

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

July 2011 Forecasts for Fiscal Year 2011

Report Date: June 25, 2011

Executive Summary

The USDA Forest Service is forecast to spend, with 80% confidence, between \$1,293 million and \$1,668 million in Fiscal Year (FY) 2011, while the agencies of the Department of the Interior are forecast to spend, with 80% confidence, between \$292 million and \$443 million. The Forest Service forecast includes \$402 million in contributions to the agency's Cost Pool and National Aviation Assets. The median forecast for the Forest Service is \$1,472 million, while the median forecast for Interior is \$367 million. Excluding the Cost Pool and National Aviation Assets, the Forest Service's median forecast for FY 2011 has increased about 7% from the May 2011 forecast for FY 2011, with the increase primarily linked to the unusually high wildfire activity in Region 3. The expenditures of Region 5 are forecasted to be above historical averages (current Pacific Ocean temperature and pressure indices are correlated with higher fiscal year spending in Region 5). Interior agency expenditures are nearly identical to those reported in the May 2011 forecast, with slightly greater precision enabled in this forecast due to the availability of highly predictive June drought information that was built into this new forecast model for the Department.

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. These updated monthly forecasts are provided during the fire season months of June through September. 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 FY 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 late June, 2011, in time for review and in compliance with the July due date for this forecast for FY 2011.

Modeling

Modeling Framework for the July 2011 Forest Service Expenditure Forecasts

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 forecasts issued in the Fall of 2009 for FY 2010, the Spring of 2010 for FY 2010, September of 2010 for FY 2011, and March and May of 2011 for FY 2011, 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 that are 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), ocean pressure indices (in alternative reports, the Pacific Decadal Oscillation, Atlantic Multidecadal Oscillation, the Arctic Oscillation, and the Southern Oscillation), and (in this report only) the most recent regional totals of spending through May of the current fiscal year. The equation for Region 5 includes a time trend. It should be noted that the spending through May was only a significant explainer of historical costs in two regional equations—that of Region 2 + Region 3, and that of Regions 8 + Region 9. These equations were, therefore, only estimable from 1998 onward (reliable, historical data on suppression expenditures through the end of May were not available prior to 1998), while other equations were estimable from 1995 onward. Equation estimates are shown in Table A1, which appears in an Appendix to this report.

Forecasts are made for region-level costs that exclude Cost Pool and National Aviation Asset charges, which are fixed components added back to the costs for the Region 10 and RFS aggregate. Data for modeling are annual fiscal year totals of expenditures, and they range from 1995 to 2010, the only years for which consistent region-level data can be assembled. For those equations that included end of May expenditures, the data range from 1998 to 2010. To erase the effects of general price inflation, all costs are deflated to the value of a dollar in 2004

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.

using the gross domestic product deflator—that is, models are estimated and costs are forecast in “real” dollar terms. After the forecast, we adjust the forecast values to put them in current dollars. SUR estimates allow for more precise identification of statistical relationships by using the correlations in estimation errors. When generating a forecast distribution (see Figure 1), we randomly sample from equation error and coefficient distributions in ways that account 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 produce 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 falls 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 the July 2011 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”) compare with observed expenditures for the Forest Service as well as forecasts produced by longer-lead versions of the forecast models. In the forecast evaluations conducted for the July model forecast reported here, statistics are calculated over the 1998-2010 time period because reliable historical statistics on Forest Service spending through May in each region were available only from 1998 onward.

Table A2 shows that the root mean squared error of the model used in this July 2011 forecast, when applied to the 1998-2010 period, is \$211m and that it has a small negative bias, tending to under-forecast by about \$53 million (-6.5%). The model has a mean absolute percent error of about 24%, meaning that the typical forecast averaged 24% above or below expenditures actually incurred during the 1998-2010 period. Finally, this model correctly predicted the direction of change in emergency suppression expenditures by the Forest Service 83% of the time—that is, in all but one of the years, 1999-2010. It should be noted that the median forecast is projected to be substantially higher than the observed expenditure for FY 2010 (Figure A1).

Modeling Framework for the July 2011 Department of the Interior Expenditure Forecast

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. The only DOI suppression expenditure data currently available for developing this forecast were annual DOI suppression expenditures for FY 1985 to FY 2010. The lack of geographic specificity in the data and the low number of observations led to a parsimonious modeling framework, wherein annual DOI suppression expenditures are forecast as a function of the current year’s June values of the Palmer H-index for regions 2 and 8 and of a time trend (Table A3). This is a different model from previous versions of this model, which use forecasts of the Forest Service’s emergency suppression expenditures rather than drought to forecast Interior costs. We find that because

much of the fire prone landscape managed by Interior agencies tend to be in the southern and southwestern portions of the country, up-to-date drought information for regions 2 and 8 apparently consolidate well the annual variations in the Department's expenditures on wildfire suppression. We also find a significant and positive trend in the Department's spending, tending to increase in real (2004 dollar) terms by about \$7.3 million per year, after accounting for drought information. The estimated equation explains 84% of the variation ($R^2 = 0.84$) in annual DOI suppression expenditures over the historical time period, 1985-2010.

Model fitness for the July forecast model for DOI is reported in Appendix Table A4. As in the case of the Forest Service July forecast model, the DOI model is evaluated by making jackknife forecasts of DOI expenditures. The July DOI forecast model has a root mean squared error of about \$52 million, a small negative bias of about \$7.8 million (-2.96%), a mean absolute percent error in the forecast of about 19%, and a correct prediction of the direction of change in emergency suppression expenditures from the previous year in 81% of the years, 1986-2010. Relevant to this last statistic, the median forecast is projected to be higher than the observed expenditure for FY 2010 (Figure A2).

Results

USDA Forest Service

FY 2011 emergency suppression expenditures are forecast to range, with 80% confidence, between \$1,293 million and \$1,668 million. The median forecast is \$1,472 million. These costs include \$402 million in Cost Pool and National Aviation Assets, 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 and National Aviation Assets, will fall below \$1,147 million. In contrast, there is a 70% chance that these expenditures will fall below \$1,550 million.

An analysis of historical real dollar expenditures in emergency suppression contains information about the likely financial magnitude of spending for FY 2011 (Table 3), by Forest Service Region or region aggregate, and in total. An examination of this table reveals some of the regional heterogeneity generating the expected expenditures. The sum of Region 2 and 3, already with high spending evident (in particular Region 3) and Region 5 stand out as regions expected to have costs in line with the upper third (tercile) of expenditures observed over the past 15 years; this results also in an agency-wide total that is also in the upper third. In contrast, the sum of Region 1 and 4, as well as 6, stand out as having lower than average costs, when compared with the last 15 years of spending in these locations. Regions 1 and 4 and 6 are expected to fall in the middle tercile of costs when compared with the costs observed since 1977, but all other regions are expected to still be in the upper tercile of the costs observed since 1977.

Department of the Interior

FY2011 emergency suppression expenditures for the DOI are forecast to range, with 80% confidence, from \$292 million to \$443 million, with a median forecast of \$367 million (Table 4). As in the Forest Service forecast, uncertainty surrounding the DOI forecast for FY 2011 can be appreciated by examining the probability density (Figure 2). The 90% confidence band spans \$271 million to \$464 million. The median forecast is \$3 million higher than the median forecast produced by the DOI May Current Year Forecast Model. Previous models and this July model, however, are not directly comparable in terms of goodness-of-fit or forecast statistics, as these are calculated for this July forecast model over a 25-year span of data, beginning in 1985, compared to previous models which used data only from 1995.

Contact Information for this Report

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Table 1. July 2011 FLAME Act Forecasts of Fiscal Year 2011 Emergency Suppression Expenditures of the USDA Forest Service, by Region and in Total, Current (FY 2011) Dollars

	R 1&4	R 2&3	R 5	R 6	R 8&9	R 10&13	Total
Millions of 2011 Dollars							
Median	\$48	\$157	\$526	\$69	\$44	\$626	\$1,472
80% Confidence Lower Limit	22	125	402	44	44	544	1,293
80% Confidence Upper Limit	105	245	648	109	47	708	1,668
90% Confidence Lower Limit	17	125	367	39	44	521	1,241
90% Confidence Upper Limit	132	278	683	124	53	731	1,726
95% Confidence Lower Limit	14	125	337	35	44	500	1,197
95% Confidence Upper Limit	160	311	714	138	58	751	1,783

Notes: This table includes the Fiscal Year 2011 Wildland Fire Suppression Cost Pool and National Aviation Assets as a fixed charge of \$402 million, which is added to the Region 10 + RFS forecast and the agency-wide total. Monte Carlo random values were limited to be no lower than observed spending through June 24, 2011, the latest expenditure data available. This explains the identical lower bounds for R 2&3 and R 8&9 across the three confidence limits shown for each.

Table 2. July 2011 FLAME Act Forecasts of Fiscal Year 2011 Emergency Suppression Expenditures of the USDA Forest Service, by Percentiles, Current (FY 2011) Dollars

Probability (%) of Falling Below Indicated Dollar Amount	Realized Amount (Millions of 2011 Dollars)
1	\$1,147
5	1,241
10	1,293
20	1,353
30	1,398
40	1,436
50	1,472
60	1,510
70	1,550
80	1,599
90	1,668
95	1,726
99	1,851

Note: This table includes the Fiscal Year 2011 WFSU Cost Pool and National Aviation Assets as a fixed charge of \$402 million, which is added to the Region 10 + RFS forecast and the agency-wide total.

Table 3. July 2011 FLAME Act Forecasts of Fiscal Year 2011 Emergency Suppression Expenditures of the USDA Forest Service, by Terciles, Current (FY 2011) Dollars

Region or Aggregate	Tercile of Costs Expected, Last 15 Years	Tercile of Costs Expected, Last 34 Years
R 1 + R4	Lower	Middle
R 2 + R3	Upper	Upper
R 5	Upper	Upper
R 6	Lower	Middle
R 8 + R9	Middle	Upper
R 10 + RFS	Middle	Upper
Total	Upper	Upper

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

Table 4. July 2011 FLAME Act Forecasts of Fiscal Year 2011 Emergency Suppression Expenditures of the Department of the Interior, Current (FY 2011) Dollars

	Millions of 2011 Dollars
Median Estimate	\$367
80% Confidence Lower Limit	292
80% Confidence Upper Limit	443
90% Confidence Lower Limit	271
90% Confidence Upper Limit	464
95% Confidence Lower Limit	251
95% Confidence Upper Limit	483

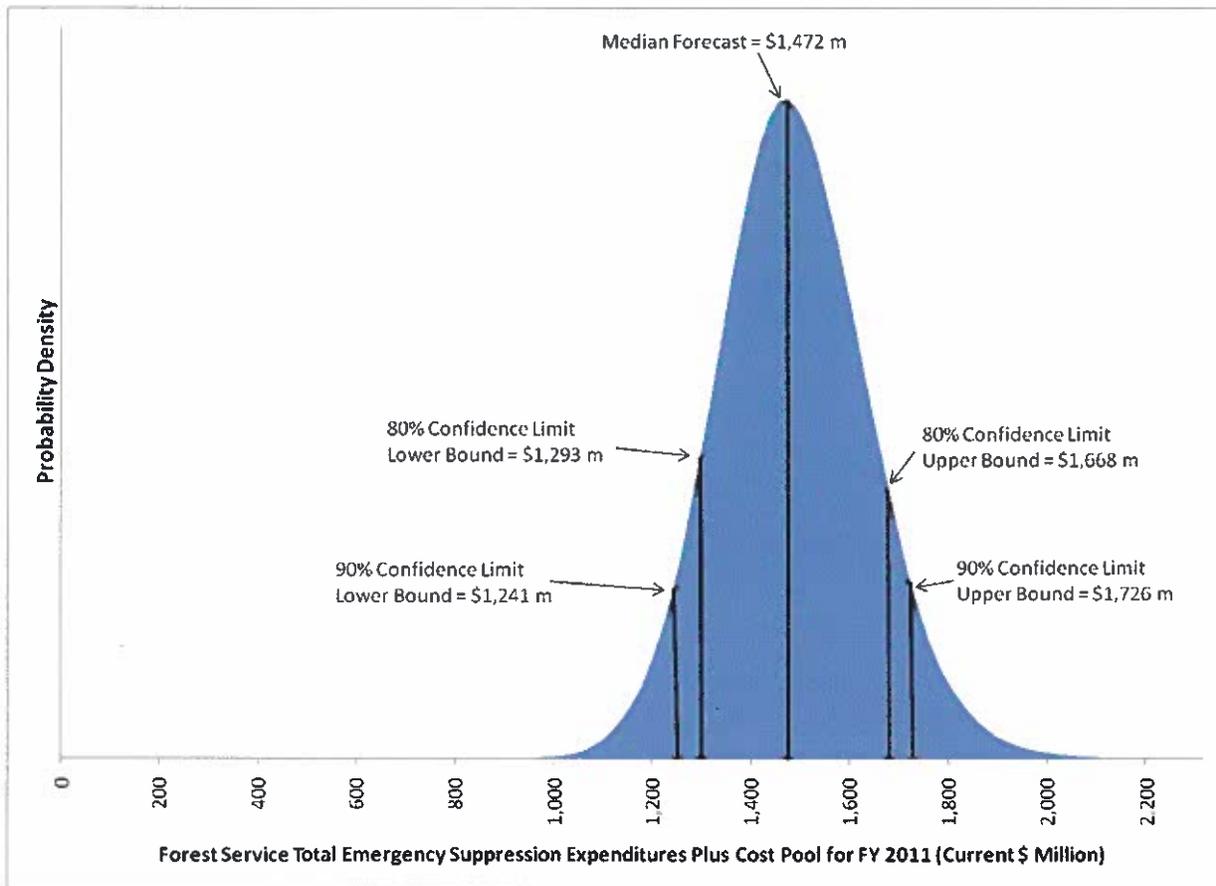


Figure 1. US A Forest Service emergency suppression expenditure forecast probability density, Fiscal Year 2011, uly FLAME Act Current Year Forecast Model. Note: The Fiscal Year 2011 WFSU Cost Pool and National Aviation Assets charges are included as a fixed amount of 402 million in this probability density display.

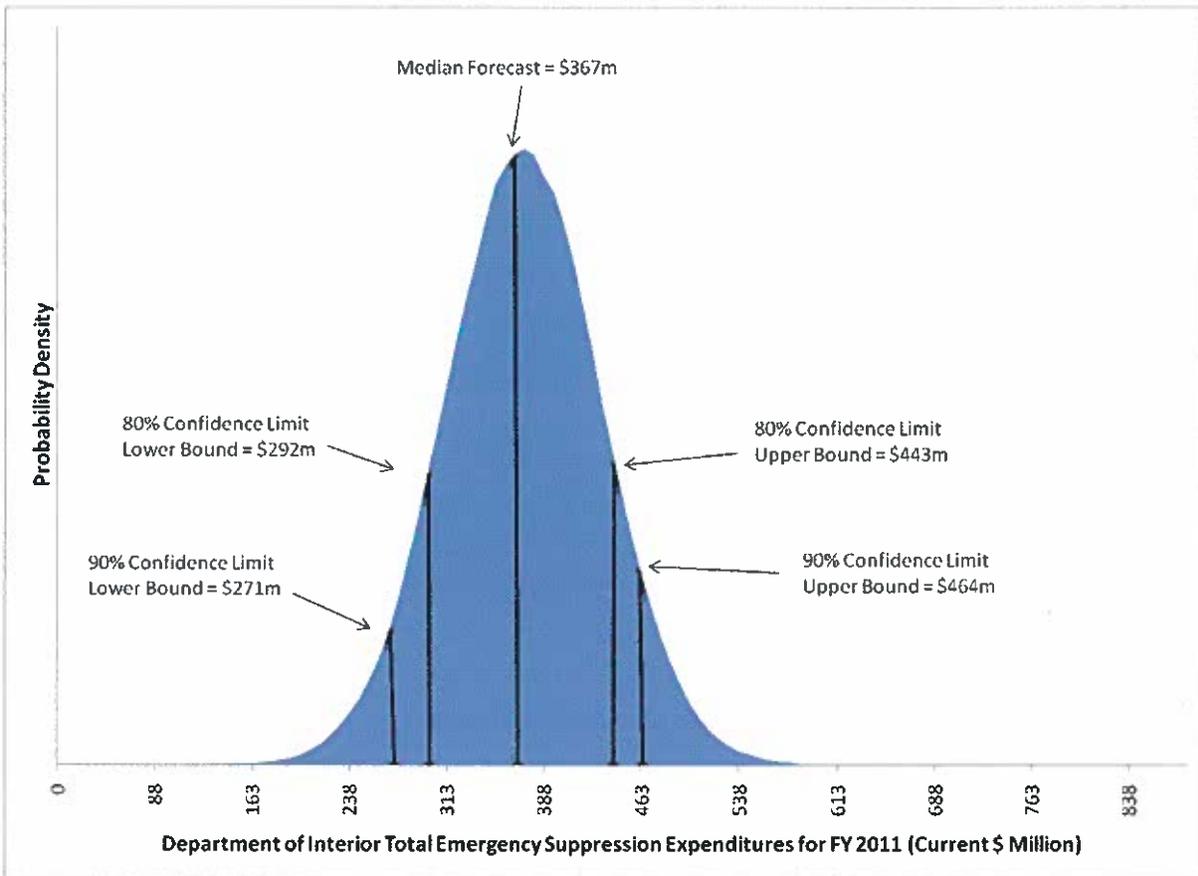


Figure 2. Department of the Interior emergency suppression expenditure forecast probability density, Fiscal Year 2011, July FLAME Act Current Year Forecast Model.

Appendix: Model Estimates and Forecast Evaluation Statistics

Table A1. Seemingly Unrelated Regression Equation Estimates, Forest Service July 2011 Forecast Model

Dependent Variable	Independent Variables	Coefficient	Std. Error	t-Stat.	P-Value	R ²	Durbin-Watson Statistic
Ln(Region 1 + Region 4 Cost)	Constant	18.35	0.13	136.06	0.00	0.59	2.11
	June Palmer H-Index, Region 1 and 4 Mean (t)	-0.23	0.06	-4.12	0.00		
	Niño-3 SSTA June (t)	-0.50	0.18	-2.82	0.01		
Ln(Region 2 + Region 3 Cost)	Constant	12.76	2.42	5.27	0.00	0.74	2.39
	June Palmer H-Index, Region 2 and 3 Mean (t)	-0.13	0.04	-3.79	0.00		
	Region 2 + 3 Emergency Suppression Spending through May (t)	0.33	0.15	2.22	0.03		
Region 5 Cost	Constant	-37,645,636,243	6,826,607,083	-5.51	0.00	0.75	1.48
	Year	19,043,110	3,414,741	5.58	0.00		
	Niño-3 SSTA October (t-1) to February (t) Mean	-72,847,298	14,599,663	-4.99	0.00		
	Region 5 September Palmer Z-Index(t-1)	159,058,477	37,066,965	4.29	0.00		
Ln(Region 6 Cost)	Constant	18.20	0.08	233.15	0.00	0.81	2.28
	June Palmer H-Index, Region 2 and 3 Mean (t)	-0.17	0.03	-5.69	0.00		
	June Palmer H-Index, Region 6 (t)	-0.15	0.04	-3.94	0.00		
	Niño-3 SSTA June (t)	-0.28	0.10	-2.79	0.01		
Region 8 + Region 9 Cost	Constant	21,200,185	6,162,735	3.44	0.00	0.86	1.97
	June Palmer H-Index, Region 8 (t)	-8,817,884	3,219,720	-2.74	0.01		
	March Palmer H-Index, Region 8 (t)	-12,796,640	2,941,335	-4.35	0.00		
	Niño-3 SSTA October (t-1) to February (t) Mean	21,540,554	3,192,653	6.75	0.00		
	Region 8 Emergency Suppression Spending through May (t)	0.92	0.24	3.80	0.00		
Region 10 + RFS Cost	Constant	92,801,045	13,511,793	6.87	0.00	0.29	2.55
	Niño-3 SSTA October (t-1) to February (t) Mean	-27,246,671	10,393,168	-2.62	0.01		
	Pacific Decadal Oscillation Index October (t-1) to February (t) Mean X Niño-3 SSTA October (t-1) to February (t) Mean	14,967,476	10,032,376	1.49	0.14		
	February (t) Mean						

Table A2. Jackknife Forecast Evaluation of the Seemingly Unrelated Regression Model Used in the July 2011 Forecast of FY 2011 Emergency Suppression Expenditures of the USDA Forest Service (1998-2010 evaluation period).

Diagnostic	
Root Mean Squared Error (Real 2004 \$)	210,774,099
Bias (Real 2004 \$)	-53,123,826
Bias (%)	-6.50
Mean Absolute Percent Error (%)	23.82
Direction of Change Prediction (% Correct)	83.00

Table A3. Equation Estimate Used in the July 2011 Forecast of the Department of the Interior.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Intercept	-14,346,739,610	2,425,549,254	-5.91	0.00
Palmer H-Index Region 2, June	-22,709,513	3,667,685	-6.19	0.00
Palmer H-Index Region 8, June	-23,902,432	5,998,403	-3.98	0.00
Year	7,297,193	1,214,230	6.01	0.00
Observations	26			
R-squared	0.84			
Equation Error	45,674,739			

Table A4. Jackknife Forecast Evaluation of the Equation Used in the July 2011 Forecast of FY 2011 Emergency Suppression Expenditures of the Department of the Interior.

Diagnostic	
Root Mean Squared Error (Real 2004 \$)	51,707,352
Bias (Real 2004 \$)	-7,818,899
Bias (%)	-2.96
Mean Absolute Percent Error (%)	18.72
Direction of Change Prediction (% Correct)	81.25

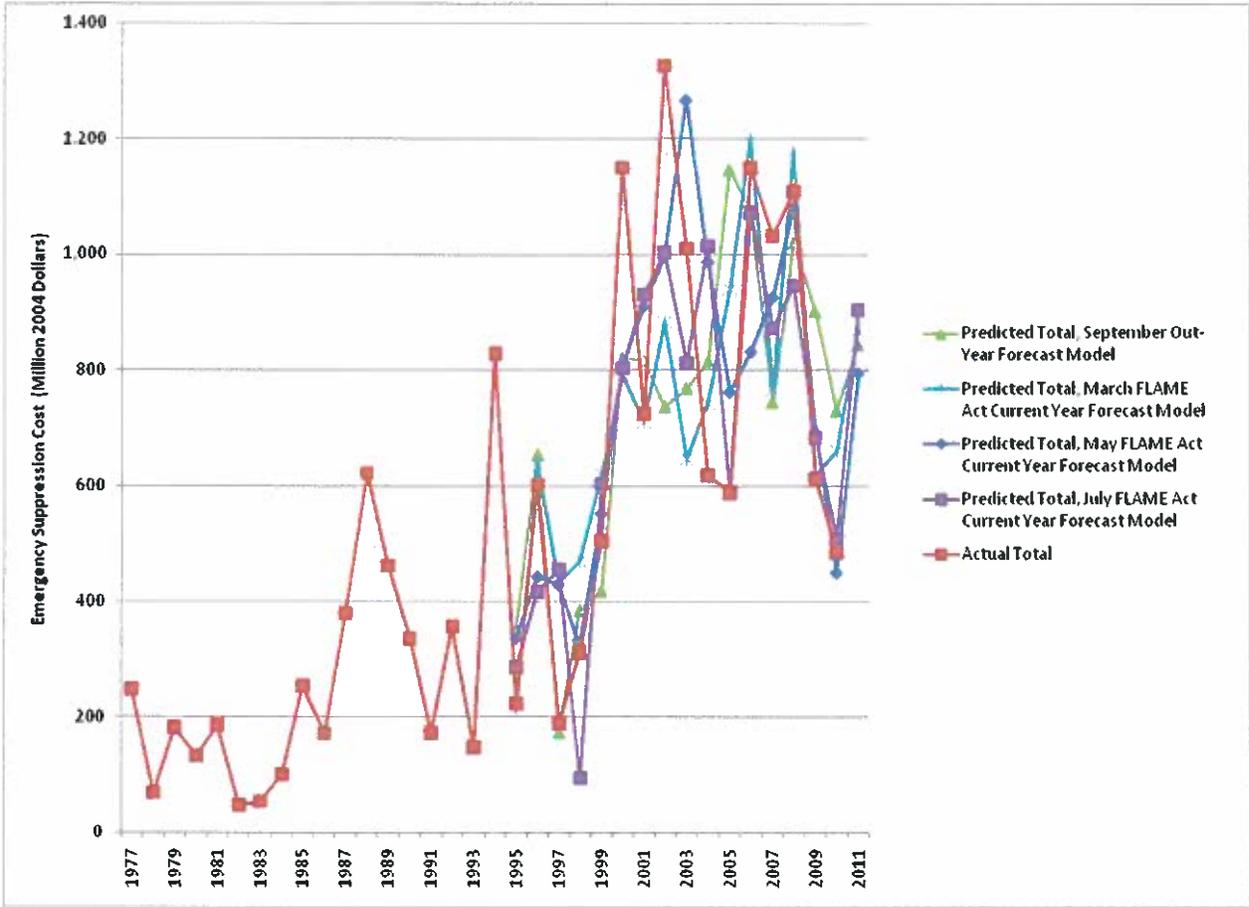


Figure A1. Actual USDA Forest Service emergency suppression expenditures (1977-2010) and the forecasts of these expenditures (1995-2011) using the July 2011, May 2011, March 2011, and September 2010 forecast models. All forecasts of those expenditures for each fiscal year are sums across the point estimates of each region or region aggregate's costs generated with a jackknife procedure. (Note: Values are in constant 2004 dollars and exclude Cost Pool and National Aviation Asset charges.)

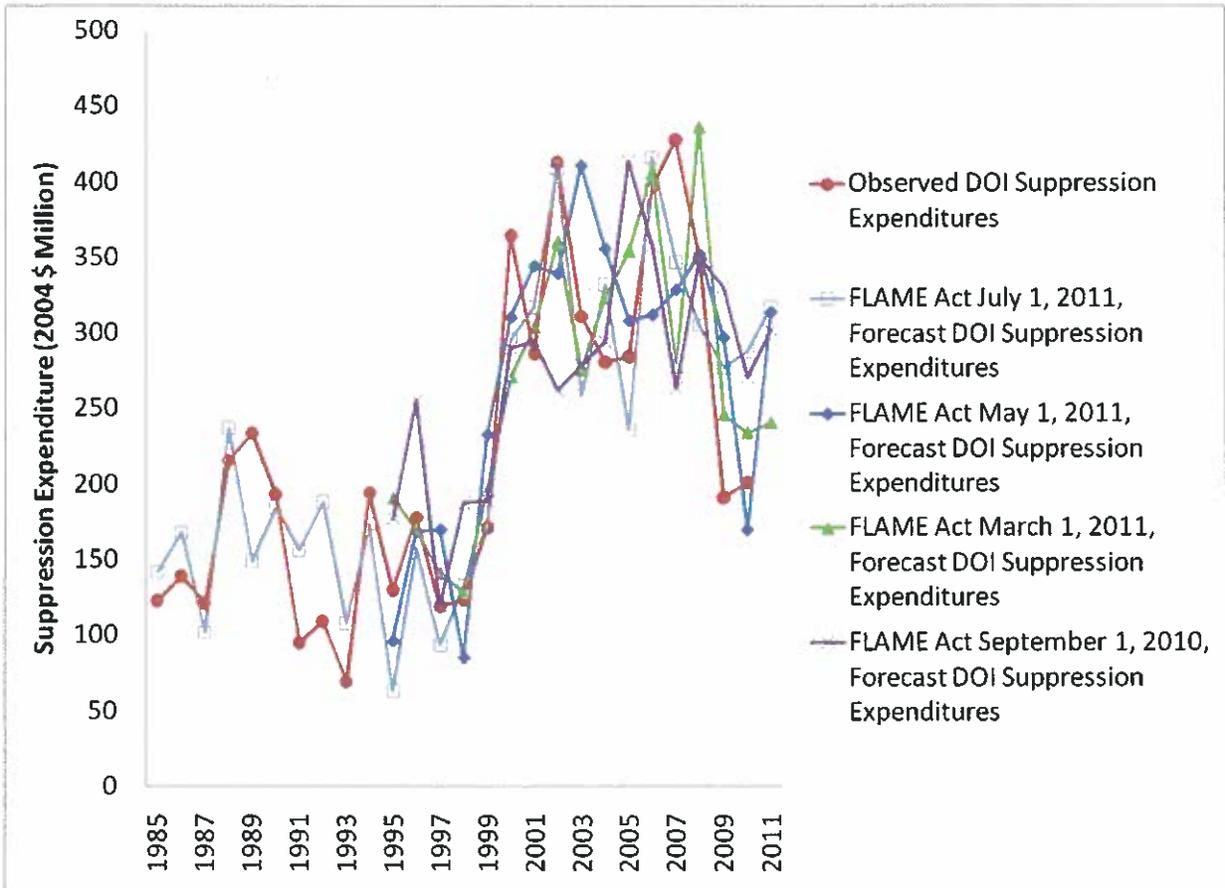


Figure A2. Actual Department of the Interior emergency suppression expenditures (1985-2010) and the forecasts of these expenditures (1995-2011) using the July 2011, May 2011, March 2011, and September 2010 forecast models. All forecasts of those expenditures for each fiscal year are the point estimates generated with a jackknife procedure. (Note: Values are in constant 2004 dollars.)