

Fiscal Year 2011 September Federal Land Assistance, Management and Enhancement (FLAME) Act Forecast For the USDA Forest Service

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Originally submitted August 31, 2010; adjusted November 10, 2010

Executive Summary

The Forest Service predicts that the Agency total emergency suppression spending for fiscal year (FY) 2011, which includes a fixed charge for the Wildlife Suppression (WFSU) Cost Pool (\$47.96 million), will range with 90 percent confidence between \$780 million and \$1.482 billion, with a median forecast of \$1.105 billion. The 80 percent confidence band ranges from \$831 million to \$1.388 billion. This total is comprised of above-average spending expected for the national forests of the Pacific Southwest (Region 5) and the combined total of the spending in Eastern (Region 9) and Southern (Region 8) national forests. Higher than recent historical average spending in these regions is expected because of ongoing La Niña conditions in the eastern tropical Pacific Ocean, which are linked to below-normal rainfall and above-normal temperatures and hence higher wildfire activity in those segments of the country. The Pacific Southwest's higher costs are also linked to the current phase of the Pacific Decadal Oscillation favoring warmer and drier weather, ongoing drought, and a historical trend of rising costs independent of drought and La Niña. In contrast, northern portions of the western U.S. are expected to continue with moderate wildfire activity because of alleviating drought and the wetter weather expected there because of the expected continuing La Niña conditions in the tropical Pacific.

Modeling Details

To meet the statutory requirements of the FLAME Act, the Forest Service developed statistical models based on peer reviewed research^{1,2}. These models are estimated simultaneously, as a system of six equations. For this forecast, like the forecasts issued in the Fall of 2009 and the Spring of 2010 for FY 2010, equations are specified for the following regions or regional aggregates: (i) Region 1 plus Region 4, (ii) Region 2 plus Region 3, (iii) Region 5, (iv) Region 6, (v) Region 8 plus Region 9, and (vi) Region 10 plus the National Interagency Fire Center, Washington Office, and research stations, which we label in this report as "RFS." The statistical relationships estimated in the system connect emergency spending in the coming fiscal year in the region or regional aggregate to lagged measures of drought (Palmer indices), ocean temperatures (the Niño-3 sea surface temperature anomaly), and ocean pressure (Pacific Decadal Oscillation, the North Atlantic Oscillation, and the Atlantic Multidecadal Oscillation indices). The equations for both Regions 5 and 6 also include a time trend. Equation Model estimates are shown in Table A, which appears in an Appendix to this report.

Forecasts are done with data on region-level costs that exclude special Cost Pool and aviation charges. Data range from 1995 to 2009 and for modeling purposes are deflated to a common

¹ Prestemon, J.P., K.L. Abt, and K. Gebert. 2008. Suppression cost forecasts in advance of wildfire seasons. *Forest Science* 54(4):381-396.

² Abt, K.L., J.P. Prestemon, and K. Gebert. 2009. Wildfire suppression cost forecasts for the US Forest Service. *Journal of Forestry* 107(4):173-178.

dollar index of 2004. Forecast models account for correlations in both coefficient statistical estimates and equation errors. Forecasts are done by randomly sampling from equation error and coefficient error distributions in a way that accounts for the observed correlations in coefficient and equation errors. Monte Carlo simulations, therefore, randomly draw from these correlated random error distributions and are repeated 50,000 times. At the end of the simulation, all values are ranked and then used to develop a probability density function (Figure 1) and are exploited to extract mean, median, and upper and lower bounds of various confidence limits.

Modeling Results

The September Out-Year Forecast Model (SOYFM) has a median forecast in 2011 inflated dollars of \$1.105 billion. This is calculated as the sum across all individual region or regional aggregate forecasts and corresponds with the middle value out of 50,000 simulated values. The 95 percent confidence limit of this forecast ranges from \$700 million to \$1.565 billion, the narrower 90 percent confidence limits are \$760 million to \$1.482 billion, while the even narrower 80 percent confidence limits are \$831 million to \$1.388 billion. The 90 percent confidence band characterizes the statistical probability that there is only a one out of ten chance that the realized value for 2011 will lay outside the range of \$760 million to \$1.482 billion. In fact, the probability that any particular budgeted amount would be sufficient can also be obtained from these same ranked Monte Carlo values (Table 2).

This SOYFM indicates that most regions should have average to above-average costs, when compared across spending from 1995 to 2009 (Table 3). The exception to this is the Region 1 + Region 4 aggregate, which is expected to have below-average costs. When compared with spending over the last 33 years, however, the entire Agency except for Region 1 + Region 4 is expected to have above-average costs.

To assess the performance of the SOYFM, cross-validated (“jackknife”) forecasts of agency-wide suppression costs were done; these are shown in Figure 2. The cross-validation is done to assess how well such a model performs in “out-of-sample” conditions. The goodness of fit in the forecast can also be assessed using the Root Mean Squared Error (RMSE), the Mean Absolute Percent Error (MAPE), and the correct direction of change prediction. The cross-validation exercise indicates that the RMSE is \$270 million in constant 2004 dollar terms. This is more uncertain than the Fall Current Year Forecast Model, which has an RMSE of \$207 million or the Spring Current Year Forecast Model, with an RMSE of \$149 million, as calculated over 1995 to 2009. MAPE comparisons indicate that the SOYFM is somewhat better, at 30 percent, compared to the FCYFM, 37 percent, but not as precise as the SCYFM, 20 percent. The correct direction of change prediction is the same for the SOYFM, FCYFM, and the SCYFM, at 87 percent.

The September forecast model can also be compared to a competing 2-Year-Out Forecast model, issued in November of 2009, which also forecast these costs for FY 2011. That model had a cross-validated RMSE of \$264 million and a MAPE of 36 percent over the same 1995-2009 period. The FY 2011 forecast using that model was \$1.144 billion (in 2004 constant dollars, and excluding the WFSU Cost Pool charges for FY 2011). However, that same model would have forecast a cost of \$1.583 billion for Fiscal Year 2010 (excluding Cost Pool and aviation charges). It is likely that the true cost excluding those charges will be half that level, closer to the costs that

would have been forecast for FY 2010 by the SOYFM (\$856 million, excluding the Cost Pool and aviation charges); this is an indication that the RMSE for the former will rise when it is calculated over 1995 to 2010, while the RMSE for the SOYFM model will either shrink or not increase as much.

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**Table 1. Fiscal Year 2011 Emergency Suppression Cost Forecasts, by Region, current
(FY 2011) dollars**

	R 1&4	R 2&3	R 5	R 6	R 8&9	R 10&13	Total
	2011 \$ Million						
Median	32	84	630	112	67	157	1,095
95% Confidence Lower Bound	7	0	431	43	23	48	700
95% Confidence Upper Bound	138	212	831	283	110	266	1,565
90% Confidence Lower Bound	9	0	463	50	30	66	760
90% Confidence Upper Bound	108	191	798	243	103	249	1,482
80% Confidence Lower Bound	12	0	500	60	38	86	831
80% Confidence Upper Bound	83	168	761	206	95	229	1,388

Note: This table includes the Fiscal Year 2011 WFSU Cost Pool as a fixed charge, which is added to the Region 10 + RFS forecast and the agency-wide total.

Table 2. Fiscal Year 2011 Emergency Suppression Cost Forecasts, by Percentiles (FY 2011) dollars.	
Probability (%) of Falling Below Indicated Dollar Amount	Realized Amount (\$ Million 2011)
1	631
5	760
10	831
20	920
30	985
40	1,042
50	1,095
60	1,150
70	1,210
80	1,283
90	1,388
95	1,482
99	1,670

Note: This table includes the Fiscal Year 2011 WFSU Cost Pool as a fixed charge, which is added to the Region 10 + RFS forecast and the agency-wide total.

Table 3. Fiscal Year 2011 Emergency Suppression Cost Forecasts, by Terciles		
Region or Aggregate	Tercile of Costs Expected, Last 15 Years	Tercile of Costs Expected, Last 33 Years
R 1 + R4	Lower	Lower
R 2 + R3	Middle	Upper
R 5	Upper	Upper
R 6	Middle	Upper
R 8 + R9	Upper	Upper
R 10 + RFS	Middle	Upper
Total	Upper	Upper

Note: Fiscal Year 2011 WFSU Cost Pool charges are assumed to be zero in this and all previous year rankings.

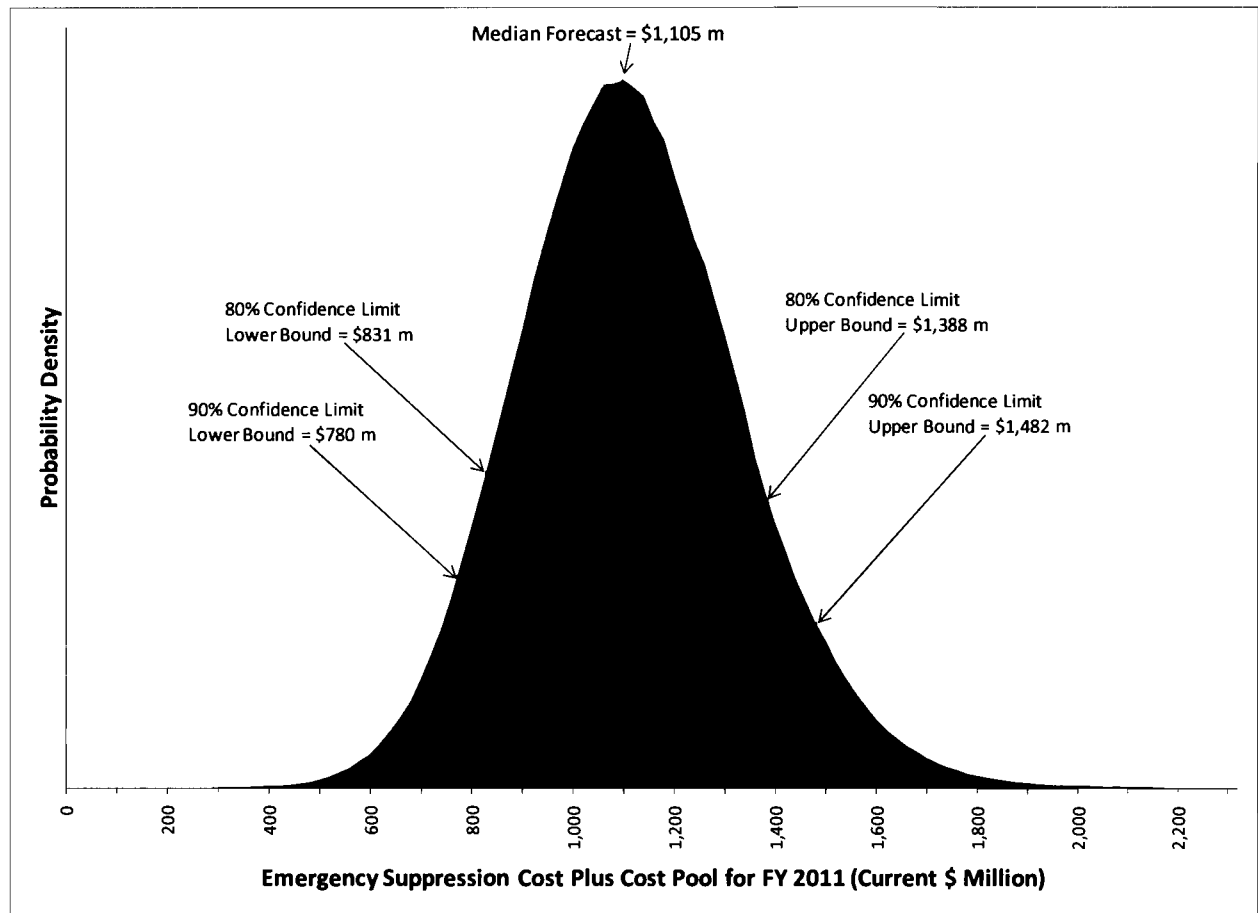


Figure 1. USDA Forest Service emergency suppression cost forecast probability density, Fiscal Year 2011, September FLAME Act forecasting model. Note: Fiscal Year 2011 WFSU Cost Pool charges are included in this probability density display.

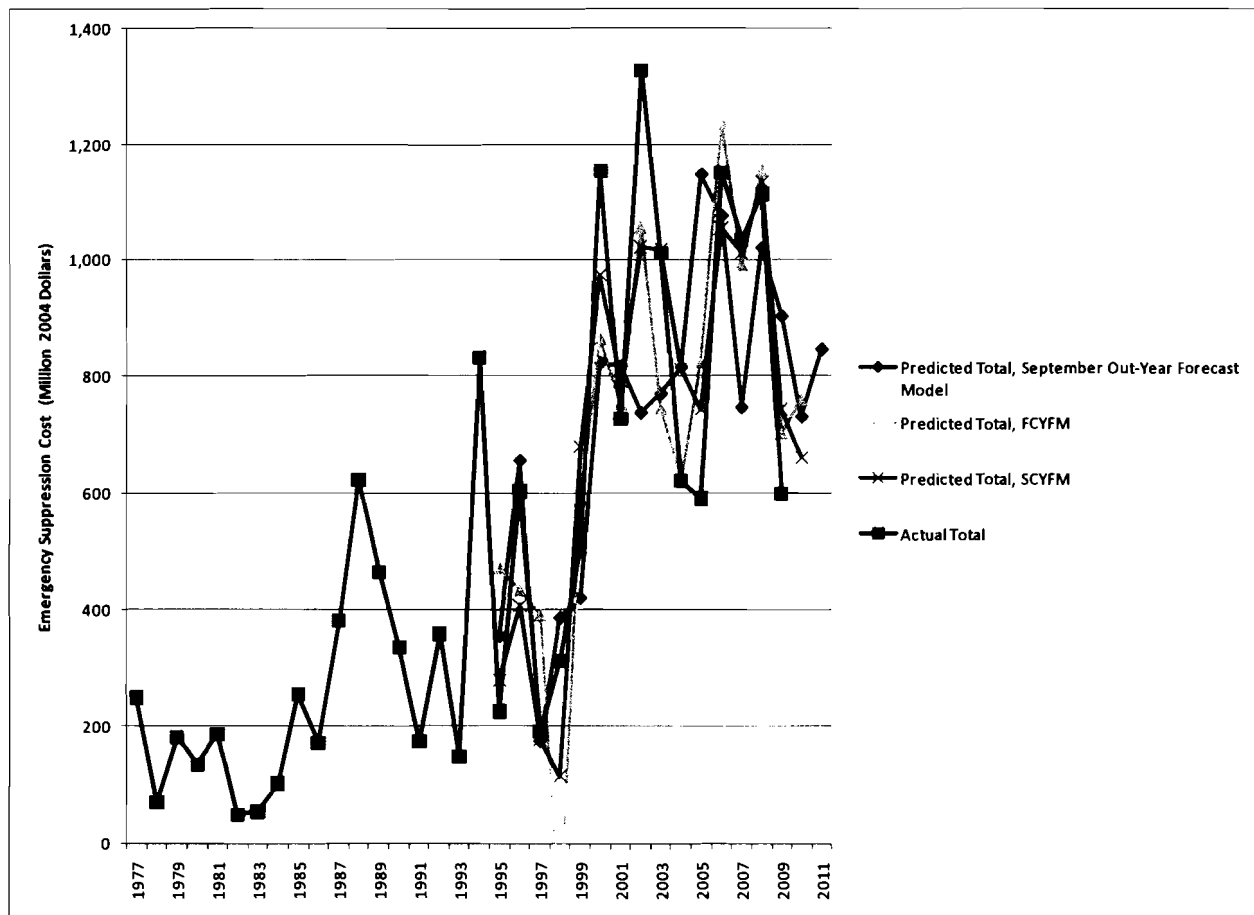


Figure 2. Cross-validated forecasts of agency-wide total USDA Forest Service emergency suppression costs, 1995-2011, and actual spending, 1977-2009, comparing the new September Out-Year Forecast Model (SOYFM) with the Fall Current Year Forecast Model (FCYFM) and the Spring Current Year Forecast Model (SCFYM). Values shown are in constant (2004) US dollars to account for inflation. All figures exclude special agency Cost Pool and aviation charges.

Appendix: Estimate of the September Out-Year Forecast Model System of Equations

Table A. Seemingly Unrelated Regression Equation Estimates, Forest Service September Out-Year Forecast Model

Dependent Variable	Independent Variables	Coefficient	Std. Error	t-Statistic	P-Value	R ²	Durbin-Watson Statistic
Ln(Region 1 + Region 4 Cost)						0.4	
	Constant	17.01	0.36	47.77	0.00	4	1.48
	AMO Oct-Feb(t-1)	4.02	0.73	5.53	0.00		
	NAO Oct-Feb(t-1)	0.90	0.22	4.06	0.00		
	PDSI R1 + R4 H-index June (t-1)	-0.28	0.09	-3.02	0.00		
Region 2 + Region 3 Cost						0.4	
	Constant	90,244,957	14,121,798	6.39	0.00	7	2.10
	PDSI R1 H-index June (t-1)	-20,809,926	4,928,099	-4.22	0.00		
	PDSI R3 H-index June (t-1)	6,483,038	3,636,131	1.78	0.08		
Region 5 Cost		-				0.7	
	Constant	45,338,064,39	7,786,268,95			6	1.82
	Year	0	7	-5.82	0.00		
	Niño-3 SSTA Oct-Feb(-1)	22,758,649	3,888,992	5.85	0.00		
	Niño-3 SSTA March-July(t-1)	78,921,998	17,079,599	4.62	0.00		
	PDO Oct.-Feb. (t-1)	-255,250,683	54,559,785	-4.68	0.00		
	PDO March-July(t-1)*Niño-3 SSTA March-July(t-1)	-31,438,948	20,181,110	-1.56	0.12		
		121,118,394	39,798,236	3.04	0.00		
Ln(Region 6 Cost)						0.7	
	Constant	-784.40	339.10	-2.31	0.02	2	1.86
	PDSI R1 H-index June (t-1)	-0.36	0.05	-6.63	0.00		
	PDSI R4 H-index June (t-1)	0.16	0.05	3.41	0.00		
	NAO Oct-Feb(t-2)	105.58	44.61	2.37	0.02		
Region 8 + Region 9 Cost						0.5	
	Constant	54,983,178	4,854,838	11.33	0.00	9	1.80

	Niño-3 SSTA Oct-Feb(t-1)	-10,816,204	3,282,869	-3.29	0.00		
	PDSI R4 H-index June (t-1)	4,254,361	1,420,711	2.99	0.00		
	PDSI R9 H-index June (t-1)	-12,380,115	3,237,714	-3.82	0.00		
						0.4	
Region 10 + RFS Cost	Constant	84,532,231	12,006,520	7.04	0.00	4	2.51
	PDSI R1 H-index June (t-1)	-20,786,288	6,774,021	-3.07	0.00		
	PDSI R2 H-index June (t-1)	15,514,660	4,990,737	3.11	0.00		