

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

*July 2013 Forecasts for Fiscal Year 2013*

*Supporting Documentation*

**Report Date: June 10, 2013**

**Executive Summary**

The U.S. Department of Agriculture (USDA) Forest Service is forecast to spend, with 90 percent confidence, between \$938 million and \$1.83 billion in Fiscal Year (FY) 2013, with a median forecast of \$1.36 billion. Excluding cost pools, the FY 2013 Forest Service median forecast is in the upper tercile of costs since both 1995 and 1977. The Forest Service July forecast is higher than the May 2013 median (\$1.191 billion) and the March 2013 median (\$985 million) but lower than the September 2012 median (\$1.584 billion). The agencies of the Department of the Interior (DOI) are forecast to spend, with 90 percent confidence, between \$316 million and \$574 million, with a median forecast of \$445 million. The DOI expenditures are expected to be in the upper tercile of costs since 1985. The July DOI forecast is higher than the May 2013 median (\$329 million), the March 2013 median (\$281 million) and the September 2012 median (\$393 million) for FY2013. The National Oceanic and Atmospheric Administration's (NOAA) Long Lead precipitation and temperature forecasts indicate below median precipitation for all regions except Region 8 and above normal temperatures for all regions except Regions 1 and 5.

**Overview**

With the passage of the FLAME Act in 2009, both the Forest Service 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 fiscal year required when the next fiscal year budget is not approved by Congress and the President by that date. Scientists at the USDA Forest Service Southern Research Station provide these forecasts to both the Forest Service and the DOI.

**Modeling**

*Modeling Framework for the July 2013 Forecast of FY 2013 Forest Service Expenditures*

To meet the statutory requirements of the FLAME Act, the Forest Service developed statistical models based on peer reviewed research<sup>1,2</sup>. These models have been developed for several forecast horizons and are generally specified as a system of equations. Each of the ten equations

---

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

<sup>2</sup> 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.

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. These equations are estimated using ordinary least squares regression (OLS).

This report is the fourth forecast issued for FY 2013, and, like the May FY 2013 report, it includes some methodological changes compared to the reports issued in September of 2012 and March of 2013. The current approach is to forecast costs by individual Forest Service Region, while in past efforts equations were sometimes specified for aggregations of two regions. The expenditures made by the National Interagency Fire Center, Washington Office, and research stations continue to be modeled as an aggregate, labeled in this Report as “RFS.” The statistical relationships that were identified with extensive research effort relate spending in the coming fiscal year to spending to May by region, lagged measures of drought (Palmer indices), ocean temperatures (the Niño-3 sea surface temperature anomaly), and ocean pressure indices (Pacific-North American teleconnection pattern, Arctic Oscillation index, and the Pacific Decadal Oscillation index).

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 0.31 (Region 4) to 0.81 (RFS). The exception is Region 10, Alaska, which has very few fires on Forest Service land hence very little expenditure on suppression. Durbin-Watson statistics, designed to detect serial autocorrelation in the residuals of estimated equations, were all within the acceptable (insignificant) or inconclusive range.

Forecasts were made using the equation estimates shown in Table A1 for region-level costs that excluded the contributions to the wildland fire suppression cost pool, which are held constant in the simulation and then added back to the total costs. Data for modeling were annual fiscal year totals of expenditures, and they ranged from 1995 to 2012, 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. When generating a forecast distribution (see Figure 1), we randomly sampled from equation error distributions in ways that accounted for the uncertainties in the forecast. These Monte Carlo forecasts, which are repeated 50,000 times, do not produce a precise estimate. Rather, they generate a distribution of estimates. This distribution is summarized in many ways: a forecast density distribution, a table reporting a median forecast and the lower and upper bounds of likely observed costs<sup>3</sup>, and a table of not-to-exceed costs by probability levels. We also describe where the median forecast value for each region 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 in a graph (Figure A1) and a table (A2). The graph shows how well the July 2013 FLAME Act 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. Table A2 shows that the root mean squared error of the model used in this July 2013 forecast of FY 2013 expenditures, when applied to the

---

<sup>3</sup> It is possible for lower bounds of the distribution to be less than zero noted by (-) in the table.

1996-2012 period, was \$303 million and that it had a positive bias, tending to over-forecast by about \$23 million (2 percent). (This bias was not used to adjust the July 2013 forecast for FY 2013.) The model had a Mean Absolute Percent Error of about 29 percent, meaning that the typical forecast averaged 29 percent above or below expenditures actually incurred during the 1996-2012 period. Finally, this model correctly predicted the direction of change in suppression expenditures by the Forest Service 87 percent of the time – that is, all years except 2008 and 2010. The predicted direction of change for FY 2013 compared to FY 2012 is negative (downward) when considered from the median forecast excluding the cost pool (Figure 1).

### *Modeling Framework for the July 2013 Forecast of FY 2013 Department of the Interior Expenditures*

The forecast model for the DOI is based on departmental total expenditure data – i.e., aggregated across all agencies and geographic regions. The July 2013 FLAME Act Model covered department wide expenditures for fiscal years 1985-2012.<sup>4</sup> We modeled aggregate DOI expenditures using a parsimonious model specification involving two April Palmer H-indices, a one-year lag of DOI expenditures, and time.

The DOI suppression expenditure forecast equation is reported in Table A3. It included the Palmer H-index for Forest Service Region 3 April (t), Regions 8 Palmer H-index values for April (t), lagged expenditures, time, and an intercept. The estimated equation explained 74 percent of the variation ( $R^2 = 0.74$ ) in annual DOI suppression expenditures over the historical time period, 1986-2012. The Durbin H-statistic indicated no evidence ( $p=0.88$ ) of residual autocorrelation in the model estimation errors.

Model fitness for the July FLAME Act Forecast Model for DOI is reported in Appendix Table A4. As in the case of the Forest Service July FLAME Act Forecast Model, the DOI July FLAME Act Forecast Model was evaluated by making jackknife forecasts of DOI expenditures. This July forecast model had a root mean squared error of about \$85 million when calculated over 1995-2012, and \$77 million when calculated over 1986-2012. The model had a bias of positive \$2.4 million (1 percent) calculated over 1995-2012 and negative \$785 thousand (-0.28 percent) calculated over 1986-2012 (and these historical biases were not used to adjust the 2013 forecast). The model had a Mean Absolute Percent Error of about 24 percent for the 1995-2012 period and 25 percent for the 1985-2012 period. It correctly predicted the direction of change in suppression expenditure for the agency from one year to the next about 78 percent of years 1995-2012 and 85 percent of years 1986-2012.

## **Results**

### *USDA Forest Service*

The FY 2013 suppression expenditures are forecast to range, with 80 percent confidence, between \$1.04 billion and \$1.71 billion. The median forecast is \$1.36 billion. These costs include \$45 million in estimated cost pool contributions, which are held constant in the Monte

---

<sup>4</sup> Although geographical and agency disaggregated data are available for recent years (since the early 2000's), there are insufficient data for modeling by geographic region or agency within the Department.

Carlo simulation that generated the median and confidence limits, but then added to the forecast total (Table 1). The forecast probability density is shown in Figure 1 and the not-to-exceed levels at a range of probabilities are reported in Table 2. As Table 2 shows, this model states that there is a 1 percent chance that Forest Service suppression expenditures, including the cost pool, will fall below \$676 million. In contrast, there is a 70 percent chance that these expenditures will fall below \$1.447 billion.

An analysis of historical real dollar expenditures in suppression contains information about the likely financial magnitude of spending for FY 2013 (Table 3), by Forest Service region and in total. An examination of this table reveals that, when compared to expenditures since 1995, regions 1, 2, 5, 6, 9, RFS, and the total for the Forest Service are forecast to be in the upper tercile in 2013, while regions 4, 8, and 10 are expected to have expenditures in the middle tercile. Region 3 is the exception in that it is forecast to have expenditures in the lower tercile. When compared with spending since 1977, costs are forecast to be in the upper tercile for all regions except regions 3, 8, and 10 which are forecast to be in the middle tercile.

*Department of the Interior*

The FY 2013 suppression expenditures for the DOI are forecast to range, with 80 percent confidence, from \$345 million to \$546 million, with a median forecast of \$445 million. The 90 percent confidence band spans \$316 million to \$574 million, while a 95 percent band spans \$291 million to \$599 million (Table 4). As in the Forest Service forecast, uncertainty surrounding the DOI forecast for FY 2013 is illustrated with a the probability density graphic (Figure 2) developed with 50,000 Monte Carlo random forecasts. The median forecast expenditure from the Monte Carlo simulation for DOI is higher in real dollar terms compared to the observed expenditures since 1985.

**Contact Information for this Report**

<b>Karen L. Abt,</b> Research Economist	<b>Charlotte Ham,</b> Postdoctoral Economist	<b>Jeffrey P. Prestemon,</b> Research Forester
Forestry Sciences Laboratory, SRS USDA Forest Service PO Box 12254 Research Triangle Park, NC 27709 kabt@fs.fed.us Tel: (919) 549-4094 Fax: (919) 549-4047	North Carolina State University SRS USDA Forest Service 240 West Prospect Fort Collins, CO 80526 charlotteham@fs.fed.us Tel: (970) 498-2558 Cell: (970) 692-3781	Forestry Sciences Laboratory, SRS USDA Forest Service PO Box 12254 Research Triangle Park, NC 27709 jprestemon@fs.fed.us Tel: (919) 549-4033 Fax: (919) 549-4047

**Table 1. July 2013 FLAME Act Forecasts of Fiscal Year 2013 Suppression Expenditures of the USDA Forest Service, by Region and in Total, Current (FY 2013) Dollars**

<i>Millions of 2013 Dollars</i>	R 1	R 2	R 3	R 4	R 5	R 6	R 8	R 9	R 10	RFS	Total*
Median	95	130	48	88	417	215	34	22	1	237	1,358
80 Percent Confidence Lower Limit	7	85	4	32	320	126	1	11	0	162	1,037
80 Percent Confidence Upper Limit	231	174	126	175	568	303	68	32	6	312	1,711
90 Percent Confidence Lower Limit	7	66	4	20	299	88	1	8	0	130	938
90 Percent Confidence Upper Limit	290	193	157	208	626	341	77	35	11	344	1,826
95 Percent Confidence Lower Limit	7	46	4	16	282	50	1	5	0	98	841
95 Percent Confidence Upper Limit	349	213	186	240	683	379	86	38	17	376	1,933

\* Note: This table includes the Fiscal Year 2013 contributions to the wildland fire suppression cost pool, expected to be \$45 million, which are added to the agency-wide total.

**Table 2. July 2013 FLAME Act Forecasts of Fiscal Year 2013 Suppression Expenditures of the USDA Forest Service, Probability of Falling Below Specified Amount, Current (FY 2013) Dollars**

Probability (Percent)	R 1	R 2	R 3	R 4	R 5	R 6	R 8	R 9	R 10	RFS	Total*
1	7	21	4	16	264	5	1	2	0	55	676
5	7	66	4	20	299	88	1	8	0	130	893
10	7	85	4	32	320	126	1	11	0	162	993
20	17	104	12	49	349	165	12	15	0	195	1,106
30	51	115	25	62	372	187	20	17	0	213	1,184
40	76	123	36	75	394	203	27	20	0	227	1,251
50	95	130	48	88	417	215	34	22	1	237	1,313
60	114	136	60	102	441	227	41	24	1	248	1,377
70	138	144	75	118	470	243	48	26	2	261	1,447
80	172	155	95	140	508	265	56	29	3	280	1,537
90	231	174	126	175	568	303	68	32	6	312	1,666
95	290	193	157	208	626	341	77	35	11	344	1,782
99	426	238	225	283	758	430	95	41	27	419	2,021

\* Note: This column of totals includes the Fiscal Year 2013 contributions to the wildland fire suppression cost pool, expected to be \$45 million.

**Table 3. July 2013 FLAME Act Forecasts of Fiscal Year 2013 Suppression Expenditures of the USDA Forest Service, by Tercile\***

Region	1995-2012	1977-2012
R 1	Upper	Upper
R 2	Upper	Upper
R 3	Lower	Middle
R 4	Middle	Upper
R 5	Upper	Upper
R 6	Upper	Upper
R 8	Middle	Middle
R 9	Upper	Upper
R 10	Middle	Middle
RFS	Upper	Upper
Total	Upper	Upper

\* Note: Historical wildland fire suppression cost pool expenditures are assumed to be zero in all year expenditure totals used in these rankings. Comparisons across years are in real (2004) dollars.

**Table 4. July 2013 FLAME Act Forecasts of Fiscal Year 2013 Suppression Expenditures of the Department of the Interior, Current (FY 2013) Dollars**

	(Millions of 2013\$)
Median	445
80% Confidence Lower Limit	345
80% Confidence Upper Limit	546
90% Confidence Lower Limit	316
90% Confidence Upper Limit	574
95% Confidence Lower Limit	291
95% Confidence Upper Limit	599

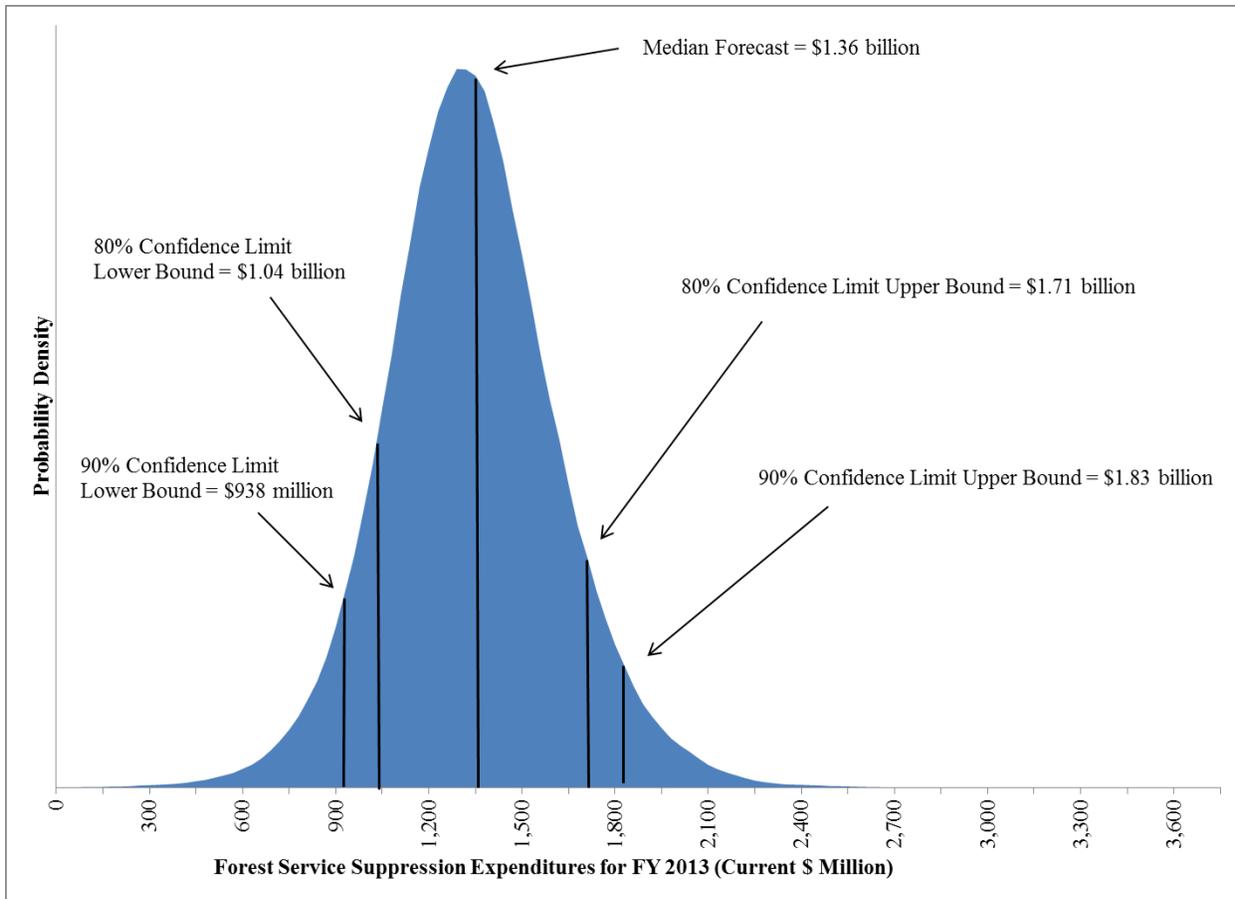


Figure 1. USDA Forest Service suppression expenditure forecast probability density, Fiscal Year 2013, July 2013 FLAME Act Forecast Model. (Note: Fiscal Year 2013 wildland fire suppression cost pool expenditures are included at their expected level of \$45 million in this probability density display.)

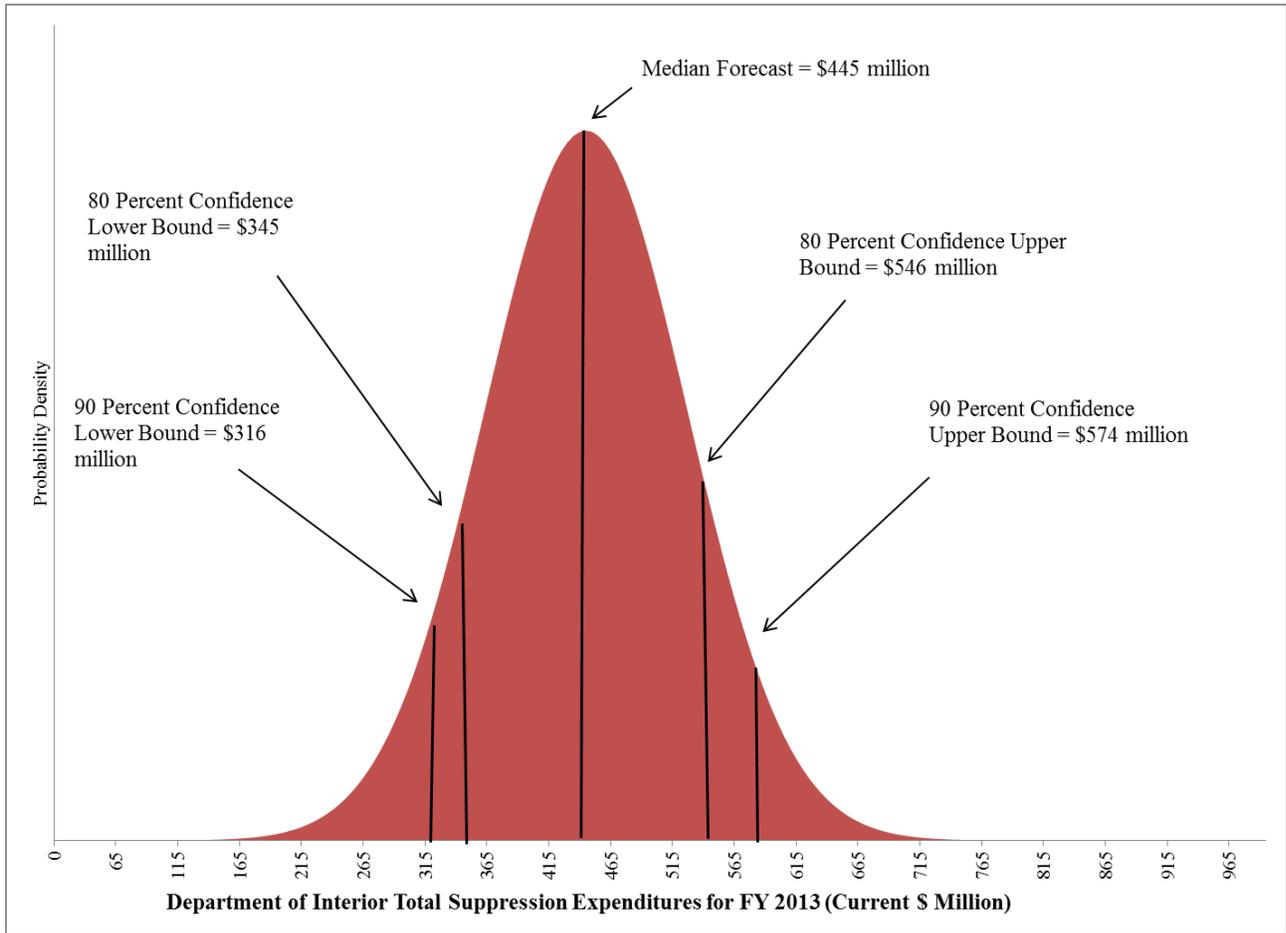


Figure 2. Department of the Interior suppression expenditure forecast probability density, Fiscal Year 2013, July 2013 FLAME Act Forecast Model.

**Appendix: Model Estimates and Forecast Evaluation Statistics**

**Table A1. Ordinary Least Squares Regression Equation Estimates Used in the July 2013 Forecast of FY 2013 Suppression Expenditures of the USDA Forest Service. Note: The Dependent Variable in All Cases is the Indicated Region Annual Real Dollar Expenditures**

<b>Dependent Variable</b>	<b>Independent Variable</b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t-Statistic</b>	<b>Prob.</b>	<b>R2</b>	<b>Durbin Watson</b>
Region 1	Constant	71,405,225	20,869,724	3.4215	0.0008	0.44	2.27
	AO May	75,768,308	29,172,638	2.5972	0.0105		
	PDO Feb	41,044,105	21,269,958	1.9297	0.0559		
Region 2	Constant	12,719,470	12,346,359	1.0302	0.3049	0.60	2.03
	PDSI R2 M-index Apr	-9,291,247	4,087,210	-2.2732	0.0247		
	R2 Costs to May	9	5	1.8015	0.0740		
Region 3	Constant	22,993,387	16,237,486	1.4161	0.1592	0.64	0.95
	R3 Costs to May	5	1	4.7886	0.0000		
Region 4	Constant	77,307,118	11,541,133	6.6984	0.0000	0.31	1.48
	PDSI R4 X-index Apr	-24,079,665	9,993,981	-2.4094	0.0174		
Region 5	Constant	212,732,589	32,380,769	6.5697	0.0000	0.41	2.03
	PDSI R5 Southern S-index Apr	-31,471,710	10,454,817	-3.0103	0.0032		
Region 6	Constant	89,446,198	18,620,497	4.8036	0.0000	0.44	1.88
	PDSI Westwide April	-27,695,962	8,643,598	-3.2042	0.0017		
Region 8	Constant	-12,005,196	17,417,829	-0.6892	0.4919	0.43	1.93
	PDSI R8 Minimum H-index Apr	-13,839,098	4,627,544	-2.9906	0.0033		
	Nino-3 SSTA Apr	21,392,822	10,449,201	2.0473	0.0427		
Region 9	Constant	-1,533,101	5,479,319	-0.2798	0.7801	0.39	1.74
	PDSI R9 Minimum Mar H-index	-4,364,652	1,667,075	-2.6181	0.0099		
	PNA Oct-Feb	-9,623,174	5,107,479	-1.8841	0.0619		

<b>Dependent Variable</b>	<b>Independent Variable</b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t-Statistic</b>	<b>Prob.</b>	<b>R2</b>	<b>Durbin Watson</b>
Region 10	Constant	2,039,791	739,407	2.7587	0.0067	0.00	0.99
Region 13	Constant	-13,489,628,024	5,443,764,235	-2.4780	0.0145	0.81	1.38
	Time	6,787,073	2,715,595	2.4993	0.0137		
	PDO Dec (t-1)	-67,100,028	12,163,824	-5.5164	0.0000		

**Table A2. Jackknife Forecast Evaluation of the Ordinary Least Squares Regression Model Used in the July 2013 Forecast of FY 2013 Suppression Expenditures of the USDA Forest Service, Calculated Over Data from 1995-2012**

	July CY Model
Root Mean Squared Error, 1995-2012 (Real 2013 \$)	302,803,366
Bias, 1995-2012, Predicted Minus Actual (Real 2013 \$)	23,175,274
Bias (percent)	2.29
Mean Absolute Percent Error, 1995-2012	29
Percent Correct Direction of Change, 1995-2012	87

**Table A3. Equation Estimate Used in the July 2013 Forecast of FY 2013 Suppression Expenditures of the Department of the Interior. Note: The Dependent Variable is the Department's Annual Real Dollar Expenditures**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Intercept	-7,450,550,392	2,803,082,560	-2.6580	0.0144
Expenditures, t-1	0.3539	0.1267	2.7925	0.0106
Palmer H-Index, Region 3, April	-10,186,552	4,758,247	-2.1408	0.0436
Palmer H-Index, Region 8, April	-22,883,168	6,398,180	-3.5765	0.0017
Time	3,804,386	1,406,304	2.7052	0.0129
Observations	27			
R-squared	0.74			
Equation Error	59,947,447			
Durbin-H Statistic	0.12	(p=0.88)		

**Table A4. Jackknife Forecast Evaluation of the Equation Used in the July 2013 Forecast of FY 2013 Suppression Expenditures of the Department of the Interior, Calculated over 1995-2012 and 1985-2012**

	1995-2012	1985-2012
Root Mean Squared Error, 1986-2012 (Real 2013 \$)	84,691,228	76,922,184
Bias, 1986-2012, Predicted Minus Actual (Real 2013 \$)	2,369,506	-785,272
Bias (Percent)	1	-0.28
Mean Absolute Percent Error, 1986-2012	24	25
Percent Correct Direction of Change, 1986-2012	78	85

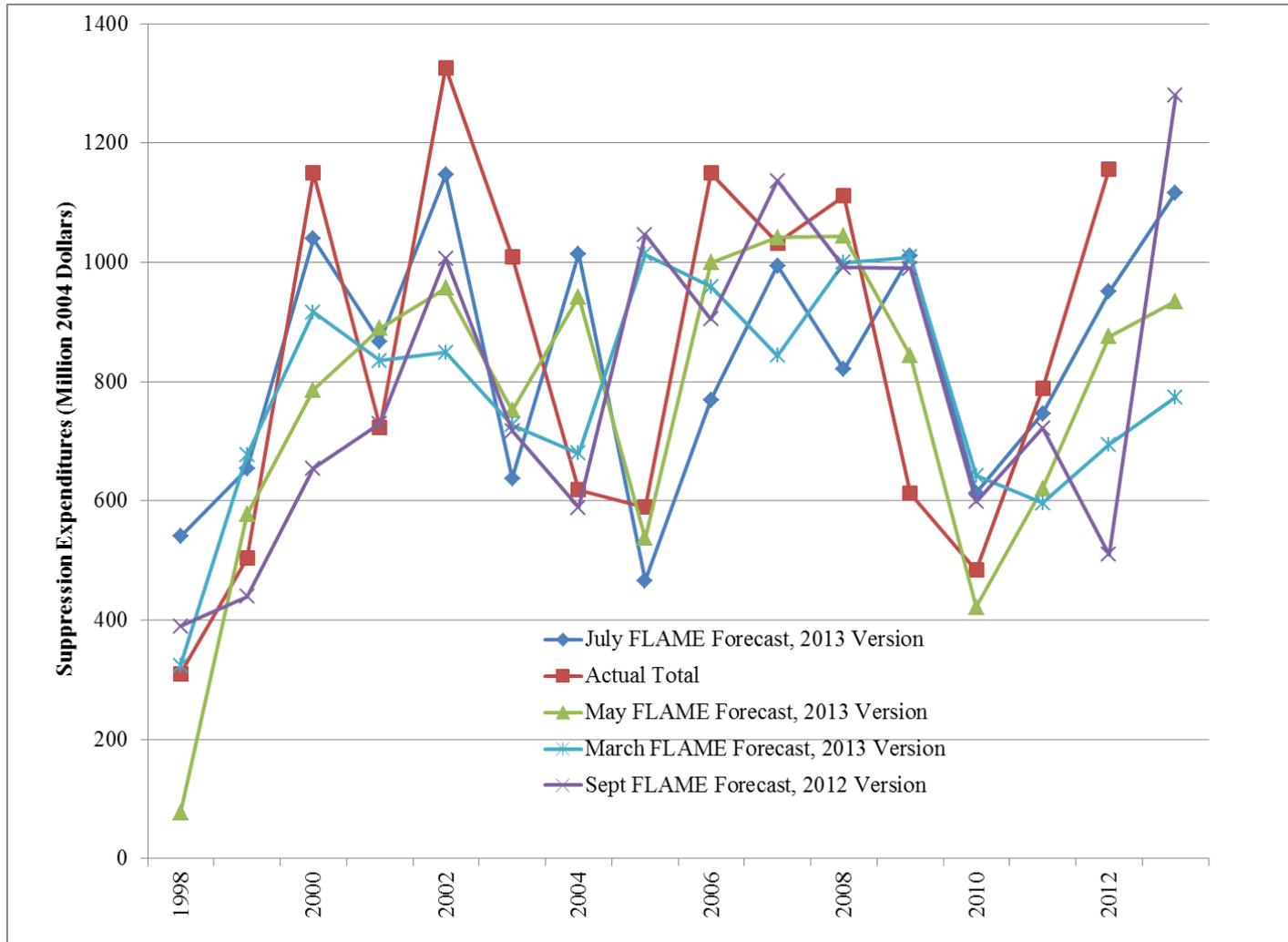


Figure A1. Observed historical USDA Forest Service suppression expenditures and the forecasts of these expenditures (1995-2013) using the July 2013 FLAME Act Forecast Model. All forecasts for each fiscal year are sums across the point estimates of each region's costs generated with a jackknife procedure. (Note: values are in constant 2004 dollars and exclude the wildland fire suppression cost pool expenditures.)

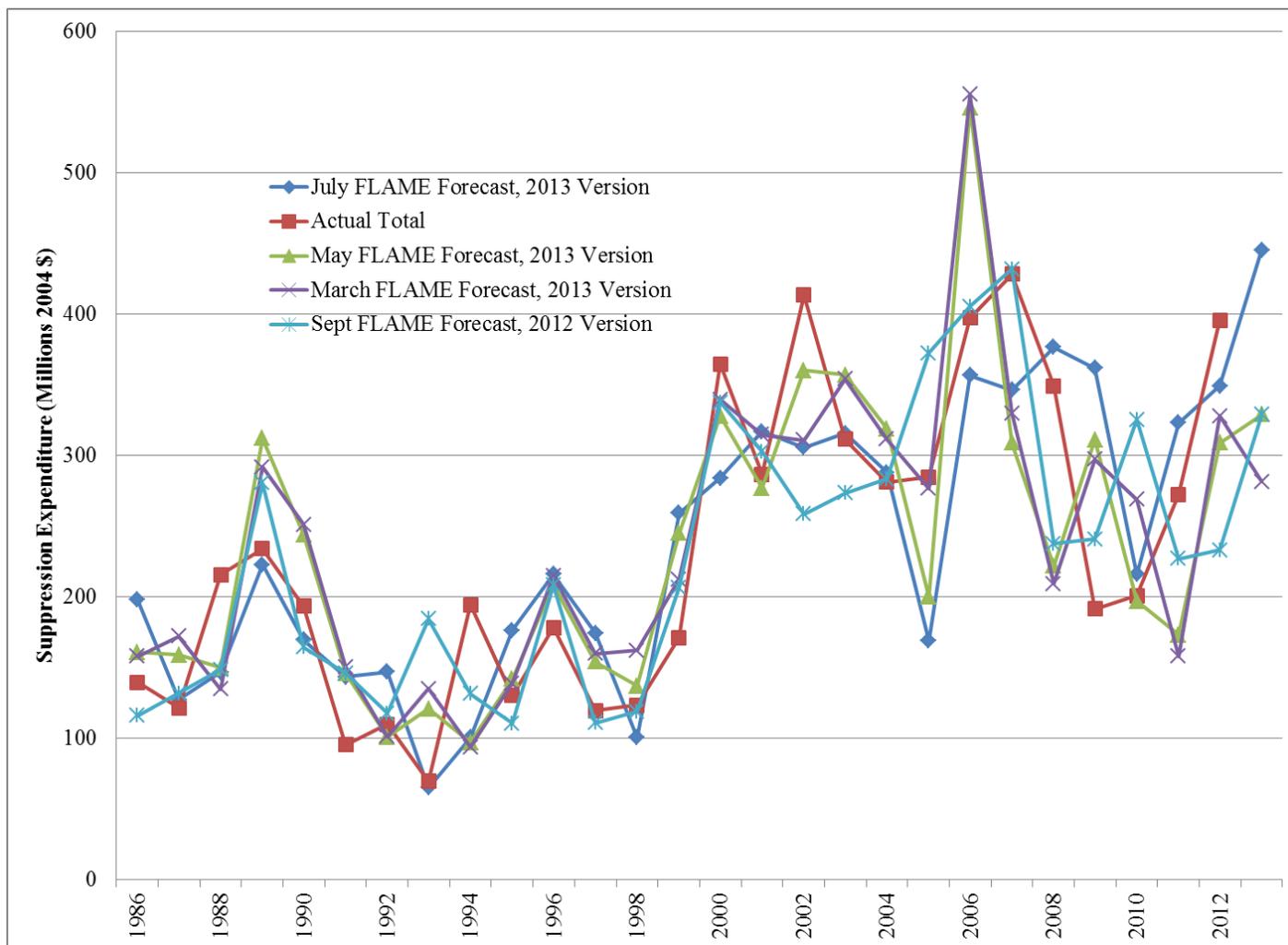


Figure A2. Observed historical Department of the Interior suppression expenditures (1985-2012) and the forecasts of these expenditures (1985-2013), using the July 2013 version of the July FLAME Act Forecast Model. All forecasts for each fiscal year are the point estimates generated with a jackknife procedure. (Note: values are in constant 2004 dollars)