point that should be recognized about our DLs is that they were developed with no regard given to other factors that influence large fire occurrence such as whether or not lightning was present or whether conditions were windy or unstable. In other words, factors such as lightning events or human starts were not extracted from the sample before the analysis to determine the DL was conducted. Therefore we don't know for certain how much of the correlation between DL and large fire occurrence was truly due to the fuel dryness and how much may be attributable to other "wildcard" influences. My present feeling is that in the grand scheme of things it will not present a significant problem because we are looking at a very large sample size over many years. Future attempts to determine fire potential will undoubtedly include many more factors than just fuels dryness, but for now we can demonstrate good correlation with fire activity and we will continue to use it.