Federal Land Assistance, Management and Enhancement (FLAME) Act Suppression Expenditures for Interior and Agriculture Agencies:

March 2012 Forecasts for Fiscal Year 2012

Report Date: February 6, 2012

Executive Summary

The USDA Forest Service is forecast to spend, with 80% confidence, between $668m and $1.421b in Fiscal Year (FY) 2012, while the agencies of the Department of the Interior are forecast to spend, with 80% confidence, between $234m and $573m. The Forest Service forecast includes $47m in expected contributions to the agency's Wildland Fire Suppression Cost Pool. The median forecast for the Forest Service is $966m, while the median forecast for Interior is $366m. Excluding the Cost Pool, the Forest Service's median forecast for FY 2012 represents average costs compared to recent years (since 1995). Compared to the September 2011 forecast of these costs for FY 2012, conditions have become more favorable for active seasons in Regions 2, 3, and 5, and this is at least partly attributable to cold central Pacific Ocean temperature (La Niña)-related drought conditions in the Southwest. Northern and northwestern portions of the West remain relatively moist, so these forecasts are little changed from September. Interior agency expenditures are also expected to be higher than average in FY 2012, due especially to persistent drought in the Southwest. The DOI forecast has shifted substantially higher since the September 2011 forecast. The primary reason for this is persistent La Niña-related dry conditions in the Southwest. A secondary reason is that the March DOI forecast model includes December drought data and uses a longer time series of historical observations. This version is also more accurate than the September version.

Overview

The Rocky Mountain Research Station (RMRS) has provided monthly forecasts of annual FS suppression expenditures since FY 1998 and annual DOI suppression expenditures since FY 2005. In addition, starting in FY 2003, the RMRS and the Southern Research Station (SRS) have collaborated to provide "early warning" forecasts of annual Forest Service suppression expenditures in the fall and spring of the fiscal year. With the passage of the FLAME Act in 2009, both the Forest Service and the Department of the Interior are required to produce forecasts of annual suppression expenditures three times during each fiscal year: March, May, and July, with a September outlook for the next fiscal year required when the next fiscal year budget is not approved by Congress and the President by that date. The current report was produced in early February, 2012, in time for review and in compliance with the March 1, 2012, due date for this forecast for FY 2012.

Modeling

Modeling Framework for the March 2012 Forecast of FY 2012 Forest Service Expenditures

To meet the statutory requirements of the FLAME Act, the Forest Service developed statistical models based on peer reviewed research[1,2]. These models have been developed for several forecast horizons and are generally specified as a system of equations. Each of the six equations contained in the current modeling system represents a statistical relationship between historical costs and a set of predictor variables for a particular Forest Service region or the sum of two regions. These equations are estimated simultaneously as a system but allowed to solve without constraints across equations within the system. For this reason, the estimation procedure is called Seemingly Unrelated Regression (SUR).

For this forecast, similar to the forecast issued in September of 2011 for FY 2012 and all previous FLAME Act forecasts, equations were 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 that were identified with extensive research effort relate spending in the coming fiscal year to lagged measures of drought (Palmer indices), ocean temperatures (the Niño-3 sea surface temperature anomaly), and ocean pressure indices (North Atlantic Oscillation and the Atlantic Multi-decadal Oscillation). The equation for the Region 10 + RFS aggregate included a time trend.

Equation estimates are shown in Table A1, located in an Appendix to this report. This table indicates that most models had moderate to high R^2's, ranging from 0.43 (Region 1 and 4 aggregate) to 0.79 (Region 5). Durbin-Watson statistics, designed to detect serial autocorrelation in the residuals of estimated equations, were all within the acceptable (insignificant) range.

Forecasts were made using the equation estimates shown in Table A1 for region-level costs that excluded the contributions to the Cost Pool, which are held constant in the simulation and then added back to the costs for the Region 10 and RFS aggregate. Data for modeling were annual fiscal year totals of expenditures, and they ranged from 1995 to 2011, the only years for which consistent region-level data could be assembled. To erase the effects of general price inflation, all costs were deflated to the value of a dollar in 2004 using the gross domestic product deflator—that is, models were estimated and costs were forecast in "real" dollar terms. After the forecast, we adjusted the forecast values to put them in current dollars. SUR estimates allowed for more precise identification of statistical relationships by using the correlations in estimation errors. When generating a forecast distribution (see Figure 1), we randomly sampled from equation error and coefficient distributions in ways that accounted for the uncertainties in the forecast. These Monte Carlo forecasts, which are repeated 50,000 times for the Forest Service forecast, do not produce a precise estimate. Rather, they generate a distribution of estimates. This distribution can be summarized in many ways. These forecasts emanating from the Monte Carlo simulation produced a forecast density distribution, a table reporting a median forecast and the lower and upper bounds of likely observed costs, a table of not-to-exceed costs by probability

[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.

levels, and a description of where the median forecast value fell within the observed historical costs for other years, in real dollar terms.

Model fitness is reported in the Appendix of this report and is described both graphically (Figure A1) and tabularly (Table A2). The graph shows how well the March 2012 Current Year Forecast Model out-of-sample forecasts (produced by dropping the observation of the forecast year, and doing this iteratively over the historical data, a technique sometimes termed "jackknife") compared with observed expenditures for the Forest Service as well as forecasts produced by the September Out-Year Forecast Model. Table A2 shows that the root mean squared error of the model used in this March 2012 forecast of FY 2012 expenditures, when applied to the 1995-2011 period, was $278m and that it had a negligible positive bias, tending to over-forecast by about $0.5m (0.08%). (This positive bias was not subtracted from the March 2012 forecast for FY 2012.) The model had a Mean Absolute Percent Error of about 31%, meaning that the typical forecast averaged 31% above or below expenditures actually incurred during the 1995-2011 period. Finally, this model correctly predicted the direction of change in emergency suppression expenditures by the Forest Service 87.5% of the time—that is, in all but two of the years, 1996-2011. The predicted direction of change is positive, the median 2012 forecast roughly $43m higher than the observed 2011 expenditure (excluding cost pools).

Modeling Framework for the March 2012 Forecast of FY 2012 Department of the Interior Expenditures

The development of a forecast model for the Department of the Interior (DOI) was constrained by a lack of detailed regional expenditure data for the Department. Therefore, DOI suppression expenditure data used in the March 2012 Current Year Model covered fiscal years 1985-2011. Although geographical and agency disaggregations were available for recent years (since the early 2000's), there are insufficient data for modeling by geographic region or agency within the Department. We modeled aggregate DOI expenditures using a parsimonious model specification involving four Palmer H-indices from the West and the one-year lag of DOI expenditures. This is different from previous models, which have primarily related DOI expenditures to Forest Service expenditure forecasts or just the drought indices. One advantage of using Palmer indices rather than Forest Service forecast expenditures is that historical values of the Palmer H-indices were available for the entire length (1985-2011) of the DOI time series.[3]

The DOI emergency suppression expenditure forecast equation is reported in Table A3. It included the Regions 1 and 4 Palmer H-index values for June of the previous year (t-1), Region 1 and 3 indices for the most recent December (i.e., December 2011 values are used to forecast FY 2012 costs), lagged expenditures, and an intercept. The estimated equation explained 73% of the variation ($R^2 = 0.73$) in annual DOI suppression expenditures over the historical time period, 1985-2011. The Durbin H-statistic indicates weak evidence (p=0.07) of remaining residual autocorrelation in the model estimation errors.

[3] Although the H-indices that we used were based on Forest Service regional geographic boundaries, this allowed for at least a partial representation of how some DOI costs typically cover some Forest Service wildfires. Lagged DOI expenditures helped to limit autocorrelation of model residuals, which can introduce downward bias in standard errors of parameter estimates.

Model fitness for the March Current Year Forecast Model for DOI is reported in Appendix Table A4. As in the case of the Forest Service March Current Year Forecast Model, the DOI March Current Year Forecast Model was evaluated by making jackknife forecasts of DOI expenditures. This March forecast model had a root mean squared error of about $79m, calculated over 1995-2011, $73m when calculated over 1985-2011. The model had a bias of about $6m (2.4%) calculated over 1995-2011 and $9m (3.8%) calculated over 1985-2011 (and these historical biases were not used to adjust the 2012 forecast.) The model had a Mean Absolute Percent Error of about 25% for the 1995-2011 period and 30% for the 1985-2011 period. It correctly predicted the direction of change in emergency suppression expenditure for the agency from one year to the next about 77% of years 1995-2011 and 73% of years 1986-2011.

Results

USDA Forest Service

FY 2012 emergency suppression expenditures are forecast to range, with 80% confidence, between $668m and $1.421b. The median forecast is $966m. These costs include $47m in estimated Cost Pool contributions, held constant in the Monte Carlo simulation that generated the median and confidence limits, which are added to the Region 10 plus RFS forecasts (Table 1). Uncertainty can be appreciated by examining the forecast probability density (Figure 1) and the not-to-exceed levels at a range of probabilities (Table 2). As Table 2 shows, this model states that there is a 1% chance that Forest Service emergency suppression expenditures, including the Cost Pool, will fall below $499m. In contrast, there is a 70% chance that these expenditures will fall below $1.13b.

An analysis of historical real dollar expenditures in emergency suppression contains information about the likely financial magnitude of spending for FY 2012 (Table 3), by Forest Service Region or region aggregate, and in total. An examination of this table reveals that, when compared to expenditures since 1995, the aggregate of regions 1 and 4 and Region 6 are expected to have expenditures in the lower tercile in 2012, the aggregate of regions 2 and 3 and Region 5 are forecast to have costs in the upper tercile, while the aggregate of regions 8 and 9 and of 10 and RFS are projected to have middle-tercile costs. On the other hand, when compared with spending since 1977, only Region 6 is expected to have lower-tercile costs in 2012. Region 5 and the aggregates of regions 2 and 3, 8 and 9, and 10 and RFS are expected to have upper-tercile costs, while the Region 1 and 4 aggregate is expected to have middle-tercile costs.

Department of the Interior

FY2012 emergency suppression expenditures for the DOI are forecast to range, with 80% confidence, from $234m to $573m, with a median forecast of $366m. The 90% confidence band spans $205m to $654m, while a 95% band spans $184m and $734m (Table 4). As in the Forest Service forecast, uncertainty surrounding the DOI forecast for FY 2012 can be appreciated by examining the probability density (Figure 2). This density distribution was developed using 50,000 Monte Carlo random forecasts, each generated by adding random errors to the forecast model. The median forecast expenditure for the Department is comparable in real dollar terms to the observed expenditures of the first decade of the 2000's.

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Table 1. March 2012 FLAME Act Forecasts of Fiscal Year 2012 Emergency Suppression Expenditures of the USDA Forest Service, by Region and in Total, Current (FY 2012) Dollars

	R 1&4	R 2&3	R 5	R 6	R 8&9	R 10+RFS*	Total*
	Millions of 2012 Dollars						
Median	$54	$161	$443	$47	$46	$157	$966
80% Confidence Lower Limit	21	84	243	27	26	107	668
80% Confidence Upper Limit	133	307	800	82	78	249	1,421
90% Confidence Lower Limit	16	70	205	23	23	98	604
90% Confidence Upper Limit	174	367	947	95	91	287	1,596
95% Confidence Lower Limit	13	60	178	20	20	91	554
95% Confidence Upper Limit	216	428	1,097	109	104	325	1,762

* Note: This table includes the Fiscal Year 2012 contributions to the Wildland Fire Suppression Cost Pool, expected to be $47 million, which are added to the Region 10 + RFS forecast and the agency-wide total.

Table 2. March 2012 FLAME Act Forecasts of Fiscal Year 2012 Emergency Suppression Expenditures of the USDA Forest Service, by Percentiles, Current (FY 2012) Dollars

Probability (%) of Falling Below Indicated Dollar Amount	Realized Amount* (Millions of 2012 Dollars)
1	$499
5	605
10	668
20	757
30	827
40	896
50	966
60	1,041
70	1,130
80	1,243
90	1,421
95	1,595
99	1,997

* Note: This table includes the Fiscal Year 2012 contributions to the Wildland Fire Suppression Cost Pool, expected to be $47 million.

Table 3. March 2012 FLAME Act Forecasts of Fiscal Year 2012 Emergency Suppression Expenditures of the USDA Forest Service, by Tercile*

Region or Aggregate	Tercile of Costs Expected, Since 1995	Tercile of Costs Expected, Since 1977
R 1 + R4	Lower	Middle
R 2 + R3	Upper	Upper
R 5	Upper	Upper
R 6	Lower	Lower
R 8 + R9	Middle	Upper
R 10 + RFS	Middle	Upper
Total	Middle	Upper

* Note: Historical Wildland Fire Suppression Cost Pool expenditures are assumed to be zero in all year emergency expenditure totals used in these rankings. Comparisons across years are in real (2004) dollars.

Table 4. March 2012 FLAME Act Forecasts of Fiscal Year 2012 Emergency Suppression Expenditures of the Department of the Interior, Current (FY 2012) Dollars

	Millions of 2012 Dollars
Median Estimate	$366
80% Confidence Lower Limit	234
80% Confidence Upper Limit	573
90% Confidence Lower Limit	205
90% Confidence Upper Limit	654
95% Confidence Lower Limit	184
95% Confidence Upper Limit	734

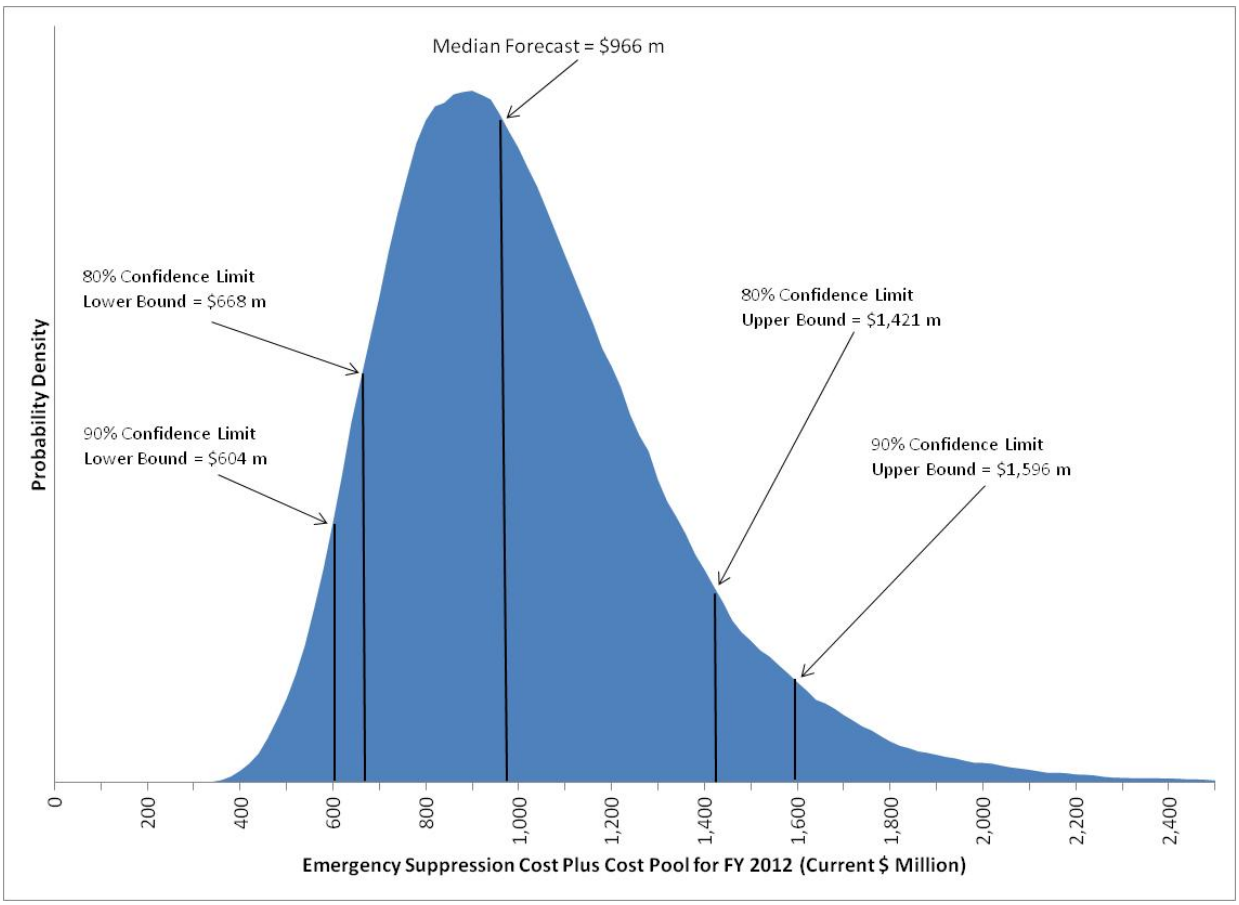

Figure 1. USDA Forest Service emergency suppression expenditure forecast probability density, Fiscal Year 2012, March 2012 version of the March Current Year Forecast Model. (Note: Fiscal Year 2012 Wildland Fire Suppression Cost Pool expenditures are included at their expected level of $47 million in this probability density display.)

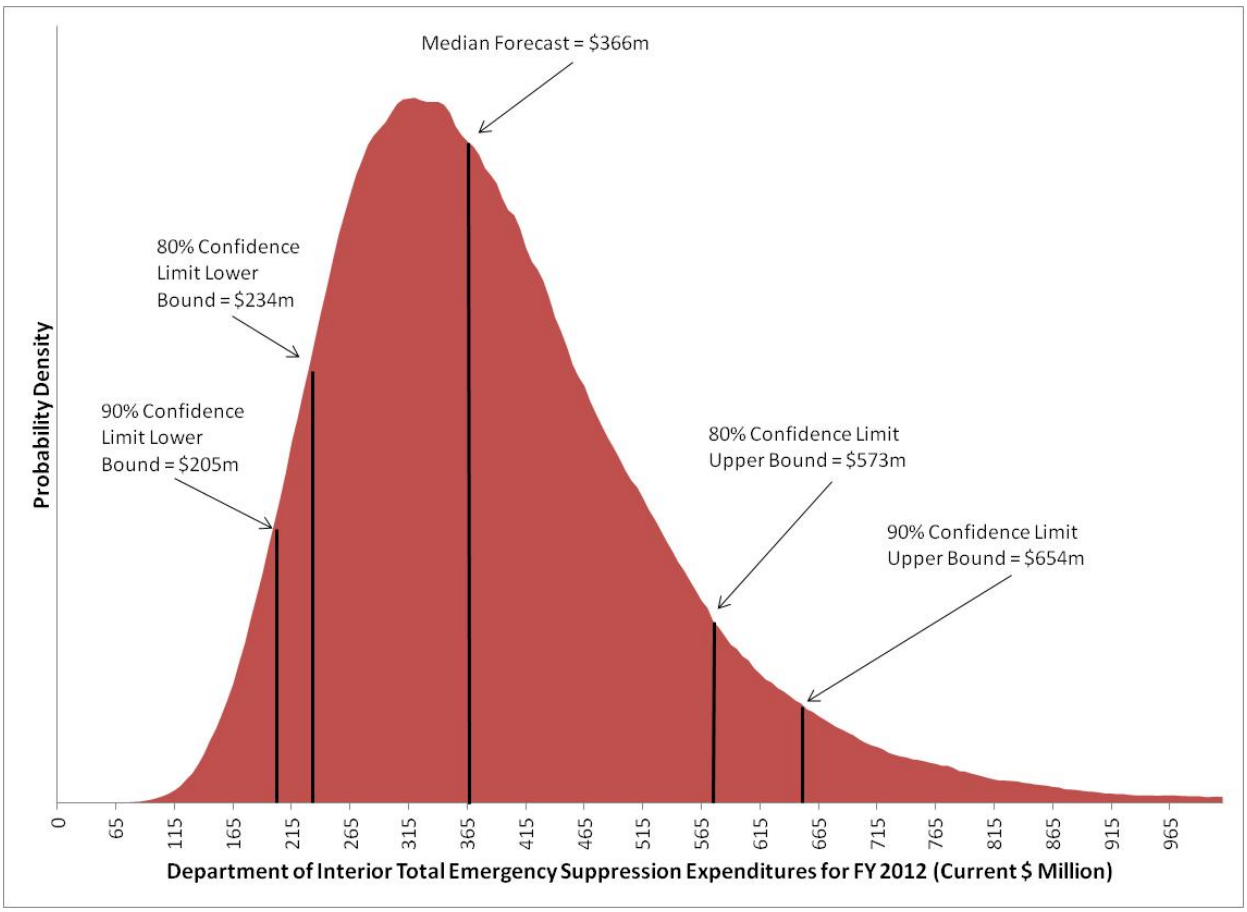

Figure 2. Department of the Interior emergency suppression expenditure forecast probability density, Fiscal Year 2012, March 2012 version of the March 2012 Current Year Forecast Model.

Appendix: Model Estimates and Forecast Evaluation Statistics

Table A1. Seemingly Unrelated Regression Equation Estimates Used in the March 2012 Forecast of FY 2012 Emergency Suppression Expenditures of the USDA Forest Service. Note: The Dependent Variable in All Cases is the Natural Log or the Change in the Natural Log of the Indicated Region or Region Sum of Annual Real Dollar Expenditures

Dependent Variable	Independent Variables	Coefficient	Std. Error	t-Stat.	P-Value	R^2	Durbin-Watson Statistic
Ln(Region 1 + Region 4 Cost)	Constant	17.388	0.313	55.583	0.000	0.43	1.70
	AMO October (t-2) to February (t-1) Mean	2.959	0.875	3.380	0.001		
	NAO October (t-2) to February (t-1) Mean	0.686	0.213	3.222	0.002		
	Region 1 + Region 4 June Palmer Z-Index, Weighted Average (t-1)	-0.263	0.092	-2.862	0.005		
D[Ln(Region 2 + Region 3 Cost)]	Constant	0.0681	0.1061	0.6423	0.5225	0.72	1.21
	D[Region 2 + Region 3 September Palmer H-Index, Weighted Average (t-1)]	0.2314	0.0343	6.7366	0.0000		
	D[March PDSI, Westwide, Weighted Average (t-1)]	-0.1936	0.0724	-2.6732	0.0091		
	D[Region 2 + Region 3 December Palmer H-Index, Weighted Average (t-1)]	-0.1473	0.0752	-1.9600	0.0536		
D[Ln(Region 5 Cost)]	Constant	-0.0178	0.0841	-0.2119	0.8328	079	1.53
	D[Niño-3 SSTA October (t-1)]	-0.3386	0.0333	-10.1671	0.0000		
	D[Region 5 December Palmer Z-Index, Weighted Average (t-1)]	-0.3865	0.0574	-6.7288	0.0000		
	D[Region 5 September Palmer Z-Index, Weighted Average (t-1)]	0.6191	0.1060	5.8403	0.0000		
Ln(Region 6 Cost)	Constant	18.1717	0.0987	184.0358	0.0000	0.69	1.86
	Region 1 June Palmer H-Index (t-1)	-0.3661	0.0495	-7.3929	0.0000		
	Region 4 June Palmer H-Index (t-1)	0.1467	0.0453	3.2406	0.0018		
Ln(Region 8 + Region 9 Cost)	Constant	17.8867	0.1044	171.4016	0.0000	0.69	1.86
	Niño-3 SSTA October (t-2) to February (t-1) Mean	-0.2486	0.0796	-3.1221	0.0025		
	Region 9 June Palmer H-Index (t-1)	-0.2552	0.0866	-2.9462	0.0042		
	Region 3 June Palmer H-Index (t-1)	0.0865	0.0334	2.5898	0.0115		
	Region 9 December Palmer H-Index (t-1)	-0.3347	0.0798	-4.1966	0.0001		

Ln(Region 10 + RFS Cost)	Constant	-1197.1339	255.4764	-4.6859	0.0000	0.77	1.71
	Region 1 June Palmer H-Index (t-1)	-0.2103	0.0541	-3.8904	0.0002		
	Region 2 September Palmer H-Index (t-1)	0.2443	0.0428	5.7036	0.0000		
	Ln(Year)	159.8513	33.6047	4.7568	0.0000		

Table A2. Jackknife Forecast Evaluation of the Seemingly Unrelated Regression Model Used in the March 2012 Forecast of FY 2012 Emergency Suppression Expenditures of the USDA Forest Service, Calculated Over Data from 1995-2011

Diagnostic	Calculated 1995-2011
Root Mean Squared Error (Real 2004 $)	278,271,710
Bias (Real 2004 $)	560,621
Bias (%)	0.08
Mean Absolute Percent Error (%)	31.42
Direction of Change Prediction (% Correct) (from 1996-2011)	87.50

Table A3. Equation Estimate Used in the March 2012 Forecast of FY 2012 Emergency Suppression Expenditures of the Department of the Interior. Note: The Dependent Variable is the Natural Log of the Department's Annual Real Dollar Expenditures

Variable	Coefficient	Standard Error	t-Statistic	Probability
Intercept	10.2433	4.0037	2.5585	0.0187
Palmer H-Index, Region 1, June (t-1)	-0.1091	0.0458	-2.3824	0.0272
Palmer H-Index, Region 4, June (t-1)	0.1750	0.0349	5.0175	0.0001
Palmer H-Index, Region 3, December (t-1)	-0.0623	0.0278	-2.2412	0.0365
Palmer H-Index, Region 1, December (t-1)	-0.0778	0.0416	-1.8682	0.0765
Ln[DOI Expenditures (t-1)]	0.4634	0.2107	2.1991	0.0398
Observations	26			
R-squared	0.73			
Equation Error	0.29			
Durbin-H Statistic (F-Test, 3, 14)	2.90*			

* Significant at 0.07.

Table A4. Jackknife Forecast Evaluation of the Equation Used in the March 2012 Forecast of FY 2012 Emergency Suppression Expenditures of the Department of the Interior, Calculated over 1995-2011 and 1985-2011

Diagnostic	Calculated 1995-2011	Calculated 1985-2011
Root Mean Squared Error (Real 2004 $)	78,368,683	72,877,225
Bias (Real 2004 $)	6,387,258	8,587,707
Bias (%)	2.41	3.80
Mean Absolute Percent Error (%)	24.67	29.91
Direction of Change Prediction (% Correct)	76.47	73.08

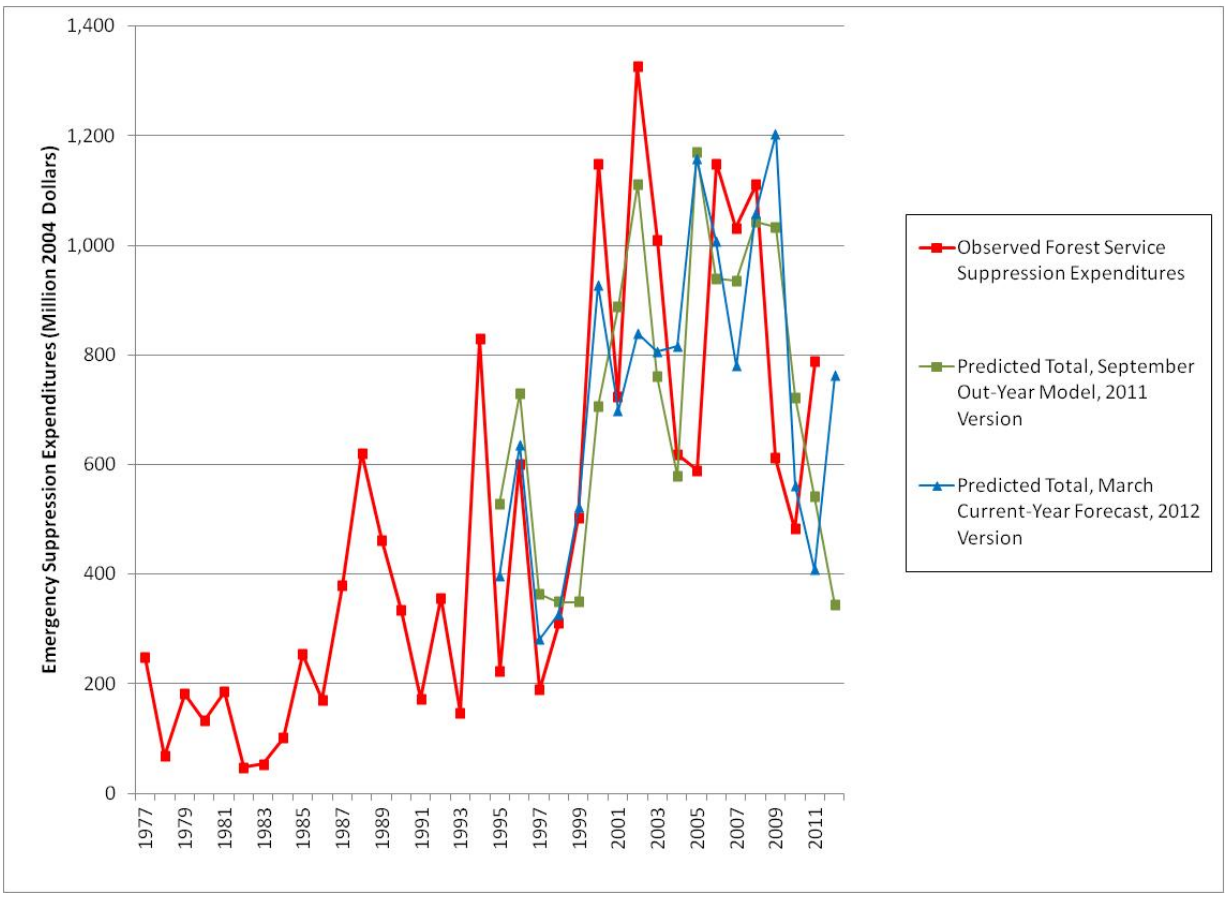

Figure A1. Observed historical USDA Forest Service emergency suppression expenditures (1977-2011) and the forecasts of these expenditures (1995-2012) using the March 2012 Current Year Forecast Model and the September 2011 Out-Year Forecast Model. All forecasts of those expenditures for each fiscal year are sums across the point estimates of each region or region aggregate's costs generated with a jackknife procedure. (Note: values are in constant 2004 dollars and exclude the Wildland Fire Suppression Cost Pool expenditures.)

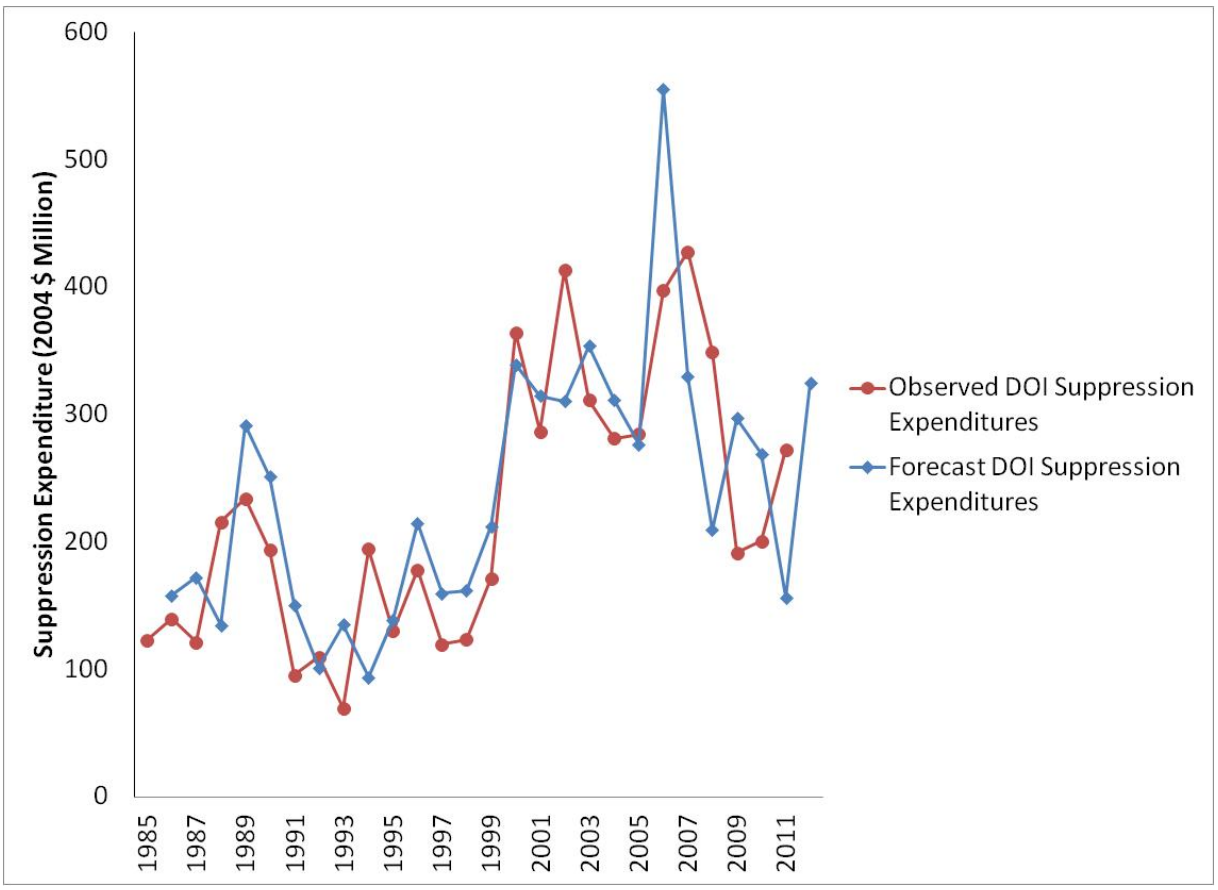

Figure A2. Observed historical Department of the Interior emergency suppression expenditures (1985-2011) and the forecasts of these expenditures (1985-2012), using the March 2012 version of the March Current Year Forecast Model. All forecasts of those expenditures for each fiscal year are the point estimates generated with a jackknife procedure. (Note: values are in constant 2004 dollars.)