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

September 2011 Forecasts for Fiscal Year 2012

Report Date: August 30, 2011

Executive Summary

The Department of Agriculture's (USDA) Forest Service is forecast to spend, with 80 percent confidence, between $297 million (M) and $668M in fiscal year (FY) 2012, while the agencies of the Department of the Interior (DOI) are forecast to spend, with 80 percent confidence, between $110M and $302M. 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 $435M, while the median forecast for Interior is $183M. Excluding the Cost Pool, the Forest Service's median forecast for FY 2012 represents continued moderate to lower than average costs compared to recent years, and this is attributable primarily to above-average moisture conditions outside of the Southwest and Southern Regions. The drier than normal conditions in the Southwest, experienced currently, are expected to lead to below-average quantities of fine fuels and hence below-average emergency suppression expenditures in FY 2012. DOI expenditures are also expected to be lower than average in FY 2012, due especially to the wetter conditions in the northern portion of the West, which have been shown to foretell lower emergency expenditures for the Department. On the other hand, for DOI bureaus, drier conditions in the Southwest in June prior to the coming fiscal year are linked to higher firefighting costs for the Agency, so the current drought there puts some upward pressure on the DOI forecast of FY 2012 emergency suppression expenditures.

Overview

The Rocky Mountain Research Station (RMRS) has provided monthly forecasts of annual Forest Service 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 USDA and DOI 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 FY required when the next FY budget is not approved by Congress and the President by that date. The current report was produced in late August 2011.

Modeling

Modeling Framework for the September 2011 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 cost 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 2010 for FY 2011, 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 FY to lagged measures of drought (Palmer indices), ocean temperatures (the Niño-3 sea surface temperature anomaly), and ocean pressure indices (North Atlantic Oscillation). The equation for Region 5 included a time trend. Equation estimates are shown in Table A1, located in an Appendix to this report.

Forecasts were made 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 FY totals of expenditures and include the years from 1995 to 2010, 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 our 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 levels, and a description of where the median forecast value fell within the observed historical costs for other years, in real dollar terms.

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[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.

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 September 2011 Out-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 2010 Out-Year Forecast Model. Table A2 shows that the root mean squared error of the model used in this September 2011 forecast of FY 2012 expenditures, when applied to the 1995-2010 period, was $277M and that it had a positive bias, tending to over-forecast by about $15M (2 percent). (This positive bias was not subtracted from the present September 2011 forecast for FY 2012.) The model had a Mean Absolute Percent Error of about 42 percent, meaning that the typical forecast averaged 42 percent above or below expenditures actually incurred during the 1995-2010 period. Finally, this model correctly predicted the direction of change in emergency suppression expenditures by the Forest Service 81 percent of the time—that is, in all but three of the years, 1995-2010.

Modeling Framework for the September 2011 Forecast of FY 2012 Department of the Interior Expenditures

The development of a forecast model for DOI was constrained by a lack of detailed regional expenditure data for the Department. The only DOI suppression expenditure data currently available for developing this forecast were annual DOI suppression expenditures for FY 1985 to FY 2010, Department-wide. Although geographical and agency disaggregations were available for recent years (since the early 2000s), these are too few years to develop reliable statistical models by geographic region or by agency within the Department. Instead, we modeled the entire Department's expenditures using a parsimonious model specification involving three Palmer H-indices from the West. This is different from previous models, which have primarily related DOI expenditures to Forest Service expenditure forecasts. 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 (1985-2010) of the DOI time series; models based on the Forest Service forecast are constrained to the length of valid Forest Service forecast totals (1995-2010).[3]

The DOI emergency suppression expenditure forecast equation is reported in Table A3. It included the Regions 1, 3, and 4 Palmer H-index values for June of the previous year (t-1) and an intercept. The estimated equation explained 55 percent of the variation ($R^2 = 0.55$) in annual DOI suppression expenditures over the historical time period, 1985-2010.

Model fitness for the September Out-Year Forecast Model for DOI is reported in Appendix Table A4. As in the case of the Forest Service September Out-Year Forecast Model, DOI model

[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. A separate (unreported) model for this report was tested that was based on the Forest Service forecast cost, and the forecast for 2012 using that model was nearly identical to the forecast developed using the H-indices.

was evaluated by making jackknife forecasts of DOI expenditures. The September DOI forecast model had a root mean squared error of about $87M, calculated over 1995-2010 and $79M when calculated over 1985-2010. The model had a bias of about -$23M (-9 percent) calculated over 1995-2010 and -$4M (-2 percent) calculated over 1985-2010 (and these historical biases were not used to upwardly adjust the 2012 forecast). The model had a Mean Absolute Percent Error of about 20 percent for the 1995-2010 period and 30 percent for the 1985-2010 period. It correctly predicted the direction of change in emergency suppression expenditure for the agency from one year to the next about 88 percent of years 1995-2010 and 84 percent of years 1985-2010.

Results

USDA's Forest Service

FY 2012 emergency suppression expenditures are forecast to range, with 80 percent confidence, between $297M and $668M. The median forecast is $435M. 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 percent chance that Forest Service emergency suppression expenditures, including the Cost Pool, will fall below $224M. In contrast, there is a 70 percent chance that these expenditures will fall below $517M.

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 all regions are expected to have expenditures in the lower two terciles in 2012, when compared to the most recent 15 years and when compared to such expenditures since 1977. For FY 2012, only the combination of Region 8 and Region 9 is expected to have average costs when compared to the last 15 years. When examined from the perspective of annual expenditures since 1977, the FY 2012 expenditures by the agency are expected to be in the middle tercile (excluding the Cost Pool).

Department of the Interior

FY 2012 emergency suppression expenditures for DOI are forecast to range, with 80 percent confidence, from $110M to $302M, with a median forecast of $183M (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 90 percent confidence band spans $95M to $347M. These forecast expenditures are projected to be more comparable in real dollar terms to the level of expenditures observed in the late 1980s and the decade of the 1990s, dropping back from the higher ($250M and greater) expenditures observed in the first 8 years of the 2000s.

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Table 1. September 2011 FLAME Act Forecasts of FY 2012 Emergency Suppression Expenditures of the USDA's 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	$40	$32	$186	$31	$35	$89	$435
80 percent Confidence Lower Limit	16	18	96	17	18	71	297
80 percent Confidence Upper Limit	100	58	364	57	70	123	668
90 percent Confidence Lower Limit	12	15	79	14	15	67	268
90 percent Confidence Upper Limit	128	68	438	68	84	138	760
95 percent Confidence Lower Limit	10	13	68	12	13	64	246
95 percent Confidence Upper Limit	159	79	517	79	99	152	848

*Note: This table includes the FY 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. September 2011 FLAME Act Forecasts of FY 2012 Emergency Suppression Expenditures of the USDA's Forest Service, by Percentiles, Current (FY 2012) Dollars

Probability (percent) of Falling Below Indicated Dollar Amount	Realized Amount (Millions of 2012 Dollars)
1	$224
5	268
10	297
20	336
30	369
40	402
50	435
60	473
70	517
80	574
90	668
95	760
99	978

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

Table 3. September 2011 FLAME Act Forecasts of FY 2012 Emergency Suppression Expenditures of the USDA's Forest Service, by Tercile.

Region or Aggregate	Tercile of Costs Expected, Since 1995	Tercile of Costs Expected, Last 35 Years
R 1 + R4	Lower	Lower
R 2 + R3	Lower	Lower
R 5	Lower	Middle
R 6	Lower	Lower
R 8 + R9	Middle	Middle
R 10 + RFS	Lower	Middle
Total	Lower	Middle

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. September 2011 FLAME Act Forecasts of FY 2012 Emergency Suppression Expenditures of DOI, Current (FY 2012) Dollars

	Millions of 2012 Dollars
Median Estimate	$183
80 percent Confidence Lower Limit	110
80 percent Confidence Upper Limit	302
90 percent Confidence Lower Limit	95
90 percent Confidence Upper Limit	347
95 percent Confidence Lower Limit	84
95 percent Confidence Upper Limit	394

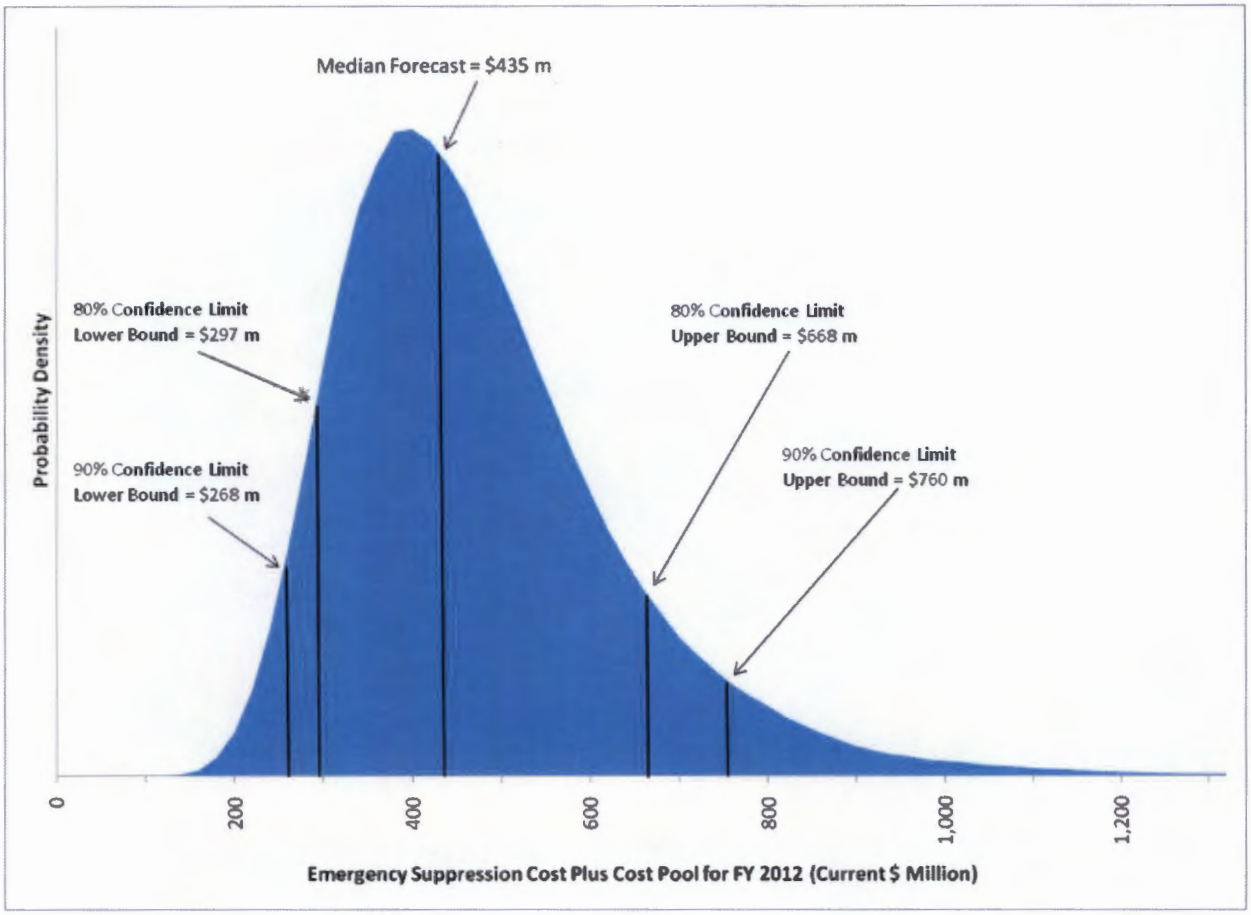

Figure 1. USDA's Forest Service emergency suppression expenditure forecast probability density, FY 2012, September 2011 version of the September Out-Year Forecast Model. (Note: FY 2012 Wildland Fire Suppression Cost Pool expenditures are included at their expected level of $47 million in this probability density display.)

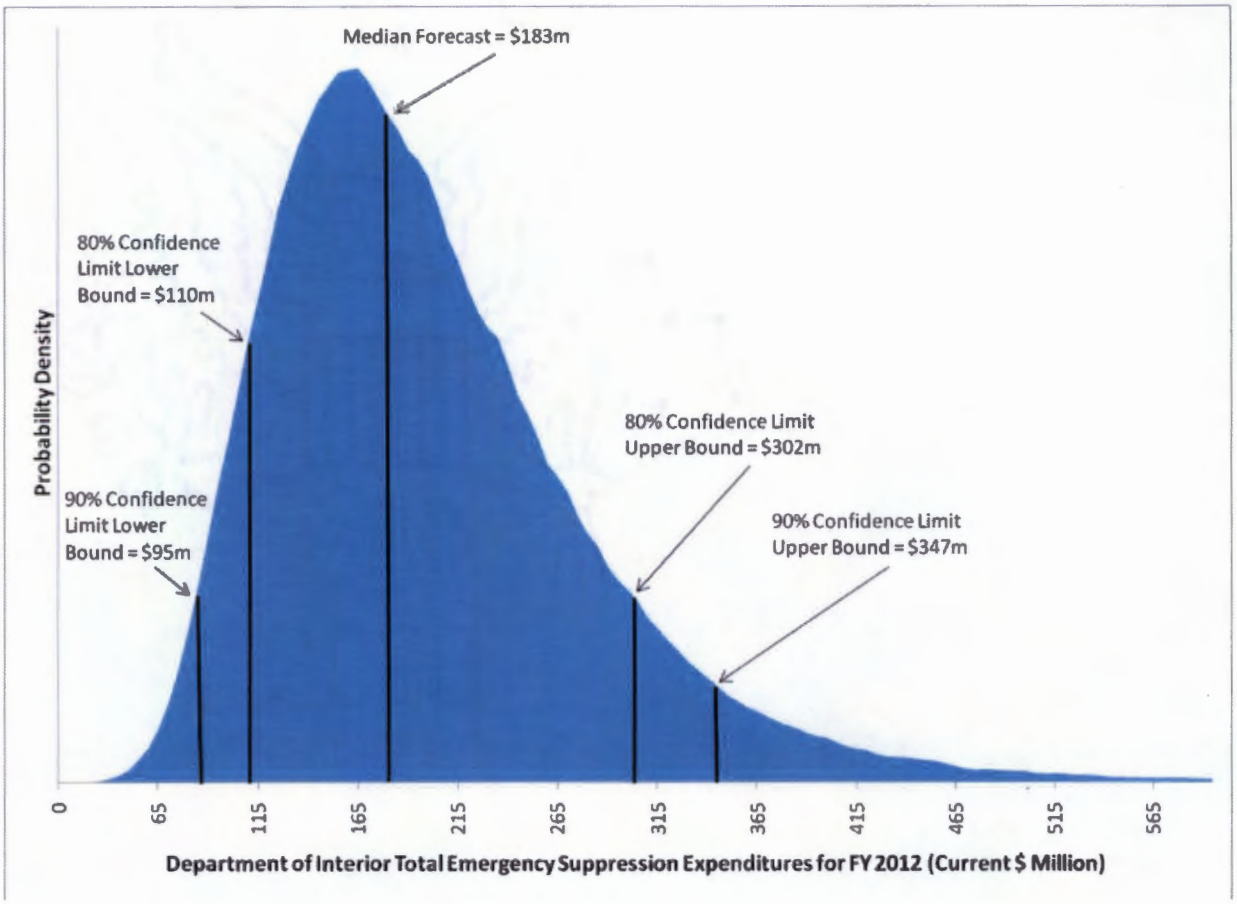

Figure 2. DOI emergency suppression expenditure forecast probability density, FY 2012, September 2011 version of the September Out-Year Forecast Model.

Appendix: Model Estimates and Forecast Evaluation Statistics

Table A1. Seemingly Unrelated Regression Equation Estimates Used in the September 2011 Forecast of FY 2012 Emergency Suppression Expenditures of the USDA's Forest Service. Note: The Dependent Variable in All Cases is 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	17.3542	0.2989	58.0599	0.0000	0.45	1.73
	AMO October (t-2) to February (t-1) Mean	2.3405	0.6540	3.5788	0.0006		
	NAO October (t-2) to February (t-1) Mean	0.8048	0.1957	4.1132	0.0001		
	Region 1 + Region 4 June Palmer Z-Index, Weighted Average (t-1)	-0.2753	0.0792	-3.4758	0.0009		
Ln (Region 2 + Region 3 Cost)	Constant	18.1069	0.1081	167.4312	0.0000	0.57	2.30
	Region 1 June Palmer H-Index (t-1)	-0.1891	0.0349	-5.4227	0.0000		
	Region 3 June Palmer H-Index (t-1)	0.0559	0.0273	2.0491	0.0440		
Ln (Region 5 Cost)	Constant	-1131.0146	299.1046	-3.7813	0.0003	0.67	2.39
	Niño-3 SSTA March (t-1) to July (t-1) Mean	-0.4407	0.1853	-2.3782	0.0200		
	Region 5 September Palmer Z-Index, Weighted Average (t-2)	0.6098	0.2157	2.8267	0.0061		
	Region 5 December Palmer Z-Index, Weighted Average (t-2)	-0.3067	0.1051	-2.9193	0.0047		
	log(year)	151.3356	39.3288	3.8480	0.0003		
Ln (Region 6 Cost)	Constant	18.1500	0.1047	173.3373	0.0000	0.69	1.88
	Region 1 June Palmer H-Index (t-1)	-0.3571	0.0634	-5.6305	0.0000		
	Region 4 June Palmer H-Index (t-1)	0.1227	0.0527	2.3275	0.0227		
Ln (Region 8 + Region 9 Cost)	Constant	17.7170	0.1423	124.5124	0.0000	0.54	1.42
	Niño-3 SSTA October (t-2) to February (t-1) Mean	-0.2581	0.0986	-2.6158	0.0108		
	Region 9 June Palmer H-Index (t-1)	-0.3358	0.0958	-3.5068	0.0008		
	Region 3 June Palmer H-Index (t-1)	0.1246	0.0445	2.7977	0.0066		
Ln (Region 10 + RFS Cost)	Constant	16.9995	0.2505	67.8681	0.0000	0.72	2.62
	Region 1 June Palmer H-Index (t-1)	-0.3018	0.0573	-5.2637	0.0000		
	Region 2 June Palmer H-Index (t-1)	0.2769	0.0431	6.4231	0.0000		
	Region 8 March Palmer Z-Index, Weighted Average (t-1)	-0.3678	0.0820	-4.4885	0.0000		

Table A2. Jackknife Forecast Evaluation of the Seemingly Unrelated Regression Model Used in the September 2011 Forecast of FY 2012 Emergency Suppression Expenditures of the USDA's Forest Service, Calculated over 1995-2010

Diagnostic	Calculated 1995-2010
Root Mean Squared Error (Real 2004 $)	277,400,069
Bias (Real 2004 $)	15,107,122
Bias (percent)	2.08
Mean Absolute Percent Error (percent)	42.11
Direction of Change Prediction (percent Correct)	81.25

Table A3. Equation Estimate Used in the September 2011 Forecast of FY 2012 Emergency Suppression Expenditures of DOI. Note: The Dependent Variable is the Natural Log of the Department's Annual Real Dollar Expenditures

Variable	Coefficient	Standard Error	t-Statistic	Probability
Intercept	18.9621	0.0723	262.1759	0.0000
Palmer H-Index, Region 1, June (t-1)	-0.2799	0.0519	-5.3932	0.0000
Palmer H-Index, Region 3, June (t-1)	-0.0972	0.0261	-3.7273	0.0012
Palmer H-Index, Region 4, June (t-1)	0.1869	0.0596	3.1382	0.0048
Observations	16			
R-squared	0.55			
Equation Error	0.36			
Durbin-Watson Statistic	1.73			

Table A4. Jackknife Forecast Evaluation of the Equation Used in the September 2011 Forecast of FY 2012 Emergency Suppression Expenditures of DOI Calculated over 1995-2010 and 1985-2010

Diagnostic	Calculated 1995-2010	Calculated 1985-2010
Root Mean Squared Error (Real 2004 $)	86,862,045	78,851,874
Bias (Real 2004 $)	-23,330,349	-4,156,679
Bias (percent)	-8.82	-1.89
Mean Absolute Percent Error (percent)	19.98	29.95
Direction of Change Prediction (percent Correct)	87.50	84.00

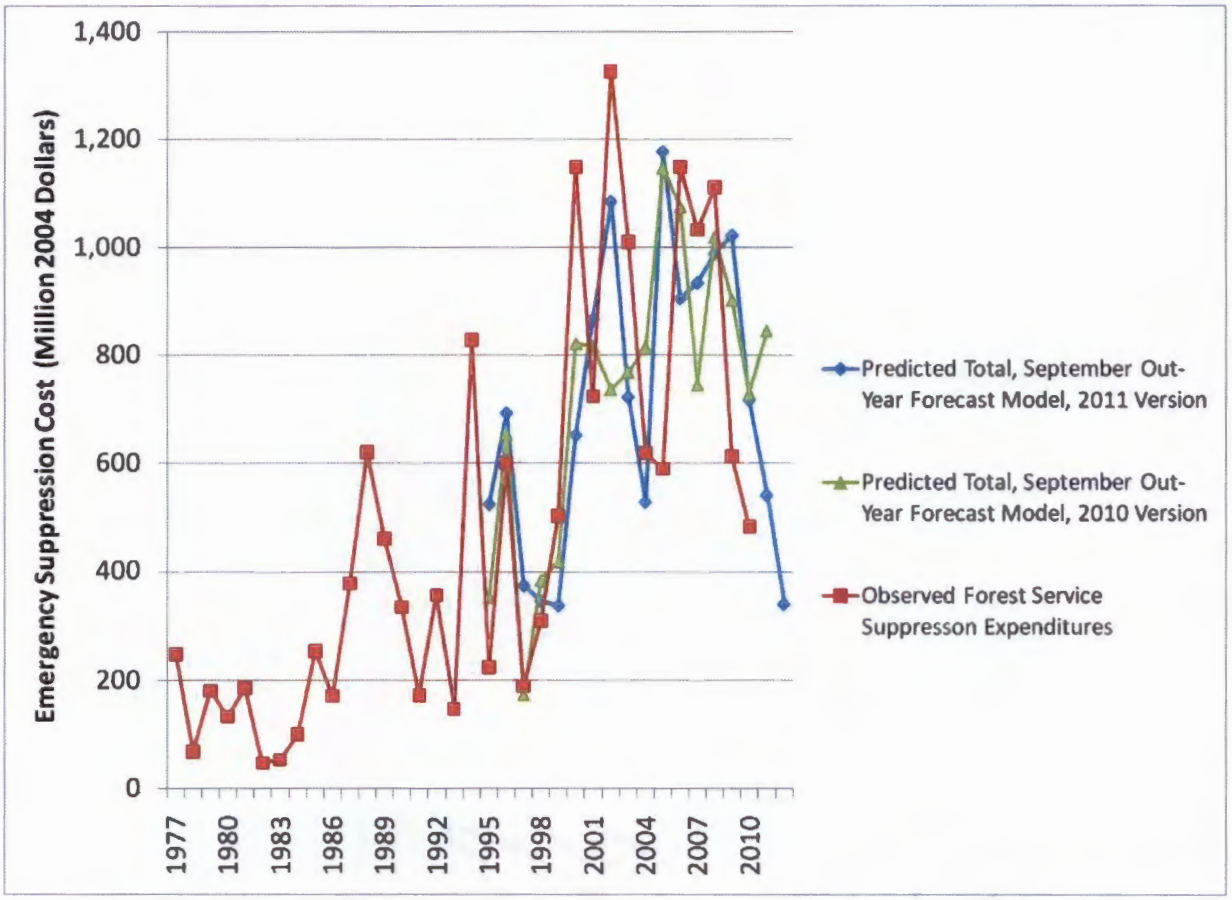

Figure A1. Observed historical USDA's Forest Service emergency suppression expenditures (1977-2010) and the forecasts of these expenditures (1995-2012) using the September 2011 and September 2010 versions of the September Out-Year Forecast Models. All forecasts of those expenditures for each fiscal year 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.)

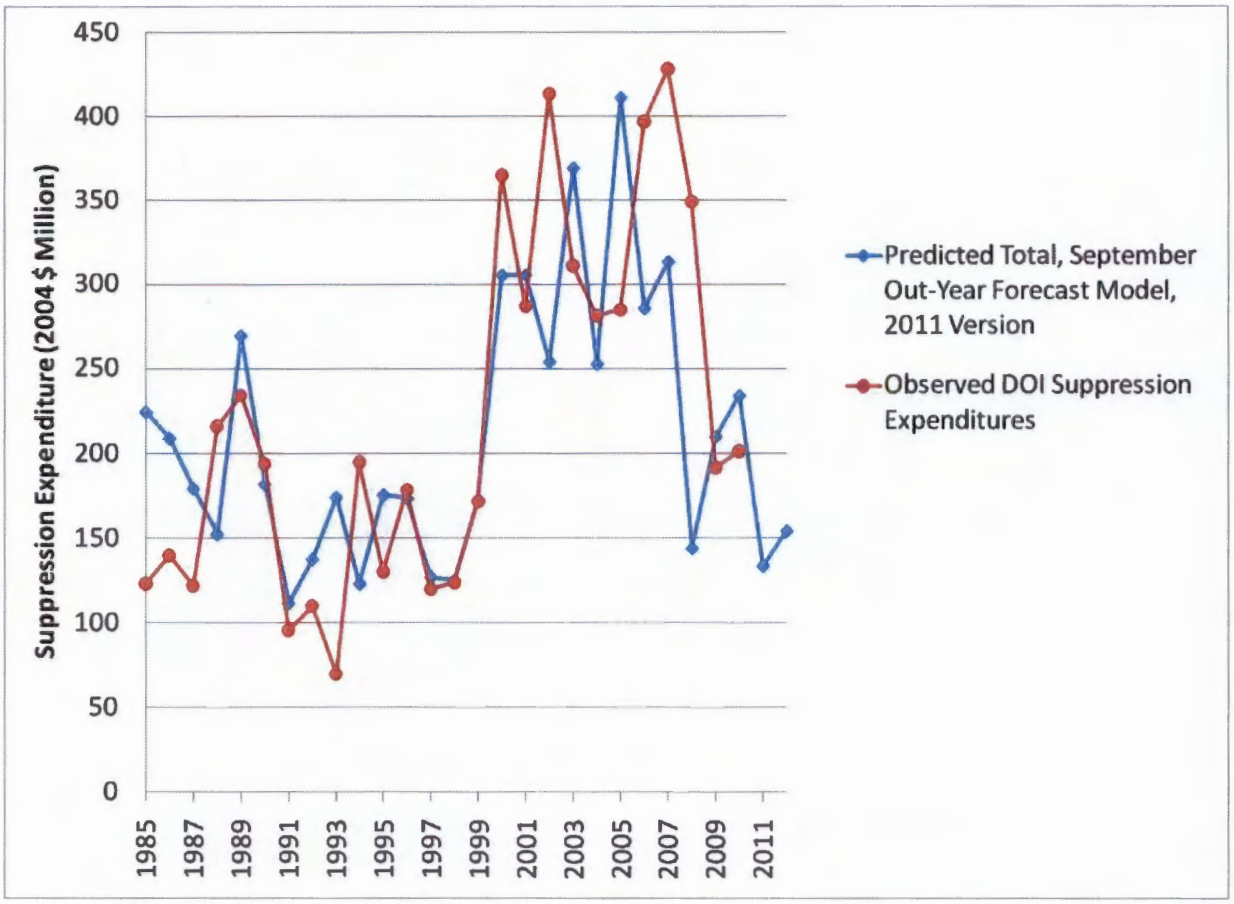

Figure A2. Observed historical DOI emergency suppression expenditures (1985-2010) and the forecasts of these expenditures (1985-2012), using the September 2011 version of the September Out-Year Forecast Model. All forecasts of those expenditures for each fiscal year are the point estimates generated with a jackknife procedure. (Note: values are in constant 2004 dollars.)