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

July 2017 Forecasts for Fiscal Year 2017

Supporting Documentation

Report Date: June 16, 2017

Executive Summary

USDA Forest Service July FLAME forecast for FY 2017 in $2017 dollars[1]:

Median forecast	$1.560 billion
90% confidence range of forecast	$1.120 billion to $1.999 billion
Forecast tercile of historical expenditures since 1985	Upper
FY17 May FLAME Median Forecast	$1.568 billion
FY17 Outyear Median Forecast	$1.321 billion

The Forest Service forecasts are reported in Tables 1-2, Tables 5-6, and Figures 1 and 3.

The Department of the Interior July FLAME forecast for FY 2017 in $2017 dollars:

Median forecast	$393 million[2]
90% confidence range of forecast	$286 million to $500 million
Forecast tercile of historical expenditures since 1985	Upper
FY17 May FLAME Median Forecast	$395 million
FY17 Outyear Median Forecast	$427 million

The DOI forecasts are reported in Tables 3-4, Tables 7-8, and Figures 2 and 4.

Overview

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

[1] Including the estimated cost pool $101,442,000 for FY 2017.
[2] The DOI models for the July, May and March forecasts should be considered identical. The $2m difference in this July forecast compared to the March and May forecasts results from a slight change in the GDP deflator.

date. Scientists at the USDA Forest Service Southern Research Station provide these forecasts to both the Forest Service and the DOI.

We tested models that included the most recent Palmer drought indices, the El Niño-Southern Oscillation (ENSO) anomalies, Kunkel growing season length and a time variable instead of, and in addition to, the shift variable. Based on our error and bias measures (as in Table 6 for FS, Table 8 for DOI), none of these models performed better than the selected model.

Forecast

USDA Forest Service

The median forecast is $1.560 billion, and the 80, 90 and 95 percent confidence bands around the median forecast are provided in 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. Uncertainty surrounding the Forest Service forecast for FY 2017 is shown by the probability density graphic (Figure 1) developed with 50,000 Monte Carlo random forecasts. The median forecast expenditure from the Monte Carlo simulation for the FS is in the upper tercile of expenditures in real dollar terms compared to the observed expenditures since 1995. All of the values, tables and figures noted here report the expenditures including the cost pool.

Department of the Interior

Table 3 shows the median FY 2017 suppression expenditure forecast for DOI ($393 million in 2017 dollars), as well as the 80, 90, and 95 percent confidence bands. As in the Forest Service forecast, uncertainty surrounding the DOI forecast for FY 2017 is illustrated with the probability density graphic (Figure 2) developed with 50,000 Monte Carlo random forecasts. The median forecast expenditure from the Monte Carlo simulation for the Department is in the upper tercile of expenditures in real dollar terms compared to the observed expenditures since 1985.

Modeling

To meet the statutory requirements of the FLAME Act, the Forest Service developed statistical models based on peer reviewed research[3,4]. This report is the third FLAME Act forecast issued for FY 2017.

Modeling Framework for the July 2017 Forecast of FY 2017 Forest Service Expenditures

The current approach forecasts expenditures by Forest Service regional aggregates for West (Regions 1-6), and East (Region 8 and Region 9) and the Rest of the Forest Service (RFS). This RFS category includes Region 10 (Alaska) because there are relatively few suppression expenditures in Region 10.

[3] Prestemon, J.P., K.L. Abt, and K. Gebert. 2008. Suppression cost forecasts in advance of wildfire seasons. Forest Science 54(4):381-396.

[4] 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.

The West statistical model relates expenditures in the coming fiscal year to the Palmer Modified Drought Index (PMDI) for May in the current FY of Region 3 and a shift variable to represent years from 2000 onward. The aggregate East Region model has lagged East expenditures and a shift variable to represent years from FY 2012 onward. The RFS equation includes a dummy variable for structural change starting in FY2011. Durbin-Watson statistics, designed to detect serial autocorrelation in the residuals of estimated equations, were all within acceptable or inconclusive ranges. Durbin-H statistics were calculated when there is a lagged variable in the model. For East Region, the Durbin-H statistic is -1.28, with p-value of 0.1, indicating no statistically significant residual autocorrelation.[5]

Equation estimates shown in Table 5 do not include the cost pool. Data for modeling were annual FY totals of suppression expenditures and ranged from 1995 to 2016, the only years for which consistent regional-level data could be assembled. To erase the effects of general price inflation, all expenditures were deflated to the value of a dollar in 2014 using the gross domestic product deflator from the President's budget[6,7]—that is, models were estimated and expenditures were forecast in "real" dollar terms. Forecasted values were then converted to expected FY 2017 dollars.

When generating a forecast distribution (see Figure 1), we randomly sampled from the equation error distribution to account for uncertainty in the forecast. This Monte Carlo forecast, which is repeated 50,000 times, does not produce a single forecast of fiscal year expenditures. Rather, it generates a distribution of expenditure predictions. This distribution is summarized as a forecast density distribution (Figure 1), a table reporting a median forecast and the lower and upper bounds of likely expenditures (Table 1), and a table of not-to-exceed expenditures by probability levels (Table 2). These figures and tables include the cost pool.

Model fitness is reported in Figure 3 and Table 6, which exclude the cost pool. The graph shows how well the July 2017 FLAME Act Forecast Model of FY 2017 forecasts out-of-sample using the leave-one-out cross validation method (produced by dropping one observation, estimating the model parameters, and predicting the left out year's value, and then repeating for all observations), compared with observed expenditures for the Forest Service.

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[5] The Eastwide forecast includes both Region 8 (Southern Region) and Region 9 (Eastern Region). As of May 2017, suppression expenditures in FMMI for FY17 ($144m) have exceeded the forecasted total for FY17 ($54m). Examining the historical Region 8 fires (1995-2016), the October-December 2016 area burned is 16 times the average for October-December, and 3 times the next highest October-December (2007). As the area burned is well outside the 90% error band for the historical data, we hypothesize that the expenditures will also fall outside the 90% confidence band for our forecast.

[6] Deflator source: https://obamawhitehouse.archives.gov/omb/budget/Historicals and Table 10.1—Gross Domestic Product and Deflators Used in the Historical Tables: 1940–2021 can be accessed from https://obamawhitehouse.archives.gov/sites/default/files/omb/budget/fy2017/assets/hist10z1.xls

[7] The Deflators has been changed slightly on the source listed as footnote 6.

Table 6 shows that the root mean squared error of the model used in this July 2017 forecast of FY 2017 expenditures, when applied to the 1998-2016 period, is $285 million ($10 million lower than FY 2017 May FLAME). The model has a positive bias of $6 million (0.55 percent), meaning that, on average, actual expenditures are higher than those predicted using the July 2017 FLAME model. This bias was not used to adjust the forecast for FY 2017.

The forecast for the total Forest Service had a Mean Absolute Percent Error of 22 percent, meaning that the typical forecast averaged 22 percent above or below expenditures actually incurred during the 1998-2016 period. Finally, this model correctly predicted the direction of change in year-over-year suppression expenditures by the Forest Service 79 percent of the time. The predicted FY 2017 median is expected to be lower than the FY 2016 actual expenditures (Figure 3).

Modeling Framework for the July 2017 Forecast of FY 2017 Department of the Interior Expenditures

The forecast model for the Department of the Interior (DOI) is based on departmental total expenditures each fiscal year—i.e., aggregated across all bureaus and geographic regions – and so involved estimation of a single equation. The July 2017 FLAME Act Model for FY 2017 covered department-wide expenditures for fiscal years 1985 to 2016. We modeled aggregate DOI expenditures using a parsimonious model specification, as a function of the Pacific-North American teleconnection pattern, the Niño-3 sea surface temperature anomaly, and a shift variable to represent years from 2000 onward. This is the same model as was used for the last two years for the March FLAME Act forecast and for the FY 2017 March and May FLAME forecasts, as well.

The DOI suppression expenditure forecast equation is reported in Table 7. The estimated equation explained 82 percent of the variation ($R^2 = 0.82$) in annual DOI suppression expenditures over the historical time period, fiscal years 1985-2016, and it had a Durbin-Watson test statistic of 1.88, which indicates no significant residual autocorrelation in the model estimation errors.

Model fitness measures of the July FLAME Act Forecast Model for FY 2017 for DOI are reported in Table 8. As in the case of the Forest Service July FLAME Act Forecast Model, the DOI July FLAME Act Forecast Model was evaluated using the cross-validation procedure for the years 1985 to 2016. This July forecast model had a root mean squared error of $64 million. The model had a bias of $0.3 million (0.1 percent), meaning that, on average, the actual DOI suppression expenditures have been higher than predictions, but this historical bias was not used to adjust the 2017 forecast. The model had a Mean Absolute Percent Error of 19 percent. It correctly predicted the direction of change in suppression expenditures for the agency from one year to the next in about 81 percent of years. The predicted FY 2017 median is expected to be higher than the FY 2016 actual expenditures (Figure 4).

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Table 1. July 2017 FLAME Act forecasts of FY 2017 suppression expenditures of the USDA Forest Service, in FY 2017 dollars.

	Total FS [a]	West	East	RFS
Median Estimate	1,560	846	54	559
80% Confidence Lower Limit	1,214	539	24	401
80% Confidence Upper Limit	1,901	1,148	84	714
90% Confidence Lower Limit	1,120	454	16	358
90% Confidence Upper Limit	1,999	1,235	92	756
95% Confidence Lower Limit	1,033	376	8	321
95% Confidence Upper Limit	2,082	1,313	100	794

[a] Including cost pool

Table 2. July 2017 FLAME Act forecasts of FY 2017 suppression expenditures of the USDA Forest Service, probability of falling below specified amount in FY 2017 dollars.

Probability (%) of Falling Below Indicated Dollar Amount	Total FS [a]	West	East	RFS
1	934	288	-1	277
5	1,120	454	16	358
10	1,214	539	24	401
20	1,334	646	34	454
30	1,419	721	42	493
40	1,490	786	48	527
50	1,560	846	54	559
60	1,626	906	60	589
70	1,701	971	66	622
80	1,784	1,046	74	660
90	1,901	1,148	84	714
95	1,999	1,235	92	756
99	2,182	1,400	108	839

[a] Including cost pool

Table 3. July 2017 FLAME Act forecasts of FY 2017 suppression expenditures of the Department of the Interior in FY 2017 dollars.

	DOI
Median Estimate	393
80% Confidence Lower Limit	310
80% Confidence Upper Limit	476
90% Confidence Lower Limit	286
90% Confidence Upper Limit	500
95% Confidence Lower Limit	265
95% Confidence Upper Limit	521

Table 4. July 2017 FLAME Act forecasts of FY 2017 suppression expenditures of the Department of the Interior, probability of falling below specified amount in FY 2017 dollars.

Probability (%) of Falling Below Indicated Dollar Amount	DOI
1	243
5	286
10	310
20	338
30	359
40	377
50	393
60	409
70	427
80	447
90	476
95	500
99	544

Table 5. Ordinary least squares regression equation estimates used in the July 2017 forecast of FY 2017 suppression expenditures of the USDA Forest Service.[a]

Dependent variable	Independent variables	Coefficient	Standard error	T value	P-value	R^2	Durbin Statistic
West Expenditures	Intercept	302,654,071	96,543,903	3.13	0.0055	0.62	1.45
	Region 3 May Palmer M-index	-52,659,374	19,375,034	-2.72	0.0137		
	Year 2000 on	457,590,898	112,842,773	4.06	0.0007		
East Expenditures	Intercept	1,058,263,425	9,953,847	10.58	<0.0001	0.68	-1.28 [b]
	East Expenditures (t-3)	-0.733208	0.142948	-5.13	0.0001		
	Year 2012on	-41,167,219	10,650,557	-3.87	0.0014		
RFS Expenditures	Intercept	162,902,624	26,475,149	6.15	<0.0001	0.72	2.2
	Year 2011 on	364,697,818	50,696,050	7.19	<0.0001		

[a] Not including cost pool.

[b] Durbin –H Statistics.

Table 6. Cross-validation of the ordinary least squares regression model used in the July 2017 Forecast of FY 2017 suppression expenditures of the USDA Forest Service, calculated over data from 1998-2016 in FY 2017 dollars.[a]

	Millions of 2017 dollars	Percent
Root mean square error	285	-
Bias	6	-
Percent bias	-	0.55
Mean absolute percent error	-	22
Percent correct direction of change	-	79

[a] Not including cost pool

Table 7. Ordinary least squares regression equation estimates used in the July 2017 forecast of FY 2017 suppression expenditures of the Department of the Interior.

Dependent variable	Independent variables	Coefficient	Standard error	T value	P-value	R^2	Durbin-Watson Statistics
Department of the Interior	Intercept	189,930,457	14,755,233	12.87	<0.0001	0.82	1.88
	Niño-3 SST Anomaly November (t-1)	-27,840,118	8,676,947	-3.21	0.0033		
	Year 2000 on	47,252,699	10,709,916	4.41	<0.0001		
	Pacific North American Oscillation December(t-1)	201,358,888	20,219,961	9.96	0.0001		

Table 8. Cross-validation of the equation used in the July 2017 Forecast of FY 2017 suppression expenditures of the Department of the Interior calculated over FY 1985-2016.

	Millions of 2017 dollars	Percent
Root mean square error	64	-
Bias	0.3	-
Percent bias	-	0.1
Mean absolute percent error	-	19
Percent correct direction of change	-	81

Table 9. July 2017 FLAME Act forecasts of FY 2017 suppression expenditures of the USDA Forest Service and the Department of the Interior, by tercile.[a]

	Tercile of Expenditures Expected, Since 1985
Forest Service	Upper
Department of the Interior	Upper

[a] USDA Forest Service comparison excludes cost pool

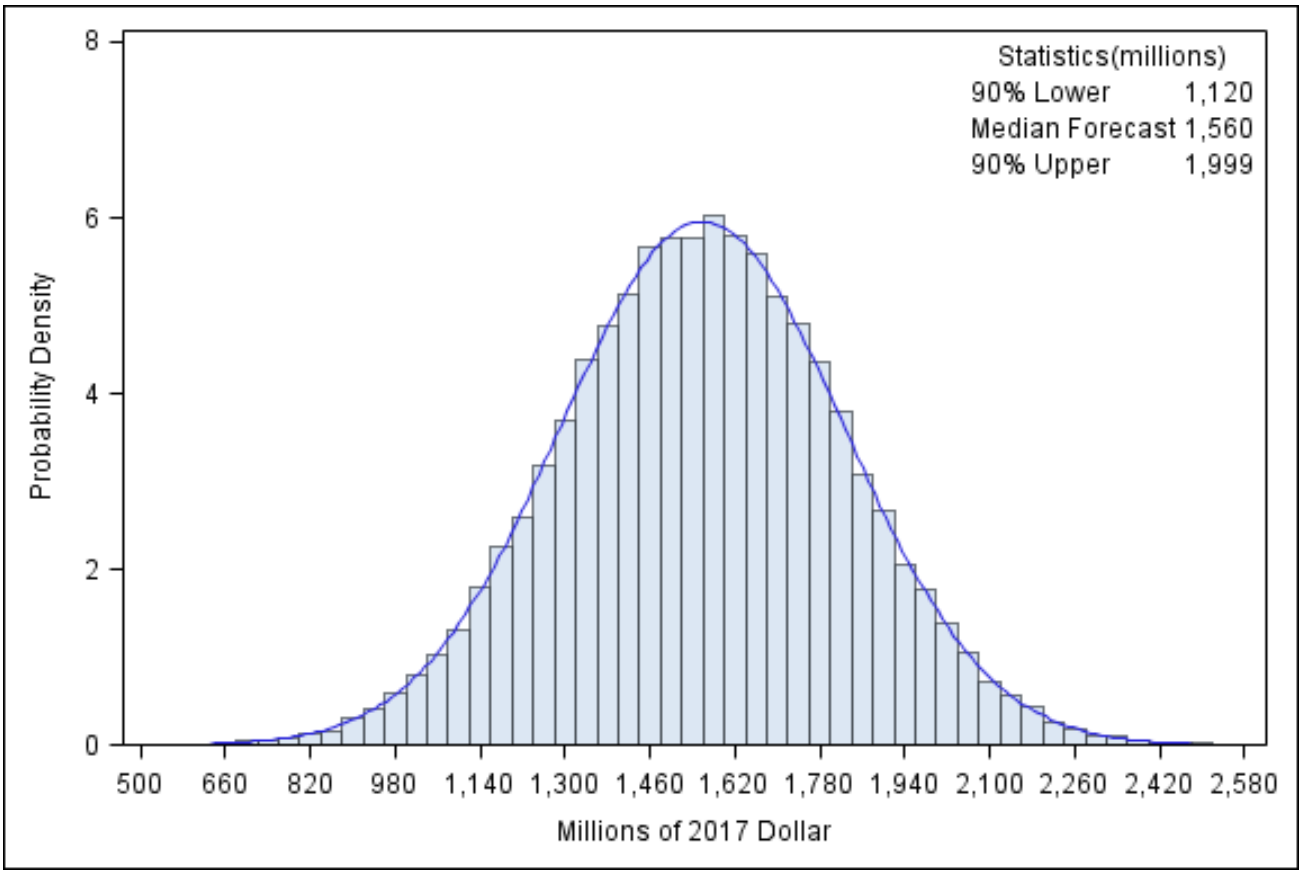

Figure 1. USDA Forest Service suppression expenditure forecast probability density, FY 2017, July 2017 FLAME Act Forecast Model, including the cost pool.

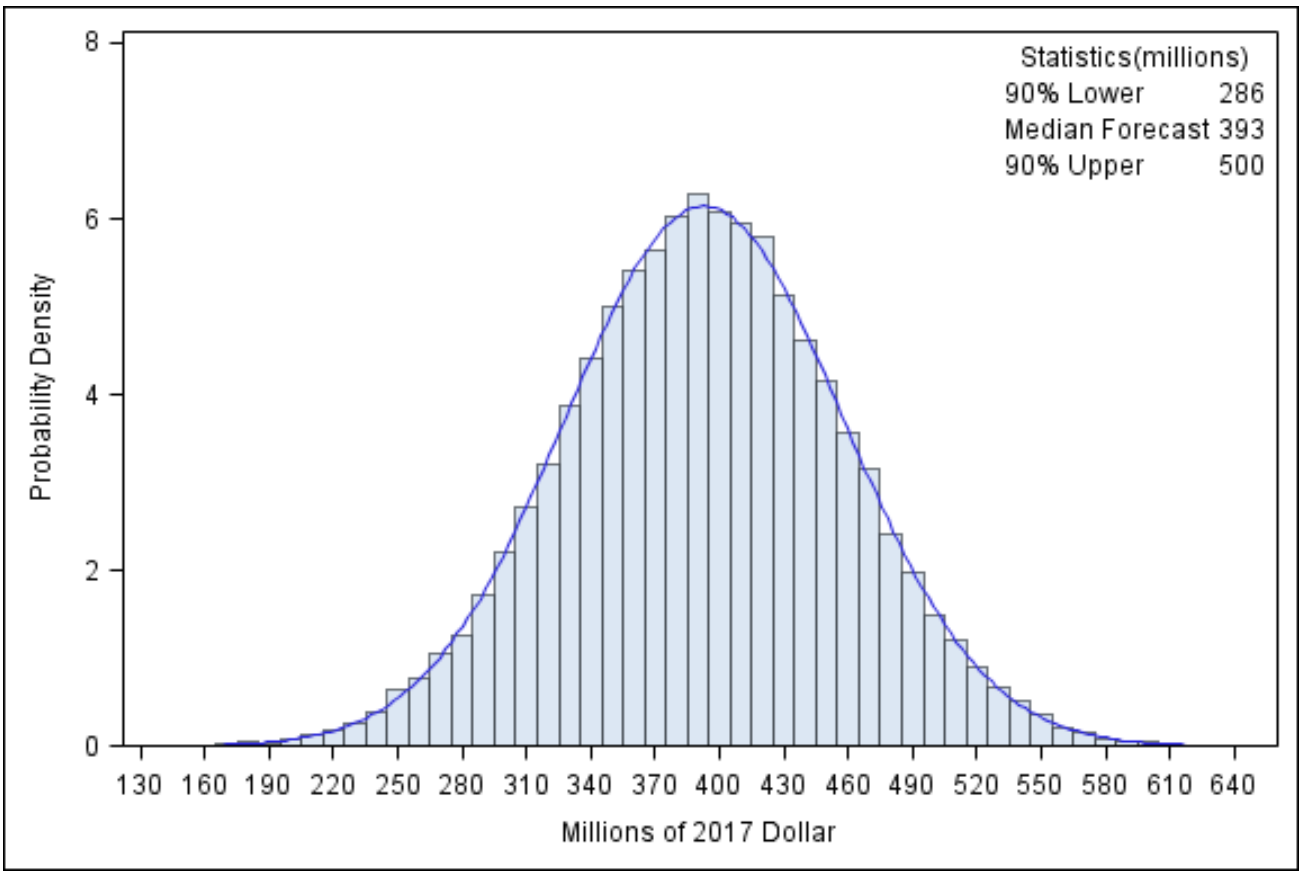

Figure 2. Department of the Interior suppression expenditure forecast probability density, FY 2017, July 2017 FLAME Act Forecast Model.

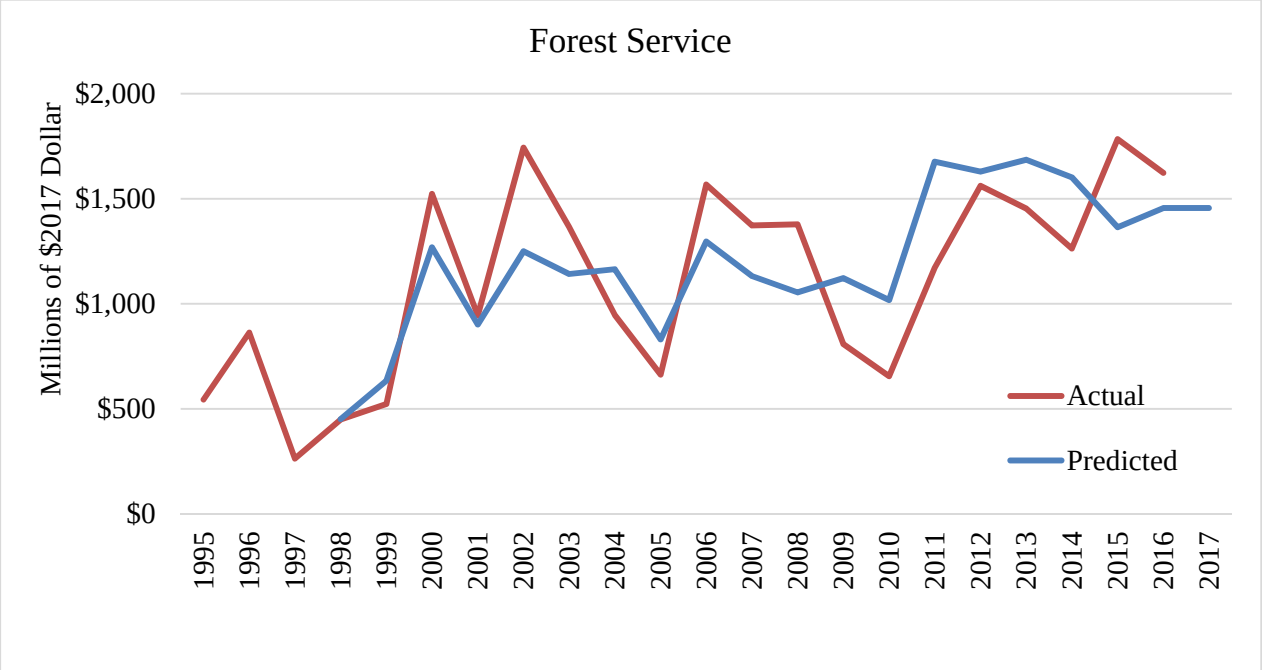

Figure 3. Observed historical USDA Forest Service suppression expenditures (1985-2016) and the forecasts of these expenditures (1998-2017) using the July 2017 FLAME Act forecast model. All forecasts for each FY are the point estimates generated with a cross-validation procedure. (Note: values shown in the figure are in constant 2017 dollars, and not including cost pool.)

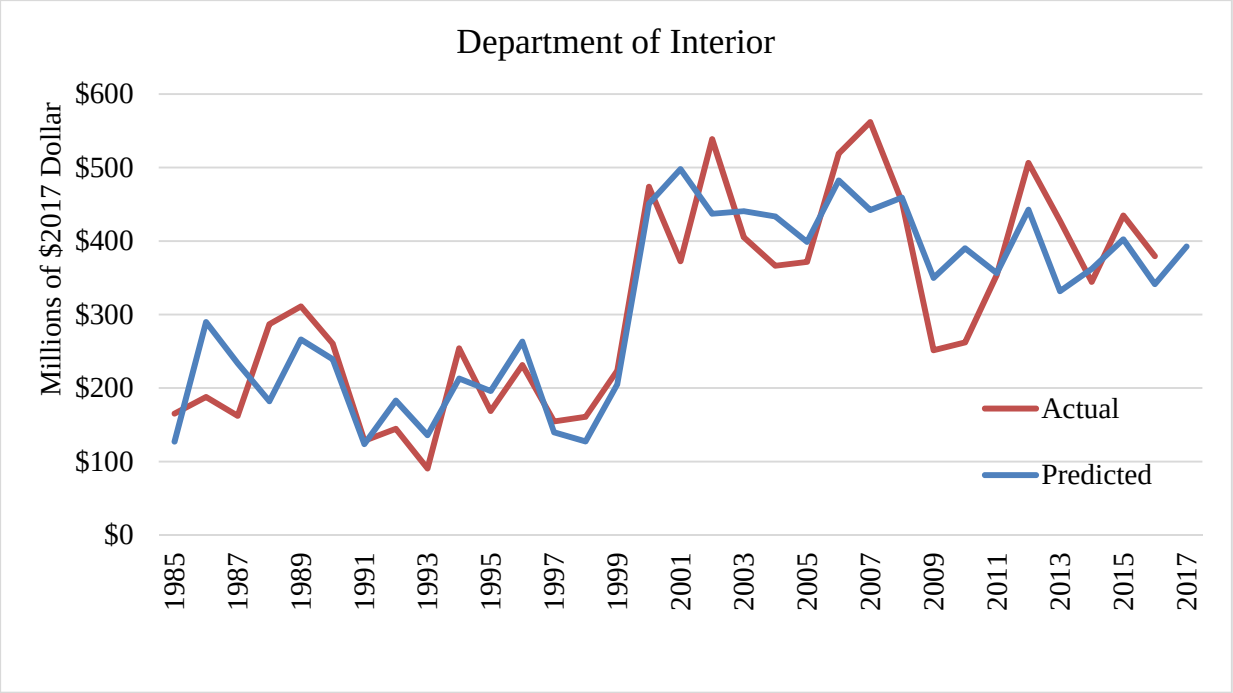

Figure 4. Observed historical Department of the Interior suppression expenditures (1985-2016) and the forecasts of these expenditures (1985-2017), using the July 2017 version of the July FLAME Act Forecast Model. All forecasts for each FY are the point estimates generated with a cross-validation procedure. (Note: values are in constant 2017 dollars)