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

May 2013 Forecasts for Fiscal Year 2013

Supporting Documentation

Report Date: April 18, 2013

Executive Summary

The U.S. Department of Agriculture (USDA) Forest Service is forecast to spend, with 90 percent confidence, between $814 million and $1.703 billion in Fiscal Year (FY) 2013, with a median forecast of $1.191 billion. Excluding cost pools, the FY 2013 Forest Service median forecast is in the middle tercile of costs since 1995 but the upper tercile of costs since 1977. The Forest Service May forecast is higher than the March 2013 median ($985 million) and lower than the September 2012 median ($1.584 billion). The agencies of the U.S. Department of the Interior (DOI) are forecast to spend, with 90 percent confidence, between $186 million and $471 million, with a median forecast of $329 million. The DOI expenditures are expected to be in the upper tercile of costs since 1985. The May DOI forecast is higher than the March 2013 median ($281 million) and slightly lower than the September 2012 median ($393 million) for FY 2013. The National Oceanic and Atmospheric Administration's Long Lead precipitation and temperature forecasts indicate a warm and dry summer for Regions 2, 3, 4, 5 and 8, and a cooler and wetter summer in Regions 1 and 6 transitioning to a warmer and drier late summer and fall. When the Pacific Decadal Oscillation is negative and the El Niño Southern Oscillation is neutral, as now, there is less certainty in the long-lead summer weather forecasts.

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 Forest Service Southern Research Station provide these forecasts to both the Forest Service and DOI.

Modeling

Modeling Framework for the May 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[1,2]. These models have been developed for several

[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.

forecast horizons and are generally specified as a system of equations. Each of the 10 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. These equations are estimated using ordinary least squares regression (OLS).

This report is the third forecast issued for FY 2013, and it includes some methodological changes compared to the previous two. 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, 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 (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 0.36 (Region 1) to 0.71 (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[3], 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 May 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 as well as forecasts produced by the September FLAME Act Forecast Model. Table A2 shows that the root mean squared error of the model

[3] It is possible for lower bounds of the distribution to be less than zero noted by (-) in the table.

used in this May 2013 forecast of FY 2013 expenditures, when applied to the 1996-2012 period, was $227 million and that it had a negative bias, tending to under-forecast by about $30 million (-4 percent). (This bias was not used to adjust the May 2013 forecast for FY 2013.) The model had a Mean Absolute Percent Error of about 38 percent, meaning that the typical forecast averaged 38 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 94 percent of the time – that is, all years except 1998. 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 May 2013 Forecast of FY 2013 Department of the Interior Expenditures

The forecast model for DOI is based on departmental total expenditure data – i.e., aggregated across all agencies and geographic regions. The May 2013 FLAME Act Model covered Department wide expenditures for fiscal years 1985-2012.[4] 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.

The DOI suppression expenditure forecast equation is reported in Table A3. It included the Palmer H-index for Forest Service Region 3 March (t), Regions 1 and 4 Palmer H-index values for June of the previous year (t-1), Region 1 Palmer H-index for the most recent December (i.e., December 2012 values are used to forecast FY 2013 costs), lagged expenditures, and an intercept. The estimated equation explained 76 percent of the variation ($R^2 = 0.76$) in annual DOI suppression expenditures over the historical time period, 1986-2012. The Durbin H-statistic indicated modest evidence ($p = 0.09$) of residual autocorrelation in the model estimation errors.

Model fitness for the May FLAME Act Forecast Model for DOI is reported in Appendix Table A4. As in the case of the Forest Service May FLAME Act Forecast Model, the DOI May FLAME Act Forecast Model was evaluated by making jackknife forecasts of DOI expenditures. This May forecast model had a root mean squared error of about $77 million when calculated over 1995-2012, and $71 million when calculated over 1986-2012. The model had a bias of negative $5.8 million (-2.14 percent) calculated over 1995-2012 and $470 thousand (0.20 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 23 percent for the 1995-2012 period and 27 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 74 percent of years 1986-2012.

[4] 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.

Results

USDA Forest Service

The FY 2013 suppression expenditures are forecast to range, with 80 percent confidence, between $891 million and $1.571 billion. The median forecast is $1.191 billion. These costs include $45 million in estimated cost pool contributions, which are held constant in the Monte 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 $673 million. In contrast, there is a 70 percent chance that these expenditures will fall below $1.335 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 2, 3, 6, 9, and RFS are forecast to be in the upper tercile in 2013, while regions 1, 5, 8, 10, and in total are expected to have expenditures in the middle tercile. Region 4 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 categories except regions 1, 4, 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 $217 million to $440 million, with a median forecast of $329 million. The 90 percent confidence band spans $186 million to $471 million, while a 95 percent band spans $159 million to $498 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 comparable in real dollar terms to the observed expenditures of the first decade of the 2000's.

Contact Information for this Report

Karen L. Abt, Research Economist	**Charlotte Ham**, Postdoctoral Economist	**Jeffrey P. Prestemon**, Research Forester
Forestry Sciences Laboratory 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 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, 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. May 2013 FLAME Act Forecasts of Fiscal Year 2013 Suppression Expenditures of the USDA Forest Service, by Region and in Total, Current (FY 2013) Dollars

Millions of 2013 Dollars	R 1	R 2	R 3	R 4	R 5	R 6	R 8	R 9	R 10	RFS	Total*
Median	38	36	172	35	247	214	46	20	1	258	1,191
80 Percent Confidence Lower Limit	-	7	122	-	106	150	23	13	-	167	891
80 Percent Confidence Upper Limit	209	114	249	110	470	315	69	32	14	349	1,571
90 Percent Confidence Lower Limit	-	5	111	-	75	135	20	12	-	127	814
90 Percent Confidence Upper Limit	282	147	279	119	554	354	72	35	35	388	1,703
95 Percent Confidence Lower Limit	-	3	103	-	50	124	19	12	-	88	748
95 Percent Confidence Upper Limit	356	181	308	124	638	392	74	37	83	427	1,835

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

Table 2. May 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	-	3	93	-	24	112	18	12	-	37	673
5	-	5	111	-	75	136	20	12	-	128	814
10	-	7	122	-	106	150	23	13	-	167	891
20	-	13	137	-	148	169	29	15	-	206	987
30	2	19	149	-	182	185	35	16	-	229	1,061
40	19	27	160	16	214	199	40	18	1	245	1,127
50	38	36	172	35	247	214	46	20	1	258	1,191
60	62	47	184	54	283	231	52	23	2	271	1,259
70	92	60	199	72	326	250	58	25	3	287	1,335
80	135	80	218	91	381	275	64	28	5	310	1,429
90	209	114	249	110	469	315	69	32	14	349	1,571
95	282	147	279	119	554	354	72	35	35	388	1,703
99	453	225	346	127	747	442	75	39	249	479	2,029

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

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

Region	1995-2012	1977-2012
R 1	Middle	Middle
R 2	Upper	Upper
R 3	Upper	Upper
R 4	Lower	Middle
R 5	Middle	Upper
R 6	Upper	Upper
R 8	Middle	Upper
R 9	Upper	Upper
R 10	Middle	Middle
RFS	Upper	Upper
Total	Middle	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. May 2013 FLAME Act Forecasts of Fiscal Year 2013 Suppression Expenditures of the Department of the Interior, Current (FY 2013) Dollars

	Millions of 2013 Dollars
Median	342
80 Percent Confidence Lower Limit	278
80 Percent Confidence Upper Limit	376
90 Percent Confidence Lower Limit	259
90 Percent Confidence Upper Limit	379
95 Percent Confidence Lower Limit	242
95 Percent Confidence Upper Limit	381

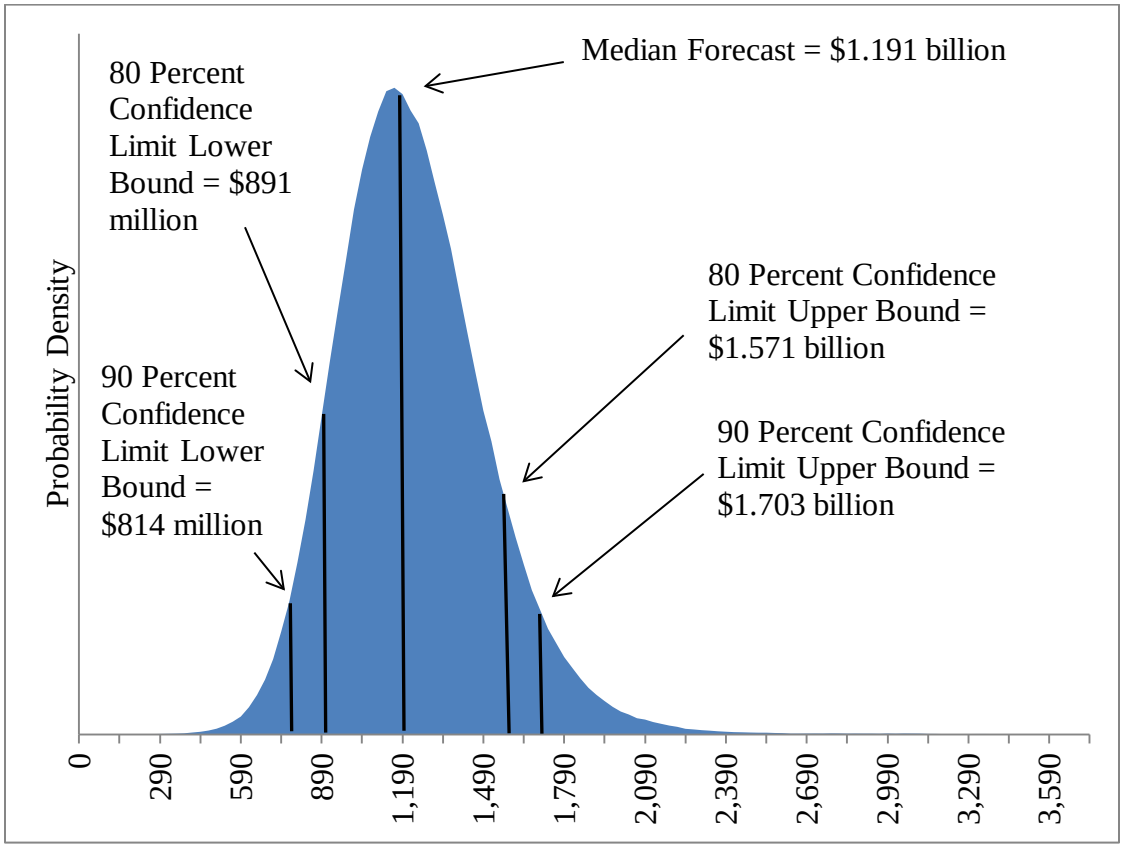

Figure 1. USDA Forest Service suppression expenditure forecast probability density, FY 2013, May 2013 FLAME Act Forecast Model. (Note: FY 2013 wildland fire suppression cost pool expenditures are included at their expected level of $45 million in this probability density display.)

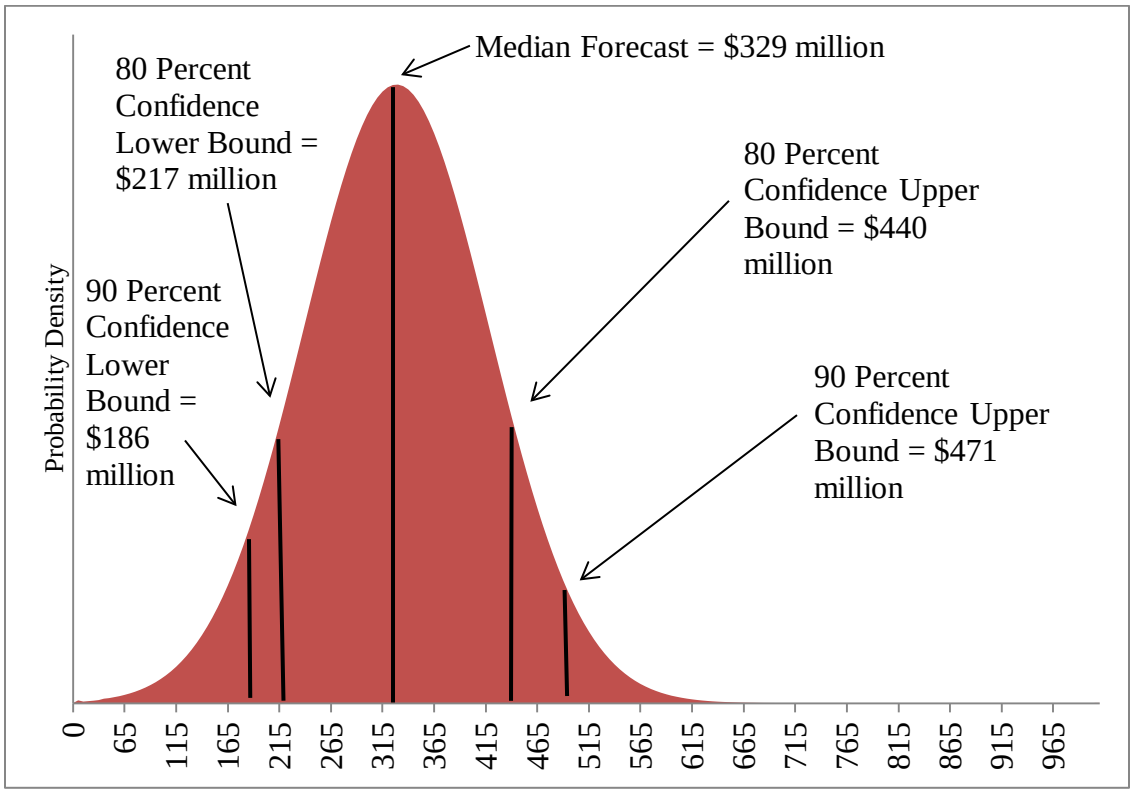

Figure 2. Department of the Interior suppression expenditure forecast probability density, FY 2013, May 2013 FLAME Act Forecast Model.

Appendix: Model Estimates and Forecast Evaluation Statistics

Table A1. Ordinary Least Squares Regression Equation Estimates Used in the May 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

Dependent Variable	Independent Variable	Coefficient	Std. Error	t-Statistic	Prob.	R2	Durbin Watson
Region 1	Constant	99,835,153	20,158,544	4.9525	0.0001	0.36	2.10
	PDO Dec (t-1)	51,751,252	20,264,207	2.5538	0.0116		
	AO Jan	33,506,520	15,742,776	2.1284	0.0349		
Region 2	Constant	-5,493,775	15,661,437	-0.3508	0.7262	0.37	2.22
	PDSI R2 H-index Feb Min	-8,639,623	3,197,870	-2.7017	0.0077		
	AO Feb	10,945,040	5,501,321	1.9895	0.0484		
Region 3	Constant	-8,086,827,002	4,295,559,845	-1.8826	0.0617	0.39	2.11
	PDSI R3 M-index Jan	-13,574,995	6,254,664	-2.1704	0.0315		
	Year	4,071,335	2,144,303	1.8987	0.0595		
Region 4	Constant	65,042,377	9,199,267	7.0704	0.0001	0.49	1.73
	PNA Dec (t-1)	35,054,045	9,989,408	3.5091	0.0006		
	Nino-3 SSTA Mar	-39,934,867	15,405,777	-2.5922	0.0105		
Region 5	Constant	470,228,476	97,225,301	4.8365	0.0001	0.65	1.25
	Nino-3 SSTA Oct-Feb	-39,639,051	20,976,877	-1.8897	0.0607		
	PDSI R5 Z-index Sep Min (t-1)	175,036,144	59,286,359	2.9524	0.0037		
	PDSI R5 South H-index Mar	-30,620,056	8,604,589	-3.5586	0.0005		
Region 6	Constant	87,027,318	15,373,495	5.6609	0.0001	0.45	2.11
	PDSI March Westwide	-25,644,780	7,085,722	-3.6192	0.0004		
Region 8	Constant	34,970,176	3,131,830	11.1661	0.0001	0.68	2.41
	PDSI R8 H-index Mar	-16,534,413	2,899,931	-5.7017	0.0001		
	Nino-3 SSTA March	27,077,974	7,014,035	3.8605	0.0002		

Dependent Variable	Independent Variable	Coefficient	Std. Error	t-Statistic	Prob.	R2	Durbin Watson
Region 9	Constant	-1,039,459	3,667,420	-0.2834	0.7772	0.45	1.74
	PDSI R9 H-index March Min	-4,238,092	1,213,347	-3.4929	0.0006		
	PNA Oct-Feb (t-1)	-9,203,313	4,422,847	-2.0809	0.0391		
Region 10	Constant	2,285,737	664,394	3.4403	0.0008	0.00	1.14
Rest of Forest Service	Constant	-18,522,873,912	4,777,817,263	-3.8768	0.0002	0.71	1.91
	Year	9,298,227	2,385,000	3.8986	0.0001		
	PDO Dec (t-1)	-51,268,848	12,917,950	-3.9688	0.0001		

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

	May FLAME Act Forecast Model
Root Mean Squared Error, 1995-2012 (Real 2004 Dollars)	226,944,107
Bias, 1995-2012, Predicted Minus Actual (Real 2004 Dollars)	-30,334,275
Bias (Percent)	-4.02
Mean Absolute Percent Error, 1995-2012	38
Percent Correct Direction of Change, 1995-2012	94

Table A3. Equation Estimate Used in the May 2013 Forecast of FY 2013 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	Std. Error	t-Statistic	Prob.
Intercept	9.9455	3.0366	3.2752	0.0036
Palmer H-Index, Region 3, March (t)	-0.0633	0.0281	-2.2560	0.0349
Palmer H-Index, Region 1, June (t-1)	-0.0663	0.0451	-1.4711	0.1561
Palmer H-Index, Region 4, June (t-1)	0.1458	0.0412	3.5406	0.0019
Palmer H-Index, Region 1, December (t-1)	-0.0948	0.0479	-1.9786	0.0611
Ln(Expenditures, t-1)	0.4795	0.1594	3.0091	0.0067
Observations	27			
R-squared	0.76			
Equation Error	0.27			
Durbin-H Statistic	-1.77	(p=0.09)		

Table A4. Jackknife Forecast Evaluation of the Equation Used in the May 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 2004 Dollars)	77,056,314	71,093,500
Bias, 1986-2012, Predicted Minus Actual (Real 2004 Dollars)	-5,817,274	470,957
Bias (Percent)	-2.14	0.20
Mean Absolute Percent Error, 1986-2012	23.20	27.33
Percent Correct Direction of Change, 1986-2012	77.78	74.07

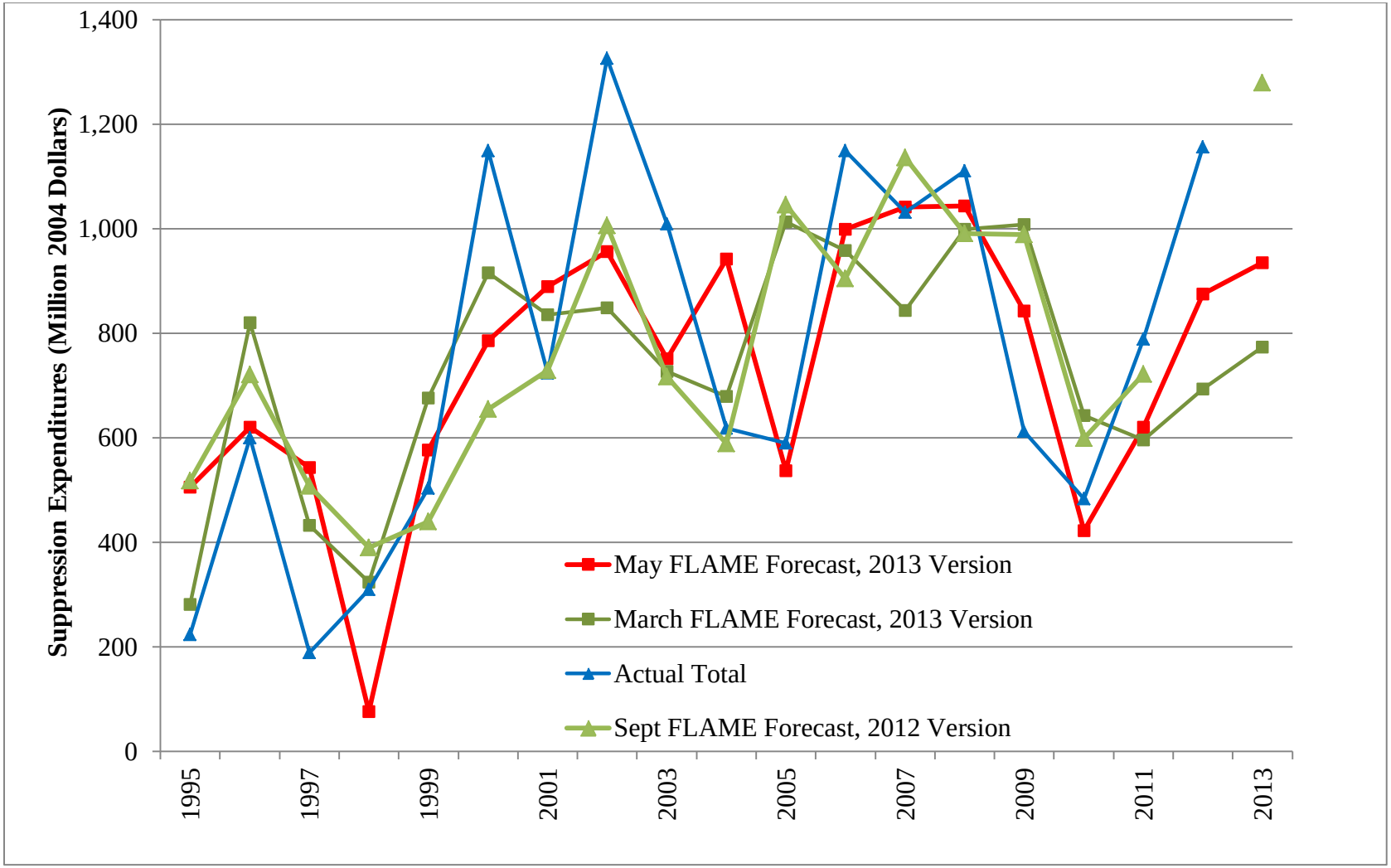

Figure A1. Observed historical USDA Forest Service suppression expenditures and the forecasts of these expenditures (1995-2013) using the May 2013 FLAME Act Forecast Model. All forecasts for each fiscal year are sums across the point estimates of each region's costs generated with a jackknife procedure.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

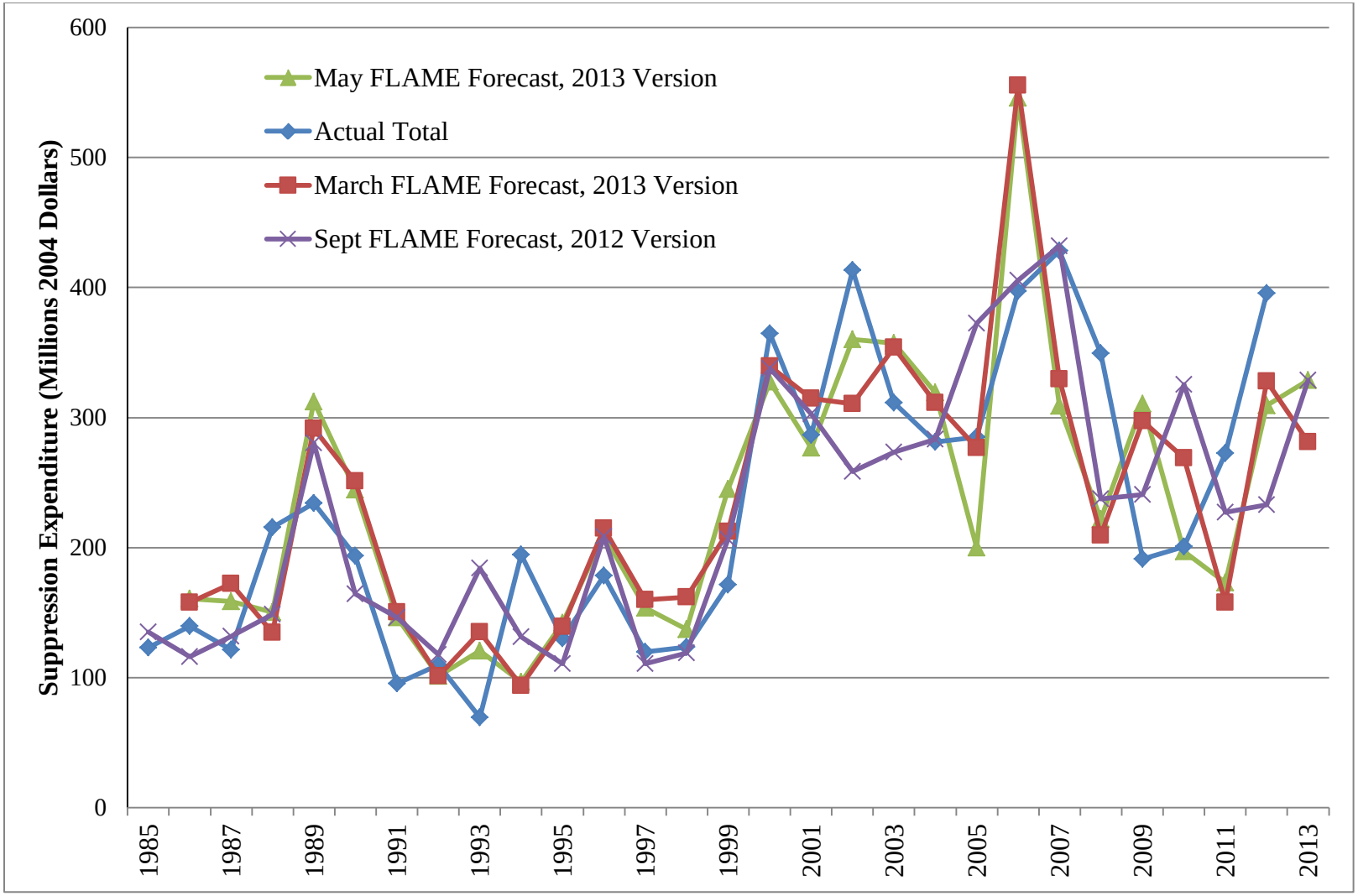

Figure A2. Observed historical Department of the Interior suppression expenditures (1985-2012) and the forecasts of these expenditures (1985-2013), using the May 2013 version of the May FLAME Act Forecast Model. All forecasts for each fiscal year are the point estimates generated with a jackknife procedure.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